Preface

As the title suggests, the subject of this book is the emergence of complexity and the mind, focusing on the role of top-down causation. The aim is to engage with the complexity of the emergence of life and the mind out of the underlying physics. What makes this possible?

The world of biology, where purpose and adaptation abound, is quite different from the natural world of rocks, oceans, atmospheres, planets, stars, and galaxies, where impersonal forces hold sway. Yet both are based on the same underlying physics. How can such different outcomes emerge from the same underlying particles and forces? Can we identify the key enabling principles?

Top-Down Causation

I will make a case that, in addition to bottom-up causation, top-down causation is a key element in what is going on, enabling genuine emergence to take place, with higher levels of structure having genuine causal powers in their own right. As well as in bottom-up causation, which is crucial, emergent entities exert downward influences on their components, and this is the basis for true complexity (Chap. 3). In some cases the less contentious phrase 'contextual effect' might be preferred, and that certainly often takes place. However, I will make a stronger claim that 'top-down causation' is appropriate in some cases, and specifically when the mind is involved.

Brain and Mind. The ultimate focus is the brain and the mind (Chap. 7). However, most of the book discusses a much wider range of issues, setting the scene for the discussion of the brain and the emergence of the mind. This broader context is crucial in order to look at the brain properly: the foundation stones for that study will have been properly laid by the time we get there.

Across all the Sciences. The aim is therefore an integrative view to show how this holds in all sciences including chemistry and physics, and is of particular significance in understanding digital computers, life and brain. Thus this book engages with sciences across the board.

Please note that I am not an expert in all the areas discussed here. However, what I am able to do is to comment on the larger patterns of causation that occurs in these various contexts, and how they relate to the theme of this book. This builds up to an integrative view of the whole.

Key Issues

Four key issues emerge:

- **Key question: Who does the work, who decides what will be done?** These are different kinds of causal effects; both occur in any complex system. The lower levels do the physical work, but the higher levels decide what work should be done. This theme will recur throughout the text, with Sect. 2.7 discussing the key example of digital computers.
- **Key issue: How is there a causal room at the bottom?** This will be dealt in depth in Chap. 4, exploiting the fact that top-down effects can change the nature of lower level elements, or even determine whether they exist or not.
- **Key concept: Multiple realisability.** A key concept in the whole schema is the multiple realisability of higher level structures and functions in terms of lower level components fulfilling higher level functions, leading to the real effective causal entities being equivalence classes of lower level entities. This is discussed in Sect. 3.5.
- **Key concept: Supervenience** Exactly identical lower level structures and excited states may lead to identical higher level effects in a bottom-up way, as is captured by the idea of supervenience. However, the relevant complex lower level states and excitations in the case of living systems can only come into being if top-down processes, and in particular adaptive effects, shape them according to their context. They cannot come into existence purely by bottom-up processes. This is discussed in Sect. 3.5.3.

Applicability. I strongly believe that science should be able to relate to the complexities of what happens in the everyday world, as well as in the laboratory; and propose that this is only possible if one takes into account the top-down strands of causation as well as the bottom-up ones. I will give many examples. Laboratory experiments seem to shield the system from top-down effects—until one realizes that the occurrence of the experiment is only possible because of the top-down effect of the human mind on the physical world, i.e., the human mind that created the laboratory and the experimental apparatus in the first place.

Effects. This is not just an academic topic. Views on how causation work affects our mental models of how things work and how we should interact with them, and in particular how the brain works and how to deal with its complexities. Consequently, there are implications in particular in health care, mental welfare, and education. These are complex topics. I will briefly consider the case of education and literacy in Sect. 8.6.

Mathematical Models. Mathematical models are needed to give depth and credibility to the discussion. They are commented on, but are largely segregated from the main text, so they can be skipped if one just wants to follow the main line of argument. There is a great deal of evidence for what is proposed here that is a valid support for the present proposal, independent of any mathematical models.

