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Edited by
Narinder Kapur
with
Alvaro Pascual-Leone
Vilayanur Ramachandran
Jonathan Cole
Sergio Della Sala
Tom Manly
Andrew Mayes

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In the spirit of the later writings of the only neuropsychologist to win the Nobel Prize, Roger Sperry (1913–1994), this book is dedicated to the memory of Mahatma Gandhi (1869–1948), who viewed his life as one of a scientist, carrying out experiments in Truth, Love and Self-Denial.

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Acknowledgements

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Preface

The study of the human brain has been variously referred to as 'the last great frontier', or a challenge equivalent to that of understanding the universe. Cosmology and neuroscience, in fact, probably have some things in common. Our galaxy, the Milky Way, has thousands of millions of stars, and some commentators have conjectured that the number of stars in the Milky Way may be similar to the number of cells in the human brain. In the past two decades, imaging and sensing technologies have transformed both the field of neuroscience and the field of cosmology. Perhaps a more interesting analogy is in the realm of awareness and human consciousness. With our current awareness mechanisms, we are usually only aware of a tiny amount of cognitive activity that mediates human behaviour – many cognitive and perceptual inferences take place at an unconscious level, we often fail to realize how our perceptions and beliefs may not be completely based on reality, and we often fool ourselves into believing that we have free will and full responsibility for all our thoughts and actions (Frith, 2007). Similarly, in the case of cosmology, with our eyes alone we are only aware of a tiny part of our galaxy, and if we were to take our perceptions literally, we would fall for the simple delusion that the sun moves round the earth.

The human brain, in its present form, seems to have evolved over the past few hundred thousand years, and it is open to debate whether it is still evolving or will remain in its current state, either after a further few hundred thousand years, or towards the end of the existence of the planet (Renfrew *et al.*, 2009). To date, the great achievements of mankind, and many of the great disasters of mankind, are probably directly or indirectly attributable in large measure to the workings of the human brain. It is likely that future achievements and calamities will also be largely due to activities of human beings that emanate from either the brilliance or the frailties of the human brain. To the extent that we can reach a better understanding of how the brain operates, its strengths and its limitations (Rees, 2008a), and how its operations may be modified for the benefit of the individual and of mankind, then it lies within the grasp of experimental and clinical neuroscientists to contribute to the welfare of humanity, and to help meet many of the daunting challenges that face human civilization (Rees, 2008b). From the perspective of the psychological sciences, here too there are major endeavours which can potentially bring about 'greater good' across a range of global issues (Miller, 1969; McKay, 2008). The only neuropsychologist to win the Nobel Prize, Roger Sperry, explored such topics in some of his last writings:

> The outlines of a value-belief system emerge that include an ultimate respect for nature and the evolving quality of the biosphere, which, if implemented, would set in motion the kind of social change needed to lead us out of the vicious spirals of increasing population, pollution, poverty, energy demands, etc. The strategic importance of neuroscience and the central role of prevailing concepts of the mind–brain relation to all of the foregoing remain evident throughout, as does also the direct relevance of efforts to bring added insight and substantiation of these mind-–brain concepts through further advances in brain research. (Sperry, 1981, p. 15)

This book aims to contribute to an understanding of the human brain from a novel perspective. The book is based on the premise that studying anomalies, the counter-intuitive and the paradoxical may shed light on the workings of the human brain (cf. Ramachandran, 2006). Therefore, I have put together, for the first time in one volume, contributions from a range of researchers who have focused on paradoxical phenomena associated with the human brain. From the perspective of experimental neuroscience, Karl Pribram (1971) helped to set the scene by pointing out a number of paradoxes in more basic neuropsychological studies. From the perspective of clinical neurology, Oliver Sacks has also set the stage for this book by his own innovative and stimulating works and titles (Sacks, 1985, 1995, 2007), including one title (*An Anthropologist on Mars*) with a 'paradoxical' subheading (Sacks, 1995). Sacks has eloquently noted

