Embodiment in Religious Knowledge

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ABSTRACT

Increasing evidence suggests that mundane knowledge about objects, people, and events is grounded in the brain's modality-specific systems. The modality-specific representations that become active to represent these entities in actual experience are later used to simulate them in their absence. In particular, simulations of perception, action, and mental states often appear to underlie the representation of knowledge, making it embodied and situated. Findings that support this conclusion are briefly reviewed from cognitive psychology, social psychology, and cognitive neuroscience. A similar representational process may underlie religious knowledge. In support of this conjecture, embodied knowledge appears central to three aspects of religious experience: religious visions, religious beliefs, and religious rituals. In religious visions, the process of simulation offers a natural account of how these experiences are produced. In religious beliefs, knowledge about the body and the environment are typically central in religious frameworks, and are likely to affect the perception of daily experience. In religious rituals, embodiments appear central to conveying religious ideas metaphorically and to establishing them in memory. To the extent that religious knowledge is like non-religious knowledge, embodiment is likely to play central roles.

When most lay people hear the term, "knowledge," they think of material acquired explicitly in formal education, such as knowledge of history or algebra. They also think of products that result from academic inquiry,

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such as scientific theories and findings. What people often fail to realize is that their cognitive systems contain tremendous amounts of mundane knowledge that enter into every facet of cognitive activity, from relatively simple perceptual processing to complex socio-cultural reasoning. Mundane knowledge remains hidden from view given that, to a large extent, it is acquired and used unconsciously. Because mundane knowledge is essential for effective cognition, the mechanisms that underlie it have important biological origins and operate relatively automatically. Clearly experience is also central. Nevertheless, the mechanisms that encode, store, and retrieve knowledge are present at birth, and operate automatically and unconsciously to a large extent from then on. Across the lifetime, extensive amounts of mundane knowledge accrue that are central to acting effectively in the world.

The Nature of Mundane Knowledge

Mundane knowledge exists for virtually every aspect of experience. People have mundane knowledge about physical objects (e.g., animals such as dogs; artifacts such as chairs), physical settings (e.g., geographical entities such as forests; dwellings such as houses), complex events (e.g., naturally occurring events such as storms; cultural events such as weddings), simple actions and behaviors (e.g., human actions such as pounding; animal behaviors such as flying), mental states (e.g., emotions such as happiness; cognitive operations such as reasoning), properties (e.g., physical properties such as roundness; social properties such as cooperativeness; mental properties such as intelligence), relations (e.g., spatial relations such as insideness; causal relations such as intending), and so forth.

In general, people have the ability to focus on components of experience, and to then establish categorical knowledge about these components (e.g., Barsalou, 1999, 2003a). Over time, people focus on a particular component of experience repeatedly, and establish categorical knowledge about it. As people focus attention repeatedly on dogs, for example, memories of these entities are extracted and integrated, relatively unconsciously, to establish categorical knowledge about them. By similarly focusing attention on specific types of settings, events, actions, mental states, properties, and relations, categorical knowledge develops in all these domains as well (cf. Keil, 1989; Sommers, 1963). Human knowledge consists of categorical knowledge for thousands of components that have been processed in this manner. For many of these categories, words become learned that can be used when referring to them. Many categories, however, do not have associated words (e.g., categories for various tastes, shapes, moods, etc.).

Although categorical knowledge is extracted out of the situations in which it occurs, it nevertheless retains information about these situations. As people extract categorical knowledge about *DOGS*, for example, they do not simply represent information about dogs in isolation.[1] Instead, they also represent the settings, events, and mental states that occur in these situations, given that this information is central to interacting with dogs effectively. Thus, categorical knowledge is typically situated in relevant background knowledge (e.g., Barsalou, 2003b; Barsalou & Wiemer-Hastings, in press; Murphy & Medin, 1985; Yeh & Barsalou, 2004).

Mundane knowledge is not a detached system that represents isolated facts about the world, which people can look up, as if consulting an encyclopedia. Instead, mundane knowledge permeates every aspect of cognitive activity from high to low cognition (e.g., Barsalou, 1999, 2003b). As people interact with the environment during goal pursuit (i.e., online cognition), mundane knowledge contributes in three ways. First, it supports perception, predicting the entities and events likely to be perceived in a scene, thereby speeding their processing. Mundane knowledge also contributes to the construction of perceptions through figure-ground segregation, anticipation, filling in, and other perceptual inferences. Second, mundane knowledge supports the potential categorization of everything perceived in a situation. As people perceive objects, settings, events, actions, mental states, properties, relations, etc., they use mundane knowledge to establish their category membership. Third, once an entity has been assigned to a category, category knowledge provides rich inductive inferences that guide interactions with it. Rather than starting from scratch during these interactions, agents benefit from category knowledge in memory. Such inferences provide an important source of expertise about everyday activities.

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[1] Italics will be used to indicate concepts, and quotes will be used to indicate linguistic forms (words, sentences). Thus, *DOGS* indicates a concept, and “dogs” indicates the corresponding word. Within concepts, uppercase words will represent categories, whereas lowercase words will represent properties of categories (e.g., *DOGS* vs. *paws*).

Besides being central to online processing of the environment, mundane knowledge is central to processing during memory, language, and thought (i.e., offline cognition). In each of these activities, a non-present situation is processed, with perception of the current environment being suppressed to facilitate processing of the imagined situation (Glenberg, Schroeder & Robertson, 1998). During memory, a past situation is evoked. During language, conversants often represent past and future situations, and also situations that have never occurred. During thought, a wide variety of situations are assessed to support decision making, problem solving, planning, and causal reasoning. In all three forms of offline processing, mundane knowledge plays central roles. In memory, mundane knowledge provides elaborative inferences at encoding, organizational structure in storage, and reconstructive inferences at retrieval. In language, mundane knowledge contributes to the meanings of words, phrases, sentences, and texts, and also to the knowledge-based inferences that go beyond them. In thought, mundane knowledge provides representations of the objects and events on which reasoning processes operate.

Besides supporting online and offline processing, mundane knowledge supports the productive construction of novel concepts (e.g., Hampton, 1997; Rips, 1995; Wisniewski, 1997). The conceptual system is not limited to representing entities and events that a person has experienced in the world. Because the conceptual system establishes mundane knowledge about *components* of experience, it can combine representations of these components in novel ways to represent novel entities. Thus, people can combine categorical knowledge for *purple* and *SAND* to represent the novel category, *PURPLE SAND*. This process allows people to categorize novel entities during online processing, and to represent these entities offline in language and thought This powerful capability allows humans to envision non-present situations, thereby increasing their evolutionary fitness (e.g., Donald, 1991). Rather than simply reacting to external and internal stimuli in the current situation – the dominant mode of cognition for most other species – humans can analyze non-present situations systematically, plan actions deliberately far into the future, and use division of labor effectively to coordinate group activity.

Finally, mundane knowledge is widely recognized as being central to social and cultural cognition. For decades, social psychologists have shown that knowledge of stereotypes, traits, situations, and so forth is central to social perception, attribution, and interaction (e.g., Kunda, 1999; Wyer & Srull, 1984a, b, c). Similarly, anthropologists have long argued that cultural knowledge of plants, artifacts, rituals, beliefs, and so forth are central to cultural identity and practice (e.g., Berlin, Breedlove & Raven, 1974; Shore & Bruner, 1998).

Knowledge in Religion

Given the universal importance of knowledge across the spectrum of cognitive activities, it is likely to be important in religious cognition as well. Knowledge clearly enters into people's religious beliefs (e.g., Barrett, 2000; Boyer, 1994, 2001). In particular, beliefs about the self, the universe, and deities constitute central forms of religious knowledge. In principle, some religious knowledge could have a biological or even purely spiritual basis. For the most part, though, we assume that religious beliefs are acquired, and thus focus on acquired religious beliefs.[2]

Knowledge also enters into religious institutions and practices. People have knowledge about churches, religious organizations, clergy, and so forth. People also have knowledge about how to perform rituals, along with the associated meanings. Knowledge further represents courses of religious development that might occur as a person practices a religion over time, along with various things that can go awry, the divergence of possible paths at various points, and many other related matters.

