



CHAPTER

## 5 Darkness and the Imagination: The Role of Environment in the Development of Spiritual Beliefs

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### Abstract

Darkness has profound effects on human behaviour and the ability to perform everyday activities. It can influence our ability to function, our moods, emotions, and cognition. Here we examine the relationship between darkness and supernatural beliefs. This work is informed by cross-cultural cave research, which suggests that cave dark zones are used as the settings for rituals from the advent of modern humans to the present. How can this phenomenon be explained? The chapter reviews research on the effects of darkness on the human mind and presents results of our own experimentation. We argue that shared human reactions to darkness, including embodied responses, stimulate the imagination in similar ways, leading to what we refer to as transcendental or imaginary thinking that lies at the heart of supernatural beliefs. Our work suggests that the natural environment is not a passive player but a causative agent in this process.

**Keywords:** [cave archaeology](#), [caves](#), [darkness](#), [religion](#), [ritual space](#), [cognition](#), [embodied cognition](#), [affect and environment](#), [spatial analysis](#), [environmental psychology](#)

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Humans are considered to be diurnal creatures, and light or the lack thereof profoundly impacts our experience of the world. Many would argue that vision is the most crucial of all human senses in interacting with the environment, given the impact of lighting conditions on our experience and the power of vision to reveal detailed and precise information at a distance unmatched by any other sense. Aside from basic survival, light plays an integral part in creating meaning in our world, including invoking affective responses. As a salient feature of aesthetics, light influences mood and states of relaxation or excitement—the play of light on the ocean, a painting by Monet, moonlight over snowy mountains, a candlelight dinner, a dark haunted house—may elicit responses, which we assume to be culturally determined. The power of these scenes relies in part on the quality of light and its effect on our conscious and unconscious mental and emotional make-up. In this chapter we question whether our perceptions of light are wholly culturally mediated or whether there is some regularity in human response to environmental conditions based on the quality of available light. We suspect the latter to be the case. At least one recent study has suggested that lighting conditions affect a number of different emotional and perceptual experiences (Xu and Labroo 2014). We also know that the absence of light may be pathological to humans, based on evidence for Seasonal Affective Disorder (SAD), a form of depression caused by the lack of natural daylight during autumn or winter months that is likely to have a physiological genetic component (see e.g. Targum and Rosenthal 2008). This condition has been demonstrated to occur more frequently in northern locales where there is little light during winter, and is treated with light therapy (Wetterberg 1995).

p. 86 In this chapter we focus on effects of the absence of light on cognition. We do not argue that people's specific cognitive responses to dark environments are universal, but rather that the absence of light provides a universally similar context that stimulates the creative and imaginary abilities within us, capacities that are central to what makes us human. As a consequence, dark spaces are often employed in similar human pursuits, and are used for rituals, meditation, enlightenment, or magic. Dark zones of caves are one of the few natural environments in which the condition of darkness is taken to its logical extreme. The shadowy environment of the dimly lit cave, along with the quietude that only deep caves can provide, is unique in the natural world. The only other natural places that are in complete darkness are deep below the surface of the ocean or perhaps in wooded groves on moonless nights, but forests and jungles lack the quietness of the cave environment. While humans need light to negotiate the complete darkness, the shadowy flickers from torches or small flames used by people in the distant past created low light conditions in which shadows danced on cave walls, adding to the cave's unique qualities (see Pettitt this volume).

To begin our discussion, we explore how dark caves have been used by humans over time and space. Because caves are enclosed and protected, they provide some of the best archaeological evidence for understanding these natural spaces beginning in the deep past. These observations helped us to shape our research questions from a phenomenological perspective, and motivated a laboratory experiment that we go on to briefly describe. To help explain our findings, we explore how darkness is conceptualized in metaphor among people today. We then consider how people experience and respond to darkness from the perspective of environmental psychology. Finally, we consider the implications of our results for the role of cave environments in the development of otherworldly beliefs, spiritual ideas, and magical thinking. Our criteria for assessing what we consider to be 'otherworldly' ideas is based on the work of Pascal Boyer (2001), who defines religious or spiritual ideas as counterintuitive to real-world understandings. According to Boyer, the best and most widely accepted spiritual concepts have structures that violate some ontological categories or expectations about the world, but preserve others. While these may be difficult to predict cross-culturally, our research is with subjects from Western cultures, so our assessments will be at least generally consistent with Western norms.

Our research is informed by both archaeological and anthropological studies regarding the human use of caves as sacred space. The term ‘cave’ is a non-scientific, non-specific term often used broadly to refer to many sorts of cavities, including rockshelters or overhangs. However, the morphology of space and quality of light is crucial to understanding how these spaces were used in the past and how they are used today. Here, we refer to deep caves with areas of complete darkness rather than rockshelters or shallow caves, which have areas of light. While people have frequently resided in rockshelters or shallow caves, perhaps using them as ritual spaces, they have rarely if ever inhabited cave dark zones. Contrary to popular belief or depictions in horror stories, humans occupy such spaces only in the most desperate circumstances (Burkitt 1966 [1933:7]; Chard 1975: 171; Clottes 2012: 16–17; Farrand 1985: 23; Faulkner 1988; Goldberg and Sherwood 2006: 15; Hayden 2003: 100; Hole and Heizer 1965: 47; Moyes 2012a). There are only a handful of documented examples of humans living in dark zones. For instance, Paul Taçon and his colleagues (2012) describe a rare instance of dark-zone habitation in Tasmania under brutally cold conditions about 30,000 years ago. There are also cases in which people may have hidden in caves when they were running from someone or something, including during times of warfare (Ranger 2012). Perhaps the most poignant example of wartime cave use is related by Anne Chapman (2010: 33–34), who studied the Selk’nam of Tierra del Fuego. In one battle with the Dutch, every man in the village was slaughtered defending a cave that was thought to be filled with treasure. Upon entering the cave the victors discovered that the ‘treasure’ consisted of the village’s women and children. Only one woman survived the massacre. In contrast to this rarity of dark-zone habitation, we find throughout time and over space that dark zones serve as venues for special or sacred activities such as burying the dead, producing art, or conducting rituals. There is a vast literature on the subject based on archaeological, historic, and ethnographic evidence, but only recently have there been any attempts to evaluate and synthesize this evidence (Moyes 2012a).