> nature's richness is to be studied in the phenomena of health and disease, in the endless forms of individual adaptation by which human organisms, people, adapt and reconstruct themselves, faced with the challenges and vicissitudes of life. Defects, disorders, diseases, in this sense, can play a paradoxical role, by bringing out latent powers, developments, evolutions, forms of life, that might never be seen, or even be imaginable, in their absence. It is the paradox of disease, in this sense, its 'creative' potential, that forms the central theme of this book. (Sacks, 1995, p. xii)

I fully accept that some of the content of this book is speculative, and may throw up more questions than answers. One of the primary purposes of this book is to raise questions, rather than to offer answers, and I will have achieved my goal if new questions and new methodologies have been brought to the minds of readers, both in the realm of a theoretical understanding of the human brain and in the realm of therapy for the human brain. In an emerging field, it is sometimes difficult to know when best to take stock and marshal evidence and viewpoints, but I feel that this is a timely opportunity in the light of recent findings and advances, both in neuroscience and in psychology. In addition to drawing attention to new or somewhat neglected experimental and clinical observations, I hope that the book will encourage new ways of thinking of established findings. 'The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them', once remarked the British scientist William L. Bragg, who was awarded the 1915 Nobel Laureate in Physics.

The two main aims in writing this book are first, to provide evidence and to suggest questions and methodologies that clinical and experimental neuroscientists may wish to consider in their journeys to understanding the workings of the human brain, while at the same time disseminating to a wider audience of clinicians and students the evidence and ideas that are the substance of this volume; second, to point to avenues by which the human condition may be improved – whether this be in the healthy population or in those with brain disorders.

I hope that the book will lead to a change in how we view the brain, and that the brain will now be seen as a dynamic, nonlinear and highly plastic device, rather than as a static, linear and rigid entity. I hope that this book will encourage more 'out-of-the-box', lateral thinking as to how the brain operates and how it can be repaired. I also hope that the book will encourage a more enlightened view of people whose brains, in one form or other, fall outside the norm, whether it be due to acquired brain pathology or due to developmental or genetic factors. Many of the findings in this book suggest that we should view such individuals as 'brain different', rather than 'brain damaged', that we should look at their positive coping strategies rather than their deficits and disabilities, and that we should focus on their achievements rather than their handicaps.

In his essay, *The Habit of Truth*, Jacob Bronowski (1961) alludes to three stages in 'the discovery of things' – assembling data, putting the data into order, and producing a conceptual framework around the ordered data. I hope that in this scientific endeavour

I have been successful in the first two stages, and I appreciate that I have only made a humble beginning to the third stage.

This book marks the end of a 20-year journey in which I have viewed the beautiful and inspiring landscapes of paradoxes in brain and behaviour. The duration of this journey is possibly similar to one that might involve human exploration of the far reaches of the Milky Way Galaxy – perhaps this analogy is not too far-fetched if one accepts the folklore that there are a similar number of stars in the galaxy as there are cells in the human brain! Such a journey would not of course have been possible without the dedicated efforts of those researchers who cultivated the findings which adorned the landscapes along my journey, and I thank them for their dedication. ‘I have attempted to blaze a track through the jungle, but make no pretence at having reached the end of the journey. I can only hope that some ardent and adventurous spirit may follow my path’, wrote Sir Henry Head, the eminent British neurologist in the preface to his treatise on aphasia (Head, 1926, p. x). I hope that ‘some ardent and adventurous spirits’ may take up the reins and pursue some of the paradoxes highlighted in this book.

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Foreword

Damage to any part of the body, if severe enough, can cause a corresponding loss of function: cardiac failure, liver failure, renal failure, etc. That this could also occur with specific areas of the brain was supported, in the 1860s, by Broca's demonstration that damage to a particular area of the left frontal lobe led to expressive aphasia – an indication, he felt, that this area constituted a 'centre' for speech. Classical neurology was founded on this deficit/lesion model, and the clinico-pathological method remains the foundation of neurology today. Indeed, in the last few decades, it has flourished, with the added power of brain imaging, which makes it possible to visualize brain lesions and their effects in living patients.

