

**Six Good Reasons Why Understanding Religion
Requires a Multidisciplinary Approach**
Response to Commentators

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I appreciate the thoughtful observations that all six commentators have provided on my book *How Religion Evolved, and Why It Endures*. They raise a number of important and interesting issues that merit far more attention than space allowed me to give them. As Lang rightly observes, this book is a deliberate (and, I hope, timely) return to the tradition of big theories in anthropology – an attempt to provide, albeit in necessarily brief format, an overview of how, why and when religion came to be part of the wider human social toolkit. I emphasise this at the outset here because, as Lockhart observes, this book explores in more detail one small corner of the grander story of human social and cognitive evolution summarised in my earlier book *Human Evolution* (2014a). The present book is really premised on the question: How did historical humans manage to maintain such large social groups as they did as coherent social entities? In fact, this is the single most important (and largely overlooked) issue at the heart of primate social evolution, but it looms especially large in humans because of their much larger groups. It is why religion came to play a significant role. Since it may help readers who haven't read the book if I give a thumbnail summary of its argument, let me first set the wider scene before addressing some of the specific issues raised in the Commentaries.

A Little Background

What ultimately limits social group size in all mammals is the escalating stresses incurred by living in close proximity to other individuals. These stresses come in two forms. One is ecological: as group size increases, so does the distance the animals have to travel to satisfy their nutritional requirements. In addition to the drain on their time budgets (Dunbar et al. 2009), this exposes them to higher heat loads (Dàvid-Barrett & Dunbar 2016) as well as higher risks of predation. The second source of stress is psycho-physiological: a combination of accumulating harassment, direct attacks and the spill over from other individuals' conflicts elevates individual stress levels in direct proportion to group size. Chronic levels of stress are generally bad for the immune system: they adversely affect longevity. However, the real problem is that they destabilise female menstrual endocrinology, leading rapidly to anovulatory menstrual cycles (the “infertility trap”) (Dunbar 2018a; Dunbar & Shultz 2021a). The

endocrinological mechanism involved has been known since the 1980s, though its significance has not been appreciated until very recently. In mammals in general, this effect is so steep that fertility will fall below the demographic replacement rate if there are more than about five females in the group (Dunbar & Shultz 2021a). In primates, this effectively limits social group size to about 15 individuals.

To live in larger groups, mammals have to find ways to buffer themselves against the infertility trap. Most mammals do this by adopting a fission-fusion form of sociality in which herds form and disband on the scale of hours (at most days) as a function of the local costs and benefits of grouping. Anthropoid primates (and a very small number of other largely species-poor orders, including equids, camelids, dolphins and elephants) have opted for an alternative, but more costly, solution based on stable, bonded social groups. This means an individual is always within the protective ambit of a group. To do so, however, they needed to find some way of buffering themselves against the stresses of group-living. Their solution has been female-female coalitions (alliances) that act as a passive deterrent to others crowding them. These coalitions do not completely prevent females from experiencing stress-induced infertility, but they do defer the decline in fertility in such a way as to allow more females to live together (Dunbar & Shultz 2021a).

Primate coalitions (“friendships”) are created and maintained by social grooming. There are two important aspects to this. First, social grooming triggers the endorphin system via a highly specialised peripheral neuron system (the afferent c-tactile fibres, with their associated CT mechanoreceptors) (Olausson et al. 2010; see also Schirmer & McGlone 2022). We know, from neuroimaging experiments, that this is also true of humans: grooming actions trigger the endorphin system (Nummenmaa et al. 2016). Second, social grooming is extremely time consuming, and there appears to be an upper limit on the amount of time animals can devote to it at around 20% of the waking day that, in turn, sets an upper limit to group size at around 50 individuals (Dunbar 2022a).

