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What agenda for the history of the modern neurosciences?

*Roger Smith**

Abstract

No one will doubt that the neurosciences have become one of the largest, best funded and most active areas of all research. This has occurred since 1945. Some people refer to 'neuroscience', in the singular, but this is more a hope than a reality; there is an interconnected mass of 'neuro-' disciplines, including neuropsychology, making up 'the neurosciences', in the plural. There are great difficulties in any researcher, or observer, having a view of the field as a whole. Nor has there been systematic historical work on this area of 'contemporary history'.

I think it is of interest and will be good for discussion to construct an agenda for such a history. Historical work may also help gain perspective on the impact of the neurosciences on cultural values, on wider questions concerning human identity and self-understanding. In a book, *Being Human: Historical Knowledge and the Creation of Human Nature* (Manchester University Press, Spring 2007), I explore the philosophical background, arguing that other kinds of knowledge, especially history, besides the neurosciences, are essential for knowledge of human actions. In this talk, I want to be more specific about how the neurosciences have come to occupy the place they do, in respect both of research commitments and impact on public consciousness of human nature. I am particularly struck by what we may call a 'new materialism'.

This is a vast topic and any attempt at comprehensiveness would be misguided. I will therefore adopt a framework of three historical stages: the pre-1940s background; the new brain science of the 1940s, followed by the separate development, in practice, of computing, physiology and psychology till about 1970, along with strict separation of philosophical (mental) and scientific (physical) interests; and the last period of highly optimistic attempts to achieve integration, with the ultimate goal a neuroscience of consciousness. I will sketch, first, reasons why the brain became an attractive focus for research in the 1940s; second, what changed in the 1960s and 1970s, associated with the so-called 'cognitive revolu-

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A longer, referenced version of this paper is available: rsmith@mail.ru.

* Member of the European Society for the History of Human Sciences. Reader Emeritus in History of Science, Lancaster University, UK; consultant, Institute for the History of Science and Technology, and associate fellow, Institute of Psychology, Russian Academy of Sciences, Moscow.

tion', belief that 'dry' models of psychological events must relate to 'wet' research on the brain, and the argument that philosophy of mind and science must work together not separately.
What I would also like to learn much more about is how far neuroscientists are materialists and why, and what the investment in neuroscientific approaches to knowledge of people implies for people's values and sense of identity. The future looks as if it will be a brain engineered future. (I have examples like Prozac and worlds of virtual realities in mind.) With such prospects in view, it is time to consider the history of the future we are now creating.
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Psychologists are inescapably interested and concerned with the neurosciences, partly because so many psychologists work under the rubric of «neuropsychology» (and related «neuro-» sub-disciplines) and partly because the neurosciences appear now to dominate many curricular, research and funding agendas. It therefore appears well worthwhile to explore the importance and relevance the history of the neurosciences. This will involve something more like constructing an agenda of topics rather than telling a connected story about how the present situation came about. The simple fact is that the story is so complex, and the multifarious elements so incompletely known or appreciated, that we first need an agenda.

The choice of topic also responds to my paper, published in the last issue of this *Revista*, to show «Why history matters». It is one thing to argue the case theoretically or philosophically, which I do in *Being Human: Historical Knowledge and the Creation of Human Nature* (Manchester, Manchester University Press, 2007). It is another thing «to do history» in a living way which shows that history does indeed matter to scientists.

Some scientists, and perhaps more some writers about science for a general audience, assert that brain science is the final science of human nature, currently establishing the knowledge which, set in the context of evolutionary biology, will finally explain human beings to themselves. The progress being made in the field, they assert, makes it legitimate to expect the neurosciences to form the framework of knowledge on which to base other areas like psychology, linguistics and anthropology. There is at present an extremely confident and optimistic rhetoric about the potential of the neurosciences, and this rhetoric features both in scientific communities and in the public presentation of science. The rhetoric also includes very large claims about what new knowledge of the brain will do for medicine.

It is not the business of historians to assess the current state of science; but historical perspective does raise questions. I would start with the observation, which thoughtful scientists have themselves made, that there is no unified discipline of neuroscience but rather a vast complex of activities, the neurosciences. We should be aware that, in spite of many hopes about unification, the social and institutional reality remains the diversity of specialised sub-disciplines.

