Life[edit]

Max's father, Herman Adler Bercov, determined that he did his undergraduate work in electrical engineering and physics at Melbourne University in 1959. [1] During this time he was influenced by the philosopher Cameron Jackson, who had been a student of Wittgenstein. This consolidated Max's interest in the relation between the brain and our psychological attributes, as in thinking, remembering and perceiving. He was then inspired, while still an undergraduate, to found the Athenian Society dedicated to understanding Plato, Aristotle and Wittgenstein (see External links). This interest in brain and mind led to postgraduate research in biology and a fascination with the connections between neurons, namely synapses (1963 – 1966). In 1968 he took up a position as lecturer in physiology at Sydney University, at a time when it housed one of the two leading laboratories in the world concerned with the synaptic and neuronal basis of vision. Because of his success in probing the physiology, development and plasticity of synapses he was awarded in 1980 the first and largest Centre of Research Excellence of the 10 established by the Australian Government over all disciplines within Australian universities. He was then appointed Personal Chair, only the second in the University's history, subsequently being made Professor of Neuroscience. In 2000 he was elected to the highest honor the University of Sydney can bestow on faculty, being made the first University Chair ('for research recognized internationally as of exceptional distinction'). In 2003 he was made Founding Director of the Brain and Mind Research Institute at Sydney, a position he still holds in 2014.

Neuroscience Research[edit]

Following his graduation in electrical engineering in 1963, and the beginning of postgraduate research in biology, Bennett decided to apply recently invented electrophysiological techniques to the problem of how sympathetic nerve synapses control smooth muscle. To his surprise the accepted paradigm of nearly 50 years, that there are only two transmitters, noradrenaline and acetylcholine, proved to be false as the electrical signs of synaptic transmission could not be blocked by antagonists to the action of these transmitters.[2] Furthermore, he discovered that when these non-adrenergic and non-cholinergic (NANC) transmitters act on smooth muscle cells, they generate action potentials due to the influx of calcium ions[3], the first to be identified. In the succeeding 45 years since these discoveries Bennett and his colleagues elucidated how NANC transmission, involving purines, neuropeptides and nitric oxide, is affected.[4][5][6][7][8] This has had profound implications for the application of pharmacology in the treatment of visceral and vascular disorders. In 1972 he discovered that lesioned nerve terminals are precisely reconstituted at the same site on a striated muscle cell, indicating the existence of synapse formation molecules on muscle cells.[9] This work initiated the search for such molecules, with the subsequent discovery of agrin and neuregulin with important implications for the establishment of nerve connections after injury to the nervous system. In 2001 Bennett and colleagues showed that once a nerve terminal is established the glial ensheathing cells can guide the formation of new synapses on mature muscle cells in a matter of minutes.[10] This research initiated the study of glial led plasticity of synapses. In 2007 he observed that that microglial cells of the brain can conduct calcium waves that are mediated by the release of NANC transmitters (purines[11]), opening up the study of the interaction of the immune and nervous systems at the level of the synapse.

History and Philosophy of Neuroscience[edit]

Bennett is the world's leading neuroscientist on the history and philosophy of brain and mind research. The main theme of his philosophical work is that brain scientists have distorted the use of language in attributing our psychological capacities as in thinking, remembering, perceiving etc

to the brain. Rather it is the person whose brain it is that possesses these attributes, the brain being necessary for us to express these abilities. This mistake is referred to as the mereological fallacy by Bennett and his colleague Peter Hacker. Clarifying these misunderstandings has profound implications for how we view ourselves. In his historical work Bennett has followed the evolution of our ideas concerning the functioning of the different components of the brain and their organization from the time of Aristotle to the present. He has shown how fundamental ideas arise in this area through a combination of research, prejudice and irrationality and of how appropriate hypotheses concerning brain function are often abandoned for extended periods of time in favor of less logical hypotheses. Bennett's most recent books concerning these issues include *The Idea of Consciousness* (1997), *History of the Synapse* (2000), *Philosophical Foundations of Neuroscience* (2003; with Peter Hacker) and *Neuroscience and Philosophy: Brain, Mind and Language* (with Daniel Dennett, John Searle and Peter Hacker; 2006). More recently he has elaborated on the theme that much of neuroscience repeatedly makes the mistake of not only attributing to the brain psychological capacities that can only be attributed to the person whose brain it is, but also attributing these capacities to parts of the brain, a modular fallacy. Indeed cognitive neuroscience 'represents' these capacities as interconnected boxes leading to reification of the person with these capacities. These difficulties are spelt out in his books *Virginia Woolf and Neuropsychiatry* (2013) as well as in *History of Cognitive Neuroscience* (2008; with Peter Hacker).

