



# WAVECRAFT

Messages from an unknown world \*

It is almost 100 years since **Hans Berger**, a provincial German psychiatrist, working with rudimentary equipment, claimed to have discovered electrical pulsations of the brain detectable at the scalp. He was dismissed as a crank until some years later **Edgar Adrian**, the eminent Cambridge physiologist, confirmed his findings. When neurologist **Frederick Golla** asked **Adrian** for someone to explore clinical applications of the 'EEG' he suggested **William Grey Walter**, a 25-year-old post-grad.

Undeterred by his critics, **Berger** went on researching and publishing, as the Nazis rose to power in his country. **Walter** became a leader in the new field of electroencephalography, and made seminal contribution to cybernetics and robotics, as the Cold War raged. This exhibition was inspired by their life and times.

\* UCL Institute of Neurology Library and Archive, 1<sup>st</sup> May-1<sup>st</sup> August 2018

**Hans Berger** was born in Saxony, Germany in 1873, the son of a country doctor. He chose to study medicine following an accident:

*As a 19-year-old student I had a serious accident during a military exercise and barely escaped certain death. Riding on the narrow edge of a steep ravine...I fell with my rearing and tumbling horse down into the path of a mounted battery and came to lie almost beneath the wheel of one of the guns. The latter...came to a stop just in time and I escaped, having suffered no more than fright...In the evening of the same day I received a telegram from my father who enquired about my wellbeing... My oldest sister, to whom I had always been particularly close, had occasioned this because she knew with certainty that I had suffered an accident... a case of spontaneous telepathy...I transmitted my thoughts, while my sister...acted as a receiver.*

*Psyche, 1940*

After training in psychiatry with Otto Binswanger he stayed on as his assistant and began looking for physiological markers of changing mental states. Working with people with skull defects, he searched for temperature and pressure changes, with no success. In 1924, equipped with the most basic equipment, he began looking for spontaneous scalp electrical activity in the same group. Such a project was physiologically naïve and ill informed, which is why the scientific establishment dismissed it, but that is how he discovered the rhythmic pulsations he was to name the 'electroencephalogram'.

**William Grey Walter** was born in Kansas in 1910 and moved to London during World War One. He made his first radio, with his English father, when aged 9, an experience that kindled a life-long interest in electronics. After gaining a first in physiology at Cambridge under leading physiologist Edgar Adrian, he stayed on for postgraduate work, including an influential year with Rozental, a visiting pupil of Pavlov. In 1935 he moved to London, on Adrian's recommendation, to work on clinical applications of the EEG at the Maudsley and Maida Vale Hospitals, with Queen's Square trained neurologist Frederick Golla. A year later he became the first person to localise a brain tumour with the EEG and named the slow frequencies that identified it 'delta waves'. In 1939 he moved, with Golla, to the Burden Neurological Institute in Bristol, an institution funded by a charitable trust and, over the years, a variety of other donors including Guinness and the military. Despite relatively poor pay, Walter enjoyed great academic freedom at 'the Burden' and stayed for the rest of his career.



(Left to right)

### **Berger**

(charcoal and chalk, war gaming figure)

'He impressed his collaborators as an authoritarian whose foremost interest was to run his clinic according to strict, meticulous and almost military routine.'

P Gloor, Introduction, *EEG and Clinical Neurophysiol Suppl.* 28, 1969.

'...it was generally felt that Berger lacked originality and was incapable of great achievements.'

Raphael Ginzberg, Three years with Hans Berger, *Journal of the History of Medicine*, Autumn 1949, 361-371

### **String Galvanometer**

(mixed media; copies of drawings from Berger's workbooks; quotation from Berger's research journal, 7/6/1929 - from Borck, 2018, with permission).

'Berger was not a physiologist and his reports were vitiated by the vagueness and variety of his claims and the desultory nature of his technique. He was indeed a surprisingly unscientific scientist.'