But there have been dissenting voices from the start – in particular, that of Hughlings Jackson, who also studied aphasic patients, but came to think that Broca's view of aphasia – as no more than a loss of function – was inadequate. The loss of speech, Hughlings Jackson emphasized, was never the sole symptom in aphasia; there were always 'positive' ones as well, which were unmasked or released as a consequence of the lesion; one of his papers, for example, was entitled 'Singing by Speechless (Aphasic) Children' (Jackson, 1871). In his 1884 Croonian Lectures on 'Evolution and Dissolution of the Nervous System', Jackson wrote, 'The symptomatology of nervous diseases is a double condition; there is a negative and there is a positive element in every case' (1884, p. 591).

He saw the brain as having many functional levels, developed in the course of evolution and hierarchically arranged, with activity at higher levels making use of, but also restraining, the activities of lower levels. For Jackson (and for Freud, an ardent Jacksonian, a few years later), the brain was not a static mosaic of fixed representations or points, but incessantly active, with certain potentials being actively suppressed or inhibited in a dynamic balance – potentials that could be 'released' if this inhibition was lifted. Among such release phenomena, Jackson included epilepsy and chorea (and Freud the violent affects and impulses of the 'id', if it was uncapped by psychosis).

Hughlings Jackson's views were largely ignored in his own time, as were attempts to reintroduce them (as when Henry Head published a collection of Jackson's articles soon after his death).

In the 1960s and 1970s, the notion of release phenomena was resurrected in regard to hallucinations, especially the visual hallucinations of those who had lost their sight, or had grossly impaired vision. It became clear that visual perception itself was necessary to keep the brain's visual mechanisms in order, and that in the absence of perception, there might be an eruption of images and patterns generated by unbridled, autonomous activity in the visual cortex. While visual hallucinations occur in only a minority of visually impaired people, there is, in almost all of them, a widespread activation of the visual cortex which may lead to exceptional powers of visualization or visual imagery, or to visual areas becoming available for nonvisual processing (reading Braille, for instance, or enhanced auditory sensitivity). These 'paradoxical' heightenings may be maladaptive, or they may be highly adaptive and useful to the individual, and it is especially in relation to these that Kapur speaks of 'paradoxical functional facilitation' (although the term has many other connotations too).

Foreword

There has long been a tendency to see neurological damage or disease as 'incurable', or treatable only to the extent that there is spontaneous recovery (as from a stroke), removal of a pathology (such as a tumour), or replenishment of something that is deficient (as with giving dopamine precursors to patients with Parkinsonism). However, it is equally important to see what is preserved and even heightened in neurological syndromes – the 'positive' elements that Hughlings Jackson spoke of – and to see these as allowing unexpected compensations and therapeutic powers. Thus, for example, the ability or propensity of aphasic patients to sing can be channelled and used therapeutically (as in music therapy or melodic intonation therapy for aphasic patients).

The great Soviet neuropsychologist Lev Vygotsky, almost a century ago (Vygotsky, 1929), emphasized the importance of positive abilities – what Kapur calls 'paradoxical functional facilitation' – in those who had no vision:

> Blindness is not merely the absence of sight . . . [it] causes a total restructuring of all the strengths of both organism and personality. Blindness, in creating a new, unique cast of personality, brings to life new forces . . . It creatively and organically remakes and forms a person's mind. Consequently, blindness is not merely a defect, a minus, a weakness, but in some sense also the source of manifestations of abilities, a plus, a strength (however strange or paradoxical this may seem!).

In *The Paradoxical Brain*, Narinder Kapur has expanded this concept to cover many areas in neurology, neuroscience and neurorehabilitation, assembling a diverse and comprehensive group of world-class experts to explore the concept of paradox in many different disciplines. Their experience and ideas are of fundamental importance and deserve close attention from all who deal with disorders of brain function, so that we may focus on the uniqueness of the individual and their positive potentials, rather than thinking solely in terms of disorder.

