

11 Grace in evolution

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In transdisciplinary terms, it can seem that there is no more challenging dialogue than that between theology and evolutionary science. It is easy to see why theologians may feel the need to accommodate evolution, but it is less clear why evolutionary scientists should reciprocate. But in fact, contemporary findings suggest that there are grounds for the view that each discipline presupposes the same centre of attention. These are the historical and environmental processes of human becoming in evolution and, in theology, an intense inquiry into the limits and possibilities of human becoming as received and understood within Christianity. It is important to note that the ‘transcendental’ claims which deeply shape modern Christian theology do not have to be accepted *a priori* in this investigation.¹ The relevance of Christianity here resides in the proven capacities of Christian religion to shape highly diverse societies over two millennia. It is this possibly unparalleled phenomenon (or ‘achievement’) of Christianity’s hyper-production of community, in terms of historical concreteness, which makes this dialogue between evolutionary science and theology both interesting and necessary.

From a theological perspective then, it will be important that we set aside the language of ‘transcendentalism’ (the ‘transcendent-immanent’ binary). This term was first used in 1839 and its historical origins may lie in the highly innovative theology of Ulrich Zwingli when, some 300 years earlier, Zwingli began to understand the challenges posed by reductive materialism and its progeny, a powerful, science-based dualism. In its place, Zwingli advocated a turn to human subjectivity and a recodification of the relation between the human spirit and the Holy Spirit, in which the role of the latter is to set the former free from matter.² However deeply grounded the ‘transcendent-immanent’ binary may be in modern theology, it remains bound up with certain early modern scientific perspectives on the world which have been entirely dissolved by new scientific insights and perspectives. Our theological predicament is that we remain deeply shaped, in ways we may scarcely be aware, by arguments in the past. The questions which have animated theology from the sixteenth century in one way or another have concerned how we can replace traditional – scriptural/medieval – cosmology as the intellectual context for faith with new

frameworks based upon subjectivity or culture. In contrast, the future-orientated issues of our own day concern the challenge of reintegrating Christianity into our own contemporary cosmologies, which are altogether more hospitable to this task. This does not amount to rehearsing cosmologies from the past, or indeed their theologies. It concerns rather learning from them in ways which will allow theology to become once again authentically cosmological. Importantly, the emphasis here does not lie upon constructivism and our ingenious capacity to design a cosmology which 'fits'. Rather, our motivation must be the simple recognition that science today appears to offer us far-reaching cosmological resources for potentially developing realist frameworks for contemporary theologies to a degree not seen before.

In this chapter, it is proposed that the pre-modern concept of 'grace' can fruitfully be explored in parallel with 'freedom'. The former offers an outrightly theological description of something that is fundamental to the human, while the latter sits within a naturalistic discourse, which is explored here in terms of a straightforward account of human evolution. We shall argue that today both 'grace' and 'freedom' can indeed be understood to describe something which is fundamental to the human and *to our experience of being human*, and we shall argue that this allows a third possibility, which incorporates features of both, to come into view. In short, we argue that contemporary scientific advances in the area of evolution and cosmology are making a new kind of theology possible: one which potentially redefines the boundaries in the dialogue between theology and science, allowing each to come closer to the other.

'Grace' and 'freedom'

According to Thomas Aquinas, *gratia* speaks to us of free gift, virtue and fullness, as well as gratitude for something graciously or unconditionally given.³ Grace is not itself a virtue, but is rather the root of both faith and the virtues.⁴ It is in our essence rather than in the power of the soul. Grace is free and, like goodness, it attracts us.⁵

Freedom likewise is used in varied contexts to mean different things. But there is also consistency here: that we are 'free' suggests we have the power of choosing among different options and can exercise responsibility. We are answerable for what we say and do. We experience both limit and freedom from limit. And freedom, like grace, attracts us. It too inheres within us and is not easily objectified except in its 'fruits' or instantiations. The key question here is to what extent the theological term 'grace' overlaps with the experience we have of being 'free' as modern human beings. If freedom with its power of choice, its answerability, and its experience of limit and the overcoming of limit is a characteristic of behaviourally modern human beings, then freedom must itself be bound up with the processes of becoming that we call evolution. The question then is the following: what kind of

light does the word ‘grace’ and the word ‘freedom’ cast on our experience of being alive in this universe today?

