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Counterintuitive Religious Ideas and Metaphoric Thinking: An Event-Related Brain Potential Study

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Abstract

It has been shown that counterintuitive ideas from mythological and religious texts are more acceptable than other (non-religious) world knowledge violations. In the present experiment we explored whether this relates to the way they are interpreted (literal vs. metaphorical). Participants were presented with verification questions that referred to either the literal or a metaphorical meaning of the sentence previously read (counterintuitive religious, counterintuitive non-religious and intuitive), in a block-wise design. Both behavioral and electrophysiological results converged. At variance to the literal interpretation of the sentences, the induced metaphorical interpretation specifically facilitated the integration (N400 amplitude decrease) of religious counterintuitions, whereas the semantic processing of non-religious counterintuitions was not affected by the interpretation mode. We suggest that religious ideas tend to operate like other instances of figurative language, such as metaphors, facilitating their acceptability despite their counterintuitive nature.

Keywords: Language comprehension; Religious concepts; Metaphorical meaning; N400; ERPs

1. Introduction

The way we interpret the world can be strongly biased by even the subtlest insinuation of a metaphor (Thibodeau & Boroditsky, 2011). Multiple interpretations of human life and natural facts have led to an infinite set of beliefs and experiences. Religion is a prominent example in this regard. Similarly to metaphorical thought, religious thought has

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been considered a natural tendency for the human mind (Boyer, 2008; McCauley, 2000). The present study explores the way we interpret religious ideas and how this relates to the processing of figurative meanings, in particular of metaphors, in order to shed light on the cognitive mechanisms behind the cultural success of religious thought.

1.1. The cognitive study of religious ideas

Different approaches have been proposed to encompass the cognitive and evolutionary mechanisms underlying religious thought. One of these approaches suggests that religious concepts are especially attractive for human cognition, that is, achieve a *cognitive optimum,* by being minimally counterintuitive (e.g., Boyer, 2001; Pyysiäinen, 2009). A minimally counterintuitive idea (MCI) may imply a *breach* of few (one or two) properties related to a certain ontological category such as persons, animals, plants, natural objects, or artifacts. For example, an invisible stone breaches the core knowledge that stones, as natural solid objects, are visible. It may also imply a *transfer* of one property from such an ontological category to another; for example, a crying statue of a saint (an artifact with a human psychological property). Aside from the violating property, all other properties of an MCI adhere to those of the corresponding category. Physical, biological, and psychological properties naturally apply to the five ontological categories depending on the domain of knowledge they activate. In the given example of the "invisible stone," stones, as natural objects, apply only to the physical domain including the spatiotemporal principles of cohesion, continuity, and contact within others (Spelke & Kinzler, 2007). Thus, any concept referring to a natural object (religious or not) that breaches those physical principles or transfers a biological or psychological property from between categories is considered as minimally counterintuitive (Boyer, 2001).

Generally, proponents of this hypothesis assume that minimal counterintuitiveness is critical for the success of religious concepts in cultural evolution. MCIs are more surprising and catchy than intuitive concepts by violating our expectations. Together with this attention-grabbing effect, religious concepts would be somewhat harder to process than intuitive concepts because they violate one or two natural expectations (Barrett, 2000; Boyer, 2003; Harmon-Vukic, Upal, & Sheehan, 2012). Minimally counterintuitive concepts are also distinguishable from other conceptual anomalies, such as maximally counterintuitive concepts, which violate several intuitive principles at once, for example, a speaking and flying table giving birth to a child, or *bizarre* concepts that respect core knowledge but are extremely odd, such as a 100 kg dachshund. Supporting evidence for the cognitive optimum of MCIs is provided by memory studies, which show retrieval advantages for MCIs over bizarre, maximally counterintuitive, and even intuitive concepts or ideas embedded in stories (Barrett & Nyhof, 2001; Boyer & Ramble, 2001; Johnson, Kelly, & Bishop, 2010).

Recently, we employed electrophysiological techniques to investigate the on-line semantic encoding of counterintuitive religious ideas (Fondevila et al., 2012). Specifically, we analyzed the N400 an event-related potential (ERP) assumed to reflect

semantic-lexical processing during language comprehension (Kutas & Federmeier, 2011 for a review). The N400 ERP component consists of a negative deflection typically peaking at around 400 ms after word onset and displaying a centroparietal scalp distribution. Its amplitude increases with the degree of incongruence of a word with the preceding text (Kutas & Hillyard, 1980, 1984), discourse context (e.g., Nieuwland & Van Berkum, 2006; Van Berkum, Hagoort, & Brown, 1999), or pragmatic knowledge (e.g., Hagoort, Hald, Bastiaansen, & Petersson, 2004; Hald, Steenbeek-Planting, & Hagoort, 2007). This N400 effect is thought to reflect the ease of mapping and integrating the meaning of incoming words into ongoing sentence or discourse contexts (e.g., Van Berkum et al., 1999; Van Berkum, 2009; alternative views are discussed in, for example, Kutas & Federmeier, 2011; Lau, Phillips, & Poeppel, 2008). In a previous study (Fondevila et al., 2012), we analyzed the N400 component elicited by the final, critical words in three types of sentences: religious counterintuitions, non-religious counterintuitions, and intuitive sentences. Religious statements such as *"From his mind emerged the moon"*[1] were extracted from religious and mythological texts of different non-Christian cultures, in the example given, Hinduism. For the counterintuitive non-religious condition, the critical word (*moon*) was replaced by "*house*" and for the intuitive sentence by "*idea*."

As expected, both counterintuitive conditions elicited an N400 effect relative to the intuitive critical words. However, the N400 was noticeably smaller for religious as compared to non-religious counterintuitions. This reduction in the N400 effect might indicate that semantic encoding is easier for religious counterintuitive ideas than non-religious anomalies, although both met the counterintuitive criteria (Barrett, 2008; Boyer, 2001), by being core knowledge violations. In other words, and according to brain activity (N400), counterintuitions used in religious texts and mythologies throughout the world resulted less counterintuitive (less anomalous) than other types of counterintuitions, in spite of structural similarities (both were core knowledge violations and thereafter rated as implausible). This led us to conclude that semantic violations used in religious texts might arguably be possible cases of MCIs and, hence, convey the advantages of MCIs (better memorability and cognitive adherence) already proved at the narrative and conceptual levels (Boyer & Ramble, 2001; Norenzayan, Atran, Faulkner, & Schaller, 2006).

The authors carried out several post hoc analyses to check whether differences in the semantic category of the critical words ("natural objects" vs. "artifacts" for religious and non-religious counterintuitions respectively) could account for the N400 decrease during the processing of religious counterintuitions in Fondevila et al. (2012). As this type of semantic analysis could not explain the results, the authors opted to explore how different modes of interpretation can affect the processing of religious and non-religious counterintuitions in the present study.

We proposed that some ideas from mythologies and religious texts appear *less* anomalous because of their additional properties besides counterintuitiveness. In fact, religious and non-religious world knowledge violations may differ in other aspects that involve the organization of our semantic knowledge and language comprehension. In particular, religious ideas may lend themselves more readily to metaphorical interpretation, facilitating

their semantic processing. With the present study we aim to explore the possible link between religious and figurative thinking. To this end, we assessed how the non-literality of interpretations built on the fly impacts the comprehension of religious counterintuitive ideas.