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[2]Note that we are using "knowledge" in a relatively general sense throughout this article. Specifically, we do not draw the sharp distinction between knowledge and belief typically found in philosophy (e.g., Carruthers, 1992; Lehrer, 1990). That is, we do not assume that knowledge is solely information about the world that is likely to be true. Similarly, we do not assume that a person has strong justification for believing something that we refer to as knowledge, nor that it is coherent. Instead, we group together a broad collection of representations that people have about the world and themselves, ranging from coherent systems of validated knowledge to incoherent fragments of tentative beliefs. Consistent with broad usage across the cognitive science community, we simply assume that knowledge is information stored in memory used to guide intelligent action. More specifically, we assume that knowledge consists of representations about components of experience, along with collections of these components, as described earlier. Because religious beliefs can be viewed as assemblies of componential representations that guide action, we assume that they constitute a form of knowledge.

Knowledge appears no less central to religious cognition than to mundane cognition. In later sections, we explore several possible roles further.

Overview

In the next section, we review two basic approaches to the representation of knowledge. Whereas amodal theories currently dominate the study of knowledge, embodied theories offer a recently revived alternative. In the subsequent section, we illustrate the evidence that is accruing for embodied theories of knowledge in cognitive psychology, social psychology, and cognitive neuroscience. Increasingly, empirical evidence suggests that knowledge is grounded in the brain's modality-specific systems. In the final section, we suggest implications of the embodied approach for religious knowledge. In particular, we explore possible roles of embodied knowledge in religious visions, religious beliefs, and religious rituals.

We do *not* claim that embodiment explains everything about the roles of knowledge in religious experience. Instead, our message is simply that embodiment may be one important factor in a complex account.

Theories of Knowledge in Cognitive Science

Because knowledge plays central and ubiquitous roles in the cognitive system, theories of knowledge have been proposed continually across the millennia. A simple distinction between classes of theory will be of primary interest here. On the one hand, amodal theories propose that knowledge consists of arbitrary amodal symbols. On the other hand, modal – or embodied – theories propose that knowledge is grounded in the brain's modality-specific systems. Each approach is summarized in turn.

Amodal Theories of Knowledge

Amodal theories largely developed in the second half of the twentieth century, following the cognitive revolution. To a large extent, they reflected major developments in logic, applied mathematics, and programming languages during the early to mid-twentieth century. As new theories of cognition developed, their assumptions about knowledge drew heavily on these recent historical antecedents.

Although amodal theories differ widely in form, they share a common underlying assumption: *the transduction principle*. This principle first assumes that the experience of a perceived situation produces representations in the brain's modality-specific systems. A living room scene, for example, produces visual representations in the brain's visual and spatial systems for perceived objects. Sitting down in a chair and feeling it activates motor programs and tactile representations in the motor and somatosensory systems. Music on a stereo produces auditory representations in the brain's auditory areas. Emotional responses to the music utilize representations in the brain's affective systems, such as feeling pleasure. Other internal states might also arise while sitting in the chair that similarly utilize representations in the respective modality-specific systems, such as states for hunger and thirst being represented in the systems that process motivation. As this example illustrates, a given experience produces a complex multi-modal representation distributed across the brain's modality-specific systems. As this example further illustrates, some of these states represent the external world (vision, movement, touch, audition), whereas others represent the agent's internal states (emotion, motivation).

According to the transduction principle, amodal symbols are transduced from this experience to represent it in knowledge. Thus, amodal symbols are transduced to represent the visual experience, such as the presence of a chair, table, and lamp in a living room. Similarly, amodal symbols are transduced to represent the sounds, actions, touches, emotions, and motivations experienced. Once the transduction process is complete, a symbolic description of the experience subsequently represents it in memory. Across many similar experiences, symbols similarly transduced from them become integrated to establish knowledge for the specific type of situation (i.e., living rooms), and for the various entities, events, and states encountered in it (e.g., chairs, sitting, music, pleasure, thirst).

Most importantly, these symbols represent the situation and its components in subsequent conceptual processing. When people are asked to describe a living room, they retrieve the transduced symbols that represent it, and then express these symbols using words associated with them. On retrieving transduced symbols for *CHAIR* and *PLEASURE*, the corresponding words, "chair" and "pleasure" are produced. Notably, the original modality-specific symbols that produced these transductions do not become active. Not only are they typically inactive during conceptual processing of the scene, they are not necessary for doing so. Instead, all meaning about the scene is purportedly carried in the amodal symbols.

These transduced representations play central roles in all the cognitive activities described earlier. As people categorize entities and events in situations, amodal symbols represent these categories, and associated amodal symbols produce knowledge-based inferences that go beyond the information given. As people store memories of situations, configurations of amodal symbols that describe these situations constitute memories of them. As people use language, they represent the meanings of sentences with amodal symbols. As people think, they manipulate collections of amodal symbols to reach various conclusions.

The transduction principle underlies the theories of knowledge that have dominated cognitive science since the cognitive revolution, including semantic networks, feature lists, frames, schemata, and predicate calculus (cf. Barsalou & Hale, 1993; Smith & Medin, 1981). In all of these theories, amodal symbols transduced from modality-specific representations are assumed to represent the properties, relations, and concepts that constitute knowledge. Even more recent, relatively radical approaches, such as exemplar and connectionist theories, often assume the transduction principle as well (although some depart from it, as discussed in the next section). When an exemplar theory assumes that amodal symbols represent exemplars, it shares the transduction principle with all these other theories. Similarly, when a connectionist net assumes that a layer of hidden units – originally linked to the input layer by random weights – redescribes perceptual inputs to establish a conceptual level of representation, then it, too, shares the transduction principle. In general, there has been widespread acceptance throughout cognitive science for decades that amodal representations underlie knowledge – not modality-specific representations.

Embodied Theories of Knowledge

Prior to the cognitive revolution, theories of knowledge took a very different form. Most philosophers who theorized about knowledge assumed that images played a central role in representing it. Images were not only central for empiricists like Locke and Berkeley, but also for nativists like

Kant and Reid (Barsalou, 1999; Prinz, 2002). Clearly, these accounts differed in important ways, but typically they included the assumption that images play some role in representing knowledge. Following the cognitive revolution, theorists were so captured by formal developments in logic, statistics, and programming languages that they abandoned image-based approaches. Instead, they adopted the amodal approaches just described, which have since dominated theories of knowledge.

Two factors, however, are precipitating a return to earlier views. First, problems with amodal symbols and the transduction principle have become increasingly salient (e.g., Barsalou, 1999; Glenberg, 1997; Lakoff, 1987; Newton, 1996; Searle, 1980). For example, theorists have failed to provide mechanistic accounts of the transduction principle, and no compelling account of how amodal symbols are linked to perception and action has been provided. Furthermore, a strong empirical case for the existence of amodal symbols in the brain has not been made. Second, neural approaches have increasingly implicated the brain's modality-specific systems in the representation of knowledge (e.g., Cree & McRae, 2003; Damasio, 1989; Damasio & Damasio, 1994; Humphreys & Forde, 2001; Martin, 2001; Pulvermüller, 1999; Simmons & Barsalou, 2003; Warrington & McCarthy, 1987). The later section on neural evidence for embodied knowledge provides specific examples of these findings.

Although earlier image-based approaches to representing knowledge are being reinvented in diverse forms, they generally tend to share what we will call *the simulation principle*. Like the transduction principle, the simulation principle assumes that modality-specific states become active as people experience a situation (e.g., visual, auditory, motor, touch, affective, motivational states). Where the two principles diverge is in what happens next. Whereas the transduction principle assumes that amodal symbols are transduced to represent the experience, the simulation principle assumes that the original modality-specific states are partially captured to represent it. Rather than creating a new symbolic level for conceptual purposes, existing representations are captured to serve double duty, not only as modality-specific representations, but also as conceptual representations.

The form of this capture varies widely across approaches. In traditional philosophical approaches, the assumption was that the mind stores mental images during perception for later use in conception. In many current theories, however, this process is viewed in more neural terms. As neural states become active in modality-specific systems during interaction with the environment, association areas become active to capture these states. Damasio (1989) utilized this basic architecture in his convergence zone theory, which Simmons and Barsalou (2003) developed to explain lesion-based deficits in category knowledge.