Cosmology

Quantum field theory began with Max Planck’s experiment on the structure of light in 1900. This was followed in 1905 by further critical insights into the speed of light by Albert Einstein and the special theory of relativity. It was discovered that reality behaves very differently at the micro level than it does at the classical level at which we live. At the fundamental level of reality, according to the classical form of quantum mechanics, entities exist in a state of ‘superposition’, which means that they are in both a wave and a particle state at the same time. It is the action of the observer which causes the ‘collapse of the wave function’, by which matter-energy ceases to be both a wave and a particle, becoming a real particle at a particular place. At this level it is only when the observer asks where the particle is (by seeking to measure it) that nature gives its answer. Prior to the collapse of the wave function through the observer, reality remains only probabilistic and *in potential*. It is not possible to predict on the basis of the wave function where the particle will appear. Nor is it understood how the instantaneous transition from wave to particle occurs.⁶

Notoriously, quantum field theory presents us with deeply complex and counter-intuitive structures, even though it has often been described as the most empirically tested and successful of all scientific theories.⁷ Celebrated experiments by Albert Einstein in 1935 and by John Bell in 1964 established that once particles have collided and have exchanged or ‘processed’ information, they nevertheless remained in an ‘entangled’ state with one another. Information communicated to one particle is instantly received by the other, even though they are so far apart that it is not possible for any communication to pass between them at the speed of light. Since nothing can travel faster than the speed of light, the phenomenon of entanglement suggests that reality at the quantum level is ‘non-local’: the world is not constituted in space and time but in the ‘non-local’ unity that is deeper than space and time.⁸ We should note also the fact that it is only because the human capacity for mathematical calculation gives cognitive access to the deepest structures of the universe that we are able to grasp something of this ‘ultimate’ unity of the universe we find ourselves in. The suggestion is that the mathematical mind can penetrate reality at a depth which lies beneath the causal matrix itself: the human mind can access interconnected reality at a point that is prior to space and time.

As Henry Stapp and others have argued, the quantum level of reality appears to escape causality and so, from one perspective at least, can be described as ‘free’.⁹ The possible connection between the pre-causal ‘freedom’ of quantum effects and our own personal sense of freedom, through conscious self-awareness and our power of choice, has long been recognized,

although it has often been regarded as speculative. In recent years, however, the argument for the possibility of a quantum basis to consciousness has gathered momentum. There are four influential schools today which suggest that this may be the case, or at least point to this as a possibility. Advocates of Integrated Information Theory suggest that self-awareness, in which ‘every experience exists intrinsically and is structured, specific, unitary and definite’, is itself ‘identical with’ integrated information systems.¹⁰ The work over decades of Sir Roger Penrose, Stuart Hameroff, and, more recently, Anirban Bandyopadhyay point to the extensive harmonization of microtubules as a possible quantum ground of consciousness.¹¹ Thirdly, recent research in quantum biology has shown widespread quantum effects in the organization of life. Jim Al-Khalili, Johnjoe McFadden, and others have argued that the quantum harmonization of ion channels in the electromagnetic field may be linked with action potential.¹² Fourthly, there has also been a focus from within mathematical psychology on the potential role of quantum connectivity in decision-making, since the mathematical structures of the mind in decision-making bear a resemblance to the paradoxical structures of sub-atomic particles.¹³ The human mind can simultaneously hold together mutually exclusive understandings, repeating the wave-particle dualism which is at the centre of fundamental material reality. Such research signals the possibility that consciousness itself may be shown to be a function of a far-reaching quantum interconnectedness in the human brain.

