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Influences: Russian training

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I grew up in Yaroslavl, an old Russian city on the Volga River, which celebrated its 1,000th anniversary in 2010. Because my mom, a medical nurse, and my dad, a railroad worker, belonged to the working class, I had no intentions of becoming a scientist. As a kid, I dreamed about becoming many things, from an army officer to a school teacher or a doctor, but never a scientist. Both my parents and my grandma Irma taught me that any work I do is good if it is done for the sake of other people and done well. The first person who influenced my future scientific career was my high school biology teacher, Lilia Denisovna Petrova. Noticing how bored I was in her class—preferring to solve mathematical problems rather than study animal anatomy—Lilia Denisovna gave me a popular book about the guiding role of the brain in human life. The brain was pictured as a mysterious computational organ, which operated according to principles that nobody had a clear idea about. Being in love with mathematics, I thought that figuring out how the brain works would be a lot of fun. These thoughts became a dream I entertained when pacing along the Volga riverfront, observing the calming flow of water, which generations of my ancestors had similarly watched before.

When I was approaching my high school graduation and thinking about college education, one of my friends proposed that we try out for the Moscow Institute of Physics and Technology (PhysTech). PhysTech had a reputation as the best school of physics in the Soviet Union, so it seemed almost unreachable for a provincial kid like me. Nevertheless, I studied a PhysTech advertisement booklet and learned that their Department of Physical and Chemical Biology was seeking candidates who loved physics, chemistry, and mathematics. I certainly loved mathematics and decided for myself that it might be a good place to study, although I later realized that of course the key word in the advertisement was physics, not mathematics. At the time, however, the spirit of adventure took me to Moscow, away from home and the Volga's riverbanks. Besides, the PhysTech entrance exams were held early in the year, so all who failed (the majority) had a subsequent chance to take the mainstream exams at their home institutions. The examination procedure at PhysTech was pretty tough; it included both oral and written physics and mathematics exams as well as an essay and an interview with departmental representatives. Although I was pretty miserable at physics, my knowledge of mathematics turned out to be sufficiently good to make my overall score just high enough to pass. My parents and I were surprised and happy at the same time. Thus, my belongings were packed, and I was sent to Moscow.

View of the Volga river in Yaroslavl. Photo courtesy of the author.

That was September of 1990, the beginning of my student life at PhysTech. My first revelation about PhysTech was the realization that it was not the fun place to study mathematics and biology that I had hoped it would be. Instead, it turned out to be three years of intense studies of basic and theoretical physics, which continued into another three years with less physics and more specialized topics of choice. PhysTech did not instill a love of physics in me, but it certainly helped me understand it better. More importantly, PhysTech taught me how to solve problems. In fact, the original purpose of creating PhysTech in 1947 was to solve problems that my country, the Soviet Union, was facing after World War II, when industry, agriculture, and science needed to be recovered or rebuilt. Many of those who advanced physics in the Soviet Union after the World War II—those who developed USSR's nuclear power, constructed rockets, launched the first man into space and built the first orbital space stations—were my PhysTech teachers. Most of them are now gone but memories about this tough generation are still alive in me, as well as the way they taught me to keep working on a problem until it was solved.

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Laboratory building of the Moscow Institute of Physics and Technology. Photo courtesy of Ekaterina Lyukmanova.

Photo of Boris Izrailevich Khodorov, courtesy of his daughter, Alla.

After the first three years at PhysTech, I started to spend time at so-called "bases"—research institutes that were typically located in Moscow or its suburbs, where PhysTech students became involved in scientific research. After rotating between several bases, each student would settle into one of them for their diploma work. That was the first time I met Boris Izrailevich Khodorov (B.I., as we called him). After visiting a number of neuroscience laboratories in Moscow, the laboratory of B.I. at the Institute of Pathology and Pathophysiology impressed me most, and B.I. himself impressed me in particular. Born in 1922 in Crimea, he graduated from Tashkent Medical Institute (Uzbekistan) in 1944. B.I. suffered the horrors of World War II as a Senior Doctor at the First Belorussian Front. His scientific career started after the World War II. From 1957 to 1988, B.I. performed pioneering research in the field of ion channel biophysics. He recorded electrical activity from nodes of Ranvier, studied the mechanism of C-type inactivation in voltage-gated ion channels, and examined the effects of neurotoxins and local anesthetics on membrane excitability. I regard those years as the time of classical ion channel biophysics. Consequently, I have always viewed B.I.'s generation—his competitors, collaborators and friends—as hardcore ion channel biophysicists, including, among others, Bertil Hille, who shared a lifelong friendship with Boris and who recently celebrated his laboratory's 50th anniversary. B.I. was very generous in lending me his only copy of Hille's book, *Ion Channels of Excitable Membranes* (1), which he regarded as a precious "ion channel Bible." Not only did I enjoy the beautiful language of Hille's book, but I also entertained myself by studying Khodorov's numerous remarks and comments on its pages.

