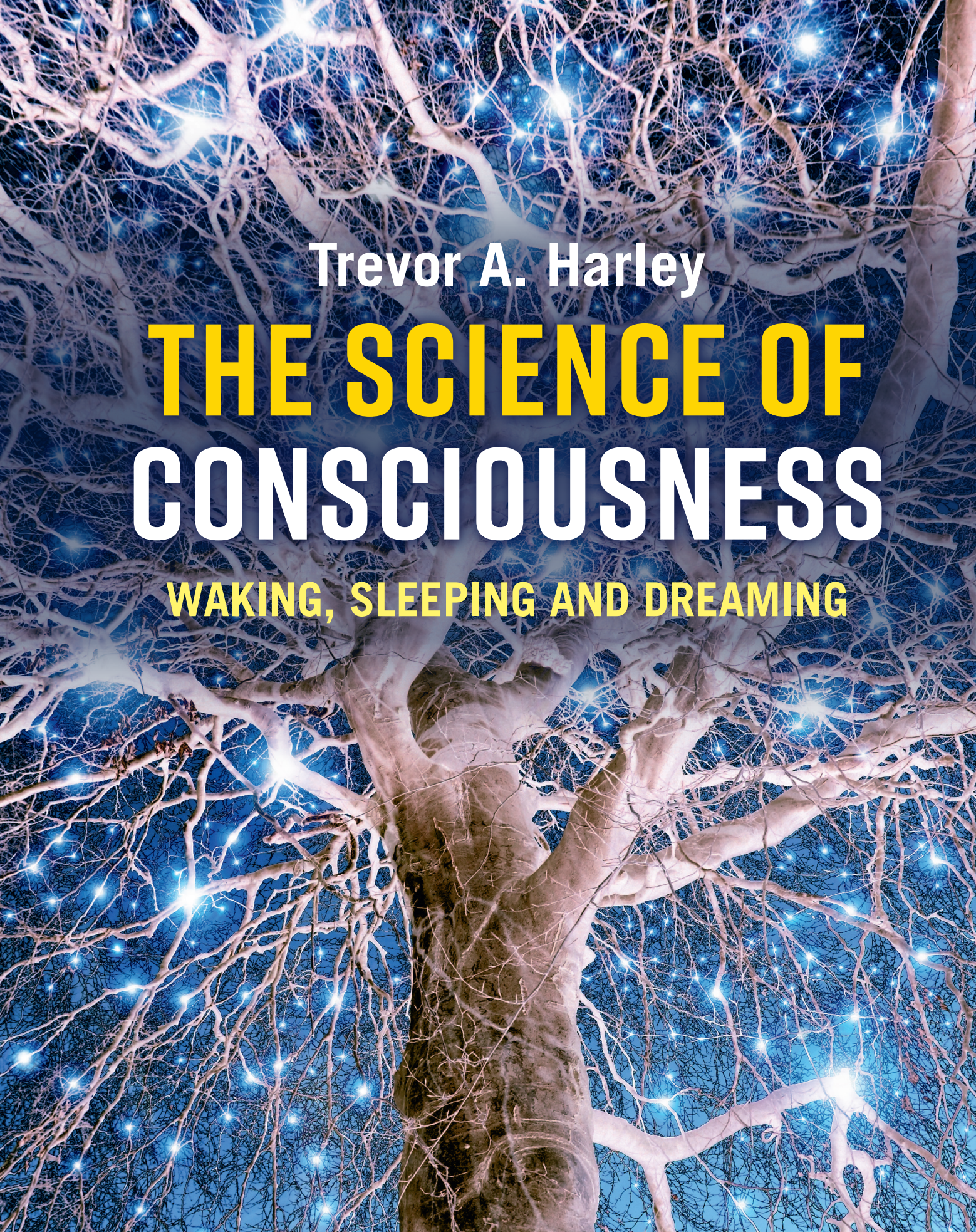
Trevor A. Harley
THE SCIENCE OF CONSCIOUSNESS
WAKING, SLEEPING AND DREAMING

The Science of Consciousness

Consciousness concerns awareness and how we experience the world. How does awareness, a feature of the mental world, arise from the physical brain? Is a dog conscious, or a jellyfish, and what explains what is conscious and what is not? How is consciousness related to psychological processes such as perception and cognition? *The Science of Consciousness* covers the psychology, philosophy, and neuroscience of consciousness. Written for introductory courses in psychology and philosophy, this text examines consciousness with a special emphasis on current neuroscience research, as well as comparisons of normal and damaged brains. The full range of normal and altered states of consciousness, including sleep and dreams, hypnotic and meditative states, anaesthesia, drug-induced states, and parapsychological phenomena and their importance for the science of consciousness, is covered, as well as the 'higher' states and how we can attain them. Throughout, the text attempts to relate consciousness to the brain.

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To Allan Hobson, who started it, and to Ruth, who finished it.

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PREFACE

The late twentieth century saw the emergence of cognitive science as an interdisciplinary approach to studying the mind, a strategy that took what was needed from experimental psychology, computer science, philosophy, linguistics, anthropology, and comparative psychology, and, increasingly, neuroscience. As I have taught the study of consciousness over the past 30 years – first as part of an introductory cognition class, and then as an advanced option – I have seen the ways in which the evidence gleaned from neuroscience in particular has become essential to our understanding of consciousness. Indeed, all of psychology has become substantially intertwined with neuroscience. During this period, consciousness has moved from being a fringe topic to one taking centre stage, unifying different areas of psychology in the process.

Yet many students are surprised by the idea that there might be nothing more to us than our brain and bodies; and if psychology students are troubled by this notion, those without a psychology background are often shocked. This insight – that our brain is all there is, and therefore that neuroscience must play a major role in our discussion of consciousness – is the main reason for the creation of this text. As an instructor, I began to feel the need of a text that could succinctly address consciousness in light of the available scientific information by putting neuroscience front and centre in the discussion, while maintaining philosophical integrity. I want a text that can show that there is still a glorious mystery ever present in our lives, and that science can cast light on that mystery. *The Science of Consciousness* is that text.

Approach

Primarily an undergraduate text, *The Science of Consciousness* is appropriate for psychology and philosophy courses in consciousness and cognitive psychology. I hope, however, that it will reach a broader audience, and consequently have written with the educated lay person in mind. As a comprehensive introduction to the science of consciousness, the text is distinguished by the following characteristics.

A Multidisciplinary Approach. Because of the profound effect on the study of consciousness by discoveries in diverse academic fields, only an interdisciplinary approach can expose students to the broadest and most up-to-date understanding of consciousness. Consequently, the text examines every major subject in terms of the light that can be shed on it by a wide range of disciplines – from social sciences to biological sciences to computer science to philosophy.

Theoretical Framework. This book is a text, not a monograph, or a piece of original research, or a mission statement. I have endeavoured to be as neutral as possible while covering a range of material from many sources, some of which contradict each other.

Psychology is distinguished by a lack of consensus in the way that would not be evident in, say, an undergraduate physics text, where much more is known and certain about the discipline being studied. It is one of the challenges of a psychology or related course that the student has to learn to live with and evaluate the uncertainty.

Although bias has no place in a text, it might occasionally shine through. My views are closer to those of Chalmers than of Dennett. I think enormous progress has been made in understanding consciousness over the last few decades, mainly as a result of sophisticated psychology experiments and advances in neuroscience, while philosophy has sharpened the issues to be debated. There is a core of problems (the 'hard problem') where advances have been less rapid, and there may be some problems that are never solved. But progress isn't achieved by giving up, and nothing would be more depressing to a student than a defeatist text. This book is called *The Science of Consciousness* because I think science is humanity's greatest invention.

Little Prior Knowledge Assumed. An interdisciplinary approach brings the challenge that few readers have a background in all of the component disciplines. Not all readers of the text will have the same level of knowledge of these diverse fields, particularly when a major contributor to understanding consciousness is neurobiology, often a difficult subject for the nonspecialist under any circumstances. Students may be apprehensive, finding it difficult to remember all the names and acronyms used in the topic. Understanding the subject can seem more like a test of memory rather than a matter of understanding principles.

Consequently, I have tried to assume as little prior knowledge as possible. Explanations take into account the reality that readers are not students of neuroscience. In addition, rather than weigh down the text with background material that not all readers will need, I have put some information in boxes so that it does not interrupt the flow of the text. Also, I have focused on trying to make the text move seamlessly from subject to subject so that concepts build organically regardless of the discipline from which they emerge. The early part of the text contains a lot of philosophy and a few experiments; later, as we examine consciousness-related topics such as attention and sleep, the text focuses less on philosophy and a great deal more on experiments.

Strong Foundation in Neuroscience. Recent rapid advances in the study of the brain have transformed our ideas about consciousness. No serious consideration of consciousness can proceed without substantial input from neuroscience. Consequently, the discussion of discoveries in neuroscience is an essential aspect of the text. As neuroscience informs every aspect of the subject, the material is integrated throughout rather than shunted into one separate chapter. The glossary though provides a resource for students with less background in neuroscience.

Integration Throughout of 'Atypical' States of Consciousness. While other texts cover sleep and dream science very briefly, three full chapters are devoted to the recent discoveries

in this field – discoveries that are especially important to psychology students interested in the latest psychotherapeutic interventions. Other chapters are devoted to 'atypical' states of consciousness; it is easy to gain the impression from the literature that consciousness is one simple state.

