



# Divine Placebo: Health and the Evolution of Religion

Patrik Lindenfors<sup>1,2</sup>

Published online: 25 March 2019  
© Springer Science+Business Media, LLC, part of Springer Nature 2019

## Abstract

In this paper, I draw on knowledge from several disciplines to explicate the potential evolutionary significance of health effects of religiosity. I present three main observations. First, traditional methods of religious healers seldom rely on active remedies, but instead focus on lifestyle changes or spiritual healing practices that best can be described as placebo methods. Second, actual health effects of religiosity are thus mainly traceable to effects from a regulated lifestyle, social support networks, or placebo effects. Third, there are clear parallels between religious healing practices and currently identified methods that induce placebo effects. Physiological mechanisms identified to lie behind placebo effects activate the body's own coping strategies and healing responses. In combination, lifestyle, social support networks, and placebo effects thus produce both actual and perceived health effects of religiosity. This may have played an important role in the evolution and diffusion of religion through two main pathways. First, any real positive health effects of religiosity would have provided a direct biological advantage. Second, any perceived health effects, both positive and negative, would further have provided a unique selling point for 'religiosity' per se. Actual and perceived health effects of religiosity may therefore have played an underestimated role during the evolution of religiosity through both biological and cultural pathways.

**Keywords** Evolution · Cultural evolution · Health · Placebo · Religiosity · Social support networks · Lifestyle

## Introduction

Some form of religion exists in every documented society on earth (Gray 1998; Hackett *et al.* 2012). Because of its pervasiveness, researchers have argued that religion needs a universal evolutionary explanation, and/or an explanation based on universal human cognitive mechanisms. However, 'religion' is a multifaceted term often encompassing some or many component aspects, such as rituals, myths, rules and regulations on ethical behaviour, social practices, and some form of belief in the supernatural (e.g., gods, spirits, souls, afterlife). Crucially, different aspects of religion may have different explanations and different explanations may apply to several aspects of religion (e.g., Boyer 2001; Atran 2002; Barrett 2004; Dennett 2006; Wilson 2010; Barrett 2012; McCauley 2012; Norenzayan 2013; Lindenfors 2016). I here consider the

evolutionary significance of one such effect of religion: the connection between religiosity and health.

## Religious Healing

Religious healing practices can broadly be categorized into the non-exclusive categories of active treatments, treatments aimed at alleviating symptoms, treatments that may trigger placebo responses, and treatments designed to appease supernatural agents. Religious healing strategies used in several contemporary and historical societies are often focused on spiritual healing practices rather than actual treatments of physical symptoms (e.g., Sachs 2004, 2012; Wootton 2007; Moberg and Ståhle 2014).

For example, every year, about six million people visit the French town of Lourdes, many to seek relief from a disparate array of physical and psychological ailments in the reputedly healing baths and through prayer. No medically active treatments are offered. According to the Sanctuary of Our-Lady of Lourdes information page,<sup>1</sup> about 350, 000 of the six million

---

✉ Patrik Lindenfors  
patrik.lindenfors@iffs.se

<sup>1</sup> Institute for Future Studies, Box 591, SE-101 31 Stockholm, Sweden

<sup>2</sup> Centre for the Study of Cultural Evolution & Department of Zoology, Stockholm University, SE-106 91 Stockholm, Sweden

<sup>1</sup> <http://en.lourdes-france.org/> (retrieved 2018-09-18)

visitors make use of the healing baths, a tradition stretching back to the middle of the nineteenth century.

This raises several important points. First, a significant number of people – even in the current ‘scientific’ place and time – are prepared to shun scientifically based medicine to seek miraculous cures for their ailments. Second, many thousands are so convinced that they have been miraculously cured that they find it worthwhile to report their healing to the Lourdes medical committee. What is not known is how many experience some form of healing without reporting to the Committee. Since its inception, about 7000 instances of healing have been reported to the Lourdes International Medical Committee, and 69 of them confirmed miraculous. Only a marginal proportion of the people seeking a miraculous cure really get one – 69 out of 350,000 people is a rate of 0.019%, or approximately one out of every 5000 people. This is a much lower success rate than for example the estimated rate of spontaneous remission of basal cell carcinoma and breast cancer, reportedly being about 20% (Printz 2001), which leads to the suspicion that the low success rate probably more is a testament to the theological diligence of the review committee than a report of actual healing rates after visiting Lourdes.