There is a specific historical story concerning the introduction and spread of the term «neuroscience» in the singular. F. O. Schmitt, a biophysicist at MIT, initiated and ran a very influential Program for Neuroscience, starting in 1962 and drawing in people with different backgrounds over the years, in order to unify a large number of different areas of researc. This programme, for example, in the mid-1970s attracted the physicist John Hopfield, and Hopfield

went on (in 1982) to formulate what is now regarded as a classic mathematical-computational model of a neural network, a physical system with emergent properties of the kind many people think consciousness might be. But, this is the key point, unification did not happen and has not happened subsequently.

The claims made on behalf of the neurosciences affect everyone, not just psychologists – and they affect psychologists as self-reflecting human beings as well as in their specialised or professional activity. The demonstration that our reason is embodied, some people argue, requires a revolution in our understanding. Claims of this kind are significantly blurring previous distinctions between philosophy, science and the public understanding of science.

The immediate concern for psychologists, as psychologists, is that the claims made on behalf of the neurosciences raise, yet again, the well-worn question of psychology's identity and the status of its activities as independent areas of scientific investigation. This is both an intellectual matter, the question of psychological knowledge and its possible reduction to purportedly more fundamental knowledge, and a question of funding and institutional arrangements affecting both teaching and research. If indeed the subject matter on which psychologists work, however understood, is a function of brain processes, on what grounds maintain psychology as an independent science? And if psychology does not have independent subject matter, is it not right to shift funds into neuroscience programmes? Psychologists, indeed, report that such shifts are currently taking place.

This question mark against the future of what many psychologists have previously thought of as firmly established and independent areas of science is most emphatic in one prominent, though certainly much criticised, argument in the neurosciences. This is the position of «eliminative materialism», first advocated by Paul M. Churchland in 1981, which argues that what people conventionally denote as «mental» is nothing but nervous processes understood according to what we can now see to be an ignorant, unscientific way. In due course, the argument goes, first scientists, and then ordinary people, will learn to replace the old language of the mind («folk psychology») with the new, true language of the brain. This argument would seem to leave no special place for psychology in the field of the sciences, except as a name for a set of specialised research techniques and applications, like those associated with testing. It is, however, an argument which does not do justice to a long-standing position in philosophy which holds that explanations of human action involve reference to intentions and linguistic and social rules, which no kind of knowledge of brain science can achieve.

I would like to state what I think is the key reason for the vulnerability of psychology to reduction, demoting it to a group of sub-disciplines of the neurosciences. This is relevant to the construction of a historical agenda. Insofar as psychologists have constituted their subject matter in a manner which has taken out social content and meaning, they have rendered psychology vulnerable to the argument that its subject matter is «really» or fundamentally material processes of the kind that neuroscientists are best equipped to study. Earlier, say, before the 1950s, knowledge of the brain was insufficient for the reductionist argument to be a serious intellectual threat to psychology, though there were many well-known earlier attempts to take this road. Recent decades, by contrast, have seen such progress in the study of the brain, so

neuroscientists claim, that it does now appear to them that empirical neuroscience knowledge is subsuming areas traditional studied by psychologists.

The neurosciences, in my view, are notable for their representation of what is human in terms which do not take account of the social nature of being human, that is, the social, linguistic and historical contexts of all human action. Insofar as psychologists have built knowledge of these contexts into representations of their subject matter, as they indeed have in some theories, for example, of language and child development, their knowledge – and their research and teaching – is much less easily subsumed by the neurosciences. I propose that it must be a central part of any historical account of the neurosciences, as of psychology, to explain the attraction and power of representations of being human in terms which efface the social dimension, and to take account of the thought and activity which has opposed this.

Let me make two further related points. First, the modern neurosciences are overwhelmingly practised and led by scientists in the United States. There is a huge investment in the field in other parts of the world, but it is surely fair to say that this follows U.S. example and leadership. We must consider in what ways the neurosciences are distinctively linked to the culture and economy of the U.S. and to their position in the world. The second point is that the claims of the modern neurosciences are both «scientific» and «popular». The growth of the field has not just been of concern to scientists but has a public setting, a large public audience. There is a substantial and apparently widely-read literature, written for non-specialist audiences, about what the new sciences mean and what changes they will bring. The historical context of the growth of the neurosciences has not been circumscribed by the interests of specialist researchers but has included the concerns of all sorts of people interested in human nature, ethics, religion, altered consciousness, new technologies of the self, and so on. If there is now support for the translation of psychological processes into material, neural terms, this is at one and the same time a feature of the scientific and the lay setting.

