TIME AND ME IN BERLIN

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It was like any other day. I think it was rainy. The details of weather were irrelevant. In the place where I was, the day started with darkness at 25 degrees Celsius and ended with darkness at 25 degrees Celsius. My job was to look at how time is kept in the tiny little circadian clock in the mouse brain, and for that reason I spent long hours in a small room under constant conditions along with my mice. I remember the day and the jokes I exchanged with a fellow researcher under an umbrella, not because I was particularly worried about smelling like a damp mouse, but because of a realization that hit me hard – I was getting old and these constant conditions were making me agnostic about the fact.

Suddenly the slogan I saw the other day on the Internet, "Gain Time to Think (at the Wissenschaftskolleg)", felt immensely appealing. Time was always there but for a long time, time was not entirely mine. Time was also the topic that fascinated me from the beginning. Would I be able to have time of my own and think thoroughly about time in the brain?

Take a time machine back to when I was a child. Albert Einstein, the quintessential scientist for many people, was a revolutionary for me. He powerfully demonstrated that philosophers do not know the truth. Yet, he did so not through experimental data, but through a *Gedankenexperiment*, something that the philosophers had been supposedly doing all along. But that was only one part of the irony. The enigma of Einstein's theory came from the fact that its central subject was time, which had been entirely philosophical. A famous showdown happened when Einstein was 42 years old and the young physicist announced to the old philosopher Henri Bergson that philosopher's time was no more special than the physicist's time. According to Einstein, the only remaining, unstudied kind of time was a psychological one, which was what I was studying. Decades have passed since then and Einstein became a cliché. I, an aspiring physics student, became a 42-year-old and a biologist. The mystic statement about time became a plain statement that light travels at a constant speed, and the whole theory became simply a classical mechanics analogy for certain things in electrodynamics. In 2016, when all the fascination with time had completely dwindled, I found myself, along with my wife Hitomi, at the Wissenschaftskolleg, Institute for Advanced Study in Berlin.

In addition to psychological time, there was biological time. Almost all living organisms on Earth harbor a clock that is set to predict the 24-hour day/night cycles. The biological clock is not precise, and all organisms effectively live in their slightly subjective time. Regardless, Einstein might have said there is no biologist's time. The laws of physics supervene the laws of biology. A barrier of complexity, however, lies between physics and biology and it is not easy to derive laws governing biological time from physical principles. Biological time stands as a good enough conceptual approximation for all practical purposes. Since biological time has an objective basis, as does physical time, I thought I could use it to understand psychological time, which was subjective. This was a more ambitious plan than it sounded. Circadian rhythms provide a rough guideline to the brain's daily ration of usable time. In many animals, the sleep/wake cycle is largely determined by the circadian clock. The human species is a bit of an outlier – we often willfully ignore what our internal clock says and just work or play through the night. Therefore,

approaching subjective time from its biological basis clearly had its limit. I had to think about time from the subjective perspective. This was like drilling the Channel Tunnel. A scientific study of subjective time must start from the biological side, but it cannot be subjective if it is not understood on the first-person side. So one has to bore the tunnel between subjectivity and objectivity from both directions. Luckily, a small library at the Wissenschaftskolleg had the collected works of Aristotle, who had thought about this issue. I tried other philosophers, such as Heidegger, but without much success. When I was struggling, I rediscovered Henri Bergson. Aristotle could define time before and after "now", the moment one is conscious of. Bergson literally stretched the "now" moment into a duration like an elastic rubber band. This is the consciousness's comfort zone, where it can wield its free will. I then imagined that biology puts a constraint on the duration's elasticity. The duration has to do with our attention to life, and this we know by our experience of time running fast when we are having fun and time slowing down when we are gloomy. The circadian clock, which counts the objective time of the day, can modulate the extent of temporality by limiting the release time of dopamine that accelerates the flow of subjective time. The circadianly controlled release happens to occur in the morning and this has an intuitively clear consequence, such that we quite often say "Oh it's already time for lunch" but we never really say the same thing about dinner. Time does run fast during the morning thanks to the timed dopamine release. Then I made a second statement that the qualia of time perception are mood states. This is likely, yet at this moment only correlational, because global analysis of Twitter patterns shows that people in the morning use the words associated with heightened mood states. I presented these thoughts at the Colloquium. Little did I know at the time that the presentation would be the basis of my future job talk, which would take me to Taiwan to study consciousness seriously.

The time I had in Berlin has definitely made some permanent changes in my life. It allowed me to ask myself the most exciting question I knew of. It allowed me to come back to where I had started. There are so many more things I wish to write about, like when I had to pass by the ruins of the *Israelitisches Krankenheim* while commuting to my office in an old human anatomy building. For now, let me close one chapter with my small intellectual encounter with Einstein and Bergson, which would not have been possible without the particular flavor of Winter in Berlin.