For archaeologists who study these sites, it becomes apparent that there have been many spurious interpretations of caves as dwellings. The idea of living in caves has gripped the imagination of both scholars and the general public to the point that the term ‘caveman’ has become synonymous with early humans. This is not surprising when we consider that European caves produced some of archaeology’s best evidence for understanding them. But when we review the reports it becomes apparent that these hunter-gatherers occupied the mouths of caves or camped in rockshelters, but did not live in cave interiors. Nineteenth-century reports of Palaeolithic sites were fairly specific in stating that deposits left by human activity were washed into dark zones from entrances, but this information was often lost in media hype. Even this period’s archaeological experts took up the mantle. Sir John Lubbock devoted an entire chapter to ‘cave men’ in his volume *Pre-Historic Times: As Illustrated by Ancient Remains, and the Manners and Customs of Modern Savages*, first printed in 1865. A few years later, in *Cave Hunting: Researches on the Evidences of Caves Respecting the Early Inhabitants of Europe*, W. Boyd Dawkins concluded that stone tools found in association with extinct mammal bones were the remains of ‘a hunting and fishing race of cave-dwellers’ (1874: 430) present in Europe during the Pleistocene. The book was published only 15 years after Darwin’s *On the Origin of Species* (1859) and only three years following *The Descent of Man, and Selection in Relation to Sex* (1871). The impact of such findings on a public who were first coming to terms with the antiquity of humans must have been considerable.

When we view ritual cave use from a global perspective over time, a number of patterns emerge (Moyes 2012a). Caves are associated with netherworlds, the dead, fertility, and the emergence of primordial humans. David Lewis-Williams (e.g. 1981, 2002) and his colleagues have argued for years that art painted or engraved onto cave walls directly relates to shamanic trance, transformation, and otherworldly imagery. Caves are often associated with rain and rainmaking, and many cultures consider them to be oracles or places of great power. Today we often think of caves as pilgrimage places associated with major world religions, but indigenous people in local communities the world over continue to practise ritual traditions rooted in the deep past.

p. 88 Arguably, Neanderthals used cave dark zones for symbolic activities. One of the earliest possible examples of special cave use was found in the dark zone of Bruniquel Cave in what is now southwestern France, where broken speleothems (stalagmites and stalactites) had been arranged in two circles, one of which contained a fire hearth (Rouzaud, Soulier, and Lignereux 1995). This is not an isolated example—a similar feature located in the Galerie Schoepflin at Arcy-sur-Cure in central France was placed about 30m into the cave’s dark zone in a narrow space with barely a meter ceiling height. It is unlikely that either of these features was

related to habitation; thus, they have been attributed to ritual use (Baffier and Girard 1998: 18–19; Farizy 1990: 307; 1991; Girard 1976: 53). While features may be open to interpretation, more convincing is the practice of Neanderthal cave burial (Clottes 2012; Hayden 2003: 100–118). Burials containing grave goods, including bear bones, were covered with stone slabs, precluding unintentional placement of the artefacts. Hayden (2003: 115) argues that this clearly indicates belief in an afterlife and may be part of a bear cult or even an early form of ancestor worship. It is possible that intentional burial in caves occurred as early as 530,000 years ago with *Homo heidelbergensis*, as per evidence at the Sima de los Huesos in Atapuerca, Spain (Price 2013: 22–24). Here, deposited in a lens of red clay, parts of skeletons of 32 individuals accompanied by bear bones were discovered at the base of a shaft 55m deep, located 500m from the cave entrance. The placement of the remains was clearly intentional, and may be the earliest evidence to date for special treatment of the dead.

During the Neolithic period, cave mortuary sites are particularly widespread. For instance, there are at least 75 burial Neolithic caves in England (Chamberlain 2012). This number rivals the number of constructed monuments as ritual places associated with the dead. Niah Cave in Borneo was used by foragers in the late Pleistocene and early Holocene but became a cemetery during the Neolithic (Barker and Lloyd-Smith 2012). Burials were placed in the twilight area between the light entrances and the dark interiors, a location that may have symbolized a liminal or boundary zone between life and death. Robin Skeates (2012) reported that caves in the Apulia region of Italy came into use as cemeteries in the Late Neolithic. He argues that mortuary rites were accompanied by feasting and the ritual ‘sacrifice’ and deposition of valued objects, and proposes that the caves may have been tied to ancestor worship during this early period. Additionally, the deep interior spaces of the largest cave sites were visually elaborated with paintings and ritual architecture such as walls and stairs, suggesting that they were used as performance spaces. Ritual cave use in this area continued into the Chalcolithic period through the Middle Bronze Age.

