# Through muscles and bones to the brain

Physiotherapy and the war ■ Sister Kenny, 1951's most admired woman ■ What we mean by the Prague School ■ How neuroplasticity revolutionised physical therapy ■ Why the root of the problem might not be where it hurts ■ Can bones wear away like concrete under a dripping tap? ■ Why Vojta's method drew the crowds ■ When physiotherapy stopped being quackery

*A young physiotherapist who once tried to persuade my back into shape complained to me that everyone apart from her parents thinks she's just a massage therapist. Maybe that's one sign that we haven't yet fully taken in the existence of rehabilitation, or physiotherapy, as a discipline—young as it is: in Czechoslovakia the profession was only acknowledged in its own right in 1954. Maybe only people who have suffered serious injury or illness really know what it's all about. How did physiotherapy first emerge?*

Rehabilitation, of which physiotherapy is part, developed primarily in the aftermath of the First World War, when soldiers were returning home with injuries that had serious, long-term effects and it was clear that they needed something more than medical treatment. The idea was to help them back onto their feet so that they could lead active lives again. That's why the *Soldiers' Rehabilitation Act* was passed before the end of 1918; the *Civilian Rehabilitation Act* followed just two years later, opening the legal doors to physical therapy for all. That was the first key period. Around the same time, the acclaimed *Jedličkův ústav* institute for the disabled opened in Prague. It was also a sort of rehabilitation centre, which provided disabled people, children in particular, with not only medical treatment but also training and qualifications suited to their

abilities and thus a route to gainful employment. That laid down the foundations of social rehabilitation.

The next major milestone came in the 1950s, with the world epidemic of poliomyelitis (infantile paralysis): physical therapy made substantial headway as a means of treatment at that time and began to emerge as a medical discipline.

*If you don't mind, Professor, I'll briefly interrupt you there to tell the story of a certain Elisabeth Kenny. She was born on an Australian farm in 1880. At the age of seventeen, having broken her wrist falling from her horse, she was taken to a doctor's surgery and there she saw an anatomy textbook and skeletal model for the first time. That moment defined the rest of her life. For years she worked as a village nurse, even though the only medical "course" she had taken was one the local midwife had given her, so the nurse's uniform she had sewn for herself was a deception; indeed, her critics never let her forget that. It was during her nursing practice that she first encountered disabled children. During the First World War, she served as a volunteer on navy ships transporting wounded soldiers between Australia and England. She made use of that experience later, when looking after victims of the polio epidemic. In the clinics she set up in Australia and, from 1940 onwards, in the USA, she attempted to help her patients regain their physical abilities through means other than medicine: instead of immobilising their paralysed muscles in a plaster shell, she mobilised them through physical exercises. In the English-speaking world, dozens of clinics were set up in her name. Sister Kenny, as she was known, also gained the support of the American President Roosevelt, who had himself suffered paralysis as a result of polio and was dependent on a wheelchair. The famous American actors Alan Alda and Martin Sheen also claimed that they were only able to get back on their feet after having polio in childhood thanks to Sister Kenny's unorthodox methods. In any case, in 1951 Gallup's survey named Kenny the most admired woman in the USA, a position held for the following ten years by Eleanor Roosevelt. What is your view of this courageous Australian woman?*

You could say that Sister Kenny was the true founder of modern physiotherapy. She used the neurophysiological knowledge of the time and chose methods known as "facilitation" or "stimulative support" for the damaged muscle functions. Poliomyelitis is a viral infection of the nerve cells in the spinal cord that control the muscles. Some of them die, while others stay alive but change into dormant nerve cells—Sister Kenny called them "alienated". These need to be reawakened, which can be done through targeted stimulus.

Sister Kenny's approach helped many people and what she achieved sparked an interest in physiotherapy as a new area of medicine. She didn't have it easy, though: even in Australia many doctors thought her methods were too innovative and controversial, but certainly they did open up a broader discussion from which further new techniques emerged. One of those was the Kabat method (also known as Proprioceptive Neuromuscular Facilitation), which is also based on the idea of reawakening muscle activity but through a different type of stimulation, and was practised extensively here during the 20th century. What is more, substantial advancements were made at that time in our neurophysiological knowledge of how movement is controlled.

