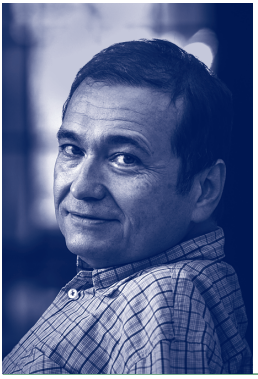

ON THE PRICELESS TYRANNY OF ACADEMIC FREEDOM

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For more than a year I had struggled with the invitation to Wiko. To spend a year thinking and having lunch sounded like taking a very long vacation. It sounded strange. I'm a devout member of the Church of Life Sciences. I believe in experiments, late-evening lab meetings, and the rush of e-mails trickling in on Sunday night when everybody demonstrates that the weekend was properly used for writing papers or re-analyzing data sets. In this religion of mine, Wiko had the smell of sin. In the end, it was a friend and former Wiko Fellow who persuaded me to risk paradise. He said: "If there would be grants providing time to think, wouldn't we all try hard to get such a grant? Well, you got this grant for free. Just say yes." So, I said "yes", but only for six months (my Prussian ego was still not completely defeated). The gates to an unexpected kind of paradise opened.

My wife Monika and I loved this place from the first moment. Much has been said about the fantastic service, the kindness of the people, the beauty and the serenity of the location. Astonishingly, it's all true. I also was never surrounded by so many interesting people from such diverse disciplines. All of them had fascinating stories to tell and some became true friends. I also developed a sharper eye for the strengths and weaknesses of the different territories of academic disciplines, including mine. I could devote my full report to all of these experiences and novel perceptions. However, being the Life Scientist that I am, I shall better report about my core work. Having thought about the best format to do so, I decided to organize my report in six points that sketch the ups and downs of my life in Berlin.

Parallelaktion

On the first official day, Thorsten Wilhelmy introduced us to the concept of *Parallelaktion*, from Robert Musil's book *The Man Without Qualities*. Although I believe that Musil had a different meaning of this word in mind, *Parallelaktion* was just what I and possibly all other Fellows kept as a secret plan: to work on several parallel projects, in addition to the official one. For me, my diverse planned *Parallelaktionen* included authoring nine papers, composing the whole theoretical introduction to an application for a Collaborative Research Centre of the German Research Council, and finishing a public science book on brain research plus associated movie shoots – and spending a lot of free time with my wife Monika in Berlin and all of that in six months. Obviously, such a lunatic planning resulted in crisis.

Crisis

The priceless tyranny of academic freedom results from a spectacular overestimation of the length of time. Being confined to my flat in the Koenigsallee 20, sitting in front of my laptop, and having no other obligation than to have lunch at 1 p.m. resulted in a pathological illusion of what can be achieved within a day. I slowly realized that, also at Wiko, reading takes time, writing arguments for manuscripts is the same struggle, and sparkling sudden insights can't be expected to occur so much more often than at home. I started to wake up in the night, realizing that my time in Berlin was running out without me having accomplished what I had expected from myself. It occurred to me that my

expectations about my achievements in Berlin had been, well, lunatic. This realization resulted in a more realistic estimation of what I could finish in Berlin.

Success

Now, being back in Bochum, I realize how unbelievably productive I was in Berlin. Indeed, I didn't properly realize this during my Wiko time. I have authored four and co-authored 14 international publications. I'm especially happy that two major papers that were very close to my heart ended up in *Current Biology* and *Annual Review of Physiology*. In addition, I finished the public science book (incl. movie shootings), wrote most (although not all) of the theory for a Collaborative Research Centre, gave many talks in Berlin and elsewhere – and roamed many corners of Berlin together with my wife. Yes, reading, writing, and thinking aren't faster in Berlin than in Bochum; but I simply had hours and hours of free, uninterrupted time to work every day. What a luxury! And added to that: the countless discussions with my colleagues broadened immensely my perspectives and resulted in new ways of thinking about diverse problems. My time to deeply dive into literature and to discuss with brilliant scholars resulted in several important insights that will affect my research for many years to come.

Insights

Yes, there were important insights. Several, but I treasure especially two of them. And I can't resist talking about them here, in this yearbook; although for many of the readers the following account will sound like Klingonian.