It seems likely that just as millions of Catholics continue to flock to Lourdes, comparable numbers of people flock to other, similar sites around the world. And that many people have historically indulged in analogous healings, where treatments often contain no active ingredient, do not necessarily target the afflicted part of the body or disease agent, and sometimes do not even physically involve the patient. In fact, the historical and anthropological literature is replete with reports of similar spiritual healing (e.g., Sachs 2004, 2012; Wootton 2007; Moberg and Ståhle 2014).

Consider, for example, the Ifugao people living in the mountainous inner regions of the island Luzon in the Philippines. According to their beliefs, human illnesses are caused by spirits, ancestral or natural, which reside in stones, trees, or rivers. To cure illnesses, animals, commonly chickens or pigs, are chosen on the basis of which spirit is determined to be causing the illness and are sacrificed to appease the spirits in a ritual termed Ayag that also involves chanting and dancing.<sup>2</sup> One thing that is *not* involved in the healing ritual, however, is any ingredient or action involving the sick person. The curative actions are completely focused on appeasing extrinsic spiritual evil-doers.

In fact, a lot of traditional healing is intrinsically interwoven with spiritual practices. Instead of combating agents causing the disease (that may be unknown to traditional practitioners), medicine men and women and shamans perform elaborate rituals or sacrifices to negotiate with and satisfy spirits held to be responsible for the misfortune. Sometimes the patient is

reduced to a mere bystander, neither touched nor medicated by the healer (e.g. Littlewood and Dein 2001; Humphrey 2002). Causal effects are inferred, even if not actual (Pronin *et al.* 2006; Sosis 2007; Sosis and Handwerker 2011; Legare and Souza 2012; Rice 2012; Stavrova and Meckel 2017).

However, it should be noted that ineffectual treatments are not confined solely to religious healers. Traditional Chinese medicine treatments are aimed at restoring harmony to the interaction between the body’s functional entities and the outside world. In traditional Indian and Greek medicine, bodily fluids are hypothesized to need to be in balance, and treatments – such as blood-letting, which was very common in medieval European medicine – were aimed at this restoration (Wootton 2007). In the San culture, healing may famously be carried out through ‘healing dances,’ where the healer – not the patient – dances him- or herself into a state of trance to activate healing energy – *num* (Katz 1982; Keeney 2003).

Such traditional theories of what causes illness are mainly factually incorrect (Wootton 2007). Most traditional treatments are therefore not active, but their effects – if any – are indirect, through e.g., placebo effects. This would make placebo one of the oldest remedies known to mankind. As an example of this, one of the world’s oldest surviving medicinal manuscripts, the Ebers papyrus, contains recipes of over 700 medicines, almost all ineffectual (Ebbell 1937). Modern evidence-based medicine has instead shown that the agents causing disease are microorganisms such as bacteria, viruses, or parasites, and medicines with active ingredients are consequently aimed at killing these.

*Observation 1: Traditional methods of religious healers do not always rely on active remedies, but instead focus on lifestyle changes or spiritual healing practices that best can be described as placebo methods.*

## Reported Health Benefits of Being Religious

There are many contemporary reported health benefits from adhering to religion. For example, in a large meta-analysis from 2012 of several hundreds of studies, Harold Koenig reported that religious involvement, as measured by factors such as self-reported religiosity or church attendance, provided benefits such as better immune and endocrine function, lower mortality from cancer, lower blood pressure, less heart disease, lower cholesterol, less smoking, more exercising, and lower mortality (Koenig 2012; see also Koenig 2008). Further, in a study using data from the Women’s Health Initiative, it was found that women aged 50 and up were 20% less likely to die in any given year if they were weekly attendants of religious services, compared to women who never attend religious services. The analysis controlled for age, ethnicity, income level, and current health (Schnall *et al.* 2010). Moreover, two reviews in an NIH-organized special section of *American Psychologist* found

<sup>2</sup> <http://www.stuartxchange.com/Cordillera.html> (retrieved 2018-09-18)

further evidence that ‘church/service attendance protects healthy people against death’ (Powell *et al.* 2003), but that even though ‘religiosity/spirituality [was] linked to health related physiological processes—including cardiovascular, neuro-endocrine, and immune function’ ‘more solid evidence is needed’ (Seeman *et al.* 2003).