The dilemma this created for the human lineage was that once it began to occupy environments that required a significant increase in group size beyond this grooming limit, increases in group size were only possible if some way was found to allow a proportional increase in grooming time. That meant either reducing foraging time (the strategy adopted by chimpanzees: Lehmann et al. 2007) or increasing the number of individuals who could be groomed simultaneously. Since great ape (and australopithecines) time budgets are already at their limit with no spare capacity (Lehmann et al. 2007; Bettridge 2012), the only variable that could be adjusted is the size of the grooming group (normally two individuals). However, the intimacy of physical touch and the need to ‘feel’ that one is the exclusive object of attention means that multi-partner grooming is relatively rare in all primates, including humans (Dunbar 2022b). The only way of solving the problem was to find behaviours that triggered the endorphin system without requiring direct physical contact.

I have argued elsewhere that hominins solved this problem in a least three distinct phases, each associated with a step change in brain size (and hence group size) (Dunbar 2014a). These were the exaptation of laughter (from the monkey and ape play pant) to create a form of chorusing in *Homo ergaster* around two million years ago (Dunbar 2022a), the extrapolation of this into a more musical form (wordless singing and dance) with the appearance of archaic humans (*H. heidelbergensis* and their allies: Bannan et al. 2023) around 500,000 years ago, and then finally, with the appearance of anatomically modern humans (*H. sapiens*) 250,000 years ago, a slew of language-based activities that include feasting, storytelling and religion (Dunbar 2014). In an

extensive series of experiments (reviewed in Dunbar 2022b), we have shown that all of these trigger the endorphin system, and that all of them enhance the sense of bonding to those actually present. The role of endorphins has typically been demonstrated by the means of pain threshold changes (a widely used proxy for endorphin upregulation), but in several cases we have confirmed this using naltrexone (an endorphin-blocker) or neuroimaging.

I pick this story up in the present book by asking how, why and when religion came into play in this mix. My argument is based on the observation that all religions, whether tribal or doctrinal, have a significant mystical undercurrent running through them – the “mystical stance”, by which I mean a tendency to attribute a form of psychological causality to phenomena that do not involve obvious physical causal processes. Using Galen Watts’ term, Watts and Dorobantu, refer to this as the “spiritual turn”. In many religions, this is associated with trance or ecstatic experiences. There has been a consistent tendency to ignore ecstatic experiences in doctrinal religions as of only passing interest, mainly on the grounds that what is important is the theology. But I suggest this misses the point that, at root, none of us is immune to these kinds of experiences. They are a product of folk physics and how the human mind functions, the everyday manifestation of a broader kind of mystical experience that, in the heightened form of trance states, sometimes allows us access to what appears to be an ineffable and unexplainable phenomenological world

To be sure, as Conrad points out, we interpret trance experiences in different ways depending on our particular cultural context, but we must be careful not to let the ethnographic details obscure the bigger picture. The underlying phenomenon is the same – and the experiences broadly similar – across cultures and religions, as Eliade (1985) reminds us. Almost all cultures describe the process of going into trance in much the same way, whether this is the result of brute force in a San trance dance and a Plains Indian sun dance or the controlled calmness of Buddhist meditation practice. As Watts and Dorobantu argue, it is very much a ‘right brain’ phenomenon – difficult to explain in left-brain words because it entails what philosophers of mind have, following Edward Tolman, referred to as ‘raw feels’ (Kirk 1994). Another way of describing it is in terms of ‘hot’ and ‘cold’ cognition – the first referring to emotional raw feels (we know what we feel but we just can’t quite put it into words), the second to deliberated conscious thought processes (often expressed linguistically). The first has, until very recently, largely been ignored by experimental psychologists. My claim in the book is that all religions were initially of this ecstatic kind – what I refer to as shamanic or immersive religions.