Regardless of whether a modal approach takes a mentalistic, cognitive, or neural stance, what they all share is the idea that modality-specific states captured in actual experiences are used later for conceptual purposes. When someone hears the word "chair," for example, a subset of the modality-specific states experienced previously for chairs are simulated (i.e., reenacted) to represent the word's meaning. These may include visual, motor, somatosensory, and affective states, among others. Notably, the original modality-specific states are not *fully* reenacted. Instead, these states are only *partially* reenacted, such that the represented information is relatively sketchy, incomplete, and perhaps distorted. Most importantly, though, the idea of a chair is not represented by amodal symbols transduced from experiences for chairs – instead it is represented by modality-specific states experienced while interacting with them.

According to this theoretical perspective, the process of simulation underlies the roles of knowledge across the spectrum of cognitive activities (e.g., Barsalou, 1999, 2003b). During categorization of entities and events in the environment, modality-specific representations in perception activate the best matching modality-specific representations associated with categories in memory. Once the best fitting category has been found, simulations of non-perceived entities and events carry knowledge-based inferences that serve goal pursuit. On perceiving a hammer, for example, visual representations of hammers best fit the input, such that the category of *HAMMER* is applied to the object. As a result, simulations about how to use a hammer, such as nailing two boards together, become active, thereby carrying a functional inference about the object. In later remembering the object, a simulation of it is evoked, as opposed to the retrieval of transduced symbols that describe it. When hearing language about the object, people simulate the situation described. When reasoning about the object, people simulate the relevant situation and manipulate the simulation to reach conclusions.

A wide variety of approaches incorporate the simulation principle in one way or another. For example, exemplar theories sometimes assume that an exemplar is the storage of a modality-specific state, such as an implicit memory, rather than an amodal description of an exemplar. Similarly, connectionist theories often assume that modality-specific states are captured for later representational use, rather than being recoded with hidden-layer units (e.g., as in auto-associative nets). Neural theories of imagery widely make this assumption, namely, a mental image is a neural reenactment of a modality-specific state. Mental imagery differs from conceptual processing in that the simulations underlying imagery may typically be conscious, whereas the simulations underlying conceptual processing may often be unconscious.

More broadly, the simulation principle belongs to a family of theories that all ground knowledge in its physical context. According to these theories, knowledge depends inherently on the brains, bodies, and environmental situations in which it resides, rather than existing independently of them. Different theories emphasize different aspects of physical contexts in the representation of knowledge. Whereas simulation theories focus on roles of modality-specific systems, embodied theories focus on roles of bodily states, and situated theories focus on roles of environmental situations. As we will see, all three forms of physical context play central roles. For convenience, and following current usage, we will refer to this family of theories as *embodied theories of knowledge*. It is important to remember, though, that *embodiment* refers generally to the entire physical context of cognition, including not just bodily states, but also modality-specific systems and environmental situations.

Evidence for Embodied Theories of Knowledge

Given how central the transduction principle has been in modern theories of knowledge, one would think that it would have received intense empirical investigation. To the contrary, no research to our knowledge has explicitly attempted to establish that a transduction process occurs. Furthermore, relatively few findings attempt to establish the simpler conclusion that amodal symbols reside in the cognitive system, and typically these findings are open to alternative interpretation (Barsalou, 1999). Instead, amodal symbols and the transduction principle have been largely adopted for theoretical purposes. On the one hand, this approach allows theorists to express the content of knowledge and the operations on it in formal terms. On the other hand, this approach allows researchers to implement theories of knowledge on computers, thereby producing machine intelligence. And, as mentioned earlier, this approach fits well with the zeitgeist of the cognitive revolution.

Nevertheless, basic theoretical assumptions ultimately require empirical evidence. If amodal symbols are transduced from modality-specific experience, it should be possible to establish evidence of this process, and to localize it in the brain. Nevertheless, such evidence is still not forthcoming. To the contrary, increasing evidence has accrued in recent years for the simulation view. Indeed, if the argument were to be decided on purely empirical grounds at this point in time – as opposed to purely theoretical ones – there would be no contest. Across cognitive psychology, social psychology, and cognitive neuroscience, increasing empirical evidence implicates modality-specific states in the representation of knowledge, as summarized briefly in the next three sections.

Evidence from Cognitive Psychology

Only recently have researchers directly attempted to show that knowledge is grounded in the brain's modality-specific systems. Earlier research, though, provided much indirect evidence in experiments designed to test other hypotheses. In this earlier work, modality-specific representations of categories often appeared central to task performance. Barsalou (2003b) reviews some of these findings from research on perception, working memory, long-term memory, language, and thought. Viewing such findings as evidence for modality-specific representations is obviously post hoc. Nevertheless, considerable amounts of such evidence exist, and viewing it as evidence for modality-specific representations is not at all unreasonable.

More recently, much research has addressed this issue directly. Increasingly, researchers have designed experiments to test whether modality-specific representations underlie conceptual processing. Barsalou (2003b) and Barsalou, Simmons, Barbey, and Wilson (2003) review this work. Here we describe a few of these studies to provide a sense of the approach.

Analogous to previous work on mental imagery, researchers have manipulated perceptual variables such as occlusion, size, and orientation during conceptual processing. If participants use perceptual simulations to represent knowledge, then perceptual variables should affect their performance. In contrast, if participants use amodal representations, it is much less obvious that perceptual variables should have effects. To our knowledge, no amodal theory has ever predicted that variables like occlusion, size, and orientation should affect conceptual processing.

Consider how occlusion could be used to explore this issue. During the actual perception of an object, occluded properties do not receive much attention because they are hidden behind the object's surface (e.g., the *roots* of a *LAWN* hidden below the *grass blades*). Conversely when a property becomes unoccluded and lies on the object's visible surface, it becomes more salient (e.g., the *roots* of a *ROLLED-UP LAWN*).

Wu and Barsalou (2004) manipulated occlusion to assess whether simulations underlie conceptual processing. They manipulated occlusion by having half the participants generate properties for noun concepts (e.g., *LAWN*), and by having the other half generate properties for the same nouns preceded by revealing modifiers (e.g., *ROLLED-UP LAWN*). If people simulate *LAWN* to generate its properties, they should rarely produce occluded properties, such as *roots* and *dirt*. Conversely, if people simulate *ROLLED-UP LAWN* to produce its properties, they should produce occluded properties more often, given that these properties are now salient in their simulations. Because amodal theories of conceptual combination typically assume that the combination of two concepts is simply the union of their properties (i.e., compositionality), with no interactive properties included, these theories do not readily make this prediction (e.g., Smith, Osherson, Rips & Keane, 1988). Without additional post hoc assumptions that produce interactions between nouns and modifiers, *ROLLED UP* does not change the properties for *LAWN* (e.g., the accessibility of *roots* and *dirt* does not vary).

As the simulation view predicted, the presence of revealing modifiers in Wu and Barsalou's experiments increased the production of occluded properties substantially. Revealing modifiers also caused occluded properties to be produced earlier in the protocols and in larger clusters. These effects occurred not only for familiar noun combinations, such as *HALF*

WATERMELON, but also for novel combinations, such as *INSIDE-OUT PURSE*. Additionally, rules for properties stored with the modifiers were not responsible for the increase in occluded properties, given that these modifiers did not always increase occluded properties (e.g., for *ROLLED-UP SNAKE*). An increase was observed only when a modifier referred to an entity whose internal parts become unoccluded in the referent of a conceptual combination (e.g., *ROLLED-UP LAWN*). Overall, this pattern of findings supports the conclusion that participants were using simulations to represent the concepts in these experiments. The presence of occlusion effects implicates visual representations in conceptual combination.