Inclusion of Cross-cultural Aspects of Consciousness. Most psychology experiments might be carried out on western young undergraduate students, but we must remember that they might not always be representative of the world's population of what is expected to soon be 8 billion. Different cultures have different views of consciousness; for example, contrast western and eastern approaches to consciousness and spirituality. Different religions place different emphases on altered states of consciousness and means of obtaining them (including prayer and drugs). Even differences between languages affect the way we think of the world.

Engaging Pedagogical Features. The text includes many pedagogical features. Students are encouraged to attempt activities, experiments, and thought experiments, labelled 'Try this', throughout the text; these exercises prompt them to examine different conceptual problems. No other subject lends itself so well to self-exploration as does consciousness. 'Try this' suggestions are clearly marked in the text.

To maintain the flow of the narrative, as well as to break up the text, boxes contain nonessential material that some students might find useful or interesting. In particular, I have provided background information about interdisciplinary approaches that many undergraduates might not know. I have illustrated the book as richly as possible, taking care to use illustrations that really add information or aid understanding, rather than being merely decorative or token. Each figure is captioned so as to aid skimming and remembering the associated material.

Each chapter contains recommendations for exploring further reading and other material. To make the supplemental reading as accessible as possible, I have focused on approachable secondary sources that will prepare the student for the primary sources of peer-reviewed journal articles and books.

Every chapter begins with a roadmap of what that chapter is about. At the end of each chapter is a clear bullet point summary telling the reader what they need to be able to take away from each chapter. The summaries can also act as another form of self-test for readers to be able to evaluate their understanding and knowledge of each topic. There are explicit self-test questions at the end of each chapter.

I think reading the text from Chapter 1 through to Chapter 18 is the best order, but have tried to make each chapter as independent as possible. There is a glossary to assist readers. Items in the glossary are in bold red on first mention (outside the introduction). There is a separate glossary of neuroanatomical location terms, with entries in the text in bold black italic, a glossary of common neurotransmitters with entries in non-bold red, and a glossary of neurotransmitter structures with entries in bold black. Other important technical terms whose scope is usually confined to one chapter are in italics. There is also a list of abbreviations and acronyms.

Online Resources

The field of consciousness research is fast changing and the reader will want a way of keeping up to date with what has happened since the book's publication. There is, of course, also far more material than can be presented in one book. In an attempt to deal with these issues, there is a website for this book at: www.trevorharley.com/consciousness.html.

Under *Consciousness* you will find corrections, additions, comments, news of recent work, informative reviews of other books on consciousness, and frequently asked questions.

One of the most difficult decisions for the writer is how many citations to include. If absolutely everything is referenced, the book will be enormous and the flow disrupted at least once a sentence. On the other hand, every statement must be obviously true or easily verifiable by the reader. If you think a particular assertion needs additional clarification or verification please email me. More generally, an enormous number of resources are available online. The number of blogs on consciousness alone is daunting, but the difficulty with blogs is that unlike journal articles they are not peer-reviewed. I have posted links to some of them on my website.

Some instructors will think this topic should be in and that topic should be out. If you think a particular topic should be covered, please contact me. If you think I should cite particular research, again please just email me. I hope that as time passes new research will overthrow old ideas and give us fresh understanding.

Organisation and Coverage

The early chapters focus on what consciousness is. After giving the matter some thought, I decided to put a chapter on machine and animal consciousness relatively early on. I think students new to the subject matter will find this discussion enhances their understanding of the nature of consciousness. In general, I have made each chapter as independent as possible, so the order of material can be determined by the instructor. I suggest though that the first three chapters be covered first.

The chapters are grouped into three parts.

Part I is on the nature of consciousness. We try to come to grips with what consciousness is.

Chapter 1 surveys the field of consciousness, explaining why it is such a difficult subject to study. The chapter summarises the whole book. The conclusion is that the 'problem' of consciousness is really several related problems.

Chapter 2 discusses the relationship between the mind and brain – a relationship that some have viewed as between hardware and software. This chapter is mainly a philosophical one. It is essential reading if you want to appreciate what the problems are, and how they might be solved. The focus is mainly on what has been called the 'hard problem' of consciousness: why does it feel like something to be me? This chapter summarises the main philosophical approaches to consciousness in the philosophy of mind.

Chapter 3 addresses the problem of free will. It asks who is making decisions about when to do something. It also examines the legal implications of this discussion; if we don't have free will, can we really be held responsible for our actions? Can we ever really be guilty

of a crime? The chapter covers philosophical, psychological, and neuroscientific approaches to deciding to act.

Chapter 4 is the first of two about other types of consciousness. Could a computer or robot ever be conscious? How would we tell? Are there any ethical issues or fears associated with machine consciousness?

Chapter 5 talks about awareness in animals, asking this time how we might tell that an animal is self-aware. What are the ethical issues concerning possible consciousness in some animals? A related issue to animal consciousness concerns the evolution of consciousness. Why are some animals conscious (presumably) but not others, and why did consciousness evolve in humans? How is the development of consciousness related to the development of human consciousness and of social groups and organisation?

Part II is about the workings of consciousness. How does consciousness arise from the brain, and how is it related to cognitive and perceptual processing?

Chapter 6 examines introspection and what we can learn about consciousness. What do we think about? What are the contents of consciousness? We think we know all about our own consciousness because it is so immediate, but psychologists understand that appearances are deceptive. Our behaviour is prone to all sorts of bias and self-deception. Some illnesses and damages to the brain have interesting and revealing effects on our abilities to access information about ourselves. This chapter also examines Freud's conception of an actively repressed unconscious and his theory about the structure of the mind. The chapter concludes with an examination of subliminal processing and priming.

Chapter 7 is about the self and our views of our own identity. Do we have a stable identity that persists over time? Is there a core 'me'? The chapter focuses on the contrast between ego and bundle theories of the sense. The text examines various illusions that show how the self can be misled about what it is, which leads into a discussion of how brain damage can disrupt our identities. In particular, the chapter explores the extent to which we derive our sense of self from our memories and what happens when our autobiographical memories are extremely disrupted by brain damage. Again, we focus on the neuroscientific basis of our sense of self.

Chapter 8 focuses more on the cognitive psychology of consciousness. We are 'thinking' all the time we are awake, but what is thought? Many of us experience an inner voice commenting on our experience. Where does this inner voice come from, and how is it related to other language systems? We examine whether the form of our language affects the way in which we think and perceive the world. 'Attention' is an important topic in cognitive psychology and is clearly related to consciousness, but as the chapter shows, attention and consciousness are not the same thing. The text discusses the neuroscience of attention and particularly the idea that there is a 'default mode' network busy when we are doing nothing else – a system that generates daydreaming. The chapter presents several models of consciousness that emphasise cognition. Finally, we look at accounts of consciousness involving quantum mechanics.

Chapter 9 takes a look at the closely related topics of the relationships between visual perception, visual awareness, the brain, and consciousness. A great deal of research has been done on visual awareness. What have we learned from all this research?

Chapter 10 examines in detail the key question of how consciousness is related to the brain. At first sight we might need look no further than how anaesthetics function, but as we shall see, although the workings of anaesthetics are instructive, they provide no definitive answers. We can learn a great deal by examining how damage to the brain affects consciousness. We can also learn something with new techniques of imaging the brain, although some caution is needed in drawing conclusions from these results. Several models of consciousness and the brain are discussed in this chapter. It looks at death, the end of consciousness. Or is it? Is there any continuation of consciousness after death? And how should we define death in the first place? Is death a sudden or lingering process, and what affects the duration of any transition from consciousness to death? Is it possible to avoid death?

Part III is about states of consciousness other than normal waking consciousness – what are called 'altered states of consciousness', including sleep, dreams, hypnosis, and drug-induced states.

Chapter 11 introduces the notion of an altered state of consciousness, a state of consciousness that is in some way different from our normal waking consciousness. We consider what happens to make the state of consciousness seem altered: how do changes in the brain lead to changes in phenomenology? This chapter looks at a range of altered states with different origins, such as sensory deprivation and out-of-body experiences.

Chapter 12 looks at that most familiar altered state, sleep, in which consciousness is largely absent. The mechanisms that control the sleep–wake cycle are likely to reveal much about what maintains wakefulness and consciousness. We look at brain structures, the connectivity of the brain, and neurotransmitters. The chapter also examines the effects of sleep deprivation and sleep disorders. Finally, we ask why we sleep, and to what extent is sleep involved in learning?

Chapter 13 examines the related topic of dreams. Dreaming is the altered state of consciousness with which everyone is most familiar. What do people dream about, and why do we dream? The subject of dreams is naturally a time to revisit Freud, but there are many other accounts of dreaming, and they are not necessarily contradictory. We ask how the brain generates dream content, and we examine dream pathology – the nightmare. We also consider lucid dreaming, when people are aware that they are dreaming and can sometimes influence dream content.

Chapter 14 discusses hypnosis. There has been much debate among psychologists and psychotherapists about whether hypnosis is indeed an altered state of consciousness, and this chapter examines the debate and the evidence. How do we induce hypnosis, and why are some people more easily hypnotised than others? We look at how post-hypnotic suggestions work, and what the clinical applications of hypnosis are. And we also address the issue of whether people can be hypnotised to do things they don't want to do.

Chapter 15 reviews the effects of psychoactive drugs – drugs that influence our mental state. There are a huge number of such drugs with many different effects – some synthesised, some naturally occurring, some used as medical treatment, some for recreation, some legal, some illegal. This chapter focuses on those drugs that tell us the most about consciousness, particularly LSD. The key question is, how do changes to the brain (particularly the chemistry of the brain) lead to changes in perception and consciousness? We look at

what the study of psychoactive drugs tells us about 'normal' consciousness. Also included is a brief discussion of the social context of these drugs, looking at how recreational drugs might have helped shape cultural changes.