1.2. Links between religious ideas and metaphors

Modulations of the N400 component have been reported for a wide range of experimental conditions and its functional sensitivity to meaningful stimuli has been crucial for the distinction between literal and figurative language (for a review see Coulson, 2012). For instance, some studies have revealed N400 effects related to metaphor comprehension, resembling the findings of Fondevila et al. (2012) for religious ideas, that is, smaller metaphor-related N400 effects relative to those elicited by other semantic anomalies (e.g., De Grauwe, Swain, Holcomb, & Kuperberg, 2010; see also Lai, Curran, & Menn, 2009; Tartter, Gomes, Dubrovsky, Molholm, & Vala Stewart, 2002). This is a first hint that religious ideas and metaphorical expressions might share similar comprehension processes. For example, when reading "*From his mind emerged the moon*," we may imagine someone having a crazy idea rather than taking the meaning literally.

Further parallels seem to exist between religious counterintuitive ideas and metaphors. According to the *Contemporary Theory of Metaphors* (CTM; e.g., Lakoff & Turner, 1989; Lakoff, 1993), metaphors are part of our conceptual system; they are grounded in human experience and, thus, processed effortlessly. This implies that metaphoric interpretations occur *by default* constituting a natural way of thinking, as it has been also argued for religious thinking (Boyer, 2008; McCauley, 2000). In this line, psycholinguistic models have proposed that metaphorical meanings are directly accessed (Gibbs, 2002) and the system does not have to first process the literal meaning before turning to the figurative one (Grice, 1975; Searle, 1979).

Modern theories (e.g., CTM) define metaphors as concepts resulting from a mapping across two conceptual domains, that is, *source* and *target* domains (e.g., Fauconnier & Turner, 1994, 1998; Lakoff, 1993; Lakoff & Turner, 1989). For instance, in *Love is a journey*, some properties of "journey" (source) are applied to "love" (target). Consequently, metaphors are assumed to be a fixed set of ontological correspondences between two domains and to constitute a subset of our conceptual system, allowing for their effortless and quasi-automatic processing. Like many religious ideas, metaphors entail the *transfer* of properties between conceptual domains. Therefore, like religious counterintuitive ideas, inferences about metaphors are based on real-world knowledge pertaining to the conceptual domains that are linked in the metaphor. These similarities in property blending and deriving inferential richness suggest that both metaphors and religious counterintuitive ideas might be a natural disposition of the human mind.

A link between metaphors and religious ideas has been suggested, for instance, by Jäkel (2002) who analyzed some passages of the Bible testing whether the main claims of the CTM could be applied to linguistic expressions contained in this reli-

gious text. The author concludes that all tenets of the CTM are corroborated except for the *invariance principle,* stating that only those properties of the *source* domain, which are consistent with the *target* domain can be mapped. Hence, religious counterintuitive ideas and metaphors may share similar comprehension mechanisms. Additionally, and in line with Jäkel's conclusions, recent theoretical approaches from cognitive archeology claim that some religious ideas are grounded in our conceptual-metaphoric system (Culley, 2008).

The present study investigates whether religious counterintuitive ideas are more prone to be understood metaphorically than in their literal sense. This was achieved by inducing different interpretation modes, namely, metaphorical versus literal interpretations, for religious counterintuitive, non-religious counterintuitive, and intuitive ideas. Of special interest was how the different interpretation modes affect the acceptability of religious and non-religious counterintutions in terms of semantic processing, as reflected in modulations of the N400 ERP-effects.

To attain the different interpretation modes, two types of verification questions were posed—block-wise—after reading each sentence. In the literal block, participants were induced to adopt a literal interpretation of the sentences questions about literal meaning aspects of the sentences. Conversely, in the metaphorical block the questions referred to possible non-literal meaning of the sentences, aiming at inducing a figurative interpretation; see Table 1 for examples of these procedures.

If the reduction in the N400 for religious relative to non-religious counterintuitive sentences observed by Fondevila et al. (2012) reflects the readability of metaphoric meaning, differences in the N400 amplitude between religious and non-religious sentences should be larger in the metaphorical than in the literal mode. In other words, interpretation mode and type of counterintuitive sentence should interactively and specifically affect the semantic processing of religious counterintuitions. If, to the contrary, the "religious" N400-effect is not related to the readability of metaphoric meaning, it should be observed similarly regardless of the induced interpretation mode.

2. Methods

2.1. Participants

Twenty-four native Spanish university students (21 women, mean age: 26.08, *SD*: 6.58; range: 18–39 years) participated in the experiment. All had normal or corrected-to-normal vision and were right handed with a mean laterality quotient of 82.53% (Oldfield, 1971). We assessed their degree of religiosity with a questionnaire (Kapogiannis, Barbey, Su, Krueger, & Grafman, 2009), which ranges from 1 (full disagreement with religiosity statements) to 7 (full agreement). On average, they scored 2.28 (Range: 0.72–4.06). Participants gave their informed consent and received payment. The study was performed in accordance with the declaration of Helsinki and had been approved by the ethics committee of the Complutense University of Madrid.

Table 1
Examples of the three types of experimental sentences and their corresponding questions (with literal English translations in parentheses)

	Sentence Type	Literal Question	Metaphorical Question
Religious	Padres y madres fueron antes energías *(Fathers and mothers were before energies)*	¿Se transformaron o permanecieron igual? *(Did they change or remain the same?)*	¿Tenían mucha vitalidad o eran débiles? *(Had they a lot of vitality or were they weak?)*
	De su mente surgió la luna *(From his mind emerged the moon)*	¿Salió de su cabeza o entró en ella? *(Did it come out or in of his head?)*	¿Era creativo o improductivo? *(Was he creative or unproductive?)*
	Dio vida a tres al estornudar *(She gave life to three when she sneezed)*	¿Eran pares o impares? *(Were they even or odd?)*	¿Se despertaron o siguieron durmiendo? *(Did they get up or keep sleeping?)*
	Su pecho destilaba rocío *(His chest distilled dew)*	¿Era sólido o líquido? *(Was it liquid or solid?)*	¿Era madrugador o nocturno? *(Was he an early riser or a nocturnal person?)*
Non-religious	Padres y madres fueron antes teléfonos *(Fathers and mothers were before telephones)*	¿Se transformaron o permanecieron igual? *(Did they change or remain the same?)*	¿Hablaban mucho o poco? *(Did they speak a lot or nothing?)*
	De su mente surgió la casa *(From his mind emerged the house)*	¿Salió de su cabeza o entró en ella? *(Did it come out or in of his head?)*	¿Era creativo o improductivo? *(Was he creative or unproductive?)*
	Dio vida a tres al correr *(She gave life to three when she ran)*	¿Eran pares o impares? *(Were they even or odd?)*	¿Se despertaron o siguieron durmiendo? *(Did they get up or keep sleeping?)*
	Su pecho destilaba cemento *(His chest distilled cement)*	¿Era sólido o líquido? *(Was it liquid or solid?)*	¿Era un obrero o un oficinista? *(Was he a laborer or an office worker?)*
Intuitive	Padres y madres fueron antes hijos *(Fathers and mother were before sons)*	¿Se transformaron o permanecieron igual? *(Did they change or remain the same?)*	¿El ciclo de la vida continúa o se detiene? *(Does the circle of life continue or stop?)*
	De su mente surgió la idea *(From his mind emerged the idea)*	¿Salió de su cabeza o entró en ella? *(Did it come out or in of his head?)*	¿Era creativo o improductivo? *(Was he creative or unproductive?)*
	Dio vida a tres al parir *(She gave life to three when she gave birth)*	¿Eran pares o impares? *(Were they even or odd?)*	¿Se despertaron o siguieron durmiendo? *(Did they get up or keep sleeping?)*
	Su pecho destilaba sudor *(His chest distilled sweat)*	¿Era sólido o líquido? *(Was it liquid or solid?)*	¿Era trabajador o vago? *(Was he a hard worker or a lazy person?)*

