



JON DRIVER

Jonathon Stevens Driver

1962–2011

JONATHON STEVENS DRIVER, psychologist and cognitive neuroscientist, was born in Halifax, West Yorkshire on 4 July 1962, the son of Dennis Driver and his wife Jane (née Stevens). Both his parents' families originated from the Halifax area where village life was based around the Chapel. His father was a Lecturer in Mathematics and Warden of Grant Hall at Hull University and his mother was a librarian at Cottingham High School.

The family moved to Hull when Jon was three and moved on to the Lawns campus of the University of Hull when he was eight. Jon had a happy childhood with his parents and two sisters: the splendid Warden's house on the Lawns provided the ideal setting for such a sociable family to host large gatherings of family and friends. The open spaces and the academic environment of the university also provided an ideal setting for his wide-ranging and deep thinking to start to develop. During this time a number of lifelong interests emerged.

At a young age Jon became interested in fishing while on family holidays, and was not deterred even after encounters with freak waves. He was later introduced to the art of fly-fishing by a local doctor, developing great skill and almost always succeeding by the end of the day; and if not, at least there was always the one that got away. Jon's lifelong love of fishing also promoted his love of the countryside. Even though in later years he was based in Crouch End and University College London (UCL), he always had a yearning for the country life: perhaps a small town or village near a fine chalk stream. As with many dreams, this was not to be, but occasional trips out to his favourite fishing haunts remained part of his life, no matter how hectic and successful his career and life became.

His second passion was music, motivated by his father's family who played the piano and sang in chapel choirs. Both Jon and his sisters took piano lessons as children. He did not pursue this, but was already showing talent, as reflected in his teacher's request to continue playing duets even when he moved on to new interests. While studying at Hymers College in Hull he played the cello; but increasingly he spent far more of his time developing his skills with his bass guitar. His passion and talent for music almost led to a very different career. He played in various bands in Hull, but most notably with a four-piece band called The London Boys. They had some initial success in the early 1980s, featuring on a compilation album and playing locally.¹ Although he made the difficult decision to leave the band when he left for university, his interest in music continued; his knowledge always impressed, and he collected and played all sorts of guitars for the rest of his life.

His third and most important passion arose after a chance event. His mother brought home a couple of books from her library to occupy his restless mind. These happened to be psychology books, written by Richard Gregory and Alexander Luria, two of the most influential individuals in the field, known for their insights and fluent thought-provoking writing styles. At this time psychology was a subject rarely taught in schools, but his reading coincided with memorable encounters with neurological patients while he volunteered at local hospitals and his grandmother's suffering from Parkinson's disease. As often in life, this chance event was to provide the seed from which such a remarkable career was to emerge and flourish. It determined where and what he would study when he left his school: The Queen's College, Oxford, reading Experimental Psychology.

During his undergraduate years, as always, Jon excelled, graduating with a first-class degree in 1984. His talent was clear, and Allan Allport and Peter McLeod were delighted when he decided after graduation to undertake a D.Phil. at Oxford. Oxford was the ideal place for his continuing studies. Jon had become intrigued by the selective mechanisms of the brain; how, from the vast array of perceptual inputs constantly flooding into the brain through sight, sound, smell, taste and touch, a coherent and focused representation was achieved. Oxford was not only a world class psychology department, but it also contained some of the world's leading researchers in this area. Jon's graduate studies in Oxford resulted in a remarkable quantity of first-rate research, but it was never all work for

¹One of their songs can be heard here: <http://www.youtube.com/watch?v=qw6X4NMjHDc&feature=player_embedded>.

Jon. Fine chalk streams for his fishing were also within easy reach of Oxford. And he established and ran the Stage Club, where his knowledge of music was appreciated by packed crowds.

During this period he started collaborating with Gordon Baylis and myself. These collaborations produced not only exciting research findings but also resulted in lifelong friendship. I still recall with fondness long discussions with Jon in Oxford pubs, him leaning back with pint in hand, giving one of his sceptical looks as I described my ideas. It was always important for me to put experimental designs to the 'Driver test' before pursuing them further. Even when he pointed out what was wrong, he always produced a more decisive approach to solve the problem.

