Laudation for Tom Baden

Senior Lecturer in Neuroscience at the University of Sussex, Brighton, United Kingdom;
Winner of the Eppendorf Award for Young European Investigators 2017

The laudation was held by the Eppendorf Award Committee Member Prof. Maria Leptin (EMBO Director) at the prize ceremony at the EMBL Advanced Training Centre in Heidelberg on June 22, 2017.

» It is a pleasure to introduce Tom Baden as this year's winner of the Eppendorf prize.

Before I come to him specifically, I would like to make a general comment about the choices the committee has made over the last few years. In particular, it is very interesting to look at the fields represented by the candidates we have chosen: Ben Lehner, with a novel approach to evolution; Liz Murchison working on transmissible cancer; Madeleine Lancaster with brain organoids. These are all highly innovative and cutting edge topics. However, we didn't choose the fields, but we chose the people. What this shows is that the best among the young go for new, uncharted territory.

And Tom Baden today is no exception.

There is another point about him you will notice as I go along: he did everything the way we tell people NOT to do things: he stayed on where he was for his PhD; he took on a postdoctoral project that happened to be offered rather than determining his own, etc. This too shows that the good people will make their own way on their own terms. To me it also says you should largely ignore the routine career advice that is dispensed so enthusiastically everywhere. That advice may prevent you from ending up at the bottom, but it's not what you need if you want to end up at the top. You need the kind of independence of thought that Tom's CV has shown.

We are used to reading in applicants' essays 'I have always wanted to be a scientist'. When Laura Machesky and I interviewed Tom, he said something similar, but a single word made it profoundly different: 'I always KNEW I would be a scientist'.

He got there on a perhaps slightly unusual path: After finishing school, he did his social service as a conscientious objector to military service in a research hospital, in the department of neuropathology in Bonn, where he was given a menial task (doing PCRs). He

concluded from this experience that 'science is great, but PCR is not what I want to do'. He had set his aim slightly higher: he wanted to 'better understand computation in the brain'.

Coming from some people, this might sound slightly megalomaniac – but Tom is actually very modest. He attributes all his successes to luck, or to simply being in the right place at the right time. For example, he credits part of his success to his interests coinciding with the advent of new imaging methods, and the 'input from others', saying he was 'lucky to ride the wave' (but we do know that others go under when they try to ride big waves!). Tom's modesty is a wonderful character trait, and we could use more people like that, but even if Tom was lucky, that was of course not purely by chance, because (a) luck favours the prepared mind, and (b) it helps to put you in a situation where luck has a chance of striking. You do choose your environment, even if you don't do it in the sense of 'planning your career', and Tom seems to have had a knack for finding the right environments.

Tom started his scientific career in Cambridge, where, as an undergrad with Holger Krapp he looked at fly visual neurons, and was amazed that it was possible to watch calcium flashes in neurons firing in a living animal while the animal was watching the world go by. He says he got hooked by working on experiments recording the activity of individual fly neurons, and you could image them live, and see the reaction when you waved your hands in front of the fly's eyes. You could see a single neuron responding.

He continued in neuroscience for his PhD, working on auditory neural signaling and processing in crickets, and one significant point he mentioned about why he enjoyed his PhD was it that was a 'really small lab'. Senior people in the audience, and funders, and institute directors, take note!

For his postdoc, he went down the road from the centre of Cambridge to the LMB where he began to work on synaptic plasticity, using vivo imaging, electrophysiology and genetics in zebrafish (with Leon Lagnado). This is one of the examples about not following the dogma: you're supposed to move to new fields after your PhD – both geographically and intellectually. And it gets apparently worse if you consider the answer he gave to my question "how did you decide?": 'honestly, very random'. He had previously submitted a grant for an independent project, which didn't get funded (he actually sounded like he was surprised about this at the time!), so he needed a position fast.

He subsequently went on to work with Thomas Euler in Tübingen (one of the leading locations for neurobiology!), to do a second postdoc, moving from fish to mouse. Again, not in line with manuals on career advice for ambitious you scientists, he went there for a project that had been pre-set by the PI, and which eventually ended up taking 6 years to complete. But he had a lot of liberty to pursue own projects, so again had found a great environment.