Until around 10,000 years ago, humans and their ancestors back to their great ape roots were hunter-gatherers. All extant hunter-gatherers live in dispersed communities divided into three or four small living groups (bands) of 30-50 individuals, with communities themselves gathered into higher order groupings (mega-bands, tribes) (Dunbar 1993; Hamilton et al. 2007; for a very nice description in an Australian context, see Bird et al. 2019). In fact, all primate societies have this kind of layered structure, with exactly the same layer sizes as we find in humans (Hill et al. 2008; Dunbar et al. 2018; Dunbar 2020a; Dunbar & Shultz 2021b). We have always assumed that this pattern of hunter-gatherer organisation reflects the demands of foraging, but in fact it probably reflects the costs imposed by the infertility trap: dispersing the community into smaller groups allows hunter-gatherers to mitigate the effects of stress, while at the same time maintaining close relationships with a network of accessible allies – much as chimpanzees in fact do. It was in this context that bottom-up shamanic-type religions emerged so as to bond these larger communities.

A sea change in these arrangements was, however, introduced in the early Holocene. A rapid, archaeologically well documented population explosion under the exceptional environmental conditions that pertained in the northern Subtropical Zone (the latitudinal band that, in the Old World, includes the southern Mediterranean coast, the Levant and Mesopotamia across to the Ganges Plain and the Central Basin in China) seems to have resulted in communities clustering their bands into settlements, probably in response to raiding (Johnson & Earle 2001). To be able to do so meant they had to solve the foraging problem (which obviously they did by farming). However, I suggest that farming was actually a rather trivial problem by comparison with solving the problems created by the scalar stresses of living in very large groups in a confined space. It was this problem that led to the development of doctrinal religions because these added top-down discipline to the bottom-up bonding effects of the older shamanic-type religions, allowing settlement size to increase dramatically from a few hundred to tens of thousands over the course of just a few millennia. The signature of the ancestral religions is still present even in the large revealed religions – in the optimal size of around 150 (the typical hunter-gatherer community size) for congregations and in a constant tendency for large scale religions to spawn small intimate cults and sects centred around a charismatic leader (often with very unorthodox beliefs).

I am conscious that many of these ideas are left-field and seem to contradict established opinion. In mitigation, however, I can only say that these ideas do not come out of nowhere. They are the product of a very long, extensive research programme on social evolution that has drawn on my background as both a psychologist and an evolutionary ecologist, combined with my occasional dabblings in history and archaeology. It has involved collaborations across a dozen disciplines from history and archaeology to neuroimaging, statistical physics and mathematics. Much of it is based on field work (and, in some cases, experimental studies) that I have personally conducted over the last five decades on monkeys, ungulates (specifically antelope and caprids), birds and even odonate insects (dragonflies). It is the comparison across this diverse array of animal forms that has given rise to this account of social evolution.

One final point. I fully endorse Fischer's plea that understanding religion, its role in human affairs and its evolution requires a multidisciplinary approach. My approach has been to draw on a very wide range of disciplines in an attempt to put all the relevant pieces of the jigsaw on the table and then try to fit them together in the right order. Not only does that allow us to box in any explanation that emerges in a causal matrix that provides a self-reinforcing framework, but it also allows us to test between different possible explanations and alternative historical sequences. The book is the product of that exercise, though much of that process probably sits in the background more than it might have done.

Having set the scene, let me now turn to address some of the issues raised by the commentaries in the context of this back story.

The Challenges of the Commentaries

I will consider the commentaries under six major topics, many of which recur in various guises in the different commentaries. These are: what I will call the “ethnographic turn”, why humans live in groups, some common traps in evolutionary explanations, the role of endorphins in bonding, the challenge of mentalising, and the evolution of rituals.

The ethnographic turn

Conrad and Fischer raise a number of important general points under this heading. Fischer, in particular, observes that the study of religion has been dominated by a Euro-American Christian/Enlightenment perspective, and that people in traditional societies see and experience the world in a very different way. There are four issues to consider here.