We have to consider also that qubits or ‘quantum entanglements’ are being used in the generation of a ‘quantum computer’ revolution whereby a relatively small number of entangled particles can be harnessed to do computations of unparalleled speed. There are contrasts of scale between the thousands of entangled particles which are on the horizon of quantum computing and the 13 trillion potential neural connections of the human brain. But it is evident that future computer technologies will further draw upon the quantum structures of the universe (‘hacking into the way the universe computes’, in Seth Lloyd’s phrase¹⁴). There may be a corollary to this in that the identification of quantum processes as underlying human consciousness leaves open the possibility that at its deepest levels the universe may, in a sense, be thinking in us.

Evolutionary anthropology

We have to begin here with the consideration that life and quantum realities may be linked. To quote Al-Khalili and McFadden, ‘Life could not have survived and evolved on earth if it hadn’t, billions of years ago, “discovered” the trick of encoding information in the quantum realm’.¹⁵ Physics presents us with an important background then, but any inquiry into ‘freedom’ and ‘grace’ needs to focus on the ‘porosity’ and openness of the human in and to the world which we can associate with our rich cultural and existential life. We need to look beyond physics to signs of a ‘thicker’, more human

participation in the world, while retaining the knowledge that this will – in all likelihood – be predicated upon the fundamental structures of reality itself, as these exist within and beyond the brain, shaping what it is to be a modern human being.

The first ‘archaic’ curvature

This and the following two sections are based upon the Extended Evolutionary Theory, especially human niche construction, as laid out by Agustín Fuentes at the start of this volume.¹⁶ The construction of the human niche entails increasing levels of the internalization of the environment within the human person on the one hand, and an increasing penetration of the human mind into the environment, on the other. This is a primary movement of ‘inhalation and exhalation’. The former manifests as the imaginative internalization of external stones as tools, for instance, while the latter entails art, travel, and again processes of imagining something not yet seen. We can still see the same rhythms endlessly reproduced today in our media, in terms of ‘cyborgs’ and ‘space-travel’. Both are bound up with our inherent potential for distinctively human *creativity*.¹⁷

In the first place, we need to point here to the so-called ‘social cognition system’. This is the ancient and powerful sociality of the human body, recently laid bare by neuroscience, which manifests both as observable ‘body language’ but also as pre-thematic (pre-conscious) informational exchange of astonishing speeds and density. If the human brain can be called ‘the most complex system so far encountered anywhere in the universe’, then two human brains extensively interacting may be taken to point to an ‘event-horizon’ of unparalleled, interactive complexity.¹⁸ The ‘social cognition system’ has been shown to be the default system of every human body today, reflecting our long history as an exceptionally altruistic social species, as presented in this volume by Penny Spikins.¹⁹ One of its characteristics is that the pre-thematic ‘social cognition system’ appears to be grounded in a set of responses which are so ancient and fundamental that they can be described as ‘world’ as much as they can be described as ‘interaction’ and ‘encounter’ between two persons. This has been well summarized in the following terms:

When we interact with another person, our brains and bodies are no longer isolated, but immersed in an environment with the other person, in which we become a coupled unit through a continuous moment-to-moment mutual adaptation of our own actions and the actions of the other.²⁰

These multiple reflex interactions occur at speeds well below the threshold of conscious perception, but communicate as a sense of ‘rapport’.²¹ As ‘complex, multi-layered, self-organizing’, they sit within the early motor

system, involving sets of mutual responses ranging from eye movement, facial expression, posture, and gesture to the synchrony of brain waves, breathing, and pulse: a subtle and pervasive ‘alignment of behaviour’ which includes ‘synergies, co-ordination and phase attraction’.²²

The ‘enactivist’ school of social neuroscience draws our attention to the extent to which in this ‘self-organizing’ system the world can be said to enact itself in the phenomenon of jointly activated social cognition systems:

