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CONVERSATION

Early career researchers: an interview with Simon Sponberg

Simon Sponberg is an Assistant Professor at the Georgia Institute of Technology, USA, where he studies neuromechanics and locomotor control. He received his joint honours Bachelor's degree in Biology and Physics from Lewis and Clark College, USA, in 2002 before moving to complete his PhD with Bob Full at the University of California, Berkeley, USA. He then completed a postdoc at the University of Washington, USA, with Tom Daniel and Adrienne Fairhall. Simon won a Young Investigator Award from the International Society for Neuroethology in 2014.

How did you get the science bug?

What really interested me in science was looking at the patterns in the world, and I got particularly interested in this in middle school. I had a very good teacher, Mr Gagermeier, who introduced me to fractals and chaos theory and got me interested in the Future Problem Solvers programme. In that programme, you get together with a team of people and you are given a situation that happens some time in the next century and then you have to brainstorm the problems that might arise, anticipate a central problem from these and then generate possible solutions; for example, the colonisation of Mars or superbug out-breaks across the world. It was a very fun way to explore problems from a lot of different perspectives and you got rewarded for creativity in the way that you looked at the situation, the problems that might arise and the solutions you came up with. It encourages you to synthesise a lot of different information and to do it in a very quick time. We attended several competitions over the year, starting at the state level and then we went to the national competition, which had some international teams too. We were reasonably successful. All the topics had some elements of science and technology but also there was a lot about economics, society, religion and culture; it was quite diverse. It is a great way to think about science and what the processes are that lead to the patterns that we see around us.

The programme led me to appreciate this type of thinking, so I started taking a lot more science classes in high school. I never really developed a strong sense that I liked one of the sciences more than another. When I started my undergraduate degree, I had a conversation with one of the faculty members, Michael Broide, at the school that I was thinking of going to and I told him that I was very interested in physics, but that I was also interested in biological systems, because life seemed to have very interesting patterns. I was interested in looking at ways that we could integrate multiple fields of science and he said 'Oh great, I'm a biophysicist, that is exactly what we do'. That is one of the reasons that I went to Lewis and Clark College, which is a small liberal arts college in Portland, OR, USA.

Can you tell me about your undergraduate experience?

At the time, Lewis and Clark had about 1600 undergraduate students, so it was about the size of my high school. It was very small, but quite a wonderful experience. You can access extraordinary scholarship in liberal arts colleges because the class sizes were much smaller, you could be on first-name terms not just with the faulty members in your department but also with all the science faculty and the philosophy faculty, so you could go and have wonderful conversations about different topics with different people all the time. Plus, it had exceptional faculty members who were doing some awesome research. I did research every summer with different faculty and that gave me a diverse range of experiences.

Lewis and Clark had an endowed summer science research programme. If you were a science student, you could get paid to work for the summer in one of the labs, which encouraged most of the science students who wanted to engage with research. I also think it really helped the faculty members, because in liberal arts colleges they rely a lot on the undergraduates to do research. This also means that the undergraduates are not at the bottom of the lab hierarchy; you can do something significant since it is just you and the faculty member, you can learn from them directly and engage with the research. All of the projects that I worked on were very formative. During my first project, I worked with a chemistry professor and a biophysicist, Janis Lockner and Bethe Scalletar. We were studying transport in neurons and how they grow. Neural transport is quite challenging, because neurons are so long; it is difficult to transport material from the nucleus out to the peripheral edges.

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I was a double major in biology and physics, but basically I did a physics degree first and then I did a biology degree because I got very excited by classical dynamics, Newton's laws and Hamiltonian and Lagrangian formulations, but I couldn't find a place where they would have an impact on the macroscopic patterns that we were seeing in biology. I was casting around looking for things that were interesting and I met a biology faculty member, Keller Autumn, who had just started. He taught a comparative physiology class with very modern laboratory-based approaches. It was an excellent class and it got me very interested in physiological systems and biomechanics. His research was looking at how geckos stick to walls and we spent a couple of really fun years exploring the mechanism of this adhesion. I like to look at physical phenomena that manifest in biological systems and I want to advocate that you can ask physics questions in a biological system at the same time that you can ask questions that are very relevant for biology.

