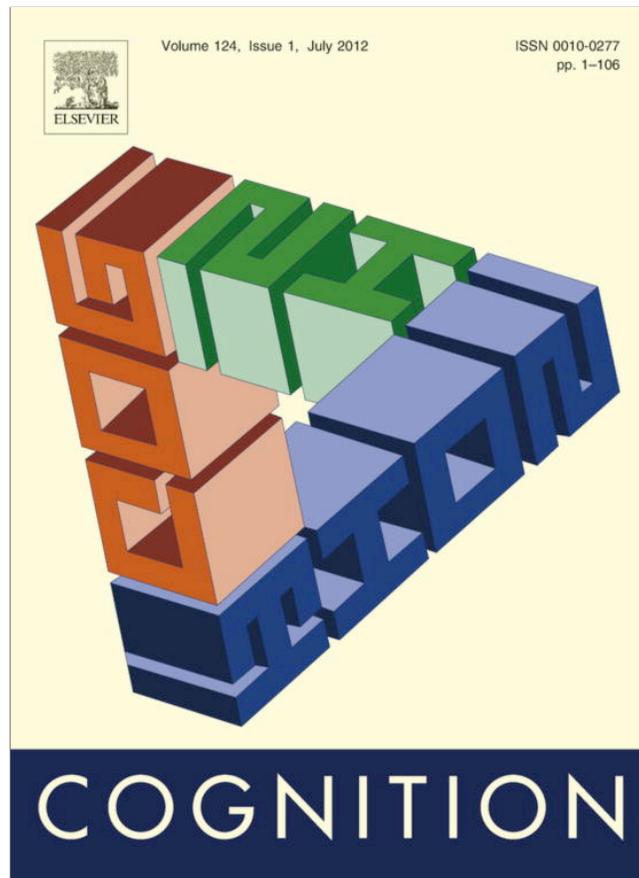


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## Evaluating ritual efficacy: Evidence from the supernatural

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## ARTICLE INFO

## Article history:

Received 10 April 2011  
 Revised 17 January 2012  
 Accepted 14 March 2012  
 Available online 19 April 2012

## Keywords:

Causal reasoning  
 Ritual  
 Supernatural cognition  
 Cognitive science of religion  
 Cross-cultural research  
 Cognition and culture

## ABSTRACT

Rituals pose a cognitive paradox: although widely used to treat problems, rituals are causally opaque (i.e., they lack a causal explanation for their effects). How is the efficacy of ritual action evaluated in the absence of causal information? To examine this question using ecologically valid content, three studies ( $N = 162$ ) were conducted in Brazil, a cultural context in which rituals called *simpatias* are used to treat a great variety of problems ranging from asthma to infidelity. Using content from existing *simpatias*, experimental *simpatias* were designed to manipulate the kinds of information that influences perceptions of efficacy. A fourth study ( $N = 68$ ) with identical stimuli was conducted with a US sample to assess the generalizability of the findings across two different cultural contexts. The results provide evidence that information reflecting intuitive causal principles (i.e., repetition of procedures, number of procedural steps) and transcendental influence (i.e., presence of religious icons) affects how people evaluate ritual efficacy.

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## 1. Introduction

“The problem of ritual is the familiar ‘rationality problem’ in a new guise—old wine in a new bottle” (Sax, 2010, p. 4).

Ritual is often interpreted in both popular scientific discourse and in ritual studies as action that is ineffective, irrational, or purely conventional (Sax, Quack, & Weinhold, 2010). Although some have argued that rituals are expressions of inner states of feeling and emotion, symbolize theological ideas or social relations, or represent psychophysical states, conceptualizing ritual exclusively in this way neglects the fact that the use of rituals for protective, restorative, and instrumental purposes is a pervasive feature of human culture (Sax et al., 2010; Sørensen, 2007). Using rituals to solve problems presupposes reasoning about their efficacy, a topic of longstanding interest and debate in anthropology (Csordas, 2002; Sax, 2004; Sax et al., 2010).

Rituals pose a cognitive paradox: although widely used to treat problems, they are cultural conventions and lack a causal explanation for their effects (Legare & Whitehouse, 2011). They are the result of “a positive act of acquiescence in a socially stipulated order”, and thus are not the product of individual innovation. “The peculiar fascination of ritual lies in the fact that here, as in few other human activities, the actors both are, and are not, the author of their acts” (Humphrey & Laidlaw, 1994, p. 5). Rituals, which we define as conventional, causally opaque procedures (Legare & Whitehouse, 2011), present a challenge to theoretical accounts of causal reasoning because they are both socially stipulated (Humphrey & Laidlaw, 1994) and not reducible to causal mechanisms (Bloch, 2004; Boyer & Liénard, 2006; Whitehouse, 2001). Even when rituals are explained in the context of a certain belief, there is often not an expectation of a direct causal connection between (ritual) actions and outcomes (Sørensen, 2007). We propose that rituals are *irretrievably causally opaque* because they (1) are not bound by the same kinds of intuitive physical-causal constraints that characterize non-ritualistic actions and (2) lack an intuitive causal connection between the specific action performed (e.g., rubbing a ceramic pot) and the desired outcome or effect (e.g., making it rain).

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For example, rituals intended to have particular effects (e.g., rituals promoting crop fertility or healing the sick) are not expected to do so by causal mechanisms that are transparent or even in principle knowable (Legare & Whitehouse, 2011). This raises a conceptual question: how do people evaluate the efficacy of ritual action in the absence of causal information?

Our objective is to examine the 'hidden logic' of ritual (Sax, 2010) experimentally, integrating and applying cognitive anthropological and cognitive psychological approaches to the study of ritual cognition. Rather than evaluate the efficacy of ritual by examining outcomes or experience (Csordas, 2002), we seek to examine the kinds of information that influence perceptions of the efficacy of ritual action.

We propose that the structure of ritual can be interpreted in light of intuitive causal beliefs about action efficacy or potency. In particular, rituals used for problem-solving purposes reflect intuitive beliefs about causal reasoning and the efficacy of goal-directed action sequences.

Consider Tambiah's (1979) classic definition of ritual as practice: "Rituals are patterned and ordered sequences of words and acts, often expressed in multiple media whose content and arrangement are characterized in varying degrees by formality (conventionality), stereotypy (rigidity), condensation (fusion), and redundancy (repetition)". We argue that the characteristics of ritual described by Tambiah (1979; i.e., rigidity, repetition) are the product of an evolved cognitive system (Atran & Norenzayan, 2004; Boyer & Liénard, 2006; Sørensen, 2007; Humphrey & Laidlaw, 1994; Whitehouse & McCauley, 2005) of intuitive causal principles. Rather than conceptualize ritual as a process of intensive symbolic communication (Tambiah, 1979), we suggest that the process of ritualization tends to evacuate actions of meaning through goal-demotion and redundancy (Humphrey & Laidlaw, 1994). Thus, we predict that intuitive causal reasoning, not content familiarity, is driving how ritual efficacy is evaluated.

### 1.1. Evaluating ritual efficacy

Although there is written record of rituals used for problem-solving purposes dating from ancient Egypt (The papyrus ebers, 1931; 1937) the use of rituals to treat problems as diverse in etiology as asthma and unemployment is widespread in contemporary cultural contexts such as the United Kingdom (Hutton, 1999), the United States (Crowley, 1989), Brazil (Cohen & Barrett, 2008; Souza & Legare, 2011), and South Africa (Ashforth, 2001; Legare & Gelman, 2008). Despite the seeming variability in the content, practices, and artifacts used in rituals around the world and over historical time, we propose that the way in which ritual efficacy is evaluated is predictable and constrained. For example, compare the following rituals used as remedies in Ancient Egypt and in present day Brazil. First consider this ritual, taken from the Papyrus Ebers, 1550 BCE, that was used to treat blindness: "Crush, powder, and make into one the two eyes of a pig [remove the water therefrom], true collyrium (i.e., mineral eye salve), red-lead (i.e., red oxide), and wild honey [in a clay bowl].

Inject [mixture] into the ear of the patient. When thou hast seen properly to this mixing repeat this formula: 'I have brought this thing and put it in its place. The crocodile [god Sobek] is weak and powerless'. Repeat twice. Thereby he will at once recover" (The Papyrus Ebers, 1931, p. 104).

Now consider a ritual used to find a partner in Brazil: "Buy a new sharp knife and stick it four times into a banana tree on June 12th at midnight (i.e., Valentine's day in Brazil, Saint Anthony's day is on the 13th). Catch the liquid that will drip from the plant's wound on a crisp, white paper that has been folded in two. The dripping liquid captured on the paper at night will form the first letter of the name of your future partner" (Scharf, 2010).