One topic in his thesis concerned the inhibitory control processes that enable selection of relevant information. At the time the more dominant account of selection was that it was a primarily excitatory process, where the internal representations of desired stimuli were boosted above background levels, while distracting information passively decayed. Jon's work helped overturn this view by providing evidence for inhibitory processes actively suppressing to-be-ignored information. This work also demonstrated a flaw in the interpretation of one of the main experimental measures at the time. That is, processing of a to-be-ignored stimulus was measured by how much it interfered with processing of a target. It had previously been assumed that no interference meant no processing of the ignored stimulus. Jon showed that in fact this was not the case, and other techniques such as priming could reveal that non-interfering distractors were indeed still processed.

His second research theme concerned the frames of reference of these attentional processes. Again a dominant position that Jon helped overturn was the idea that attention was an exclusively spatial process, where a spotlight was moved from one location to another highlighting relevant information on an internal map. Working with his supervisor Peter McLeod, and developing collaborations with Baylis, he showed that this spatial metaphor was incorrect, and that attention mechanisms could act on object-based representations, where for instance inhibition of an irrelevant object would move through space as the object moved. The collaboration with Baylis continued over many years, and Jon's accounts of object-based attention remain influential, as reflected in the many citations his work has received since.

After completing his D.Phil. he was awarded a James S. McDonnell Foundation post-doc to work with Mike Posner at the University of Oregon. Jon commented that this was probably the most important year

in his career. Oregon was a first rate department, and Posner was one of the most influential scientists studying selective attention processes. Working with such a strong group, and experiencing academic life in the American system, would provide invaluable experience on his return to the UK.

During this time he also met Bob Rafal, spending the second half of the year in California at the Martinez VA Hospital. Rafal had come to experimental psychology via a different route, training in medicine and specialising in neurology. Although Jon had previously studied individuals who had suffered brain damage, it was working with Rafal where he felt he gained most insight. Direct contact with patients on the front line of the clinic revealed to him the day-to-day problems they faced and enabled him to realise how pathology could reveal insights to brain processes that could not be detected by any other means.

While in Oxford, Jon had begun studying neglect patients with Peter Halligan, and he now enthusiastically grasped the opportunity to continue this research line while spending time with Rafal. People with neglect usually have damage to the right side of the brain, often in the parietal lobe, and they behave as if the left side of space no longer exists. The problem appears to be one of a failure to orient attention rather than a failure to perceive, and so was directly relevant to his research interests. These studies, including one published in *Nature* with Baylis and Rafal, showed that symmetry and figure ground segmentation occurred pre-attentively, even in the apparently 'blind' side of space.

He also collaborated with Rob Egly, studying object-based attention and showing that parietal lesions increased the time it took to shift attention between objects more than the time to shift within objects. These studies were early examples of the really symbiotic potential of patient work with well-controlled theoretically grounded cognitive psychology. A subsequent study in a split-brain patient gave evidence for a special role of the left hemisphere in shifting attention between objects. This burst of creative research confirmed for him the importance of studying people with focal brain damage. He felt that such work could identify the forms of residual processing upon which rehabilitation could build and his interests in neuropsychology continued throughout his career.

But perhaps the main reason why this brief time in the USA was important for him was that he met his future wife, Nilli Lavie, at the Summer Institute for Cognitive Neuroscience at Dartmouth. Nilli was also an experimental psychologist at an early stage of her career. She was already beginning her influential work describing the load theory of atten-

tion, which resolved some open debates in the field, providing a unifying account. For Jon it seems this was love at first sight: the complete package of intelligence and beauty. They remained together as husband and wife, intellectual soul mates and parents of two sons to the end. This was a classic academic marriage: love and support, but with the edge of intellectual competition and challenge of ideas as they continued their, mostly parallel, investigations of selective attention.

After this productive period in the USA he returned to the UK, taking a lectureship at Cambridge. During this time he established his research programme and started to develop the ideas that were born while in Oregon, concerning the integration of the senses. With his Ph.D. student, Charles Spence, he carried out groundbreaking studies showing that attention could be captured by one modality, such as sound or touch, and facilitate processing within another modality such as vision, as long as both sources of input came from the same location. For example, an irrelevant touch to the hand automatically attracted attention to that location and facilitated the processing of a visual stimulus near the hand.