Peter Tompkins (2009; 2012) noted that of the 2,000 caves on the island of Crete, about 200 contained Neolithic and Bronze Age materials that have been traditionally interpreted as evidence of domestic use. He argues that these interpretations are misguided, and that the caves are actually ritual sites. Exceptions that are clearly ritual in nature are ‘burial caves,’ mainly of Early Minoan date (c.3100/3000–2000 BCE), or sacred caves of Middle (c.2000–1600 BCE) or Late Minoan date (c.1600–1100 BCE). In his extensive study, Tompkins concludes that burials in caves became more common in the Late Neolithic (c.5300–4500 BCE), and suggested that burial practices were related to increasing social hierarchy and control of symbolic natural resources.

p. 89 While burial practices provide some of the most convincing archaeological evidence for sacred or ritual cave use, indications may not be so overt. Cave formations (speleothems) that consist of crystalline spars or drip formations, such as stalactites and stalagmites, were found at the Neolithic site of Çatalhöyük in Turkey (Erdoğu et al. 2013). This is interesting because an elemental analysis conducted by Erdoğu and his colleagues suggests that these formations were collected from caves 100km distant. The fact that the people of Çatalhöyük visited caves and collected cave formations points to the importance of these places in the landscape. In her study of caching behaviour at the site, Carolyn Nakamura (2010) suggested that these formations were part of ‘magical’ deposits or caches, which indeed may be the case, given cross-cultural examples of similar speleothem use. In a recent assessment of the materials, Moyes (2014) noted that the morphology of the speleothems tended to correspond with different contexts. Most of the drip formations were associated with burial contexts, whereas cave crystals were found in others such as middens, indicating that they were used in different ways. The presence of stalactites in burials suggests that there may have been a cognitive link between caves and death or the afterlife.

It is also possible for us to trace archaeological traditions of ritual cave use over time from regional perspectives. For instance, in Greece ritual use begins in the Neolithic and is sustained throughout the classical period, when caves became enshrined in myth as houses of deities and venues for oracular enlightenment and prophecy (Ustinova 2009). In classical Greek mythology, deities of nature such as nymphs and the god Pan were thought to dwell in caves, and Apollo was often depicted as inhabiting dark nooks and caverns. Caves were also thought of as entrances to the netherworld where one could contact the dead. Yulia Ustinova (2009: 258–259) posits that the consultation of oracles required altered states of consciousness that only the solitary darkness of the cave could provide. She concluded that for the ancient Greeks, dark caves were essential in the quest for ‘ultimate truth’.

Caverns are salient features in ancient Egyptian cosmology and religion as well. The Nile itself was purported to emerge from secret deep caverns, but ironically, no natural deep caves upon which to draw for inspiration and only small caves and shallow grottos exist in the area (Smith 2012). Here, ritual cave use begins in the Neolithic and is continued into the classical periods, where we see caves and grottos playing a central role in solar cosmology and funerary theology. As written in the New Kingdom Book of Gates (c.1300 BCE), as well as the Book of Caverns and Earth (c.1200 BCE), in a continual cycle of renewal each night the sun god re-entered the dark cavernous underworld realm, where he lit the land of the dead and battled and defeated the forces of chaos so that he could be reborn with each sunrise. This journey through the netherworld was also undertaken by the dead in their quest for immortality. It is not surprising that this mythical underworld journey was echoed in temple architecture that employed cave symbolism. The ideal temple plan moved from open lit entrances to restricted areas in dark space. Temples sometimes even incorporated built caverns, such as in the sanctuary of Amun-Re at Deir el-Bahari, a mortuary temple (Wilkinson 2000: 178).

Ritual cave use is also an important part of New World cosmology (Moyes and Brady 2005; 2012). In Mesoamerica, caves were and still are considered to be openings into the sacred earth that contain life-giving powers, and figure as mythological places of origin that gave rise to both humans and their sustenance. In Aztec myth, humans emerged autochthonous from *Chicomostoc*, the seven-lobed cave (Heyden 1975), and in Maya iconography, caves are represented as the source of primordial corn and water (Saturno et al. 2005). Both ethnohistorically and ethnographically, caves are thought to provide passages to the fearsome Underworld through which souls were required to journey after death (Moyes 2012). In many Mesoamerican cultures, caves are homes for rain deities and modern Maya attest that clouds form in their interiors (Vogt and Stuart 2005: 164–165). Evidence of ritual cave use dates from at least as early as 1000 BCE (Moyes and Brady 2012), continuing through the classical periods and into the present. Today agricultural rituals, rainmaking, and other rites are still performed in traditional areas.

In the American Southwest, ritual cave use is prevalent, and although many archaeological sites have been reported and described, few syntheses have been undertaken. In a recent literature review, Scott Nicolay (2012) reported on 44 ritual caves and rockshelters in the ancestral Puebloan, Hohokam, and Mogollon culture areas. He argued that, as in Mesoamerican religions, caves represent a gateway from this world to the world beneath the earth. Supernaturals inhabiting the netherworld may be supplicated in caves to request rain and sustenance.

Cave use is recorded today in the North American Great Plains both ethnohistorically and ethnographically (Blakeslee 2012). As in other North American traditions, they are thought of as entrances to the underworld from which primordial humans emerged. They are also associated with water, hunting magic, curing disease, and fertility. In the North American East, Woodland period cultures (1000 BCE–1000 CE) were avid cave users, producing copious amounts of cave art including paintings, petroglyphs, and mud glyphs constructed of damp clay. Cave burials also became a tradition at this time (Watson 2012). While some archaeologists recognized the ritual nature of these sites (e.g. Faulkner 1988), little was done to interpret and synthesize findings from this area. Yet ethnographically and ethnohistorically indigenous people living in the area considered the landscape to be sacred, and caves to be places of primordial emergence from the underworld. Caves contained the bounty of the earth and deities were thought to dwell in them (Claassen 2012). Recent interpretations of the archaeological record suggest that among other rites, caves were used for male initiations (Crowthers 2012), women's fertility rites (Claassen 2011), and possibly as sweat lodges (Claassen 2012: 220).