Oliver Sacks

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Author affiliations

Aarts, Esther
Center for Cognitive Neuroimaging, Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, The Netherlands
Chapter 23 – Paradoxical effects of drugs on cognitive function pp. 397–417

Ashwin, Chris
Autism Research Centre, University of Cambridge, Cambridge, UK
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Ashwin, Emma
Autism Research Centre, University of Cambridge, Cambridge, UK
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Bajbouj, Malek
Head of the Affective Neuroscience and Emotion Modulation Research Group, Charité, University Medicine, Berlin, Germany
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Baron-Cohen, Simon
Professor, Director of Autism Research Centre, University of Cambridge, Cambridge, UK
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Brown, Peter
Sobell Department of Motor Neuroscience and Movement, Institute of Neurology, London, UK
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Butler, Andrew C.
Research Associate, Duke University, Durham, NC, USA
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Chakrabarti, Bhismadev
Senior Researcher, Autism Research Centre, University of Cambridge, Cambridge, UK
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Cole, Jonathan
Honorary Senior Lecturer in Clinical Neurosciences, University of Southampton, Professor, University of Bournemouth and Consultant in Clinical Neurophysiology, Poole and Salisbury Hospitals, Poole Hospital, UK
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Cools, Roshan
Center for Cognitive Neuroimaging, Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen, The Netherlands
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Dror, Itiel E.
Institute of Cognitive Neuroscience, University College London, London, UK
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Eichenbaum, Howard
Professor, Boston University, Center for Memory and Brain, Boston, MA, USA

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Fisher, James L.
Research Scientist, Ohio State University, Ohio, USA
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Ghazanfar, Asif A.
Assistant Professor, Neuroscience Institute and Department of Psychology, Princeton University, Princeton, NJ, USA
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Goldstein, David
Professor of Psychology, University of Toronto, ON, Canada
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Hasher, Lynn
Professor, Department of Psychology, University of Toronto, ON, Canada
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Hirstein, William
Professor of Philosophy, Elmhurst College, Elmhurst, IL, USA
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Hughes, Howard C.
Professor, Department of Psychological and Brain Sciences, Dartmouth College, Hanover, NH, USA
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Hurlow, Jonathan
Institute of Psychiatry, Kings College, London, UK
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Jha, Ashwani
Sobell Department of Motor Neuroscience and Movement, Institute of Neurology, London, UK
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Kapur, Narinder
Visiting Professor of Neuropsychology, University College London;
Honorary Professor of Neuropsychology, University of Southampton; formerly Head of the Neuropsychology Department, Addenbrooke's Hospital, Cambridge, UK
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Karavodin, Linda
Principal Consultant at Karavodin Preclinical Consulting
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Kolb, Bryan
Canadian Centre for Behavioural Neuroscience, University of Lethbridge, Alberta, Canada
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Lewkowicz, David J.
Professor, Florida Atlantic University, Boca Raton, FL, USA
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MacCabe, James H.
Senior Lecturer and Honorary Consultant Psychiatrist, National Psychosis Unit, Section of General Psychiatry, Institute of Psychiatry, London, UK

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Manly, Tom
Research Scientist, MRC Cognition and Brain Sciences Unit, Cambridge, UK
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Mehta, Mitul A.
PET Psychiatry Group, MRC Clinical Sciences Centre, Institute of Psychiatry, Kings College, London, UK
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Merabet, Lotfi B.
Berenson-Allen Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA
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Merkl, Angela
Charité, University Medicine, Berlin, Germany
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Miller, Bruce L.
A. W. Clausen Distinguished Professor of Neurology, University of California, San Francisco, CA, USA
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Najib, Umer
Clinical Research Fellow, Department of Medicine, Division of Allergy and Inflammation, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA
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Obretenova, Souzana
Research Assistant, Berenson-Allen Center for Noninvasive Brain Stimulation, Beth Israel Medical Center, Boston, MA, USA
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Pascual-Leone, Alvaro
Berenson-Allen Center for Noninvasive Brain Stimulation, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA
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Ramachandran, Vilayanur
Professor, Center for Brain and Cognition, University of California, San Diego, CA, USA
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Robertson, Ian H.
Professor, School of Psychology, Trinity College, Dublin, Ireland
Chapter 4 – Paradoxes in neurorehabilitation pp. 74–93