First, let me say in my own defence that I spent the first two decades of my life in East Africa, deeply immersed in a very multicultural everyday environment, with Europe a vague foreign concept. Most of us who grew up in these places learned the native languages of our locality (in my case Swahili) as we learned English, sometimes even before we learned English. We were fully bilingual and bicultural – so much so in my case that I wrote poetry in Swahili, and am probably the only non-Swahili who has ever done so in the original adapted Arabic script that was used during the eighteenth and nineteenth centuries. I also benefitted from the fact that my father was born and grew up under similar circumstances in India (and hence was bilingual in Hindi). As a result, we mixed socially with the very large and ethnically diverse local Indian communities as well as African communities. Because of this, I was familiar at first hand from as early as I can remember through to adulthood with a variety of cultures and, more importantly in the present context, with their doctrinal-level religions: Islam (seen from both Arab sunni and Indian shia perspectives), Sikhs and Parsees, as well as in a more direct way with Roman Catholic, Anglican and Presbyterian Protestant Christianity, leavened at the edges by several African tribal religions (notably the ancestor-worshipping Sambia and the monotheistic Maasai). Later, in my mid-teenage years, I was immersed in Hinduism and Buddhism. I do not consider my views to be especially dependent on Christianity, or even the Abrahamic religions; if anything, they are much more heavily influenced by the religions of the East. It is certainly fair comment that most of the experimental data that I cite derive from Euro-American Christian populations, but that is a consequence of where most of the relevant research has been done. I would point out that, as part of the project on which this book is based, we ran experiments on Afro-Caribbean syncretic religions in Brazil as well as comparative analyses on hunter-gatherer societies based on data from original ethnographies.

The second issue is what I would call the *Whorfist trap*: just because another language lacks words for something (or maybe has many words for different nuances of the same thing) does not mean that speakers of that language do not see the world the way other cultures do. I suspect this has much to do with the fact that, like Worf, most anthropologists' knowledge of the cultures they study is secondhand via a translator. It does not come via growing up in the culture. It has frequently been claimed, for example, that gender-marking in language (either as gendered nouns [most Indo-European languages from French to Hindi] or the use of gendered pronouns [English and the Scandinavian languages]) causes speakers to behave in a more sex-biased way than is the case in genderless languages (the Uralic languages like Finnish and Hungarian, Chinese and most of the Bantu family, including Swahili). In fact, the empirical evidence shows that, if anything, the reverse is actually the case: gendered languages actually correlate with more liberal inter-gender relationships (Prewitt-Freilino et al. 2012). That has also been my experience as a native Swahili speaker. In fact, I hadn't even noticed until I was in my 40s that Swahili did not have gendered pronouns. Despite this, Swahili speakers do not mistake one gender for the other, or behave differently as a result of not being able to distinguish linguistically between *he/him* and *she/her*. Another example is that Swahili does not distinguish between the colours red and brown; it uses the same word *nyekundu* for both. But Swahili speakers do not make mistakes, or see colours in a different way, as a result. Languages label what is locally convenient, and then use workarounds for anything else. We do this in English all the time, for example, as when confronted conversationally with the words *pear*, *pair* and *pare*, or *rain*, *reign* and *rein*, or *where*, *wear* and *were*[*wolf*].

A third issue arises from Conrad's claim that science is replacing religion in the modern world. I think my response would have to be: and the evidence for this is what, exactly? There are too many well attested cases (from Duhem and the nineteenth century French intellectuals to the Marxist regimes of the USSR and China in the early and late twentieth century, respectively) to remind us that attempts to eradicate religion have largely failed dismally. The main reason for my pessimism is that religion invariably seems to bounce back, especially in the face of oppression, conflict and natural disasters (Henrich et al. 2019). It plays a very strong role among migrant communities – precisely because it provides a sense of community and communitarian support for individuals facing significant disorientation, discrimination and poverty. In the unlikely event that we can end conflict, poverty, migration and natural disasters, I am sure we will see a decline in religiosity, but the chances of that seem, at best, slim if not fanciful. The real problem is that science does not provide psychological hope and comfort. Even highly educated people keep rediscovering religion – it is very heady (literally) stuff. If you don't believe me, I invite you to go out into an unfamiliar forest alone on a dark night, and I will show you someone teetering on the verge of religion.