The true nature of the amygdala: The amygdala is a strange composite of little nuclei in the brain. They process emotional stimuli and coordinate fast, inborn reactions to emotionally relevant objects. The amygdala is a core entity of fear learning and fear extinction (extinction learning: a conditioned stimulus that previously signaled the immediate occurrence of an aversive event is now no longer followed by this event. As a result, the organism learns not to respond with fear to the conditioned stimulus anymore. However, the old memory is not erased; it is only inhibited. As a consequence, fear can easily regain control over behavior when the inhibition of the old learned fear response weakens). I study the neuronal fundaments of extinction learning and am working on an overarching theory of extinction learning for the planned Collaborative Research Centre. The problem

is: most research in this field uses aversive conditioning and for all of this research the amygdala is the core area of analysis. But there are other forms of extinction learning and for them it is possible that the amygdala plays no major role. Which other areas of the brain could replace the amygdala in these cases? By reading very old (in my field: >30 years) literature for weeks, it dawned on me that the amygdala doesn't exist as an anatomical entity. In reality, it is just a combination of deep cortical layers plus parts of the striatum. If this is true, every corticostriatal circuit in the brain should do the identical job as the amygdala during extinction learning. The limited knowledge we have exactly fits into this interpretation. When I had this insight, I had the feeling that a huge door suddenly opened wide. I could see vast horizons of explanations, studies to do, novel questions to ask. And I now have a plan how to organize the Research Centre for, I hope, twelve years of grant support.

Why big brains are good for you: In the core project with which I came to Wiko, I planned to understand how birds can achieve such astonishing cognitive feats with such small brains that do not even possess a cortex. As further outlined below, I made nice progress in this field. But there was one obstacle that was always in the way: based on much data in the literature, I argue that small corvid brains and big ape brains are similar in their cognitive ability. I also go on to argue that these two brains are more similar in their internal architecture than previously assumed. But then I have to find an explanation why we mammals have such big brains when birds can do similar things with their much smaller brains. After all, we mammals could save tremendous energy by having much smaller brains, if they would do a similar job. Wiko provided me the time to do much broader reading. So, I started to read many papers on insect cognition. Suddenly it occurred to me that we have to disambiguate cognitive processes (that can be achieved with smaller neuronal circuits) from memory (that should be about proportional to synaptic number ≈ brain volume). Could it be that the main difference between bird and mammalian brains is not cognition but memory capacity? It's impossible to test this idea between species (after all, it's difficult to prove that a pigeon remembers more items than a rat). But I can study intelligence and memory within the species Homo sapiens. Our individual brain sizes differ between about 1,100 g and ca. 1,400 g. Maybe this difference correlates with signatures of memory capacity? We directly started to test this in Bochum – and yes: we find astonishingly high correlations between the general knowledge of our participants (≈ memory) and their cortex size. Together with one of my postdocs, I now started a major series of studies plus a grant application to go into the details of this

idea. We are presently in the absolute beginnings; but one more door is wide open and a vast horizon suddenly becomes visible.

My Project

My plan was to seek answers for the following question: "What happens on the neural level when the cognitive skills of two groups of animals converge during evolution? Do their brains also assume a similar neural architecture? Or are differently organized brains able to produce comparable cognitive skills?" I wanted to analyze this fundamental question of Cognitive Neuroscience by comparing cognitive operations and their neurobiological fundaments in mammals and birds. Indeed, in the last few years, novel cognitive tasks were invented that produced a completely new picture of avian cognition. But are birds on a par with mammals in all fields of cognition, or are they just specialized for a few domains? Together with Thomas Bugnyar, a colleague in Vienna, I reviewed twelve key cognitive skills in birds, such as causal reasoning, planning ahead, and perspective taking, and compared them with those of mammals. This analysis revealed that there is hardly any realm in which at least one bird species doesn't reach a level of competence comparable to that of apes. But how is it possible that small, non-cortical brains can produce these cognitive skills? Recent neurobiological discoveries reveal that avian and mammalian forebrains are homologous and show similarities in connectivity and function up to the cellular level. In addition, a structure in the bird brain was identified as being very similar to the mammalian prefrontal cortex. So, avian and mammalian brains are radically different in their macro-geometry, but similar in their micro-connectivity. Taken together, an increase in cognitive skills seems to be established by the same means in birds and mammals. Thus, the neural degrees of freedom to create different neural architectures for the generation of identical cognitive functions seem to be very limited. The presubmission inquiry of this core aspect of my work in Berlin has meanwhile been accepted in *Trends in Cognitive Science*. We'll see if the final manuscript also fares well.

Partly Changing My Mind

In the very beginning, I had struggled with the invitation to Wiko. Then I accepted it, but only for six months. After a while, I realized that this was absolutely stupid and asked for two months more (it was accepted). Now, I'm sure that the full length of ten months

would have been the best option. Wiko changed some aspects of my approach to science but also helped to see that other parts of my attitudes had been correct from the beginning. I'm now confident that every scholar needs from time to time a monastery-like seclusion to read, to write, and most importantly, to think. Possibly, natural scientists in particular need this, since they have created a working style in which times of uninterrupted thinking are reduced to a minimum. However, I also saw how healthy it is that we natural scientists start our endeavors with a crisp question and, if at all possible, with a hypothesis. The absence of this attitude in parts of the humanities was a glaring cultural difference that I learned to recognize with some frustration at Wiko. Despite these and other differences between different academic fields, I realized that we scholars are all representatives of the whole quintessentially human quest, our continuing attempt to understand the world around us. In this sense, the German word "Wissenschaft" captures us Fellows in the best possible way.