Caves feature prominently in world religions as well. Christianity, Islam, and Judaism, for example, locate a number of important shrines in caves. Mohammed received his first divine messages in a cave. Holy Land pilgrimage sites also include the Dome of the Rock in Jerusalem, built over the rock floor of a cave on the ancient Temple Mount, and believed by Muslims to be the site of Mohammed's ascent to Heaven, and by both Jews and Muslims to be the location of Abraham's attempted sacrifice of his son. The Church of the Nativity in Bethlehem, Jesus' birthplace stands over a grotto, as does the Eleona that stands outside the walls of Jerusalem on the Mount of Olives, originally associated with the Ascension and the revelation of the mysteries to the Apostles (Wharton 1992). Jews venerate the Caves of the Patriarchs in Hebron as the burial place of biblical figures Abraham, Sarah, Isaac, Rebekah, Jacob, and Leah as well as possibly Adam and Eve. Muslims venerate it as the burial place of Abraham, and place the tomb of Joseph there as well (Meri 2003). The Church of St Peter in Antioch, Turkey, encompasses a natural cave, and Catholics venerate the major

pilgrimage site of the cave in Lourdes, France, where Bernadette Soubiros convinced the Vatican she had received several visitations of the Virgin Mary in 1858 (Davidson and Gitlitz 2002: 356–359).

Buddhist and Hindu cave temples serve as pilgrimage shrines today (Hobbs 2012). In Tibet, many caves are considered to be *gnas-chenor* power places in both Buddhist and pre-Buddhist traditions (Aldenderfer 2012). Indeed, caves are of special interest to Buddhists, for it is within a cave that the historical Buddha meditated for six years in his search for enlightenment, which he achieved only after his emergence from the cave (Barnes 1999: 119–120). Monks and lamas seeking nirvana have emulated this tradition for centuries in meditation caves, which may be the reason that caves and chambers often serve as foundational elements of major temple and monastic complexes. The Potala palace, one of Tibet's most sacred sites, is said to have been founded upon a meditation cave used by Songsten Gampo, the first Buddhist king of Tibet.

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## The cave and the mind

The pattern of ritual cave use is so strikingly pervasive that one must ask 'why caves?' Are long-standing cave traditions primarily the result of social memories, reinforced by the landscape presence (Edmonds 1999: 15–31; Tilley 1994: 7–75; Tompkins 2009: 135)? Is it possible that we are bearing witness to a long history of diffusion beginning in the Upper Palaeolithic or perhaps even earlier? Are cave traditions independent inventions, or do we have a combination of both independent invention and diffusion? How is it that cave traditions over time and space share so many similar concepts? This is one of the oldest and most intractable issues facing cross-cultural researchers. Dubbing this 'Galton's Problem', Raoul Naroll (1961) pointed out that this was one of the crucial weaknesses in the cross-cultural quantitative survey method. The concept dates from an 1889 lecture in which Edward B. Tylor examined relationships between marriage laws and descent patterns using data drawn from a cross-cultural sample. Sir Francis Galton suggested that the regularities that Tylor noted could have been the result of diffusion rather than a functional relationship between various institutional forms. If cultures were considered to be a unit of measurement, cultural borrowing skewed statistical analyses by inflating the number of instances that a trait was represented, because each example is not an independent instance. Swayed by this argument, Franz Boas argued that cross-cultural comparisons were valueless (Lowie 1946: 227, 230). How do we get around Galton's Problem if it is impossible to know for sure whether culture traits, particularly those of the distant past, were the result of diffusion or independent innovation or both? Is it possible to understand cultural similarities without invoking diffusion?

Studies of human cognition open up new avenues from which to explore similarities in independent invention and patterns of cross-cultural regularities by introducing new lenses and methodologies for understanding human behaviour. Cognitive science shifts research away from cultures as a unit of analysis to individuals or populations as the focus of study. For years, Maurice Bloch has challenged the nature/culture dichotomy, and his most recent volume (2012) issues a call for cultural anthropologists to more carefully consider the interaction between historical social processes and conceptualization in mainstream research. Bloch argues that cultural symbols are based on 'meaning for people'; therefore, the separation between public meaning and private thought is unsustainable (2012: 4). He argues that for too long there has been ongoing hostility between the natural sciences and anthropology, and that cognitive science offers an olive branch to a field that has undervalued the individual.

In his efforts to understand human behaviour, Bloch argued that what sets us apart from other animals is imagination, which is at the heart of all sociality, including religious beliefs (Bloch 2008: 2060). So, for Bloch, the study of the origins of beliefs is 'nothing special.' He divides human sociality into the transactional social and transcendental social. The transactional social is grounded in real-world events, manipulations, assertion, and defeats. We share this type of sociality with non-human primates and other animals. What differs in humans is that we also display a transcendental sociality that consists of essentialized roles and groups such as fathers, mothers, nations, presidents, monsters, ghosts, and deities that are the products of human imagination. Bloch concludes that it is our ability to live largely in our imagination that sets humans apart from other species and gives rise to human sociality, which includes religious beliefs.