It seems to me that most of those who suggest that Westerners have a science-based Enlightenment attitude to religion are in fact people who spend most of their time interacting with highly intelligent, well educated people (usually in universities). They are a highly selected sub-sample of the western world. The majority of people who live in post-industrial economies are little different either from their own immediate ancestors just a generation or two back or from people who still live in small scale traditional societies. I devoted a great deal of Chapter 1 in the book to arguing that folk physics (or, if you will, folk religion) is pretty universal. Most people in the western world have the same 'superstitions' as people in traditional tribal cultures: they both see the physical world as deeply infused with the spirit world. They all believe in the evil eye, go to wishing-wells and wishing-trees (in some cases even inside churches – look for the noticeboard just inside the door), seek out horoscopes or good luck charms for love and war, or, even within the staid environment of late nineteenth century Anglican rural England, engage the services of a sin-eater to speed a deceased relative's progress into the hereafter. One of the major themes of the book is that none of this stuff has gone away with science and education – it is still happily bubbling beneath the surface of our consciousness, and that subconscious psychology is universal.

The bottom line is that none of us contemplates the significance of quantum physics when proposing to sit on a chair. If we did, we probably wouldn't sit down, because the chair is actually mainly empty space held together by a handful of atoms – or, less convincing still perhaps, quantum smears connected by a few nebulous forces. Instead, we rely on folk physics – something closer to Newtonian physics. Even science does this. We know that Newtonian physics is only a very rough approximation to the actual physics of the universe, and as a result will produce wildly inaccurate predictions when used at extreme scales. Yet we are happy to use it on a "good enough" basis when it suits – as when NASA had the absurdly crazy idea of using the moon as a slingshot to get the Apollo 13 astronauts back to earth after their capsule had lost all power.

There has, as Watts and Dorobantu observe, been a dramatic decline in attendance at mainstream Christian churches in the West since the 1960s in particular. However, they note that this has involved a turning away from formal religions in favour of "religions of the heart" that have a more individualistic rather than a communal character – Grace Davie's sense of "believing without belonging". People are still actively religious and hanker after meaning.

Islam continues to be very buoyant, especially in migrant communities, and many of the evangelical Christian churches have experienced dramatic growth. Beyond the formal religions, cults and sects abound, many derivative of the hippie movement of the 1960s with its overtones of Indian mysticism: these kinds of religious movements are often chaotic and anarchic, very small scale and wholly dependent on a charismatic leader.

The fourth issue is a simple matter of fact. Fischer worries that mentalising has been developed and tested only on western people. This is not in fact true: it has been studied in Iranian, Chinese, Japanese, rural Turkish, Indonesian and Australian Aboriginal children to list but a few (Shahaeian et al. 2011; Kuntoro et al. 2013; O'Reilly & Peterson 2014; Slaughter & Perez-Zapata 2014). While there are certainly some cultural effects, these mainly have to do with the speed at which different stages are achieved – and even these effects are usually overshadowed by factors such as the number of siblings. I grant that the number of studies on hunter-gatherer societies is negligible, but that is a wake up call for anthropologists not psychologists.

Why humans live in groups

A widespread view, echoed by Lang, is that human social groups exist to enable cooperative tasks to be undertaken – anything from building houses to hunting and warfare. This view largely emanates from behavioural economics. For perhaps obvious reasons, the economists' worldview is focussed entirely on trading, mostly with strangers. But that is not the world in which most of us, and particularly those in small scale societies, actually live. Most of our instances of cooperation and exchange are with people we know well at a personal level (extended family and friends) (for an historical example from the Icelandic Vikings, see Dunbar et al. 1995). Cooperation is a by-product of obligations derivative of, and guaranteed by, personalised relationships embedded in social networks of a few hundred people. Transactional trading relationships are what happens out beyond that community of 100-200 people. It still does, even in industrialised societies.