Neuropsychiatry[edit]

In 2009 Bennett and his colleagues turned to consideration of the functioning of synapses in neuropsychiatric diseases and established for the first time how stress leads to the loss of synapses in certain parts of the brain, which in turn is responsible for the loss of grey matter observed in patients using Magnetic Resonance Imaging.[12] Preliminary calculations of his then provided the first quantitative account of how synaptic activity in the brain, driving impulse activity, is responsible for utilizing most of the cortical energy.[13] This was followed by a quantitative account of how the loss of nerve pathway integrity in the brain in schizophrenia leads to dysfunction of synapses in the grey matter and hence a decrease in cortical energy.[14]

Establishment of Organizations for promoting Neuroscience and the Alleviation of Mental Illness[edit]

The following organizations were initiated by Max Bennett in this regard:

- Federation of Australian Scientific and Technological Societies (FASTS; now Science and Technology Australia), 1985 http://www.fasts.org; http://scienceandtechnologyaustralia.org.au/
- Institute for Biomedical Research (IBR; now the Bosch Institute), 1995 http://www.ibr.usyd.edu.au
- International Society for Autonomic Neuroscience (ISAN), 1995 http://www.isanweb.org
- Brain and Mind Research Institute (BMRI), 2003 http://www.bmri.sydney.edu.au
- Tropical Brain and Mind Research Foundation (TBMRF), 2013 http://www.tropicalbrainandmind.com.au/

Awards and Lectures[edit]

A detailed listing of achievements can be obtained from the Who's Who of Australia. Officer of the Order of Australia, appointed in The Queen's Birthday 2001 Honours List, 'for his service to the biological sciences, particularly in the field of neuroscience and as a major contributor to the establishment of organisations aimed at furthering interdisciplinary research in this field, and to

education'. In addition, Bennett has received the following recognition: Goddard Research Award, Australian National Heart Foundation, 1996; Ramaciotti Medal, Clive and Vera Ramaciotti Foundation, 1996; Renensson Research Award, Australian National Heart Foundation, 1998; Burnet Medal, Australian Academy of Science, 1999; Malcolm Research Award, Australian National Heart Foundation, 1999; Distinguished Achievement Medal, Australian Neuroscience Society, 2001; Excellence in Science (Tall Poppy) Award, Australian Institute of Political Science, 2001; Almgren Research Award, Australian National Heart Foundation, 2001; Academia Opthalmologica Internationalis Award, 2002; Centenary Medal, 2003; Honorary Fellow, Australian Neuroscience Society, 2010. In 1996 Bennett gave the Opening Plenary Lecture at the World Congress of Neuroscience (Tokyo). This was succeeded by distinguished lectures in neuroscience, neuropsychiatry as well as in the history and philosophy of neuroscience as follows: Burnet Lecture, Australian Academy of Science, 1999; Plenary Lecture, International Conference, Research Society on Alcoholism , 2001; Featured Speaker, XIV World Congress of Cardiology , 2002; Academia Ophthalmologica Internationalis Oration, 2002; Plenary Lecture, American Philosophical Association, 2005; Plenary Lecture, International Congress of Neuropsychiatry, 2006; Plenary Lecture, The Royal Australian & New Zealand College of Psychiatrists, 2007; Plenary Lecture, World Congress in Medical Informatics, 2008; Plenary Lecture, International Congress in Nanotechnology, 2008; Plenary Lecture, World Congress of Mental Health Nurses, 2009; Grass Lecture, Indian National Institute of Mental Health & Neuroscience, 2009; Nour Foundation Lecture (at the United Nations, NY), 2009; Franke Lectures, (Yale University), 2013