Chapter 16 examines meditation. What is meditation, and does it work – and, if it does, how? An overwhelming amount of evidence suggests that regular meditation is beneficial in a large number of ways, and this chapter considers these. The chapter also examines the related idea of mystical and religious experiences. The chapter concludes by asking whether there is a state of consciousness that is in some way 'better' than our normal resting state, or at least a 'heightened' state of consciousness.

Chapter 17 reviews the existence of paranormal phenomena, and the methodological difficulties involved in testing for them. What is the evidence for extrasensory perception and related phenomena? And what if anything does the subject tell us about consciousness?

Finally, Chapter 18 revisits the questions posed at the end of the first chapter and summarises what we have learned.

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I have many people to thank for this book. Several anonymous reviewers have improved the book immeasurably. The discussion of artificial intelligence has benefitted from years of argument with Richard Loosemore.

This book would not have happened in this form without the enthusiasm and encouragement of Allan Hobson. I am grateful for his generosity, hospitality, experience, knowledge and enthusiasm. I am conscious of the fact that he won't always approve of the approach I have taken, but nevertheless, Allan, this book is for you. Numerous other people helped. Matthew Bennett of Cambridge University Press (CUP) got the project rolling, and I am grateful to CUP for all their help and particularly their patience. I would like to thank Lisa Pinto for all her guidance and patience, and Linda Stern for all her detailed comments and hard work; I hope you think it has paid off. Jane Adams has been a superb editor. Particular thanks are due to Rachel Norridge for the extraordinary amount of time and help she has given me. I have had many conversations over many years with Richard Wilton about many of the topics in this book. We have recently written a book together (*Science and Psychology*), which has a chapter about consciousness and another about free will, and I am sure my current approach to the legal issues surrounding free will has been influenced by cowriting the latter chapter in particular. Frank John Snelling read chapters as an 'intelligent lay person', and his comments on what he found difficult or needing definition were illuminating.

Finally, here is a word of consolation. The study of consciousness is difficult; if you find it hard going at times, it isn't just you. It's right up there in conceptual difficulty with quantum mechanics and relativity. And more difficult than rocket science and brain surgery.

ABBREVIATIONS

ACC	Anterior cingulate cortex
AI	Artificial intelligence
AIM	Activation input modulation
APA	American Psychological Association
ASC	Altered state of consciousness
ASPD	Antisocial personality disorder
AVH	Auditory verbal hallucination
CBD	cannabidiol
CN	Caudate nucleus
CSF	Cerebrospinal fluid
CLIS	complete locked-in syndrome
DBS	Deep-brain stimulation
DCH	dynamic core hypothesis
DID	Dissociative identity disorder
DLPFC	Dorsolateral prefrontal cortex
DMN	Default mode network
DMT	N,N-dimethyltryptamine
DN	Default network
DSM	The American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders
EEG	Electroencephalogram
ESM	Experience sampling method
ESP	Extrasensory perception
fMRI	Functional magnetic resonance imaging
fNIRS	functional near infrared spectroscopy
GWT	Global workspace theory
GESP	a general extrasensory perception
HPPD	hallucinogen persisting perception disorder
IIT	Integrated information theory
LIFG	left inferior frontal gyrus
LRE	life review experience
LIS	Locked-in syndrome
MAOI	Monoamine oxidase inhibitor
MEG	Magnetoencephalography
mPFC	Medial prefrontal cortex
MCS	Minimally conscious state
MRI	Magnetic resonance imaging
ms	Millisecond, 1/1000 th of a second
MSR	Mirror test of self-recognition

MVPA	multi-voxel pattern analysis
NCC	Neuronal correlates of consciousness
NDE	Near-death experience
NREM	Non-rapid eye movement sleep
OBE	Out-of-body experience
OCD	Obsessive-compulsive disorder
OFC	Orbito-frontal cortex
PCC	Posterior cingulate cortex
PCP	phencyclidine
PET	Positron emission tomography
PK	psychokinesis
PGO	Ponto-geniculo-occipital
POSTS	Positive occipital transients of sleep
PPC	posterior parietal cortex
PTSD	Post-traumatic stress disorder
PVS	Persistent vegetative state
REM	Rapid eye movement (sleep)
REST	Restricted environmental stimulation therapy
RP	Readiness potential
SCN	Suprachiasmatic nucleus
SSRI	Selective serotonin re-uptake inhibitor
SWS	slow-wave sleep
TUTs	task unrelated thoughts
TST	threat simulation theory of dreaming
THC	Tetrahydrocannabinol
TLE	Temporal lobe epilepsy
TMS	Transcranial magnetic stimulation

PART I

THE NATURE OF CONSCIOUSNESS

1 THE PROBLEM OF CONSCIOUSNESS

This chapter will introduce you to consciousness and its most important characteristics. We will look at definitions of consciousness, and examine what it means to say that consciousness is a private experience. We will look at the idea that it is like something to be you or me. The chapter mentions ideas and themes that will be covered in more detail in the rest of the book, and explains why the topic is an important one.

Research on consciousness is big on questions but shorter on answers. Nevertheless these questions are central to what it means to be human, or indeed at the heart of what it's like to be anything – what it's like to be conscious.

Think of yourself just now. What does it feel like to be you right at this moment? Think of a loved one. What do you think it is like to be them? Do they know exactly what they're feeling, and do you know just what they're feeling? We might have some idea, but the answer in both cases is no, and not only 'no', we can't see how we ever could know for sure. It's *my* consciousness and *your* consciousness.

Why Study Consciousness?

The study of consciousness is the study of what it means to be us. We perceive the world (or at least we think we do) through the lens of our consciousness. And how can we understand the universe if we don't understand how we experience it?

What is consciousness and how does it arise are two of the fundamental questions of science, along with others such as 'what is life?' and 'where did the universe come from?'.

The study of consciousness is at the limit of our understanding of natural science. For some researchers the gap between our understanding of consciousness and the laws of physics is so large that they think physics must either be incomplete, or that understanding consciousness is beyond physics.

Consciousness and Psychology

The study of consciousness is a unifying topic in psychology because consciousness links research on attention, executive processes, working memory, perception, decision making, and language. We think of consciousness as the result of all the processing that goes on in the mind. For example, when perceptual processing of an object is complete, it enters visual awareness. Is this view that consciousness is the last stage of processing correct?

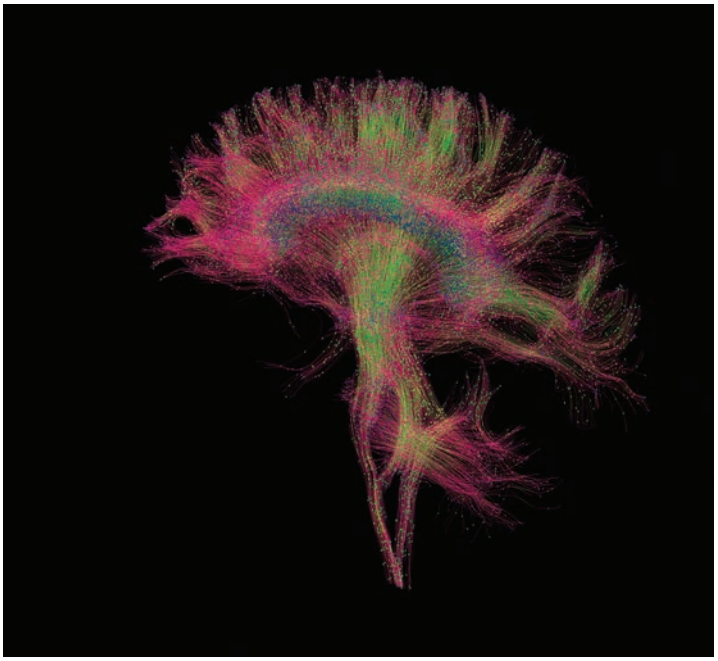

Figure 1.1 Diffusion tensor imaging is at the cutting edge of techniques available for imaging the living brain, and produces spectacular (and useful) images such as this one. Source: Callista Images/Cultura/Getty Images.

Figure 1.2 Democritus (c. 460–c. 370 BCE). Democritus was a Greek philosopher who argued that all things were made of 'atoms', with the motion of atoms determined by causal laws. There was no place for chance or choice in his scheme of things. Source: De Agostini Picture Library/Getty Images Plus.

Consciousness and Neuroscience

The search for the seat of consciousness in the brain has shown how parts of the brain are connected, and how information flow between these parts gives rise to consciousness. Neuroscience research on consciousness has advanced our understanding of how psychological processes are underpinned by brain systems, and how normal psychological processing depends on the delicate balance of many systems in the brain. It shows what can go wrong and what the results of dysfunction are. Some of the most exciting neuroscience research is currently being carried out on topics related to consciousness (see Figure 1.1).

Consciousness and Philosophy

Consciousness is one of the central problems in the philosophy of mind. How can matter give rise to awareness? How can my private experience be explained by the laws of physics?

Consciousness is also entwined with one of the fundamental concerns of philosophical thought, the problem of free will. It seems to me, as I sit here, aware and conscious writing this paragraph in a trendy coffee shop, that I am choosing not to pick up my mug of coffee and throw it on the floor. This choice is my free will in action. On the other hand, if all I am is determined by my genes and my past, and by the history of the universe up to now, that sense of free will is illusory. My future has already determined that I will remain seated here, sipping my coffee, polite, restrained, and demure. I have no choice – a conclusion very counter to my everyday beliefs. Philosophers have been aware of the problems with free will and choice since antiquity (see Figure 1.2), but there is still no widely accepted resolution.

