

ICT & Art Connect : Revelations by Flicker, Dreamachines and Electroencephalographic signals in art

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Abstract. How did ordinary tools in the Neurophysiology department become means for spiritual enlightenment ?

The combination of brainwave (EEG) monitoring by the early adopters with stroboscopes induced side-effects in many of the clinical experimentees in neurophysiological research, hallucinations that were named 'Flicker.' Patient's experiences described increasingly bright, complex patterns of colour behind their closed eyelids. Soon Cyberneticians, psychologists and artists were spontaneously informing this interdisciplinary exchange, during a time of pioneering chemistry, new artistic styles and implementation of new tools for experiencing Art. An aleatoric crossover occurred between Dr Grey Walter's neurological research with strobes and electroencephalographs, and the culture of 'The Beats' following his publication of "The Living Brain." Unifying this is the hypnotic light ensemble the 'Dreamachine'. Now an object synonymous with generating visions by Flickering patterns, and for many, a drugless portal to Altered States on Consciousness (ASC). This article follows the involvement of Human brainwaves in artistic expressions as pioneered by composer Alvin Lucier almost 50 years ago. The harnessing of the EEG signal in interactive artworks encourages dialogue and updatable synergy between the arts and the sciences. Through medical research into Epilepsy and visual artefact I trace the emergence of EEG in artworks. I will describe how artists' work, including my own is harnessing the EEG signal, bridging various methods and arousing questions in art and human experience.

1 INTRODUCTION

Inducing hallucinations by Flickering light emerged long before the scientific era. In 1564 Nostradamus conducted Flicker experiments (at the bequest of Catherine de'Medici), he was inspired by the legends of Lucrezia Borgia and the subtle magic of 'photic-entrainment² by flames she employed to access visionary divinations, and predict future events.

"Angels and New Jerusalem and Madonnas and Future Budhas - they're all related to some kind of unusual stimulation of the brain areas of primary projection - the visual cortex for example"[1]

At this time Churches had collection boxes outside to beckon donations for the upkeep of their multicoloured vehicles for reaching visions - stained glass windows, illuminated by the sun. How far removed this now seems from our contemporary zones of individual user, customisable stimulation, secreted behind

sunglasses and headphones, immersed in immediate isolation. At ten years old William Blake saw his first vision, it was a tree full of angels. This ability to "see" what he imagined never deserted him in his visionary creations of poetry, painting and engraving. Those who watched him draw imaginary personages affirmed that he had the rare ability to see mental images as if they were outside of his head. He writes 'The imagination is not a state. It is the human existence itself.'[2]

Neuroscience revealed more secrets about the Mind in 1819 when Bohemian physiologist Dr Jan Purkinje's interests in understanding vision were stimulated, encouraged through reading Goethe's *Farbenlehre*[3] and because of his use of the phenomenological method. Purkinje, who had also been trained by monks and was a by now a friend of Goethe, wrote a detailed account in his first book of his preliminary scientific accounts of 'Flicker'. Here he observed various patterns like crosses, stars and spirals, when waving his hand between his eyes and a gaslight. Another influential discovery was made by inventor Shelford Bidwell, best known for his work with "telephotography". 'Bidwell's ghost' is a visual phenomenon associated with after-images produced by alternating flashing lights. Early electrical scientific Flicker published in the neurology journal *Brain* used a device known as 'Benham's top.' It can be traced to a French monk, Benedict Prévost, who in 1826 observed colours 'like a heavenly light on his fingers' – when he waved his hands about in the cloisters. Finding that this also happened with white cardboard, he realised that it has a physiological origin, in the eye, and correctly attributed it to different rates of action of specific colour mechanisms of the retina. The arcs of pale colour are termed Fechner colors or pattern-induced Flicker colors (PIFCs.) Clinical reports of Flicker stimulation appear as far back as the beginning of the 20th century. In the Salpêtrière Hospital in France, patients gazed into the Flickering light produced from a spinning, spoked wheel in front of a kerosene lantern, which doctors observed a reduction in their anxiety and hysteria.[4]

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² a technique using flashes of light to guide the brain into various states of brainwave activity.

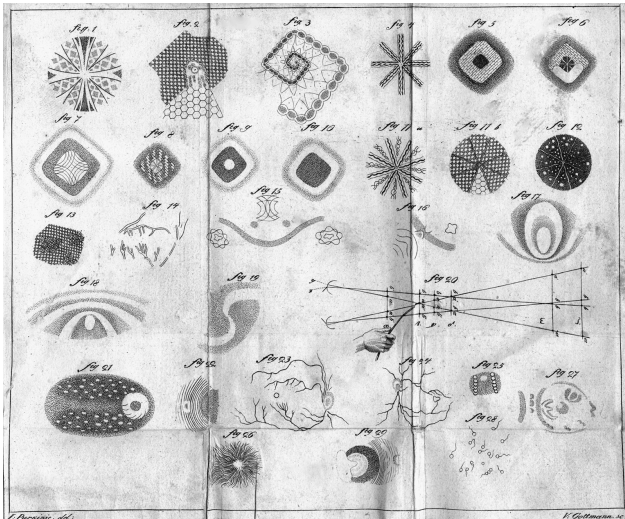


Figure 1. Flicker illustrations, Jan Evangelista Purkinje, *Beobachtungen und Versuche zur Physiologie der Sinne*, vol. 1, *Beiträge zur Kenntniss des Sehens in subjectiver hinsicht*, 2nd ed. (1823)

In the mid Nineteenth century further investigations made by Han Helmholtz were published, when he also coined the term 'shadow patterns'. Up until the middle of the twentieth century, only a handful of scientists besides Helmholtz had made "brief reference to hexagonal figures, grids, radial lines and mosaics." Notably this captivates the fervent desire of the time to demystify and scientifically quantify visionary and psychic phenomena in describable terms, which soon led to the invention of the electroencephalograph.