Barsalou, Barbey, and Hase (2004) provide another example of how researchers are assessing the presence of modality-specific representations in conceptual processing. In their experiment, participants were videotaped as they produced properties for object concepts. On a small subset of trials, the object was something that would typically be either above a person or below (e.g., *BIRD* vs. *WORM*, respectively). When participants produced properties for objects typically found above them, their eyes, face, and hands were more likely to drift up than when they produced properties for objects typically found below them. This finding suggests that participants simulated the experience of "being there" with the objects whose properties they were producing (Barsalou, 2003b). These simulations included imagining the typical setting that contains the object, along with the participant's perspective on it (either looking up or down). Because these simulated perspectives include the motor movement of looking in a particular direction, these movements were generated implicitly as participants produced properties.

On several additional trials, participants received words associated with positive emotion vs. negative emotion (e.g., *SMILING BABY* vs. *ATTACKING DOG*). In further support of the simulation view, Barsalou et al. found that participants tended to express positive emotions on their faces and in their voices for positive concepts, but to express negative emotions for negative ones. These results further indicate that participants were simulating the experience of being there, not only orienting visual attention to where the object would be in a typical setting, but also generating appropriate emotional responses.

In recent years, other behavioral experiments have produced similar findings. In work that motivated the Barsalou et al. (2004) experiment, Spivey, Tyler, Richardson, and Young (2000) described a physical setting to participants and found that they produced the appropriate motoric orienting response for the setting (also see Spivey & Geng, 2001). Similarly, Glenberg and Kaschak (2002) asked people to evaluate a simple sentence about a motor action for its grammaticality, and found that its meaning activated the motor system (also see Glenberg & Robertson, 2000). Stanfield and Zwaan (2001) had people read a text that implied a particular orientation for an object, and found that people appeared to simulate the orientations visually (also see Zwaan, Stanfield & Yaxley, 2002). Fincher-Kiefer (2001) asked participants to adopt either a visual or verbal working memory load during text comprehension and found that the visual load produced the greatest interference on a subsequent inference task, suggesting that a simulated situation model represented the text.

Additional research from our laboratory has implicated modality-specific representations in higher-order cognitive processing. When participants verify the properties of concepts, the size and perceptual detail of the properties affect processing, suggesting that simulations of the properties are being verified (Solomon & Barsalou, 2001, 2004). Similarly, Pecher, Zeelenberg, and Barsalou (2003) showed that when participants must shift modalities to verify a property, a processing cost is incurred, further suggesting that properties are being simulated in modality specific systems (also see Barsalou, Pecher, Zeelenberg, Simmons & Hamann, in press; Pecher, Zeelenberg & Barsalou, 2004).

Together, these results from traditional cognitive paradigms converge on the conclusion that modality-specific representations are central in knowledge. Participants do not appear to operate solely on amodal symbols to perform these tasks. Instead, people appear to simulate the relevant content, and then to extract the information needed from the simulation.

Evidence from Social Psychology

Much additional behavioral evidence for modality-specific representations in knowledge has accrued in social psychology. Indeed, the amount of evidence in social psychology is considerably larger than in cognitive psychology. On the one hand, many studies show that embodied states result from processing social information. On the other, many studies show that embodied states affect social processing. Recently, Barsalou, Niedenthal, Barbey, and Ruppert (2003) reviewed this literature and suggested that its findings can be explained as the outcome of simulating social situations (also see Niedenthal, Barsalou, Ric & Krauth-Gruber, in press; Niedenthal, Barsalou, Winkielman, Krauth-Gruber & Ric, 2004).

Specifically, these researchers argue that people establish entrenched simulations of frequently-experienced situations, where a given simulation includes (among many other things) a variety of bodily states, such as facial expressions, arm movements, and postures. When environmental cues trigger the simulation of a social situation, part of the simulation is expressed in relevant bodily states. Conversely, if the body is configured into a state that belongs to one of these simulations, the state retrieves the simulation, which then affects social information processing. In the following sections, we briefly summarize these findings.

Social information processing produces embodied states. Much research demonstrates that activating knowledge about a stereotype generates associated bodily states. In an extensive research program, Bargh and his colleagues activated various stereotypes by asking participants to process a few associated words. To activate the *ELDERLY* stereotype, for example, these researchers presented participants with words like gray, bingo, and Florida, and then asked them to use them in a sentence (Bargh, Chen & Burrows, 1996). Of primary interest were the embodied effects that resulted. Once the elderly stereotype became active, people walked more slowly to the elevator when they thought that the experiment was over compared to when no stereotype was activated. In similar studies, activating the elderly stereotype even slowed the time to verify that letter strings are words (Dijksterhuis, Spears & Lepinasse, 2001).[3]

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[3]Of critical importance in these studies is ensuring that participants do not know the hypotheses being tested. For this reason, the researchers performing this work take great care in disguising the hypotheses. A cover story is typically included that orients participants towards some other issue. At the end of the experiment, participants are interviewed to ensure that they did not perceive the experiment's true purpose. In general, the experiments reviewed here have taken the necessary steps to ensure that participants' are unaware of the critical hypotheses. For the details on how this was done, and for evidence that these efforts were successfully, see the papers cited.

Priming other stereotypes produces related embodiments. Priming the *OBNOXIOUSNESS* stereotype, for example, makes participants increasingly willing to interrupt a conversation (Bargh et al., 1996). Similarly, priming the *POLITICIAN* stereotype increases participants' long-windedness in writing essays. As Dijksterhuis and Bargh's (2001) recent review of this literature indicates, activating a stereotype readily activates associated embodied states. One concern might be that these embodiments are simply epiphenomena that accompany the processing of amodal symbols. As we will see in the next section, however, these embodiments have causal effects on social cognition, suggesting that they play fundamental – not peripheral – roles (see Barsalou, Niedenthal et al., 2003, for further discussion of this issue).

Many other social stimuli besides words also trigger embodied responses. When people view positive vs. negative scenes, the musculature in their faces adopts positive vs. negative expressions, respectively (e.g., Cacioppo, Petty, Losch & Kim, 1986). Similarly, when people view the faces of people from "in-groups" their faces adopt positive expressions, whereas when they view people from "out-groups," their faces adopt negative expressions (e.g., Vanman & Miller, 1993; Vanman, Paul, Ito & Miller, 1997). Even posture is affected. When students learn that they've received a good grade, their posture tends to become erect; when they learn that they've received a poor grade, they slump (Weisfeld & Beresford, 1982).

As all of these studies demonstrate, perceiving social stimuli triggers associated embodiments. Social stimuli do not simply activate amodal data structures that describe social situations and how to act in them. Instead, social stimuli activate simulations of these situations that include relevant embodied states.

Embodied states affect social information processing. As we just saw, processing social information produces embodiments as effects. Here we see that embodiments also function as potent causes. In particular, we will see that states of the face, head, arms, and torso all affect social processing.

Considerable work has shown that once the face adopts a particular expression, it triggers the associated emotion, which in turn colors social judgment (for a review, see Adelmann & Zajonc, 1989). In the typical study, participants are induced to adopt a facial expression under the guise of another task that obscures the nature of the expression and its hypothesized effects. One approach, for example, uses the guise of studying how to best teach paraplegics to write. Participants are either asked to write with a pencil held in their teeth, which activates the smiling musculature, or to write with a pencil held in their lips, which activates the frowning musculature. Once the face is configured into a particular expression, it produces corresponding emotional states (e.g., Duclos et al., 1989). In turn, these emotions influence other tasks. For example, induced facial expressions affect the perceived funniness of a joke (Strack, Martin & Stepper, 1988), and the perceived fame of a face (Strack & Neumann, 2000).

Inducing participants to perform various head movements similarly affects social processing. In one line of research, participants were induced to either nod their heads forward and backward or to shake their heads sideways, believing that they were trying to dislodge headphones from their heads while bopping to music (e.g., Tom, Pettersen, Law, Burton & Coole, 1991; Wells & Petty, 1980). The nodding action led participants to later rate messages heard during this time as more compelling, and also to judge products as more valuable, relative to the shaking action. Because nodding is associated with positive affect and shaking with negative affect, the different actions produced different affects, which in turn differentially influenced judgment

Inducing participants to perform arm actions similarly affects social cognition. Arm actions that pull something towards a person (approach behavior) produce more positive judgments than arm actions that push something away (avoidance behavior). For example, these two arm motions produce differential liking of abstract figures (Cacioppo, Priester & Bernston, 1993).