*What was so important about those new neurological discoveries?*

One of the most crucial discoveries for rehabilitation, although it came slightly later, was that when one part of the brain fails another part can adopt its functions. We call this ability "neuroplasticity".

*If I'm not mistaken, that was discovered by the American neuroscientist Paul Bach-y-Rita, who—as it happens—was inspired by what had happened to his own father, Pedro, who was a Catalan poet and literary scholar. At the age of 65, Pedro suffered a stroke that left him paralysed on one side and unable to talk. His doctors more or less gave up on him, but his sons were determined not to. One of them, George, who was a medic*

*and went on to become a psychiatrist, took Pedro into his home in Mexico and played with him just as he would with a baby as it gradually learned to crawl, pick things up, sit up, walk and talk. The result of their mutual patience and trust was that after just two years Pedro was able to return to his teaching job, and he even married again. He enjoyed seven years in full health before dying of a heart attack while skiing in the Andes. Doctors were shocked by his post-mortem, which revealed that vast sections of his brain that had been damaged in the stroke had never regenerated, but their functions had been adopted by about three per cent of the fibres that connect the brain to the spinal cord. And so Bach-y-Rita set about researching this phenomenon.*

And he discovered that through targeted exercises, the brain can alter its structure and reorganise its functional circuits to respond better to the task in hand. So if we practise a certain set of ball-game moves for a few weeks, the grey matter in particular areas of the visual cortex involved in processing visual-spatial information becomes denser. At the same time, the density of the white matter in the areas of the brain responsible for visual-spatial memory also increases.

These structural changes in the brain can be detected using modern imaging techniques, such as functional magnetic resonance. It is not yet entirely clear what causes them, but one possible explanation is that the brain can create new connections between neurons and functionally reorganise the white matter. When this was discovered, it marked the end of the doctrine of the immutable brain, based on which people born with cerebral disabilities or those who suffered brain damage later in life had previously been written off.

To begin with, the researchers who promoted this idea that the brain can adapt its structure and functions met with disbelief from their colleagues. I recall that when Václav Vojta (who was later granted a professorship) told neurologists at one of his lectures that cerebral palsy in children was a condition with potential, those in attendance diagnosed him with *paranoia inventoria*, a psychiatric term used to describe mad inventors. All Vojta meant was that if rehabilitative therapy is

begun soon enough, children with minor cerebral disabilities need not remain disadvantaged or disabled for life, but this was something quite unimaginable at the time.

*How did rehabilitative therapy respond, in practice, to these revolutionary neurophysiological discoveries?*

New rehabilitative techniques developed that make use of sense substitution. Take, for example, the case of a patient whose vestibular system in the inner ear is not working. This causes balance problems, because the brain is not receiving the information it needs from the inner ear about the head's position and movements. In this case, we can use an instrument that replaces the vestibular function through electrotactile stimulation of the tongue.

*That's rather hard to picture!*

I will try to explain. The neurophysiologist we mentioned, Bach-y-Rita, suggested that if one sensory system stops working, it's possible to retrain the brain so that it can make use of a different system, one that is working. So a blind person can start to "see" with the help of proprioception—information from the sensory receptors in their muscles or joints—while a patient with a balance disorder can use their tongue to sense their position… as a result, we now use an instrument in balance therapy that records the position of the head and translates that information into a pattern of electric impulses, which the patient feels through special electrodes on their tongue. We stimulate the tongue because it is very sensitive to "touch" and because by doing so we can stimulate certain parts of the brain directly, through the nerve fibres in the head: the tongue also serves those nerves. The latest findings have even shown that this therapy results in the brain functionally adapting in the areas of the cerebral cortex responsible for maintaining balance and that those changes do not revert after the end of the treatment. Incidentally, one patient whose progress we are monitoring at our clinic has almost an entire hemisphere of his brain missing, yet he can see through both eyes and walk normally: that is proof of the immense plasticity of our organism.