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It is part of this transcendental sociality that interests researchers like Pascal Boyer (2001) in his attempts to predict the kinds of ideas that lead to the adoption of salient religious beliefs. He explains the occurrence of similar beliefs over time and space as the result of similar templates that organize information. Boyer

suggests that these ideas are counterintuitive and therefore attention-grabbing, which lends them a certain staying power as they are passed along between agents. Boyer's explanations are mentalist, focusing on the structure of the mind as the fundamental source in these developments, so he does not consider the role that human environmental perception plays in establishing cosmologies or foundational religious principles.

He is not alone, as many researchers of ancient religion attribute religious beliefs to internal dynamics and ignore the role of the environment in the production of religious ideas. In the very earliest anthropological research on religion, Tylor (2012 [1874]) argued that dreams were the causative agent in the generation of religious ideas and at the very heart of spirituality. Dreaming transports the individual to other worlds and opens up all kinds of possibilities for alternative realities. These alternative realities or ecstatic states are also part of traditional religions and are at the heart of shamanism, which is generally accepted as the most likely form of early religion (See Hayden 2003: chs 1–4 for thorough discussion). The visual geometric patterns or *entopics* experienced in ecstatic states or trance have received a great deal of attention because of their utility in interpreting rock art. Much of this art is associated with open rockshelters, but some is located in deep caves such as many well-known European Palaeolithic sites. Titling one of his volumes *The Mind in the Cave*, Lewis-Williams (2002) recognized the importance of the cave space itself in the origins and creation of Upper Palaeolithic art. However, he attributes the use of dark cave interiors to preconceived cosmological beliefs, and envisions early shamanic cosmologies to include an otherworld or Underworld component that would attract ritual practitioners to the labyrinthine passages of the dark cave. He suggests that the cave space may have served as a metaphorical 'mental vortex that leads to the experiences and hallucinations of deep trance' (2002: 209). In other words, he argues that humans are attracted to cave spaces because of mental constructions experienced while in trance states, but does not view the cave as *causal*. This is analogous to Laurence Straus's (1997) idea of caves being 'convenient cavities,' placing caves in the role of passive environments. Our work suggests that the environment takes a more active role in human cognition.

Our stance requires that we reject Cartesian notions of mind/body duality in favour of modern theories of embodied knowledge, such as experiential realism. In this theory, developed by George Lakoff and Mark Johnson (1999), mental models of the world evolve from one's direct experiences with it. Even though the mind cannot experience the world 'directly', the indirect experiences of the world are shaped in consistent ways by its physical nature, by the physical nature of our individual senses, and by the physical nature of our own bodies and how they interact physically with the world. More recently, Vittorio Gallese (2005) has joined Lakoff in further developing this theory by reviewing evidence from neuroscience. Both argue that the formulation of concepts cannot be divorced from sensorimotor regions of the brain and are thus grounded in material reality and experience. This aligns with Gerald Edelman's (1992) theory of neuronal group selection (TNGS), which argues that minds become structured not on a genetically specified schedule but by the building of certain neural firing patterns reinforced by experience. Therefore, we will argue that it is 'the cave and the mind' rather than the 'mind in the cave' that produces mental states that become associated with supernatural phenomena.

While culturally specific concepts could affect an individual's experience of cave dark zones by creating contexts based on preconceived notions, our question is whether there are factors other than culture at work in these formulations, and to what extent perceptions may influence cultural meanings rather than the other way around. Montello and Moyes (2012) proposed that caves have physical properties experienced by humans that lead to similar experiences and the assignment of similar meanings among different human groups across time and space. For instance, caves often have exceptionally complex layouts and topology, including 3D structure rarely seen in other terrestrial environments. They tend to be articulated in very irregular ways that offer only short lines of visibility (sightlines). Even if illumination was available, caves would not support large vistas, and the appearance of their surfaces is usually undifferentiated, creating disorientation in people. Most caves have relatively few distinct landmarks, especially for caving non-specialists, and external features like celestial bodies are not present. Furthermore, cave locomotion often requires great physical effort and may be accompanied by anxiety or even claustrophobia. To the degree that a cave is a natural environment, it will not contain signs or other cultural artefacts that convey a sense of familiarity and the everyday world for people in the cave.

Research on environmental aesthetics point to culturally universal characteristics of human–environment interaction, such as 'legibility' and 'mystery', that help explain common emotional responses to cave environments. This led Montello and Moyes (2012) to conclude that darkness and poor visibility in caves are

the most salient properties in explaining common human responses to them. This may be particularly true for ancient people who used torches or small oil lamps to illuminate dark zones. The quality of light would have been directed and variable, producing perceptual distortions of the surrounds. Based on our observations of how deep caves were used and thought of by humans, we conducted a human-subjects experiment to investigate the cave's most salient property—darkness.

## Human response to darkness: an experiment

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In a very dark environment, one has to become accustomed to accepting the existence of objects that cannot be readily seen. This happens at a very basic sensorimotor level. We wanted to know if thinking induced or inspired by darkness could lead to conceptualizations of the supernatural in the minds of modern humans. Thus, we have begun to carry out ongoing laboratory experiments to explore the effects of light and dark on the human mind. The results of our first study summarized here are intriguing.