The distinction is important, not least because the conventional view falls foul of the public good dilemma problem. If sociality is solely about cooperation, there is always an upfront cost when I offer my services to you. If you cheat on my generosity, I will, after the first few disappointments, refuse to cooperate. One of the most robust findings in the behavioural economics literature has been that people gradually stop cooperating when they play public goods games over a repeated series – even when it would pay them to continue cooperating (Andreoni & Croson 2008). The problem is that a temptation to freeride always seems to surface, and that produces a cascade of isolationism and a reduction in group size (Barrio et al. 2015). We are very sensitive to the risk of being cheated. We prefer to satisfice rather than maximise. The blunt truth is that, despite how we like to see ourselves, humans are neither especially altruistic (see Madsen et al. 2007) nor cooperative.

Nor is cooperative hunting the answer. It is extremely rare in mammals, being only characteristic of cursorial hunters that run prey down (spotted hyaena, wild dogs, wolves). Most carnivores are stealth hunters. Except under rare special circumstances (e.g. buffalo jumps: Reeves 1978), most hunter-gatherers are likewise stealth hunters, and invariably prefer to hunt alone (at best in pairs) because large groups disturb the prey and make them skittish (Smith 1991). Nor are warfare and warrior grades the answer: these only become relevant in large scale societies long after humans started living in groups.

As a result, it has proved difficult to develop convincing evolutionary explanations for cooperation without resort to all manner of cultural institutions like punishment and reputation. But then in all these experimental contexts, we play against strangers, not people we know;

when we do cooperate, we do so with the people we live with and/or have close relationships with (Dunbar et al. 2021). Cooperation on mundane tasks is a by-product of living in groups, not its cause. The only case where cooperation is genuinely an explanation for group-living is pairbonded monogamy: two strangers cooperate over the task of reproducing that both expect to gain equally from (though there are risks involved).

In animals, large groups typically form for protection against predators, and the basis of that arrangement is *coordination*, not cooperation. There is no upfront cost to pay, because you are simply a member of the group (and gain the collective benefits) or not (in which case you don't). Nobody can force you to stay in the group against your will, or exploit you if you do, because the costs and benefits are unavoidably shared more or less equally by everyone. Once in the group, however, there is a natural basis on which cooperation can evolve between familiar partners who know whom to trust and whom not.

Evolutionary traps for the unwary

Biology is a systemic discipline: its structure involves sets of causal relationships that play very different, but crucial, roles in the explanatory arrangement. These can usefully be differentiated as causes, consequences and constraints (Dunbar & Shultz 2022). Unfortunately, rather too many analyses forget this and approach tests of evolutionary hypotheses with a psychological mechanisms paradigm. The commentaries raise two areas where this is a genuine issue. One involves the reasons why unusually large brains evolved in the primates (and, by extension, humans); the other involves the function(s) of religion.

Citing a recent analysis by DeCasien et al. (2017), Fischer suggests in passing that large brains evolved in primates to enable efficient foraging, in doing so reinforcing a widespread view that food finding (meaning hunting and tool-making) played a central role in human evolution. Unfortunately, the DeCasien analysis manages to fall foul simultaneously of two of the more egregious conceptual errors in evolutionary arguments: Tinbergen's Four Why's and Dobzhansky's Dictum. The problem is not hard to see. Because they treated their analysis as a psychological mechanisms problem instead of a biological one, they inadvertently asked a completely different question (what limits brain size in living primates?) to the one they thought they were asking (what selected for large brains in the historical past?) (Dunbar & Shultz 2023). These are not the same: one is about constraints on brain growth in living species and the other is about the historical selection pressures that drove brain evolution against these constraints. By regressing brain size in primates on group size and diet as they did, they ask whether group size or diet constrains brain size. The answer, of course, is diet – with group size, perhaps not too surprisingly, being irrelevant. Reverse their analysis, however, and you ask a very different question (does brain size or diet constrain group size?) and get a very different answer: brain size determines group size and diet plays no role. More careful analysis using more sophisticated statistical methods makes it uncontroversially clear that it is group size that selected for brain size during primate evolution, and that changes in diet are a *consequence* (not the cause) of having a large brain – for the rather obvious reason that large brains are energetically expensive and create a massive energy throughput deficit that needs to be addressed (Dunbar & Shultz 2017; Shultz & Dunbar 2022). Regrettably, far too many analyses misinterpret correlation as implying causation by confusing selection pressures with constraints (or costs).

