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# Colwyn Trevarthen: Mentor and friend

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ABSTRACT

As a pioneer of the burgeoning research field of imaging neuroscience, I describe the pivotal role of Colwyn Trevarthen during my interactions with him over 30 years, in inspiring and guiding the enquiries that led to unprecedented measurements of brain activity associated with human performance.

## Early Years: 1979-84

I first met Colwyn Trevarthen in 1979, through a mutual friend, David Bloor, a member of the University of Edinburgh's Science Studies Unit. I was then conducting a participant-observer ethnographic study of a fishing village a few miles east of Edinburgh, focused particularly on the sociology of knowledge in the social context of a new enormous electrical power station recently built adjacent to the village. I wanted to assess the extent to which science-based ideology had filtered into the deeply religious and traditional local world-view. At this time, Colwyn, assisted by Lynne Murray, was researching mother-infant communicative interactions. Hearing of my study, and wishing to enrich his own observations made in controlled laboratory conditions, Colwyn approached me with a request that I take careful note of day-to-day mother-infant interactions in the community of my study. I had to tell him that as a man of 33, I had no entrée into the world of young mothers in the fishing community, and I could not even offer the help of my wife, because she had no contact with local women, being engrossed in completing her university degree in theology.

However, this introduction really set something in motion. From the very beginning, Colwyn's humanistic view of psychology resonated with me. I was impressed by his scepticism regarding cognitivist approaches to the human mind, that neglect embodiment and the overwhelming importance of neuroanatomy. His appreciation of human diversity and the dialectic between genetic inheritance, upbringing and culture matched the awareness that I gained during my childhood in the African bush as a son of the anthropologists Vic and Edie Turner. Our conversations were long and wide-ranging, and catalysed a productive interaction between Colwyn and my parents (Turner, 2012a,b), culminating in their joint participation in the Star Island Summer Conference of the Institute on Religion in an Age of Science, in 1983.

My academic background is a BA degree in physics and mathematics, and a PhD in physics. After three years as a physics postdoctoral fellow at the Cavendish Laboratory at Cambridge, pursuing research into liquid metals, and then liquid crystals, I had left in 1975 to study social anthropology for two years at University College London. There I was taught that in the interpretation of other cultures, Western concepts and categories regarding social behaviour should be given little place. Other cultures should rather be understood in their own right, as arising from the traditions, economics, and beliefs of their social participants. This laudably relativistic approach obviously and immediately poses the severe problem of the translation of culture, the question of what aspects of human nature and cognition can be assumed to be consistent across our species, as natural kinds.

In 1978 I obtained funding from the UK's Social Science Research Council to pursue the ethnographic field work research just mentioned, as a research fellow at the University of Edinburgh, under the supervision of Roy Willis. Later that year, already embarked on this study, and living in the semi-derelict fisherman's cottage that my wife and I were laboriously renovating, I read the famous paper by Niels Lassen and David Ingvar recently published in Scientific American, in which they used $^{133}$Xe- SPECT to image changes in cerebral blood flow associated with specific brain tasks. I found the Lassen and Ingvar results highly relevant to the question of how much human brains work alike, and to what extent their operations are modified by cultural variables.

In 1982, by then again teaching physics at Napier College in Edinburgh while supervising two Edinburgh University PhD students who were performing a follow-up anthropological fieldwork study, I was introduced to magnetic resonance imaging (MRI) in a lecture by John Mallard. It was Mallard's team at the University of Aberdeen that designed the first commercial MRI scanner, and one of these had just been installed at the Edinburgh Royal Infirmary. "Could MRI be useful in investigating cross-cultural consistency and variation in human brain structure and function?" was the question I asked myself.

Very soon I was discussing this possibility with Colwyn Trevarthen, who had already encountered brain imaging techniques in relation to the celebrated split-brain studies on epilepsy patients he had engaged in with Roger Sperry. I made it my goal from that day on to investigate whether MRI could be used to measure human brain function as well as anatomy, and whether this could shed light on the deep similarities and

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differences between people living in different societies and different cultures. At that stage, Colwyn and I talked about comparative quantitative measurements of the corpus callosum, the massive band of white matter nerve fibres connecting the two cerebral hemispheres. Colwyn brought me up to date with the very meagre literature then available.

One weekend in the spring of 1983, I was casually browsing a Sunday newspaper when I noticed a small advertisement for a temporary lectureship at the University of Nottingham, with the opportunity to work with Peter Mansfield (later Sir Peter), one of the two pioneering inventors of MRI. I applied for this position, and was immediately offered the job, which entailed leaving my home, a tenured lectureship position, and many friends in Scotland. Mansfield's particular research goal at that time was to carry through to wider acceptance an extremely fast MRI technique that he had invented in 1977, Echo-Planar Imaging (EPI), which requires only a fraction of a second to collect enough data for a complete two-dimensional cross section of a body part.