However, ‘evidence of an association between religion, spirituality, and health is weak and inconsistent’ (Sloan *et al.* 1999: 667) and it is therefore considered unethical to advocate religious faith to patients for health purposes (Sloan 2006). Even without the presence of such a ‘faith factor,’ specific correlations between religiosity and health often do exist, and some existing research suggests that religiosity is correlated with better health and longevity. However, the correlations seem to differ in different contexts – most studies rely on data from the United States. A recent study examining religiosity and self-rated health across 59 countries showed that the positive association between health and religiosity is an exception found in only a small number of countries. In countries where religiosity is the social norm, religious people reported better health than non-religious, while in less religious countries the relationship is the opposite (Stavrova 2015; see also Hayward *et al.* 2016).

A hint as to why this should be lies in the fact that most ailments that are reportedly affected by religiosity in the study by Koenig (2012) are disorders that can be affected by a healthier life-style. Healthier living through a more regulated lifestyle, better diet, increased exercise, and less smoking may be more common in poorer, more religious countries among people who self-report as religious. Further, well-functioning social networks have also been shown to play an important role in physical health (Seybold and Hill 2001).

Green and Elliott (2010), through interviews with 4510 Americans about their outlook on life and religiosity, captured another type of correlation between health and religiosity: ‘People who identify as religious tend to report better health and happiness, regardless of religious affiliation, religious activities, work and family, social support, or financial. Thus, the self-reported view of life *in general* is (in some contexts) positively related to the degree of religiosity, something that may provide another hint to the link between spirituality and healing in so many cultures – the placebo effect (Sachs 2004).

*Observation 2: Actual health effects of religiosity seem to be context dependent and mainly traceable to effects from a regulated lifestyle, social support networks, or placebo effects.*

## Placebo Responses

A few studies have investigated a direct causal link between religion and health. For example, research has shown that in highly religious participants expectations contribute to

reduced pain levels during prayer (Jegindø *et al.* 2013a), that pain can be modulated through religious rituals during religious piercing (Jegindø *et al.* 2013b), that synchronized training creates heightened endorphin surges compared with similar training regimes carried out alone (Cohen *et al.* 2009), and that there is comparable synchronized arousal in participants in fire-walking rituals (Konvalinka *et al.* 2011). There are also a number of studies showing that prayer may work personally in a coping context, but not when praying for others (Roberts *et al.* 2009). Further, a study by Paldam and Schjoedt (2016) revealed that diseases and symptoms healed through charismatic prayer healing showed that even in testimonies published to convince others about the divine powers of prayer, most accounts included relatively mundane reports of pain relief in the musculoskeletal system. Cases of immediate and complete healing of serious diseases were also sometimes found in the material, but were tempered by variables relating to the credibility of each testimony.

The parallels between healing rituals and placebo treatments are clear. As stated by Kaptchuk (2011) ‘Experimental research into placebo effects demonstrates that routine biomedical pharmacological and procedural interventions contain significant ritual dimensions. This research also suggests that ritual healing not only represents changes in affect, self-awareness and self-appraisal of behavioural capacities, but involves modulations of symptoms through neurobiological mechanisms.’ Research linking religiosity with health mainly indicates that there are aspects of these rituals that either changes peoples’ behaviours, such as rituals, ethical and social practices, or their beliefs, such as belief in the supernatural.

The placebo effect is well known from the medical literature – the observation that there exist beneficial health effects just from believing that a treatment will work. For example, if an experimenter tells a group of patients that a (passive) pill will decrease pain, a majority of patients will report that their pain has diminished after taking the pill. There is also a mirror effect – the nocebo effect – where there are detrimental effects from beliefs (though this is much less well-researched due to ethical problems in experimenting with nocebo). Placebos and nocebos work through two main pathways – either by activating the body’s capacity for self-healing or by shifting the patients’ perception of the situation, or both (Benedetti 2009).

Placebos have measurably different consequences depending on cues provided with the treatment. For example, marketing matters: branded aspirin works better than unbranded aspirin, which works better than a branded placebo, which works better than an unbranded placebo (Branthwaite and Cooper 1981). More expensive medicine (\$2.50) produces better outcomes than cheap medicine (\$0.10) (Waber *et al.* 2008). Placebos can even be addictive. A study of a group of women receiving hormone replacement therapy or a placebo showed that while 63% got withdrawal symptoms from

ending hormone treatment, 40% got withdrawal symptoms from quitting the placebo (Ockene *et al.* 2005).