On the surface, there are many differences between these rituals. They involve different substances (e.g., red-lead vs. sap from a banana tree), different practices (i.e., mixing vs. paper folding), incorporate different artifacts (i.e., clay bowl vs. a knife), and treat different problems (i.e., blindness vs. attracting a partner). Yet, there are also many similarities. They involve information such as procedural repetition (i.e., repeat twice vs. twice a day for two weeks), a large number of procedural steps (i.e., seven vs. six), time specificity (i.e., early rising vs. June 12th at midnight), high levels of procedural detail (i.e., mixing wild honey vs. buying a new sharp knife and sticking it four times into a banana tree), and the presence of supernatural agents (i.e., Sobek, an ancient Egyptian deity vs. Saint Anthony, a Catholic marriage saint).

We hypothesize that information reflecting intuitive biases in causal reasoning (i.e., repetition, number of procedural steps, and the specificity of procedural detail) is used to evaluate the efficacy of ritual action. Although biases in causal reasoning are used to evaluate the efficacy of all action, their influence on action efficacy judgments may be especially salient or influential when information about causal mechanisms is unavailable. Whereas some of the intuitive causal principles hypothesized to influence perceptions of ritual efficacy examined in the present studies are likely to be related to previously documented biases in causal reasoning (i.e., repetition), others have not been well studied (i.e., number of procedural steps and specificity of procedural detail).

We propose that repetition of similar actions (e.g., pressing a button repeatedly to call an elevator) is perceived to be causally efficacious. A long-standing philosophical tradition supports the claim that beliefs about causal connections arise from impressions (projections of the mind) of repeated instances of similar relations (Hume, 1740). Converging psychological research has demonstrated that repetition may also influence reasoning about a variety of behaviors by making information more psychologically available (Oppenheimer, 2008), familiar (Scott & Dienes, 2008), and attractive (Zajonc, 1968).

The number of procedural steps and procedural specificity of the action sequence may also influence perceptions of causal efficacy. A larger number of procedural steps (e.g., seven steps) may increase the perception of causal efficacy over a smaller number of procedural steps (e.g., three steps) by giving the impression that multiple actions may have the capacity to produce a particular

effect. The specificity of the action sequence (i.e., inclusion of specific, detailed information) might also influence perceptions of action efficacy. Given that human beings are expert intention-readers, seeing someone engaging in a detailed course of actions (e.g., catching the liquid that will drip from the plant's wound on a crisp, white paper that has been folded in two) may give the impression that particular details of the action sequence (i.e., time specificity, item specificity) has the potential to produce the desired, intended outcome, even if the mechanism is unknown or unavailable (Legare & Whitehouse, 2011).

In addition to intuitive causal principles, supernatural agents may play a role in the evaluation of ritual efficacy (Sax et al., 2010). Indeed, images and icons of supernatural agents are frequently used in rituals (Cohen, 2007; Souza & Legare, 2011; Whitehouse, 2004) and thus intuitions about ritual efficacy may invoke the involvement of a supernatural agent at some level in the ritual sequence (Barrett & Lawson, 2001; Sørensen, Liénard, & Feeny, 2006). If supernatural agency is involved in the ritual efficacy evaluation process, ritualistic actions may not be constrained by the same physical-causal expectations as non-ritualistic actions (Barrett & Malley, 2007; Boyer, 2001).

An additional objective of this research is to examine the extent to which evaluating ritual efficacy generalizes to believers and nonbelievers as well as to cultural groups unfamiliar with the content of particular ritualistic belief systems. There may be important differences in reasoning about ritual between those that endorse particular supernatural worldviews (believers) and those that do not (nonbelievers or members of other cultural contexts unfamiliar with particular ritualistic practices). For instance, social psychological research on differences in reasoning about existentially arousing phenomena indicates that the awareness of mortality reliably increases the tendency to believe in supernatural agency for those that espouse religious beliefs (Norenzayan & Hansen, 2006). When mortality and cultural worldview threats are primed, nonbelievers are more likely than believers to denigrate a culturally threatening message, possibly because believers respond to existential threats with a religious stance that transcends their secular cultural identity (Norenzayan, Dar-Nimrod, Hansen, & Proulx, 2009).

### 1.1.1. Present studies

The objective of the current studies was to investigate the intuitive causal principles that are used to evaluate the efficacy of ritualistic action. To give empirical traction to this topic using ecologically valid content, data were collected in Brazil, a cultural context in which rituals or "recipes" – called *simpatias* – are available, endorsed, and used for everyday problem-solving purposes. *Simpatias* are ritualistic remedial procedures, and are not confined to any particular Brazilian religious group, although some of them do include religious information. They are used to solve a variety of everyday problems (e.g., sinusitis, asthma, depression, anxiety, lack of luck, and infidelity). *Simpatias* are available to the general population, are relatively low-cost, and do not require any specialized expertise to be performed.

We propose that studying how *simpatias* are evaluated from a cognitive perspective speaks directly to the general question of how people evaluate ritual efficacy, and thus provides a unique opportunity to use ecologically valid content to investigate reasoning about causally opaque events in particular and ritual cognition in general. An important aspect of cognitive science research involves weaving together different methods from different disciplines. An ecologically valid paradigm maximizes the best possible trade-off between internal and external validities (Markman, Beer, Grimm, Rein, & Maddox, 2010). The use of culturally meaningful content to create our experimental stimuli optimizes this trade-off for this research; our methods and materials thus closely approximated the real-life practices under investigation. We consider this innovative interdisciplinary methodology to be a core contribution of this research.

We hypothesized that information that reflects the defining characteristics of ritual such as frequency of repetition, number of procedural steps, and specificity of procedural detail will increase ritual efficacy evaluation because information of this kind reflects intuitive beliefs about causal potency. We also predicted that the presence of supernatural agents would impact the evaluation of ritual efficacy (Barrett & Lawson, 2001; Sørensen et al., 2006; Souza & Legare, 2011). Study 1 was designed to develop and assess the ecological validity of our experimental stimuli. Study 2 examined potential kinds of intuitive information or *criteria* that may influence how ritual efficacy is evaluated. Study 3 provided a more systematic investigation of the intuitive criteria that were found to influence the evaluation of ritual efficacy in Study 2 and explored the impact of these criteria on reasoning about ritual efficacy among believers. Study 4 examined the extent to which the findings from Studies 1–3 represent universal features of human cognition, using identical stimuli in a cultural context unfamiliar with these ritualistic practices (US sample).

## 2. Study 1

In order to explore the extent to which intuitive criteria influence evaluations of ritual efficacy, *simpatias* were designed experimentally (modeled after content and information available in real and widely available *simpatias*). The objective was to isolate and experimentally manipulate the kinds of information hypothesized to impact judgments of ritual efficacy. The objectives of Study 1 were (1) to identify the kinds of information that are widely available in *simpatias* in general in order to establish the ecological validity of the experimental stimuli and (2) to determine if *simpatias* could be randomly paired with the kinds of problems that *simpatias* are frequently used to treat. To this end, fifty *simpatias* were analyzed for content and common features. The *simpatias* were randomly selected from widely available sources, including popular websites, magazines, and books. Based on a quantitative analysis of the content of these *simpatias* and qualitative data from native speakers from this cultural community, the following nine criteria were identified as potentially

**Table 1**  
Criteria and experimental manipulations.

Criteria	Experimental manipulation	
Specificity of time	Time is specified (11)	Time is unspecified (23)
Specificity of place	Place is specified (14)	Place is unspecified (5)
Specificity of material	Type of material is specified (16)	Type of material is unspecified (12)
Repetition of procedures	Repetition of at least one component of the procedure (11)	No repetition (6)
Number of procedural steps	Smaller number of different steps (5)	Greater number of different steps (32)
Number of items	Smaller number of different items (7)	Greater number of different items (19)
Edibility	Edible items included (29)	Edible items not included (21)
Digestibility	Edible items ingested (19)	Edible items not ingested (22)
Religious icon	Presence of a religious icon (46)	Absence of a religious icon (4)

Numbers in parentheses are out of 50.

relevant to efficacy judgments based on widespread inclusion in *simpatias*: (1) specificity of time, (2) specificity of place, (3) specificity of material, (4) repetition of procedures, (5) number of procedural steps, (6) number of items used, (7) edibility (presence or absence of edible items), (8) digestibility (presence or absence of any sort of ingestion), and (9) religious icon (presence or absence of a religious icon). Table 1 provides an overview of the particular manipulation used for each of the nine criteria in addition to the frequency with which information of each kind occurred in the 50 *simpatias* analyzed.

Eighteen experimental *simpatias* aimed at resolving a variety of problems were designed to isolate and experimentally manipulate each of the nine criteria mentioned above. To ascertain the extent to which the experimental material we created was ecologically valid, two *simpatias* were designed per criterion. The manipulation varied only in content concerning the particular criterion being investigated. For example, for the specificity of time criterion, the manipulation consisted of either specifying the time that the *simpatia* should be performed or not specifying this information. The experimental *simpatias* were designed to address the same kinds of everyday and familiar problems that pre-existing *simpatias* are used to treat.