He developed this research programme further in subsequent years by combining psychophysics, studies of patients with brain damage and imaging techniques such as evoked related potentials (ERP) and functional magnetic resonance imaging (fMRI), to identify the neural systems mediating these multisensory effects. His findings were remarkable, such as the demonstration that higher-level structures encoding multimodal information can feedback and influence distant unimodal processing systems, such as visual cortex. Demonstrating the multimodal nature of perception and the interactions between different cortical structures provided a framework for understanding how damage to high-level structures can influence the processing of earlier intact neural systems.

After Cambridge, Jon accepted a Chair at Birkbeck, only eight years after gaining his D.Phil. By this time it was clear that he was an exceptional scientist, as this rapid rise to the eminent position of professor reflects. His stay in Birkbeck was short, and by 1998 he had accepted a Chair at the Institute of Cognitive Neuroscience (ICN) at UCL. The rapid move from Birkbeck to UCL was prompted by his acute awareness of the dramatic change in experimental psychology brought about by the rising dominance of new brain imaging technologies, such as fMRI. Jon had quickly seen that the emergence of non-invasive brain imaging technology provided a step change in our abilities to understand the brain. The new technologies provided exciting new ways to differentiate between different theoretical accounts of psychological processes, and he was always able

to see where the field was moving and what questions would become important, before most others.

This was the perfect moment where the right person arrives in the right place at the right time. He remained at UCL for the rest of his career because the ICN and Wellcome Trust Centre for Neuroimaging provided the cutting edge techniques he required and the Neurology Department at Queen Square provided access to the clinical environment he always felt was so important. Jon's intellectual energy thrived in this environment, generating the publication of hundreds of some of the most influential papers in his field.

Jon's levels of insight and creativity were extraordinary, and it is not possible in this memoir to describe more than a fraction of the many discoveries that he made. But of particular note, he continued to develop exciting new methods for direct, non-invasive study of the interactions between interconnected regions of the human brain. He was acutely aware that each neural system was embedded in a complex interactive network, and that the previous approach of studying each system in isolation was too limited. What was now required was the innovative approach of manipulating the processing of an area of cortex, and directly observing how processing in distant regions was affected; for example, stimulating a brain region with transcranial magnetic stimulation (TMS) and simultaneously observing the impact of this intervention on remote interconnected regions using concurrent fMRI.

This combined TMS-fMRI technique is extremely complex and challenging, and Jon's team was one of the first to achieve these technical breakthroughs and produce clear and important empirical data. He extended this work to show that the interactions between distant neural systems were not hard wired, but influenced by task demands such as the current contents of working memory and the focus of attention. Again, his work provided a step change in our understanding of how the brain mediated complex processes of attention and perception. He coined the term 'remote but interacting brain areas', and the influence of this approach will be felt for some time to come.

During this latter period he also turned his attention to emotional and reward-based modulation of sensory processing. In particular, he wanted to discover how networks in the brain encoding emotion and reward would interact with the networks controlling attention and cross-modal processes. With Patrik Vuilleumier and colleagues, he investigated emotional coding during face perception. They demonstrated, for example, that damage to the amygdala impairs the encoding of fearful face expres-

sions at specific early processing time points (for example, 100 to 150 ms), but that at other periods typical processing is observed. His findings reveal multiple routes to fear expression processing that vary in their dependence on amygdala function.

Most recently, with Patrick Haggard, Jon examined how cross-modal processing could influence the perception of pain. It was demonstrated that merely viewing a body site could reduce reported levels of pain, and this analgesic effect was associated with reduced activity in somatosensory cortex (SI). Most revealing was the interaction between two neural networks: one encoding pain and a second more posterior network activated when viewing the body. The connectivity analysis showed increased interactions between parietal nodes encoding vision of the body with pain networks such as somatosensory area 2, anterior and posterior insula and anterior cingulate. This work again reflects Jon's approach, demonstrating how understanding interactions between neural networks is key to understanding highly complex processes that impact real-world issues such as the control of pain.