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There is some degree of diversity in the age range and ethnic backgrounds of the University of California, Merced, undergraduates used in this experiment; therefore it was important to maximize the likelihood that these factors were evenly distributed across the experimental conditions by using random assignment of each participant to either of the two lighting conditions. We randomly assigned participants to fill out a questionnaire on magical or supernatural thinking while sitting either in a room that was well lit with natural light or in a room that was nearly dark. Both rooms were small 1.2 m × 1.8 m laboratory spaces. In the light condition, the room had a large picture window that let in a great deal of natural light during the day, when we collected data. The dark condition was presented in a windowless room dimly illuminated only by a reading light attached to the questionnaire clipboard. The dark room was otherwise identical to the light room. The reading light provided barely enough light to read the questionnaire. The questionnaire consisted of two parts. The first included 15 questions asking to what degree participants believe (on a 0–10 scale) in a wide variety of types of supernatural thinking, including extrasensory perception, ghosts, reincarnation, a deity that listens to one's prayers, etc. The second part included 10 short vignettes describing anomalous events in everyday situations, offering multiple-choice responses for how the participant might interpret and explain the event. Two of the alternative responses involved supernatural explanations, while the other two involved common scientific explanations.

We tested 104 participants, 52 in each room with its attendant lighting condition. Because we randomly assigned participants to one or the other room, we can attribute any reliable difference between the two groups' responses on the supernatural-thinking questionnaire to the light/dark manipulation. In fact, the participants in the dark room rated their beliefs in supernatural thinking on the first part of the questionnaire as two-thirds of a point higher on average than those in the light room. Although this effect is subtle, it is sufficiently reliable across participants that the difference is statistically significant ( $p < .05$ ). In a two-sample *t*-test, the effect-of-lighting condition obtained a *t* value of 4.74, with degrees of freedom of 102, and a *p* value of 0.032 (which indicates the probability that the difference in these conditions resulted from pure chance). This difference was replicated on the second part of the questionnaire. Compared to participants in the light room, those in the dark room were 11 per cent more likely to select a multiple-choice response that was associated with supernatural thinking. This difference was also statistically significant in a two-sample *t*-test, where the effect-of-lighting condition obtained a *t* value of 4.57, with degrees of freedom of 102, and a *p* value of 0.035.



Even in the case of modern Western humans measured with a simple paper-and-pencil questionnaire, it seems that a dark environment can facilitate beliefs in supernatural explanations. We do not have a definitive explanation for our findings, but research by psychiatrists, psychologists, neuroscientists, cognitive scientists, philosophers, and linguists provide theoretical propositions that help to explain them. First we consider how people today think about darkness and how darkness is used in metaphor. Mark Johnson (1987) argued that knowledge of the world mediated through bodily experience is organized by image schemata, which he describes as the 'geography of human experience'. This idea of image schemata is at the heart of Johnson's theory of knowledge construction in that they are the building blocks of thought that arise from bodily perceptions and experience in the world. They are not rich visual images or primitives; rather, they are non-specific scaffolds ↪ for structuring human meaning and understanding. Because of their inherent structural properties, image schemata give rise to countless metaphors for extending our knowledge of the world. There are many image schemata, including 'container', 'path', 'part-whole', 'light/dark', 'blockage', 'link', and 'center-periphery'. Johnson goes on to argue that the internal structure of image schemata and their metaphorical systems inspire and constrain human thought. This accounts for how similar patterns of inference can develop across different people over a wide range of spatial, temporal, and cultural domains.

Metaphor is far more than a rhetorical or literary tool. It structures our everyday thoughts, feelings, and actions (Gibbs 1994; Lakoff and Johnson 1980; Ritchie 2013) and is grounded in our everyday embodied experience (Feldman 2008; Gibbs and Matlock 2008). As such, metaphor provides a lens through which we make sense of states, events, and situations in the world, and which influences how we feel and take action. For instance, it influences our perceptions and attitudes of government, politicians, and political campaigns (Lakoff and Wehling 2012; Matlock 2012). One of the main functions of metaphor is to shape how we talk and make sense of relatively abstract things in the world, including time (Clark 1973; Radden 1996) and emotions (Kövecses 2000). This is done by anchoring our understanding of a relatively more abstract domain in terms of phenomena that are readily perceivable and concrete. For instance, political campaigns are often described in terms of foot races (Matlock 2013) and relationships are often described in terms of journeys (Gibbs and Nascimento 1996). Even though metaphors vary somewhat across cultures, some appear to be universal because human bodies, genes, and physical environments are highly similar across cultures and historical periods (Kövecses 2006).

A number of metaphors use darkness to structure abstract concepts. Some of these basic conceptual metaphors have been discussed in the domain of film by Forceville and Renckens (2013). Many resonate with our conceptions of caves. One pervasive darkness metaphor is 'bad is dark'. In this metaphorical construal, darkness is used to portray evil, ill will, sinister thinking, and bad deeds. We also see this metaphor at work with expressions like 'dark deeds' and 'black heart'. Another common darkness metaphor is 'danger is dark'. With this metaphor, things that are foreboding are often framed with darkness. This combination (along with 'evil is down') is very common in horror films (see Winter 2014 for discussion). Together, these and other metaphors of darkness form a coherent system that underlies and motivates the way we describe and make sense of evil, misfortune, despair, unhappiness, and lack of knowledge. In many respects they relate to our conceptions of caves. When we step into a cave, there is danger and mystery. With this comes vulnerability. We do not know what lies ahead. We may lose our way. These metaphors may very well explain why caves are often chosen as places to depict evil, unknown, mysterious, and spooky events in film and literature. It may also be why they are perfect for hosting spiritual activities. With darkness and uncertainty, there is the hope of a state change to enlightenment.