Using a between-subjects design, each of these nine criteria was manipulated individually in order to investigate its unique contribution. Here is an example of a *simpatia* designed to investigate the specificity of time on judgments of ritual efficacy:

*In the first day of last quarter phase of the moon, take the milk from a coconut and give it to the affected person to drink. After that, ask the person to spit three times in the hole made in the coconut. Following this, light up a brand-new white candle and drop the wax around the hole until the hole is sealed. Take the coconut to a far away beach or river.*

In the example above, the time when the *simpatia* should be performed is specified (i.e., *in the first day of last quarter phase of the moon*). The comparison condition was identical except that the information about when the *simpatia* should be performed was not provided (see Appendix A for all 18 experimentally designed *simpatias*). In addition to developing our experimental stimuli, we also sought to determine the extent to which our experimental *simpatias*

could be randomly paired with different problems and to assess their ecological validity.

## 2.1. Method

### 2.1.1. Participants

Sixty Brazilian Portuguese-speaking adults (36 females, 24 males) participated in Study 1. Participants were from the metropolitan area of the city of Belo Horizonte located in the southeastern region of Brazil. They were recruited from public health centers located in a low-income neighborhood of Belo Horizonte. The public health centers (known as *Posto de Saúde*) are centers maintained by the city administration and serve the population from the community in which the center is located. They differ from hospitals in that they do not deal with complex medical procedures such as surgery and life-threatening emergencies.

According to the Brazilian Institute of Geography and Statistics, Belo Horizonte has a population of over 6,082,776 people. The ethnic composition of the population is 41% Pardo (mixed-race), 12% White, and 47% Black. In terms of religious composition, over 68% of the population self-identify as Catholic, 19% Protestant, and 8% of the population reported not having any religious affiliation. Although the religious composition is somewhat mixed, the endorsement of *simpatias* exists across all religious groups.

### 2.1.2. Materials

To assess the extent to which the experimental *simpatias* could be randomly paired with particular problems and to assess their ecological validity, eighteen questionnaires were designed, two for each criterion. Each questionnaire consisted of a *simpatia* and a list of 18 problems (e.g., bronchitis, earache, anemia, toothache, asthma, sinusitis, coughing, headache, skin boils, sadness, lack of friends, depression,<sup>1</sup> lack of money, unemployment, lack of luck, infidelity, lack of love, and evil-eye<sup>2</sup>).

<sup>1</sup> In general, Depression is different from Sadness in terms of seriousness. Sadness (from the Portuguese *desânimo*) can be broadly defined as "lethargy" or a general lack of energy to accomplish physical and mental tasks. Depression is defined as the pathological state characterized by a long-lasting lethargy and lack of motivation.

<sup>2</sup> "Olho Gordo" in Brazilian Portuguese.

### 2.1.3. Procedure

Each participant was interviewed individually and asked to choose from the list of 18 problems the problem(s) he or she thought the simpátia would most effectively treat. Each participant was also given the opportunity to indicate that none of the problems would be resolved by the simpátia in question. In this case, the participant was asked to identify the problem(s) he or she thought the simpátia would be effective for. Given the relevance of the distinction between judgments of intention and judgments of efficacy, we used language that would query what the simpátia in question would be effective for and not what the simpátia was intended to treat. Each participant paired nine simpátias with a total of 18 candidate problems. Half of the participants saw simpátias from one version of the experimental manipulation (per criterion); the other half of the participants saw the other version.

## 2.2. Results and discussion

An 18 (simpátias) by 18 (problems) matrix was constructed from the choices participants made for each simpátia. For the purposes of assessing the ecological validity of individual simpátias, we analyzed each simpátia separately. Each cell of the matrix contained the number of participants who identified the specific problem-simpátia pair as valid.

None of the specific simpátia-problem pairs was chosen by more than 3% of the participants (i.e., more than nine participants). A Chi-square analysis of Association revealed no significant association between specific simpátias and specific problems ( $\chi^2 = 277.48$ ,  $df = 289$ ,  $p = ns$ ). Thus, in Study 2, each of the experimentally designed simpátias was randomly paired with one of the 18 problems. We also found evidence that the experimental simpátias were representative of simpátias in general. For example, in the process of answering questions about the simpátias, many of the participants spontaneously reported that they had used several of these particular simpátias themselves in the past.

## 3. Study 2

The objective of Study 2 was to investigate the extent to which the frequently occurring kinds of information identified in Study 1 (i.e., the nine criteria) influence the evaluation of ritual efficacy. We hypothesized that information consistent with intuitive beliefs about causal efficacy (i.e., frequency of an action, specificity of the action sequence) would increase ritual efficacy evaluation to a greater extent than familiar information (i.e., information that is frequently found in simpátias).

### 3.1. Method

#### 3.1.1. Participants

Eighty Brazilian Portuguese-speaking adults (53 females, 27 males) participated in Study 2. As in Study 1, participants were from the metropolitan area of the city

of Belo Horizonte, Brazil. The ages ranged from 21 to 45 years old ( $M = 33.39$ ,  $SD = 7.54$ ). They were also recruited from public health centers. None of the participants of Study 1 participated in Study 2.

#### 3.1.2. Materials

The 18 simpátias validated in Study 1 (two per criterion) were used to explore the nine intuitive criteria that we hypothesized influence ritual efficacy evaluation (see Appendix A). To assess the perceived efficacy of each simpátia, we used a Likert scale to answer questions about the efficacy of each simpátia.

#### 3.1.3. Procedure

Each session consisted of nine trials (one trial for each criterion); that is, each participant saw nine simpátias, each randomly paired with a specific problem. Half the participants were randomly assigned simpátias from one version of the experimental manipulation (per criterion); the other half saw the other version of the experimental manipulation. A native speaker of Brazilian Portuguese conducted the study and assisted with experimental design. Each simpátia and the subsequent questions were read to each participant individually. Each session lasted approximately 25–30 min. The order of presentation of simpátias was randomized between participants.

After the presentation of each simpátia, participants were asked to rate, using a Likert scale ranging from 1 (strongly agree) to 10 (strongly disagree), the extent to which they thought the simpátia would be effective for treating the specific problem. In all the analyses, ratings closer to 1 were considered more effective and ratings closer to 10 were considered less effective. Participants were also asked to indicate whether they currently use or have ever used simpátias before.

## 3.2. Results

The primary objective of Study 2 was to investigate the extent to which intuitive principles or criteria about rituals impact participants' ritual efficacy ratings. We directly compared the mean efficacy ratings of simpátias that differed only in the content of the experimentally manipulated (and isolated) information for each criterion.

The focal analyses concerned the extent to which individual manipulations (per criterion) impacted participants' efficacy ratings. Of the nine criteria examined, we found a statistically reliable difference between two items (simpátias) of the experimental manipulation for three criteria, namely, specificity of time, repetition of procedures, and number of procedural steps. The simpátia specifying time ( $M = 3.97$ ,  $SD = 2.32$ ) was rated as significantly more efficacious than the simpátia not specifying time ( $M = 5.12$ ,  $SD = 2.35$ ),  $t(77.9) = 2.20$ ,  $p < .05$ , Cohen's  $d = .50$ . Similarly, the simpátia specifying greater repetition of procedures ( $M = 4.70$ ,  $SD = 2.40$ ) was rated as significantly more efficacious than the simpátia with fewer repetition of procedures ( $M = 6.28$ ,  $SD = 2.50$ ),  $t(77.9) = 3.87$ ,  $p < .001$ , Cohen's  $d = .87$ . Additionally, the simpátia with a greater number of steps ( $M = 4.42$ ,  $SD = 3.14$ ) was rated as significantly

