Epilogue

George Gerstein: Obituary (1933–2018)

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On March 28, 2018, our colleague and friend George Gerstein passed away.

George Gerstein was a great scientist, a dedicated teacher, and a true friend—in short, a real character, one of a kind. George had many facets: in science, in teaching, in interacting with students and colleagues, and in private. We will try to capture some of these aspects in the following paragraphs, being aware that we can only scratch the surface, based on our personal interactions with George. Fortunately, we could also draw from a manuscript by George's Ukrainian friend Dr. Valya (Valentina) Zelinskaya, and from our private correspondence with George's former wife Linda and their children Mark and Eva.

George Gerstein as a Neuroscientist

George was a truly unique person, in many ways. He profoundly influenced the development of scientific methodology in the neurosciences. His mission was as straightforward as it was ambitious, as formulated already in the abstract of

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his seminal paper with Benoit Mandelbrot in 1964, one of the very first papers ever to develop a mathematical model of single-neuron spiking activity (Gerstein and Mandelbrot 1964): *"Quantitative methods for the study of the statistical properties of spontaneously occurring spike trains from single neurons have recently been presented. Such measurements suggest a number of descriptive mathematical models. One of these, based on a random walk towards an absorbing barrier, can describe a wide range of neuronal activity in terms of two parameters. These parameters are readily associated with known physiological mechanisms."*

Here, in this short abstract, we meet several terms that characterize George Gerstein's approach to neuroscience, inherited from his solid background in physics: quantitative methods, statistical properties, mathematical models, model parameters, clearly linked to physiological mechanisms.

These various notions continued to be prominently present, in one way or the other, in all of George Gerstein's scientific contributions, throughout his long and productive academic career. From his very first papers in the early 1960s until his final ones in the late 2010s, all his contributions focused on a single, unifying scientific goal: to measure and quantify single and multiple neurons' spiking activities from experimental recordings in relation to behavior and, from the results of such analyses, to gain insight into these neurons' contributions to the functional role of the networks they participated in, preferably in the form of an appropriate mathematical model. Meanwhile, it is almost impossible to imagine neuroscience research without the many fruitful quantitative methods and measures developed by George Gerstein over the years.

Fortunately, we do not need to go through the many individual instances of George's work to document and illustrate these contributions. The various chapters in this Volume, introducing and reflecting on George Gerstein's scientific contributions to a wide range of topics in neuroscience research, written by a selection of his former students and close associates over the years, document and illustrate these contributions more than convincingly.

George Gerstein as a Teacher

George Gerstein was an influential teacher. Starting in his early years at MIT, throughout his long career at UPenn, and via his many extended research periods at Universities and scientific institutes all over the world, George was able to attract many students and postdocs into his unique way of thinking science. Among others, this is reflected in the large number of George's former students making their way successfully into academia and in the type of neuroscience research they contributed ever since, as is also wonderfully illustrated by their contributions in the various chapters of this Volume.

George took a great pride in contributing to the training of neuroscience students from Eastern European countries, especially from Poland. Thus, he spent a sabbatical year (1978–1979) at the Nencki Institute in Warsaw (Poland), together

with his wife Linda and their children Mark and Eva. Moreover, he hosted an impressive series of Postdoctoral students from the Nencki Institute in his lab at UPenn over the years. When going to Poland in 1978, George managed to bring two Z-80 minicomputers to the Nencki Institute (not a trivial task at the time) and got them to work. These were the very first minicomputers available for neuroscience research in Poland at the time. The spike train cross-correlograms computed on these machines were henceforth, quite appropriately, called "Georgeograms." Hence, very appropriately, the very first Nencki Award was awarded to George Gerstein in 2008 (see 'Nencki Award for George L. Gerstein' this Volume).

Such activities did not go unnoticed in the USA at the time. George told me (AA) years later that some time after his stay in Poland, he received an unannounced visitor, dressed in a long trench coat and with a fedora hat, who insisted on interviewing him on which advanced technologies and scientific insights he had transferred to the "enemy," Needless to say that George threw him out and continued his dedicated contribution to training neuroscience students and postdocs, both from within and beyond the USA.