As there are many ailments with differing psychological and physiological causes and effects, modern placebo researchers like to point out that there is not really a single ‘placebo effect,’ but many ‘placebo responses’ (Benedetti 2009). Placebo effects happen after the administration of a placebo – whatever the actual cause of these effects (such as, for example, spontaneous remission/healing). Placebo responses are not due to other factors besides actual psychological or physiological reactions that are caused by the placebo.

Placebo responses have been reported for a number of ailments, such as pain relief, Parkinson’s disease, sleep disorders, sexual dysfunction, depression, anxiety, dementia, addiction, as well as cardiovascular, respiratory, gastrointestinal, and genitourinary disorders, and from sham surgery. Misattribution of a healing event to some previous unrelated factor may be termed a placebo effect (though it makes more sense to just call it misattribution), but not a placebo response. For example, there are reported placebo effects when treating common colds. However, colds typically subside after a few days no matter what the treatment is.

To understand why placebo responses occur one has to look at individual ailments separately and investigate the physiological response to each psychological manipulation. There are two main pathways that placebos can affect a disease: the placebo can change the *experience* of symptoms or placebos can change *physiological states* in the body - the former alters *subjective* measurements of disease while the latter alters *objective* measurements of disease. Note that even for subjective experiences such as pain, brain scans reveal measurable changes in several brain regions that inhibit pain transmission. Thus, patients experience less pain as their brains inhibit the pain responses.

Objective placebo responses can be attributed to conditioning. The most famous case of conditioning is also the first described: ‘Pavlov’s dog.’ For his experiment, Pavlov measured salivation in a dog, and could record increase in salivation when he presented meat powder in the dog’s mouth. He then started ringing a bell before giving the dog the meat powder. After a few repetitions, Pavlov could demonstrate that the dog salivated from just hearing the bell ring. This involuntary physiological reaction to a stimulus is now termed a conditioned response.

An example of a conditioned placebo response is to repeatedly associate ‘something’ and aspirin. After the body has been conditioned to expect pain relief, the aspirin can be removed. The ‘something’ can be stimuli such as pills of a certain colour, brand, shape, but also hospitals, doctors, nurses, white coats, stethoscopes, syringes, etc. For this reason it is sometimes necessary to administer something termed an ‘active’ placebo, instead of a ‘passive’ placebo, where passive placebos are purely inert pills (sugar, water) while active

placebos induce similar side effects as those of the actual medicine (e.g., drowsiness or dryness of mouth). If a placebo is administered before being associated with a drug it has a lower effect than if administered after the association has been established (Amanzio and Benedetti 1999).

McQuay *et al.* (1995) reported on a study where 7–37% of those given a placebo reported more than 50% pain reduction. Pain alleviation from a placebo works through two mechanisms: a conditioned release of endorphins and through changing the patients’ perception of pain. Levine *et al.* (1978) reported the first indication that both these mechanisms are important. They conducted a study where they administered naloxone, which blocks opioid receptors, to one of two groups of patients who had had their third molar extracted. In the group that received naloxone, the placebo effect was much lower, indicating an endorphine-mediated conditioned placebo response.

Among nocebo effects reported are increased pain following a negative diagnosis or as a result of distrust of medical personnel and diagnoses (Barsky *et al.* 2002). Negative expectations can even change the effect from alleviating pain to increasing the reported pain experience, as has been shown in experiments using nitrous oxide (Dworkin *et al.* 1983). Even reports in mass media have also been shown to produce a nocebo effect, for example reports of headaches from mobile phone use (Ofstedal *et al.* 2007). Finally, fear of pain can lead to experiencing worsening pain (Leeuw *et al.* 2007).

*Observation 3: There are clear parallels between religious healing practices and currently identified methods that induce placebo effects. Placebo and nocebo responses can make you think that you are better or worse, but they can also make you actually better or worse through conditioned responses. Religious practices may thus have both perceived and actual effects on health, through aforementioned lifestyle effects, social support networks, and through placebo responses.*

## Health, Placebos, and the Evolution of Religion

As the three observations presented above indicate, religiosity may affect actual and perceived health both positively and negatively. Through these stick and carrot-like effects, positive and negative health effects may have helped to introduce and sustain certain aspects of religion in human populations. This is my main claim in this paper.