When I see the other’s action or gesture, I see (*I immediately perceive*) the meaning in the action or gesture; and when I am in a process of interacting with the other, my own actions and reactions help to constitute that meaning. I not only see, but I resonate with (or against), and react to the joy or the anger, or the intention that is in the face or in the posture or in the gesture or action of the other.²³

Our ‘social cognition system’ has been called our ‘participatory sense-making’ of the human other.²⁴ It is a species-wide system in which the evaluative protocols of one are densely exposed to the evaluative protocols of the other. As a ‘self-organizing’ material system of unparalleled informational exchange and density, it has been the means whereby human beings have closely bonded for millions of years, and still do bond through ‘body language’ and embodied social interaction.

What is striking, however, is the extent to which this is a radically open and inclusive system (as we see in the young child). At its core it shows very high levels of reflexivity, affectivity, empathy, and evaluation (allowing us to estimate what kind of person it is we are talking to and whether we are getting on). But these powerfully evaluative functions are themselves pre-thematic (non-self aware), and so we know them as feelings or intuitions about the other. In contrast to this pre-thematic engagement with its unconditional inclusivity, the engagement of our self-awareness will often reflect more selfish considerations and also, of course, calculated forms of prejudice.²⁵

From an evolutionary perspective then, we can see the human ‘social cognition system’ as an ancient and immersive system which has constituted the primary mode of our participative belonging within our environment: as a social environment constituted by the internalization of the faces and bodies of others. But we have to balance this system with a different kind of penetration into the environment, which we can associate with extensive tool manufacture and use. In early Oldovan and then Acheulian technologies, the human imagination penetrated stones, identifying possible alternatives of shape: the tool and the improved tool.²⁶ Inventive toolmaking and tool use on a large scale, together with our social nature, in combination, reflect and enhance our powers of imagining and constitute a distinctive feature in our lineage. We can call this our first, or ‘archaic’, curvature.

The second 'linguistic' curvature

Of course, all creatures make themselves at home in their 'niche', but as genus *Homo*, we appear to have done this in unusually intensive ways. The combination of an ever deeper penetration into the world through immersive, interfacial relations on the one hand, and through technologies on the other, set us on a particularly dynamic evolutionary trajectory. This 'archaic' or first curvature then leads to a second or 'linguistic' curvature which is associated with the production of advanced language. Advanced language proceeded from an immersive outflow into the environment and a parallel internalization of the material properties of words by the mind, through which, over time, environment became anatomy. Thus the internalization of the sound and shape of words, in parallel with the internalization of tools, became a new and more powerful mode of being in the world. Words gave us a new power of understanding the world, through reference and joint attention, but also through the development of advanced mathematics. Words constituted a new depth of our 'porosity' in and to the world: the human mind can filter and control the world through words, but it is also through words, and their material properties, that the world floods into us through cognition, performance, and the arts.²⁷ At the interface of self and world, words are both tool and voice, both rhythm and imagination, both inside and outside.

The context for this second, 'linguistic' curvature, in parallel with the advent of behaviourally modern human beings, can specifically be linked with features characteristic of human populations some tens of thousands of years ago. With 'domestication by 15–10,000, and early cities by 5,000 years ago', as Fuentes records, we see the emergence of characteristically modern human behaviours, such as mathematical computation, the beginnings of complex ritual and religion, as well as previously unseen occurrences of systematic group violence (massacres of population groups). The last of these is arguably the product of a new power of naming the other as 'non-human'.²⁸ We can also include here, in the early Neolithic, the first widespread appearances of representations of the human face.²⁹ This suggests a new power of objectification of the most fundamental orientation of all: the immersive reality of our human interfacial relations.