George Gerstein as a Person

Here, George's Ukrainian friend Dr. Valya Zelinskaya writes:

"George Gerstein was born in Berlin in 1933 to an intellectual Jewish family, which had emigrated from Riga a year before the October Revolt in 1917. In 1938, when he was 5 years old, the family left Nazi Germany, literally by 'the last train,' for the United States. There, at home in New York, according to his stories, there was everything necessary to satisfy the intellectual requests of his family, but never anything excessive. Thus he remained an ascetic for the rest of his life. In everyday life he lived minimally. In his opinion, for instance, a car requires 4 wheels to drive, but does not need any frills. Also, he was extremely modest in clothing and food. "I'm not posh" he often said. However, one luxury he didn't reject was books, art and travel. He had a highly developed feeling of beauty. He found it and admired it not only in the arts, but also in everything that surrounded him—a beautiful flower, an autumnal leaf."

"George's school years passed in New York. During these years George had read every book, from A to Z, available in the public library. Incredible, but he told me about this as we passed by the library, walking around Manhattan one day. At age 15, he moved to Harvard to continue his education. As he no longer lived with his family anymore, he did not speak Russian—sometimes for years, and he always wondered, how he had retained this language for life. He enjoyed speaking Russian, and liked when we called him by his Russian name '*Yura*.'"

"George liked to travel the world and share his scientific expertise/inspiration with others. He spent Sabbatical leaves in the Soviet Union, Poland, Israel, Germany, and England. In 1968 he came to a conference in Kiev (then still part of the Soviet Union). There he teamed up with Dr. Valentina Zelinskaya (alias Valya)

and her husband who worked on data recorded by Valya in the Basal Ganglia of normal and 'Parkinsonian' rats. A couple of years later he spent half a Sabbatical year in Moscow and visited Kiev again. That half year was used by his, then, spouse Linda to study Churches in the region. Later, George spent many hours organizing the multitude of pictures she had made in a well-organized data base."

In Israel, George spent 5 extended research periods with Moshe Abeles at the Hebrew University in Jerusalem. A year before his third visit, Valya and her family (spouse, children, and grandchildren) emigrated to Israel. Valya came to work in the lab of Moshe Abeles, who did not know about her acquaintance with George. Imagine her and George's surprise and joy, when meeting on the first day he came to the lab. During this visit, he joined the retreat of students and teachers of the ICNC at the Hebrew University in Kibbutz Ein Gedi. Moshe Abeles remembers:

"In these retreats I always organized a half-day hike in the Judean desert. This breaks the barriers between students and professors and allows for honest discussions of problems. At this particular retreat, we hiked along a gorge of a dry river-bed running down towards the Dead Sea. All of a sudden, I saw Valya and George depart from the group and walking towards a paved path running on the elevated bank of the gorge. I caught up with them to inquire what had happened. Valya told me that George had eye problems that made it difficult for him to walk over the boulders and the uneven river bed. Prior to this, I did not notice any problems, but she was by far more sensitive than I was. This was the first sign of the progressive deterioration of George's eye sight. Later on, he had eye surgery that improved his eye sight a bit. He could read and write, work on the computer, developing software for analyzing data, and carry on his data analyses. In his next two extended visits to Israel, together with his new companion Janet, they both enjoyed the science and the country tremendously."

George Gerstein as a Colleague and Friend

For us, writing this obituary is a bit like riding a roller coaster, oscillating between reliving fond memories of our many constructive interactions with George and feelings of sorrow, due to George's deteriorating health and growing isolation in spite of his clear mind in his final years. We decided to focus on and rejoice our fond memories in the following and keep the sorrow to ourselves.