The concept of religion, however, as it is employed in academic as well as non-academic contexts, covers a multitude of widespread cultural phenomena. Several evolutionary explanations for different aspects of religion have been proposed in recent research; sometimes several explanations for the same phenomenon, and sometimes the same explanation for several different phenomena. Suggestions of the evolutionary

roots of religion thus take on seemingly competing forms. These may be roughly divided into three categories:

1. *Cultural evolution* – Theories that mainly focus on religious phenomena as by-products of human psychological dispositions that originally evolved for other purposes.
2. *Gene-culture co-evolution* – Theories that postulate a set of evolved psychological dispositions, or biases, particularly related to social learning, but views these as the ‘hardware’ for an independent cultural evolutionary process alongside and/or in combination with biological evolution.
3. *Biological evolution* – Theories that hypothesize religious phenomena (beliefs, and practices motivated by beliefs) have evolved as human dispositions or cultural phenomena because they have been of direct biological adaptive significance.

In the academic study of religions, the by-product perspective is currently particularly dominant within what is termed the ‘cognitive science of religion,’ established in the early 1990s. Basically, religious phenomena, beliefs, practices, and social organization are explained as the result of a selective process on religious cultural traits where those most compatible with human evolved psychological dispositions will be maintained and propagated. According to scholars taking this perspective, the psychological dispositions that give rise to religious phenomena are no different than the dispositions that are active in everyday cognition, in isolation or in combination; mainly concept formation, categorization, and inferences. Hence the widespread beliefs in superhuman agents (gods, spirits, etc.) and their supposed involvement in human affairs are made possible and salient because of an evolved ‘theory of mind’ together with a set of specialized mental systems such as a proposed ‘hypersensitive agency detection device,’ an intuitive morality, and diverse mental mechanisms particularly related to social cognition (e.g., Boyer 2001; Atran 2002; Barrett 2004, 2012; McCauley 2012).

Perspectives on religious phenomena as adaptations in themselves, as a result of either biological or cultural evolution, tend to focus on their function in relation to social cohesion, cooperation, and norm enforcement through, for example, providing shared ethnic markers or a common unifying cause (Bulbulia 2004; Johnson 2005; Wade 2010; Wilson 2010). Better group cohesion is good for the group, which stays together longer, but also good for the individuals (and the genes of those individuals) who benefit from being part of a tighter cooperative network, and finally also beneficial for the beliefs and practices themselves due to the better survival and reproduction chances of the carriers of such beliefs and practices. Different aspects of religion can be more straightforwardly advantageous in other ways. Religious myths can, for example, provide psychosocial comfort through providing

satisfying explanations of the world and an individual’s place in it, or through explanations of seemingly inexplicable events in times of stress (Clark and Leikes 2005). Or there may be increased life satisfaction through increased opportunities to provide help for others (Sibley and Bulbulia 2014), or better coping during stressful situations (Sosis 2007; Sosis and Handwerker 2011).

The evolutionary hypothesis proposed here thus belongs in all categories of explanations, suggesting that religious healing is a potential adaptation, both biological and cultural. In a cultural evolutionary scenario, religions that have health effects should persist longer and spread more effectively through populations than those that do not. It has consequently been suggested by anthropologist James McClenon that there may have been natural selection for a biologically encoded susceptibility to placebo treatments during human evolution. According to McClenon, in this ‘ritual healing theory, shamanic healing is effective due to placebo and hypnotic processes. As a result, genotypes related to absorption, dissociation, and hypnotic capacities were selected, shaping the biological basis for modern spirituality’ (McClenon 2011:136, 1997, 2002). This effect could be expected to work both ways, however, as different religious traditions display different notions of superhuman agents where some will affect health positively (e.g., gods and benevolent spirits), others negatively (evil spirits, devils). I do not here explicitly advocate McClenon’s suggested pathway since it is hard to envision evolutionary pathways to susceptibility per se, but would instead like to point to three other potential scenarios, two biological and one cultural.

1. Adhering to religious rules and regulations may result in a life-style that is healthier on average than a non-religious life-style. This would be true if, for example, prohibitions against substance abuse were better adhered to, or if a religious life-style was more risk-averse, or if religious social support networks were institutionalized, or through other, similar scenarios such that actual recommendations given in a religious context have actual health effects.
2. Religious healing rituals induce placebo responses that may physiologically trigger the body’s own coping and healing responses – patients *actually* become better through a triggering of their physiological healing mechanisms.
3. Religious healing rituals induce placebo responses that alter the patient’s *perception* of the illness – patients do not *actually* become better but nevertheless *feel* better.

There are thus two pathways through which religiosity can affect health directly and one pathway through which religiosity can alter the perception of health. Note that these effects can be both positive and negative. Such positive and negative effects of religion on personal health can have worked as religion’s ‘stick and carrot’ during their evolution.