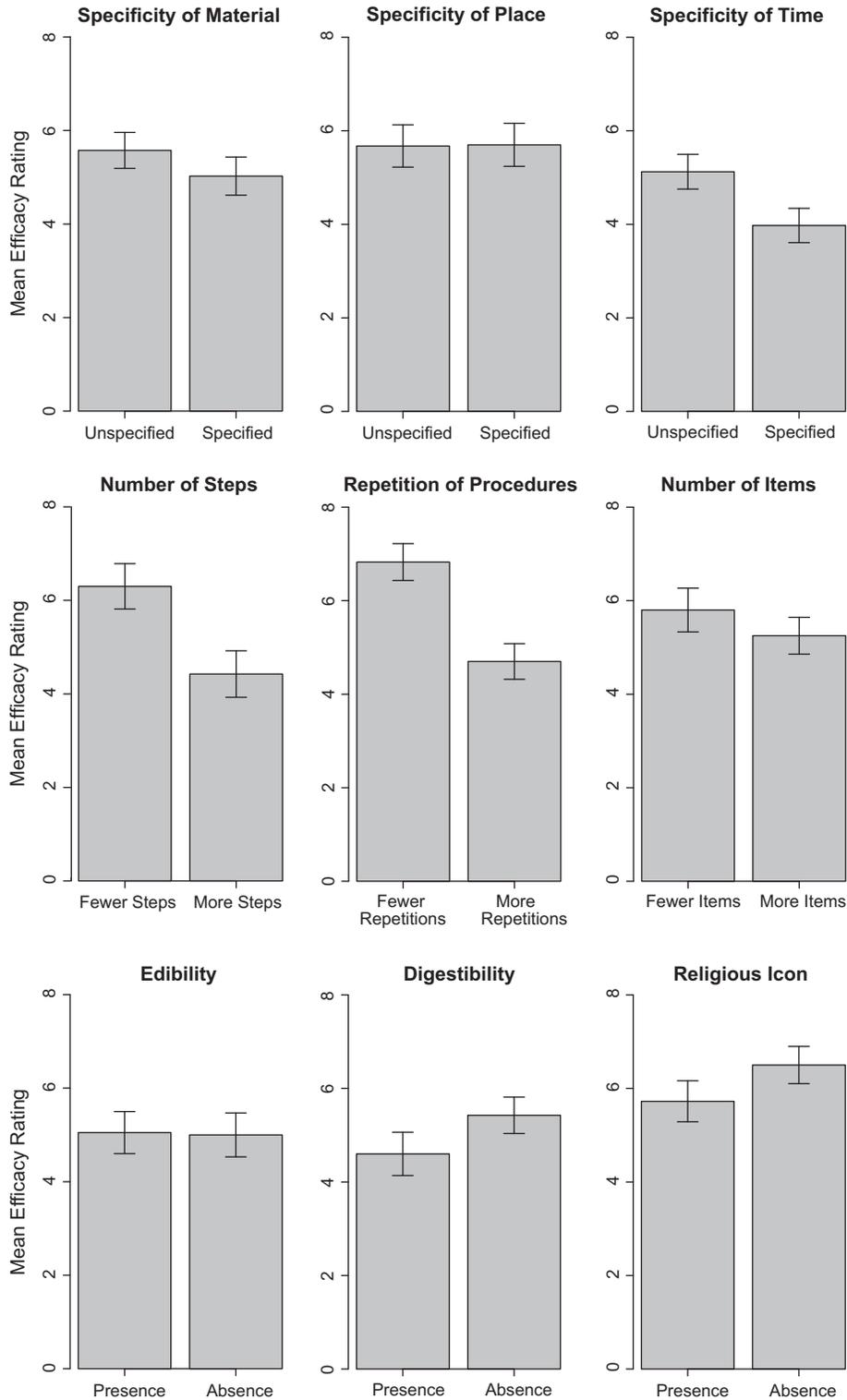


Fig. 1. Mean efficacy rating per criterion and condition for Study 2.

more efficacious than the simpata with fewer steps ( $M = 6.30$ ,  $SD = 3.07$ ),  $t(77.9) = 2.67$ ,  $p < .05$ , Cohen's

$d = .61$ . No other criteria showed a statistically significant difference between conditions (See Fig. 1).

Additionally, participants who reported that they do not use or had never used *simpatias* ( $N = 17$ ;  $M = 5.98$ ,  $SD = 2.77$ ) appeared to rate these rituals as less effective than those who used or had ever used *simpatias* ( $N = 63$ ;  $M = 5.20$ ,  $SD = 2.74$ ). Although these differences were not statistically significant, in Study 3 we asked participants a more explicit and direct question about whether they believed in *simpatias* and focused exclusively on those participants who endorsed the use of *simpatias* (believers).

### 3.3. Discussion

The primary objective of Study 2 was to explore the extent to which intuitive causal principles reflecting the defining characteristics of ritual impact the evaluation of ritual efficacy judgments. Specifically, more repetitive rituals (i.e., rituals specifying greater frequency of performing the ritual act) and more rigid or “stereotypical” rituals (i.e., rituals specifying a greater number of specific steps and rituals specifying a particular time the acts should take place) were perceived as more effective than rituals lower on these dimensions or lacking in this information.

Although the results of Study 2 support our initial hypothesis, a number of limitations needed to be addressed in order to make claims about the generalizability of our findings. For example, additional *simpatias* per criterion are needed to ensure that the experimental effects were not driven by particular content in the *simpatias* we designed. The sample in Study 2 also consisted of a mixed group of participants (those who endorsed using *simpatias* and those who did not). Given that participants who indicated they did not use *simpatias* tended to rate *simpatias* as less effective than those who did, it may be that use is representative of belief and that those who believe in the efficacy of *simpatias* in general are more strongly influenced by the hypothesized criteria than non-users (or nonbelievers).

## 4. Study 3

The objective of Study 3 was to examine more systematically the criteria identified in Study 2 that were found to impact evaluations of ritual efficacy. We created multiple *simpatias* per criterion (six *simpatias* per criterion in total, three per condition) in addition to modifying the content of the *simpatias* to more carefully control for complexity, ecological validity, and word length (see Appendix B). We also sought to examine the influence of belief on the evaluation of ritual efficacy. We selected a sample of believers who endorse the efficacy of *simpatias* and use them in their daily lives. Rather than retesting all criteria, we selected only those criteria that were found to influence ritual efficacy ratings in Study 2, in addition to the religious icon criterion.

### 4.1. Method

#### 4.1.1. Participants

Twenty-two Brazilian Portuguese-speaking adults (17 females, 5 males) participated in Study 3. Only participants

who indicated that they used and endorsed *simpatias* were included in this study and none of the participants in Study 3 participated in Studies 1 and 2. As in the previous two studies, participants were from the metropolitan area of Belo Horizonte, Brazil and were recruited from public health centers. The ethnic composition of the sample was comparable to the samples in Studies 1 and 2.

#### 4.1.2. Materials

Similar to Study 2, 24 *simpatias* were designed experimentally – six per criteria. For Study 3, we included only four criteria from Study 2: (1) specificity of time, (2) repetition of procedures, (3) number of procedural steps, and (4) presence of a religious icon. We designed six *simpatias* (3 pairs) per criterion (see Appendix B). As in Study 2, the experimental manipulation varied only in content concerning the particular criterion being investigated.

#### 4.1.3. Procedure

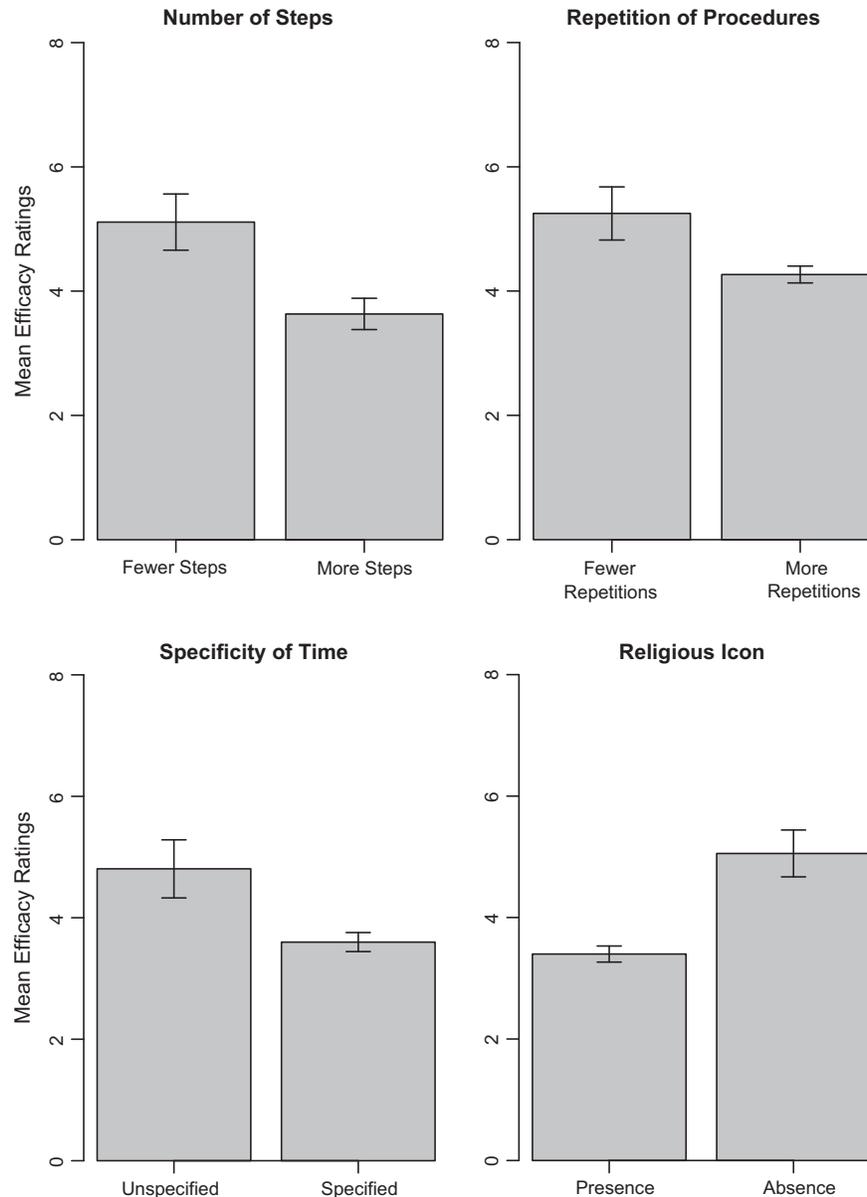
Each session consisted of 12 trials (three for each particular criterion); that is, each participant saw 12 *simpatias*, each paired with a specific problem. As in Study 2, half of the participants saw *simpatias* from one version of the experimental manipulation. A native speaker of Brazilian Portuguese conducted the study and assisted with experimental design. The *simpatias* and test questions were read to each participant individually. Each interview lasted approximately 25–30 min. The order of presentation was randomized between participants.