Finally, inducing particular postures also influences social processing. Whereas an upright posture produces positive affect and judgment, a slumping posture produces negative affect and judgment. For example, posture affects participants' confidence in their task performance (Riskind & Gotay, 1982), and also their pride in it (Stepper & Strack, 1993).

As these results illustrate, embodiment does not only result from perceiving social stimuli, it also has causal impact on subsequent social processing. When a particular bodily state occurs, it activates patterns of social knowledge that contain it. As these patterns become active, they trigger related emotional states that can then influence a variety of cognitive processes.

Evidence from Cognitive Neuroscience

Cognitive neuroscience has also provided much compelling evidence that knowledge is grounded in the modalities. Two literatures, in particular, are informative: the literature on category-specific deficits that result from brain lesions, and the neuroimaging literature on category localization in the brain.

Category-specific deficits. Neuropsychologists have reported that lesions in a modality-specific system increase the likelihood of losing categories that rely on that system for processing exemplars. Because visual processing is central to interacting with *LIVING THINGS* such as *MAMMALS*, damage to visual areas increases the chances of losing knowledge about these categories (e.g., Damasio & Damasio, 1994; Gainotti, Silveri, Daniele & Giustolisi, 1995; Humphreys & Forde, 2001; Cree & McRae, 2003; Warrington & Shallice, 1984). Similarly, because action is central to interacting with *MANIPULABLE OBJECTS* such as *TOOLS*, damage to motor areas increases the chances of losing knowledge about these categories (e.g., Damasio & Damasio, 1994; Gainotti et al., 1995; Humphreys & Forde, 2001; Cree & McRae, 2003; Warrington & McCarthy, 1987). Analogously, lesions in color processing areas produce deficits in color knowledge (e.g., DeRenzi & Spinnler, 1967; Damasio & Damasio, 1994), and lesions in the spatial system produces deficits in location knowledge (e.g., Levine, Warach & Farah, 1985).

Based on this pattern of findings, many researchers have concluded that knowledge is grounded in the brain's modality-specific areas. Because the brain systems used to process a category's members show knowledge deficits when lesioned, category knowledge appears to rely on these areas for representational purposes.

Theorists have also proposed that category-specific deficits can reflect other factors besides damage to sensory-motor systems. Caramazza and Shelton (1998), for example, propose that localized brain areas represent specific categories that are evolutionarily important, such as *ANIMALS*. Alternatively, Tyler, Moss, Durrant-Peatfield, and Levy (2000) propose that the statistical distribution of shared vs. unique property information for categories determines their vulnerability to lesion-based deficits. In this spirit, a number of theorists have proposed that multiple mechanisms underlie the representation of categories. Depending on the location and nature of a lesion, a variety of deficits may result (e.g., Cree & McRae, 2003; Coltheart et al., 1998; Simmons & Barsalou, 2003). Nevertheless, the findings from this literature have led many researchers to conclude that modality-specific systems play central roles in knowledge representation.

Neuroimaging studies of category knowledge. The neuroimaging literature offers further support for this conclusion. Consistent with the lesion literature, different types of categories activate different sensory-motor systems. Categories that rely heavily on visual information (e.g., *ANIMALS*) strongly activate visual areas (e.g., Kiefer, 2001; Martin, Ungerleider & Haxby, 2000; Martin, Wiggs, Ungerleider & Haxby, 1996; Perani et al., 1999; Pulvermüller, 1999; Spitzer et al., 1998). Categories that rely heavily on action (e.g., *TOOLS*) activate the motor system (e.g., Martin, Haxby, Lalonde, Wiggs & Ungerleider, 1995; Martin et al., 2000; Martin et al., 1996; Perani et al., 1999; Pulvermüller, 1999; Spitzer et al., 1998). Color categories activate color areas in the visual system (e.g., Chao & Martin, 1999; Rösler, Heil & Hennighuasen, 1995; Martin et al., 1995; Martin et al., 2000). Social categories activate brain areas used during social interaction (e.g., Decety & Sommerville, 2003; Gallese, 2003).

Consider three examples of such studies. In Chao and Martin (2000), participants observed briefly presented pictures of manipulable objects, buildings, animals, and faces while lying passively in an fMRI scanner. When participants viewed manipulable objects (e.g., hammers), a brain circuit that underlies the grasping of manipulable objects became active. This circuit was not active while participants viewed buildings, animals, and faces. In previous research, this grasping circuit became active when monkeys and humans actually performed actions with manipulable objects, or while they watched others perform such actions (e.g., Rizzolatti, Fadiga, Fogassi & Gallese, 2002). Notably, though, Chao and Martin's participants did not move in the scanner, nor did they view any agents or actions – they passively viewed pictures of static objects in isolation. Nevertheless, the grasping circuit became active. Chao and Martin concluded that activation of the grasping circuit under these conditions constituted a motor inference about how to act on the perceived object Viewing a manipulable object activated category knowledge that included motor inferences (e.g., a hammer can be swung). Most importantly, these inferences appear to be represented in the motor system.

Simmons, Martin, and Barsalou (2004) performed a similar experiment with food categories. Participants lay passively in an fMRI scanner while viewing food pictures for 2 sec, and simply evaluated whether the picture currently present was the same as the previous one (i.e., a physical match task). Participants were not asked to categorize the foods, think about how they taste, or conceptualize them in any other way. Nevertheless, the pictures activated a brain area that represents how foods taste, along with areas that represent the reward value of foods. Even though participants were not actually tasting the foods, their category knowledge about foods became active and produced taste inferences in the brain's gustatory system.

Modality-specific inferences from category knowledge not only occur in response to pictures but also in response to words. In Hauk, Johnsrude, and Pulvermüller (in press), participants simply read words for 2.5 sec each in an fMRI scanner. Embedded within the list were words that refer to head actions, arm actions, and leg actions (e.g., "lick," "pick," and "kick," respectively). All three types of words produced activation in the motor system, suggesting that their meanings are represented in brain areas that produce motor behavior. Furthermore, the three different types of action words differentially activated their respective motor areas. Words for head actions activated the region of the motor system that produces head actions; words for arm actions activated the region that produces arm actions; words for leg actions activated the region that produces leg actions.

All these results support the conclusion that category knowledge is grounded in the brain's modality-specific systems. When people process pictures and words, the category knowledge that becomes active utilizes the relevant modalities systematically.

Other brain areas are almost certainly involved as well. According to Cree and McRae (2003), for example, associative mechanisms that represent property frequency, uniqueness, and correlation complement the modality-specific mechanisms that represent knowledge. Similarly, Simmons and Barsalou (2003) argue that conjunctive units in the brain's association areas are central to controlling modality-specific simulations.[4] Thus, a variety of systems, including the modalities, appear to work together in representing knowledge.

Theoretical Issues

The empirical case for the simulation view is becoming increasingly compelling. Nevertheless, other significant issues remain. For some time, theorists have suggested that modality-specific representations do not have sufficient expressive power to represent knowledge (e.g., Pylyshyn, 1973). Regardless of the empirical case for the simulation view, a central issue is whether this view can implement a fully functional conceptual system.

Barsalou (1999) offers an existence proof that it can (also see Barsalou, 2003a; Barsalou & Wiemer-Hastings, in press). By making certain assumptions about the selection, integration, and manipulation of modality-specific information, a simulation-based system can, in principle, distinguish types from tokens, generate knowledge-based inferences, represent novel concepts productively in conceptual combination, implement the prepositional hierarchies that underlie text meaning, and represent abstract concepts. It remains an open empirical question whether the brain actually uses simulation to perform these functions. In principle, though, this appears possible.

Currently, no computational account of this theory exists, and this remains another major step to be taken. Nevertheless, the current empirical literature warrants the following conclusion: The conceptual system appears to rely heavily on modality-specific systems for representational purposes.

[4]In principle, these conjunctive units could be viewed as amodal symbols. Problematically, however, these units typically have modality-specific tunings, suggesting that no part of the brain is truly amodal (e.g., Barsalou et al., in press; Damasio, 1989; Simmons & Barsalou, 2003). Furthermore, the primary purpose of these units may be to activate modality-specific representations, rather than to operate as stand-alone representations (Simmons & Barsalou, 2003).