'perceptions also can only be the result of psychic energy'[5]

John Smythies in the University of Cambridge later categorised and documented these types of archetypal patterns observed when looking a different strobe flash frequencies. From research into insulin hypoglycemia he reported visualisations of entopic phenomena. Since these effects also appeared in hypnagogic hallucinations, Smythies believed that the "form constants of hallucinations represents a worthwhile field of study"[6]. In his earlier mescaline research, he ardently fought to prove that his visions counted as proper and legitimate forms of scientific observation.

The birth of the stroboscope can be traced to 1832, when Belgian scientist Joseph Plateau used slotted disks turning at high speeds to provide a viewer with an illusion of movement. The mathematician and physicist Simon Stampfer built a similar apparatus and soon thereafter coined the term "stroboscope." In the 1920s electronic stroboscopes for visualising fast phenomena were already commercially available for industry. The development of this technology is usually credited to Harold Edgerton, professor of electrical engineering at MIT and author of well-known photographs of bullets in mid-flight and half-exploding balloons.

The invention of the Electroencephalograph by German psychiatrist Hans Berger was made in 1924. His work on the human EEG was part of a forty year program of psychophysical research. The central theme in Berger's Work was the search for the correlation between objective activity of the brain and

subjective psychic phenomena and his desire to understand the mysterious relationship between mind and matter.

Hans Berger was one of a few to recognise a scientist from Liverpool - Richard Caton's importance - as he had already laid the groundwork for EEG (electrocorticogram) recording in 1902. Berger cited Caton posthumously in his his published report on the discovery of Alpha waves in 1929, when he announced it officially to the British Medical Association.[8]

'Caton has already published experiments on the brains of dogs and apes in which bare unipolar electrodes were placed either on the cerebral cortex and the other on the surface of the skull. The currents were measured by a sensitive galvanometer. There were found distinct variations in current, which increased during sleep and with the onset of death strengthened, and after death became weaker and then completely disappeared.'[7]

The introverted Berger was initially unsure of his findings, and they were met with incredulity and derision by the German medical and scientific establishments. But these were revolutionary discoveries, and in fact, Berger founded an entirely new and very important branch of medical science - Clinical Neurophysiology. Describing the discovery of Alpha brainwaves Berger noted - 'a rhythmic oscillation of potential at a frequency of 10 cycles per second .. detected in the human subject by electrodes applied to the head .. present when the subject lies quietly with eyes closed and disappearing when attention is fully occupied.'[8]

Two English scientists Lord Edgar Adrian and Dr Matthews repeated and elaborated on Berger's work. Their paper on the cerebral Alpha rhythm was published in the Neurology journal *Brain*[9] in 1934. Here they proved how 'a coordinated beat' could be imposed on the Alpha rhythm of a test person sitting in front of the lamp (with his or her eyes closed). To produce the Flicker they were using 'Benham's top' - a rotating disc with a black and white pattern that fuses to form concentric rings of different color, visible at different places on the disc.

Ethical implications soon emerged when a psychiatrist was the first to use an EEG recording as evidence defending his epileptic patient charged with the murder of a schoolgirl, and contrastingly a situation when a diagnosis of psychopathy from an EEG brain print helped secure a conviction.

2 FLICKER IN THE BRAIN

EEG or brainwave recording is used routinely as a diagnostic test in neurology, psychiatry and as a common tool in brain research studying the electrical currents within the brain. Electrodes are attached to the scalp, over skin and hair (generally 'non-invasive') with cables connected to a machine, which records the electrical impulses. There are distinct configurations within the signal, commonly separated into the following bandwidths (rhythms): Delta, Theta, Alpha, Beta and Gamma waves. Different speeds (measured in Hertz) of these electrical impulses can denote various mental states such as highly focused concentration, altered states, drowsiness and various stages in the sleep cycle. Epilepsy research relied a lot on the EEG and here Neuroscience accidentally opened a door for artists to peer in though, when Dr Grey Walter described intermittent 'photic-driving' in his seminal book *The Living Brain*[10]. It was 'scientific strobe lights that were triggered in real-time from EEG signals.' The "Flicker-following response" is the brain's

electrical response to repetitive stimulation, these physiological outcome studies were about to shape relationships in Art, enhanced since the invention of the electric strobe light in the 1940s. Importantly, his team were struck by the popularity and wide range of visual hallucinations reported to them. These Flickering images held a power of addiction, some subjects described *missing their presence*, once their fascination was aroused looking into them. But the hallucinations received more than average attention from the members of the scene known as 'The Beat'³ in the 1950s, these poets and artists, seeking this imaginative, secretive place (as creative minds do), were soon to start manufacturing their own stroboscopes out of 'Heath Robinson' apparatus. It is claimed that using a Dreamachine allows one to enter a hypnagogic state, but to escape one needs only to open, open one's eyes !

Hans Berger was also interested in telepathy and wanted scientific proof of its existence. This intensified after he discovered his sister had had a feeling he was in danger following a narrowly avoided accident with a horse-drawn cannon during military service. The evidence was a telegram, as she had insisted their father contact him at the moment ! Following this incident he became obsessed by the idea of how his mind could have carried a signal to his sister and he wrote : 'It was a case of spontaneous telepathy in which at a time of mortal danger, and as I contemplated certain death, I transmitted my thoughts, while my sister, who was particularly close to me, acted as the receiver.'