Actual positive health effects are self-evidently biologically beneficial. Concerning the first case of adhering to religious rules and regulations, this is therefore an example of a culturally learned trait that has true biological consequences. The second case, however – physiological placebo responses – is somewhat problematic, as it makes no evolutionary sense (Humphrey 2005). Why would the body need permission to heal? Should the body not heal as quickly as possible always? The answer, as understood from other mammals' placebo responses, concerns the balancing of energy expenditure between healing, storage, and survival. The production of immune agents, such as antibodies, requires energy. For example, animals lose weight if their immune system is artificially triggered, and in humans the immune system requires as much energy as the brain during its development in early childhood (Svensson *et al.* 1998). For such reasons, in certain situations healing is postponed until some triggering mechanism signals sufficient energy is available. For example, such a mechanism has been identified in photoperiod and stress effects on wound healing in Siberian hamsters (Kinsey *et al.* 2003). Placebo responses in humans indicate the presence of such 'triggers' that can be targeted through placebo treatments.

Lastly, some treatments shift the perspective of the situation rather than affecting actual health problems – one does not *become* better, but at least *feels* better. This is nonetheless important. First, it can help people with health problems to cope with their difficulties better. Some ailments have to be lived through and this becomes easier if there is less discomfort involved. Second, this shifting of the view of the situation is a unique selling point of religious healing rituals. That everything *feels* better after a healing ritual is something that will be recounted to family and friends who will then have a greater inclination to participate in the same ritual.

Through these two mechanisms – biological advantages for the individual through actual health benefits and cultural advantages for the trait 'religiosity' through both actual and perceived health effects – religion has potential fitness effects, but also an advantage compared to healing rituals that invoke placebo responses less effectively. That the latter mechanisms also are important is evidenced by the presence of a number of non-religious healing traditions such as Greek medicine, Chinese medicine, homeopathy, and aromatherapy. That some of these can be experienced as being borderline religious is very much to the point.

**Funding** This study was funded by Marianne and Marcus Wallenbergs Foundation (Grant 2017.0049).

### Compliance with Ethical Standards

**Conflict of Interest** The author declares that he has no conflict of interest.

## References

- Amanzio, M., and Benedetti, F. (1999). Neuropharmacological Dissection of Placebo Analgesia: Expectation-Activated Opioid Systems Versus Conditioning-Activated Specific Subsystems. *The Journal of Neuroscience* 19: 484–494.
- Atran S 2002 *In gods we trust*. Oxford University, Oxford.
- Barrett JL 2004 *Why would anyone believe in God?* AltaMira Press, Walnut Creek.
- Barrett JL 2012 *Born believers: The science of children's religious belief*. Free Press, New York.
- Barsky AJ, Saintfort R, Rogers MP & Borus JF 2002 Nonspecific medication side effects and the nocebo phenomenon. *Journal of American Medical Association* 287: 622–627.
- Benedetti F 2009 *Placebo effects: understanding the mechanisms in health and disease*. Oxford University Press: Oxford.
- Boyer P 2001 *Religion explained*. Vintage, London.
- Branthwaite A & Cooper P 1981 Analgesic effects of branding in treatment of headaches. *British Medical Journal* 282: 1576–1578.
- Bulbulia J 2004 Religious costs as adaptations that signal altruistic intention. *Evolution and Cognition* 10: 19–38.
- Clark A & Lelkes O 2005 Deliver us from evil: religion as insurance. *Papers on Economics of Religion* 06/03, Dept. Economic Theory and Economic History of the University of Granada
- Cohen EE, Ejsmond-Frey R, Knight N & Dunbar RIM 2009 Rowers' high: Behavioural synchrony is correlated with elevated pain thresholds. *Biology Letters* 6: 106–108.
- Dennett DC 2006 *Breaking the spell: Religion as a natural phenomenon* (Vol. 14). Penguin.
- Dworkin SF, Chen AC, LeResche L & Clark DW 1983 Cognitive reversal of expected nitrous oxide analgesia for acute pain. *Anesthesia & Analgesia* 62: 1073–1077.
- Ebbell B 1937 *The Papyrus Ebers: The greatest Egyptian medical document*. Levin & Munksgaard, Copenhagen.
- Gray JP 1998 *Ethnographic atlas codebook*. World Cultures 10: 86–136.
- Green, M., and Elliott, M. (2010). Religion, Health, and Psychological Well-Being. *Journal of Religion and Health* 49: 149–163.
- Hackett C, Grim B, Stonawski M, Skirbekk V, Potančoková M & d Abel G 2012 *The global religious landscape*. Washington, DC: Pew Research Center.
- Hayward RD, Krause N, Ironson G, Hill PC & Emmons R 2016 Health and well-being among the non-religious: Atheists, agnostics, and no preference compared with religious group members. *Journal of Religion and Health* 55: 1024–1037.
- Humphrey N 2002 Great expectations: The evolutionary psychology of faith-healing and the placebo response. Pages 225–246 in *psychology at the turn of the millennium, Vol. 2: Social, developmental, and clinical perspectives*. von Hofsten C & Bäckman L (eds.) psychology press, Hove.
- Humphrey N 2005 Placebo effect. In: *The Oxford companion to the mind*, Richard Gregory (ed.). Oxford: Oxford University Press.
- Jegindø, E-ME, Vase L, Skewes J, Juul Terkelsen A, Hansen J, Geertz AW, Roepstorff A Jensen TS 2013a Expectations contribute to reduced pain levels during prayer in highly religious participants. *Journal of Behavioral Medicine* 36: 413–426.
- Jegindø E-ME, Vase L, Jegindø J, Geertz AW 2013b Pain and sacrifice: Experience and modulation of pain in a religious piercing ritual. *International Journal for the Psychology of Religion* 23: 171–187.
- Johnson D. 2005 God's punishment and public goods: A test of the supernatural punishment hypothesis in 186 world cultures. *Human Nature* 16: 410–446.
- Kapchuk TJ 2011 Placebo studies and ritual theory: A comparative analysis of Navajo, acupuncture and biomedical healing. *Philosophical Transactions of the Royal Society, Series B* 366, 1849–1858.
- Katz R 1982 *Boiling energy: Community healing among the Kalahari kung*. Harvard University Press.