2.2. Materials

2.2.1. Experimental sentences

Materials consisted of 120 sentence triplets; religious counterintuitive, non-religious counterintuitive, and intuitive sentences, differing only in the last word (i.e., critical word). Religious counterintuitive ideas were randomly collected from original texts of religions and mythologies other than Christian in order to avoid familiarity effects. Sentences describing non-empirical facts were selected to a similar proportion from each of the consulted texts of the following mythologies: Hindu, Mesoamerican, Japanese, Egyptian, Greco-Roman, African, Australian, Chinese, Polynesian, and Inuit (Allen, 1975; García Noblejas, 2007; Knappert, 1988; Ovid, 2004; Poignant, 1967; *Popol Vuh*, 2008a; Resenberg, 2001; *The Egyptian Book of the Dead*, 2008b; *The Kojiki*, 1982; *The Rig Veda*, 1981). We created non-religious counterintuitive and intuitive sentences by changing the critical words of the religious counterintuitions identified from these texts, described non-religious unacceptable facts and the plausible situations of the real world, respectively. Around 80% of both religious as well as non-religious counterintuitive sentences contained core knowledge violations according to the definition of counterintuitive concepts (Boyer, 2001). The remaining sentences described bizarre ideas, abstractions, substances, or events, prevailing in religious texts, but did not conform to the theoretical definition of minimally counterintuitive concepts (Barrett, 2008; Boyer, 2001). That is, they do not describe breaches or transfers of properties between ontological categories (persons, animals, plants, natural objects, or artefacts). Both religious and non-religious anomalous sentences were rated as implausible (or semantically unacceptable) within our previous work (Fondevila et al., 2012).

Critical words of the experimental sentences were matched across conditions for psycholinguistic variables known to affect the amplitude of the N400 component. The frequency of use according to the Spanish database from Sebastián, Cuetos, Martí, and Carreiras (2000) was not significantly different across sentence types (mean religious = 366.74, mean non-religious = 344.59, mean intuitive = 356.24; $F(2, 359) = 0.03$, $p > .1$) as was syllable length (mean religious = 2.69, mean non-religious = 2.55, mean intuitive = 2.65; $F(2, 359) = 1.33$, $p > .1$). Additional features such as the number of concrete words (religious = 25, non-religious = 18, intuitive = 25), of nouns (religious = 104, non-religious = 105, intuitive = 103), verbs (religious 13, non-religious 13, intuitive 13), and adjectives and adverbs (religious 3, non-religious 2, intuitive 4) were also matched for the critical words across sentence types. Sentence length ranged from 4 to 18 words. Moreover, we used 40 filler sentences (all intuitive) of 6 and 10 words (short and long fillers, respectively) to equate the number of semantically plausible and implausible sentences.

Experimental sentences were tested for cloze probability, familiarity, and metaphoricity in three different groups of volunteers who did not participate in the ERP experiment. Forty-six participants performed the cloze probability rating (percentage of participants who predicted the actual critical words when they were presented with the pool of experimental sentences containing a blank for every last word that had to be filled in). Cloze probability was 0 for both religious and non-religious counterintuitive sentences and

20.69% for the intuitive sentences. Familiarity was assessed by counterbalancing experimental sentences and fillers across eight lists, which were presented in pseudo-random order to a total of 160 participants (20 per list). In order to measure sentence familiarity, participants to rated how often they had heard/read the sentences before, using a five-point Likert-scale from 1 (*Never*) to 5 (*Many times).* Only intuitive sentences ($M = 3.37$, $SD = 0.19$) were significantly more familiar than both religious ($M = 1.54$, $SD = 0.18$) and non-religious ($M = 1.45$, $SD = 0.35$) sentences ($ts > -20$, $ps < .001$), which did not differ ($t(29) = 1.07$, $p = .29$).

Using the same procedure, an additional group of volunteers rated the metaphoricity of the experimental sentences on a Likert scales from 1 (*Not at all metaphorical*) to 5 (*Very metaphorical*). Religious counterintuitions ($M = 3.56$, $SD = 0.47$) were rated as more metaphorical than non-religious counterintuitive ($M = 3.26$, $SD = 0.49$) sentences ($t = 4.67$, $p < .001$), and both were rated as more metaphorical than the intuitive ($M = 1.79$, $SD = 0.56$) sentences ($ts > 21.63$, $ps < .001$).

2.2.2. Experimental questions

In order to induce either a metaphorical or a literal mode of interpretation, two types of comprehension questions were asked for each experimental sentence. One type of question referred to the pure literal meaning of the sentence while the other aimed at its potential metaphoric meaning. Most of the sentence triplets (i.e., religious, non-religious, and intuitive versions of a sentence) shared the same literal question (115 out of 120), referring to the explicit meaning of the common sentence context preceding the critical words. The remaining five triplets had different literal questions associated with each of the three types of sentences because their meanings were driven by the critical words, which were the objects of the transitive action described.

The potential metaphoric meaning to which our questions referred were driven by a word of the sentence context in 66 sentence triplets, for which the same metaphorical question could be used across all sentence variants of a given triplet. The remaining 64 sentence triplets were associated with different metaphorical questions across conditions, as their metaphorical interpretation was based on the critical words, which were either the subject or the object of the action described. Importantly, in all cases metaphorical questions related to possible non-literal meanings and were systematically created based on CTM (Lakoff, 1993). That is, roughly half of them entailed mappings between the semantic domain of the critical word and of the preceding sentence context. The remaining questions were created according to conventional metaphoric meanings of the critical words. There were always two possible answers for each question, but only one was correct according to the content of the sentence. Some examples are given in Table 1 (all experimental materials are available in Appendix S1).

2.3. Design

We created six sets of 160 sentences each, consisting of 40 religious and 40 non-religious counterintuitive sentences, and 40 intuitive sentences. Additionally, 40 filler

sentences (all intuitive) were added to each set. None of the sentences was repeated or presented in different versions within the same set. For each set, half of the sentences were associated with a literal question (literal block: 60 experimental sentences and 20 fillers), and the other half with a metaphorical question (metaphorical block).

Each participant performed a literal and a metaphorical block whose order was counterbalanced across participants. The blocks started with a few practice trials, which did not include any of the experimental sentences or questions.

2.4. Procedure

Participants were seated in a comfortable chair in a shielded room and were instructed to carefully read every sentence for comprehension. Each sentence was presented one word at a time for 300 ms each and at a SOA (stimulus-onset asynchrony) of 600 ms. Words of the experimental sentences subtended visual angles between 0.7° and 1.3° in height and between 1.1° and 6° in width. They were presented white-on-black on an LCD screen and controlled by Presentation® software. One second after critical word offset a comprehension question was presented for 4 s, together with the two possible answers located on the left and right side of the screen. The position of the correct answer was randomized individually for each participant.

The task required subjects to press the button corresponding to the location of the correct answer. Participants used the index and middle finger to respond, and the use of left or right hand was counterbalanced across participants. After the response, an ITI (interstimulus interval) of 300 ms preceded the next trial. In order to minimize motor and ocular artefacts, participants were asked to avoid movements and blinks as much as possible while reading the experimental sentences.