The study of consciousness tells us who we are – or are not. Who is this 'I' that has a choice, or not? When 'you' are deciding to do something, who is the 'you'? Who is in control? We often think of ourselves as watching the world and observing our mental life, as though there is a person with us. We call this little person a **homunculus** (see Box 1.1), but the homunculus idea suffers from the problem of an *infinite regress*. A related idea is that we have permanent 'selfs' that experience things. I think of myself (myself is my self) as being the same person as I remember listening to a piece of music on my fifth birthday. Why do I think that? Does it make any sense to do so? I think of my self as having an identity that persists over time. Where does this notion of 'self' come from? As we shall see, many consciousness researchers argue that the self is an illusion. Research on consciousness will cast light on where our sense of ourselves and of our identities comes from.

Box 1.1 The Homunculus Inside Us

Homunculus means 'little person' in Latin. The idea is that there is a little person inside our heads who observes everything and decides how to act. The idea has its roots in the pre-scientific practice of alchemy. Some version of the homunculus idea is popular among non-psychologists (and some psychologists too): we don't really think there is a little person inside us, but we do have the impression that 'I' am looking out from inside my head at the world. The problem with the homunculus idea is that we have no idea how the homunculus works. Does the homunculus have another homunculus inside it, observing and controlling the bigger homunculus? If so, we have only displaced the problem, and quickly enter an infinite regress of an endless series of homunculi inside each other. The idea pops up in popular culture: the Numskulls was a comic strip in the D.C. Thomson comics the *Dandy* and the *Beano* that showed a team of tiny technicians who lived inside our heads working our senses and brains. But what ran the brain of the Numskulls? A team of even smaller Num-Numskulls?

The study of consciousness has implications for society. If we don't have free will, there are important consequences for how we view individual responsibility. If I had no alternative other than to rob a bank, why should I be punished for the crime?

Consciousness and Spirituality

Consciousness is the bridge between science and the humanities. Why do you find a particular piece of music moving, or a piece of art beautiful? Can you imagine a computer appreciating beauty or justice, and why not? Science does not tell us how to behave, while ethics in philosophy describes ways of living, and does suggest how we should behave. But what would such injunctions mean without consciousness?

Our consciousness is intimately involved with our *spirituality*, our deepest values and our sense of things beyond science. What do we find spiritual, and what creates these feelings of spirituality? You may meditate, or attend church, or practise a religion in some other way, and feel that some experiences are richer or on a higher plane than everyday

Figure 1.3 The way in which religions are practised varies across the world. Here, Buddhist nuns practise kung fu at the Amitabha Drukpa Nunnery on the outskirts of Kathmandu. Source: AFP/Getty Images.

experience (see Figure 1.3). Or you might have experienced some unusual state, such as feeling that your mind has left your body. Some people have taken drugs to 'expand' their consciousness; what, if anything, does this statement mean? What is the relationship between these different states of consciousness?

The study of consciousness also informs what happens when we are not conscious, including when we are asleep, when we are in a coma, and when we are dead. Is sleep merely the absence of consciousness? What happens when we are dying, and afterwards?

The study of consciousness informs our search for meaning in life. However, being conscious can be sometimes seen as a curse; as the Danish philosopher Søren Kierkegaard (1813–1855) put it in 1844:

> What does it mean to be a self-conscious animal? The idea is ludicrous, if it is not monstrous … It means to know that one is food for worms. This is the terror: to have emerged from nothing, to have a name, consciousness of self, deep inner feelings, an excruciating inner yearning for life and self-expression – and with all this yet to die. (Kierkegaard, 1980)

Without consciousness there would be no pain, but neither would there be pleasure, joy, beauty, or love. And it's one of the most fascinating topics in science, and a topic that bridges science and the arts. Those are pretty good reasons to study it.

How We Study Consciousness

The scientific study of consciousness was once the sole domain of philosophers, but is now an interdisciplinary affair. For some time the study of consciousness was thought to be not quite respectable. I'm not sure whether the word 'consciousness' was used at all in my undergraduate degree in psychology at Cambridge (although that was a long time ago). Fortunately, that has changed, and consciousness is being studied by a coalition of psychologists, philosophers, neuroscientists, surgeons, computer scientists, and anthropologists. We call the research carried out by this joint enterprise of cognitive scientists *consciousness studies*.

One way of finding out about consciousness is simply to think about what you're experiencing. After all, you're conscious right now, so why not just consider what's going inside your mind? Surely that act more than anything else will tell us about consciousness? This process of observing ourselves and reporting on our experience is called **introspection**. Introspection has its uses, but it's not always that reliable. By definition, we can only introspect upon what we're conscious of at the time. Our knowledge of ourselves is limited,

and we are often not aware of our limitations, as shown by the work of psychologists such as Daniel Kahneman (2012) on human reasoning. For example, when we make judgements about things such as spending money, we think we're making a reasoned judgement, but in fact we're influenced by all sorts of biases and prejudices of which we are mostly unaware. For example, we're usually strongly averse to taking risks. We might not actually be conscious of very much at any one time, but everything else of which we are not conscious might nevertheless be influencing us. So when we introspect and report on the contents of our consciousness, and think about why we're behaving in a certain way, our picture is at best incomplete, and occasionally quite wrong. We'll look in detail at the limits of introspection, and how difficult it is to know our own mind, in much more detail in Chapter 6.

So, to study consciousness, we must use a range of methods. Along with philosophical analysis, we carry out psychological experiments that measure some variable we think is associated with consciousness, and observe the effect of our experimental manipulations on that variable. We then make an inference from our results to construct a theoretical model of what is happening.

Scientific Experimentation

Psychology and neuroscience are experimental sciences (see Box 1.2 and Box 1.3), which means that typically we manipulate independent variables (such as the length of a word) and observe the effect of these manipulations on a dependent variable (such as how long it takes to name that word). Consciousness research is difficult because there is no way yet known of measuring consciousness, and so it is difficult or impossible to turn it into a dependent variable. There is no 'consciousnessoscope' that we can put on our heads and read out a number for how conscious we are, what we're really thinking, or what we're experiencing just now. This difficulty sometimes motivates pessimism about how far we can get with studying consciousness. But even if we cannot (yet) measure consciousness directly, we can measure variables that we assume are dependent on or related to consciousness, such as a verbal report of something, or a judgement about ourselves or the world.

Box 1.2 The Role of Falsification in Science

Science is a method of gaining knowledge about the world. We use the scientific method when we collect data about the world and construct theories to explain those data. Data is anything we can measure. Science is concerned with controlled observations, which involves making comparisons where as few things as possible are left to chance.

Theories then lead to novel predictions, which we can then test against more data. If the predictions are verified, then the theory is supported and gains in strength; if the predictions are wrong, then the theory has to be revised in some way. The eminent Austrian-British philosopher of science Sir Karl Popper (1902–1994) argued that science should proceed by *falsification*: instead of trying to prove our theories, we should be trying to disprove them (see Figure 1.4). It's only by finding that our predictions are wrong that science progresses and theories are overturned. We rejected Aristotelian physics because its predictions turned out to be wrong once experiments were carried out. We found that the velocity with

Box 1.2 (cont.)

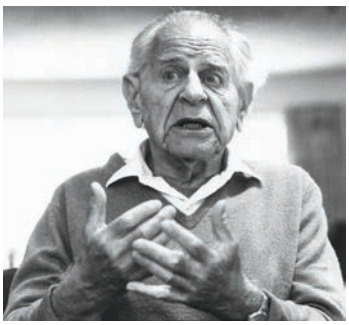

Figure 1.4 Sir Karl Popper (1902–1994). Karl Popper was an Austrian-born philosopher who for many years was professor of logic and scientific method at Imperial College, London. Popper argued that science proceeded not by verification (proving things right, which is impossible), but by falsification – trying to disprove a theory. Source: ullstein bild/Getty Images.

which different objects travelled when dropped from the same height does not depend on the objects' weight, and that bodies in motion carry on in a straight line without decelerating if no other forces acted upon them. Newtonian mechanics gave a much better account of the world.

Although falsification is important, science doesn't always progress by rejecting falsified theories. There are two main reasons for this pattern. First, if a theory has done very well, people are understandably reluctant to reject it altogether and go back to scratch and design a whole new theory just because one prediction is falsified. Perhaps the whole theory isn't wrong, but just one of the assumptions we have made along the way? So when we drop a feather and a heavy ball from the top of a tower, and observe the feather floating down as the ball plummets, we don't reject Newtonian mechanics. Instead we think about factors such as air resistance, and realise that it's our assumption that the medium through which the objects are falling doesn't matter that is wrong, not the whole theory. Second, we have to make measurements to collect data. Perhaps our measurements or our observing devices are wrong. If I look at a section of a brain through a microscope, and see a perfectly circular black object in it, it's most unlikely that I'm observing a new brain structure that has amazingly been missed for centuries – and far more likely there's a mark on my microscope lens.

Box 1.3 The History of Neuroscience

Neuroscience is the scientific study of the nervous system, with cognitive neuroscience being the study of how the nervous system and associated biological processes underlie cognition.