As in Study 2, after the presentation of each *simpatia*, participants rated the extent to which they thought the *simpatia* would be effective for treating the specific problem. In all the analyses, ratings closer to 1 were considered more effective and ratings closer to 10 were considered less effective. We also included a specific question about whether the participant believed in the efficacy of *simpatias* or not.

### 4.2. Results

There were two objectives of Study 3. The first was to systematically investigate the extent to which information about specificity of time, repetition of procedures, number of procedural steps, and presence/absence of a religious icon impacts ritual efficacy ratings. As in Study 2, we directly compared the mean efficacy ratings of *simpatias* that differed only in the content of experimentally manipulated information of each dimension. However, instead of including 1 pair of *simpatias* per criterion tested, as in Study 2, we included three pairs of *simpatias* per criterion (for a total of 12).

In addition to examining the extent to which efficacy ratings differed between categories per criterion, we aimed to examine the effect of this information on a sample of people who endorse and use *simpatias* (believers). As anticipated, the mean rating of efficacy ratings differed significantly for each kind of information examined (Fig. 2). *Simpatias* that included actions with a greater number of procedural repetitions ( $M = 4.26$ ,  $SD = .76$ ) were rated as significantly more effective than *simpatias* with less frequently repeated actions ( $M = 5.25$ ,  $SD = 2.56$ ),  $t(41.8) = 2.19$ ,  $p < .05$ , Cohen's  $d = .57$ . *Simpatias* that included a greater number of procedural steps ( $M = 3.63$ ,  $SD = 1.37$ ) were rated as significantly



**Fig. 2.** Mean efficacy rating per criterion and condition for Study 3.

more effective than simpatias with fewer procedural steps ( $M = 5.11$ ,  $SD = 2.71$ ),  $t(53.7) = 2.85$ ,  $p < .05$ , Cohen's  $d = .74$ . Additionally, simpatias that specified when they should be performed ( $M = 3.60$ ,  $SD = .85$ ) were rated as significantly more effective than simpatias that did not specify this information ( $M = 4.80$ ,  $SD = 2.86$ ),  $t(42.2) = 2.39$ ,  $p < .05$ , Cohen's  $d = .62$ . Finally, and in contrast to the results of Study 2, simpatias that included a religious icon ( $M = 3.40$ ,  $SD = .72$ ) were rated as significantly more effective than simpatias without a religious icon ( $M = 5.05$ ,  $SD = 2.31$ ),  $t(42.9) = 4.05$ ,  $p < .001$ , Cohen's  $d = 1.05$ .

Overall the sample of believers from Study 3 ( $M = 4.45$ ,  $SD = 2.13$ ) rated the simpatias (independent of the manipulation) as being more efficacious than the mixed sample of believers and nonbelievers in Study 2

( $M = 5.37$ ,  $SD = 2.76$ ), but differences in the actual materials used in each study preclude formal statistical analyses.

#### 4.3. Discussion

The objective of Study 3 was to examine more systematically the criteria identified in Study 2 that were found to impact evaluations of ritual efficacy. We created multiple simpatias per criterion (six simpatias per criterion in total, three per condition) in addition to modifying the content of the simpatias to more carefully control for complexity, ecological validity, and word length (see Appendix B). As in Study 2, we directly compared the mean efficacy ratings of simpatias that differed only in the content of experimentally manipulated information

of each dimension (i.e., specificity of time, repetition of procedures, number of procedural steps, and presence/absence of a religious icon). We also examined the influence of belief on the evaluation of ritual efficacy. We selected a sample of believers who endorse the efficacy of *simpatias* and use them in their daily lives. Rather than retesting all criteria, we selected only those criteria that were found to influence ritual efficacy ratings in Study 2, in addition to the religious icon criterion. We included this criterion in order to examine the effect of matching religious icons to the particular problems with which they are most frequently associated.

The results of Study 3 replicate the core results of Study 2. The mean rating of efficacy ratings differed significantly for each kind of information examined (Fig. 2). *Simpatias* that included actions with a greater number of procedural repetitions, a greater number of procedural steps, or that specified when they should be performed were rated as significantly more effective than *simpatias* that included fewer repetitions, fewer steps, or did not specify this information. In contrast to the results of Study 2, *simpatias* that included a religious icon were rated as significantly more effective than *simpatias* without a religious icon. Overall, the sample of believers from Study 3 rated the *simpatias* (independent of the manipulation) as being more efficacious than the mixed sample of believers and nonbelievers in Study 2.

## 5. Study 4

To investigate whether the findings from Studies 1–3 generalize to a different cultural context, we systematically investigated the extent to which information about specificity of time, repetition of procedures, number of procedural steps, and presence/absence of a religious icon impacts ritual efficacy ratings in a cultural group unfamiliar with these ritualistic practices (US adults). As in Study 3, we directly compared the mean efficacy ratings of *simpatias* that differed only in the content of experimentally manipulated information of each dimension and included three pairs of *simpatias* per criterion (for a total of 12).

### 5.1. Method

#### 5.1.1. Participants

Sixty-eight undergraduate students (45 females, 23 males) at a large research university located in the southwest of the United States participated in Study 4 for course credit.

#### 5.1.2. Materials

The materials were the same used in Study 3, except that they were translated into English by the second author.

#### 5.1.3. Procedure

Each session consisted of 12 trials (three for each particular criterion); that is, each participant saw 12 *simpatias*, each paired with a specific problem. As in Study 3, half of the participants saw *simpatias* from one version of the experimental manipulation. Stimuli were presented using SuperLab 4 for Windows. The order of presentation was randomized between participants.

As in Study 3, participants were asked to rate the extent to which they thought the *simpatias* would be effective for treating the specific problem. For consistency, in all the analyses, ratings closer to 1 were considered more effective and ratings closer to 10 were considered less effective.

### 5.2. Results

As in Study 3, the mean efficacy ratings differed significantly for procedural repetition, number of steps, and the presence of a religious icon (Fig. 3). *Simpatias* that included actions with a greater number of procedural repetitions ( $M = 7.90, SD = 2.06$ ) were rated as significantly more effective than *simpatias* with less frequently repeated actions ( $M = 8.45, SD = 1.82$ ),  $t(202) = -2.04, p = .042$ . *Simpatias* that included a greater number of procedural steps ( $M = 8.07, SD = 2.36$ ) were rated as significantly more effective than *simpatias* with fewer procedural steps ( $M = 8.66, SD = 1.83$ ),  $t(202) = -1.99, p = .048$ . Finally, *simpatias* that included a religious icon ( $M = 8.36, SD = 2.14$ ) were rated as significantly more effective than *simpatias* without a religious icon ( $M = 8.92, SD = 1.39$ ),  $t(202) = -2.19, p = .03$ . *Simpatias* that specified when they should be performed at a specified time ( $M = 7.29, SD = 2.65$ ) were not rated as significantly more effective than *simpatias* that did not specify this information ( $M = 7.59, SD = 2.20$ ),  $t(202) = -.88, p = .38$ .

As anticipated, overall the sample of believers from Study 3 ( $M = 4.45, SD = 2.13$ ) rated the *simpatias* (independent of the manipulation) as being more efficacious than the US sample in Study 4 ( $M = 8.18, SD = 2.16$ ).

### 5.3. Discussion

The objective of Study 4 was to examine the generalizability of our findings in a population (i.e., US undergraduates) unfamiliar with the content of these ritualistic practices (i.e., *simpatias*). Our results demonstrate that even with unfamiliar content, procedural repetition and the number of procedural steps increased ritual efficacy evaluations, findings consistent with the results of Studies 2 and 3. Although the trend was in the expected direction for time specificity, the results were not significant. Also consistent with Study 3, we found evidence that the presence of a religious icon increased the efficacy evaluation. Although the participants in Study 4 were unfamiliar with *simpatias*, one possible explanation for this finding is that appealing to religious idols (saints) for restorative or protective purposes is a common practice in Catholicism and thus may have been familiar to U.S. participants.