The second issue arises from Fischer's concern that there is an inconsistency in my account: I appear to both deny and then claim that there are individual-level (as well as group-level) benefits to religion. However, I was making two separate points. One was to point out that, contrary to the conventional view in the cognitive science of religion, religion does seem to

have direct fitness consequences at the individual level (at least in terms of health benefits). The other was a reminder that biological systems involve both causes and consequences (sometimes in complex feedback loops) and that, in socially complex species like primates (and hence humans), we are often dealing with multilevel (or *group augmentation*) selection effects.

Living in a group provides fitness benefits, but these benefits select not for group size directly but for the skills needed to manage social relationships. The benefit arises from the group, but the fitness payoff is at the level of the individual and their social skills. However, it happens that the social bonding mechanism that helps bind groups together (endorphins) also activates the immune system, in particular the natural killer (or NK) cells that specifically target viruses and some cancers. There is now very considerable evidence from a wide range of species (including monkeys, apes, horses and dolphins, as well as humans) that socially well-embedded females are healthier, have lower stress levels, are more fertile, live longer and have more surviving offspring (Dunbar 2018b). It is *this* that explains the health benefits of religion. These benefits are not a consequence of religion itself, but rather of the rituals of religion (in effect, communal jogging) and how these help to create a community of friends. Indeed, actively religious people have (or at least *believe* they have, and this is the psychologically operative issue) more friends than less religious people (Dunbar 2020b). The number of close friends and family you have is the single best predictor of health, happiness and fertility in humans, primates and a number of other intensely social mammals (Dunbar 2018b), but it is a consequence (or beneficial by-product) of living in groups, not the cause.

Role of endorphins in bonding

Several of the commentaries are sceptical of the role endorphins play in religious rituals. Fischer, for example, questions the evidential basis for this directly, and suggests that endocannabinoids may be a better explanation. Endocannabinoids certainly make a welcome change from the usual alternative often cited in this context but mercifully absent for once – namely, oxytocin. There are two separate issues here. One is that Fischer radically underestimates the evidential basis for the role of endorphins in both primate and human social bonding (for summaries, see Machin & Dunbar 2011; Dunbar 2022a). The second issue is whether endocannabinoids could fill this role. I have no doubt at all that endocannabinoids are upregulated during physical exertion and undoubtedly play an important role in sustaining physical action, including that involved in many exhausting or painful religious rituals. But the question is: do they produce the same opioid psychoactive effects as endorphins and do they enhance the sense of trust and bonding as a result? And, perhaps more importantly, are endocannabinoids activated by as wide a range of activities (soft touch such as stroking, laughter, singing, listening to music, eating, listening to stories) as we know endorphins are? And do they have the remarkably long half-life of endorphins (measured in hours compared to minutes in the case of oxytocin: Dunbar 2022b)?

A longstanding problem has been that far too many studies have tried to ‘prove’ the importance of their favoured neurohormone, but failed to check whether it is the only active ingredient. If oxytocin, endocannabinoids and endorphins are all triggered by the same activity (physical exercise), how do we know which one is responsible for the trust and bonding outcome? The one attempt to look at this seriously, at least in terms of the genetics of six major social neurohormones, clearly identified the endorphin-dopamine complex as the functional mechanism in respect of social predispositions and social relationships (Pearce et al. 2017, 2018).

The challenge of mentalising

Lockhart and Winkelman express some doubts as to whether mentalising plays any role in the evolution of religion. I agree with Lockhart that high order mentalising is not involved in ecstatic experiences; and I agree with Winkelman that it did not evolve to make religion possible. At root, ecstatic experiences are the product of neurophysiology (most likely the endorphin system, which produces states similar to those experienced with the more familiar psychoactive and psychedelic drugs). However, mentalising is what makes it possible for two individuals to *communicate* about their ecstatic experiences (after they have had them), and hence to concoct a coherent explanation for what these *mean*. It is religion that would not be possible without high order mentalising, not ecstatic experiences. High order mentalising did not evolve *for* religion, however; it evolved to handle social relationships (we have shown in many studies that the number of friends a person has correlates with their mentalising abilities: Dunbar 2018b), and was then exploited to allow storytelling as a mechanism for both building friendships and, from that, community bonding. These were necessary for human social life long before religion (and particularly doctrinal religions) appeared. But once high order mentalising had been acquired, religion became a possibility. The issue is the difference between *necessary* and *sufficient* explanations (see also below).