Selected works[edit]

Articles[edit]

- Bennett MR, Hacker PM. The motor system in neuroscience: a history and analysis of conceptual developments. Prog Neurobiol. 2002 May;67(1):1-52.
- Bennett MR, Hacker PM. Perception and memory in neuroscience: a conceptual analysis. Prog Neurobiol. 2001 Dec;65(6):499-543.
- Bennett MR. Criminal law as it pertains to 'mentally incompetent defendants': a McNaughton rule in the light of cognitive neuroscience. Australian and New Zealand Journal of Psychiatry 2009; 43(4):289-99.
- Bennett MR. The discovery of a new class of synaptic transmitters in smooth muscle 50 years ago and amelioration of coronary artery thrombosis. Acta Physiol (Oxf). 2013 Feb;207(2):236-43
- Bennett MR, Pettigrew AG. The formation of neuromuscular synapses. Cold Spring Harb Symp Quant Biol. 1976;40:409-24.
- Bennett MR. Schizophrenia: susceptibility genes, dendritic-spine pathology and gray matter loss. Prog Neurobiol. 2011 Nov;95(3):275-300.

Books[edit]

Bennett's books have been translated into several languages.

- *Autonomic Neuromuscular Transmission* (1972) Publisher: Cambridge University Press; ISBN 0521084636
- *Optimising Research and Development in Australia* (1987) Publisher: Australian Academy of Science; ISBN 0858471388
- *The Idea of Consciousness: Synapses and the Mind* (1997) Publisher: Harwood Academic; ISBN 9057022036

- *History of the Synapse* (2001) Publisher: Harwood Academic; ISBN 9058231321
- *Philosophical Foundations of Neuroscience* (2003) Publisher: Blackwell; ISBN 1 4051 0855 X(with Peter Hacker)
- *Neuroscience and Philosophy : Brain, Mind and Language* (2006) Publisher: Columbia University Press (with Daniel Dennett, John Searle and Peter Hacker)
- *History of Cognitive Neuroscience* (2008) Publisher: Wiley/Blackwell; ISBN 9781405181822 (with Peter Hacker)
- *Virginia Woolf and Neuropsychiatry* (2013) Publisher: Springer; ISBN 9789400757486

References[edit]

1. **Jump up^** Australian Academy of Sciences interview with Max Bennett, 1996
2. **Jump up^** Bennett, M.R., Burnstock, G. & Holman, M.E. (1966). Transmission from intramural inhibitory nerves to the smooth muscle of the guinea-pig taenia coli. J. Physiol. (Lond.) 182: 541-558. This work showed that another transmitter other than noradrenaline or acetylcholine exists in the peripheral nervous system.
3. **Jump up^** Brain, K.L. & Bennett, M.R. (1997). Calcium in sympathetic varicosities of mouse vas deferens during facilitation, augmentation and autoinhibition. J. Physiol. (Lond.) 502: 521-536. First to show that calcium changes in a nerve terminal directly related to synaptic efficacy.
4. **Jump up^** Bennett, M.R., Farnell, L. & Gibson, W.G. (2000) The probability of quantal secretion within an array of calcium channels of an active zone. Biophys. J. 78: 2222-2240. First realistic Monte Carlo account of calcium changes and transmitter release.
5. **Jump up^** Hansen, M.A., Balcar, V.J., Barden, J.A. & Bennett, M.R. (1998). The distribution of single P2x1 -receptor clusters on smooth muscle cells in relation to nerve varicosities in the rat urinary bladder. J. Neurocytol. 27: 529-539. Showed for the first time the relationship between single synapses and transmitter receptors in the postganglionic nervous system.
6. **Jump up^** Dutton, J.l., Poronnik, P., Li, G.H., Holding, C.A., Worthington, R.A., Vandenberg, R.J., Cook, D.I., Barden, J.A. & Bennett, M.R. (2000) P2X1 receptor membrane redistribution and down-regulation visualized by using receptor-coupled green fluorescent protein chimeras. Neuropharmacology 39: 2054-2066. First description of changes in distribution of agonist excited receptors in membranes in real time.
7. **Jump up^** Bennett, M.R. (1972). Autonomic Neuromuscular Transmission. Monograph of the Physiological Society No. 30, Cambridge University Press. This monograph established the prevailing paradigm of the structure and function of autonomic junctions.
8. **Jump up^** Bennett, M.R. (1967). The effect of cations on the electrical properties of the smooth muscle cells of the guinea-pig vas deferens. J. Physiol. (Lond.) 190: 465- 479. First proof that action potentials can be due to the influx of calcium ions.
9. **Jump up^** Bennett, M.R. & Pettigrew, A.G. (1976). The formation of neuromuscular synapses. Cold Spring Harb. Symp. Quant. Biol. 40: 409-424. This work established the prevailing paradigm of how synapses are formed during development and regeneration.