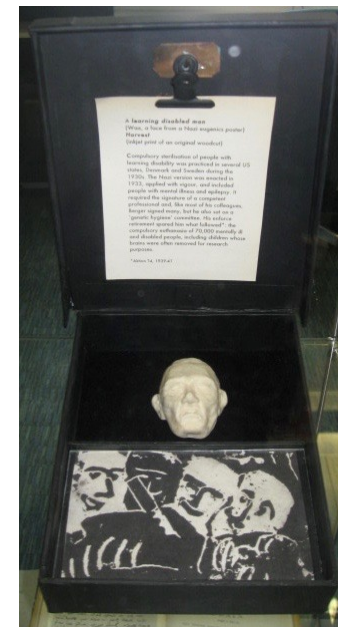
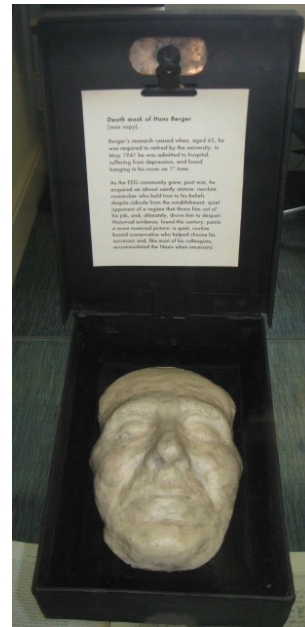
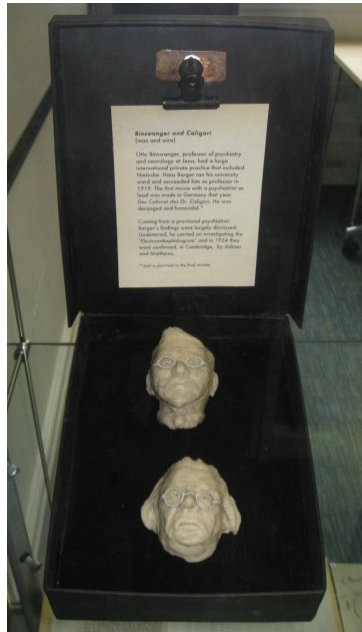
WG Walter, *The Living Brain*, 1953.

A string galvanometer recorded the first ECG trace, at five times the voltage of the EEG, in 1909.

### **Subjects**

(charcoal, chalk and plaster; based on the only photograph of a Berger subject)

Early recordings were carried out on patients with traumatic or surgical skull defects, usually on Sundays when the building was otherwise electrically silent and free from prying eyes.



(Left to right)

**Binswanger and Caligari (wax)**

Otto Biswanger, professor of Psychiatry and Neurology at Jena, had a large international private practice that included Nietzsche. Hans Berger ran his university ward and succeeded him as professor in 1919. The first movie with a psychiatrist as lead was made in Germany that year, *Das Cabinet des Dr Caligari*. He was deranged and homicidal\*. Coming from a provincial psychiatrist, Berger's findings were largely dismissed. Undeterred, he continued investigating the 'electroencephalogramm' and, in 1934, they were confirmed, in Cambridge, by Adrian and Matthews.

\*Until a plot twist in the final minute

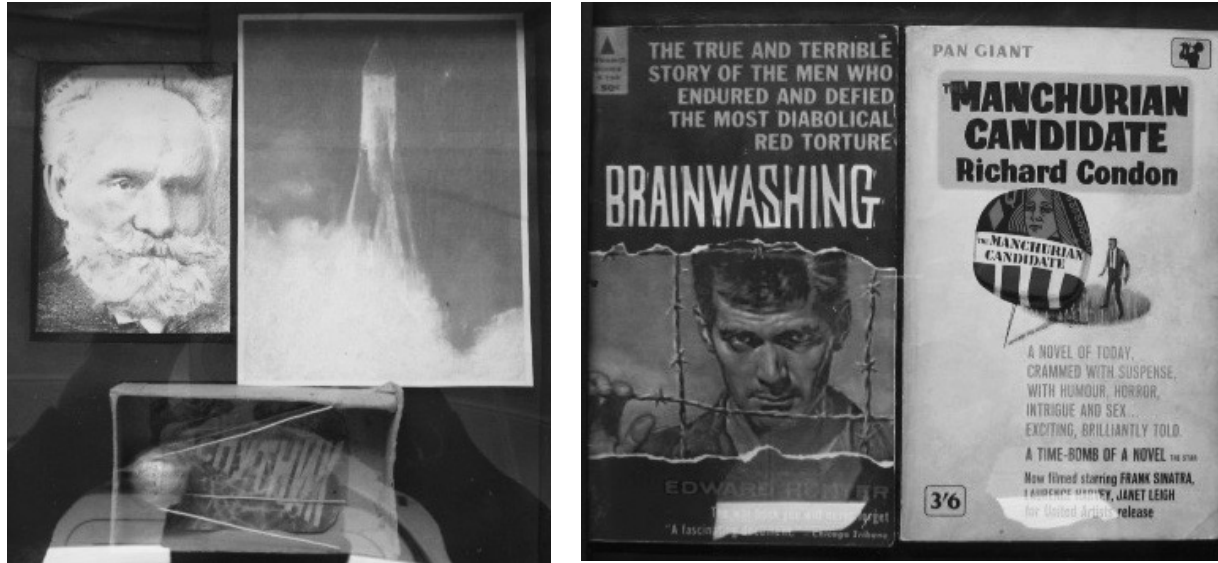
**Death mask of Hans Berger (wax copy)**

**Hans** Berger was found hanging in his hospital room on 1<sup>st</sup> June 1941, having been admitted a few days before suffering depression.