The whole experiment lasted about 50 min (including one short break).

2.5. Electroencephalographic recordings

Electroencephalographic (EEG) was recorded from 27 tin electrodes embedded in an electrode cap (EasyCap). Scalp locations were Fp1, Fp2, F7, F3, Fz, F4, F8, FC3, FC4, T7, C3, Cz, C4, T8, TP7, CP3, CP4, TP8, P7, P3, Pz, P4, P8, O1, O2, FT7, and FT8 according to the revised 10/20 International System (American Clinical Neurophysiology Society, 2006). Bipolar vertical and horizontal electrooculograms were recorded for monitoring eye-related activity. In addition, two electrodes were placed on the mastoids. Electrode impedances were kept below 3 KΩ. All electrodes were referenced to the right mastoid; the EEG signal was filtered online with a band pass from 0.01 to 40 Hz and sampled at 250 Hz.

2.5.1. Data analysis

The continuous EEG was re-referenced offline to the average of the two mastoids, segmented into 1-s epochs time-locked to the onset of the critical word, and baseline-corrected for a 200 ms pre-stimulus interval. Raw data were low-pass filtered offline at

30 Hz. Blinks and eye movements were corrected off-line using the method described by Gratton, Coles, and Donchin (1983). Epochs containing a signal range exceeding ±100 μV were automatically excluded from the analyses. Epochs classified as artefact free were further inspected manually and discarded if presenting contaminations undetected by the automatic processing.

Repeated-measures ANOVAS were conducted on performance data and mean ERP amplitudes within the selected time windows, including factors' intuitiveness (religious and non-religious counterintutive, and intuitive sentences), interpretation mode (literal, metaphorical), and—for ERP data—electrode site (27 levels) as within-participant factors. Greenhouse-Geisser correction was applied when necessary.

3. Results

3.1. Behavioral data

Mean error rates and response times (RTs) for correct trials are given in Table 2.

ANOVA of mean RTs showed main effects of intuitiveness ($F(2, 46) = 8.46$, $MSE = 15{,}856.66$, $p < .01$) and interpretation mode ($F(1, 23) = 15.41$, $MSE = 122{,}957.70$, $p < .001$), with longest RTs for non-religious counterintuitions and for the metaphorical interpretation mode, respectively (see Table 2). Importantly, the two effects were driven by a strong trend for an interaction between intuitiveness and interpretation mode ($F(2, 46) = 3.23$, $MSE = 31{,}243.07$, $p = .06$) with longest RTs for non-religious sentences when interpreted metaphorically.

According to our a priori hypothesis that religious ideas could be specifically modulated by the mode of interpretation, and to the results of the overall ANOVA, we conducted separate ANOVAS for the literal and the metaphorical modes. For both modes there was a main effect of intuitiveness ($F(1, 23) = 4.09$, $MSE = 67{,}542.96$, $p < .05$ and $F(1, 23) = 5.83$, $MSE = 191{,}684.02$, $p < .01$, for the literal and metaphorical mode, respectively). We further assessed the hypothesized specificity of interpretation mode effects by conducting an ANOVA on the difference between metaphorical *minus* literal mode, with intuitiveness as factor. The significance of the effect ($F(1, 23) = 3.23$, $MSE = 47{,}771.90$,

Table 2
Accuracy and reaction times (mean plus SDs in parentheses) across Sentence Type and Interpretation Mode

	Literal Mode		Metaphorical Mode	
Sentence type	Mean Errors (%)	Mean RT(ms)	Mean Errors (%)	Mean RT(ms)
Religious	2.43 (6.26)	1,504.74 (309.00)	2.96 (5.03)	1,650.47 (395.19)
Non-religious	3.33 (4.06)	1,507.91 (335.94)	4 (4.32)	1,791.44 (465.75)
Intuitive	2.87 (6.68)	1,422.06 (289.69)	3.43 (5.71)	1,660.74 (460.94)
Averages	2.87	1,478.23	3.46	1,700.88

$p < .05$) reveals that religious sentences were least impaired by the imposition of a metaphorical interpretation of their meaning (Mdiff = 143 ms), whereas non-religious counterintuition was impaired most (Mdiff = 301 ms; intuitive sentences: Mdiff = 259 ms).

Pairwise comparisons (Bonferroni corrected) revealed significant differences in religious and non-religious counterintuitions relative to intuitive sentences in the literal mode ($ts > -2.30$, $ps < .01$), while both counterintuitions did not differ from each other ($t(23) = -0.08$, $p > .1$). Conversely, in the metaphorical mode only for non-religious counterintuitions the difference with intuitive sentences was significant ($t(23) = -3.11$, $p < .001$).

Regarding the percentage of errors, no significant effects were observed for the factor intuitiveness ($F(2, 46) = 0.35$, $MSE = 30.06$) or for its interaction with interpretation mode ($F(2, 46) = 0.002$, $MSE = 86.96$). However, we observed a main effect of interpretation mode ($F(1, 23) = 4.16$, $MSE = 2.92$, $p < .05$) with more errors in response to metaphorical than to literal questions.

3.2. ERP data

On average, 16.7% of all epochs were rejected because of artifacts or incorrect answers; the rejection rate did not significantly differ between conditions ($Fs < 1.42$, $ps > .1$). Fig. 1 displays ERPs to the critical words in all experimental conditions. Waveforms to both religious and non-religious counterintuitions clearly displayed a negative-going deflection between 380 ms and 480 ms relative to intuitive sentences, identified as the N400 component. Visually, the N400 in both counterintuitive conditions were similar in the literal mode but differed in the metaphorical mode. This was confirmed by statistical analyses as described below.

ANOVA on the mean amplitudes (cf. *Data analysis* section) showed a main effect of intuitiveness ($F(2, 46) = 8.56$, $MSE = 25.11$, $p < .001$), a significant intuitiveness × electrode site interaction ($F(52, 1196) = 3.14$, $MSE = 8.99$, $p < .01$), and a trend for a three-way interaction intuitiveness × interpretation mode × electrode site ($F(52, 1196) = 1.8$, $MSE = 7.68$, $p = .08$). No other effect approached significance ($Fs < 1$).

Based on our a priori hypothesis that religious counterintuitive ideas are naturally understood in a metaphorical manner (see also Fig. 1), planned comparisons were performed. Separate ANOVAS were carried out for literal and metaphorical modes. For the literal mode, we observed a main effect of intuitiveness ($F(1, 23) = 3.71$, $MSE = 28.05$, $p < .05$). A decomposition of the effect by pairwise comparisons (Bonferroni corrected) revealed significant differences between intuitive and non-religious sentences ($F(1, 23) = 5.81$, $MSE = 29.52$, $p < .05$). Importantly, religious and non-religious counterintuitions were indistinguishable ($F(1, 23) = 1.02$, $MSE = 14.84$, $p = .32$). No other effect reached significance ($Fs < 2.95$, $ps > .1$).

Similarly, intuitiveness effects were significant also within the metaphorical mode ($F(2, 46) = 4.60$, $MSE = 28.69$, $p < .01$) and interacted with electrode site ($F(52, 1196) = 2.89$, $MSE = 10.42$, $p < .05$). However, when pairwise comparisons (Bonferroni corrected) were performed, a different scenario emerged relative to the literal mode.

