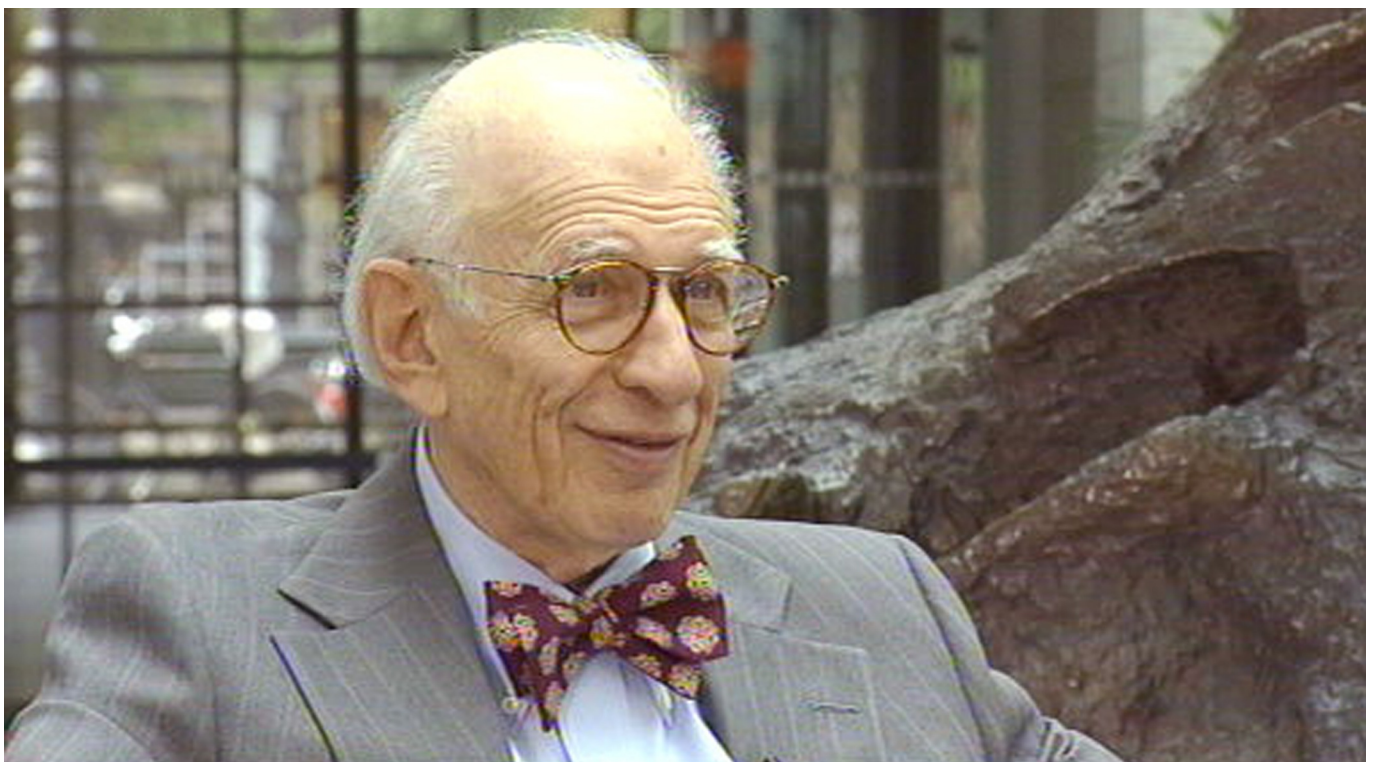


Feuer der Erinnerung
Medizin-Nobelpreisträger Eric Kandel
im Gespräch mit Gert Scobel in Berlin



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Wien im November 1938 - Reichspogromnacht. Systematisch zerstören die Nazis in dieser Nacht jüdische Geschäfte und Einrichtungen im gesamten Deutschen Reich. Wer in dieser Nacht nicht ermordet oder deportiert wird, flieht. Das Ende einer Welt.

Stockholm im Dezember 2000: Die Welt ehrt einen Überlebenden: Eric Richard Kandel, Kind österreichischer Juden und 1939 aus Wien geflohen, ist heute ein weltberühmter Hirnforscher. Er erhält den Medizin-Nobelpreis für seine lebenslangen Forschungen über die Natur des menschlichen Geistes - und für seine Entdeckung eines Proteins, dem beim Lernen und Erinnern eine Schlüsselfunktion zukommt. Kandel erforscht an der Columbia Universität die Biochemie von Lernen und Vergessen, Gedächtnis und Erinnerung. Als Modellorganismus dient ihm die Meeresschnecke *Aplysia*, an deren extrem großen Nervenzellen sich einfache Formen des Lernens studieren lassen.