As the EEG community grew Berger acquired an almost saintly stature: resolute researcher who held true to his beliefs despite ridicule from the academic establishment; quiet opponent of a regime that, ultimately, threw him out of his job, stopped his research and drove him to despair. Historical research this century paints a different picture: He was a conservative who, like most of his colleagues, accommodated the Nazis when necessary (signatory of many compulsory sterilisation orders, sitting on a 'genetic hygiene' committee). He was however required to retire by his university, 6 months after his 65<sup>th</sup> birthday, and seems to have found the loss of his research particularly difficult.

**A learning disabled man (wax, from an image on a 1930s Nazi eugenics poster) Harvest (inkjet print of original woodcut)**

Compulsory sterilisation of people with learning disability was practiced in several US states, Denmark and Sweden during the 1930s. The Nazi version was enacted in 19033, applied with vigour and included people with mental illness and epilepsy. It required the signature of a competent professional and, like most of his colleagues, Berger signed many, but also sat on a 'genetic hygiene' committee. His enforced retirement in 1938 spared him involvement in what followed, the involuntary euthanasia of 70,000 mentally ill and learning disabled people, including children whose brains were often removed, and prized, for research purposes.



## **Cold Warrior**

(Inkjet prints of pencil and charcoal originals; mixed media model)

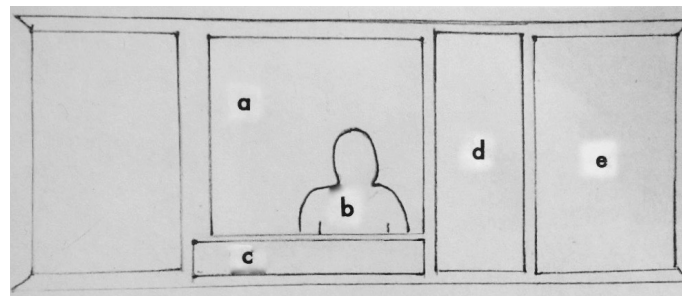
As the Cold War became glacial in the 1950s two events boosted the funding of brain science: the Korean War and the success of the Soviet R7 rocket. A month after the R7 put *Sputnik* into orbit a smaller US rocket failed on the launch pad. As a result President Eisenhower created DARPA\*, an agency tasked with preventing the US falling behind the Soviet Union in technologies that could be weaponised, and that included neuro-technologies. When American POWs were filmed denigrating the US shortly after capture some form of fiendish Communist mind control or 'brainwashing' was suspected, based on advanced Pavlovian conditioning. Having worked with one of Pavlov's pupils Walter was ideally placed to take advantage; he and the Burden received military funding from the early '50s onwards. In 2013 President Obama announced DARPA was putting \$40 million into brain research, including wireless brain implants for intractable PTSD.

Edward Hunter's book, published in 1951, described the supposed threat to the US of Communist 'brainwashing', and this popular paperback edition fed the public appetite for fiendish Communist plots. Richard Condon's novel, a successful '50s thriller on the theme, featured an ex-POW brainwashed by conditioning to assassinate the president. The film version was released in the middle of the Cuban missile crisis, but withdrawn a year later after Kennedy's assassination. In the 2006 remake 'Manchurian' was a global corporation and 'mind control' exerted through wireless brain implants.

\*Defence Advanced Research Projects Agency.



**Maida Vale**

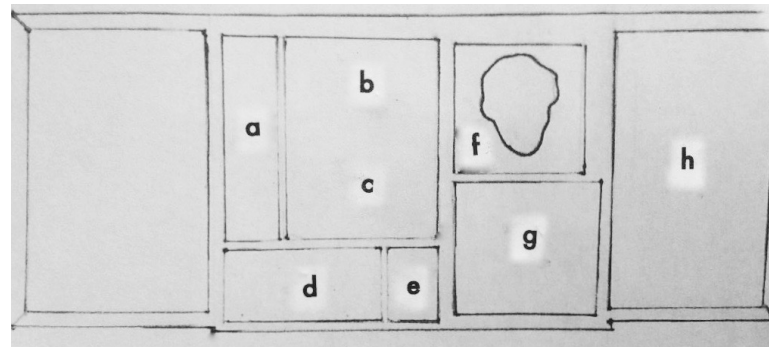


- a. Grey Walter in his 'laboratory' in 1936 (a ward side room at Maida Vale Hospital).
- b. Model of a subject and the electrode housing he built, from a recycled table lamp and woman's hair net (mixed media).
- c. An early smoked drum record of EEG slow waves.
- d. His paper from *Lancet* of 8/8/36, the first to report localizing tumours by EEG and suggesting the term 'delta waves'.
- e. Illustrations from Walter's workbook.