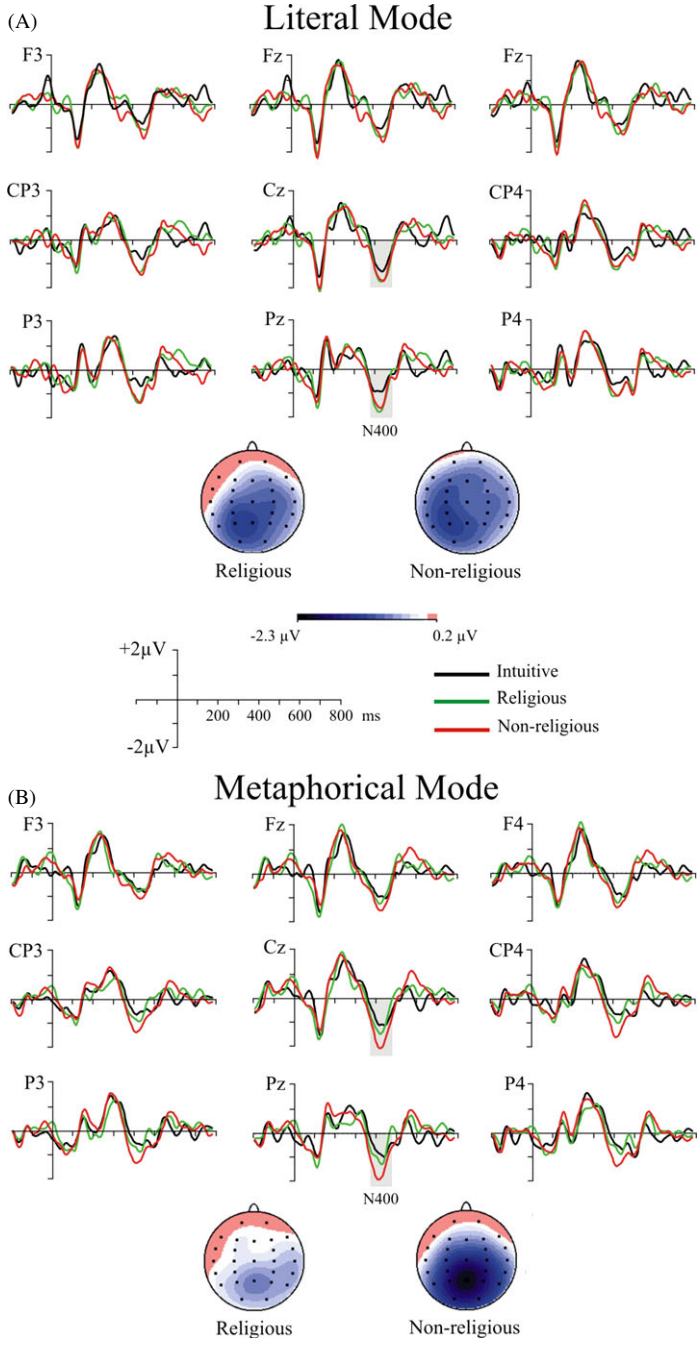

Fig. 1. ERPs for religious counterintuitions, non-religious counterintuitions, and intuitive sentences in the literal mode (A) and in the metaphorical mode (B). ERP waveforms are represented at a selection of electrodes for the three types of sentence endings. Difference maps of the effects (religious *minus* intuitive and non-religious *minus* intuitive) for the N400 time-window (380–480 ms) are also provided.

Non-religious counterintuitive sentences diverged from the other two conditions ($Fs > 5.23$, $ps < .05$), whereas the difference between religious and intuitive sentences was no longer significant ($F < 1$).

Critically, when differences between interpretation modes were tested individually for each sentence type, the difference was significant only for religious counterintuitions ($F(1, 23) = 4.95$, $MSE = 19.90$, $p < .05$ and $F(26, 598) = 3.11$, $MSE = 13.98$, $p < .01$ for interpretation mode and its interaction with electrode site, respectively), with a reduced N400 in the metaphorical compared to the literal mode. Neither for non-religious counterintuitive nor for intuitive sentences was the N400 amplitude affected by the reading mode ($Fs < 1$).

Analyses carried out at Pz electrode position, where differences between conditions were more conspicuous, confirmed the pattern that emerged in the omnibus analyses with all electrodes, and converged with the behavioral pattern. As expected, in the literal mode similar N400-effects were elicited by religious and non-religious counterintuitions (relative to intuitive sentences: $ts > 1.95$, $ps < .05$), which did not differ from each other ($t(23) = -0.40$, $p = .69$). In contrast, in the metaphorical mode, only for non-religious counterintuitions N400-effects are still present ($t(23) = 2.91$, $p < .01$), whereas they vanished for religious counterintuitions ($t(23) = 1.24$, $p = .22$).

Although no effect in later time windows was predicted, we tested for this possibility by analyzing the signal mean activity in two different intervals: 500–650 ms and 650–800 ms post-stimulus-onset covering the P600 component. ANOVAS (with all electrodes included) did not reveal either significant main effects or interactions ($Fs < 0.1$).

4. Discussion

Both religious and metaphoric thought have been labeled as "natural" for human cognition (Boyer, 2008; Lakoff, 1993; McCauley, 2000). So far, no study directly investigated a possible link between the two and between the cognitive processes behind their comprehension. The present study addressed this issue by assessing whether religious counterintuitions from mythological and religious texts are easily understood because of their intrinsic metaphorical properties. For this purpose, we encouraged literal and metaphorical interpretation modes of three sentence types: religious counterintuitions, non-religious counterintuitions, and intuitive sentences. This was achieved by asking questions, in a block-wise manner, referring to either the literal or possible metaphorical meaning of each sentence.

Importantly, the interpretation manipulation was shown to be effective at both performance and ERP levels. The performance level showed how the type of interpretation mode induced over each kind of sentence contributed to its processing time as an end product of the whole processing stream. As more direct online-indicators of processing the different critical words in the two induced processing modes we recorded ERPs, focusing on the N400 component.

4.1. Performance

Overall, we found faster responses to literal than metaphorical questions. This result converges with previous findings in metaphor studies, showing a prevalence of literal over figurative language (Janus & Bever, 1985), mainly for unconventional metaphors (Blank, 1988; Brisard, Frisson, & Sandra, 2001).

Regarding the effects of sentence type, it took longer for participants to respond to comprehension questions about the content of non-religious as compared to religious counterintuitions. This reflects a more effortful search for reaching a coherent interpretation of non-religious counterintuitions in both interpretation modes. By contrast, religious counterintuitions appear more semantically flexible in nature. In fact, they are less susceptible to the induction of a non-literal interpretation mode as the time to decide about their meaning is least affected by the imposed retrieval of a non-literal meaning, contrary to non-religious counterintuitions and intuitive ideas. What is the same, religious counterintuitions gain access to the non-literal meaning of their content more readily than other anomalies or non-violating concepts.

Post hoc analysis further confirmed this view; whereas in the literal mode they resembled non-religious counterintuitions, the metaphorical interpretation of religious counterintuitions was reached faster than for both, non-religious counterintuitions and intuitive ideas. Relative to other kinds of concepts, religious counterintuitions are understood more easily as metaphorical ideas.

The present results also converge with semantic judgments of the same religious counterintuitions employed here (Fondevila et al., 2012): They were less frequently judged as implausible relative to non-religious counterintuitions, similar to conventional metaphors when compared to semantic anomalies (Glucksberg, Gildea, & Bookin, 1982).