We suspect that darkness creates uncertainty or may unleash the imagination when the mind is freed by reduced sensory input. Studies of sensory deprivation prevalent in the mid-twentieth century are informative in this regard. Impetus for these experiments came from anecdotal evidence in which social isolation or unique instances of sensory deprivation caused hallucinations. As early as 1760, naturalist Charles Bonnet reported the case of his 89-year-old grandfather, who suffered from vision loss due to cataracts and began to see visions of people, figures, and animals although his cognition was otherwise normal. This later became known as the Charles Bonnet Syndrome (Siatkowski et al. 1990). Men cast adrift on the sea or in other kinds of monotonous environments were known to have ↪ hallucinations (Solomon et al. 1957). What spurred a large body of experimental research were the experiences of prisoners of war who were brainwashed using sensory deprivation techniques as well as poliomyelitis patients encased in

tank-type respirators who began to suffer hallucinations (Leiderman et al. 1958). Research centres at major institutions in the US and Canada including the National Institute for Mental Health in Bethesda, Maryland, Boston City Hospital, Harvard Medical School, Rutgers University, McGill University, and the University of Manitoba were prolific, and spurred a large number of studies using various experimental protocols (e.g. Solomon 1965; Suefeld 1969a; Zubek 1969). These studies vary widely in their definitions of sensory deprivation, their methods of testing factors such as visual, auditory, or somatic deprivations, their results across individuals, and their interpretation of data. In research, perceptual deprivation is methodologically differentiated from sensory deprivation. Sensory deprivation involves reduced sensory stimulation such as wearing masks to cover the eyes or ears, whereas perceptual deprivation involves an attempt to reduce the patterning and meaningful organization of sensory input such as placing pingpong balls over the eyes to admit diffused light but not allow for clear imagery (Rossi 1969: 18–19; Schultz 1965: 6–10). Despite variable results based on set (preconceived notions), setting, and methodology, there is agreement that effects of sensory deprivation cause changes in perception due to events in the visual cortex which may include hallucination (a variety of ‘visual imagery’), and show ‘deficiencies in visual-motor coordination, changes in size and shape constancies, color perception, apparent movement, loss of accuracy in tactual, spatial, and time orientation and a variety of other changes’ (Kubzansky and Leiderman 1965: 228–229).

A number of theories account for the mid-century research findings, including theories based on emotion, cognition, and physiology (see Schultz 1965: 169–194; Suefeld 1969b; Zuckerman 1969). Duane Schultz’s (1965: 30) ‘sensoristasis’ theory readily explains visual abnormalities and affective responses and their variability between subjects. Based on his synthetic analysis of laboratory results prior to 1965, Schultz postulated that there is a homeostatic mechanism he defines as ‘a drive of cortical arousal which impels the organism (in a waking state) to strive to maintain an optimal level of sensory variation ... a balance in stimulus variation to the cortex mediated by the ARAS or ascending reticular activation system’ (Schultz 1965: 30). In other words, our brains strive to create a certain level of varied sensory input to maintain cortical arousal at an optimum level. If visual sensory input is lacking, such as in a dark room or a cave environment, our bodies may attempt to provide it.

Many findings from sensory deprivation research are qualitative, and involve affective responses including ‘boredom, restlessness, irritability, and occasionally fear of panic proportions’ and descriptions of post-isolation states referred to as ‘fatigue, drowsiness, and feelings of being dazed, confused, and disoriented’ (Kubzansky and Leiderman 1965: 229). Additionally, effects are greater under conditions of perceptual deprivation as opposed to total sensory deprivation, which is perhaps closer to what one might experience in a darkened shadowy room or in a cave environment lit with flickering light. Kubzansky (1961: 63) suggested that from a cognitive perspective, ‘the effects may be best characterized as a general loosening of subject’s ability to perceive reality and the weakening of stable internal norms against which to evaluate perceptual (visual) experience’. It is this loosening of perceived reality that may allow imaginary leaps to become more prominent in our experimental findings and in the history and prehistory of cave dark-zone ritual practice.

p. 97 Psychedelic drugs produce similar but more dramatic effects compared with those induced by sensory deprivation, and research into the mechanisms in the brain responsible for them may be pertinent to our study. Psychedelics are noted for visually intensifying colours and producing *entoptics*, described as visual effects that can often include vibrating geometric patterns (Lewis-Williams 2002: 126–130; Lewis-Williams and Dowson 1988). They may also produce hallucinations that include figures, beings, and sounds, which may be beautiful or terrifying. These drugs also produce intense euphoria, profound intellectual or spiritual insights, out-of-body experiences and temporal distortions (Strassman 2001: 29–41).

Though LSD was well studied in the 1960s, more recently the molecule DMT (dimethyltryptamine) and its sister 5-MeO-DMT have piqued the interest of researchers because they are naturally occurring psychedelic compounds found in both plants and animals including humans (Barker et al. 2012; Strassman 2001). DMT belongs to the tryptamine family and is a close relative of LSD and psilocybin found in mushrooms and other fungi. DMT has been synthesized in the laboratory (Manske 1931), enabling its use in human-subject experimentation; it is considered preferable to LSD for research because its effects last only a few minutes as compared to hours. In the 1990s psychiatrist Rick Strassman (2001) conducted research on human subjects at the University of New Mexico aimed at determining if the drug had therapeutic properties, and at understanding its effects on human consciousness and how it might relate to near-death experiences. He dubbed DMT the ‘spirit molecule’ because of the number of mystical states and spiritual experiences that subjects reported during testing. Because of similarities between reports from his subjects and from those

who were clinically dead and returned to life, Strassman asserted that DMT is likely to be generated in near death-experiences. Many of Strassman's subjects reported feeling as if they died and had come back, and some witnessed similar effects such as going into vortexes or tunnels and seeing white light while under the influence of the drug.