## 6. General discussion

One of the most remarkable characteristics of human cognition is the capacity to reason about the causal relationships and mechanisms that explain the world around us (Ahn & Kalish, 2000; Carey, 2009; Gopnik & Schulz, 2007; Keil & Wilson, 2000). Understanding causal reasoning is of long-standing interest in both psychological and anthropological disciplines (Boyer, 1995; Sperber, Premack, & Premack, 1995) due in large part to the fact that despite substantial cross-cultural variability in the content of causal beliefs (Leg-

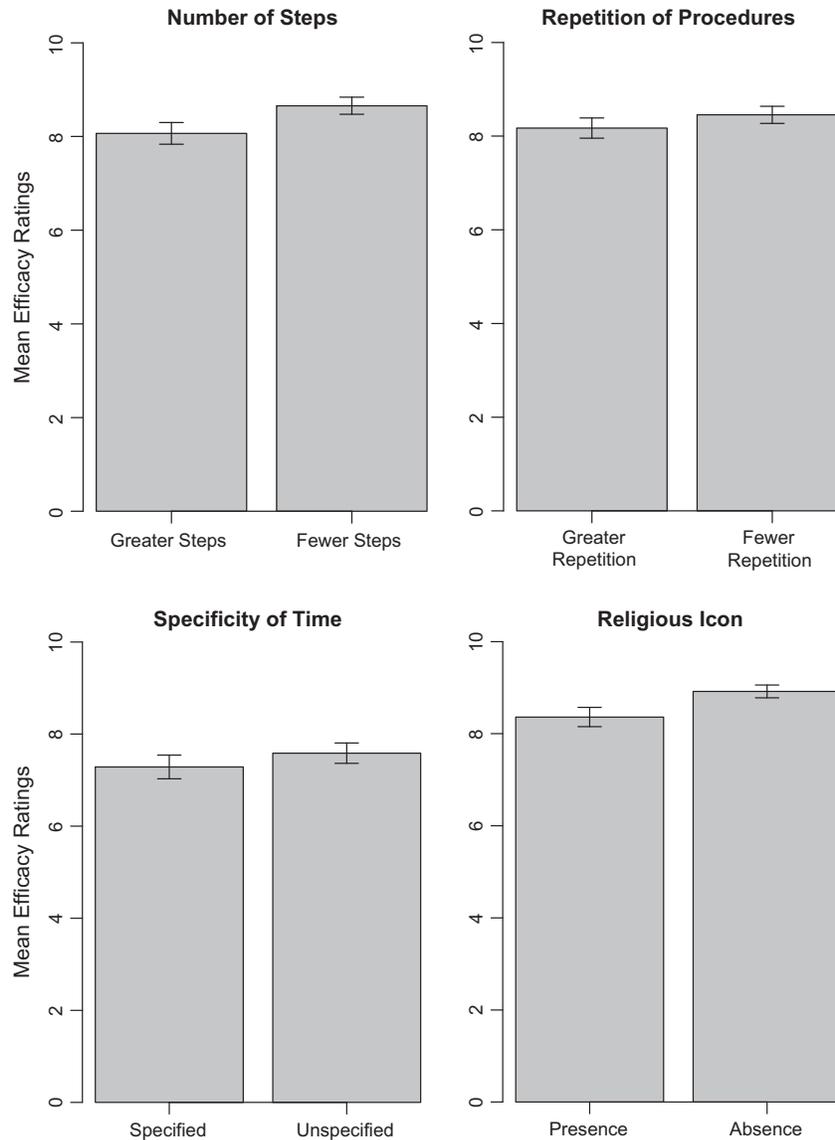


Fig. 3. Mean efficacy ratings for the US sample.

are, Evans, Rosengren, & Harris, 2012; Legare & Gelman, 2008), causal judgments are constrained by universal intuitive causal principles (Gopnik & Schulz, 2007; Shultz, 1982).

Despite substantial psychological evidence for our early developing (Baillargeon, Li, Gertner, & Wu, 2011; Keil, 2011) and sophisticated capacity to reason causally, we are frequently confronted with everyday experiences that we wish to understand or interpret and yet cannot explain causally. Reasoning about *causally opaque* events or outcomes (those lacking a causal explanation) is a pervasive feature of human cognition. We propose that examining how people reason about rituals used for problem-solving purposes provides unique insight into the more general question of how people reason about the efficacy of causally opaque actions.

To our knowledge, these are the first studies to investigate how ritual efficacy is evaluated from a psychological

perspective. The results provide support for our proposal that information reflecting intuitive causal principles (i.e., repetition of procedures, number of procedural steps (Studies 2–4), and procedural specificity (specificity of time, Studies 2 and 3) increase ritual efficacy evaluation. We propose that one possible explanation for the effects of frequency (i.e., repetition of the ritual act(s), a greater number of procedural steps) and greater specificity (i.e., time specificity) is that information of this kind activates intuitive causal principles that evolved to understand causal efficacy about real-world events.

In addition to the effects of repetition, greater number of procedural steps, and procedural specificity, and contrary to the results of Study 2, the results of Studies 3 and 4 demonstrated that *simpatias* that included a religious icon were perceived as more efficacious than *simpatias* without a religious icon. One possible explanation for

this difference between Studies 2 and 3 may be that the participants in Study 3 were believers and that the participants in Study 2 included both believers and nonbelievers. One possible explanation for the results of Study 4 is that although the participants in Study 4 were unfamiliar with *simpatias*, appealing to religious idols (saints) for restorative or protective purposes is a common practice in Catholicism and thus may have been familiar to US participants. Thus, data from Studies 3 and 4 support the proposal that association with a superhuman agent (Barrett & Lawson, 2001; Sørensen et al., 2006) impacts perceptions of ritual efficacy, especially for believers.

There is also evidence that content familiarity alone is not driving these effects; our data do not support the possibility that any kind of familiar information (or information typically found in *simpatias*) increases perceptions of ritual efficacy. Importantly, information about all 9 of the criteria tested in Study 1 are available in commonly used *simpatias* (Table 1) and thus, if familiarity alone was responsible for these effects, it follows that any kind of information frequently available in *simpatias* would influence the evaluation of ritual efficacy. However, we did not find evidence that familiar information in general increased ritual efficacy evaluation; the results from Study 2 demonstrated that information about where the *simpatia* should be performed, the number of items involved, where these items should come from or whether these items were edible or ingestible had no effect on ritual efficacy ratings. We also replicated our core effects in a population entirely unfamiliar with the culturally specific content of *simpatias* (Study 4). Likewise, we propose that these results cannot be explained by the labor or time-intensiveness of using particular kinds of information. Notably, not all criteria that would necessitate considerable effort on the part of the ritual actor increased the evaluation of ritual efficacy. For example, specifying the place the ritual should be performed, increasing the number of items required, or specifying the particular place a ritual artifact must come from were not found to impact the evaluation of ritual efficacy. We also found no evidence that information consistent with folkbiological beliefs about health and illness (i.e., edibility, digestibility) influenced ritual efficacy evaluation.

Our results are consistent with the hypothesis that ritual efficacy evaluation is driven by intuitive causal principles and thus are not contingent upon familiarity with ritualistic content. We examined the kinds of intuitive criteria hypothesized to influence ritual efficacy evaluation in three studies that included mixed populations of Brazilian believers and nonbelievers (Study 2), a homogeneous population of believers (Study 3), and participants from a cultural context unfamiliar with *simpatias* (Study 4). We examined the effect of our experimental manipulation on these particular populations based on previous research (Norenzayan et al., 2009) indicating that there are differences in how believers evaluate supernatural information. Although mean efficacy ratings were higher for participants in Study 3 (believers) than in Study 2 (mixed sample of believers and nonbelievers) and Study 4 (US adults), the core findings were consistent across each sample.

We propose that studying how *simpatias* are evaluated from a cognitive perspective speaks directly to the general

question of how people reason about and evaluate ritual efficacy. Additionally, these culturally specific rituals provide a unique opportunity to investigate ritual cognition. Whereas some rituals are part of controlled religious organizations, and therefore require the presence of an expert (Whitehouse, 2001), the kind of ritual examined in the present studies does not require specialized expertise and is not tied to particulars of religious denomination. This is noteworthy because the accessibility of *simpatias* allowed us to investigate the evaluation of ritual efficacy experimentally using ecologically valid content. Although the number of studies investigating ritual cognition has increased considerably in recent years (Boyer, & Liénard, 2006, 2008; Legare & Whitehouse, 2011; Whitehouse, 2001), prior experimental work has focused exclusively on artificial or novel rituals (Barrett, 2002; Barrett & Lawson, 2001; Sørensen et al., 2006) that are not based on authentic rituals belief systems. In contrast, the use of culturally meaningful content to create our experimental stimuli allowed us to closely approximate the real-life practices under investigation. We consider the innovative experimental methodology to be a core contribution of this research and hope that it will pave a new path for interdisciplinary approaches to the study of human cognition, one that treats ecological validity as an integral part of research in cognitive science.

In future research, it will be important to investigate the relative impact of particular kinds of information on the evaluation of ritual efficacy. Although our data demonstrate that the presence and amount of particular kinds of information influences how participants evaluate ritual efficacy, the relative contribution of different kinds of information remains unspecified. Due to the challenge of controlling for the non-binary nature of many of these criteria (e.g., procedural specificity), additional research is needed to examine the extent to which null effects on efficacy ratings for some criteria tested in Study 2 may reflect the difficulty of providing exactly equivalent (specified) conditions. Further research on how the intention of the ritual actor vs. the characteristics of the ritual action sequence influences the evaluation of ritual efficacy is also needed (Barrett, 2002) as well as additional research on the religious affiliation, gender, and age of participants. Finally, research exploring how perceived control (Whitson & Galinsky, 2008) and the treatability of the problem influence the extent to which ritualistic action is used would provide additional insight into reasoning about ritual efficacy.