4.2. Event-related potentials

The modulations of the N400 brain responses to the sentence final words in each of the three conditions showed that their semantic encoding was differentially affected by the induced mode of interpretation. When interpreted literally, both counterintuitions—religious and non-religious—elicited similar N400 effects. That is, their semantic processing, be this integrating the meaning of critical words into ongoing sentence context (Van Berkum et al., 1999; see also Kutas & Federmeier, 2011) was similar. This implies that both counterintuitions taxed the semantic system to a similar degree leading to a costly understanding.

In contrast, and in accordance with our hypothesis, the induction of a metaphorical interpretation evoked a significant reduction in the religious sentence-related N400 to the extent that religious and intuitive sentences were indistinguishable. Furthermore, neither the non-religious counterintuitions nor the intuitive sentences showed an observable modulation of the N400 amplitude through the induced mode. Therefore, our data indicate that religious counterintuitions, as implemented here, are understood more easily as metaphor than in a literal sense.

Our pattern of results converges with previous findings on the semantic processing of metaphors (e.g., Arzouan, Goldstein, & Faust, 2007; De Grauwe et al., 2010; Lai et al., 2009; Tartter et al., 2002). These studies reported larger N400 amplitudes for metaphors than for literal sentences, but reduced amplitudes when compared to other semantic violations. Additionally, anomalous relative to literal meanings commonly displayed an N400 effect comparable with the effect elicited by our non-religious counterintuitions.

In this vein, the activation of a metaphorical sense of religious counterintuitions presumably occurred within the N400 period and we did not observe later effects, for example as P600 or Late Positive Component. This would further indicate no need for extra processing to integrate additional material from semantic memory (e.g., Coulson & Van Petten, 2002, 2007), or to solve the conflict between the implausibility of the literal and metaphorical sense (e.g., De Grauwe et al., 2010; see also Lai & Curran, 2013). In addition, the lack of later effects argues against interpretations of our findings in terms of fully serial models (e.g., Grice, 1975; Searle, 1979) for which literal meaning is always accessed first and is only subsequently overridden by the metaphorical one.

In contrast, the metaphorical meaning seems directly activated for religious counterintuitions. The associated reduction in the N400 amplitude may reflect alignment and inference processes between conceptual domains—in terms of the *structural-mapping theory* of metaphor comprehension (e.g., Bowdle & Gentner, 2005; Coulson, 2000; Wolff & Gentner, 2011). In line with the *conceptual mapping* account of metaphor comprehension (e.g. Lakoff, 1993; see also Lakoff, 2009), our religious counterintuitions seem to be able to expedite mappings (breaches and transfers of properties) at a superordinate level between conceptual domains, leading to effortless processing.

Another plausible scenario for our data is that both literal and metaphorical meanings of the religious counterintuitions are partially active by default and task-induced interpretations enforced the access to a specific meanings while the activation of the non-dominant one decreased. This interpretation is supported because in the literal mode religious and non-religious counterintuitions are eliciting equivalent effects; that is, their literal meaning appears to be similarly anomalous. Accordingly, the "religious" N400 effect observed previously (Fondevila et al., 2012) may reflect the (at least partial) activation of a metaphorical meaning by default, facilitating semantic processing compared to non-religious counterintuitions. Furthermore, by inducing a metaphorical interpretation mode such activation can be enhanced making religious counterintuitions easier to process, even if classified as implausible. Overall, our present and previous findings would support the view that a metaphorical mode of understanding language is something natural, usual, or inherent, as some authors propose (see, e.g., Lakoff, 1993).

Our findings show remarkable differences between religious and non-religious ideas although both met counterintuitivity criteria (Barrett, 2008; Boyer, 2001). These differences are most likely based on the ease and flexibility to interpret religious counterintuitions, contrary to the non-religious ones. Indeed, it appears similarly difficult to semantically process non-religious counterintuitive ideas in either mode, whereas for religious ideas this is true only when the activation of a literal meaning is demanded.

Empirical findings concerning the cognitive underpinnings of religious thought have evidenced different aspects contributing to the recall and transmission of religious concepts besides their minimal counterintuitive nature. Some of these factors are emotionality (e.g., Purzycki, 2010; see also Aristei et al., 2011) or the pre- and post-expectancy of the context in which concepts are embedded as well as the integration of such context (Harmon-Vukic & Slone, 2009; Upal, Gonce, Tweney, & Slone, 2007). Our results revealed that the easy accessibility to the metaphorical sense of some religious counterintuitions seems a major aspect in determining their ease of comprehension. Even isolated from their original discourse, religious ideas describing counterintuitive situations are more easily integrated than other semantic incongruencies spontaneously (Fondevila et al., 2012), this being enhanced when a metaphorical mode of thinking is induced (the present results). Additionally, this easiness vanishes when literal thinking is primed. Hence, counterintuitions used in religious texts appear as less counterintuitive than other world knowledge violations presumably by virtue of their metaphoricity.

As an outcome, religious counterintuitions would convey an increase in difficulty (they are rated as implausible), but of small magnitude (as reflected in the N400), which characterizes MCIs. Assuming therefore that religious counterintuitions are cases of MCIs, they would be more memorable and cognitively adherent than intuitive (plausible) ideas as well as than other, harder to comprehend counterintuitions (Boyer & Ramble, 2001; Norenzayan et al., 2006).

Together with previous findings the present results show that a representative number of counterintuitions extracted from religious texts throughout the world are more easily interpreted metaphorically, at variance with other types of counterintuitions. Recent findings have demonstrated that analytic reasoning, at variance to abstract reasoning typical of metaphorical thought, is inversely correlated with religious belief (Gervais & Norenzayan, 2012; Pennycook, Cheyne, Seli, Koehler, & Fugelsang, 2012). Therefore, metaphoricity should be taken into consideration as an additional relevant factor facilitating the acceptability of counterintuitive religious ideas and—by applying the properties of MCIs—possibly their superior recall and cultural transmission.

Finally, it is important to point out some limitations of the present experiment to better frame and interpret its results. First, in the literature there is a lack of unitary criteria relative to the definition of MCIs. Indeed, while here we followed the original proposal by Boyer (2001) focusing on innate intuitions to represent objects and agents (see Introduction), the ideas we found in real mythologies and religious texts did not always conform to this model. It seems that theoretical claims and empirical data do not always overlap accurately. Second, the present study, as our previous one (Fondevila et al., 2012), is restricted to sentence or idea level explanations disregarding the effects of the larger contexts. Several authors have claimed that context bias might be more important than content for the acceptability of religious ideas (e.g., Gervais & Henrich, 2010). However our data indicate that content seems also to convey some degree of relevance in this respect.

5. Conclusions

In sum, when a literal interpretation takes place, any type of counterintuitive idea is regarded as similarly incongruous with real-world knowledge. However, when metaphorically interpreted, the abstract nature of an idea gains importance. The metaphorical interpretation of religious counterintuitions emerges readily while non-religious counterintuitions cannot be "converted" easily into metaphorical meaning. Like metaphors, religious ideas are based on general cognition. If the human mind can easily assume and interpret metaphors, religious metaphorical thinking benefits from this property or even be its outflow, which might in turn partially explain their successful cultural transmission.

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Note

1. Literal translations into English from the original Spanish version.

References

Anonymous. (1981). *The Rig Veda*. London, UK: Penguin Books.