To my mind, the key questions are: How has it come about that the neurosciences now appear, to many professional scientists and to lay people alike, to be the foundation of human self-understanding? If we attribute this to the growth of knowledge, what actually is this knowledge and what has made it possible? And, what changes in ways of life, in the manner of being human, what human technologies, are linked with the growth to such prominence of the neurosciences?

In addressing such large-scale questions, it is always possible for the historian either to take a «deep» historical approach or to research more specifically into what English-language scholars call «contemporary history», in effect the history of the recent past. There certainly is a «deep» history to the neurosciences, as many scientists themselves signal by bringing in the name of Descartes. As these common references to Descartes make clear, many people believe that modern developments carry out, or even complete, an understanding of the world initiated in the period of «the Scientific Revolution» but blocked or delayed in its application to the human sphere. It is a common view that the neurosciences are putting to rest difficulties in Descartes' (and Christianity's) representation of the duality of body and soul. I do indeed think that we draw upon ways of thinking established in earlier centuries, especially in the psychological and brain sciences, where the most basic categories of the sciences, such as body,

soul, mind, consciousness, nature, reason and language, themselves have a complex history. All the same, my discussion now is not with this «deep» past but with the decades since 1945 – contemporary history.

The 1940s was the turning point. There was then a concerted intellectual, institutional and financial commitment to initiate new research directly on the brain, which was understood, with space, to be «the last frontier» of human understanding. Academic historians of science have, however, by and large, paid little attention to the modern brain sciences. This is a striking gap. But, in the early twentieth century, and even more later, the scale, complexity and diversity of relevant events, and the difficulties facing outsiders, not expert in specialised fields of research, in achieving an understanding of scientific activity and publications, has made historical work in this area extremely difficult. It is also difficult to achieve the kind of historical overview which gives meaning and purpose to narrow studies. It is worth noting that scientists themselves have rarely had such an overview: the modern neurosciences have been marked by specialisation and technical expertise in highly circumscribed areas. Thus, as a matter of fact, there are no standard, systematic narrative histories of the neurosciences for the twentieth century.

If historians of science are to do more than contribute narrowly focused studies of specific developments, as scientists themselves have done, for example, on the history of nerve conduction, they will need an overview. As a first step towards this, we need an agenda, taking account of what has already been done by way of historical research.

I suggest that the historian's agenda should include at least the following:

(1) Studies of the 1930s and 1940s to explain why it was then thought that «the time had come» for experimental research directly on the brain. This will require assessment of knowledge of the brain in the 1930s, and of how scientists then conceived relations between psychology and physiology. It will have to take account of the questions posed to scientists by World War II and the subsequent Cold War, questions about the machine-human interface, the comparability of human and machine functions and the potential for controlling human actions. These decades saw increased resources for brain science, which supported a number of important institutional developments and research programmes. These included the teams led by Wilder Penfield at the Montreal Neurological Institute, by H. W. Magoun, founding what was to become the UCLA Brain Research Institute, and the work by Kenneth Craik at the Applied Psychology Unit in Cambridge, England.

(2) The establishment of a map of the major claims to new knowledge. I have strongly felt the need for such a map in order to negotiate such a diverse domain. It has been commonplace to refer to the spectacular «progress» of the brain sciences, but such claims usually accompany statements about developments in one specialised area, for example, in scanning. It is very hard for those of us who are not brain scientists to assess what any particular empirical claim means, all the more so as the assessments which scientists themselves made have usually been controversial and changing over time. Thus, for example, in what sense had knowledge of brain waves produced «progress» by 1960? There was an enormous amount of empirical data

about brain waves, but what this data said, if anything, about mental functions was obscure. Accounts by scientists of what they accomplished, which take for granted the importance and excitement of one specialised area of work, do not provide a map, and such accounts are all that we have for many developments in the 1950s and 1960s.

