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CONVERSATION

Early career researchers: an interview with Yossi Yovel

Yossi Yovel is an Assistant Professor at Tel-Aviv University, Israel, where he studies bat echolocation. He received his joint honours Bachelor's degree in Biology and Physics before moving to complete his PhD with Hans-Ulrich Schnitzler at University of Tübingen, Germany, in 2008. He then completed postdocs at the Weizmann Institute, Israel, and University of Chicago, USA.

Where did you go to University?

I went to Tel-Aviv University and I studied biology and physics; I did two degrees in parallel. Biology was for the soul and physics was for being a better scientist. I knew that I needed to study something like physics in order to have the computational skills, but I really liked the courses in biology. At the age of 16 in high school, I chose to study physics as a major, even though I wanted to be a biologist. It was already clear to me that I would need the math skills; without them, I would not be able to do the kind of science that I wanted. In Israel, most people don't start university until they are at least 21 because they have to do Military Service for 3 years from the age of 18: the Israeli military is not professional with professional soldiers. Many also go abroad for 1 year or work after doing their service, so it is very common to start when you are 23 or even 24. I believe that this delay has some advantages for becoming a scientist as Israeli students are more independent and mature. Many people also gained knowledge from their service. For example, many students come from technological units, and they often have experiences that you would only gain in civilian life when you are in your 40s or 50s. I served in Intelligence.

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How did the interruption affect your studies?

University physics is not just a little more difficult than high school, it is one million times more difficult. I was used to everything being easy in high school, but it was difficult at university. In the first month of physics at university, you cover everything that you studied in high school, so it doesn't really matter that it has been a while since you left school. Physics is a lot of work, you have to spend a lot of time doing homework and practising, while in biology you can pick up the book a week before the exam, read it carefully and pass the exam. Most of the courses that I chose to attend in biology were courses on subjects that I really liked, but if it was not possible to attend, I would take the book, read it before the exam and that was enough. When I was in the military, I also learned how to study a lot of material quickly and to try to separate what is important from what is less important. And I was less nervous about exams and grades; it was clear to me that I was coming to study what I like and that it would be OK to get lower grades at what I like less.

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How did you decide where to do your PhD?

That was a difficult decision. There was a direct PhD programme at Tel-Aviv University so I started that, but then less than a year after starting, a friend forwarded an email to me saying that a lab studying bats in Germany was searching for PhD students. I knew that Hans-Ulrich Schnitzler's group in Tübingen, Germany, was studying bat echolocation, because I did a project on bats during my undergraduate degree. I had learned about bats' echolocation system and I realised that this is a system that combines physics and animal behaviour, which was perfect for me. I wrote to him thinking that moving there would never happen; I had already started a PhD and the chances that I would move to Germany were zero. Then I was invited to visit the lab. It was winter and it was snowing and I

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thought that there was no chance that I would ever come to do a PhD in this cold place, but half a year later I was there.

My PhD was a combination of animal behaviour and computational biology. The main question was how do bats classify objects based on their echoes? The idea was to record echoes of different objects – mostly plants, because they are really complex – to see if I could build a machine classifier that can tell apart the different objects. We were able to classify different plants and we showed that we can record an echo from a plant and identify which sort of plant it is, which is something that bats do. At the time, machine learning was mostly discussed by computer scientists so it was not common to apply it to biology, especially not behavioural biology.

What did you move on to after your PhD?

I was thinking, 'OK, I don't do genetics (everybody is doing genetics), I am not recording from neurons (everybody is recording from neurons), I am only looking at behaviour; what can I do with it?' I was in a real dilemma about what I could do next. Once again, an opportunity came along: Nachum Ulanovsky, my postdoc supervisor, opened a lab in the Weizmann Institute doing the neuroscience of bats. He was great and was looking for postdocs, and I was homesick, so I took the job, although I was still wondering if I should leave the whole field and do something that was completely different. However, I was quite lucky and thanks to a quick publication, I was offered a faculty position less than 2 years after starting my first postdoc. The fact that I continued in the same field, studying bats, actually allowed me to show a variety of research and I think this really helped me to get the position. If you are doing something completely new for your postdoc, it takes time to accumulate proof of your ability. I could show a whole story from classifying plants to using sonar in different ways. However, I already had this plan to go to do molecular and genetic work with a simple model organism, so I decided to do it anyway and I went to Chicago for a year, where I did a second postdoc working on *C. elegans* using molecular techniques after I had been promised a faculty position.

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Is international experience essential during the early stages of a research career?

In Israel, it is a considered a must. You do your PhD in Israel and then you do your postdoc abroad. I am probably one of the only cases of a person in Israel who got a faculty position without going down this route. I think that it is important because some people are extremely independent as PhD students and some are not. It is very hard to know if a student did the research or if it was done by the supervisor, so it is important to go abroad to show that you can perform independently.

Can you tell us about your research during your postdoc?

I started working with large microphone arrays to record bat beams, which was a new technology. We were not the first to do so – for example, Cynthia Moss in Maryland did it before us – but we were one of the first. The technique opened a whole new dimension to studying bat echolocation, because now, in addition to recording the signals, you could follow their spatial sensory acquisition, so you can see where they are pointing their signals in space, and this is a new enabling technique. Using this technology, we published a paper in Science in which we showed that bats point their sonar beam to the side, instead of directly, and that this actually allows them to improve object localisation. I think that the faculty position offers came because of a combination of getting this very high-impact paper, getting to control this new technology, which now allows me to ask many new questions, and completing the story, from the sonar signal design to the applicative aspects of plant classification (which I worked on during my PhD) and to the spatial aspects of sensory motor behaviour (which I worked on in my postdoc).