As with his previous steps, he easily turned the situation to his benefit. While he pursued the postdoctoral 'pre-set' project, he also looked at other things, starting on a few small side projects. And he began to apply for his own grants for these, and succeeded. So maybe the pre-set project (that wasn't his own, even if it interested him) gave him the intellectual space to play around with things that were really his own, and to explore them without pressure. Having his own money also meant he was able to recruit people to work with him, and he has singled out his first graduate student, Kathrin Franke, as one the cases of 'luck' that he's had.

How did he end up in Sussex? 'Quite randomly' – once again. Had wanted to go to Switzerland where his girlfriend was at the time (she now has a prestigious position in London), but then found this position which suited him very well – a good environment, tenured position, infrastructure in place, and relevant expertise among faculty.

What were Tom's great discoveries?

Tom explains that the retina is like a satellite disk where light from the outside environment is perceived and turned into signals that the brain uses to build a picture of visual reality. It comprises complex networks of receptor cell – the cones and rods – that allow distinction of colour, light and dark, motion and pattern. There are 5-6 strata of different cell types that receive and transmit aspects of a visual stimulus to the brain. Since the 1950's neuroscientists have developed tools such as calcium imaging to record firing of individual neurons in response to light patterns and to allow them to see in real time how the neuronal cells of an animal respond to light.

Central questions surrounding the science of vision include:
> Information processing: How do complex patterns of light get converted into the apparently simple binary language of the neuron, transmitted and stored?
> Handling complexity: We have a finite number of neurons and connections with which to process extremely complex spatial and temporal information – how do so relatively few cells and connections handle this complexity?

Tom Baden's research has made major inroads into understanding both of these central problems. During his postdoctoral studies with Lagnado, Tom became interested in the bipolar cell, a cell which sits in between the receptive rods and cones and the transmitting ganglion cells. The retina has 125 million photoreceptors, but only around 1 million axons in the optic nerve. Thus, information from images must be processed and compressed to be transmitted to the brain.

The bipolar cell is an information processor – it converts the signals received by the rod and cone cells into calcium spikes that are then relayed to the brain via ganglion cells. Tom discovered that bipolar cells use multiplexing to handle complex signals and transmit outputs that vary in intensity and frequency to communicate visual stimuli. This was particularly exciting because rather than just functioning as go-between cells, bipolar cells transmit multiple types of signal (varying intensity, gain and adaptation) via their multiple synaptic terminals of different size. Tom's discovery of multiplexing helped explain how a finite number of receptors could encode and relay complex signals about position and motion to the brain using this multiplexing feature. Thus, Tom was living his dream of solving how the brain computes information.

Although he sees this (PLoS Biology paper) as his best paper, it was not noticed as much as he thought it deserved to be, with relatively few citations. His paper on ganglion cells is much better known. But the finding he describes in it was discovered again by a more famous person two years later and published in Nature, 'so it felt good to know that I had been right, and had been first'.

Tom also discovered (he says stumbled across) that bipolar cells, thought to respond with a graded (analog) increase in signaling in response to light, could signal with an all or nothing (digital) spike. Rather than ignore this anomaly, Tom found this spiking interesting and

pursued it to show that spiking occurs in vivo in response to visual stimuli. This was a textbook changing discovery, as these cells were not known to be capable of both digital and analog signaling. Tom went on to show that bipolar cells could signal with millisecond precision and thus contribute to the extremely fast resolution of the retina. Spikes might also help to filter out noise and to integrate the excitatory and inhibitory signals.

Finally, Tom also does important and interesting stuff outside his science, the most notable perhaps his engagement with enabling science in Africa. This started as a venture to teach neurobiology in Africa – called TReND in Africa, Tom organised an international neuroscience PhD programme for African PhD students that has so far graduated over 100 students. He hopes that these alumni will propagate the learning and that he has seeded an exciting future of neuroscience research in Africa. Along with this effort, he has developed protocols for using 3D printers to make cheap lab equipment for researchers in Africa, and teaches them how to do it. Now that 3D printers are available relatively cheaply and are increasing in quality, many labs in developing countries could take advantage of what Tom calls 'Open Labware' which he curates together with PLoS Biology.

He considers this type of outreach as very important, but is again humble about his efforts, saying only he 'needs it to get out a bit', and feels that it's good for him because 'happy people work better'. Well, it looks like he's proved that point, it's good to see such a happy and successful person; choosing and interviewing him has made me happy, and I think we are now all happy to hear his scientific presentation. «