Wie aber lernt der Mensch? Was sind die biologischen Grundlagen der menschlichen Seele?

Wie brennen sich prägende Erfahrungen – Traumata – bis in die zelluläre und molekulare Struktur von Gehirnen ein? Was ist Bewusstsein? – Das größte ungelöste Rätsel unserer Zeit.

Der vollständige Interviewtext in englischer Sprache:

Scobel: "In your book you mentioned that you grew up or your parents grew up in a climate very close to Freudian thoughts and you wanted to become a psychoanalyst. Why was that so?"

Kandel: "When I first came to the United States having fled from Vienna I wanted very much to understand what motivated people to shift from being cultured, decent human beings to becoming killers. I wanted to understand the nature of human motivation. And I first thought I would get a good insight into that by studying German and Austrian intellectual history. As I was doing this I fell in love. I met a wonderful Viennese woman who was the daughter of two psychoanalysts: Ernst and Marianne Kris. And they made me realize that psychoanalysis gave one a completely new view of mental life. It is hard to appreciate in 2006 how exciting psychoanalysis was in 1950. It was the royal way to understanding the mind. So, I began to read Freud and I realized that he gave us a wonderfully nuanced, sophisticated, detailed understanding of human motivation, of human action."

Scobel: "Have you found an answer to that question why culturally educated people turn into killers?"

Kandel: „No. It’s a very, very deep question. – I think the ability to kill is probably built into everybody’s genome in some level. I also think that there has been in Europe an endemic culture of anti-Semitism which probably dates to the fact that the Catholic Church taught that the Jews killed Christ. This must be a subhuman species that could do something like this to kill the Saviour. And I think defining them in racial terms as if they were completely different from Arian human beings made it possible to take an attitude towards them as if they didn’t count. So, I think it’s a combination of factors.

Scobel: "Until recently there was like a huge gap between Freud and psychoanalysis and what neuroscience did. Now with your work the two came together. How did that happen?"

Kandel: „Well – as you probably know very well Freud began as a biologist. In fact, Freud in his early years made brilliant biological research. He studied the structure of nerve cells which was a very complicated issue in 1880 and 1890 when he was looking at it. And he realized that the various components of the nerve cells – the dendrites where nerve cells receive information from other nerve cells, the axons

where they send information to other cells – are all parts of the same unit. So, he realized the nerve cell was a complex unit with three parts. That was a brilliant insight! That was the neuron doctrine, the basis of our modern understanding of the nervous system. So, Freud was close to deep insights into this but I think several things intervened to have him turned to clinical practice. One is in his time you had to be financially independent to do research. He had just gotten married, he didn't have the income – he came from a poor family, he needed money. So, the only way to support oneself as a physician was in a private practice. He started off as sort of a neurologist, then became interested in mental illness – hysteria – and that led him to his talk therapy. So, he moved gradually from biology to psychology and psychoanalysis, always with the hope that some day he could come back.

Scobel: “One of the reasons that made him stop was he couldn't find on the level of anatomy a difference between conscious and unconscious processes. Would you say you have an answer today to Freud's question at that time?”

Kandel: “Ja! He realized quite correctly that in 1890 we did not have a biological underpinning for mental processes. We are now beginning to understand. It is an enormously complicated problem. The most difficult problem in all of science. But we now know that vision is represented in certain parts of the brain and there is a special area for face representation. And we have an understanding of how certain acts are unconscious, where they are represented – and certain acts are conscious and where they're represented. So, we don't have a detailed breakdown of Ego, Id and Super-Ego – but we know that those are – each of them represent a set of functions and each of those set of functions are represented in one or more areas of the brain. We are making very good progress in understanding that. People often ask me: Look, this training in psychiatry, in psychoanalysis – was it useful for you? You work on the snail – what has this to do with psychoanalysis? And I say that almost all my ideas are stimulated by my interest in behaviour, my interest in mental processes. I wouldn't be tackling memory and learning if it was not for my early interest in psychiatry and psychoanalysis. So, I think one's cultural background bears importantly on the overall view that one has of science and the overall questions that one answers, tries to answer.”