Interacting with George on neuroscience was a true pleasure and a headache at the same time. The pleasure came from his ceaseless creativity in suggesting new measures for quantifying neuronal spiking in relation to behavioral tasks, in relation to other neurons' spiking, and in relation to neuronal population activity measures such as LFP and EEG. The headache came from his stubborn insistence on truly understanding these measures and his highly detailed approach of calibrating them vis-a-vis a comprehensive set of possible neuronal interaction scenarios, each one implemented in a detailed neuronal network simulation scheme. Not unexpectedly, this typically took forever and, hence, application of his new measures to experimental data took considerably longer than the experimentalists had hoped

for. Nevertheless, whenever these measures finally emerged from these hard testing grounds, they invariably proved to be extremely worthwhile and insightful.

George was not religious, but he was keenly aware of his Jewish ancestry. When he spent his sabbatical year in Tübingen in 1986–1987, he told me (AA) that he had had a very hard time to decide spending longer time in Germany, the nation that had erased all his relatives, except for his own small private family that managed to escape Germany in the very last moment. What ultimately convinced him was that he would be visiting and working with two non-Germans in Germany: Valentino Braitenberg (Fig. 1, from Italy) and myself (from NL). On several hikes we made on the Swabian Alb or elsewhere in the vicinity of Tübingen, George would invariably ask: "Just look at this country, it's just so beautiful! Why on earth did they leave this wonderful place and march east to claim more 'Lebensraum'?"

Several years later, in 1998, George joined me (AA) for the FENS Forum in Berlin. After enjoying a late afternoon coffee with us in a street café in downtown Berlin, George silently left, without notifying any of us. It was only 2 hours later that he returned. He had gone to re-visit the house where he had been born in 1933 and had spent a happy youth until the age of five. Remarkably, he said, he remembered it all—and nothing much had changed since then.

Fig. 1 George Gerstein (left) and Valentino Braitenberg at the MPI for Biological Cybernetics in Tübingen in summer, 1987

Over the years, George was drawn again and again to spend sabbatical (and otherwise) time in Israel, to be together with his Israeli colleagues and friends, and to practice his Hebrew and to enjoy speaking his Russian. Together with one of us (MA), he spent many hours looking for repeating spike patterns (Fig. 2). Until the present day, we do not know if they found any—that is, above chance level. But in some instances, that does not even matter—when the ultimate charm is in the search, not in the finding (Fig. 3).

Fig. 2 Moshe Abeles (left) and George Gerstein in the Judean Desert in the late 1990s

Fig. 3 Moshe Abeles, George Gerstein, and Ad Aertsen. Picture taken by our colleague Bill Newsome at Moshe's home, on the occasion of the "Being on Time" Symposium for Moshe Abeles at the Hebrew University in Jerusalem, January 3–5, 2007. We thank Bill for making this picture available to us for this purpose

Apart from science, George loved the arts, especially music. He loved to play the piano and, even more so, his clavichord that he kept in a "wohltemperiertes Zimmer" in his beloved home at Whitemarsh Road in Ardmore, PA. There, with spikes, amplifiers, computers, and math out of the way, he loved to spend time with his dearest friend, Johann Sebastian Bach, enjoying his preludes and fugues. After his last sabbatical leave in Freiburg in 2010, he wrote: "The social and cultural aspects of my stay in Freiburg were delightful. I was able to attend a good many concerts, particularly a series of organ recitals and various interesting performances at the Hochschule für Musik. And the Augustiner Museum provided a fascinating look at medieval art and architecture."

George Gerstein presented a rare and unique combination of human qualities. On behalf of those of us who had the privilege to work with him, to interact with him, and to learn from him, we thank him for this privilege. His passing away is a great loss, for all of us—but his being among us was a great experience and a true pleasure. His legacy as a scientist, a person, a colleague, and a friend will always remain with us.

Reference

Gerstein GL, Mandelbrot B (1964) Random walk models for the spike activity of a single neuron. Biophys J 4(1, Part 1):41–68. https://doi.org/10.1016/S0006-3495(64)86768-0