10. **Jump up^** Macleod, G.T., Dickens, P.A. & Bennett, M.R. (2001). Formation and function of synapses with respect to Schwann cells at the end of motor-nerve terminal branches on mature amphibian (Bufo marinus) muscle. J. Neurosci. 21: 2380-2392 (cover story). Showed that the mature intact nerve terminal continually makes and regresses synapses under the influence of the ensheathing glial cells.
11. **Jump up^** Bennett, M.R., Buljan, V., Farnell, L., Gibson, W. (2007). Purinergic junctional transmission and propagation of calcium waves in cultured spinal cord microglia networks. Purinergic Sig. 4: 47-59. This work showed for the first time that microglial cells, the most dynamic cell in the brain, act as an interface between the neural and immune systems by propagating calcium waves using purines as transmitters.
12. **Jump up^** Kassem MS, Lagopoulos J, Stait-Gardner T, Price WS, Chohan TW, Arnold JC, Hatton SN, Bennett MR. Stress-induced grey matter loss determined by MRI is primarily due to loss of dendrites and their synapses. Mol Neurobiol. 2013 Apr;47(2):645-61. Establishes for the first time the cellular basis of grey matter changes in the brain, determined by MRI.
13. **Jump up^** Hyder F, Rothman DL, Bennett MR. Cortical energy demands of signaling and nonsignaling components in brain are conserved across mammalian species and activity levels. Proc Natl Acad Sci U S A. 2013 Feb 26;110(9):3549-54. Shows that the energy required to maintain a synapse-initiated impulse in a neuron remains the same over different behavioural states and species.
14. **Jump up^** Bennett MR, Farnell L, Gibson WG. Fiber pathway pathology, synapse loss and decline of cortical function in schizophrenia. PLoS One. 2013 Apr 8;8(4). Indicates that changes in the energy expended in particular areas of the brain, and therefore impulse activity there, can be quantitatively explained as due to changes in the integrity of axons joining these areas.

External links[edit]

- Melbourne University Undergraduate: the Athenian Society (http://our-history.unimelb.edu.au/biographies/ken-mcnaughton/)
- University of Sydney Profile: (http://sydney.edu.au/medicine/people/academics/profiles/maxb.php)
- Neurobiology Profile: (http://www.physiol.usyd.edu.au/research/labs/nrc/members/bennett.html)
- Australian Academy of Sciences Profile: (http://www.science.org.au/scientists/interviews/b/bennett.html)
- Career Interview, Australian Academy of Sciences: (http://www.science.org.au/scientists/interviews/b/notes_bennett.html)
- Superstars of Science Ratings: (http://superstarsofscience.com/scientist/max-bennett)
- United Nations Lecture on 'The Impact of Brain Function on the Concept of Criminality' (YouTube: http://www.youtube.com/watch?v=aeKTxlp5W6U)
- Yale Franke Lecture I: The History of the Mind (YouTube: http://www.youtube.com/watch?v=JPt5Ot1UdDs&list=PLqHnHG5X2PXAtLjtYUZHXEcrF6Xfi4ikh&index=4)

- Yale Franke Lecture II: The History of Consciousness
  (YouTube: http://www.youtube.com/watch?v=BUadXXaEuPk&list=PLqHnHG5X2PXAtLjtYUZHXEcrF6Xfi4ikh&index=3)