Scobel: “Would you say that at some point you will be able to pin down you know to the language of neurons what the I, what consciousness is?”

Kandel: „Absolutely! I don't think it's gonna happen tomorrow, it may not happen within the next 70 or 100 years but biology is in a position to provide a detailed understanding of all mental processes. Now, many people are afraid that once we understand the biology of mind we will become disenchanted with intellectual activity, with creativity because we will understand it all. I don't have that fear at all. We appreciate that the heart is a muscular pump that drives the blood through the body. Yet it is nonetheless marvellous to behold. The biology itself provides a new level of explanation. When you go to a museum and somebody explains to you what the significance of Mona Lisa's smile is, what it is in the painting that makes you respond to the mystery – that explanation doesn't make the painting less interesting, it makes it more interesting”

Scobel: “Maybe it's to jump ahead a bit but there is a discussion about neuro-ethics. We have to ask the question if we have criteria to judge who is able to or who should enhance his brain or not.”

Kandel: “That's a wonderful question and I would say there are several components to it: If I show you somebody who is 75 years old and is beginning to show a weakening of memory with age you and I would have no difficulty saying that this person deserves, needs and will be helped by medicines that improve his memory. If I would show you a 15 year old boy who is preparing for – I don't know – Gymnasium or University, wants to take an exam – we would not recommend that he takes a drug to improve his performance. We would say. Go home and study little bit more! With younger people I am extremely sceptical of its utility: It's a little bit like using steroids to improve the athletic performance of it. It poses several problems: One is we don't want to raise

a culture on drugs. We don't wanna move from Marihuana to Heroin to cognitive enhancers, okay? Number one. Number two: Drugs are expensive. It takes a long time nowadays to develop a drug. It will cost a lot of money to buy these drugs. People who have money will be able to buy drugs for their young kids to take the university exam. People who don't have money won't. We don't want that kind of a society. The third thing is: Every drug – Aspirin – has dangers.”

Scobel: “Side effects” associated with it. You know if you have mental retardation you're willing to take a chance. If you are 70 years old and you have a memory loss you're willing to take those risks, they are usually small compared to it. But if you are 15 you should not take a risk like that.”

Scobel: “The same medication might even work for forgetting which is the opposite of what we just talked about and there is also a question whether or not we should use that for example in cases of traumatisation.”

Kandel: “That's a more complicated issue and I have not formulated my final thoughts on that. But I at the moment don't have any difficulty in giving a firefighter a pill when they go into a building flaming with fire in which they might loose their colleague or they might see people caught in the fire and burnt alive. Or I don't see any difficulty giving pills to troops going at the combat. I think society has a responsibility that if it sends people into dangerous situations in which their emotions can be profoundly disturbed for years after that we try to protect them.”

Scobel: “In terms of military it would make it easier to have wars then, wouldn't it?”

Kandel: „No, these pills don't protect you from war. They protect you from the trauma of war. Ja, the emotional impact of the war. That's true, I mean it's conceivable that people would become more careless, more callous, would be willing to tolerate murder more if they don't have an after effect. That's a very good point. I was more thinking of the fact that people come back after the war and have posttraumatic stress disorder. You raised a thoughtful point that if one removes the painful memories one might lower the threshold for going at the combat again. Usually it is not the soldiers at the battlefield that determine whether we go to war - it is the president of the United States.”

Scobel: “Could you explain to a non-scientist how it is possible to understand something complex like learning in terms of biochemistry?”

Kandel: „Ja. When I started to study learning I began by examining its most complex form: in the mammalian brain. And I found this is very difficult. So, I went to the simplest possible example how a simple reflex in a simple animal can be modified by learning. And there I could see the skeleton outline of the learning process.”

Scobel: „Do you think that behaviour can be translated one to one into a neurocell?”