(3) Recognition of the central place of technology. I think it is not possible to write the history of the modern brain sciences separate from the history of modern technology. Indeed, the history of the brain sciences calls into question the distinction between science and technology; the brain sciences are a human technology. It is pertinent to be aware that writing in the history of technology generally has changed considerably in the last twenty years or so. It is now taken for granted that the form of material engagement with nature has a structuring effect on knowledge production (methods are not neutral), and that technologies are complex social systems not just a series of «technical» developments. These insights are very relevant to the brain sciences. The effective operation of technology, especially associated with the conduct of war, involving large-scale production and complex systems with complex human-machine interfaces, was the major stimulus to investment in the brain sciences in the 1940s and 1950s. There is a significant historical literature about the interconnections of brain science, cybernetics, military objectives and early computing.

It has also been technological innovations which have made modern experimental research on the brain possible. The introduction of electronic valve recording devices in the early 1920s was followed by such devices as microelectrodes and the electron microscope in the late 1930s and biochemical, or pharmacological, analytic techniques in the 1950s and 1960s. The introduction of scanning technologies, common from about 1980, is of huge importance, encouraging some of the more excessive claims about a new ability to represent psychological events in physical terms. The history of scanning also exemplifies the way in which highly sophisticated, and extremely expensive, technologies generate whole sub-fields whose prime concern is the operation of the technologies themselves.

This leads to a further point. Certain technologies, sometimes called «defining technologies», structure the way scientists think about the subjects they study. In such cases, the technology does not just make certain kinds of research possible but shapes what scientists think to be true about nature. This has happened in a profoundly influential way with computing. Confidence in the possibility of representing mental events as «like» computing processes has played an overriding part in claims that neuroscience will provide a unified theory of human nature. The same confidence supports the argument that psychology has no subject matter distinct from the subject matter of neuroscience, which studies mental processes as in some sense like computing processes. To throw into relief the importance of computing as a defining technology, one might want to bear in mind that a number of scientists think that the brain may not be like a computer at all; yet computer modelling of events which ordinary language calls «mental» has been a major feature of science for decades.

(4) The cultural history of the neurosciences. Knowledge of the brain is not knowledge of some remote features of nature, like distant stars, when it seems that knowledge can have no effect on its object, but is knowledge about ourselves as knowledge creators. The brain sciences have been caught up in a circle of interactions, in which knowledge of being human and ways

of being human change together. I have already alluded to this by noting the public context of interest in new knowledge and technologies of the brain. I would like history to address such questions as: what is it that has made materialistic approaches to human nature, which a number of neuroscientists advocate, so attractive? Scientists, like the late Francis Crick, have made a point in public of asserting that science now empirically «proves» the non-existence of the soul. Informal evidence indicates that many, probably most, neuroscientists are materialists in the sense that they believe mental events to be brain functions, and they certainly do not believe in the existence of any kind of mental or soul-like entity. What is at stake in the propagation of such claims and why is there an audience for them? In addition, it is of great interest that a significant number of academic philosophers have discarded their previously strong commitment to the separation of analytic and empirical statements (separating philosophical work from scientific work) and now argue that, in future, philosophy of mind and the neurosciences must work together. Many philosophers therefore appear to support materialistic, or at least naturalistic, approaches which make knowledge of brain decisive in questions about the work of the reasoning mind.

The issues are hugely complex. But surely, here like social scientists, historians will have in view the cultural shift in many parts of the world towards a fully commodified view of all aspects of life. «Commodification» denotes the social process which renders an aspect of the human condition into elements which can be bought and sold and which thus have a market value as opposed to an intrinsic value. It seems to me that we must draw upon some understanding of this kind in studying the social context of the neurosciences. These sciences, because their subject matter is human nature in general and group or personal identity in particular, constitute a human technology, including «technologies of the self», in one popular phrase. What the brain sciences in principle make possible, and will in practice make possible if their most optimistic advocates are correct, is a technology permitting consumer choice in acquiring whatever personal elements of reason, experience, emotion, beauty or life we feel a need for. This involves the transformation of the world in which what was held to be of value – learning, the sacred, the fine arts, the mystery of life and death, ethical judgment, personal relations – was understood as an expression and achievement of the mind or spirit. This earlier world now appears to many people to have been intrinsically elitist, that is, it linked what was valued highly to a mental life to which only restricted groups had access. By contrast, the neurosciences (linked to the genetic sciences) appear to open up the possibility that each human capacity can be obtained as a technology, bought and sold and hence made available to all. In the case of new medical technologies, few people will question the benefits. But medical technologies blur into a host of potential interventions into human nature, making it possible to imagine a designer self, the cyborg of the future. Indeed, brain technologies are already part of everyday life, most especially with the spread of consciousness-altering drugs, such as Prozac, and with the marketing of virtual realities.