For a long time, the only available means of studying how the brain is related to human behaviour was an autopsy performed on a person with brain damage; we observed the effects of damage while the person was living, and then later found out which parts of the brain had been damaged. In some cases, researchers could estimate which parts of the brain were affected by examining the location of the injury (such as the position of the blasting rod that perforated the brain of the American railway worker Phineas Gage in 1848; see Chapter 7 for more detail on his case). Neurosurgical operations told us exactly which parts of the brain had been damaged. For example, in *split-brain* patients, we knew that the only significant damage to the brain was to the body of nerve fibres called the **corpus callosum** that connects the two cerebral hemispheres, and then conducted experiments to see which aspects of behaviour changed as a consequence of this damage. We could also extrapolate from animal studies, although obviously some caution is necessary in linking

Box 1.3 (cont.)

animal studies to human models, particularly given animals do not use language, and the degree of self-awareness is limited and questionable.

More recently non-invasive techniques of brain imaging have enabled scientists to examine the structure of the brain and measure its electrical activity while working. The biggest revolution has come from a technique known as *functional magnetic resonance imaging* (fMRI), which allows us to observe what different parts of the brain are doing in real time, with reasonable spatial and temporal accuracy. The earliest scientific studies on humans were carried out in the early 1990s, but as the equipment has become cheaper and more accurate, and the skills necessary to carry out the research more widespread, the use of fMRI is widespread.

As with any technique, the use of imaging requires some caution. First, the brain is always doing more than carrying out the specific task under consideration, so methods are necessary to isolate the task of interest from the background noise. Second, these techniques do not measure neural activity directly, but do so through some intermediate measure, such as oxygen uptake (Lilienfeld et al., 2015). Third, at present there is something of a tradeoff between physical and temporal resolution (see Figure 1.5). Finally, we need to remember that knowing where and when something is happening might not tell us exactly what is happening. Nevertheless there is no doubt that psychology is a very different subject from 30 years ago, and our understanding of behaviour and the relationship between the brain and behaviour has advanced enormously.

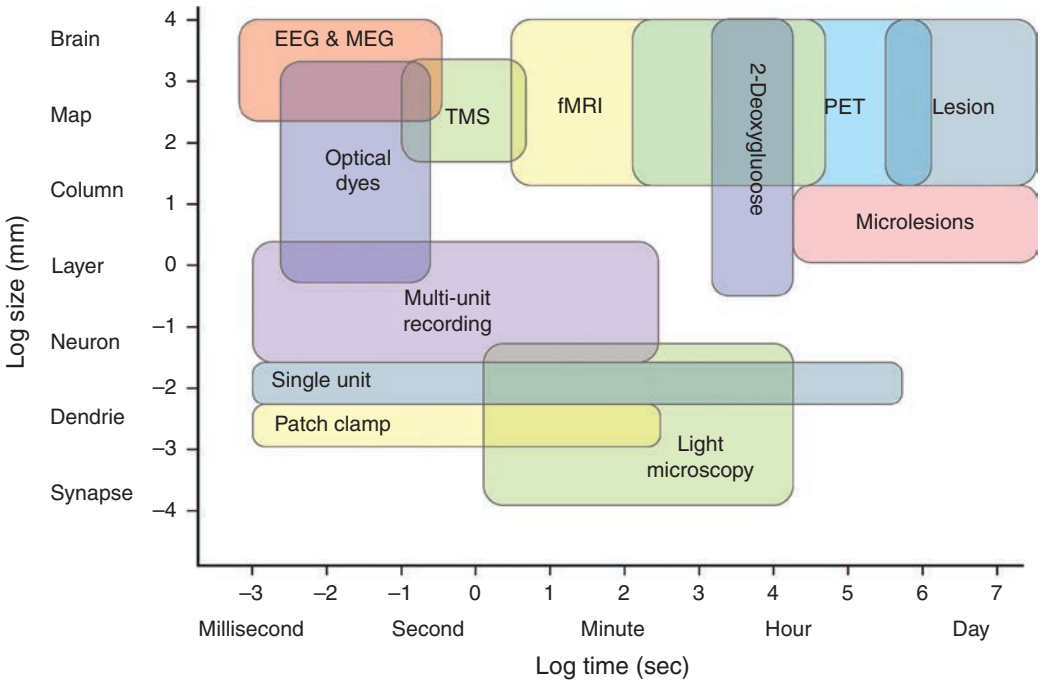

Figure 1.5 The spatial and temporal accuracy or resolution of various neuroscience investigatory techniques. The *y*-axis is size and *x*-axis time; the scales are logarithmic, meaning each tick on the axis is 10 times more than the preceding one. See text and glossary for the meaning of abbreviations.

Psychology and the study of consciousness has advanced rapidly with modern developments in techniques of brain imaging. Until not too long ago, the only way of looking at a brain was to wait until a person died and then carry out an autopsy, and even then a chain of inference was necessary to relate brain functions to psychological processes. Imaging enables us to look at the living brain, and modern functional imaging enables us to look at what the living brain is doing. Other techniques enable us to influence what the brain is doing, so for the first time we can see what is happening in the brain as we think and make decisions.

There are though a few caveats we should bear in mind. The first is that brain-imaging techniques are still restricted in what can be done: at the moment it takes a relatively long time to take measurements that are highly spatially accurate, so the *temporal resolution* of brain imaging is presently not that accurate. Other techniques that are more accurate in identifying when things are happening currently have relatively poor spatial resolution, and so at the moment there is a tradeoff between temporal and spatial accuracy (see Figure 1.5). The machines are still big and noisy, so it's going to be difficult (but not impossible) to test people when they're sleeping and dreaming, say. Of course, all these limitations will probably disappear, hopefully sooner rather than later. The second caveat is more important: we are not measuring consciousness directly, but what is going on in the brain, and as the only access to consciousness is through a person's verbal report, or some other indirect measure of what is happening, the best we can do is correlate our imaging data with aspects of consciousness. Furthermore we are not measuring brain activity directly, but some correlate of it, such as oxygen uptake. Nevertheless, the techniques are a huge advance in what has previously been available, and are in part responsible for the scientific study of consciousness being taken more seriously than it has previously been.

Another way of studying the relationship between the brain and consciousness is to examine the effects of brain damage, by injury, stroke, or surgery, upon consciousness. The effects of damage to the brain vary depending on exactly which parts of the brain are damaged, and by how much. We shall see that the study of brain damage reveals a great deal about the nature of consciousness. These neuropsychological studies are now often combined with imaging so that we know exactly which parts of the brain are damaged.

Philosophical Thought Experiments

Philosophy is the study of fundamental problems concerning the nature of knowledge, what exists, the nature of the mind, and the nature of values. In this book our primary concern is the sub-discipline known as the philosophy of mind. One of the most important weapons in the armoury of the philosophy of mind is the **thought experiment**, in which we consider some hypothesis or situation, and think through the consequences to what we think is a logical conclusion. Science is characterised by experiment, but thought experiments deal with scenarios that are impossible, or at least very difficult, to construct in reality, at least now. The idea is that the thought experiment reveals our prejudices, or shows how our prejudices lead us to surprising conclusions. A good thought experiment clarifies the problem and our assumptions. We will meet many in the next few chapters, including the China brain and Mary the clever neuroscientist.

Artificial Intelligence

Another way of investigating consciousness is to try to build it. Is it possible that a computer or robot could be conscious? Or is consciousness for some reason restricted to biological systems? Supposing we could build one, what would be the characteristics of a conscious machine – would we be able to say exactly what it was that we did to make the computer conscious, or would artificial consciousness be as baffling as human consciousness? Crucially, how would we tell if the computer was conscious or not? In the *Terminator* series of films (Cameron, 1984), the artificial intelligence (AI) SkyNet launches a nuclear attack on humans in an attempt to defend its self-awareness: if we do construct a sentient artificial intelligence, would we have anything to fear from it? Could we limit its powers so that it poses no threat?

As well as constructing an artificial intelligence, we could construct machines that move and interact physically with the world; such machines are better known as **robots**. Robots can be made to look more like humans, but appearances can be deceptive. How important is being able to interact with the world for the development of consciousness?

Although well beyond our current capability, we could aim to learn about psychology, neuroscience, and consciousness by trying to build a brain (see Figure 1.6). Attempts at doing so are already well underway, and to date we have attained large-scale models containing millions of nerve cells, or **neurons**. There are two ways of approaching the problem: simulating neurons, or building artificial neurons, with the first slower but currently easier. In a similar vein, we could augment, or 'upgrade', our brains with specialised components, ranging from very simple capabilities (fancy a GPS chip?) to much more wide ranging (such as more memory). What are the implications for consciousness of such changes?

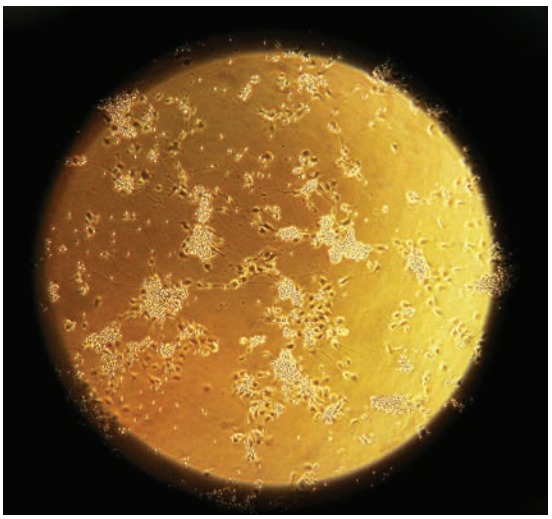

Figure 1.6 Growing brain cells. A magnified view of mouse stem cells producing new neurons at a neuroscience lab at the Stanford Medical School. Building a biological brain depends on being able to grow nerve cells. Source: MediaNews Group/San Mateo County Times via Getty Images.