Roediger, Henry L., III
Washington University, St. Louis, MO, USA
Chapter 8 – Paradoxes of learning and memory pp. 151–176

Sachdev, Perminder S.
Professor, The Neuropsychiatric Institute, Prince of Wales Hospital, University of

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New South Wales, Sydney, Australia
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Schachter, Steven C.
Professor, Department of Neurology, Harvard Medical School, Boston, MA, USA
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Schwartzbaum, Judith
Associate Professor, Ohio State University, Columbus, OH, USA
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Tavassoli, Teresa
Autism Research Centre, University of Cambridge, Cambridge, UK
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Teskey, G. Campbell
Professor, Department of Cell Biology and Anatomy and Psychology, University of Calgary, Alberta, Canada
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Viskontas, Indre V.
Research Fellow, University of California, San Francisco, CA, USA
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Wojtowicz, J. Martin
Professor, Department of Physiology, University of Toronto, ON, Canada
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Zimerman, Shira
Visiting Graduate Student, Rotman Research Institute, Baycrest Center, Toronto, Canada
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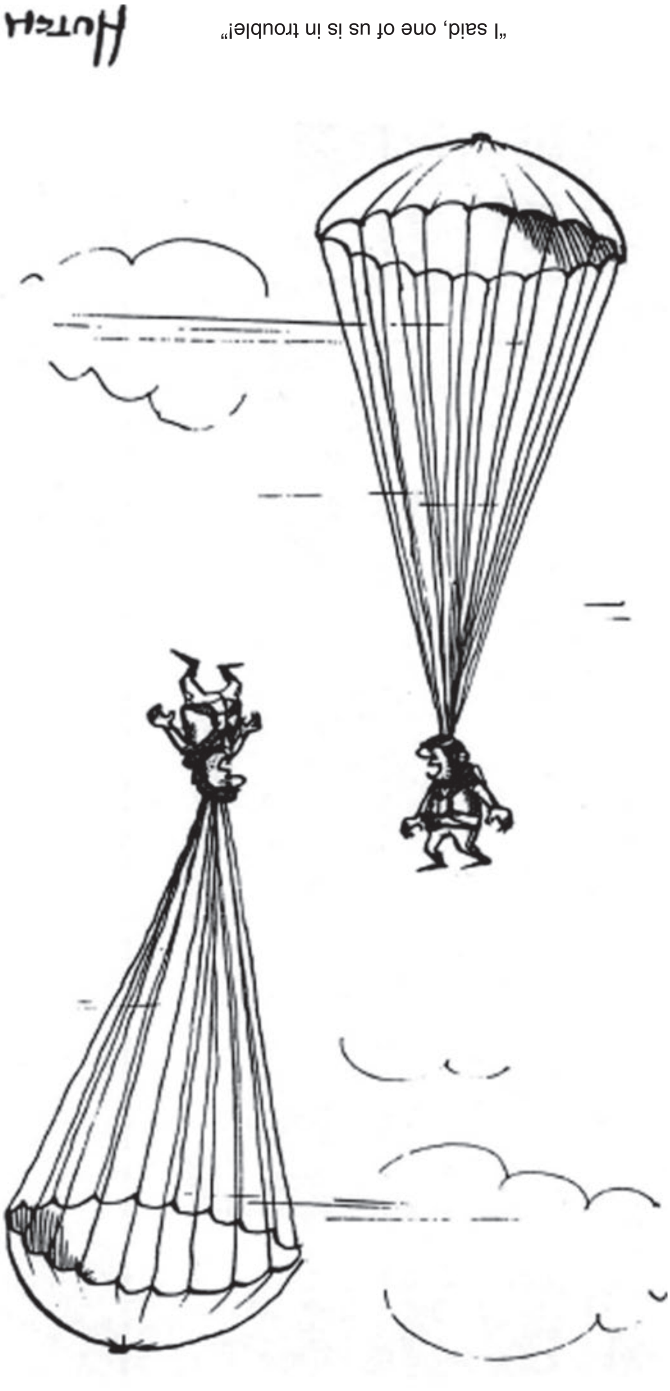
Abbreviations