What did you decide to do after completing your undergraduate degrees in physics and biology?

I ended up doing my PhD with Bob Full at the University of California, Berkeley, USA, in the Integrative Biology department with a focus on biomechanics. Bob is one of the most synthetic thinkers I know, meaning he can pull ideas from really far-flung fields, see the connections, and put them together in an exciting picture. I was also really impressed by the other students at Berkeley; I felt they were people who were really motivated to pursue their own individual research interests. Also, I really liked the flexibility of the programme there; there were no required classes for my PhD except for having completed a course on evolution, so I could take classes from a number of different departments and get input from a number of different professors and create my own path.

Who did you work with during your postdoc?

I went to the University of Washington, where I worked with two faculty members. I was primarily in the lab of Tom Daniel in Biology but I was also co-advised by Adrienne Fairhall, who comes from a physics and computational neuroscience background and was in the Department of Physiology and Biophysics. Adrienne thinks about problems of neuroscience in a very different way; she introduced me to the field of computational neuroscience and the way a physicist might think about these problems. Tom has a very interesting background and is one of the most interdisciplinary scientists I have ever met. Tom's lab can seem an intimidating place to work because he draws students and projects from all over the place, but he is such a good communicator and advisor that you pretty quickly feel comfortable. I think advising in a way that creates a scientific community and a dialogue is extraordinarily challenging. But it really benefits both the quality of science and the happiness of the scientists. I hope to gain enough wisdom to be able to emulate that environment in my own lab.

Can you tell us about your experience of working with the media?

In 2015, we published a paper in *Science*, 'Luminance dependent visual processing allows moth flight in low light'. I started the work with Tom near the end of my postdoc and continued once I became a faculty member at Georgia Tech. I had dealt with the media previously in smaller cases, but this was the most systematic coverage that I had got. Learning that you really have to sharpen your message was interesting. You have to come up with ways to describe your work that are tractable in a non-jargony way, so that involves a lot of use of metaphors – analogies to things people have direct experience of that they can relate to. In the case of the moth study, the idea was that they effectively slow their brains down, so they can process light with a greater degree of sensitivity, and that is a lot like increasing the exposure time in your camera – leaving your shutter open for a longer time. That gives you a lot more light, but it makes the images blurry and that is the trade-off for slowing things down and integrating light for a longer period of time. I had a lot of help from the Georgia Tech communications team and I think it is a really good idea to learn how to work with these folks at whatever institution you are at. It can make a big difference to how the public and other scientists see your work.

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Can you tell us about an unusual piece of equipment that you use?

We go to the Argonne National Laboratory, USA, and use their Advance Photon Source (APS). The APS is a synchrotron that starts by firing up electrons through a linear accelerator tens of metres long, boosting them to even higher energies in a circular track and then storing and focusing them in a storage ring that is over a kilometre long. The synchrotron then produces very focused, very bright X-rays that we use to image things that are very, very small. When we are there, we sort of do protein crystallography, except on proteins in muscles that are already arranged as if they were in a crystal. I like to think of muscle as a living crystal. It turns out that if you look at muscle at the nanometre (10^{-9} m) scale, it is composed of many long thin filamentous proteins. There are two types, actin and myosin, and they alternate to form a very regular structure. The arrangement is so regular that when you shoot X-rays of the appropriate wavelength through them you get a diffraction pattern. This is wonderfully full-circle for me, coming back to my introductory physics labs where we did two slit diffraction experiments and now we are doing that through living tissue. The cool thing about muscle is you can do that while the tissue is still viable, while it can still undergo contractions. We have been looking at the spacing changes in the muscle lattice and how they scale up to the changes in function at the macroscopic scale with Tom Irving, who runs the BioCAT line at Argonne National Lab, Tom Daniel and Dave Williams at University of Washington, and Peko Hosoi and José Alvarado at the Massachusetts Institute of Technology, USA. We essentially do high-speed video at the molecular level at the same time that we measure the macroscopic behaviour of the system. I think that is one of the interesting things in modern biophysics – understanding how behaviour at the macroscopic level emerges from behaviour at smaller scales.