While Mansfield's lab was initially dedicated to imaging of the beating heart, I realized that such a rapid technique might also find a role in mapping brain activity. I joined the Nottingham Physics Department in January 1984, just after my father's untimely death in Virginia, and set about building an MRI scanner in order to understand properly how the technique worked. In 1986, using Peter Mansfield's more powerful 0.5T MRI scanner, I performed an unsuccessful experiment using EPI on my own brain, which was intended to show changes in brain activity between eyes-shut and eyes-open. During the same year I proposed another strategy, diffusion-weighted MRI, to measure and map capillary blood flow in the cerebral cortex, which I presented at a summer school in L'Aquila, Italy. On regular social visits back to Edinburgh I kept Colwyn informed of these efforts.

## The rise of neuroimaging: 1984-present

But it was not until 1989, after I had moved to the Biomedical and Engineering Instrumentation Program at the National Institutes of Health in Bethesda, Maryland, that I was again able to test out my ideas for functional brain mapping, this time using a commercial GE MRI scanner at 1.5 T, retrofitted with a high-performance home-built head-only gradient coil to enable echo-planar imaging. These ideas, evolving into a method for mapping cerebral blood oxygenation, came to fruition in May 1991 at the Massachusetts General Hospital's MRI research lab, when a collaborative partnership between me and Ken Kwong, together with his colleagues at Harvard Medical School, achieved the first-ever non-invasive MR images of human brain function.

The resulting explosion of research on human brain function using functional MRI (fMRI) swept me rapidly (in late 1993) into a Wellcome Principal Research Fellowship and a Personal Chair at University College London, at the Functional Imaging Laboratory (FIL) of the Wellcome Department of Cognitive Neurology (as it was then called). Papers from this lab, in which I was the senior physicist, began to pour into the top journals—Nature, Science, Neuron, PNAS. Besides a few physics and statistical analysis methods papers, these mostly described the mapping of the neural correlates of a wide range of mental activities, identifying discrete 'blobs' representing the average activity over many individual brains while the experimental psychological task was being performed.

Keeping well in touch with Colwyn Trevarthen over those heady and exciting years, I have found that his misgivings over the concepts of cognitive psychology became more and more timely. An important aspect of cognitivism, as an approach to cognitive psychology, is that it breaks down the processes of thought into 'modules' that perform particular tasks and combine in different ways for specific mental purposes. Many neuroscientists fell in love with the idea that such modules could at last be depicted as brain regions or networks of brain regions. Although based on frequently unexamined assumptions, the methods that my colleagues and I established at the FIL for designing experiments, for making measurements, for analyzing the data, and for interpreting the findings rapidly became adopted across the world. Among other ground-breaking achievements, the FIL was a prime mover in the founding of a new scientific journal NeuroImage, which has become one of the largest, most important and most influential journals in neuroscience.

But Colwyn's much more embodied view of mind, increasingly shared by a new generation of psychologists and neurophilosophers such as Sean Gallagher, rejects this modular cognitivist approach, arguing that there are few truly empirical methods for demonstrating the existence of any specific theoretical module in the human mind or brain. By contrast, interaction theory, built largely on Colwyn's seminal ideas published in the 1970's, "looks to embodied processes (involving movement, gesture, facial expression, vocal intonation, etc.) and the dynamics of intersubjective interactions (joint attention, joint action, and processes not confined to an individual system) in highly contextualized situations to explain social cognition" (Gallagher and Varga, 2015) and indeed, by extension, cognition in general. Inspired by Colwyn's approach, I have critiqued the ethnocentrism of the ontology of cognitive science (Turner, 2012a,b).

The search for brain models which incorporate this enactivist perspective (Gallagher 2017), and pay the respect to neuroanatomical details that they deserve (Turner and De Haan, 2017), is likely to become a major theme in human systems neuroscience in the decades to come. Psychology, properly defined as a science built on the understanding of our brains and how they are incorporated in our bodies, owes a great debt to Colwyn Trevarthen's penetrating humanistic insights. Once we have established sound, testable mechanistic models of properly defined normal mental processes, including as fully as possible the powerful shaping forces of social and cultural experience, we can look forward to far more effective and compassionate treatments of mental disorders (Trevarthen et al., 2014). Above all, we must never imagine that human persons comprise only their brains.

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