AD	antidepressant drug
ADHD	attention deficit hyperactivity disorder
AED	antiepileptic drug
AS	Asperger's syndrome
ASC	autism spectrum conditions
ASD	autism spectrum disorder
AV	audio-visual
BDNF	brain-derived neurotrophic factor
BrdU	bromodeoxyuridine
CIAT	constraint-induced aphasia therapy
COMT	catechol-*O*-methyltransferase
CRPS	chronic regional pain syndrome
CSF	cerebrospinal fluid
CT	computerized tomography
CVS	caloric vestibular stimulation
DA	dopamine
DAT	dopamine transporter
DBS	deep brain stimulation
DG	dentate gyrus
DLPFC	dorsolateral prefrontal cortex
DNA	deoxyribonucleic acid (hereditary material in living organisms)
DPSD	dual process signal detection
DRM	Deese–Roediger–McDermott
ECS	electroconvulsive shock
ECT	electroconvulsive therapy
ED	Executive Dysfunction
EEG	electro-encephalography
EPF	enhanced perceptual functioning
FEF	frontal eye fields
FFA	fusiform face area
GCL	granule cell layer
GOT	gratings orientation task
GP	globus pallidus
GPe	globus pallidus externa
GPi	globus pallidus interna
HD	Huntington's disease
HVA	homovanillic acid
IPL	inferior parietal lobule
LTD	long-term depression
LTP	long-term potentiation
MAO	monoamine oxidase
MCI	mild cognitive impairment
MEG	magnetoencephalography
MEP	motor-evoked potential
MNI	Montreal Neurological Institute
MNS	mirror neuron system
mPFC	median prefrontal cortex
MRI	magnetic resonance imaging
MST	magnetic seizure therapy
NAcc	nucleus accumbens
NHL	non-Hodgkin's lymphoma
OCD	obsessive–compulsive disorder
OFC	orbital frontal cortex
ORE	other race effect
PET	positron emission tomography
PFC	prefrontal cortex
PFF	paradoxical functional facilitation
PNFA	progressive non-fluent aphasia
PPC	posterior parietal cortex
PTSD	post-traumatic stress disorder
RBD	REM sleep behavioural disorder
REM	rapid eye movement
ROC	receiver operating characteristics
ROI	region of interest
RSD	reflex sympathetic dystrophy
rTMS	repetitive transcranial magnetic stimulation
SCR	skin conductance response
SEM	standard error of the mean
SGZ	subgranular zone
SMA	supplementary motor cortex
SNP	single nucleotide polymorphisms
SPL	superior parietal lobule
SQ	systemizing quotient
SRTT	serial reaction time task
SSRI	selective serotonin reuptake inhibitor
STS	superior temporal sulcus
SUDEP	sudden and unexplained death in epilepsy
SVZ	subventricular zone
TBI	traumatic brain injury
tDCS	transcranial direct current stimulation
TENS	transcutaneous electrical nerve stimulation
TIA	transient ischaemic attack
TLE	temporal lobe epilepsy
TMS	transcranial magnetic stimulation
VBM	voxel-based morphometry
VNS	vagus nerve stimulation
VR	virtual reality
WCC	weak central coherence



"I said, one of us is in trouble!" Hutch