Anonymous. (1982). *The Kojiki: Records of ancient Matters*. Singapore: Tuttle; Classics.

Anonymous. (2008b). *The Egyptian book of the dead. Or the papyrus of Ani*. London, UK: Penguin Classics.

Anonymous. (2008a). *Popol Vuh*. Madrid, Sain: Trotta.

Allen, L. A. (1975). *Time before morning: Art and myth of the Australian aborigines*. New York: Crowell.

American Clinical Neurophysiology Society (2006). Guideline 5: Guidelines for standard electrode position nomenclature. *Journal of Clinical Neurophysiology*, *23*(2), 107–110.

Aristei, S., Nerlich, T., Knoop, C., Lubrich, O., Sommer, W., Jacobs, A., & Abdel Rahman, R. (2011). Neurocognitive correlates of minimally counterintuitive concepts and their modulation by context affectivity. 17th Meeting of European Society of Cognitive Psychology (ESCOP), San Sebastian, Spain, September 29th – October 2nd (Oral presentation).

Arzouan, Y., Goldstein, A., & Faust, M. (2007). Brain waves are stethoscopes: ERP correlates of novel metaphor comprehension. *Brain Research*, *1160*, 69–81. doi: 10.1016/j.brainres.2007.05.034.

Barrett, J. L. (2000). Exploring the natural foundations of religion. *Trends in Cognitive Sciences*, *4*(1), 29–34. doi: 10.1016/S1364-6613(99)01419-9.

Barrett, J. L. (2008). Coding and quantifying counterintuitiveness in religious concepts: Theoretical and methodological reflections. *Method and Theory in the Study of Religion*, *20*(4), 308–338. doi: 10.1163/157006808X371806.

Barrett, J. L., & Nyhof, M. A. (2001). Spreading non-natural concepts: The role of intuitive conceptual structures in memory and transmission of cultural materials. *Journal of Cognition and Culture*, *1*(1), 69–100. doi: 10.1163/156853701300063589.

Blank, G. D. (1988). Metaphors in the lexicon. *Metaphor and Symbolic Activity*, *3*(3), 21–36. doi: 10.1207/s15327868ms0301_2.

Bowdle, B., & Gentner, D. (2005). The career of metaphor. *Psychological Review*, *112*(1), 193–219. doi: 10.1037/0033-295X.112.1.193.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. New York: Basic Books.

Boyer, P. (2003). Religious thought and behaviour as byproducts of brain function. *Trends in Cognitive Sciences*, *7*(3), 119–124. doi: 10.1016/S1364-6613(03)00031-7.

Boyer, P. (2008). Religion: Bound to believe? *Nature*, *455*, 1038–1039. doi: 10.1038/4551038a.

Boyer, P., & Ramble, C. (2001). Cognitive templates for religious concepts: Cross-cultural evidence for recall of counter-intuitive representations. *Cognitive Science*, *25*(4), 535–564. doi: 10.1207/s15516709cog2504_2.

Brisard, F., Frisson, S., & Sandra, D. (2001). Processing unfamiliar metaphors in a self-paced reading task. *Metaphor and Symbol*, *16*(1), 87–108. doi: 10.1207/s15327868 ms1601&2_7.

Coulson, S. (2000). *Semantic leaps: Frame-shifting and conceptual blending in meaning construction*. Cambridge, UK: Cambridge University Press.

Coulson, S. (2012). Cognitive neuroscience of figurative language. In M. J. Spivey, M. F. Joanisse, & K. McRrae (Eds.), *The Cambridge handbook of psycholinguistics* (pp. 523–538). Cambridge, MA: Cambridge University Press.

Coulson, S., & Van Petten, C. (2002). Conceptual integration and metaphor: An event-related potential study. *Memory & Cognition*, *30*(6), 958–968. doi: 10.3758/BF03195780.

Coulson, S., & Van Petten, C. (2007). A special role for the right hemisphere in metaphor comprehension? ERP evidence from hemifield presentation. *Brain Research*, *1146*, 128–145. doi: 10.1016/j.brainres.2007.03.008.

Culley, E. V. (2008). Supernatural metaphors and belief in the past: Defining the archeology of religion. In K. Hays-Gilpin & D. S. Whitley (Eds.), *Belief in the past: Theoretical approaches to the archeology of religion* (pp. 67–83). Walnut Creek, CA: Left Coast.

De Grauwe, S., Swain, A., Holcomb, P. J., & Kuperberg, G. R. (2010). Electrophysiological insights into the processing of nominal metaphors. *Neuropsychologia*, *48*(7), 1965–1984. doi: 10.1016/j.neuropsychologia.2010.03.017.

Fauconnier, G., & Turner, M. (1994). *Research report 9401*. Conceptual Projection and Middle Spaces. Available at: http://www.cogsci.ucsd.edu/research/documents/technical/9401.pdf. Accessed February 10, 2015.

Fauconnier, G., & Turner, M. (1994). *Research report 9401*. Conceptual Projection and Middle Spaces. Available at: http://www.lit.kobe-u.ac.jp/~yomatsum/resources/Fauconnierturner1984.pdf. Accesed February 10, 2015.

Fauconnier, G., & Turner, M. (1998). Conceptual integration networks. *Cognitive Science*, *22*(2), 133–187. doi: 10.1207/s15516709cog2202_1.

Fondevila, S., Martin-Loeches, M., Jiménez-Ortega, L., Casado, P., Sel, A., Fernández, A., & Sommer, W. (2012). The sacred and the absurd: An event-related potentials study (at sentence level). *Social Neuroscience*, *7*(5), 445–457. doi: 10.1080/17470919.2011.641228.

García Noblejas, G. (2007). *Mitología de la antigua China*. Madrid: Alianza.

Gervais, W. M., & Henrich, J. (2010). The Zeus problem: Why representational content biases cannot explain faith in Gods. *Journal of Cognition and Culture*, *10*(3), 383–389.

Gervais, W. M., & Norenzayan, A. (2012). Analytic thinking promotes religious disbelief. *Science*, *336* (6080), 493–496. doi: 10.1126/science.1215647.

Gibbs, R. W. (2002). A new look at literal meaning in understanding what is said and implicated. *Journal of Pragmatics*, *34*(4), 457–486. doi: 10.1016/S0378-2166(01)00046-7.

Glucksberg, S., Gildea, P., & Bookin, M. B. (1982). On understanding nonliteral speech: Can people ignore metaphors? *Journal of Verbal Learning and Verbal Behavior*, *21*(1), 85–98. doi: 10.1016/S0022-5371(82)90467-4.

Gratton, G., Coles, M. G., & Donchin, E. (1983). A new method for off-line removal of ocular artifacts. *Electroencephalography and Clinical Neurophysiology*, *55*(4), 468–484. doi: 10.1016/0013-4694(83)90135-9.

Greenhouse, W. S., & Geisser, S. (1959). On methods in the analysis of profile data. *Psychometrika*, *24*(2), 95–112.

Grice, H. P. (1975). Logic and conversation. In P. Cole & J. Morgan. (Eds.), *Speech acts. Syntax and semantics* (pp. 41–58). New York: Academic Press.

Hagoort, P., Hald, L., Bastiaansen, M., & Petersson, K. M. (2004). Integration of word meaning and world knowledge in language comprehension. *Science*, *304*(5669), 438–441. doi: 10.1126/science.1095455.