Like ICT & Art Connect⁴ which I took part in during 2013, this is an example of specialists and artists working at the edge of different disciplines, which produced unexpected representations of the Mind, altered perceptions and thereby provoked new insights. 'ICT can enhance our capacity to sense the world, but an artwork can reach us more deeply.'

But the Flicker phenomenon had been largely forgotten until the invention the EEG machine and its combining with scientific strobes for driving stimulation. British neurophysiologist Dr William Grey Walter visited the lab of Hans Berger in the 1930s where he revealed that our brain responds to stimuli by emitting electronic impulses in waves of varying intensity. Dr Walter next produced his own version of Berger's EEG recording machine with improved capabilities and discovered 'Theta' and 'Delta' waves in the electroencephalogram (the brain waves associated with light and deep sleep, respectively). In the 1960s Dr Grey Walter also devised hypothesis testing for ESP⁵ with the support of Parapsychologist and psychic Eileen Garrett. During this photic-driving (entrainment), both hemispheres of the brain

would often work in unison⁶. Dr Walter argued that Flicker had the potential to produce intellectual, even evolutionary advancements, remarkably he postulated that the Old Testament's 'tree of Knowledge' is a cloaked reference to the effect of the sun's piercing rays interrupted by swaying leaves and branches. Furthermore, higher primates' exposure to this Flicker resulted in entoptic imagery with contemplative effects, accelerating a genesis of human consciousness. The energetic scientist also discovered that he was one of 15% of the population whose brain could not produce the 'Alpha' wave cycling at 8-12 Hertz (associated with a calm resting state of mind).

I have described so far how the intrinsic tools for my artistic practice were previously unassociated techniques and technologies (early ICT) that had evolved in different temporal spaces (over 120 years) and in different geographic locations and languages. Now a dialogue developed between them when they were removed further from their primary intended clinical environments and re-appropriated by creative minds. A new way of experiencing art emerged, a future vision stimulated by novel solutions to technological and cultural challenges. Here technologists and artists re-informed each other's version of the original design, and these new visuals, devices and concepts gained power.

3 BURROUGHS & GYSIN

So how did these ordinary tools in the neurophysiology department become a means for spiritual enlightenment and artistic expression ? A cultural crossover was occurring with Dr Grey Walter's cybernetic research and the drug culture, easy to understand ontologically, with a shared interest in the performative brain. In 1958 the painter, writer and creator of the 'cut-up' surrealist technique Brion Gysin had a revelation during a journey. It was the provocative flickering of sunlight he experienced whilst passing through a tree-lined avenue in a coach. By facing the sun's light rapidly winking behind the trees, intricate coloured & moving patterns appeared behind his closed eyelids. He momentarily and unexpectedly entered the place where "the visual merges with the visionary."⁷

The next conduit was Paris, as whilst searching for strange and occult books Gysin stumbled upon 'The Living Brain' and shared it with another tenant back at number nine, rue Gît-le-Coeur 'The Beat hotel' his friend the author William S Burroughs. Here they rediscovered a phenomenon that had been

3 The Beat Generation was a group of American post-World War II writers who came to prominence in the 1950s, as well as the cultural phenomena that they both documented and inspired. Central elements of "Beat" culture included rejection of received standards, innovations in style, experimentation with drugs, alternative sexualities, an interest in Eastern religion, a rejection of materialism, and explicit portrayals of the human condition

4 <http://www.ict-art-connect.eu/>

5 "Conference on Inter-Disciplinary Studies". Among others, Douglas Dean, Martin Ebon, Aldous Huxley, Jan Kappers, Marcel Martiny, and W.Grey Walter discussed the potential contribution of a variety of disciplines to the problems of parapsychology. Some of the specific topics discussed were research in the then Soviet Union, the effects of LSD on ESP, and psychoanalysis and ESP, held in St. Paul de Vence in France in 1961

6 'Psycho-Physiological Correlates of Paranormal Mental States' which focused on the relationship of psychophysiology and altered states of consciousness to paranormal phenomena. Among the participants were John R. Smythies, Inge Strauch, and W. Grey Walter, held in St. Paul de Vence in France in 1963

7 J. Geiger, *The Chapel of Extreme Experience: A Short History of Stroboscopic Light and the Dreamachine*, page 62 (2003)

known to scientists for some time - the hallucinatory effect of Flickering light. Jan Purkinje scientifically defined Flicker effects simply by waving his fingers in front of one eye while staring at the sun, and in 1823 he drew the patterns that he saw.

Author Aldous Huxley had met Grey Walter in London, and Walter told him about experiments in psychosurgery, where electrodes had been placed in the brain of seriously ill mental patients. By switching on a battery in their pockets, the patients could stimulate their brain "and pass in the twinkling of an eye, from deepest depression to a broad grin." Author John Geiger tells us that Huxley remarked - 'How unimaginative I was in Brave New World !'[11]

Now that Gysin understood the cognitive science of the rhythmic flashes he had researched he focused on a certain brainwave frequency range known as Alpha, at a speed of 8 to 12 cycles per second. His mathematician friend, lover and 'systems analyst' Ian Sommerville commented 'The intensity of the effect varies with the individual; melancholics tend to be irritated, some see nothing.'[12] Together they invented a kinetic light called a 'Dreamachine', it's perforated, spinning template could provoke Alpha waves, potentially producing an inspiring change of consciousness in receptive viewers. Affordably simple constructed from easily accessible items - a working record turntable (stylus not necessary), paper 4ft long and enough to be rolled into a cylinder 12 inches in diameter, scissors and a light bulb on a cable. When in motion the ensuing stroboscopic effect stimulates the brain into a state usually only noticed in normal people in trance rituals or under the influence of drugs.