How important are fellowships and awards for early-career researchers?

Two awards have been most formative for me. One was a Fannie and John Hertz Foundation fellowship, which a lot of people in biology don't know about. It is an incredibly powerful and liberating fellowship because it gives you 5 years of full funding as a graduate student that you can take anywhere, so it decouples you from your advisor and your school. The Hertz Foundation folks are adamant that that is the purpose of the award. It is a competitive fellowship, but it is about more than just the money; you get a community of very inspired thinkers around you who help push you in new directions. I still have connections to a number of the Hertz fellows. We had retreats every summer in the San Francisco Bay Area and there was a broad diversity of people to interact with. I was also funded as a postdoc by a National

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Science Foundation Biological Informatics Postdoctoral Fellowship, which was really beneficial because that allowed me to work with Tom and Adrienne; the fellowship required you to have two advisors.

One of the underappreciated benefits of fellowships is the act of applying for them, because you have to write and articulate your ideas. I think that is one of the most important reasons to have a grant structure in science, so that you write and sharpen your ideas prior to going out and engaging in research. That can really help you to cope, especially when you are dealing with very complex systems where there are a lot of different ways to approach problems. It is also really important to start that early in your career.

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I also won a Young Investigator Award from the International Society for Neuroethology, which is doing a remarkable job supporting young scientists. Their meetings are set up to highlight and promote work by young researchers. The award allowed me to give a symposium talk at their International Congress in Neuroethology when it was in Sapporo, Japan, in 2014. Providing these platforms where postdocs and young investigators that are just starting their careers can lay out their vision and framework is an extraordinary service to the community.

Do you prefer to publish open access and if so why?

I do like to publish open access when available, but I think as an early-career scientist my philosophy is to publish where I think my work will have the most impact. Fortunately, that is in open access journals more and more often. However, I also feel that I have to get my career established before I can be a good advocate for open access. Actually, the first thing I tend to look for is whether the publishing location is for profit or not-for-profit. I also think it is important to have more online-only options and preprint servers like arXiv and bioaRxiv to have more ways to publish and disseminate research. Open access is incredibly important but it can be expensive – it is difficult for people to afford – but I understand why there are costs.

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If you could give two pieces of advice to your younger self what would they be?

One is to figure out how to set aside time to push your work towards publication. Setting aside time for writing is very relevant; I would even give myself that advice right now. The other piece of advice is to explicitly seek out a broad supportive mentorship network. It is very hard to create one, especially if you feel the immediate environment around you is not entirely supportive or does not meet your needs. One of the things that I realise as a faculty member is that even though I don't feel that I am unapproachable, I know that when I was a young scientist I sometimes felt that faculty members were unapproachable. If you are a young scientist who is trying to set up a network, it is reasonable to be very direct in asking for help and mentorship, even if there is not a specific need for mentorship at that moment. And it doesn't have to be your primary mentor; in fact, your broader network should be your peers, people older than you and even people younger than you, so that you have a number of people who you communicate with and respect so that you can ask their opinion. In general, it is very flattering to be asked to be a mentor – very few people are going to be insulted if you ask them.

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If you were not an academic, what would you do instead?

If I went out of science I would be a tea shop owner; I love tea. When I was an undergraduate, I studied in China for a semester and I got exposed to a lot of the wonderful teas; I am a big fan of oolong teas. One of the things that I have noticed about tea is that every culture has something, someway, that they express themselves through consumption of a beverage and it is very frequently tea – sometimes coffee is interesting and there are alcohol traditions too – but tea is a pretty diverse one and it is so fun to see the different ways that different cultural perspectives are manifest through the way you drink your tea. The Chinese and Japanese tea ceremonies couldn't be more different, but they are both beautiful and very tasty. I also grew up serving chai in an Indian restaurant in Montana. I have always liked seeing other perspectives and cultures through food and drink.

Simon Sponberg was interviewed by Kathryn Knight. The interview has been edited and condensed with the interviewee's approval.