This second level of curvature is associated with the internalization of thousands of arbitrary material signs by which advanced modern language was formed and, with that, advanced linguistic consciousness. It is easy to forget that every word we use in our advanced languages today is encoded in its physical properties and its meanings within the human brain in strongly interconnected networks. Each is internalized from the environment, according to its material properties of sound and shape, and is an arbitrary, symbolic representation of conceptual meanings which are themselves also encoded in the 'semantic system' of the human brain.³⁰ Practices of 'learning', or the internalization of so many words and phrases, which

can dominate our lives through and beyond our early years, effect a material change within us and they have been compared with the ‘extended’ and ‘supersized mind’ theories of AI.³¹

This second ‘curvature’ of the human mind into the material world is not purely an extension of the first, however. Rather we should think of the ‘linguistic curvature’ as being itself the *creative product* of the ‘archaic’ one. Arguably the sustained ‘ratcheting effect’ of the two different orientations in the world – interfacial orientation and hand-world tool use in combination – generated a new system which itself represents enhanced creativity. And in fact, as we shall see later, the occurrence of the more advanced forms of social learning, which are associated with advanced language, are in fact sporadic or spontaneous, and do not fit easily into a straightforwardly progressive model.

Advanced language is an autonomous system characterized by its creativity then, where creativity in this case signals spontaneity and freedom, and with freedom, the power of *choice*. According to Saussurean linguistics, each utterance (*parole*) requires a choice between a range of potential linguistic possibilities (*langue*). We can choose our words from all the possible words we might have used, and so allow ourselves to be held to account for them.

The third ‘reflexive’ curvature

In its creativity then, the second ‘linguistic’ curvature, which brings us the freedom of choice associated with advanced language, and contains within itself a further ‘reflexive’ curvature which specifically concerns *how we use our linguistic freedom*.³² We can use it to choose one word or another, or to reason deliberatively, coming to judgment about what we shall do or what we shall believe. The productivity of language is evident in its shaping of our power to act and in its shaping of our world (cf. tool use). But advanced language also inevitably separates us from the world. The internalization of words serves to ‘press minds like ours from the biological flux’ and powers a new, higher framework of integrated self-reflexion.³³ But this power of objectification comes at a price. In the orientation of their self-awareness, the observer and actor are both somehow ‘outside’ the world which they observe or in which they choose to act. The second, ‘linguistic’ curvature of mind into world which gives us self-awareness and awareness of the world around us means that we are also always at a distance from the world, separated from it precisely by the distance that comes from our power of choice.

But this second curvature contains the possibility of a third. Since in every instance words are themselves material form, there always exists the possibility that, should I choose to do so, I can also *highlight the materiality of the sign* at the point of utterance, through rhyme, chant, song, or, in written form, through calligraphy. At one level, this points to Roman Jakobson’s theory of ‘poeticity’, by which my choice of words will reflect at least in

part the physical properties of surrounding words, as in the production of a rhyming text.³⁴ But it may also appear in quite different and more directly social ways, as when I consent to ‘going with the flow’ when I sing, chant, or dance with others, or lose myself in the calligraphic reproduction of words. In religious contexts, people consent to praying repetitively in ways that allow the sound or rhythm of the words to be emphasized. The key factor to note then is that what is aimed at here is not the predominantly referential function of words which serve to name, establishing order and control. Rather, what comes to the fore is a quite different, more ancient, often repetitive function of words based upon the materiality of the signs which all of us share. Since advanced linguistic consciousness is what we are as subjects, the freedom we have to emphasize the materiality of words, beyond their power of reference, is effectively the celebrating of our human embodiment together.

It is through the material form of our words, as sound or shape, that our advanced linguistic mind is most directly in the body. The dense linguistic architecture which gives us our advanced linguistic consciousness is itself the product of processes of internalization, by analogy with the way that the human brain ‘internalizes’ the stone held in the hand so that it becomes a highly effective tool. Words then are ‘social tools’, and when we *directly* emphasize their materiality, by freely foregrounding their sounds and shapes, the human mind *indirectly* finds its way back into our human embodiment, in a free communitarian act.