Though highly controversial, Strassman's work is of interest to our research because he has hypothesized that DMT is produced by the pineal gland. This small organ, shaped like a pine cone, is present in birds, reptiles, and mammals. In lizards and amphibians it is considered to be the 'third eye' because the gland is positioned so that it has direct access to light and functions to regulate body temperature and skin coloration. In humans it is housed deep in the brain between the two cerebral hemispheres, but is not part of the brain in the sense of direct nerve connections. The gland is, however, located in close proximity to the visual and auditory *colliculi*, which serve as relay stations for electrical and chemical impulses that begin in the eyes and ears and pass through them before registering in the brain. Any secretions by the pineal gland would easily settle onto the colliculi. Additionally, the limbic system, which is responsible for emotional responses, surrounds the pineal, granting it direct access (Strassman 2001: 61).

The original research on the pineal gland revealed that it was rich in serotonin (with more serotonin than anywhere else in the body) and primarily responsible for producing melatonin (Lerner et al. 1958), a light-sensitive hormone that regulates circadian rhythms and is instrumental in regulating reproductive cycles based on seasonality in mammals (Axelrod 1974). Melatonin, a tryptamine like DMT, is called the 'hormone of darkness' because it is produced only at night. There is some evidence that fluctuations in melatonin levels may increase or decrease dreaming (Strassman 2001: 351). Additionally, one of the major building blocks for producing DMT from serotonin, melatonin, or tryptamine are enzymes (*methyltransferases*) also found in the pineal gland. Because the necessary building blocks for DMT were found in abundance in the pineal, Strassman hypothesized that the gland was responsible for the production of these enzymes in the brain. He was not able to prove his theory by simple blood testing because this form of DMT is not in the bloodstream and because DMT breaks down very quickly. However, recent research conducted with his colleague Steven Barker (Barker et al. 2013) has for the first time isolated DMT in the brains of laboratory rats, suggesting that this same process may occur in humans. Although this research is quite new and tentative, it suggests to us that secretions produced by the light-sensitive pineal gland or other means of endogenous DMT production have the potential to contribute to the effects produced by sensory deprivation triggered by immersion in dark spaces. Even minor psychedelic effects would serve to either loosen one's grip on reality or change the individual's perception of reality (see Gatton this volume).

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This supports the argument advanced by Montello and Moyes (2012) that the physical properties of caves, particularly darkness, influence psychological responses including perceptions, cognitions, emotions, and behaviours. They contend that common experiences and meanings lead to similar use of cave dark zones as sacred or ritual spaces that may in turn function as venues for intentional semiotic communications with or about the supernatural. Thus, our experiment supports the hypothesis that cave dark zones provide an 'affordance' for magical/supernatural thinking and action. The concept of affordance was introduced by the perceptual psychologist J. J. Gibson (1977) to refer to the fact that objects and environments afford certain human actions, depending on a mutual fit between the objective properties of the objects/environments and the physical capabilities of the person. For example, a rock provides an affordance for sitting to the degree that it is a solid flattish object of the right height and width for a human body. An opening in a canyon provides an affordance, as does an entry into a cave to the degree that it is high and wide enough for human bodies and it can be visually identified by eyes that pick up electromagnetic radiation in the proper portion of the spectrum. Caves offer humans an environment that is morphologically complex and without light. They often do not allow upright posture or easy locomotion, leading readily to spatial disorientation. The dark zones of caves do not provide good affordances for human habitation, but they do offer good affordances for hiding, for ritual, and for experiencing alternate mental states of reality. They offer a shadowy and unusual environment that is different from the surface world, an environment that inspires mystery and flights of the imagination. Montello and Moyes (2012: 394) call this 'transcendental affordance', which refers to the numinous properties that caves provide.

Our work adds to the growing body of data that helps explain how religious ideas are formulated in the human mind. We suggest that shared human cognitive and emotional reactions to darkness itself, including embodied responses, encourage and stimulate the imagination in similar ways cross-culturally. This occurs because darkness releases the mind from attending to visual inputs available in well-lit environments and is reinforced by cultural concepts of darkness associated with supernatural beings, states of mind, and other similar notions. Although it is certain that there is a convergence of multiple factors that contributed to early humans developing beliefs in the supernatural, our preliminary laboratory study provides intriguing evidence that darkness—of the type found in the dark zones of caves (perhaps lit by shadowy torchlight)—is an important causal force in the transcendental or imaginary thinking so commonly exercised in cave dark-zone locales. This point is not trivial, as it agrees with a number of researchers who suggest that imaginary thinking brought on by altered states of consciousness, no matter how they are attained—hallucination, trance, possession, vision, sensory deprivation, or dreaming—are fundamental to the genesis of religion (Furst 1976; Lewis-Williams 2002: 135; 2008; McClennon 1997; Tylor 2012[1874]; Winkelman 2008). Most importantly, our work suggests that the natural environment itself is not a passive player but a causative agent in religious or spiritual conceptualizations produced by the human mind. Our work demonstrates that quality of light is a major factor in considering how space is thought of and used by humans cross-culturally through time and space, and calls for archaeologists and anthropologists to be more attentive to its effects on human consciousness.

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