Gysin had previously travelled between Morocco and Paris, seeking techniques to prolong hallucinations for spiritual enlightenment. Now here, in his living room using a static light with a hand-made spinning shade, he could regain this slow alteration in his brainwaves' frequencies, producing a trance-like state quantified by Grey Walter's 'photic-entrainment'. Gysin proudly pronounced "the end of art" - in favour of the transcendental powers of pure light !

Interestingly enough, the chapter in his book *The Living Brain* that Grey Walter used to describe the effects of stroboscopic light was named 'Revelation by Flicker' which certainly must have struck a chord with these artists. Soon the first Beatniks showed up at the Beat Hotel to sit in his room to experience Flicker, Gysin's latest creation. This new form of art, to have their share in the experience, though all agreed that the combination of psychedelic drugs *and* Flicker worked best.

Cut-ups had made Gysin a pioneer of sound poetry with his implementation of magnetic tape and computer technology at a time when such practice was the preserve of scientists. Gysin equated his permutations to being created by his mind thinking like a machine, a theory simultaneously explored by British cyberneticians engaging psychiatry, engineering, management, politics, music, architecture, education, tantric yoga and complexity theory. Burroughs also further developed the 'fold-in' technique. His book 'The ticket that exploded' is full of Dreamachine imagery descriptions.

"What is art? What is colour? What is vision? These old questions demand new answers when, in the light of the Dreamachine, one sees all of ancient and modern abstract art with eyes closed."[13]



Figure 2 David Woodard and William Burroughs standing in front of a Dreamachine invented by Brion Gysin

Within the Beat's network, Bryon Gysin benefited from the American poet Allen Ginsberg's connection to Dr. Timothy Leary, a psychologist at Harvard University and director of the university's Centre for Research in Personality. Months earlier, Ginsberg had tried psilocybin under Leary's supervision, and was anxious to introduce other writers and artists to Leary's methods of mind expansion. The first time that Brion Gysin met Ginsberg he demonstrated to him the Dreamachine in the Beat Hotel (although they did already knew of each other through Burroughs). When he experienced the Dreamachine for himself, Ginsberg wrote -'I looked into it - it sets up optical fields as religious and mandalic as the hallucinogenic drugs - it's like being able to have jewelled biblical designs and landscapes without taking chemicals.'

In May 1961, Timothy Leary wrote to Aldous Huxley, who had also been participating in the psilocybin experiments, to inform him that "we are trying out some of Grey Walter's ideas." Huxley had previously encouraged the academic to study Walter's theories, and not only Flicker, which Leary termed "the infused vision of the open cortex, flashing at speeds which far outstrip our verbal machinery."

Ginsberg urged Leary to contact Burroughs, saying he knew more about drugs than anyone alive. In a letter written at the Beat Hotel in Paris, Burroughs responded with a declaration that his writing "benefits from hallucinogens MEASUREMENTABLY. Wider use of these drugs would lead to better work conditions on all levels."

Aldous Huxley gave the visions as much realism and effect as to those attained by imbibing the strong hallucinogen Mescaline. In his book *Heaven and Hell* Huxley describes "an arrangement of electrical impulses interpretable as a living, self-modulating Japanese landscape unlike anything the subject has ever seen, suffused with preternatural light and color and charged with preternatural significance?" [14] The patterns become shapes and symbols like crosses and swastikas swirling around, until the user feels surrounded by colors.

'The Cut Ups' and Tony Conrad's structuralist film 'The Flicker' were shown in public on a large screen in The Cinephone in London "the experiential excess that Flickering light made accessible". The cinema was described to resemble a battlefield after the confabulous guests departed leaving clothing, umbrellas, accessories with much diversity and frequency! Burroughs suggested cut-ups may be effective as a form of divination saying – "When you cut into the present the future leaks out."

In 1961 Gysin showed a Dreamachine in Morocco, describing it as 'the first art object to be seen with the eyes closed'. Standing on a record turntable, with the same diameter as a disc, spinning at 78 rpm, the cylinder of card has tulip and minuet regular shapes cut-out in repeated lines. The template's turning and streaming filters light from a bulb dangling inside the tube, and the pulsating light stimulates the optical nerve and alters the brain's electrical oscillations. Ideally the provoking of 'interior geometry' in mechanisms of hallucination with 'flights of colours', *catherine* wheels, animated herringbones, honeycombs, intersecting maltese crosses - and more, upon more archetypal neural doodles. Further randomised psychedelically layered visual phantasms allowing direct insight into the process in which the brain fails to handle a response properly, A warning was circulated: this experience may sometimes be quite intense! A Dreamachine may be dangerous for people with photosensitive epilepsy or other nervous disorders. It is thought that one out of 10,000 adults will experience a seizure while viewing the device; about twice as many children will have a similar ill effect. John Smythies in the University of Cambridge had already categorised and documented the types of archetypal patterns observed. In his mescaline research, he ardently fought to prove that his visions counted as proper and legitimate forms of scientific observation.