What we are calling here the ‘third curvature’, which is the deeper entry of mind into the body, generates a sense of ‘freedom in’ (which is to say, ‘freedom in materiality’) and it is closely bound up with the production of community. ‘Freedom in’ is principally constituted in our encounter with the human other – in the shared celebration of our materiality – as mind. It is not surprising, therefore, that this third, ‘reflexive’ curvature should be closely associated with the intensive forms of community that we know as religions. The celebratory group performance of the materiality of the sign in ritual constitutes a shared, non-local state of openness of mind – or ‘porosity’ – to the reality of the material world. It points both to the unity of mind and body which occurs in that moment, and also to the ‘togetherness’ of one body with others, in a rhythmic or synchronized harmonization. We know today that this synchrony repeats the deepest nature of embodiment as harmonious system, underlying the phenomenon of consciousness. The intense, synchronic informational exchange systems of our human social cognition system reach far back in time. These denote our fundamentally *participative* belonging in the world, which remains the case in whatever way our more recent advanced linguistic consciousness may construe the nature of the world and how we are within it. Even the most scientifically astringent and committed example of modern *Homo faber* is fundamentally in the world through the massively

complex and dense exchange of information which constitutes the basis of our proximate sociality. Here we see the very core of human niche construction. Our internalization of the human other creates deep, pre-linguistic community which we carry with us through life, returning to our loved ones to refresh ourselves at its spring. This other self – we can call it *Homo socius* – has its own way of reasoning (‘social’ or ‘relational reasoning’) and its own form of life. Moreover, it also has its own kind of freedom. Freedom *in*: freedom which is within our participative belonging in the world.

There is, of course, only one self, but it is a self who is profoundly shaped by two quite different evolutionary strategies: the interfacial social on the one hand who builds community (‘multiplying the human resource’) and the toolmaker and user who controls and shapes the environment in habitable and sustainable ways on the other. Jayne Wilkins has drawn our attention to the importance not of technological advances or new behaviours in human evolution, but rather to the distinctive role and nature of different kinds of social learning, exercised specifically in the making of sophisticated tools. She states:

While there are anatomical changes that mark the speciation of *Homo sapiens*, the first appearance of our species is not associated with major technological or behavioural changes. Instead, the archaeological record documents spatially and temporally discontinuous variation in social learning mechanisms and sociality.³⁵

This leaves us with a striking image of *Homo socius* and *Homo faber* in deep continuity with one another, precisely at the point of the production of tools. These two strategies – of sociality and technology – have combined in our evolution: together they are niche construction. Whether they still combine, and how this question can be addressed, is the topic of another day.

Each of the three ‘curvatures’ outlined here marks a new stage in human access to the environment, entailing behavioural and anatomical processes which furthered our niche construction. We can identify this niche construction with our belonging in the world. With the production of advanced language, through the internalization of material signs, the momentum of this evolution has shown itself to be one which enhances our human freedom. Religions, and Christianity among them, implicitly foreground this freedom in the shaping of their moral imperatives. The concept of freedom is at the heart of Christianity, and Christians will want to call this ‘grace’. But the freedom which comes into view through our evolutionary history seems to lie deeper than these distinctions. Just how ‘deep’ can our freedom be? Arguably, it is our capacity to be free in this world which marks the point of our deepest humanity. We can call it ‘freedom’, or we can call it ‘grace’; but neither excludes the other.