Hald, L. A., Steenbeek-Planting, E. G., & Hagoort, P. (2007). The interaction of discourse context and world knowledge in online sentence comprehension: Evidence from the N400. *Brain Research*, *1146*, 210–218. doi: 10.1016/j.brainres.2007.02.054.

Harmon-Vukic, M. E., & Slone, D. J. (2009). The effect of integration on recall of counterintuitive stories. *Journal of Cognition and Culture*, *9*(1–2), 57–68. doi: 10.1163/156853709X414638.

Harmon-Vukic, M. E., Upal, M. A., & Sheehan, K. J. (2012). Understanding the memory advantage of counterintuitive concepts. *Religion Brain & Behavior*, *2*(2), 121–139. doi: 10.1080/2153599X.2012.672816.

Jäkel, O. (2002). Hypothesis revised: The cognitive theory of metaphor applied to religious texts. Metaphorik.de, 2, 20-42. Available at http://www.metaphorik.de/sites/www.metaphorik.de/files/journal-pdf/02_2002_jaekel.pdf. Accessed February 10, 2015.

Janus, R. A., & Bever, T. G. (1985). Processing of metaphoric language. An investigation of the three stage model of metaphor comprehension. *Journal of Psycholinguistic Research*, *14*(5), 473–487. doi: 10.1007/BF01666722.

Johnson, C. V. P., Kelly, S. W., & Bishop, P. (2010). Measuring the mnemonic advantage of counter-intuitive and counter- schematic concepts. *Journal of Cognition and Culture*, *10*(1–2), 111–123. doi: 10.1163/156853710X497194.

Kapogiannis, D., Barbey, A. K., Su, M., Krueger, F., & Grafman, J. (2009). Neuroanatomical variability of religiosity. *PLoS ONE*, *4*(9), e7180. doi: 10.1371/journal.pone.0007180.

Knappert, J. (1988). *Reyes, dioses y espíritus de la mitología Africana*. Madrid: Anaya.

Kutas, M., & Federmeier, K. D. (2011). Thirty years and counting: Finding meaning in the N400 component of the event related brain potential (ERP). *Annual Review of Psychology*, *62*, 621–647. doi: 10.1146/annurev.psych.093008.131123.

Kutas, M., & Hillyard, S. A. (1980). Reading senseless sentences: Brain potentials reflect semantic incongruity. *Science*, *207*(4427), 203–205. doi: 10.1126/science.7350657.

Kutas, M., & Hillyard, S. A. (1984). Brain potentials reflect word expectancy and semantic association during reading. *Nature*, *307*(5947), 161–163. doi: 10.1038/307161a0.

Lai, V. T., & Curran, T. (2013). ERP evidence for conceptual mappings and comparison processes during the comprehension of conventional and novel metaphors. *Brain and Language*, *127*(3), 484–496. doi: 10.1016/j.bandl.2013.09.010.

Lai, V. T., Curran, T., & Menn, L. (2009). Comprehending conventional and novel metaphors: An ERP study. *Brain Research*, *1284*, 145–155. doi: 10.1016/j.brainres.2009.05.088.

Lakoff, G. (1993). The contemporary theory of metaphor. In A. Ortony (Ed.), *Metaphor and thought* (pp. 202–251). Cambridge, UK: Cambridge University Press.

Lakoff, G. (2009). The neural theory of metaphor. In J. R. Gibbs (Ed.), *The Cambridge handbook of metaphor and thought* (pp. 17–38). New York: Cambridge University Press.

Lakoff, G., & Turner, M. (1989). *More than cool reason: A field guide to poetic metaphor*. Chicago, IL: The University of Chicago Press.

Lau, E. F., Phillips, C., & Poeppel, D. (2008). A cortical network for semantics: (De)constructing the N400. *Nature Reviews Neuroscience*, *9*(12), 920–933. doi: 10.1038/nrn2532.

McCauley, R. N. (2000). The naturalness of religion and the unnaturalness of science. In F. Keil & R. Wilson (Eds.), *Explanation and cognition* (pp. 61–85). Cambridge, MA: MIT Press.

Nieuwland, M. S., & Van Berkum, J. J. A. (2006). When peanuts fall in love: N400 evidence for the power of discourse. *Journal of Cognitive Neuroscience*, *18*(7), 1098–1111. doi: 10.1162/jocn.2006.18.7.1098.

Norenzayan, A., Atran, S., Faulkner, J., & Schaller, M. (2006). Memory and mystery: The cultural selection of minimally counterintuitive narratives. *Cognitive Science*, *30*, 1–23.

Oldfield, R. C. (1971). The assessment and analysis of handedness: The Edinburgh Inventory. *Neuropsychologia*, *9*(1), 97–113. doi: 10.1016/0028-3932(71)90067-4.

Ovid & Reaburn, D. (2004). *The metamorphoses*. London, UK: Penguin Classics.

Pennycook, G., Cheyne, J. A., Seli, P., Koehler, D. J., & Fugelsang, J. A. (2012). Analytic cognitive style predicts religious and paranormal belief. *Cognition*, *123*(3), 335–346. doi: 10.1016/j.cognition.2012.03.003.

Poignant, R. (1967). *Oceanic mythology: The myths of Polynesia, Micronesia, Melanesia, Australia*. London: Hamlyn.

Purzycki, B. G. (2010). Cognitive architecture, humor and counterintuitiveness: Retention and recall of MCIs. *Journal of Cognition and Culture*, *10*(1), 189–204. doi: 10.1163/156853710X497239.

Pyysiäinen, I. (2009). *Supernatural agents: Why we believe in Souls, Gods, and Buddhas*. Oxford, UK: Oxford University Press.

Resenberg, D. (2001). *World mythology: Anthropology of great myths and epics*. London: MacGraw-Hill.

Searle, J. (1979). *Expression and meaning*. Cambridge, UK: Cambridge University Press.

Sebastián, N., Cuetos, F., Martí, M. A., & Carreiras, M. (2000). *LEXESP: Léxico informatizado del español*. Barcelona: Ediciones de la Universidad de Barcelona.

Tartter, V., Gomes, H., Dubrovsky, B., Molholm, S., & Vala Stewart, R. (2002). Novel metaphors appear anomalous at least momentarily: Evidence from N400. *Brain & Language*, *80*(3), 488–509. doi: 10.1006/brln.2001.2610.

Thibodeau, P. H., & Boroditsky, L. (2011). Metaphors we think with: The role of metaphor in reasoning. *PLoS ONE*, *6*(2), e16782. doi: 10.1371/journal.pone.0016782.

Upal, A., Gonce, L., Tweney, R., & Slone, D. J. (2007). Contextualizing counterintuitiveness: How the context affects comprehension and memorability of counterintuitive concepts. *Cognitive Science*, *31*(3), 415–439. doi: 10.1080/15326900701326568.

Van Berkum, J. J. A. (2009). The neuropragmatics of 'simple' utterance comprehension: An ERP review. In U. Sauerland, & K. Yatsushiro (Eds.), *Semantics and pragmatics: From experiment to theory*. New York, NY: Palgrave.

Van Berkum, J. J. A., Hagoort, P., & Brown, C. M. (1999). Semantic integration in sentences and discourse: Evidence from the N400. *Journal of Cognitive Neuroscience*, *11*(6), 657–671. doi: 10.1162/089892999563724.

Wolff, P., & Gentner, D. (2011). Structure-mapping in metaphor comprehension. *Cognitive Science*, *35*(8), 1456–1488. doi: 10.1111/j.1551-6709.2011.01194.x.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Experimental material.