Gysin fully believed that the Dreamachine's internalised visuals would replace television in homes and that the future of painting was the mind, which could be an inexhaustible source of artistic revelation. In 1962 The legendary Olympia magazine (number two) edited by Maurice Girodias was published featuring the articles Flicker by Ian Sommerville and Dreamachine by Brion Gysin and disseminated do-it-yourself template for 78RPM for Beatniks to build their own DreamMachine.



Figure 3

Both Figures 3 and 4 from the Olympia magazine, photography by Herman Leonard, permission for reproduction kindly by 10111.org, Switzerland.

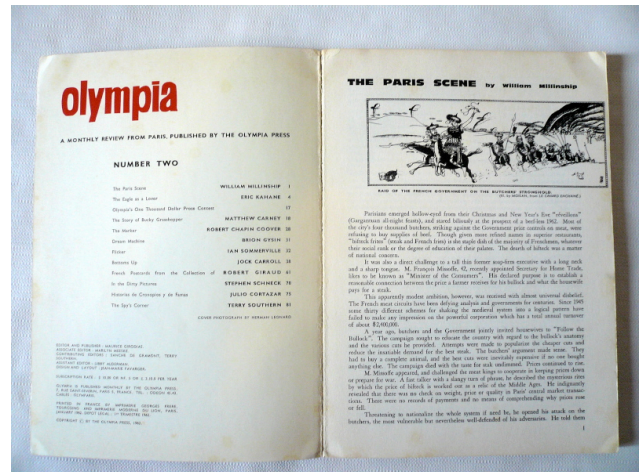


Figure 4

4 INTEGRATING ART AND BRAINWAVES

In their 1934 article in the journal *Brain* [15], Dr Adrian and Dr Matthews reported to the science world how they succeeded in listening to human brainwaves, a recording possible and made according to Hans Berger's methods. This was surely the first example of the 'sonification' of human brainwaves, and has inspired artists as described soon. Changing audiences' perceptions of recording EEG signals, when it is not vital or medical, into an act for Art was initiated in 1965.

Musician Alvin Lucier was working with physicist Edmond Dewan, performing experiments that used brainwaves to create sound. In 1965 he was inspired to compose a piece of music

using brainwaves as the primary generative source. Music for solo Performer⁸ was presented with encouragement from John Cage, at the Rose Art Museum of Brandeis University. When the seated and still Lucier closed his eyes, his pathological inhibition of Beta waves permitted slower, occipitally-challenged Alpha waves to come to the fore, they were the interactive trigger for releasing sound vibrations into the PA system. On top of each speaker were percussive variations such as cymbals with microphone pick-ups in close proximity. The setting and stage were artistically arranged so invisible and intangible brainwaves effectively 'played' the percussive tools positioned on speakers into a thunderous cacophony around the room! Lucier performed this piece several more times over the years, but the presence of his EEG was not intrinsic⁹ for his own compositions. Lucier's art relied totally on the intangible presence of EEG in the auditorium, elevating brainwaves into a performer of the kinetic, resonating soundscape, exemplifying the transmutation of brain science into art performance. And to finish Lucier keeps his eyes closed for a good 10 seconds before finally opening them to acknowledge that the piece is over. Technologically although seemingly a very basic sensor, he actually used EEG equipment belonging to the US Air Force and with their technical support.

In the same year British artist Stephen Willats¹⁰, inspired by Cybernetics theories of learning, feedback loops and alpha rhythms, he developed the series of 'Visual Automatics' including 'Visual Transmitter No. 3' whilst working with Dr Christopher Evans at the National physical laboratory in Teddington. Willats was also concerned with Alpha rhythms, and made environmental and architectural works, scaled in relation to the body of the viewer, that were capable of producing random light sequences and after-images, as with the 'Shift Box' series. Some of the 'Visual Automatics' also include devices which spin to the frequency of the Alpha rhythm. Another artist informed by Grey Walter, Gordon Pask¹¹ and Norbert Wiener. His more complex electronics were assisted by an engineer Peter Whittle, titled a 'Mark:Space ratio Oscillator' which power banks of lights pulsing at slightly different speeds. When switched on, the pulsing lights elicit a change in the perception of the concrete environment, shadowing (but without psychedelics) the Beats invention and research.

Since then artists including Keith Haring and musicians such as the eccentric frontman of 'Psychic TV' Genesis P-Orridge have taken on the mantle of distributing the Dreamachine's Flicker design in DIY printout format. Genesis published a book in 1986 including a 78rpm Dreamachine template. Accompanying the package was a recording (available in vinyl

or CD) of sound for enhancing the effects of the Dreamachine. In the 1990s collectives The Org23 and 10111.ORG brought new audiences awareness by publishing limited edition monoprints for the assembly of Dreamachines around every home, if you could use scissors to subtract all the little pieces where the light must shine through. Further more, experimental artists David Rosenboom, Atau Tanaka and Yoichi Nagashima have involved EEG and realtime bio-data to create sound art, through installations and interactive performances. In 2001 artist Neam Cathode showed 'Cyber Mondrian' in Montreal's Oboro Gallery, his work incorporated computer generated images with synthesised sound controlled using an 'IBVA' portable EEG monitor. Professor Eduardo Miranda, in The Neuromusic lab at the University of Plymouth also discusses the IBVA EEG system as an interactive tool in his book 'New Digital Musical Instruments: Control and Interaction Beyond the Keyboard'[16].