Notes

- 1 On the nineteenth-century origins of this term, see Johannes Zachhuber, 'Transcendence and Immanence', in *The Edinburgh Critical History of Nineteenth Century Christian Theology*, edited by Daniel Whistler (Edinburgh: Edinburgh University Press, 2018), 164–181.
- 2 Oliver Davies, 'Spirit, Body and Letter', in *The Spirit and the Letter: A Christian Tradition and Its Late Modern Reversal*, edited by Paul Fiddes and Günter Bader (London: T&T Clark Continuum, 2013), 179–194.
- 3 Thomas Aquinas, *Summa Theologiae*, Latin and English, edited by T. Gilby and T. C. O'Brian (London: Eyre and Spottiswoode; New York: McGraw Hill, 1964–74), I – II, q. 110, art 1, response.
- 4 Aquinas, *Summa Theologiae*, art.3, reply to objection 3.
- 5 For an extended discussion of 'grace' and 'nature' in the context of Karl Rahner, see Karen Kilby and J. Matthew Ashley, 'What Difference Does Grace Make? An Exploration of the Concept of Grace in the Theological Anthropology of Karl Rahner', current volume.
- 6 Alexander Wendt, *Quantum Mind and Social Science* (Cambridge: Cambridge University Press, 2015), 43–57; Shimon Malin, *Nature Loves to Hide: Quantum Physics and the Nature of Reality, a Western Perspective* (Oxford: Oxford University Press, 2001), 111–119.
- 7 Henry P. Stapp, *Quantum Theory and Free Will*, 2nd ed. (Cham: Springer International Publishing, 2017), 43.
- 8 Niels Bohr, 'Can Quantum-Mechanical Description of Physical Reality Be Considered Complete?' *Physical Review* 48, no. 8 (1935): 696–702; John S. Bell, 'On the Einstein Podolsky Rosen Paradox', *Physics Physique Fizika* 1, no. 3 (1964): 195–200.
- 9 Henry P. Stapp, *Quantum Theory*.
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- 11 S. Hameroff and R. Penrose, 'Consciousness in the Universe: A Review of the "Orch or" Theory', *Physics of Life Reviews* 11, no. 1 (2014): 39–78; Subrata Ghosh, Satyajit Sahu, and Anirban Bandyopadhyay, 'Evidence of Massive Global Synchronization and the Consciousness: Comment on "Consciousness in the Universe: A Review of the Orch or Theory" by Hameroff and Penrose', *Physics of Life Reviews* 11, no. 1 (2014): 83–84.
- 12 Jim Al-Khalili and Johnjoe McFadden, *Life on the Edge: The Coming of Age of Quantum Biology* (London: Transworld Publishers, 2014), 231–265.
- 13 James M. Yearsley and Jerome R. Busemeyer, 'Quantum Cognition and Decision Theories: A Tutorial', *Journal of Mathematical Psychology* 74 (2016): 99–116. See also E.M. Pothos and J.R. Busemeyer, 'Can Quantum Probability Provide a New Direction for Cognitive Modeling?' *Behavioral and Brain Sciences* 36, no. 3 (2013): 255–274.
- 14 See *Closer to Truth* interviews on 'Does Information Create the Cosmos?' www.closetotruth.com/series/does-information-create-the-cosmos (accessed 11 September 2019). See also Seth Lloyd, *Programming the Universe: A Quantum Computer Scientist Takes on the Cosmos*, kindle ed. (London: Random House, 2007).
- 15 Al-Khalili and McFadden, *Life on the Edge*, 229.
- 16 I am adapting the term 'gravity' here from the title of Simone Weil's short work, 'Gravity and Grace', in which she states: 'Grace is the law of the descending movement. To lower oneself is to rise in the domain of moral gravity. Moral gravity makes us fall towards the heights'. See Simone Weil, *Gravity and Grace* (London and New York: Ark Paperbacks, 1987), 1–4.