Kandel: „One to one! The communication between nerve cells is specified by genetic and mental processes. So, you're born with a brain that is hooked up accurately and correctly if your brain functions normally and in your case it functions extremely well. So, we have a brain functioning well, connections as specified – what is not specified is the exact strength of the communication. And what learning does is to alter the strength. It modulates the strength of synaptic connections. Once we found that we could ask several questions. One is: What is the difference between short-term-memory – looking up a telephone number in a telephone directory – and long-term-memory – repeating something over and over again and learning it. And we found what's short-term-memory: the connection changes functionally. There are no anatomical changes. But long-term-memory you actually grow new synaptic connections. So, insofar as you and I remember anything about this conversation and I know I will it is because I will have a somewhat different head after this interview than I had before. It will be new anatomic connections. That's quite profound. It means every single person we know, every single person in Germany has a somewhat different brain than any other person if only because of the difference in social experience. And so we began to look

what are the molecular underpinning and we found that when you turn on short-term-memory you activate a signalling system within the nerve cell called cyclic AMP and that strengthens the connection for a short period of time. When you turn on the long-term-memory, when you repeat it you give cyclic AMP a chance to go into the nucleus – the center for gene regulation – and to turn on genes. So, when you and I have a conversation genes are being altered in our respective brains. This is a surprising finding. Many people think the genes are the commanders of behaviour, the controllers of behaviour. They don't realize that they are also the servants of the environment. Genes in your brain respond to learning and environmental stimulations of various kinds. They alter the level of expression and that gives rise to the growth of new nerve cells.

Scobel: „Now there are millions of genes. How did you find out which one exactly worked?“

Kandel: „We looked in those nerve cells that we altered so we could limit it dramatically and we had an idea of what genes cyclic AMP acts on. So, we went on these genes – it's called cyclic AMP response element binding protein that had been identified in other organs of the body – and we blocked that. And we showed that we blocked long-term-memory without effecting short-term-memory. And then we did a more remarkable experiment: We took this protein, we exposed it to cyclic AMP, we injected it into the cells and: BOOM! We could get memory in that system. So, that clearly showed that this was an important component.

Scobel: „Do you think there is a difference today between let's say the German-Austrian tradition to do science and the way science is done in the States or the Anglo-Saxon countries?“

Kandel: „Yes. What America introduced at the beginning of the 20th century through people like Thomas Hunt Morgan was a democratic attitude towards science. In Germany and Austria there was the "Geheimrat". He was the major person and everybody worked for him and people had enormous respect for him and he treated himself as being very important. There was a clear hierarchy. With Thomas Hunt Morgan and following him many people in the United States developed a different attitude: Everyone was equally important. What counted was your ideas. So young students if they had a good idea were listened to and people were on per-du-basis with one another in the lab. So, it created a different culture in which young people were respected if and only if they were valuable members of the lab, irrespective of the family they came from, how many years they were in the lab, how old they were. So, it was a change in emphasis and it equalized things in the lab. Thomas Hunt Morgan wrote a classic book in 1915 on the nature of the gene in which two of the co-authors of the book were undergraduates at college. Undergraduates! Could not have happened in Europe! When François Jacob came to the United States in 1947 he couldn't get over the fact that Arthur Kornberg – one of the most important biochemists in the world – that in his lab the students called him Arthur. He said when I entered Monods lab he was only five years older than me I didn't know what to call him. So, the first seven years I called him nothing! It is a big difference in attitude and it effects the encouragement of creativity in young people.

Scobel: „Do you think what people like Julian Jaynes for example said is true that religion or the concept of God is really the outcome of some sort of interrelation between the brain hemispheres?“

Kandel: „Well, I think that is a position - to put it into broad terms - there are two positions on the nature of God that there is a universal designer who is responsible for the structure of the universe or at least had some say over it on the one hand – and variations of that theme. Most major religions are variations of that theme. And the other is our mind has created the deity. We have a need to assure ourselves that there will be life after death, a sense of immortality. We need somebody to shepherd us through this uncertainty and we create out of our own imagination, out of our own brains our view of a deity. And the fact that all deities share certain similarities is also

consistent with the view that it might be created by human beings.

Scobel: „What’s your personal view?“

Kandel: „I like being Jewish. I like very much the cultural aspect of Judaism. I don’t believe there’s somebody up there. I like the moral, social aspects, the scholarly aspects of Judaism. I separate myself from a devout belief that there is a universe soul, presence.