New York improviser David First created OPERATION: KRACPOT in 2002 using "brainwave entrainment" and the phenomenon of the *Schumann resonance* to create haunting music. New York based artist Mariko Mori's 'Wave UFO', 2004-2011 is a rotund Science Fiction installation involving a holographic spaceship where visitors are connected, the brainwaves of three participants at a time are connected to EEG interfaces inside the mothership, and their combined brainwaves interact and effect the MAYA driven immersive visual display whilst they lie down inside. Special EEG headsets similar to interfaces in the film 'The Minority report' (used to record EEG from the 'pre-cogs' clairvoyants in the pool) were also designed for this extensively touring Art work. Similarly in the earliest of Berger's surviving diaries he vividly revealed his preoccupation with *cerebral energetics* and 'psychic energy', as well as his episodes of self-doubt and depression, and the many difficulties he encountered in acquiring and operating electrophysiological instruments. Berger returned to study medicine with the goal of discovering the physiological basis of "psychic energy". His central theme became "the search for the correlation between objective activity in the brain and subjective psychic phenomena."

⁸ At the premier of *Music for Solo Performer* in May, 1965, Lucier's amplified Alpha wave output was routed to "16 loudspeaker- percussion pairs deployed around the museum." Lucier further explains that, "During the course of the 40-minute performance Cage randomly raised and lowered the stereo amplifiers' volume controls, channeling the Alpha signal to various instruments around the room."

⁹ "You see, one of the inaccuracies of the title is that it's not really for solo performer. You need someone to run the amplifiers, to pan the sounds around, to turn on one loudspeaker and then turn on another, and I've always...done it with another player, an assistant. In the score that I wrote, I stipulated that someday, when electronics became what it's now become, you could have an automatic switching arrangement, such that so many bursts of Alpha would be a code to a switching device, and the Alpha could control itself without an assistant." Alvin Lucier, *Reflexionen: Interviews Notation Texte* (Cologne: MusikTexte, 1995)

¹⁰ the comparison with heath robinson was proposed to the author by Willats, who described how he made the Visual Transmitters in his cramped studio with limited funds and assistance. the man who first identified the source of the alpha rhythm in the brain, grey Walter, is himself known as the creator of a robinsonesque three-wheeled machine called Machina Speculatrix

¹¹ Willats was working as an occasional assistant at gordon pask's System research ltd between 1964 and 1965 it has become standard to claim that these early three-dimensional works bear the traces of cybernetics - Antony Hudek in *META-MAGAZINE. CONTROL*, 1965-68, in Ravenrow gallery catalogue for Stephen Willats 2014 exhibition



Figure 5 Mariko Mori -Wave UFO



Figure 6 EEG headset in Wave UFO

Figures 5 and 6 The Wave UFO shown here in The Venice Biennale 2005, a visitor has the EEG sensor headset connected before entering Mariko Mori's Wave UFO installation in a combined EEG installation (photos author's own)

5 IMPLEMENTATION

I have been recording EEG signals for almost 20 years since studying Interactive Art with Roy Ascott in Newport, Wales. Already productive and trained as a Fine Artist in Ravensbourne college of Art and Design, the new media and acquisition of raw physiological bio-signals was a lonely frontier for me, which I eagerly began venturing into, with heart (ECG), muscle (EMG) and stress monitors (GSR). Once I was set on brainwaves (EEG), and discovered an affordable, portable two channel system with its own custom software that I could patch other filters and audio communications into (on a Apple Macintosh), I decided to use these ancillary gestures in my performances. I was enabled to

create generative *sonifications* of different 'states of mind' - taking the active playback as an intervention within arrangements of multi-layered compositions. I demanded interactivity to influence these risky brainwave performances, sometimes connecting members of the audience¹² at the same time, to join with me in influencing the evolution of the performance. Within 20 metres this can transmit raw brainwave data to a computer equipped with MIDI and custom *Audio Unit* plugins to affect tracks in the sound software, such as Logic. I first began doing this whilst taking part in the Future of Sound¹³ tour in the UK between 2007 and 2010. The idea of music *made by your mind* also appealed to mass media at this time, and I was interviewed and featured in Wired UK and the USA online edition, as well as in various UK Broadsheets. As an artist I was particularly delighted to be quoted in The New Scientist describing my practice as - "It's like playing a theremin with your brain." [17] As part of a group of sound artists led by musician Martyn Ware we performed in some large auditoriums including The Sage Gateshead, The Royal Institution, BAFTA, Shunt's Vault in London, Norwich Art's centre, The Box in Liverpool's FACT, and live on BBC Radio 4, so dealing live with an interface that was inspired by esoteric interests sometimes heightened the peculiarities in the musicality and frailty in my sound work. At an interactive performance in Hoxton, London I had used my own Dreamachine, and sonified a participant's EEG through the PA, I thought I was lulling him into a relaxed, receptive state. When I requested his description of the experience of Flicker at the end, he was firstly surprised how quickly the time had passed (but, he had been reviewing a recent event when he was mugged)! My interviewee was not reporting a dialogue I could engage with, then suddenly another audience member added she had also been reflecting on a dangerous situation when she was attacked and she shared her story, without anecdotal treatment !