Defining Consciousness

The British psychologist Stuart Sutherland once famously defined consciousness as: 'a fascinating but elusive phenomenon: it is impossible to specify what it is, what it does, or why it has evolved' (Sutherland, 1989).

Sutherland goes on to say that nothing worth reading has been written about it. I hope that, if nothing else, this book shows that this statement is no longer true. It is true, however, that consciousness is difficult to define. It's one of those things that you know when you see it.

TRY THIS: Defining Consciousness

You probably think you know what consciousness is, so how would you define it? Then use a search engine to find some definitions of consciousness. How do they compare with your own?

Definitions of Consciousness

Consciousness is our experience of being us here now. It's what is lost when we are in a dreamless sleep and what returns next morning when we wake up (Tononi, 2004; Tononi & Edelman, 1998). Consciousness is permanently lost when we die, but as we shall see in Chapter 10, this statement also leaves plenty of room for discussion.

The American philosopher Thomas Nagel (1974) proposed that an organism is conscious if there is something it is like to be that organism. There is something it is like to be you reading this text at the moment; you will almost certainly think that there is something it is like to be a robin hopping around the garden hunting worms; but presumably you will think it is like nothing to be a laptop or lump of rock (see Gallagher & Zahavi, 2012).

We can further distinguish consciousness, which is equivalent to **awareness**, the experience of perceiving a sensation of some sort, from **self-consciousness**, which is awareness of our own awareness or consciousness.

Vimal (2009) reviewed the various meanings of the word consciousness used in the research literature, and identified 40 distinct meanings. He concludes that 'consciousness can be optimally defined as a mental aspect of an entity (system or process) that has dual-aspect: conscious experience and conscious function. In other words, a system or a process is conscious iff [an abbreviation of 'if and only if'] its mental aspect is conscious experience and conscious function' (p. 17). Note that we have the word 'conscious' in the definition of consciousness!

Awareness

The words 'aware' and 'awareness' crop up consistently in dictionary definitions of consciousness: being conscious involves being aware. When we ask people what they think consciousness is we might be told that it's what it's like to be awake, and it's what it's like to be aware of things. 'Awareness' then is clearly important in our conception of consciousness. Look up the meaning of 'awareness' and you get … 'conscious'. Awareness is the state of feeling or perceiving sensations (Cohen & Dennett, 2011).

In addition to being aware, we can be self-aware, in that we can be aware of our being aware. While we think we are aware all the time we are awake, we are only self-aware when we turn our attention to our awareness. And while you may think many animals are aware, is it likely that few if any of them are self-aware? Perhaps self-awareness sets humans apart from other animals? That's an important question and one we'll discuss in Chapter 5.

Notice that we can only be conscious of our own experience. We cannot explain to another person what it is like to be us, and they can't explain to us what it is like to be them. They can't describe the pain they feel in a way that we can feel it. There is something essentially private about consciousness.

We can only be aware of our consciousness now. Of course our consciousness isn't completely trapped in the present because we have our memories, but when we remember something, it is the memory we're aware of, not the original event.

TRY THIS: Observe Your Mind

Whatever you are doing, just observe your mind. What is happening? What are you aware of now? Were you thinking about something in particular? Were you thinking in words, or in pictures? Were you remembering something, or perceiving something? Now can you make yourself aware of something else? Try to hold on to the present moment for as long as possible; how soon is it before you would say things have changed and you're in a new moment? How would you characterise self-awareness, awareness of your awareness?

The Problem of Other Minds

There's something peculiar about our own experience: it's our own and nobody else's. Consciousness is very different to the world outside our heads, which is typically studied by science. There are several ways of describing this difference: we can say that consciousness is subjective, and everything else objective. We have the first-person perspective in our own mental life, whereas science uses the third-person perspective to describe the world. The outside world is public, but our experience is private.

This privacy of consciousness makes its study so difficult. What is it like to be you? Other minds are for ever closed to us. Our experiences are private, and we have no way of sharing them. The problem of other minds is that we have no way of knowing what anyone else is experiencing – I cannot access the contents of your consciousness, or you mine. We cannot truly share our pain. We can use words like 'pain' and 'red' and 'hot' and hope that you mean the same things with them as I do.

In 1974, Nagel wrote a famous paper called 'What is it like to be a bat?'. Bats navigate and find prey by sonar – a different kind of sense to the five human senses (see Figure 1.7). We can guess what it is like to be most other humans because we assume that we all have broadly similar types of experience, but we cannot begin to imagine what it must be like being a bat. A bat perceives the world primarily through a sense we do not possess, echolocation, a form of sonar. The bat emits a sound, mostly in a frequency range beyond the limits of human hearing, and detects the echo. The sense is accurate enough to enable the bats to hunt fast-moving insect prey. Presumably it is like something to be a bat, but we cannot conceive of

Figure 1.7 A bat using sonar. What is it like to be a bat? Source: Danita Delimont/Gallo Images/Getty Images Plus.

it. According to Nagel, we can never really grasp what it is *like to be a bat*; some aspects of 'bathood' are, as McGinn (1989) puts it, 'perceptually closed to us'. There's nothing special about bats – it's just that the differences between us and them are rather more extreme than between us and other mammals. At least that's the standard argument; perhaps we can have some idea what it is like to be a bat – after all, echolocation is a form of hearing, one that humans use to a much lesser extent – but we cannot completely appreciate what it is like to be a bat.

Figure 1.8 Helen Keller with her teacher Anne Sullivan, in 1888. What was it like to be Helen Keller? Source: Bettmann/Getty Images.

Figure 1.9 Meet my miniature poodle, Beau. Does it make any sense to ask what does he think it is like to be Trevor?

We are even limited in what we can conceive about human experience; I cannot imagine what it must be like to be blind from birth, and surely neither can a person who has never seen contemplate what sight must be like. Helen Keller was born in Alabama in 1880; at around 19 months old she contracted an illness, possibly scarlet fever or meningitis, that left her deaf and blind. When she was seven years old she started to learn to communicate through touch with her teacher, Anne Sullivan (see Figure 1.8). What would the experience of Helen Keller have been like before that moment of contact? Even after that in what ways would her experience be similar and dissimilar to ours? Keller's story is remarkable: she lived until the age of 88, and was the first deaf-blind person to obtain a degree in art.

Finally, meet my dog, Beau (see Figure 1.9). He's a miniature poodle, just over two years old. We'll consider his point of view a few times in the book. Beau is an interesting case: I know him extremely well. We are very close. I am sure he's conscious and I think at times he's self-conscious. He knows a few words of language (such as the name of all of his toys), but doesn't to my knowledge understand syntax, the details of word order. He perceives the world differently from me – his sense of smell is 300 times more sensitive than mine. I think I know something of what it is like to be Beau, although I am less sure what he thinks of me. Does he just think of me as a big dog? That part of him is closed to me.

The Hard and Easy Problems of Consciousness

The Australian philosopher David Chalmers called the central problem of consciousness, that of how phenomenal awareness arises in a physical world, the **hard problem**. Another way of putting it is by asking how do the objective processes studied by science, particularly the physical structure of the nervous system and brain, give rise to subjective experience? The hard problem is sometimes phrased in terms of the **explanatory gap**, which is the difference in our ability to explain physical properties of the universe with physical laws and our inability to explain mental properties. The hard problem is the problem we have in bridging this gap between mechanistic laws and feelings and experiences.

In contrast to the hard problem, the easy problems are everything else we want to know about consciousness. They're questions about psychological processes, such as what's the difference between being awake, asleep, or being in a coma, how do vision and the other senses work, how do we plan for the future and control our behaviour, what are the processes that control how we sleep and dream, what is attention, how do we access memories, how do we access and report our internal states, how do drugs affect us, how do we decide to act and move, how does brain damage alter cognitive processing, what can we report about our own mental processes, and many more. Note that these problems are only easy relative to the hard problem: in spite of a hundred years or more of experimental psychology, our understanding of many of them is patchy at best.

For philosophers such as Dennett (2014, 2018), once we have solved all the easy problems (which he thinks aren't that easy at all), the solutions to the 'hard problem' will either drop out or it will turn out not to be a problem at all. We just don't understand the field of research or the problems properly yet. He also argues that it is a mistake to separate consciousness from its functions, and it is this mistake that leads to there appearing to be a hard problem (Cohen & Dennett, 2011). A similar line is taken by Dehaene (2014), who also argues that the 'easy' problems are in fact the hard one, and our labelling of 'easy' and 'hard' changes as our knowledge of the field evolves. The philosopher Peter Hankins takes a different approach, also saying that the easy problems are actually hard ones, but that the hard problem is impossible to solve (Hankins, 2015).

If this book were about the hard problem alone, it could be a very short book. We have made enormous progress over recent years on the easy problems, but very little on the hard problem, other perhaps than understanding it better. As we shall see, some people argue that we can never, in principle, solve the hard problem. Others think we have as good as solved it, or at least know the way to solve it, while others deny even that there is a hard problem. Others just hope we will make progress one day.

Intentionality: Are We Always Conscious of Something?

'Conscious' is an ambiguous word – in everyday conversation we can use it in different ways. There's consciousness in the sense of awareness that we've just been looking at. You can be 'conscious of the time' – meaning that you are aware of the time and that the clock is ticking. We might also say something like 'I'm conscious that you need money.' In this sense of consciousness, we're conscious of something.