The results of the present studies support our hypothesis that the structure of ritual can be interpreted in light of intuitive causal beliefs about action efficacy. We propose that rituals used for instrumental, problem-solving purposes reflect intuitive causal reasoning beliefs about the efficacy of goal-directed action sequences. We argue that the characteristics of ritual (i.e., rigidity, repetition; Tambiah, 1979) are the product of an evolved cognitive system (Atran & Norenzayan, 2004; Boyer & Liénard, 2006; Sørensen, 2007) of intuitive causal principles. By examining the 'hidden logic' of ritual (Sax, 2010) experimentally, we have demonstrated that ritual provides a uniquely informative context for studying causal cognition and that intuitive causal reasoning provides insight into the cognitive underpinnings of the evaluation of ritual efficacy.

**Appendix A. Studies 1 and 2: Experimental simpatias.**

Particular criterion	Unspecified	Specified
Specificity of time	Take the milk from a coconut and give it to the affected person to drink. After that, ask the person to spit three times in the hole made in the coconut. Following this, light a brand-new white candle and drop the wax around the hole until the hole is sealed. Take the coconut to a far away beach or river.	In the first day of last quarter phase of the moon, take the milk from a coconut and give it to the affected person to drink. After that, ask the person to spit three times in the hole made in the coconut. Following this, light a brand-new white candle and drop the wax around the hole until the hole is sealed. Take the coconut to a far away beach or river.
Specificity of place	Ask the person with the problem to lean against a wall and then make a mark of the person's height on the wall; hammer a nail at the mark. Take out three strands of hair from the person and wrap them around the nail. The problem will go away as the strands of hair unwrap from the nail.	Ask the person with the problem to lean against the kitchen wall and then make a mark of the person's height on the wall; hammer a nail in the mark. Take out three strands of hair from the person and wrap them around the nail. The problem will go away as the stands of hair unwrap from the nail.
Specificity of material	Purchase seven red apples. In the morning, before eating anything, peel the apples, eat them and save the peel. Right before going to bed, make a tea with the peel.	Collect seven red apples directly from an apple tree. In the morning, before eating anything, peel the apples, eat them and save the peel. Right before going to bed, make a tea with the peel.
Particular criterion	Fewer	Greater
Repetition of procedures	In a single day, the person with the problem should go to a crossroad. While there, the person should say: "Problem, stay here!" The person should not walk through the crossroad for 1 year.	For 5 days, the person with the problem should go to a crossroad. While there, the person should say: "Problem, stay here!" The person should not walk through the crossroad for 1 year.
Number of items	Throw a piece of the person's clothing into a streaming river unbeknownst to the person. As the river flows away, the problem goes away.	Throw a piece of the person's clothing, in addition to an object and a shoe that belongs to them, into a streaming river unbeknownst to the person. As the river flows away, the problem goes away.
Number of procedural steps	Get an orange, squeeze its juice out and bury its flesh for seven days. Drink the juice three times a day (morning, afternoon, and evening).	Get an orange, peel it, squeeze its juice and bury its flesh. Place the peel on top of the dirt. Drink the juice three times a day (morning, afternoon, and evening).
Particular criterion	Presence	Absence
Edibility	Fill a cup with milk and ask the person with the problem to spit inside the cup. Seal the cup and bury it upright before the sunrise.	Fill a cup with sand and ask the person with the problem to spit inside the cup. Seal the cup and bury it upright before the sunrise.
Digestibility	Get a living earthworm, cut it into three pieces, fry them, and add boiling water to make a tea. Give the tea to the person with the problem. The person should not know what is in the tea.	Get a living earthworm, cut it into three pieces, fry them, and add boiling water to make a bath. Give the person with the problem a bath using the solution. The person should not know what is in the bath solution.
Religious icon	Go to a streaming river and throw one of the persons' shirts in the river. Then say: "This shirt should take away the problem right away". Collect some of the water from this river and put it under an image of Virgin Mary in your house.	Go to a streaming river and throw one of the persons' shirts in the river. Then say: "This shirt should take away the problem right away". Collect some of the water from this river and put it somewhere in your house.

**Appendix B. Study 3: Experimental simpatias**

Specificity of time	Unspecified (any time)	Specified (specific time)
Simpatia 1 (Quit drinking)	Take out the water from a coconut and give it to the person to drink on any day that you choose. After that, ask the person to spit in the hole made in the coconut. Following that, light a brand-new white candle and drop the wax around the hole until the hole is sealed. Take the coconut to a far away beach or river.	In the first day of last quarter phase of the moon, Take out the water from a coconut and give it to the person to drink. After that, ask the person to spit in the hole made in the coconut. Following that, light a brand-new white candle and drop the wax around the hole until the hole is sealed. Take the coconut to a far away beach or river.
Simpatia 2 (Depression)	On any day of the month, throw a piece of the person's clothes into a streaming river unbeknownst to the person. As the river flows away, the problem goes away.	On the last day of the month, throw a piece of the person's clothes into a streaming river unbeknownst to the person. As the river flows away, the problem goes away.
Simpatia 3 (Quit smoking)	On a day of your choosing, buy seven red apples. Before eating anything, peel the apple, eat it and save the peel. Right before going to bed, make a tea with the peel.	On the first day of the month, buy seven red apples. Before eating anything, peel the apple, eat it and save the peel. Right before going to bed, make a tea with the peel.
Repetition of procedures	(Unspecified) One time	(Specified) Several times
Simpatia 1 (Sadness)	In a metal container, put the leaves of a white rose. After that, set fire to the leaves. Get the remaining ash from the leaves and put it in a small plastic bag. Take the small plastic bag and leave it at a crossroad. Do the procedure one time.	In a metal container, put the leaves of a white rose. After that, set fire to the leaves. Get the remaining ash from the leaves and put it in a small plastic bag. Take the small plastic bag and leave it at a crossroad. Repeat the procedure for 7 days in a row.
Simpatia 2 (Lack of friends)	Wear a white t-shirt for an entire day. After that, wash the t-shirt using salted water. Put the t-shirt to dry in the shade. After it has dried, fold the t-shirt and take it to a church.	Wear a white t-shirt for five days in a row. After that, wash the t-shirt using salted water. Put the t-shirt to dry in the shade. After it has dried, fold the t-shirt and take it to a church.
Simpatia 3 (Lack of love)	Light a candle on a saucer and pray our Father. After the candle finishes burning, get the saucer, wrap it in a white paper and bury it in a garden with lots of flowers. Do this one time. While burying the saucer, pray Hail Mary once.	Light a candle on a saucer and pray our Father. After the candle finishes burning, get the saucer, wrap it in a white paper and bury it in a garden with lots of flowers. Repeat this six times. While burying the saucer, pray Hail Mary.
Number of steps	Fewer steps	Greater steps
Simpatia 1 (Sexual performance)	Make a small bag with white cloth. Put inside it three leaves of guiné. Right after putting the leaves inside the white bag, close the small white bag. After closing the bag, put the small white bag with the guiné leaves inside a drawer where you keep your personal belongings.	Cut a piece of white cloth and make a small bag with it. Put inside it three leaves of guiné. Pray Hail Mary once and close the small bag. Then, rub the bag on your forehead, and then rub it on your neck. Put it inside a drawer where you keep your personal belongings.
Simpatia 2 (Lack of luck)	Get an orange that grows on a tree, squeeze the orange juice out and following that, bury its flesh. Drink the remaining juice from the orange three times a day (in the morning, then in the afternoon and again in the evening).	Get an orange, peel it, squeeze its juice and bury its flesh. Place the peel on top of the dirt. Pour some juice on the peel and some in the dirt. Drink the remaining juice three times a day (morning, afternoon and evening).
Simpatia 3 (Infidelity)	Go to a streaming river that has water flowing through it and throw a white handkerchief in this streaming river. Then say: "This handkerchief	Go to a streaming river, get down on your knees by the river bank, say the name of your partner and throw a white handkerchief in the river. Then

(continued on next page)

Appendix B (continued)

Specificity of time	Unspecified (any time)	Specified (specific time)
	should take away the cheating”. Collect some of the water from this river that has running water that you threw the handkerchief in and take some home.	say: “This handkerchief should take away the cheating”. Collect some of the water from this river, drink some of it, and take some home.
Religious icon	Presence	Absence
Simpatia 1 (Evil eye)	Put two leaves of <i>manjeriçao</i> inside a container with honey. Mix it well. After mixing it, spread some of it in your hands and place the rest of it, with a lid, under an image of <i>Virgin Mary</i> .	Put two leaves of <i>manjeriçao</i> inside a container with honey. Mix it well. After mixing it, spread some of it in your hands and place the rest of it, with a lid, in a cupboard in the kitchen.
Simpatia 2 (Lack of money)	Put 4 olives inside a bottle of wine, and leave them there for 15 days. After this period, put a cup of the wine next to the image of <i>São Expedito</i> and leave it there for 10 days.	Put 4 olives inside a bottle of wine, and leave them there for 15 days. After this period, put a cup of the wine in a flowered garden and leave it there for 10 days.
Simpatia 3 (Lack of employment)	Boil a cup of water with a few pieces of an apple. When it starts boiling, take the apple out and wait for the water to cool down. Drink a little bit of the water and put the rest under an image of <i>Saint Edwiges</i> .	Boil a cup of water with a few pieces of an apple. When it starts boiling, take the apple out and wait for the water to cool down. Drink a little bit of the water and put the rest in a crossroad.