- Keeney BP (ed.) 2003 Ropes to god: Experiencing the bushman spiritual universe. Vol. 8. Leete's Island Books.
- Kinsey SG, Prendergast BJ, & Nelson RJ 2003 Photoperiod and stress affect wound healing in Siberian hamsters. *Physiology & Behavior* 78: 205–211.
- Koenig HG 2008 *Medicine, Religion and Health: Where Science and Spirituality Meet*. Templeton Science and Religion Series.
- Koenig HG 2012 Religion, spirituality, and health: The research and clinical implications. International scholarly research network, psychiatry 1-33.
- Konvalinka I, Xygalatas D, Bulbulia J, Schjødt U, Jegindø E-ME, Wallot S, Van Orden G, Roepstorff A 2011 Synchronized arousal between performers and related spectators in a fire-walking ritual. *Proceedings of the National Academy of Sciences* 108: 8514–8519.
- Leeuw M, Goossens M, Linton S, Crombez G, Boersma K & Vlaeyen JWS 2007 The fear-avoidance model of musculoskeletal pain: Current state of scientific evidence. *Journal of Behavioral Medicine* 30 77–94.
- Legare CH & Souza AL 2012 Evaluating ritual efficacy: Evidence from the supernatural. *Cognition* 124: 1–15.
- Levine JD, Gordon NC & Fields HL 1978 The mechanisms of placebo analgesia. *Lancet* 2: 654–657.
- Lindfors P (2016) Evolutionära förklaringar av religion. In: Thurffjell D (ed.) *Varför finns Religion?* Stockholm: Molin & Sorgenfrei.
- Littlewood R & Dein S 2001 *Cultural Psychiatry & Medical Anthropology: An introduction and reader*. Athlone.
- McCauley RN 2012 *Why religion is natural and science is not*. Oxford University Press, Oxford.
- McClenon J 1997 Spiritual healing and folklore research: Evaluating the hypnosis/placebo theory. *Alternative Therapies in Health and Medicine* 3: 61–39.
- McClenon J 2002 *Wondrous healing: Shamanism, human evolution, and the origin of religion*. DeKalb, Illinois: Northern Illinois University Press.
- McClenon 2011 Evolutionary theories of schizophrenia: An experience-centered review. *Journal of Mind and Behavior* 32: 135–150.
- McQuay H, Carroll D, Jadad AR, Wiffen P & Moore A 1995 Anticonvulsant drugs for management of pain: A systematic review. *British Medical Journal* 311: 1047–1052.
- Moberg J & Ståhle G (eds.) 2014 *Helig hälsa: Helandemetoder i det mångreligiösa Sverige*. Dialogos, Stockholm.
- Norenzayan A 2013 *Big gods: How religion transformed cooperation and conflict*. Princeton University Press.
- Ockene JK, Barad DH, Cochrane BB, Larson JC, Gass M, Wassertheil-Smoller S, Manson JE, Barnabei VM, Lane DS, Brzyski RG, Rosal MC, Wylie-Rosett J & Hays J 2005 Symptom experience after discontinuing use of estrogen plus progestin. *Journal of the American Medical Association* 294: 183–93.
- Oftedal G, Straume A, Johnsson A & Stovner LJ 2007 Mobile phone headache: A double blind, shamcontrolled provocation study. *Cephalalgia* 27: 447–55.
- Paldam, E., and Schjøedt, U. (2016). Miracles and Pain Relief. *Archive for the Psychology of Religion* 38: 210–231.
- Powell LH, Shahabi L & Thoresen CE 2003 Religion and spirituality: Linkages to physical health. *American Psychologist* 58: 36–52.