This point is an important one: consciousness when used this way is about or directed towards something. In fact, consciousness always seems to be directed towards something. We are always aware of something. We are conscious of our thoughts, or sensations coming in from the outside world, or of our body, and perhaps all of these at once. It seems impossible to be completely empty headed. Even if you try to think of nothing, that nothing becomes the something that consciousness is directed towards. The idea that consciousness is about something is called **intentionality**. Although the idea is an old one, it is most associated with the German philosopher Franz Brentano (1838–1917). Brentano was one of Sigmund Freud's PhD supervisors, and his ideas influenced early psychoanalysis and hence our later conception of the unconscious. Brentano (1874) said that intentionality is one of the major characteristics of thought and consciousness. Thoughts are always about something, and we can't just be aware; we are always aware of something, even if it is just being aware. Consciousness has content.

There are limits on what we can be conscious of. You can't be conscious of your digestion. Occasionally you might hear an embarrassing rumble, or be aware of indigestion, but these are side effects of digestion acting on the nervous system. But the processes of digestion themselves are completely opaque to us. Getting closer to home, when we accidentally stab ourselves with the rose thorn, we are conscious of the pain, but not of the nerve cells that carry that pain, no matter how hard we might try to think about them.

TRY THIS: Being Conscious of Nothing

Try to be conscious of nothing at all. Empty your mind. Do you think it is possible to be conscious without being conscious of anything? If you think it is, how do you know you're not thinking of anything?

Consciousness is also unable to access many psychological processes. When you hear someone say a sentence, you understand it (normally); but you can't make yourself aware of how you understood it. When you're a skilled driver or tennis player, the processes involved are automatic. Indeed, focusing on skilled performance can cause problems: if a skilled tennis player or golf player starts to focus consciously on their movements, performance can deteriorate quite dramatically.

Types of Consciousness

Psychologists and neuroscientists are justifiably proud of the progress they have made in understanding the brain and behaviour and the relationship between them over the last century or so, with the rate of progress accelerating over the last few decades. Many say that they've made huge progress in understanding consciousness as well. But this chapter has examined some of the fundamental problems of consciousness thrown up by researchers, and it should come as no surprise that several people have distinguished between different types or aspects of consciousness.

Phenomenal and Access Consciousness

The American philosopher Ned Block (1995) distinguished between **phenomenal consciousness** and **access consciousness**. Phenomenal consciousness is what we experience: it's what it's like to be us. It's the sensations of perception from the outside, and the

experience of wanting, thinking, and feeling from the inside. It's what we've been talking about mostly in this chapter, and for many understanding phenomenal consciousness is the central 'hard problem' to be addressed. Access consciousness concerns language, thought, attention, the control of action, and reasoning. It concerns what we talk and think about and, importantly, it's what we can report – so it's our thoughts, feelings, and desires themselves (rather than our experience of them) and the representations that are manipulated in cognition. Block uses the abbreviations P-consciousness and A-consciousness. Most cognitive psychology experiments are on A-consciousness, while the *Try This* thought experiments in this chapter have mostly been about P-consciousness. A-consciousness is said to be definable within a computer program, but P-consciousness is not.

To what extent are P- and A-consciousness *dissociable* – that is, can we have one without the other? Normally, Block says, P-consciousness and A-consciousness interact, but in principle they could exist independently of each other. So Block believes that beings could exist that would have A-consciousness but not P-consciousness: for example, we might build a robot that does all the things we do but without phenomenal consciousness. On the other hand, many non-human animals may have P-consciousness but not A-consciousness; they have experiences but the experiences are not involved in cognitive processing, so they have experiences but not the sense of themselves experiencing anything. What this statement means in practice, and how we could tell for sure, are difficult to evaluate.

Block's division is controversial because P-consciousness is, by definition, non-computational – only A-consciousness can be manipulated symbolically. That is, it takes A-consciousness to solve a maths problem or write a sentence. Block (1995) stresses the importance of introspection, our ability to look into our own minds, and states that only events that are available to introspection can be manipulated symbolically. Furthermore, if we accept this type of distinction, we must also accept that sensations arise from non-computational mechanisms, an idea some researchers find unpalatable (see the Block, 1995, target article for many peer critiques of his ideas). Others take issue with the access–phenomenal distinction for how it accounts for partial awareness (Kouider et al., 2010; but see Block, 2005, for a differing view).

Another problem with this distinction is that many people feel P-consciousness is all we normally mean by consciousness; what Block calls access consciousness, while important for psychology, isn't really anything to do with consciousness. On the other hand, some researchers believe that everything can be explained by A-consciousness (Naccache, 2018).

Other Types of Consciousness

Other researchers make similar types of distinction as Block's between phenomenal and access consciousness. The Nobel Prize-winning American biologist Gerald Edelman distinguished primary consciousness, which is the awareness of the present arising from the binding together of information from different senses and the integration of the senses with recent memory, from secondary consciousness, which is awareness of our consciousness and the ability to access our thoughts, plans, and memory. Secondary consciousness enables us to manipulate our own thoughts and carry out abstract reasoning (Edelman, 2003).

What all these attempts at categorisation show is that we are aware that we need to make certain distinctions – between awareness and non-awareness, between awareness and self-awareness (awareness that we are aware), between feeling and emotion, and between living merely in the present, having a memory for the past, and a sense of the future. The lack of agreement in these divisions shows that we do not know how best to carve up the space of consciousness and awareness.

Many people are interested only in core consciousness and P-consciousness, and wonder why we need to be concerned with those peripheral psychological and neuroscience issues such as attention, memory, and vision. For these people (like Chalmers) we should tackle the hard problem head on, in as much as we can, because that's the only important question in consciousness research. On the other hand, for those like Dennett who believe that the hard problem will only be solved by attacking the easier ones, these 'peripheral' problems are the key to everything else.

Degrees of Consciousness

Consider whether you are conscious when you're dreaming. We can have vivid visual, auditory, and sometimes motor experiences. So, we're conscious, but in a way that's clearly different from 'normal' waking consciousness. We are though (usually) unable to reflect upon these experiences; they may be very bizarre, but they don't cause us to stop and think, 'hey, this is weird, this shouldn't be happening; am I dreaming?'. Our ability to influence our actions in our dreams is very limited. What about when we're asleep and not dreaming? Mostly, we say we're unconscious, but even then being unconscious isn't the same as not existing: if there's a loud noise in the room when you're sleeping, you'll most probably wake up.

What about a baby laughing away at some dangling toy? Infants don't yet have language; they don't yet have many memories; they can't move very far; their consciousness must be very different from ours, yet most people would say that they're conscious in some way.

What about a chimpanzee, or your companion animal, or a bird in your yard? They all seem to act as though they're conscious in some way. Most people think that other primates are conscious. Many animals clearly seem to show distress and signs of being in pain. If shown a series of photographs – a human, a picture of an early human, a chimpanzee, a dog, a bird, a fish, a shrimp, an ant, a bacterium, a tree, a rock – and asked which you think is conscious, what would you say? Answers can vary a great deal, but mostly draw the line of consciousness somewhere around fish and ant (Reggia et al., 2015). We have no way of knowing (at the moment) what the answer is, but clearly most people think that consciousness is not limited just to humans. And, as we shall see, people might be being tough on the fish (see Chapter 5).

Clearly the consciousness of babies and dogs is different from adult human consciousness, but does it make any sense to talk about *degrees* of consciousness? Am I more conscious than a dog or a baby? The noted polymath Douglas Hofstadter (2007) thinks so; in his book *I Am a Strange Loop* he presents a hierarchy of consciousness in which he talks about 'more' and 'less' consciousness. Are we more conscious when we're wide awake than

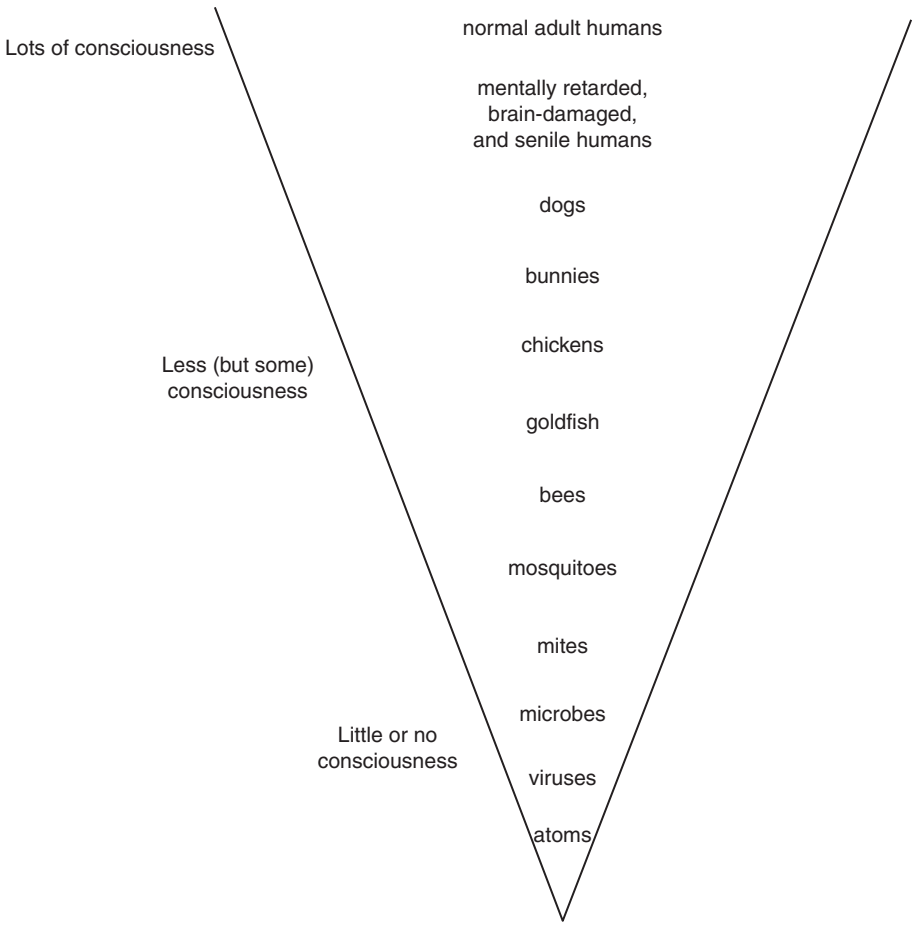

Figure 1.10 Hofstadter's 'consciousness cone'. (with his terminology) Most people think that consciousness is a graded phenomenon: some organisms have 'more' of it than others. Is this lay belief correct? Source: Hofstadter (2007).