The evolution of rituals

Both Lang and Winkelman argue that the function of rituals is to coordinate emotional states in different individuals so as to facilitate cooperation, and hence that they are very ancient and may even predate the origins of the hominin lineage because they exist in chimpanzees and perhaps even monkeys. I agree with Winkelman that memesis is important in ritual and involves “an intentional attunement with the internal states of the observer with the observed” (and hence that rituals *qua* actions do not require mentalizing). However, I fear there is a serious risk here of confusing two different phenomena: one is the well-established role of ritualization in animal behaviour, the other is rituals as we find them in human religions. They are not the same thing. The first is very ancient (examples include the highly ritualised courtship behaviour of grebes and other birds [Huxley 1914], or the greeting and “notification” rituals of male baboons [Dal Pesco & Fischer 2020]). The second exploits this process, but adds *meaning* of a much more abstract kind to create *religious* rituals. I do not believe that religious rituals could play quite the role they do without that additional component. Indeed, Charles et al. (2023) show that the religious significance of rituals does seem to add an additional effect not present in secular versions of the same ritual. Fischer et al. (2013) provide further evidence from a naturalistic experiment to support this.

Winkelman suggests that “maximal displays” (i.e. ritualised behaviours) reduce conflict in primate societies. I know of no evidence to support that claim. These displays are basically a form of bullying in which violence pays by intimidation (much as it does in most human societies). Identifying precursors that are exapted for later purposes is one thing, but claiming that these phenomena are identical is a category mistake. Formal religions emerge only when we can convince others that our rituals have meaning. There is a direct analogy here with the evolution of speech. The evolution of bipedalism some eight million years ago was a necessary precursor for the evolution of speech: it gave us the control over breathing that allows us to “walk and talk”, something that no quadrupedal animal can do (Aiello 1996). However, this does *not* mean that speech evolved 8 Ma. Speech and the hearing of speech depend on a suite of anatomical and neural changes that emerged all at the same time in archaic humans (*Homo heidelbergensis* and their allies) a mere 500,000 years ago (Dunbar 2009, 2022b; Bannan et al.

2023). Speech would not have been possible without bipedalism, but the evolution of bipedalism did not mean that speech *had* to evolve. It might well not have done so.

For the same reasons, I would suggest that Lang is overplaying the evidence in claiming that *Homo ergaster/erectus* engaged in rituals of the kind that we would recognize in a contemporary religious context. They did not have the vocal or auditory apparatus for speech (Bannan et al. 2023) or, given their brain size, the mentalizing competences to create sentences of sufficient complexity to express concepts of any great sophistication even if they had language (Dunbar 2014; Pearce et al. 2014). However, they did, I have suggested, evolve laughter as a bonding mechanism (Dunbar 2022b), and, in Lang's and Winkelman's sense, that was highly ritualized behavior (as it still is with us). Once again, however, rituals are not religion, merely a necessary precursor for religion.

Conclusion

I am grateful to all six commentators for taking the time and trouble to read the book and reflect on its contents. This has provided me with a valuable opportunity to clarify some important issues in my account of the evolution of religion that might otherwise have been left hanging. Exchanges of this kind contribute measurably to the progress of science, both in terms of correcting errors or misunderstandings and in terms of evaluating alternative hypotheses. Science progresses not through providing evidence to support any one hypothesis (which is always subject to confirmation bias), but through being able to test between competing hypotheses that purport to explain the same phenomenon (Dunbar & Shultz 2023).

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