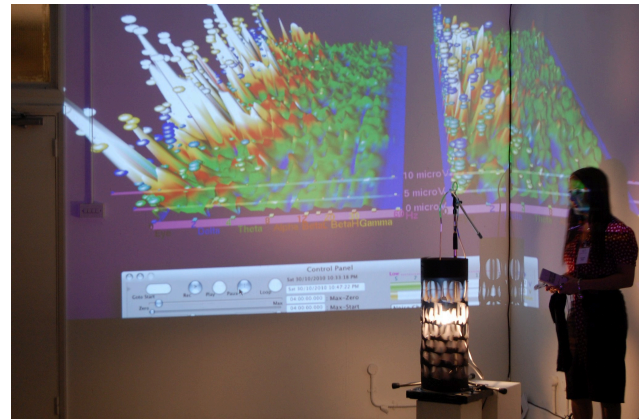


Figure 7 'Analogue Oneironism'- performance sonifying the audience's EEG data (projected), during experience of Dreamachine in the Phoenix studios, Brighton 2010 (photos author's own)

¹² I monitor with pre-gelled, non-invasive electrodes on the forehead above each eyebrow to record the electrical activity of the brain's frontal lobes with 4 electrodes. This provides 2 live channels from the medical 10:20 placements, connected to a small, portable, Bluetooth enabled EEG system (IBVA) www.brainmachine.co.uk

¹³ <http://www.futureofsound.org/schedule.htm>

More Artists preserve and promote new growth in this field, with a need for the stimuli, as a ticket to future visions, new languages, styles and desire for the ephemeral not quite incarnate. Recently 'AoN' - association of Neuroaesthetics (based in Berlin), began cultivating interdisciplinary efforts and encouraging a dialogue and lasting cooperations between the arts and the sciences. In 2010 'SEEING WITH EYES CLOSED'¹⁴ one of their projects by artist Ivana Franke and neuroscientist Ida Momennejad showed concern with the visual experience of flowing images induced by stroboscopic light behind closed eyes[18]. Olafur Eliasson discoursed on his work in lighting and retinal fields, which has undercurrents of enormous interest to neuroaesthetics – time, uncertainty, ambiguity. The desire for more holistic approach has intensified the exchange between science, humanities and the Arts, and maybe Neuroaesthetics is a conduit for interdisciplinary exchange, bridging various methods and questions in art and human experience.

6 DREAMMACHINES AND EEG ART NOW

A resurgence of the Dreamachine Art scene happened simultaneously in London and New York in 2012. In New York's Bowery, The New Gallery had a large Gysin exhibition. And William S Burroughs' show 'All out of time and into space' was on display in London's The October Gallery, Bloomsbury. Also in London, Apiary Studios and The Parasol Gallery both held Dreamachine shows - most memorably the imposing physical presence of Shezad Dawood's 'New Dreamachine Project'¹⁵.



Figure 8 'New Dreamachine Project'- by Shezad Dawood, Parasol Gallery, London, February 2013, (photo author's own)

A three meter high kinetic light sculpture emitting kaleidoscopic light (it also facilitated as the outdoor performance space for the Master Musicians of Jajouka one evening.) These show how the interest in how science, art and mysticism come together continues with new and surprising technological innovations that resulting, updating the paradigm. In February 2014 I recently co-facilitated a 2 day workshop in Liverpool's FACT, in the Co Working¹⁶ space - to build your own Dreamachine, and gave a performative lecture demonstrating changes in EEG with the audience experiencing various decorated dreamachines The first project of performance artist Marina Abramovic's 'Institute Science Champor' - 'an interdisciplinary platform that brings together scientists and artists to co-create durational experimental works that explore the relationship between artist, scientist, performer, viewer, and

¹⁴ during a Neuroscience and Art in dialogue symposium with the Peggy Guggenheim Collection, Venice (2010)

¹⁵ listed for The Abraaj Capital Art Prize in Abu Dhabi, (2011)

¹⁶ The CX project Hybrid Lives, a public co-working space, opened on December 12th 2013 at FACT in Liverpool as part of their major exhibition Time and Motion. Hybrid Lives was a collaboration between the Royal College of Art, Bossons Group, Unwork, and Swansea Metropolitan University.

research subject' is to be *Mutual Wave Machine*. This looks at the notion of the popular phrase "being on the same wavelength." Rather literally, investigating brainwave synchronisation using custom software that collects and analyses brain activity in real-time. Similar to her *The Artist is Present* performance, members of the public will sit opposite each other, connected over time to (unspecified) EEG headsets, while sharing a silent "mutual gaze" as the equipment records their activity and displays it in real-time—with the aim to explore the 'transfer of energy between performer, public, and participant'. She used Kickstarter¹⁷ to raise most of the money for the institute. It is a more poetic use of EEG, their scientific explanation does not reveal to the participants any more than a holistic therapy does, yet,

The most impressive new sculptural artwork employing EEG (recording of artist Gustav Metzger) is by British artists London Fieldworks¹⁸ entitled NULL OBJECT. Linking a computer brain interface to an industrial manufacturing robot, a block of Portland stone has been rendered hollow as a consequence of the artist thinking *about nothing*. It fuses together mind-stuff with software, wetware and hardware to produce a void in stone. A timely addition and challenge to the present climate of technological evolution and increasing cybernetic augmentation, NULL OBJECT¹⁹ offers an alternative model for a creative, non-invasive interface between body, mind and machine. Possibly the title subtly eludes to an exhibit titled 'L'Objet', in the Musée des Arts Décoratifs du Louvre in Paris in 1962 ? That was the title of the first (EEG influenced) Dreamachine, in public view.

7 CONCLUSIONS

Maybe the Flickering, twittering and 'jigging like a clumsy Narcissus' *mirror-dance* (as invented by Walter's next generation of tortoise robots) when responding to automated commands to seek light, demonstrating self-recognition and narcissism, will also have a worldwide renaissance !