- Printz C 2001 Spontaneous regression of melanoma may offer insight into cancer immunology. *Journal of the National Cancer Institute* 93: 1047–1048.
- Pronin E, Wegner DM, McCarthy K & Rodriguez S 2006 Everyday magical powers: The role of apparent mental causation in the overestimation of personal influence. *Journal of Personality and Social Psychology* 91: 218–231.
- Rice WR 2012 The evolution of an enigmatic human trait: False beliefs due to pseudo-solution traps: (Sewall Wright award address). *The American Naturalist* 179: 557–566.
- Roberts L, Ahmed I, Hall S & Davidson A 2009 Intercessory prayer for the alleviation of ill health (review). *The Cochrane Library* 2: 1–71.
- Sachs L 2004 *Tillit som bot. Placebo i tid och rum*. Studentlitteratur, Lund.
- Sachs L 2012 *Sjukdom som ordning*. Natur & Kultur, Stockholm.
- Schnall E, Wassertheil-Smoller S, Swencionis C, Zemon V, Tinker L, O'Sullivan MJ, Van Horn L & Goodwin M 2010 The relationship between religion and cardiovascular outcomes and all-cause mortality in the Women's health initiative observational study. *Psychology and Health*, 25: 249–263.
- Seeman TE, Dubin LF & Seeman M 2003 Religiosity/spirituality and health: A critical review of the evidence for biological pathways. *American Psychologist* 58: 53–63.
- Seybold KS & Hill PC 2001 The role of religion and spirituality in mental and physical health. *Current Directions in Psychological Science* 10: 21–24.
- Sibley CG & Bulbulia J 2014 Charity explains differences in life satisfaction between religious and secular new Zealanders. *Religion, Brain & Behavior* 5: 91–100.
- Sloan RP 2006 *Blind faith: The unholy Alliance of religion and medicine*. Macmillan, New York.
- Sloan RP, Bagiella E & Powell T 1999 Religion, spirituality, and medicine. *Lancet* 353: 664–667.
- Sosis R 2007 Psalms for safety: Magico-religious responses to threats of terror. *Current Anthropology* 48: 903–911.
- Sosis R & Handwerker HP 2011 Psalms and coping with uncertainty: Religious Israeli women's responses to the 2006 Lebanon war. *American Anthropologist* 113: 40–55.
- Stavrova O 2015. Religion, self-rated health, and mortality: Whether religiosity delays death depends on the cultural context. *Social Psychological and Personality Science* 6: 911–922.
- Stavrova O & Meckel A 2017 The role of magical thinking in forecasting the future. *British Journal of Psychology* 108: 148–168.
- Svensson E, Råberg L, Koch C & Hasselquist D 1998 Energetic stress, immunosuppression and the costs of an antibody response. *Functional Ecology* 12: 912–919.
- Waber RL, Shiv B, Carnom Z & Ariely D 2008 Commercial features of placebo and therapeutic efficacy. *Journal of the American Medical Association* 299: 1016–1017.
- Wade N 2010 *The faith instinct: How religion evolved and why it endures*. Penguin Books, London
- Wilson DS 2010 *Darwin's cathedral: Evolution, religion, and the nature of society*. University of Chicago Press, Chicago.
- Wootton D 2007 *Bad Medicine*. Oxford University Press, Oxford.

**Publisher's Note** Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.