The mid 1990s were the years in which Perestroika seriously hit the economy and hence the lifestyle of an average Russian citizen. Students were one of the most disadvantaged social groups. The devalued stipend was so small that low-quality food and hunger became intrinsic components of a student's life. The majority of my friends who were students at that time ended up leaving science and becoming businessmen. To stay in science, one needed to find funding. The phenomenon of B.I. was not only his ability to obtain the available federal funding but also his talent for finding support opportunities for his laboratory personnel through international programs. For example, I was a recipient of a stipend from the Soros Foundation for Basic Research, and I remain grateful to B.I. for helping me to make it through those difficult years and remain in science.

At the time I joined Khodorov's laboratory, the laboratory included B.I., me, and Sergey Koshelev, a research scientist who taught me how to prepare rat brain slices and get patch-clamp recordings from acutely isolated hippocampal neurons. Our rig was handmade from scrap, the amplifier and application system were self assembled, and the acquisition and analysis programs were self written. On the top of this, B.I. had to obtain all necessary chemically pure reagents, including NaCl, from abroad. He used to return from his trips to international conferences with numerous falcon tubes filled with chemicals, which were generous gifts from his friends or former students. In spite of everything, the experiments worked miraculously and we were excited to record NMDA receptor–mediated currents from pyramidal neurons.

It was a fantastic time. Despite numerous difficulties, B.I. was able to create a small comfortable world, filled with a special spirit that enthralled us to do science. B.I. was both curious and funny. He continuously challenged us with his endless questions that started with "why." He always kept us alert and thinking about science. It seemed like B.I. thought about science all the time; he would wake up in the middle of the night and barely hold himself back before calling us early in the morning to deliver new ideas. This lifestyle was infectious. It kept us in the laboratory late at night and during weekends. Khodorov's witty humor, limitless funny stories, and jokes would always generate a good mood, even if experiments were not working well.

That was a truly blessed time for experimentation. Apart from work at the rig, my experimentation was brought to bear on various everyday experiences. Once, for instance, I decided to speed up the defrosting of our laboratory freezer with an open-spiral electric heater. I learned not just how not to defrost a freezer, but also how quickly the freezer plastic melts and then explodes, covering everything around in a thick layer of black ash. That day I narrowly escaped burning the entire Institute of Pathology and Pathophysiology building to the ground thanks to B.I.'s new graduate student, Maria Yelshanskaya. She was the first to notice the fire and helped me to extinguish it and scrub the entire laboratory afterwards.

When not burning laboratory equipment, I was busy recording NMDA receptor–mediated currents from acutely isolated rat hippocampal neurons. Our team, which was led by B.I. and included me, Sergey, and Maria, used ion channel blockers of different sizes and shapes as tools to probe the pore architecture and gating machinery of the NMDA receptor channel (2). This was long before the first ionotropic glutamate receptor (iGluR) channel structure was solved, but we felt excitement as we analyzed the numerous currents that we had obtained and imagined what the channels that conducted such currents would look like.

As well as inspiring us scientifically, B.I. was a wise and generous leader. He gave us a great deal of scientific freedom, accepting our own solutions to scientific problems as well as providing us with opportunities to publish independently (3, 4). Long after my departure from his laboratory in 2000, B.I.'s wisdom and advice continue to guide me through my scientific journey, during which I have been lucky to work with a number of excellent scientists, including my postdoctoral mentors Lonnie Wollmuth and Eric Gouaux. B.I.'s fearless and persistent approach to tackling scientific problems, which served as inspiration when embarking on the challenging tasks of solving the first crystal structures of an iGluR (5) and a TRP channel (6), is something that I try to pass on my own students and postdocs. B.I. passed away in the summer of 2014, but his memory continues to live in my heart and hearts of others who proudly consider themselves members of Boris Khodorov's scientific school.

B.I., my PhysTech teachers and friends, my family, my home city of Yaroslavl and the Volga river with its embankments, which I am now walking mostly in my dreams, are those Russian roots that influence my entire life. They make me who I am today and inspire my next adventures.

Lesley C. Anson served as editor.

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