Respecting the Physics. My argument will not in any way deny the nature of the science that enables and underlies our existence: nothing I propose in any way suggests that science is overridden by the processes I describe. Rather what I put forward is a broadening of our understanding of how causal effects work in accordance with the underlying scientific laws, when higher levels of causation are taken into account as well as the level of particles and forces that is the focus of fundamental physics. Physiology is a science just as much as physics is: it is compatible with physics and operates within the constraints imposed by the underlying physics, but it is not determined by physics. It is shaped by the logic of physiological needs, which determine physiological structures and function.

Novelty. A great deal of the book is a survey of well-established results presented from a particular perspective involving the interaction of bottom-up and top-down effects. For example, I give a discussion of digital computing from this viewpoint in Chap. 2. However, the discussion also has various new aspects. What is novel is noted in Sect. 1.6.2.

Controversial Aspects. Some people, such as those working on integrative aspects of the brain or physiology, will take what I say as quite uncontroversial. Others, primarily working in physics or molecular biology, may find it either trivial or simply wrong. I believe the latter viewpoints are answered adequately in the main text. A brief note on which items in my discussion are controversial is given in Sect. 1.6.1.

Chapters and References

The chapters of this book have, at the request of the publisher, been written so that they can to a large degree be read independently. Therefore some important topics are covered several times, and references for each chapter have been given separately at the end of the chapter. This results in some duplication of references. The

payoff is that you can refer to them easily by turning to the end of the chapter, if that is all you have downloaded.

Origins

The origin of this book was a series of Vatican Observatory–CTNS discussions organized by George Coyne, Bob Russell, Nancey Murphy, and Bill Stoeger. My interest in top-down causation arose through discussions there with Arthur Peacocke, Phil Clayton, and Nancey Murphy, and led to a number of papers on the topic referred to in the text, as well as a book with Nancey Murphy.[1] This interest developed further through a Wawona meeting convened by Mary Ann Meyers, leading to a book jointly edited with Nancey Murphy and Tim O'Connor,[2] a meeting with Gennaro Auletta and Luc Jaeger in Rome and Cape Town, and a London meeting also convened by Mary Ann Meyers, leading to proceedings jointly edited with Denis Noble and Tim O'Connor.[3] Interactions with Paul Davies and Sarah Walker at the Beyond Centre, Arizona State University, have taken it further, as has a Manchester Gödel Centenary meeting (which I attended thanks to Hyung-Choi) in the case of digital computers, and an FQXI essay competition in case of physics.

One should note that, although these are the origins of what is written here, it then developed its own logic over a period of some decades, a logic which is presented here. Of course, the arguments given must stand or fall on their own merits, irrespective of how they arose.

Thanks

I thank all the colleagues mentioned above for valuable discussions and insights. I particularly thank the Vatican Observatory–CTNS collaboration (George Coyne, Bill Stoeger, Bob Russell, Nancey Murphy) for their very enlightening conferences which were crucial in my thinking, Phil Clayton for important discussions on causal closure, Gennaro Auletta, and Luc Jaeger for key discussions on multiple realizability, Tim Maudlin for helpful comments, Hyung Choi and Mary-Ann Meyers for support of various of these events via the Templeton Foundation, Paul Davies and Sara Walker for their ASU meetings, and Angela Lahee for the suggestion to

[1] N Murphy and G F R Ellis (1996) *On the Moral Nature of the Universe: Cosmology, Theology, and Ethics* (Fortress Press, Minneapolis).

[2] N Murphy, G F R Ellis, and T O'Connor (Eds) (2009) *Downward Causation and the Neurobiology of Free Will* (New York: Springer).

[3] G F R Ellis, D Noble, and T O'Connor (Eds) (2012) "Top-down causation: An integrating theme within and across the sciences?" *Royal Society Interface Focus* Special issue **2**:1–140.

publish this as a Springer book. I thank Mark Solms for very helpful discussions as regards Chap. 7, and two referees who made comments that led me to improve the text.

And above all, I thank my wife Carole for her loving support. Discussions with her on the case of learning to read have been invaluable, and she co-authored Sect. 8.6 on this topic with me.

Cape Town George Ellis
April 2016

http://www.springer.com/978-3-662-49807-1

How Can Physics Underlie the Mind?
Top-Down Causation in the Human Context
Ellis, G.
2016, XXVI, 482 p. 36 illus., Hardcover
ISBN: 978-3-662-49807-1