- 17 Agustín Fuentes, *The Creative Spark: How Imagination Made Humans Exceptional* (New York: Penguin Random House, 2017).
- 18 Adam Zeman, *A Portrait of the Brain* (New Haven and London: Yale University Press, 2009), 1.
- 19 Rogier B. Mars, Franz-Xaver Neubert, MaryAnn P. Noonan, Jerome Sallet, Ivan Toni, and Matthew F.S. Rushworth, 'On the Relationship between the "Default Mode Network" and the "Social Brain"', *Frontiers in Human Neuroscience* 6 (2012): 1–9; Wanqing Li, Xiaoqin Mai, and Chao Liu, 'The Default Mode Network and Social Understanding of Others: What do Brain Connectivity Studies Tell us', *Frontiers in Human Neuroscience* 8 (2014): 1–15; P.A. Spikins, H.E. Rutherford, and A.P. Needham, 'From Hominity to Humanity: Compassion from the Earliest Archaic to Modern Humans', *Time and Mind* 3 (2010): 303–325. See also Shihui Han, *The Sociocultural Brain* (Oxford: Oxford University Press, 2017).
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- 21 Linda Tickle-Degnen and Robert Rosenthal, 'The Nature of Rapport and Its Nonverbal Correlates', *Psychological Inquiry* 1, no. 4 (1990): 285–293.
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- 24 Di Paolo and Jaegher, 'The Interactive Brain Hypothesis', 2.
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- 28 Vittorio Gallese, *New Scientist* 221, no. 2952 (2014): 1. See also Nam C. Kim and Marc Kissel, *Emergent Warfare in our Evolutionary Past* (Routledge: London and New York, 2018).
- 29 Ian Kuijt, 'The Regeneration of Life', *Current Anthropology* 49, no. 2 (2008): 171–197.
- 30 Alexander G. Huth et al., 'Natural Speech Reveals the Semantic Maps That Tile Human Cerebral Cortex', *Nature* 532, no. 7600 (2016): 453–458. See also Robinson, 'On the Origin of Symbols'.
- 31 Andy Clark, *Supersizing the Mind: Embodiment, Action and Cognitive Extension* (New York: Oxford University Press, 2011).
- 32 On niche construction and language, see Chris Sinha, 'Language and Other Artifacts: Socio-Cultural Dynamics of Niche Construction', *Frontiers in Psychology* 6 (2015): 1601; see also Oliver Davies, 'Niche Construction, Social Cognition, and Language: Hypothesizing the Human as the Production of Place', *Culture and Brain* 4, no. 2 (2016): 87–112.
- 33 Clark, *Supersizing the Mind*, 53–60.

- 34 Roman Jakobson, 'Linguistics and Poetics', in *Selected Writings III: Poetry of Grammar and Grammar of Poetry* (The Hague: Mouton, 1981), 18–51.
- 35 See Jayne Wilkins, 'Archaeological Evidence for Human Social Learning and Sociality in the Middle Stone Age of Southern Africa', current volume. See also Marc Kessel, and Agustín Fuentes, "Behavioral Modernity" as a Process, not an Event, in the Human Niche', *Time and Mind* 11, no. 2 (2018): 163–183.

Glossary

curvature: a neologism adapted from Simone Weil's understanding of 'gravity' as something which combines depth with height. The more deeply we enter our environment, through niche construction, the greater our power of conceptualization.

Extended Evolutionary Theory: a new evolutionary theory which includes the principle that organisms modify the environment they belong to through niche construction.

grace: in Thomistic discourse, grace is like a gift freely given and is a quality anchored in the soul rather than in the powers of the soul.

Homo socius: as a partner to *Homo faber*, *Homo socius* appears in Peter Berger and Thomas Luckmann's *The Social Construction of Reality* (Penguin Books, 1966), 69. The Latin term 'socius' means 'friend' or 'companion'.

qubit: a qubit or quantum bit is the basic unit of quantum information. A qubit is a two-state quantum mechanical effect in which opposite effects simultaneously occur (as in the spin up and spin down of an electron).

social or relational reasoning: this refers to reasoning which internalizes the perspective of the other and so escapes instrumentalization. It characteristically accepts and works with the complexity of the world – as this comes to meet us in other human beings – rather than reducing the complexity of the world as in instrumental reasoning.

transcendence and immanence: Karl Hermann Scheidler wrote an article for the *General Encyclopaedia for the Sciences and the Arts* in 1839 in which this term was first used in a binary sense to reflect the transcendentalism of modern German philosophy. But it also reflected the paradox that modern theistic religion requires a transcendence which presupposes but goes beyond immanence.

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