Can you tell us about the bat colony that you have set up at the University of Tel-Aviv and how you maintain it?

One of the most interesting questions for me is to relate what is going on inside a bat's roost to what it is doing outdoors. That is, how much does the time spent with its neighbours in the roost influence what it is going to do later on that night? To answer questions like that we needed a system in which we could track the animals not only outdoors but also indoors. Our first thought was that we could monitor a cave with cameras, but that is extremely difficult. It is much easier when the animals are roosting in one of your offices, so that is what we did. We generated our own colony of fruit bats which live in our cave-like facility, but they are free. We were hoping that they would come back, because they generally come back to where they were born. We see hopping between colonies, so we know that our colony is part of the network in the area. We know that it is really part of the natural ecology of the city.

The colony is in the zoological garden of Tel-Aviv University. It is dark with an opening that looks like a cave entrance and the temperature is similar to that in a cave. There was a colony in the zoo before I came, with individuals that had been there for very long time. We used some of those individuals and we caught others in the wild. We kept them indoors for a few months before opening the window. Having set up our own bat colony, we developed miniature GPS devices that we can mount on the bats, which also include a whole set of sensors, microphones and electrodes, to track and monitor them.

How did you structure your search for a faculty position?

It just happened. After the Science paper, I was approached by a university in Israel to come and give a talk. It is a small community here, so when you give a talk in one place, somebody else invites you to give a talk in their university and then very quickly I started negotiating start-up funding. Actually, I never officially applied. It was always, 'Give a talk about your work', and then, 'Maybe you should give a job talk in a few weeks'. I also think that my exotic topic helped – not many people study bat echolocation around the world and hardly anyone does so in Israel, so it generated interest.

Do you think that scientists should get involved in politics and if so why?

I think that scientists should definitely advise politicians and help the public to make decisions. Global warming is a classic example: there is so much disinformation being spread that even I expect scientists who work in this field to explain to me what is right and what is wrong, to provide information that I can understand as a human being, not as a scientist. In my field, wind turbines are killing bats in Europe and the USA and it is becoming an issue in Israel. The National Park Authority came to consult with me about

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modelling bat movements. It does not mean that I am becoming a politician, but it means that I must provide my knowledge in order to assist politicians to make the right decision.

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What characteristics do you look for in people when you are recruiting your team?

Computational skills are really important. Candidates don't have to have mastered basic programming but they have to be keen to learn and to be able to acquire these skills. Another feature that is extremely important for a student is the ability to translate thought into action. I think many of us have this gap; we have great thoughts and ideas, but there is a point at which you have to stop thinking and start doing. A lot of troubleshooting is only possible after you start doing things. I often tell students, 'We can't plan the whole experiment. We have to start with some preliminary experiments and see how it works'. I have seen people who are very smart, but they get stuck at the thinking level.

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Do you have to do much teaching?

I am part of a crew of professors teaching three courses. I only teach half of each semester, which makes it much easier to do science. I think that patience is very important when you teach. You need to be able to explain things simply again and again from different angles. The ability to translate a complex thought into a simple explanation is not easy.

I think that teaching is rewarding in two ways. First, the interaction with the students and learning from them; you get good feedback, which is personally a very rewarding process. Second, it is a cliché, but sometimes you only really understand something when you explain it. Often, I teach subjects that are not my speciality. They are subjects that I understand, but perhaps I have not followed all of the detail. We have more than 400 undergraduate students on some of the courses that I teach and then you always get good questions, because there are 400 brains in front of you. Somebody will think of something that you have not thought of yet, or some angle that you have not thought of, and you will always be facing new interesting questions. You will always be surprised by 'how come I have not thought of this before?'

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What is the most important lesson that you have learned through your career?

I'm not sure if this is the most important lesson, but it is one of them. Nachum Ulanovsky taught me to be patient. Students usually want to publish projects as soon as they are finished. It is very difficult to decide to collect more data, which can sometimes take another year before you can write the publication. Sometimes, we waited another 2 years before resubmitting a paper, because it required more data collection or analysis, which was very important.

What applications are there for your work?

We are applying sonar in robotics in collaboration with colleagues in mechanical engineering. We now have a robot that moves autonomously through a new environment guided by acoustics only. In another interesting collaboration, I am working with a guy in the governmental Volcani Center for Agricultural Research and we are trying to apply this robot to agriculture. The idea is that the robot can move through a field, a greenhouse or orchard and estimate the condition of the field, how big the crop is or whether there are pests. It is part of a rapidly growing field called precision agriculture.

What do you most like doing out of the lab?

In the last 5 years I have dedicated a lot of time to the lab; I hope this will change now that it is kind of up and running. Before that, I used to do long hikes, 10 days with all of the equipment on my back. I also used to write quite a lot, I even published a novel in Hebrew a while ago; I really hope to go back to that and to write a better one next time. Now I have an 18 month old kid who occupies a lot of my free time and I am happy about that. I joke that I am running research on him too.

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