(5) To complement the previous items on this agenda for the history of the neurosciences, we need, in broad outlines, to periodise the field. I suggest we distinguish three major periods, pre-1940s, 1940s to 1960s and 1970s to the present.

The first period saw the establishment of physiology and psychology as separate, independent sciences. Historians of science have studied the institutionalisation of these disciplines in some detail, but in spite of this there are no systematic histories of neurophysiology for the first four decades of the twentieth century. By and large, the demand to achieve scientific rigour made the linking of psychological process to brain appear a task for the future rather than the present, and scientists got on with work which they could do with precision. Direct study of the brain took place, for the most part, in the context of medical neurology and relied on clinical methods and anatomy rather than experiment; the experimental study of the brain seemed technically just too difficult.

This changed in the 1930s, and the change marks the start of the second period and the founding of the neurosciences in their modern forms, though the name was not then in use. There was new technology which gave people the confidence that the brain was accessible to rigorously controlled experiments. John Fulton at Yale University, with Rockefeller Foundation support, standardised the macque monkey as an experimental subject which would substitute for humans in experimental brain research, in order to make it possible to extend approaches to lower levels in the nervous system to higher levels. Magoun and his co-workers showed that it is possible to insert electrodes into the deep-lying, previously inaccessible and extremely complex area of the mid-brain, and, in the mid-1940s, this appeared a living proof of the possibilities for new experimental work. From 1934, when E. D. Adrian and Brian Matthews confirmed Hans Berger's findings, demonstrating the alpha rhythm, there was excitement about the potential of brain wave studies to provide some kind of direct record of activity.

War brought new opportunities and imperatives. Most directly, it brought a host of cases forcibly to the attention of psychiatrists and neurologists; Luria's subsequently world-famous work took place in this context in the Soviet Union. In the U.S., military goals and events created a climate of political opinion directing considerable funds, both from the state and through private foundations like Josiah Macy, towards brain research. The military world acquired an interest in the brain, which was sustained in the United States over subsequent decades and which was to be the largest single source of funds for research relevant to the neurosciences. World War II, and even more the Cold War, demanded knowledge of the related areas of complex systems and of the human-machine interface, and computing, communications theory, systems analysis, operational research, cybernetics, ergonomics and other sciences responded to this. Early on, in 1943, Warren S. McCulloch and Walter Pitts, in a now «classic» paper, pointed out the structural identity of the «all or none» nature of the nervous impulse and the «on/off» logic of digital computing. This laid the theoretical basis for the idea of neural nets and for the subsequent development of artificial intelligence (AI). In the late 1940s, there were also calls to end the separation of neurophysiology and psychology, to recognise that it was becoming possible, as McCulloch and Pitts' paper suggested, to explore the structural relationship between brain processes and psychological processes. This was the theme of the Hixon Symposium at Caltech, in 1948 and the theme to which Donald Hebb drew the attention of psychologists.

These were exciting developments. All the same, the institutional and intellectual reality through the 1950s, and to a considerable extent thereafter, was the perpetuation of special-

ties largely unconnected with each other. Neurophysiologists working on the monkey brain, experimental psychologists of behaviour, computer programmers developing AI, specialists in cybernetics, clinical neurologists – each group worked substantially independently, and in many cases in ignorance, of each other. The sheer investment of time and training necessary to acquire expertise in the technical methods of research in any one area, and the system of career advancement in science, explains this easily enough.