Possible Roles of Embodied Knowledge in Religious Phenomena

As we have seen, knowledge about physical and social categories appears grounded in the brain's modality-specific systems. What about the religious knowledge that people have about the self, the universe, and deities, and also about religious institutions and practices? If the brain typically uses modality-specific systems to represent mundane knowledge, perhaps it also uses them to represent religious knowledge, at least to some extent.

We hasten to note two important caveats. First, we are not proposing that modality-specific mechanisms are the only important mechanisms that represent knowledge. As described earlier, other mechanisms are certainly involved as well. Just as other mechanisms contribute to the representation of non-religious knowledge, they also probably contribute to religious knowledge. Second, some aspects of religious knowledge may not be grounded in modality-specific systems. To the extent that some religious thoughts are truly spiritual, they may have other origins. We will remain agnostic on this matter.

In the remainder of this article, we speculate on how simulations in the brain's modality-specific systems might underlie three religious phenomena: religious visions, religious beliefs, and religious rituals. Based on the literatures just reviewed, along with our intuitive sense of these phenomena, it seems plausible that simulations play central roles in them. Thus, the observations in the following three sections should be viewed as hypotheses for future research. Embodied knowledge is probably relevant to a variety of other religious phenomena as well.

Religious Visions

The history and practice of religion are replete with accounts of religious visions. Religious practitioners often experience visions during a wide variety of mundane religious activities, such as prayer and ritual. More profound religious visions can occur during once-in-a-life-time conversion experiences, and during the religious experiences that inspire prophecy. Capturing the content of such visions typically appears to be a common goal of religious painting and writing. For all these reasons, religious vision appears to be a powerful and ubiquitous force in religious experience.

Simulation is an obvious candidate for the mechanism that produces religious visions. Essentially the same simulation process described earlier that represents mundane knowledge about the physical and social world may be responsible. When people see, hear, and/or feel a religious vision, their visual, auditory, and/or somatosensory systems may be producing these experiences.

One difference may be that the simulations underlying religious visions are typically more vivid and more conscious than the simulations underlying mundane knowledge, where these latter simulations may often be relatively sketchy and unconscious (Barsalou, 1999, 2003b). If so, then religious visions may be more like the mundane imagery studied widely in the mental imagery literature (e.g., Farah, 2000; Fink, 1989; Kosslyn, 1980, 1994; Shepard & Cooper, 1982). Just as imagery about mundane events in the world can be highly vivid (e.g., memories of traumatic events), so can imagery about religious events (e.g., being visited by angels). Most importantly, the same representational process may underlie both. As Barsalou (1999) suggests, a wide variety of representational processes may all utilize simulation in some manner (e.g., perceptual inference, imagery in working memory, long-term memory, text meaning, mental models in reasoning). Although important differences probably exist between the simulations that underlie these processes, the important property of reenacting modality-specific states may be common to all. Most importantly for our purposes here, religious visions may belong to this representational family, perhaps being most closely related to mental imagery.

Sources of religious visions. A number of obvious sources could contribute content to religious visions. One obvious possibility is religious art, including painting, stained glass, sculpture, and so forth. As people view these objects, their visual systems are driven into neural states that represent them. Association areas then capture these states, such that they can be partially reenacted later (i.e., the process described earlier for acquiring the simulations that underlie mundane knowledge). During religious visions, association areas reactivate the visual system to partially reproduce what was seen earlier. For example, if someone views a painting of an angel, their brain may partially capture the neural states activated to represent it in vision, such that they can later simulate how the painting looked.

Rather than simply simulating the painting per se, however, people may situate its content *personally* to make the simulation more meaningful. An angel in a painting comforting a peasant, for example, might instead be simulated as comforting oneself. As Barsalou (1999, 2003b) describes, the simulation process is, in principle, capable of combining simulations productively to simulate situations never actually experienced. By combining a visual representation of *STRIPED* with a visual representation of *CLOUD*, people can simulate a *STRIPED CLOUD*, even though they have never seen one (Wisniewski, 1998; Wu & Barsalou, 2004). Simulating an angel comforting oneself could utilize essentially the same process. The content from the painting could be combined with content captured while being comforted by actual people, thereby producing the simulation of being comforted by the angel.

Perceiving religious plays, pageantry, and rituals may also provide content for religious visions. As people perceive these actual events, their brains capture the multi-modal states that underlie experiences of them. On later occasions, pieces of these states may be incorporated into a wide variety of simulations, often involving oneself, that are interpreted as religious visions. For example, if village elders produce a play of deceased elders coming back to advise the living, later simulations of such events may contribute to religious visions of the elders advising oneself. Although such visions may occur most often in people with normal brains, neurological disorders that produce hallucinations may increase their rate and unusualness (see Livingston, this issue).

Religious visions during the processing of religious texts. What about religions whose primary account of deities and religious events resides in texts as opposed to iconic media? How might people acquire the content for religious visions from them? The recent literature on language comprehension suggests an interesting possibility. As described earlier, increasing evidence indicates that people use simulations to represent the meanings of texts. When people read about someone pounding a nail into a wall, they simulate the event with the nail positioned horizontally (Stanfield & Zwaan, 2001). Similarly, when people read about opening a drawer, they simulate the requisite pulling action (Glenberg & Kaschak, 2002). Even when people hear isolated words, such as “lick,” “pick,” and “kick,” they simulate the meanings in their motor systems (Hauk et al., 2004). In none of these cases are any iconic displays present. Nevertheless, the perceived words trigger simulations similar to the visual representations that iconic displays would produce if perceived instead.

It follows from these findings that when people read religious texts, they may simulate their meanings in the brain's modality-specific systems. If a text describes a deity, people may simulate the experience of perceiving it. If a text describes a religious event, people may similarly simulate what the event would be like to experience. As a result, the same basic type of representation becomes established in memory that would have become established if iconic displays had been perceived instead. Regardless of the media used to convey information about religious deities and events, the underlying representations may often be qualitatively similar.

We hasten to add that important representational differences may result from acquiring religious knowledge from iconic displays versus texts. Iconic displays may produce more vivid simulations of religious content than text displays. Text displays may produce more flexible representations that reflect the relative ease of combining words vs. icons. Our point is simply that both displays may establish modality-specific representations of religious content in memory that can later be used to produce religious visions.

Religious Beliefs

As theorists have argued, a tension between the spiritual and the physical underlies religion (e.g., Durkheim, 1915/1957). In many religions, the goal is to escape the physical and embrace the spiritual. To facilitate this process, religions often develop rituals that debase the physical world, especially the human body, thereby making the spiritual world more salient and important (e.g., Bloch, 1991). Thinking about religion from the embodied perspective highlights the physical side of this relationship. Beliefs about the body and the world are central across religions, and vary widely between them. Furthermore, these beliefs influence how people practice their religions, and also how they experience their bodies and the world. In the following sections, we provide several examples.

Buddhism. In a common form of Buddhist meditation, one goal is to stop thinking. Ruminating about situations in the past, present, and future ideally should cease. The goal is not to attain a spiritual idea that resides within or outside oneself. Instead, the goal is to simply be aware of one's body and the surrounding environment, moment after moment over time, experiencing the continual oneness of oneself in the world. This form of meditation emphasizes the body and the environment heavily.

The importance of experiencing the environment in meditation, not just the body, highlights a theoretical perspective mentioned earlier: situated cognition. According to this view, environmental situations, not just bodies, play central roles in intelligent behavior. Over the courses of both evolution and learning, organisms adapt to optimize their fitness in the situations in which they operate regularly (e.g., Gibson, 1979). As as result of these adaptations, knowledge about situations develops that greatly facilitates the ability to select relevant actions and inferences, and to achieve important goals (e.g., Barwise & Perry, 1983; Brooks, 1991; Yeh & Barsalou, 2004). Although embodied and situated theories focus somewhat differently on the body vs. the environment, both assume that the *entire physical context* of cognition is central to the structure and function of cognitive systems. Because organisms are constantly trying to optimize their behavior within this physical context, the cognitive system becomes fundamentally organized around it. Scientifically, if we are to understand natural cognitive systems, we must view the brain as a control system for situated action, not as a detached system for information storage (e.g., Barsalou, 2003b; Clark, 1997).