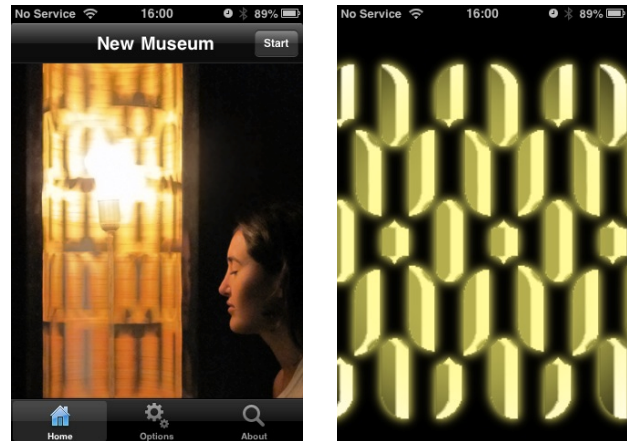


Figure 8 The New Museum's free Dream Machine smartphone app for a personal, portable flicker experience. Users can customise the interior and exterior colours

As new tools for transcendence – linking artists, scientists and academics for interdisciplinary research emerge, I hope they are presented and shared publicly. But newcomers to the field are taking this to an entirely new level. I expect we will see advances in brainwave monitoring technology creating many new and exciting art genres. EEG is not as pure a form of expression as a heartbeat (ECG) because of processing by software, there is semantic distortion in interpretation. In summary, the 'Flicker phenomenon' took off in the early days of science mainly as a curiosity. The medically entraining stroboscope effects subsequently turned into a Dreamachine, and during the 1960s it became a genuine cult object. Today I have an application on my smart phone to instantly offer Dreamachine effects, it is no replacement for the 'Object d'Art; which is the only reason I keep a record turntable for nowadays. I also have miniature personal audio & visual entrainment tools with adjustable frequencies of lights, sounds & binaural beats to reset my mind and provide legal highs. Effects that have taken research and journeys spanning entire lifetimes are now reduced to circuits in my pocket, and maybe they might contribute to my improved creativity, access to the visionary, reduce fatigue increase my REM cycle in sleep, perchance to dream?

¹⁷ Kickstarter is the world's largest funding platform for creative projects. A home for film, music, art, theater, games, comics, design, photography, and more.

¹⁸ (Bruce Gilchrist and Jo Joelson), The exhibition at WORK in Kings Cross presented video and sculptural representations of the process alongside the robotically carved sculpture.

¹⁹ "Null Object mocks the persistent narcissism of the artist, who believes secretly that he is a little god. It is a release into a more profound and complex reality. A great liberation." - Hari Kunzru.

The philosopher and historian Hans-Jörg Rheinberger recently asserted that making visible, rather than making facts, constituted the foundational task of modern science: “It is probably not too far-fetched to postulate that making visible something that does not manifest itself directly and therefore is not immediately evident – that is, does not lie before our eyes – is the foundation and at the same time the foundational gesture of the modern sciences.”[19]

So hard-science facts were feeding science fiction, and chemical-grade psychedelic substances designed for analysing psychological expressions, escaped the clinic. They found mouths with minds in The Beats and professors like Timothy Leary, espousing visions and declaring boundaries are to be broken, whilst learning more about the mind than cybernetics and black boxes had so far predicted. Nowadays artists can access medical Functional magnetic resonance imaging (fMRI)²⁰ for non-essential or medical services, and surely most breathtakingly, gain creative inspiration from the theoretical discoverers of the Higgs boson, colloquially called the "God particle". In 2011 'Collide@Cern'²¹ was launched in the European Organisation for Nuclear Research a new arts programme²² to bring together artists and physicists in CERN's laboratory near Geneva.

Artist in residence from 2012 Julius von Bismarck explains - 'The root reason why I am an artist is the same as it would be for being a scientist: finding out what there is out in the world and how I can contribute to our understanding of it. I am interested in making science sense-able – through the body and its senses'

An updated Music for (networked) *solo* performer is waiting to happen as simple EEG interfaces now dangle from smart phones and home computer game consoles alongside other interfaces for skin resistance (GSR), pulse (ECG) and eye-tracking (OCG) previously only implemented in psychological research. I would like to conclude with a quote Dr Grey Walter, sounding much like a character from one of Burroughs' novels, when experimenting with a strobe he declared - 'like a modern detective, we can not only tap the lines of communication, but even interject suitably phrased messages of our own and observe the reactions of the suspect.' Hopefully, when I allow ideas to come to my mind, I can receive Theta rhythms in my idling state of consciousness, a receptive mood, divergently combine disparate ideas, I would like to tap the line and record an augmented message with my mind.

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²⁰ Functional magnetic resonance imaging or functional MRI (fMRI) is a functional neuroimaging procedure using MRI technology that measures brain activity by detecting associated changes in blood flow. This technique relies on the fact that cerebral blood flow and neuronal activation are coupled.

²¹ Collide@Cern falls into a wider Cern policy for engaging with the arts called Great Arts for Great Science is a three-month residency programme for artists to be mentored by leading scientists, supported by a stipend of €10,000. Patrons of the project include Swiss architect Jacques Herzog, German photographer Andreas Gursky; sculptor Anthony Gormley and musician Brian Eno all of whom have been inspired by the work at Cern.

²² Antony Gormley told *The Art Newspaper*: "My whole philosophy is that art and science are better together than apart," he said. "We have somehow accepted an absolute division between analysis and intuition but I think actually the structures that they both come up with are a very intricate mix of the two."