The attempt to overcome this uncoordinated and diverse research effort and create a unified neuroscience marks out what I distinguish as the third stage. This is not to say that the attempt has been successful; far from it, since the same pressures for specialisation and fragmentation continue into the present, if anything in stronger form, as yet more researchers join the field and yet further sophisticated technologies become available. Nevertheless, since the 1960s, there have been a number of major developments which appeared at the time to bring together previously separated traditions of research. Much of this will be familiar to psychologists in a general way, though the amount of seriously researched historical literature, as opposed to the informal memory shared among scientists, is small.

Along with the MIT Neuroscience Research Program, we can mention a UNESCO sponsored colloquium in Moscow in 1958, followed by the setting up of the International Brain Research Organization (IBRO), mutating in 1969 into the Society for Neuroscience. What was of more importance to psychologists, however, was the so-called «cognitive revolution», though there was no «revolution», except perhaps in certain centres in the United States. In the years around 1970, there was a substantial shift of attention among psychologists towards computer models of psychological activity, in areas like memory and intelligence, and this certainly raised the question of the relation between knowledge of AI and knowledge of psychological processes. Then, a decade later, it became common to lament the separation of studies of computer reasoning and psychological processes from what neurophysiologists actually were learning about «the wet brain». There was talk about «the embodied mind» aimed at overcoming the separation between physiology and psychology. In the late 1980s, there was excitement about parallel distributed processing, which, it was thought, was much more like what goes on in real brains than earlier forms of processing. Thus, we can discern a recurring pattern in which researchers experience the coming together of diverse work around a common understanding and unity of purpose. For many people in the 1990s, this unity of purpose became the goal of a theory of consciousness. No even remotely tenable theory is in fact in view, but, for many people, consciousness studies have become a focus for hopes that psychology and physiology will unite in a common field.

To this very general sketch we must add yet other major areas of investigation, other traditions of research, each requiring high levels of specialist expertise and each making claims upon psychology. Let me mention three. First, there is enormous commercial and public interest in and support for pharmacological studies of the brain. Following the introduction of chloropromazine into mental hospitals, beginning in 1952, in the 1960s there was rapid expansion of studies on chemical transmitters and organisers in the brain. This research brought together the interests of psychiatrists, experimental psychologists (e.g., those involved in sleep research), chemical physiologists and pharmacologists. One may suppose that the subjective experience

of consciousness altered by drugs has been of immeasurable importance in creating a climate of opinion sympathetic to the view that neuroscience is the key to human identity. Second, the introduction of scanning technologies, besides creating a number of highly specialised, technologically-driven areas of expertise, popularised the opinion that mental processes had become «visible», and hence experimentally accessible, in a way they had not been before, thus again linking psychology to brain science. Lastly, it seems to me to be a very significant step, for the aspiration to a unified understanding based on knowledge of brain, that a substantial number of influential philosophers of mind began to argue that the analytic reasoning of philosophy must take into account, or build on, the empirical knowledge that scientists now have of the brain. There are very varied philosophical views about the relation of psychological processes and consciousness to brain, but the interaction of philosophers and scientists over the last two decades is a noteworthy shift from the state of affairs in the 1950s.

I hope that I have said enough to provoke discussion about an agenda of research topics in the history of the neurosciences which psychologists will see as relevant to themselves. In this regard, it clearly should be on the agenda for future historical research to learn when, where and why scientists first used, and then continued to use, the label «neuropsychology». Many people, especially those educated in a humanistic culture, and not only people with belief in the spiritual reality of a soul, are deeply troubled by where the scientific, philosophical and technological innovations in the neurosciences leave ethical questions, or indeed any notion of «values». I have indicated in which direction I think argument should go: towards recognition of the historical and social nature of the ways we have of being human, including being human in creating materialist technologies which serve identifiable material interests. We need historical knowledge.

Let me conclude with what may sound like a superficial joke; but I think it cuts deep. Over the decades in which the neurosciences have developed, it has become something of a cliché to assert that the brain is the most complex object in the known universe and hence, obviously, the greatest and final challenge to science. The expression rhetorically conveys something of the awe and mystery which anyone who contemplates the brain and its functions must feel. But as an assertion the cliché is simply false, and it is false in a very revealing way. In the room in which people listened to this talk were people. While in each person was a brain, the system which linked people together and enabled them to understand one other was assuredly more complex than any one brain.