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Conversations with Scientists

Johanna Meijer: Defining Rhythm in Biological Clocks

June 2014

Courtesy of Johanna Meijer/photo by M. Goudswaard

"You don't have to expect to feel totally dedicated to science all day long in order to become a good scientist. Keeping a certain distance from science may even be preferable…. Talent and expertise both grow, and when you are 18, you don't already have to know what you want to do."

Johanna Meijer is a professor in the physiology department at Leiden University Medical Center in the Netherlands. Born in The Hague, the Dutch center of government, in 1959, Meijer earned her Ph.D. in neurophysiology and neuropharmacology in 1985 under a "free-study" program at Leiden University Medical Center, Nottingham University in England and Dalhousie University in Halifax, Canada. She received a Ph.D. in Medical Sciences under the same program in 1989. After completing a three-year postdoctoral fellowship at the Royal Dutch Academy of Sciences, Meijer joined the Leiden University faculty in 1992.

Meijer is the recipient of numerous grants and honors. She is the author of more than 100 peer-reviewed articles and book chapters, as well as an editorial reviewer and a board adviser. A frequent lecturer and an enthusiastic mentor, Meijer was on the board of the Society for Research on Biological rhythms, is a visiting professor at Oxford University and is a member of the Royal Dutch Society of Sciences.

Meijer's research focuses on "24-hour rhythms in bodily functions." Her lines of research include: "neuronal network organization of the circadian clock; decline of clock function in aging, depression, migraine and neurodegenerative diseases; circadian rhythms and the metabolic syndrome; retinal signaling to the SCN (suprachiasmatic nucleus) clock; chronobiological optimization of drug application in humans; and ADHD and the circadian system."

Below are Johanna Meijer's July 26, 2014 responses to questions posed to her by Today's Science. *Some of the questions deal with how she became interested in science and began her career in biology, while others address particular issues raised by the research discussed in Wild Mice Run for Fun.*

Q. When did you realize you wanted to become a scientist?

A. I was never sure of it. I was suddenly offered a research (Ph.D.) position, and I accepted it, as I had no other plans. I had been considering very different careers as well, such as a Ph.D. in philosophy of science, and alternatively I had considered continuing with ballet.

Q. How did you choose your field?

A. As a student, I did my internship in the field of biological clocks. What I liked about it was that the output of this system is unambiguously measurable. A 24-hour rhythm can be defined, or measured, irrespective of the species that is under investigation (fruit fly, mouse or human being), and also irrespective of whether you measure genes, cells, networks of cells or behavior. This is a unique situation.

Q. Are there particular scientists, whether you know them in person or not, that you find inspiring?

A. To me, Eugene Stanley of Boston University is very inspiring. He is called a "pioneer of interdisciplinary science." He works on many systems, and identifies common rules in these systems. I think this is an important aspect of science; not to identify new elements, but to see laws behind them.

Q. What do you think is the biggest misconception about your profession?

A. That you can make large discoveries. Science is an incremental process. There are no real breakthroughs, although the media like to present it that way, and scientists as well, if they publish in high-impact journals or write grant proposals. It is often many scientists working together who achieve new insights.

Q. Do you have any idea how prevalent in wild mice the inclination to run on a wheel is—that is, do you think most wild mice like to run, or a minority of them?

A. We noticed that young mice in particular run in wheels.

Q. You had many observations of mice running. Do you think these observations captured a relatively small number of mice engaging in a number of running episodes—repeat customers, as it were—or was it a great many mice, each running once or at most a few times?

A. Good question. We really do not know. We should attach chips to the mice to distinguish between them in order to answer that question. It is on the list of our new projects.

Q. The study reports an observation that is fascinating and quirky—but what do you see as its implications, in terms of more "normal" science? Are there additional aspects of your finding that you intend to explore, and, if so, what are they?

A. What do you mean by "more normal science"? I think this was actually an example of classical normal science. You wonder about something, formulate a question, and design a test.

Q. Where do you spend most of your workday? Who are the people you work with?

A. Most of the workday, I either write or talk with other researchers in the lab. Mostly with Ph.D. students, but also with master's candidates, postdocs and my colleagues.

Q. What do you find most rewarding about your job? What do you find most challenging about your job?

A. Most rewarding is getting a new good idea for an experiment. We often have ideas, but only some will lead to an actual experiment. It is quite challenging to choose the experimental questions that you consider most interesting or revealing, simply because of time and money limitations.

Q. What has been the most exciting development in your field in the last 20 years? What do you think will be the most exciting development in your field in the next 20 years?

A. In the last 20 years, it became obvious that the biological clock is of major importance for health. I didn't realize that when I started working on it. I thought it was a beautiful model system for understanding the principles of the brain, and it is, but in addition we learned that rhythm disorders are closely related to many diseases, such as diabetes, depression and sleep disorders. A challenge for the next 20 years will be to develop strategies that can help explain how the system—the biological clock—works as a whole. Current science is very reductionist, and we identify elements that play a role at a scale below the scale of our observations. But elements interact, and by interacting, they develop new properties. I expect that for instance our mental capabilities are primarily a result of all the interactions and are formed to a large degree at the network level, rather than being determined by genes or protein products. Of course the system fails if you leave out essential components, but that does not mean this is a revealing strategy to understand mental activity. If you want to understand the working mechanism of a radio, you do not produce a radio without zinc, iron or whatever, and check its sound-producing capacity. You will probably start by investigating properties of functioning units within the radio. It is not so easy to think of ways to understand the mechanism of the ensemble, without endlessly trying to identify individual components, and the numerous interactions among them. A real challenge is to find ways to understand and predict the ensemble. Network theory is an example of this, but it is just an example.

Q. How does the research in your field affect our daily lives?

A. I think people are now more aware that they need sufficient sleep, that jet lag affects your health, and that sufficient levels of light during the day help our biological clock; this is very relevant for the elderly who live in nursing homes. People also know that, after experiencing jet lag, they have to expose themselves to a new light cycle in order to get adjusted. Shift workers know that light at night is not healthy. They should try to live healthy lives in other respects: by watching their diets and getting enough sleep and exercise.

At a 2013 conference, Meijer focuses on the lessons to be learned from and the challenges of the complex systems approach to science.

Q. For young people interested in pursuing a career in science, what are some helpful things to do in school? What are some helpful things to do outside of school?

A. This is a very important question. I think that the answer is: you should do what you like most. Personally, I cannot imagine that you are already pursuing a career in science while in high school. I know many very famous scientists who did not originally want to become scientists, but instead were aiming for careers in music or art. (For instance, the new director of the prestigious Institute for Advanced Study in Princeton, New Jersey, who is Dutch, stopped studying physics for a year to attend art school; Gene Stanley, a renowned physicist, first wanted to become a clarinetist; Carl Johnson, a former president of the Society for Research on Biological Rhythms, wanted to become a musician.) So I would like to stress that you don't have to expect to feel totally dedicated to science all day long in order to become a good scientist. Keeping a certain distance from science may even be preferable. Having broad interests—in fields other than science—is really good. Creativity is also very important, as is dedication. All scientists are different, and diversity among scientists is a good thing. We would probably lose the most promising students by implementing an early-selection process based merely on grades in particular fields. This is a real concern, and an unwanted by-product of conducting early screenings for the best universities. Talent and expertise both grow, and when you are 18, you don't already have to know what you want to do.

Citation Information

"Johanna Meijer: Defining Rhythm in Biological Clocks." *Today's Science*. Infobase Learning, June 2014. Web. 22 Aug. 2014. <http://tsof.infobaselearning.com/recordurl.aspx?wid=99270&ID=30727>.