Jon was one of the earliest recruits to the ICN, and he clearly helped establish it as a world leading research centre, and a place for ambitious young academics to spend time. His positive influence throughout all aspects of the ICN meant that when Tim Shallice retired from the Directorship, Jon was the natural successor. Even though this would be a heavy administrative role he generously took over the Directorship in 2004. He was a natural and popular choice to take on the leadership, and it was clear as the Institute developed over the next years that it was the right choice. His energy, creativity and generosity provided guidance, support and leadership for colleagues and students while the Institute continued to develop its world-leading reputation with further appointments of leading academics.

What was also remarkable during this period was that Jon not only guided the Institute and continued personally to produce large numbers of world-class research outputs, but he also played a central, perhaps leading, role in securing the new Sainsbury-Wellcome Centre for Neural Circuits and Behaviour, which will be completed at UCL in 2014. There is no doubt that the time and energy he expended on this was substantial and his creativity and insight would have enabled an impressive proposal to be established. This is the largest single investment in neuroscience in the UK, and it is sad that he never saw the results of his dedicated energy and creativity. Nevertheless, this is one of many legacies for which he is owed a great deal.

In 2009 he stepped down from the Directorship of the ICN when he was awarded a Royal Society Anniversary Research Professorship. The award celebrated 350 years of the Royal Society, and Jon's award was a remarkable achievement as only six were awarded across all areas of science. This provided him with ten uninterrupted years of research support, and he now felt real progress could be made. When considering how much he had already achieved with teaching demands and the burden of Directorship on his shoulders, it is hard to imagine the volume and quality of output 'real progress' might reflect. Certainly many of his colleagues were expecting further step-changes in our understanding of the neural systems mediating perception and attention.

Jon Driver is acknowledged by his peers internationally as one of the most exceptional cognitive neuroscientists of his generation. His achievements in a short period of time were remarkable. His studies were groundbreaking, shedding new light on normal brain functioning and the disabling cognitive deficits after brain damage, employing innovative combinations of techniques such as concurrent TMS and fMRI to identify causal influences between remote but interconnected regions in extended networks of the human brain and, most importantly, his experiments possessed a simplicity and elegance that could be breathtaking. At the time of his death he had published over 300 research articles, his citation count was over 16,000, and he had an h-index of 73 (Web of Knowledge). The outstanding research achievements were reflected in numerous awards such as the Spearman Medal and President's Award from the British Psychology Society and the mid-career award from the Experimental Psychology Society; he was elected to the Academy of Medical Sciences in 2005, and a Fellow of the British Academy in 2008.

Even though his achievements were already monumental, his productivity was increasing, and we can be sure that the best was yet to come. His Royal Society grant gave him the freedom to develop his long-term research programme over the next decade. This would, without doubt, enable him to go significantly beyond what he had already achieved. Driver was approaching his peak. But in a moment, while riding his scooter home from work, a car accident was the beginning of the end. He was seriously injured, and after two bouts of failed surgical intervention, was consigned to an existence of permanent disability. Unable to work, and suffering relentless excruciating neuropathic pain and mental anguish, he could not continue. On 28 November 2011, he committed suicide. He was only 49 years old.

Jon will not just be remembered for his remarkable intellect and achievements in science, but also for the sort of man he was. His powerful intelligence could make him intimidating to both students and colleagues. Within a very short time he could reach to the core of an issue: his questions would reveal the flaws to an argument, and confounds in an experimental design. And his creativity and insightfulness was such that occasionally colleagues could be hesitant in proposing their ideas. But this was simply a reflection of his single-minded focus on intellectual clarity and rigour; and there was never any intent to intimidate, only to stimulate and guide. Indeed, the sixty Ph.D. students and postdocs he supervised and mentored, colleagues around the globe, friends and most importantly family, were always central to his life. His concern was for the person, both academic and personal, and a belief in helping each person achieve their full potential. For those of us observing his incredible creativity and productivity, it was hard to understand how he always seemed to have time for a chat and provide a kind word and support. His sudden death had a profound impact on cognitive psychologists and neuroscientists around the world. As well as the intense sadness at the loss of such a remarkable and influential person, there remains the constant questioning of what might have been.

STEVEN TIPPER

Fellow of the Academy