The conception of the body and the environment as a unified physical context for cognition is closely related to Buddhist conception of becoming one with the world: During Buddhist practice, becoming closely attuned with the brain systems that process the body and the environment is central to producing experiences of being in the moment. Becoming a Buddhist leads to the acquisition of beliefs about this process. In turn, these beliefs affect religious practice (e.g., meditation), and ultimately the experience of life (e.g., experiences of the body, the environment, and the relation between them).

Taoism. A similar conception underlies Taoist teachings. According to Taoism, the universe is a physical field of energy permeated by the Tao. Although our normal belief systems might make things appear otherwise, all components of this energy field are actually working together harmoniously, including one's body and its local environment. Like Buddhism, the goal is not to attain a spiritual state that resides somewhere else. Instead, the goal is to bring one's awareness into the physical ground of being, such that its inherent harmony becomes apparent. In both religions, teachings and the resultant beliefs focus heavily on the self and the physical world in the current moment. Once these beliefs are in place, they appear to have strong impact on people's experience of their bodies and environments through religious practice.

Christian Science. At the opposite end of the continuum are religions such as Christian Science that minimize the importance of the physical world. Because these religions focus so heavily on the spiritual, the body and environment become peripheralized. Indeed, the body is so unimportant in Christian Science that if one becomes ill, the only recourse is to spiritual healing, not to medical (physical) healing. Relative to religions like Taoism that draw strength and inspiration from the physical world, religions like Christian Science see weakness in it, turning instead to the spiritual.

Even when religions emphasize the spiritual, the importance of the body remains implicit. Teachings in these religions often explicitly describe the limitations, weaknesses, and evils of the body, thereby motivating a spiritual focus. Beliefs about the body that develop subsequently may have considerable impact on how practitioners experience their bodies. Teachings in these religions may similarly affect practitioners' perceptions of their environments.

Hinduism. Many religions view the body as a vehicle of the spirit. Hinduism offers a particularly interesting case. The basic idea underlying reincarnation is that the spirit in a person's body has resided in previous bodies before and will reside in subsequent bodies after. A spirit's current body is selected on the basis of what the spirit needs to experience in the world so as to purify and raise it to a higher level. Thus, the good or bad deeds of the current body affect the spirit, determining what its reincarnation will be in the next body (karma).

Again, the body is a central component of these religious beliefs. Here, though, how one treats one's body affects the quality of the spirit residing in it, and its subsequent journey. It would not be surprising if such beliefs affect people's experiences of their bodies, not just experiences of their spirituality.

In summary, these examples illustrate that beliefs about the body and the environment are central to many religious frameworks. In religions like Buddhism, Taoism, and Hinduism, the body and the environment lie at the center of religious beliefs. Even in religions that emphasize the spirit, the body remains implicitly important by virtue of being something that should be de-emphasized. Thus, beliefs about the body and the environment are typically central in religious thought and practice. Examining the particular beliefs that a particular religion has about the body and the environment may be important to understanding the religious cognition associated with it. Depending on the religious perspective that a person adopts, their beliefs about the body and the environment are likely to vary, along with how they experience their physical context.

Anthropomorphic concepts of religious deities. Barrett and Keil (1996) have shown that people often imbue religious deities with human qualities, such as desires, sensory abilities, communicative abilities, being bounded in space, and having the ability to move along a spatio-temporal path. Where might these anthropomorphized beliefs originate?

One possibility is the human body. At first blush, this may seem counter-intuitive, given that a central belief about religious deities is that they do *not* have bodies. Interestingly, people nevertheless conceptualize non-physical entities as having bodily qualities. This tendency may reflect the powerful human ability to productively construct conceptualizations of entities never experienced (e.g., Barsalou, 1999, 2003a). As discussed earlier, much work on conceptual combination demonstrates that people can construct a conceptual representation and then transform it systematically to create never-experienced conceptualizations (also see extensive evidence for such transformations in the imagery literature; e.g., Finke, 1989). For example, people can conceptualize a cloud and then systematically vary its color, shape, and texture, conceptualizing a variety of never-experienced clouds in the process (e.g., an olive tweed cloud in the shape of a griffin). In much the same way, people may systematically combine functional aspects of their bodies with conceptions of non-physical deities to create deities that are bounded, have sensory abilities and desires, and move along spatio-temporal paths. Given that people's bodies are so central in their own cognition, they cannot but help include bodily functions and properties in deistic concepts, which, in principle, need not have any.

Interestingly, people similarly anthropomorphize their beliefs about space aliens. As Finke, Ward, and Smith (1992) have shown, science fiction writers, not just lay people, typically conceptualize space aliens as having bodily qualities, such as bilateral symmetry, sensory systems, desires, and so forth. As for deities, space aliens, in principle, need not have such qualities. Indeed, not having them might make them even more exotic and powerful. Nevertheless, people tend to attribute bodily qualities to space aliens, further suggesting that people's bodies are so central in their mundane cognition that they generalize their own bodily functions to other imagined agents.

Religious Rituals

Because religious rituals typically include physical actions, they are obviously embodied. Here we explore two cognitive implications that these embodiments may have: control of cognitive states via metaphor, and entrenchment of religious beliefs via memory enhancement. We also explore the different embodiments associated with different classes of ritual.

Embodiment as a source of cognitive control via metaphor. Often, the embodiment in a ritual appears to metaphorically convey a mental state that is religiously important (cf. Lakoff & Johnson, 1980). In the embodiment research from social psychology discussed earlier, we saw that inducing a particular embodiment produced a corresponding mental state. Configuring the face into a smile, for example, triggers positive emotion, which can similarly result from head nodding and approach motions. The embodiments in rituals may have similar effects on mental states. Indeed the design of rituals may typically attempt to capitalize on such relationships.

Consider the importance of a still body in meditation. A still body is a physical metaphor for a still mind. Furthermore, stilling the body often seems to actually have a stilling effect on the mind. For this reason, meditation practice often stresses physical stillness, and has techniques for achieving it. Because the body and mind are so closely related, the physical state of the body contributes to the control of the mind. Thus, the embodiment associated with meditation is far from random. Instead, embodiments are selected that have the potential to convey and implement the desired mental state.

Similarly consider the importance of kneeling in prayer. In social situations with other humans, kneeling is an act of submission. In a religious context, kneeling becomes a metaphor for a similar submissive stance towards a deity. Kneeling while praying is likely to activate the same submissive attitude. To engender submissive states towards deities, religions may have selected this particular embodiment for prayer. To the extent that religious practitioners develop submissive attitudes toward deities, they are more likely to absorb their teachings, as conveyed by their worldly representatives.

Accepting the wine and wafer in communion provides a powerful physical metaphor for accepting the holy spirit. Just as one takes food and drink into the physical self, one takes the holy spirit into the spiritual self. Again, the ritual provides a metaphor for the desired mental state and helps achieve it. By selecting an embodiment for the ritual that conveys the desired mental state, Catholicism greatly increases the chances that its practitioners will understand the mental state they are supposed to achieve, and will actually adopt it.

Finally, consider pilgrimages. Pilgrims typically take a long difficult journey from their current location to a holy location. Such journeys constitute a metaphor for what pilgrims are supposed to experience spiritually, namely, a major transition from their current spiritual state to a significantly holier state. The pilgrimage depicts what is supposed to happen, and helps to achieve it. Again, the embodiment of the ritual is conducive to producing the desired cognitive result.

Embodiment as a memory enhancer for entrenching religious beliefs. As we just saw, the embodiments in rituals typically convey desired mental states and help achieve them. These embodiments may also have longer term effects on the ability to remember rituals and their associated mental states. Three classic encoding factors may be important: the subject-performed task (SPT) benefit, the location benefit, and the concreteness benefit. Each is addressed in turn.