Scobel: „You mentioned the visual system that there are different areas in which different visual processes are processed. Do you think a similar thing might be true for what we call the I or consciousness that there are different parts in it put together?“

Kandel: „Very good. Good. That’s a very good insight. Consciousness is the deepest of all problems. If we consider the brain the challenge of science in the 21st century this is the epitome of that challenge. We don’t even know whether there is such a thing as consciousness. Once we understand the brain completely that term may not have a great deal of meaning because it represents not one function but a whole set of different functions. And as we understand each of those functions more precisely we may use different terminology. We do not as yet have any neuro-anatomical basis for it. We know if you make certain lesions on the brain you’re unconscious. But there’s a big difference between being unconscious and what you and I think what consciousness is, awareness of self, how I sense myself to be a unique person and how you sense yourself to be a unique person. These are deep problems to which we don’t have understandings. And this will be interesting you know. The issue is, which makes it so difficult is we can study something which is objective, which is out there. But why I react to this colour blue in a different way than you react to it is a problem that is much more difficult That’s the difference. That’s the subjectivity of consciousness. That is very hard.

Scobel: “Do you think we might have a theory, a scientific theory of how all these different aspects which make the I are bound together?“

Kandel: „Yes. So, that’s a both an empirical and conceptual issue. An empirical question is when I look at you my nervous system dissects the image of you into component parts. So, I take the shape of your head and I process that in one way. I take the colour of your skin and I process that in another way. When you shake your head there is a separate system that handles movement of the visual object. Somehow these have to be brought together. That’s called the binding problem. Wolf Singer says: When information occurs in these three systems at the same time the cells fire in synchrony, they fire at the same time. And that binds them together okay. So, there are different views of how this occurs. This is a very important issue. But there is also the issue of how do you perceive that. Why is it once that comes together, one perceives it. And that one doesn’t understand as well yet.“

Scobel: „But in your view there is no qualitative difference between animal brains and human brains?“

Kandel: „Oh no, no, no. I wouldn’t say that. I would say that the human brain is so much larger, has the power for language, those what we call emergent properties add new dimensions to complexity. So, I think the strategy that I’ve used – sort of a radical, reductional strategy – is necessary to explore the human brain but it’s not sufficient. You need much more than that. You need a logic that allows you to tackle complex systems of neurons and as with the binding problem when you get to these high order problems you need theoretical approaches. My work is essentially – I mean it has theory but theory of the middle range You need complex theories. You need to have mathematical, computational models and this is why for the first time computer scientists, model builders, computational neuroscientists become extremely important in this field.

Scobel: „That changes biology, doesn’t it?“

Kandel: „Changes biology dramatically! Just to give an example: At Columbia where we have quite strong neuroscience we've never had a computational group until recently. But in the last three or four years Larry Abbott, Ken Miller, several outstanding people have been recruited to Columbia. They've made an enormous difference.”

Scobel: „What do you think will be the next steps in your view the next steps say in the coming ten years – what do you think?“

Kandel: “I think moving from Aplysia to the human brain – I'm joking – moving from simple neural circuits to comp..., the structure, the functional architecture of complex neural circuitry, how it processes information, is the next major step. How we generate motor balance for walking, how we generate parlance for speech, for eating – these complex behaviours how they're generated in detail is the next agenda.

Scobel: “If we succeed in that – and it's a very interdisciplinary approach – do you think it will change the view we view each other? The kind of view we have what man is?“

Kandel: „Ja. I must tell you for me that jump occurred you know some time ago. I don't think understanding neuropsychiatry will change my view of this. I have a pretty biological view of human mental processes – but it certainly will give me a better understanding of what the underlying biology is. So, for example: A wonderful set of discoveries that emerged recently from an Italian laboratory – Rizzolatti – on mirror cells is quite extraordinary. When a monkey picks up a piece of fruit and puts it in his mouth certain cells in the monkey's brain fire. When you pick up a piece of fruit and put it in your mouth the same cells and the same monkey cells fire. So, those cells are involved not only in the act itself but in the imitation, the appreciation of the act. And this occurs in an area – the motor system. So, this is interesting from two points of view: First of all the motor system is involved in cognitive aspects of behaviour - number one. And number two: There's built in the brain a mechanism for empathy, for understanding what is going on in somebody else's behaviour. Imitative aspects of behaviour. So, people are wondering autism which is a disorder in which I cannot perceive what's going on in your mind – maybe this is a defect in that mechanism. So, there are lots of consequences: the acquisition of speech, children looking at their mothers, infants seeing the movements of their mouths probably use a mechanism like this for the early babbling, for the early expression of language. So, there are lots of things that come out of that. So, these high order processes I think this is the task of the next ten, 20 years.

Scobel: „Thank you very much for the conversation.”

Kandel: „My pleasure.“