when we're dreaming? Hofstadter's proposed hierarchy of consciousness is illustrated by Figure 1.10. Note that there's guesswork involved: maybe some birds are more conscious than some dogs. Who knows? If we talk about 'more conscious', then we are presuming that consciousness has some kind of size dimension that can be measured, and it is most unclear what this dimension should be.

Research on anaesthesia, and on people in comas and with different types of brain damage, also suggests that it makes sense to talk about consciousness as a graded phenomenon (see Chapter 10 for more on this topic). And what about when you're waking up, particularly if you're confused as to when it is and where you are? We say, 'we're not quite awake yet', and that could be taken more literally than we might have intended.

Humans are not just aware of our surroundings, but are also self-aware in that we can be aware of our own awareness – we can reflect on our consciousness. This ability is mostly restricted to normal waking consciousness, because dreaming is usually characterised by a lack of self-awareness and an inability to stop and ask if we're awake or asleep. This apparently infinite regress of being aware of being aware of being aware is an example of what is called **recursion** – when something is defined or uses itself. Some researchers think that the ability to think recursively is limited to humans and is essential for the ability to learn

human language (Corballis, 2014). If this idea is correct then it will be the case that only humans are capable of self-awareness.

Our consciousness can be changed from its normal waking state in various ways. Dreaming is an obvious example, but the most dramatic changes occur after taking mind-altering drugs. The effects of such drugs can be mild, depending on the drug and dose, or extremely dramatic, as with hallucinogenic drugs such as LSD. How do drugs alter the mind, and how do their chemical effects lead to changes in perception, cognition, and particularly our consciousness? How is the biology of drugs related to our phenomenology?

There are though many other ways in which consciousness can be altered. Meditation, mindfulness, and hypnosis are all techniques deliberately employed to change our normal waking state. What changes are involved, and how does the brain change in parallel? Profound mystical or religious experience also involves a change in consciousness. Sensory deprivation can be used both as a means to relax and as a method of torture.

Death is the final alteration of consciousness. Is that right – is death like a switch, which when pressed just leads to the permanent extinction of consciousness? How do we define death, and is it a sudden or gradual process? Some people who are close to death but then survive report near-death experiences, typically involving feeling peaceful, even joyful, and often travelling down a tunnel of light. What accounts for such unusual experiences? Are these people really going to heaven and coming back, as some of them think?

It's clear that our 'normal' waking state of consciousness is not the only type of consciousness. What accounts for the phenomenology of these states – what we feel and experience – and how are the changes in state related to changes in the nervous system?

The History of Consciousness Research

It is not surprising that consciousness has been of great interest to thinkers from the beginning of history given that we all experience the world, and that experience is the most prominent feature of our existence. The Greek philosophers speculated about it. Religions place human consciousness in the form of a non-material *soul* centre. In some religions the soul is immortal and persists after death in a number of ways, either existing independently from the body to await judgement (such as with Christianity) or being reincarnated in another body at some later stage (such as in Buddhism).

The scientific revolution began in the sixteenth and seventeenth centuries, originally with the work of astronomers such as Copernicus, Kepler, and Galileo. Most early science focused on the physical and then the biological sciences, with psychology and consciousness still topics in the realm of philosophy. The French philosopher René Descartes (1596–1650), for example, proposed that there were two fundamentally different types of substance, mind and matter, giving rise to an account of the mind–body problem called dualism (see Chapter 2).

In 1907, Duncan MacDougall, a physician from Haverhill, Massachusetts, hypothesised that souls have physical weight. He tried to measure the mass lost by a human when the soul left the body. He weighed six patients at the moment of death, comparing their weight just before and just after death. He concluded that the soul weighs 21 grams, a

figure widely quoted in fantasy fiction and movies, a figure almost certainly generated by measuring error.

The science of psychology only really developed in the late nineteenth century with figures such as the philosopher Wilhelm Wundt (1832–1920) in Germany and the philosopher William James (1842–1910) in America (Schultz & Schultz, 2015). Early psychology focused, unsurprisingly, on what could be measured easily, such as perception and memory. The rise of behaviourists such as J.B. Watson and B.F. Skinner (see Figure 1.11) in the early part of the twentieth century in the United States saw consciousness research pushed to the margins as concepts that were considered vague, such as mind, were effectively abolished, to be replaced by observable behaviour.

Figure 1.11 The American behaviourist psychologist B.F. Skinner (1904–1990) with his invention, the Skinner Box. The Skinner Box was used for conditioning pigeons and rats. As the name implies, the behaviourists concentrated on animal behaviour, and there was no place for abstract constructs such as consciousness. Source: Joe Wrinn/The LIFE Images Collection/Getty Images.

Cognitive psychology became the dominant paradigm in psychology from the middle of the twentieth century with the work of the American linguist Noam Chomsky (b. 1928) and the development of the digital computer, which soon became a metaphor for how the mind works. Much of early cognitive psychology could be viewed as adopting essentially a dualist stance, with research on cognitive processes without much consideration of how the brain worked. There was very little research on consciousness at this time; it was considered a weird, almost taboo subject.

It was really only with the development of brain-imaging techniques at the end of the twentieth century that psychology became obsessed with the brain, and a new discipline, cognitive neuroscience, merging cognitive psychology and brain sciences, became the dominant paradigm. With the rise of brain imaging, consciousness came to the fore of psychology and is now one of the most exciting and researched topics. However, as we shall see, different researchers mean different things by consciousness.

The Problems of Consciousness

From the preceding discussion, it seems that the problem of consciousness is really several related problems. The following summary of 11 problems for consciousness researchers amplifies and extends our discussion above, introducing some key terms and ideas. The remainder of the book discusses our current state of knowledge about each of them.

1. The hard problem: Why does it feel like something to be me? Why do sensations appear to us as they are? What is this ‘red sensation’ we have when we see a red rose, and why can’t we describe it to anyone else? Why do we have phenomenal experiences at all? When most people think about consciousness, they have the hard problem in mind.

2. The temporal problem: Why do I have the illusion of choosing to act when my brain has apparently made that decision for me some time ago? The brain activity associated with consciousness appears too late for consciousness to be involved in perceptual processing and motor action.
3. The free will problem: The free will problem How and why do I have the illusion of choice and control if all my actions are determined?
4. The why problem: We are only certain that humans are self-aware and conscious, although it is likely that some other animals are conscious to some degree. It is, however, likely that many animals get by perfectly well without self-awareness. So, why this additional complexity? Why are animals conscious but not beaches of sand or galaxies of stars even though they contain huge numbers of grains of sand and stars? Why is my laptop not conscious (I think)? Why is a horse more conscious than a fly (probably)?
5. The self problem: Who is this 'I' who thinks they have a choice? Who is experiencing my experiences?
6. The unconscious problem: Why are some things conscious, and others unconscious? What additional things does consciousness give us? Virtually all processing is unconscious, so why do a very few things become conscious – particularly if it is too late to affect anything?
7. The cognitive problem: Does something as complicated as an intact adult human have to be conscious? What is it about our cognitive machinery that gives rise to consciousness? Where does consciousness fit into cognitive processing?
8. The binding problem: How do different sensations get bound together so that we perceive one object with all the associated emotions? Why when I see a tiger do I see the orange and black stripes moving with each other and see the shape of the tiger distinct from the background? Why when I hear the tiger's roar does it seem to come from the tiger? And why does that object alone in the environment promote feelings of fear and awe? Binding is both within modality (so that we recognise one object with everything in the right place) and across modalities (the roar goes with the sight of the tiger).
9. The neural correlates problem: How does the brain give rise to consciousness? Are there particular brain structures we can identify that are active when we engage in certain sorts of processing? How does brain damage affect consciousness? Why does the cerebral cortex appear to give rise to consciousness, but not the cerebellum, even though it contains more neurons and is just as richly interconnected?
10. The altered state problem: What do we mean by a 'normal' state of consciousness? What causes an alteration in our state of consciousness? How do changes in neurotransmitters in the brain lead to changes in the phenomenology of consciousness? What is altered in an altered state of consciousness?
11. The science problem: Is it even going to be possible for science to provide a complete account of consciousness?

Broadly, problem (1) is a question about P-consciousness, and all the others about A-consciousness. In this chapter, we've examined what consciousness is, and hopefully you now also have some idea of why consciousness is more mysterious than it might first seem.