

sign. In this study SCP neurofeedback was compared to alpha-power neurofeedback, and only the group who received SCP neurofeedback demonstrated a significant reduction in seizure frequency.<sup>76</sup> In order to understand the historical context about this SCP neurofeedback better, in the following we will talk more about Niels Birbaumer.

## NIELS BIRBAUMER

Niels Birbaumer, born in Ottau, Czechoslovakia in 1945 just three days after the end of the second World War, spent most of his youth in Vienna, Austria where his parents ended up after they fled from Czechoslovakia. In his teenage years, Birbaumer was member of a teenage street gang in Vienna and at a specific moment at the age of 15, Birbaumer was arrested after having stabbed a scissors into a competing street gang member's foot who stole his sandwich. After this incident his dad picked him up from the police station, he threatened to force him to start working as an upholsterer, and actually had him work at an upholsterer's workshop. This made the young Birbaumer realize that staying in school was a better alternative. In addition, he made a deal with his father that he changed schools and by this internal realization as well as change of environment, was able to flourish and deviate the course he was on or as he stated in his book 'Your Brain Knows More Than You Think': *"...I was able to break out of the gang and eventually graduate..."* This initial event demonstrates a central point in Birbaumer's thinking, about the capacity of our brains to change, adapt and reorganize, rather than accepting the notion of the brain as a fixed system, and thus individuals as 'unchangeable', such as for example the psychopath that should be locked behind bars forever, or the locked-in Amyotrophic Lateral Sclerosis (ALS) patient whose will should be willfully executed, without accepting the notion a patient might have different experiences and thoughts at this moment. As we will see, this notion of the capacity to change, has been a central theme in many of Birbaumer's research studies he would embark in later, and provide very valuable insights.

In later years, Birbaumer discovered his passion for literature, and while having attempted to study the German language and literature, he decided “...*It was a catastrophe. Boring...*” Of great importance for his career was the compulsory lecture ‘*Introduction to Psychology*’ by Hubert Rohracher. Rohracher was a psychologist, but an anti-Freudian and positivist and read about brain and behavior. That impressed Birbaumer (*pictured right*) and he left German studies and switched to psychology as his main subject. Rohracher – who would eventually become Birbaumer’s mentor – was an early EEG pioneer and his first EEG works can be traced back to 1933, just years after Berger. In 1944, Rohracher discovered microvibrations in muscles, which were weak mechanical vibrations in the body surface with the limbs in a totally relaxed state and he observed the vibrations were in the 8-12 Hz range, since then replicated by many researchers. Since these microvibrations only occurred in warm-blooded animals he reasoned these microvibrations must play an important role in maintaining a constant body temperature. Furthermore, it would help keep the body musculature in a constant state of readiness, thereby making possible rapid motor responses. Noting the remarkable similarity between these 8-12 Hz microvibrations and the 8-12 Hz EEG alpha rhythm, implied a possible causal connection according to Rohracher, which however never got substantiated by empirical data. The International Congress of Psychology in Paris in 1937 was one of the few congresses where Hans Berger was actually present, and Rohracher and Adrian were also present at that conference. According to Birbaumer, they had a big discussion there, where in line with the above reasoning of microvibrations, Rohracher reasoned that alpha was related to the metabolic activity of the brain to keep itself warm, which was a mechanism to keep the metabolism in the brain going and keep the brain warm.

While at Rohracher’s lab in 1969, Birbaumer had to come in every morning at 7:30, wear a white coat as a doctor, and open the door when the professor came in, open a lift door, and go to his room without saying anything and then the professor would give Birbaumer orders. One day Rohracher gave Birbaumer the assignment, “... *you have to find out thinking in the EEG...*” Birbaumer thought “*what?*” Rohracher said, “...*I give you a sentence... ‘THINKING NEEDS*



*TIME'... and I want you to do these experiments that you get a read-out of the EEG pattern and decode these words..." Birbaumer wanted to comment, but chuckled his words, because at that time you didn't question what the professor asked. The only machine they had at that time was Grey Walters EEG machine, which produced enormous heat, but also produced frequency spectra. So, since Birbaumer was not allowed to discuss the impossibility of the assignment with Rohracher, he went to the basement where the machine was located, knowing it would never work, he did the experiments. After half a year, Birbaumer went up to Rohracher and said: "...Herr Professor, I'm very sorry but it didn't work..." Rohracher responded angry, "...what, it didn't work? I bought you that amplifier that you wanted, and you cannot even show me these sentences in the EEG?..." And Birbaumer said, "...I'm sorry, I cannot do this..." Then he punished Birbaumer and said, "...from now on you will only do microvibration research. If you cannot see the thinking in the brain, we'll try to find it in the muscles..."*

Retrospectively this turned out to become the exact question Birbaumer spent most of his life on solving, even to this date, trying to decipher someone's thoughts from their brain activity, or a brain computer interface (BCI) as we know it today.

When the roaring 1960's were in full swing and the student movement arrived in Vienna in 1969, Birbaumer was among those who agitated particularly aggressively; teach-ins, protest notes, political events, that were tolerated by Rohracher. However, when Rohracher retired in 1969, Birbaumer was fired by one of the less tolerant senior assistants. Thereby his chances of getting into any German speaking university were gone, which made him decide to work in the department of psychiatry in Middlesex Hospital in London in 1969-1970, where he learned behavioral therapy and did treatment of obsessive-compulsive disorder patients and neurosis. Then in 1970 he came back to Germany as an assistant professor at University of Munich, and in 1975 he accepted the position as professor of Clinical and Physiological Psychology in Tübingen, where most of his pioneering work on Slow Cortical Potentials, neurofeedback and brain computer interfaces started.