Much research in the SPT literature has shown that actually performing an action helps people remember a description of the action at a later time (e.g., Engelkamp, 1998; Zimmer, 2001). In these experiments, participants typically receive linguistic descriptions of many actions and later have to remember them (e.g., "turn on a faucet," "iron a shirt," "scratch a cat"). A widely obtained and robust finding is that actually performing the action while reading its description produces substantially better memory than simply reading it alone (i.e., the SPT effect). A large literature has attempted to identify the underlying mechanisms responsible for this effect, and multiple accounts exist. For our purposes here, the important point is simply that performing actions enhances memory for related linguistic descriptions.

Consider the analogous issue with respect to ritual (McCauley & Lawson, 2002). On the one hand, a religion could attempt to convey religious ideas simply via iconic depictions or texts. Alternatively, a religion could include motor actions in the religious practices it uses to convey religious ideas. The SPT effect suggests one reason embodiment may be so widespread in rituals. Because motor actions enhance memory, religions incorporate them extensively into religious practice. Besides helping convey the associated spiritual idea, as we saw earlier, these actions also help entrench these ideas in memory.

A second factor that may also help entrench religious ideas in memory is location. Much research shows that location is a powerful mnemonic aid, as in the method of loci (e.g., Gruneberg, 1992). If one stores pieces of information in unique locations, the subsequent memories of them are enhanced. On the one hand, storing a piece of information in a unique location helps insulate it from competing pieces of information stored elsewhere in memory. On the other hand, once information is stored in a location, knowledge of spatial locations can later be used to cue it. One can search through known locations where information has been stored, assessing whether the desired information is stored at each location.

Location may similarly play a role in establishing religious knowledge. Religious rituals are often performed in locations reserved for religious activities (e.g., churches, prayer rooms). As a result, these locations insulate knowledge of rituals from competing information. Because competing information is typically associated with other locations, it is less likely to intrude on people while in religious locations, or while they are simulating them. Furthermore, once people are in a religious location, or when they simulate one, these locations are likely to activate the rituals and their associated mental states. Thus, the situatedness of rituals, like their embodiment, contributes to establishing them in memory.

Concreteness is a third factor that may also help establish religious ideas in memory. Much work demonstrates that people remember concrete material better than abstract material (e.g., Paivio, 1986; but see Schwanenflugel, 1991). In general, people understand concrete material more easily than abstract material, they learn it faster, and they retrieve it more easily. Given that religious ideas are typically abstract, they should be relatively difficult to understand, learn, and retrieve.

Thus, religions often find ways to make their central ideas concrete. One way to accomplish this is to ground religious ideas in concrete narratives. In Christianity, for example, the abstract idea that succumbing to temptation can produce a fall from grace is made concrete by grounding it in the story of Adam and Eve. Another way that religions appear to make abstract ideas concrete is by associating them with concrete embodiments and locations in rituals. As we saw earlier, an embodiment can convey the religious idea that underlies a ritual metaphorically, thereby making the idea easier to understand. Furthermore, by associating abstract ideas with concrete cues in the body and environment, religions capitalize on the concreteness benefit in memory. Once people start performing a ritual, its embodied and situated aspects should be easily recognized, given their concreteness. Once these aspects of the ritual have been accessed in memory, they lead, via association, to the accompanying religious ideas. Although these abstract ideas might normally be difficult to retrieve in isolation, they become easier to retrieve when linked to concrete cues.

In summary, religious rituals appear to capitalize on classic factors that facilitate memory: the SPT benefit, the location benefit, and the concreteness benefit. By designing religious practices that include bodily actions in unique locations, religions increase the chances that their abstract ideas will be learned and remembered. Furthermore, by linking abstract ideas to concrete cues, religions make it easier to overcome the difficulties that people have with abstract materials.

Embodiment in different classes of ritual. Theories of religious cognition have noted an important difference between two types of ritual: once-in-a-lifetime rituals vs. repeated mundane rituals (e.g., McCauley & Lawson, 2002; Whitehouse, 2004). From casual observation, it appears that different types of embodiments may be associated with each type. Furthermore, it appears that the respective embodiments may be tailored to the goal that each type aims to achieve.

Consider the goal of once-in-a-lifetime rituals. These rituals often attempt to have a major impact on people's cognitive system for interpreting the world. Specifically, these rituals attempt to produce radical changes in people's conceptual systems, pushing them out of their current world view into a religion's world view. If these rituals aim to cause a major cognitive shift, then it makes sense that their embodiments should be relatively dramatic, awe inspiring, and shocking. By creating powerful emotional responses in people, such rituals increase the chances that people will abandon their current way of interpreting the world and adopt a new one.

Once-in-a-life time rituals, such as certain initiations and pilgrimages, offer excellent examples. Typically, a given individual only experiences these rituals once. Nevertheless, these events are supposed to have a major long-term impact on a person's religious sensibilities. By suspending or changing normal daily activities for an extended period of time, accompanied by personal sacrifice and possibly suffering, these rituals induce powerful motivational forces for personal change. Grounding the idea of a radical religious change in a radical physical experience produces high levels of sensory pageantry and optimizes the chance of success. Examples of such rituals include the Baktaman male initiation (Barth, 1975), full immersion Baptism, and bat- and bar-mitzvahs.

In contrast, consider repeated mundane rituals. Once people become committed to a religion, perhaps after experiencing a once-in-a-lifetime initiation experience, the next step is to entrench the religion's belief system into their cognitive system. They need to acquire a large variety of new concepts and theories about themselves and the world that they did not have before. The primary function of repeated mundane rituals may be to establish this new conceptual system. The accompanying embodiments may be tailored to this goal.

For example, these embodiments may often be designed to help people understand difficult religious ideas via metaphor. As we saw earlier, kneeling in prayer may help people understand the submissiveness that they should feel towards a deity. The embodiments associated with mundane rituals also be designed to help entrench important concepts and beliefs into memory. For example, the rosary provides a method of loci for learning important beliefs in Catholicism. In addition, these embodiments may typically be easy to perform over and over, such that including them in daily life is not too taxing to perform regularly. To the extent that these rituals are easy, enjoyable, and perhaps even addicting to perform, they increase their potency for establishing associated religious ideas via the various mechanisms described earlier.

In summary, the goal of a ritual may determine the form of its embodiment. When a ritual attempts to change people's world view, it may include embodiments that are highly shocking and motivating. When a ritual attempts to establish a belief system that will dominate people's daily interpretation of the world, it may include embodiments that help convey, entrench, and retrieve the relevant concepts.

Conclusions

Outside the study of religious experience, increasing evidence suggests that mundane knowledge is grounded in the brain's modality-specific systems. The representations that become active to represent objects, people, and events in experience are later used to simulate them in their absence. Many findings in cognitive psychology, social psychology, and cognitive neuroscience support this conclusion.

Embodiment is likely to be central in religious experience as well. The process of simulation offers a natural account of religious visions. Although these visions may often be spectacular in content, they may typically arise from simulation mechanisms that underlie a wide variety of other cognitive processes.

With respect to religious beliefs, knowledge about the body and the environment are typically central in religious frameworks. In some religions, increasing awareness of the body and the environment may be important for attaining religious goals. Even in religions where increasing awareness of spirituality is more important, the body becomes significant by virtue of being peripheralized. Regardless, religious beliefs may have considerable impact on people's perceptions of the body and the environment.

With respect to rituals, embodiments may play central roles in conveying religious ideas metaphorically. Performing embodiments may help drive people's cognitive systems into appropriate religious states. These embodiments may also help entrench religious ideas in memory, with a ritual's particular embodiment being tailored to the goal that the ritual aims to achieve. Whereas the embodiments associated with once-in-a-life time rituals may be designed to motivate major conceptual shifts, the embodiments associated with repeated mundane rituals may be designed to entrench religious concepts into the cognitive system, such that people interpret themselves and the world differently.

We offer these suggestions about possible roles of embodiment in religious knowledge as hypotheses. Perhaps these conjectures will motivate future research that increases what we know about religious knowledge and its effects throughout religious cognition. To the extent that religious knowledge is like non-religious knowledge, embodiment is likely to play central roles, including many not entertained here.

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