Acknowledgements

We are grateful for funding from the James S. McDonnell Foundation Causal Learning Collaborative, the Fell Foundation at the University of Oxford, and a grant from the Cognition, Religion, and Theology Program funded by the John Templeton Foundation. We would like to thank Jacqueline Woolley, Patricia Herrmann, and an anonymous reviewer for helpful comments on previous versions of the manuscript and Brooke Wooley for assistance with transcription.

References

Ahn, W., & Kalish, C. W. (2000). The role of mechanism beliefs in causal reasoning. In F. C. Keil & R. A. Wilson (Eds.), *Explanation and cognition* (pp. 199–225). Cambridge, MA: The MIT Press.

Ashforth, A. (2001). An epidemic of witchcraft? The implications of AIDS for the post-apartheid state. In H. Moore & T. Sanders (Eds.), *Magical interpretations, material realities* (pp. 184–225). London, UK: Routledge.

Atran, S., & Norenzayan, A. (2004). Religion's evolutionary landscape: Counterintuition, commitment, compassion, communion. *Behavioral and Brain Sciences*, 27, 713–730.

Baillargeon, R., Li, J., Gertner, Y., & Wu, D. (2011). How do infants reason about physical events? In U. Goswami (Ed.), *The Wiley-Blackwell handbook of childhood cognitive development* (2nd ed., pp. 11–48). Oxford, UK: Blackwell.

Barrett, J. (2002). Smart gods, dumb gods, and the role of social cognition in structuring ritual intuitions. *Journal of Cognition and Culture*, 2, 183–193.

Barrett, J., & Lawson, T. (2001). Ritual intuitions: Cognitive contributions to judgments of ritual efficacy. *Journal of Cognition and Culture*, 1, 183–201.

Barrett, J., & Malley, B. (2007). A cognitive typology of religious actions. *Journal of Cognition and Culture*, 7, 201–211.

Bloch, M. (2004). Bringing ritual to mind: Psychological foundations of cultural forms. *Journal of the Royal Anthropological Institute*, 10, 202–203.

Boyer, P. (2001). *Religion explained*. New York, NY: Basic Books.

Boyer, P., & Liénard, P. (2006). Why ritualized behavior? Precaution systems and action-parsing in developmental, pathological and cultural rituals. *Behavioral and Brain Sciences*, 29, 1–56.

Boyer, P., & Liénard, P. (2008). Ritual behavior in obsessive and normal individuals: Moderating anxiety and reorganizing the flow of behavior. *Current Directions in Psychological Science*, 17, 291–294.

Boyer, P. (1995). Causal understandings in cultural representations: Cognitive constraints on inferences from cultural input. In D. Sperber, D. Premack, & A. Premack (Eds.), *Causal cognition: A multidisciplinary debate* (pp. 615–649). Oxford, UK: Oxford Medical Publications.

Carey, S. (2009). *The origin of concepts*. New York, NY: Oxford University Press.

Cohen, E. (2007). *The mind possessed: The cognition of spirit possession in Afro-Brazilian religious tradition*. Oxford, UK: Oxford University Press.

Cohen, E., & Barrett, J. (2008). When minds migrate: Conceptualizing spirit possession. *Journal of Cognition and Culture*, 8(1–2), 23–48.

Crowley, V. (1989). *Wicca: The old religion in the new age*. London, UK: The Aquarian Press.

Csordas, T. J. (2002). *Body/meaning/healing*. New York, NY: Palgrave Macmillan.

Gopnik, A., & Schulz, L. (Eds.). (2007). *Causal learning: Psychology, philosophy, and computation*. Oxford, UK: Oxford University Press.

Hume, D. (1740). *A treatise of human nature* (1967 ed.). Oxford, UK: Oxford University Press.

Humphrey, C., & Laidlaw, J. (1994). *The archetypal actions of ritual*. Oxford, UK: Oxford University Press.

Hutton, R. (1999). *The triumph of the moon: A history of modern pagan witchcraft*. Oxford, UK: Oxford University Press.

Keil, F. C. (2011). Science starts early. *Science*, 331, 1023–1033.

Keil, F. C., & Wilson, R. (Eds.). (2000). *Explanation and cognition*. Cambridge, MA: The MIT Press.

Legare, C. H., & Whitehouse, H. (2011). *The development of social learning mechanisms*. Paper presented at the Society for Research in Child Development Biennial Meeting, Montreal, Canada.

Legare, C. H., Evans, E. M., Rosengren K. S., & Harris, P. L. (2012). The coexistence of natural and supernatural explanations across cultures and development. *Child Development*, in press.

Legare, C. H., & Gelman, S. A. (2008). Bewitchment, biology, or both: The co-existence of natural and supernatural explanatory frameworks across development. *Cognitive Science*, 32, 607–642.

Markman, A. B., Beer, J. S., Grimm, L. R., Rein, J. R., & Maddox, W. T. (2010). The optimal level of fuzz: Case studies in a methodology for psychological research. *Journal of Experimental and Theoretical Artificial Intelligence*, 21, 197–215.

Norenzayan, A., Dar-Nimrod, I., Hansen, I. G., & Proulx, T. (2009). Mortality salience and religion: Divergent effects on the defense of cultural values for the religious and the non-religious. *European Journal of Social Psychology*, 39, 101–113.

- Norenzayan, A., & Hansen, I. G. (2006). Belief in supernatural agents in the face of death. *Personality and Social Psychology Bulletin*, 32, 174–187.
- Oppenheimer, D. M. (2008). The secret life of fluency. *Trends in Cognitive Science*, 12, 237–241.
- Sax, W. S. (2004). Healing rituals: A critical performative approach. *Anthropology and Medicine*, 11, 293–306.
- Sax, W. S., Quack, J., & Weinhold, J. (2010). *The problem of ritual efficacy*. Oxford, UK: Oxford University Press.
- Sax, W. S. (2010). Ritual and the problem of efficacy. In W. S. Sax, J. Quack, & J. Weinhold (Eds.), *The problem of ritual efficacy* (pp. 3–16). Oxford, UK: Oxford University Press.
- Scharf, R. (2010, February 18). How to get a husband the Brazilian way. <<http://deepbrazil.com/2010/02/18/how-to-find-a-husband-the-brazilian-way/>>.
- Scott, R., & Dienes, Z. (2008). The conscious, the unconscious, and familiarity. *Journal of Experimental Psychology: Learning, Memory and Cognition*, 35, 1264–1288.
- Shultz, T. R. (1982). Rules of causal attribution. *Monographs of the Society for Research in Child Development*, 47, 1–51.
- Sørensen, J. (2007). *A cognitive theory of magic*. Lanham, MD: Rowman Altamira Press.
- Sørensen, J., Liénard, P., & Feeny, C. (2006). Agent and instrument in evaluations of ritual efficacy. *Journal of Cognition and Culture*, 6, 463–482.
- Souza, A. L., & Legare, C. H. (2011). The role of testimony in the evaluation of religious expertise. *Religion, Brain & Behavior*, 2, 1–8.
- Sperber, D., Premack, D., & Premack, A. (Eds.). (1995). *Causal cognition: A multidisciplinary debate*. Oxford, UK: Oxford Medical Publications.
- Tambiah, S. J. (1979). A performative approach to ritual. *Proceedings of the British Academy*, 45, 113–169.
- The papyrus ebers*. (1931). (C. P. Bryan, Trans.). New York, NY: D. Appleton and Company.
- The papyrus ebers*. (1937). (B. Ebbell, Trans.). Copenhagen, Denmark: Levin & Munksgaard.
- Whitehouse, H. (2001). Transmissive frequency, ritual, and exegesis. *Journal of Cognition and Culture*, 1, 167–182.
- Whitehouse, H. (2004). *Modes of religiosity: A cognitive theory of religious transmission*. Oxford, UK: Altamira Press.
- Whitehouse, H., & McCauley, R. (Eds.). (2005). *Mind and religion: Psychological and cognitive foundations of religiosity*. Oxford, UK: Altamira Press.
- Whitson, J., & Galinsky, A. (2008). Lacking control increases illusory pattern perception. *Science*, 322, 115–117.
- Zajonc, R. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology Monographs*, 9, 1–27.