*The Burden*



- a. Grey Walter at the Burden Neurological Institute, around 1940.
- b. Recording from the first EEG pen recorder.
- c. Walter mid-experiment in the late 1960s.
- d. The Burden Neurological Institute, Bristol, 1939.
- e. Frederick Golla (Burden Director '39-'59)

- f. The first UK paper on Electroconvulsive therapy (Walter made the equipment at Golla's request).
- g. Harold Shipton, ex-RAF radar technician recruited by Walter in 1946.
- h. Walter's sketch of his design for the first real time EEG frequency analyzer (1944)



(Left to right)

### **Topsy**

(mixed media; *Topsy in situ*; quotation from WG Walter, *The Living Brain*, 1961 )

In 1948 Harold Shipton and Bunny Warren, ex-RAF technicians, used radar display technology to create *Topsy*\*, an analogue marvel conceived by Walter: 22 oscilloscopes displayed shifting EEG frequencies as they spread over the brain surface in real time. *Topsy* explored many things, but in the end the brain's complex visual language defied all but the most basic interpretation. More *avant garde* artwork than useful tool, *Topsy* was abandoned for simpler digital technologies in the 1960s.

\*the 'toposcope'

**A stop-motion animation of the toposcope, based on published images, is available here:**

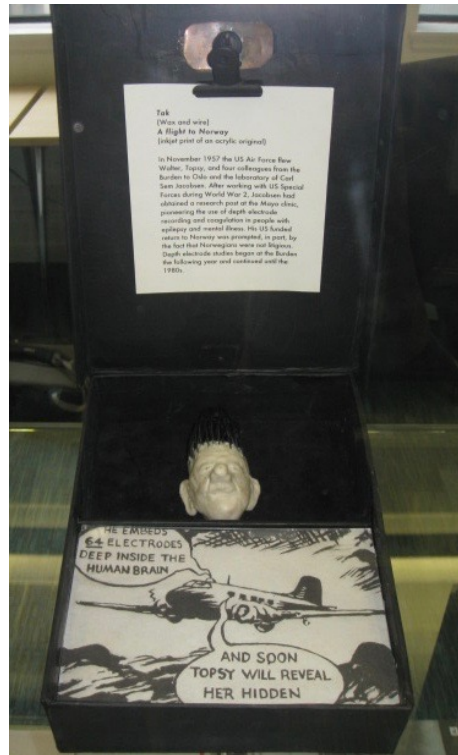
<https://www.youtube.com/watch?v=vW29gnKZSPs> (or search 'walter toposcope')

### **Walter**

(charcoal and chalk; based on a photograph in the Burden archive taken mid-experiment in 1956; quotation from *The Living Brain*)

'Grey was an especially gifted teacher...with immense powers of persuasive oratory... At a time when science is beset by bureaucracy, manipulated by special interest and mistrusted... the loss of such giants as Grey Walter is especially hard to bear.'





## Tak

(Wax and wire)

### A flight to Norway

(inkjet print of an acrylic original)

In November 1957 the US Air Force flew Walter, Topsy, and four colleagues from the Burden to Oslo and the laboratory of Carl Sem Jacobsen. After working with US Special Forces during World War 2, Jacobsen had obtained a research post at the Mayo clinic, pioneering the use of depth electrode recording and coagulation in people with epilepsy and mental illness. His US funded return to Norway was prompted, in part, by the fact that Norwegians were not litigious. Depth electrode studies began at the Burden the following year and continued until the 1980s.

## Cyborgs

(wax and wire, based on a 1921 collage by Max Ernst; stills of Walter as subject in his own experiment in 1969)

In the early 1960s Walter noticed an apparent negative shift in the EEG between stimuli in another conditioning linked experiment. The CNV\* or 'expectancy wave' was, arguably, his most significant discovery, the first of a family of 'event-related potentials'. In 1969 he programmed a computer to recognise one of them, the 'readiness potential', and turn on a TV on when detected – the first direct brain-computer interface. A few months later he came off his Vespa scooter and suffered a severe head injury. Despite a brain haemorrhage, cardiac arrest and three week coma he returned to work. He died in 1977 of a heart attack.

\*Contingent Negative Variation.



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