

Time: Devotion Turns Fly to Flight

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Abstract: The following is a personal reminiscence to commemorate Professor Martin Heisenberg's retirement from university duties as Professor Emeritus.

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Time flies—it has been almost 10 years since I began my career in scientific research. The excitement from when I received a fellowship from the Alexander von Humboldt Foundation 12 years ago and joined Professor Martin Heisenberg's lab is still fresh in my memory. At the time, I was yearning for the future, as unknown as it was. I am grateful to Professor Heisenberg for urging me to venture into the field of brain and behavior in *Drosophila*. My postdoctoral research experiences in Würzburg were especially unforgettable, and it was very important for me to be engaged in such a scientific setting.

During my PhD studies, I read the book *Vision in Drosophila*, which opened a window for me to understand how to investigate the visual system of *Drosophila*. Subsequently, when I would read related literature from Professor Heisenberg's lab, the phrase “flight simulator” continuously caught my attention and aroused my curiosity. The flight simulator is equipment in which a single fruitfly can be conditioned to choose a flight orientation toward visual patterns (Wolf & Heisenberg, 1991). It was such an ingenious system that I was filled with admiration, and I gradually became interested in behavioral studies of the *Drosophila* brain.

Before I joined Professor Heisenberg's lab, his group discovered that flies with mushroom body (MB) defects also exhibit impaired olfactory memory, yet MBs are dispensable for conditioned visual flight orientation (de Belle & Heisenberg, 1994; Wolf et al., 1998). Nevertheless, changes in visual stimuli significantly affect the visual memory of *Drosophila*. The role of MBs in *Drosophila* visual learning and memory under various visual contexts became my project of study. At the beginning of my postdoctoral period, I not only had to

adapt to a new way of life, but also to many new experimental conditions. Reviewing the literature, as well as having constructive discussions with other members of the lab, helped to make me aware of previous and current knowledge in the field. I was also able to repeat some of the previous experiments to hone my newfound skills with the flight simulator. All these experiences were extremely useful for my further studies.

What impressed me the most was the German scientist's rigorous work style, as well as the unremitting pursuit of uncovering answers to scientific questions. An old Chinese proverb says, “A good start is half the success,” so I put my whole heart into my experiments with the flight simulator, exploring the mystery of the brain in *Drosophila*. After some time, and some preliminary results from my experiments, I discussed my conclusions with Professor Heisenberg. To my surprise, he displayed deliberation; several questions that he posed made me realize that my conclusions were not convincing. Once he fully understood the entire experimental process and final results, he greatly appreciated what I had obtained. He anticipated that the results would be very important and necessary for the future, but he felt that more experiments and proof were still needed. He believed that final conclusions should be a result of step-by-step experimental results. For young scientists to become successful, critical questions are needed. When young scientists become frustrated, more encouragement is necessary. This was Professor Heisenberg's credo. Results from each experiment should be used as foundation stones to reach a final, convincing conclusion. Further conjecture of results will only mislead, or worse, result in the wrong conclusions.

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Professor Heisenberg's lab seminars were an important platform for scientific communication and provided an inspiration for me for scientific research. All members of the group participated and presented their work. This often led to warm discussions, with excited talking when people agreed, or debates when there was sharp opposition. These discussions included inquiries into the experimental design, challenging the experimental results, explanation of various questions, and pondering over conclusions. Whenever possible, Professor Heisenberg listened earnestly and asked questions carefully. In such an environment, I was extremely unable to conform, especially when I first became the target of public criticism. It felt as if my work had no merit, and I became frustrated. However, several questions that Professor Heisenberg asked indicated that he recognized the importance of my work. Such training taught me how to withstand academic criticism, to be able to listen attentively to constructive criticism, even when under attack, to understand what other researchers were questioning, and to learn from others' strong points to offset one's weakness.

Professor Heisenberg is not only a rigorous scientist, but also a philosopher. While exploring scientific questions, he always maintains a humble heart, with keen insight, exploring the intrinsic, essential relationship between various phenomena. To be exposed to such scientific communication and collisions of thoughts, it is difficult not to be inspired and stimulated—it provided me with the gift of unceasing exploration in this exciting scientific field.

A strong academic atmosphere is the fertile soil that is so critical for great achievements. Over time, we discovered that memory retrieval is, indeed, partially context independent. Moreover, we demonstrated that the MBs, which are required for olfactory—but not visual or tactile—learning, effectively support context generalization (Liu et al., 1999). These new discoveries brought exciting prospects, and both molecular genetics and behavioral studies were utilized to analyze the fruit fly's elementary cognitive functions (Menzel & Giurfa, 1999).

Toward the end of 1999, I returned to the Institute of Biophysics at the Chinese Academy of Sciences. While setting up my own lab, I received unlimited support from Professor Heisenberg. Because the flight simulator was not commercially available, Professor Heisenberg not only donated a flight simulator to me for my continued studies in Beijing on visual learning and memory in *Drosophila*, but also maintained an intensive, academic cooperation with my group. Professor Heisenberg remains active in promoting Sino-German scientific cooperation. In addition to collaborations with my group, he promoted a student exchange program between the University of Würzburg and the Chinese Academy of Sciences, with the aim of training students. Under this framework, several

PhD students have gone to the University of Würzburg, and several PhD students from there have been to Beijing and Shanghai. Meanwhile, we have held two joint scientific symposiums in Shanghai and Würzburg, respectively. All these efforts have greatly strengthened the scientific activity between the two groups. During this long-term cooperation with Professor Heisenberg, we have used genetic manipulations to correlate brain structure and function of *Drosophila*. We discovered two distinct memory traces of visual-pattern recognition that are localized to small groups of neurons innervating two horizontal layers of the central complex (Liu et al., 2006). These results clearly showed that genetic trickery has changed the *Drosophila* species from being one of the worst organisms for studying functional neuroanatomy to one of the better ones. Indeed, for localizing individual, complex memories, it might be the best (Quinn, 2006).

Professor Heisenberg is devoted to international cooperation within the scientific field. He focuses on the future and has much regard for young scholar exchanges and doctoral candidate training. His students are now spread throughout the world; it could be said that he "has pupils everywhere." Man's exploration of outer space is limitless; similarly, humanity is also unlimited with regard to the mystical cerebral structure and function. Professor Heisenberg has been dedicated to building exchange platforms, establishing multidisciplinary and multilevel research networks, and extremely inspired to solve scientific questions. The time has come for the seed, which Professor Heisenberg has spread, to germinate; the fruitflies that Professor Heisenberg raised have already begun to soar.

Further, Professor Heisenberg is a person possessing universal love. His lab was composed of a large, international family, filled with students, post-docs, and scholars from various countries. He cared for foreign scholars and their family members to the greatest extent, from arranging room rentals and the reunion of family members, to children's entrance to kindergarten or school, all with meticulous concern. We will never forget the time in Würzburg when Professor Heisenberg invited our family to celebrate Christmas Day with his. Outside, the white snow covered the rise and fall of the mountains and the beautiful city of Würzburg. Inside, beside the Christmas tree, the candlelight shone, and a wonderful Christmas concert was held at home. The melodious music warmed the hearts of foreigners. It fluttered outside the window, escaping to the wilderness. Music, which bridges the gap between different cultures, possesses no nationality. Similarly, science also possesses no nationality. People benefit from science across the world.

Finally, I am grateful to Professor Heisenberg and my colleagues in Würzburg. I would also like to express my thanks to the Alexander von Humboldt Foundation,

without whom, I never would have had the spectacular opportunity to meet Professor Heisenberg.

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