Neuro Art: liminal reflection, introspection, and participatory art

The emerging media art genre of Neuro Art, also known as brain art, brainwave art or neuroarts has been the subject of significant number of recent publications (Nijholt 2019, Siler 2015, Gingrich 2018, Gingrich & Rahman 2021) and an array of artistic investigations that spans back several decades: As early as the 1960s, artistic practitioners examined the creative potential of the human brain to contribute to artistic outputs, directly or indirectly.

Artists such as Lisa Park, Mariko Mori, Lancel / Maat, Luciana Hail or recently Refik Anadol stand in this tradition, exploring both the diegetic as well as the mimetic or representational potential of the human brain. What new insights can representations of the human brain reveal? What new artistic experiences can the power of our brain contribute to? And can our cognitive potential help to provide new storytelling techniques? (Halttunen & Rahman 2021, Rahman et al. 2021).

1. NOMENCLATURA OF A NEW GENRE

The nascent field of Neuro Art, also known as brain art, brainwave art or neuroarts has been the subject of significant number of recent publications (Nijholt 2019, Siler 2015, Gingrich 2018, Gingrich & Rahman 2021) and an array of artistic investigations that spans back several decades: As early as the 1960s, artistic practitioners examined the creative potential of the human brain to contribute to artistic outputs, directly or indirectly.
From the outset the genre of neuro-art oscillated between extremes: mind-control (Eaton 1971) versus creative expression (Gingrich & Rahman 2021, D’aleman & Rahman 2021), technical gimmick versus sonic or visual art, artistic representation versus audience participation:

Some of the trends, trajectories and genres within this field have been identified by scholars such as Nijholt (2015) and Lysen (2019), pointing to a tight relationship between science, research and artistic practice, an ongoing dialogue that influenced and enriched both parties equally: Sci-art, new media art, and tech-art has long been criticised for operating outside of the rigorous spectrum of scientific research, with practices of free interpretation of data often circumventing critical questions on data accuracy, data measurements, confounding variables, with some critics even suggesting a form of pseudo-science. Yet, the realm of art has also enabled new forms of discourses, that focus more on the subjects of interface design, meaningful interactions between participants and the art they engender as well as the concept of neurofeedback.

2. GENESIS OF AN EMERGING ART FORM

The origins of EEGs or electro-encephalography date back to 1875, when the Liverpudlian Richard Caton published his findings on measures of brainwave activity on monkeys and rabbits in the British Medical Journal. From the 1930s and 1940s onwards EEG measures were used for clinical-analytical purposes as well as neurofeedback, a method of attempting to induce states of minds through a combination of measurement, and self-observation (Adrian & Matthews 1934; Kornmuller 1945 cited in Borck 2018).

The term neuroscience, however, is relatively new, and only dates back to the early 1960s (Duffin 2010). It was not until the mid-1960s and early 1970s that EEGs were used for artistic purposes, not at least to create experiential performances, with artistic, meditative and sometimes even hypnotic aspirations.

Alvin Lucier’s pioneering artwork ‘Music for a Solo Performer’ is widely recognised as being one of the first recorded artworks to use EEGs and neurofeedback in a live performance context (Lysen 2019). Previous forays in creating art using EEG measurements include Dr William Grey Walter’s ‘cerebral music’ (Hail 2019). Alvin Lucier’s performance was inspired by the idea of entrainment, that by amplifying alpha waves, at 10khz inaudible to the human ear, the mind could be induced into a state of meditation.

While Alvin Lucier was interested in EEG as a facilitator for novel performance, the composer Manford Eaton was interested in alpha waves as a tool for mind control (Eaton 1971, Joseph 2011, Lysen 2019): Supported by the ministry of defence, Eaton’s composition is now regarded as having had an ulterior motif: that of direct manipulations of his audience.

Whereas Manford Eaton, Alvin Lucier and contemporaries such as Richard Teitelbaum with his 1968 performance of ‘In Tune’ (Teitelbaum 1968) attempted this meditative state through an auditive and explicitly non-visual approach (Lucier 1995), other early neuro-artists explored the concept of neurofeedback through visual representation: William Grey Walter’s toposcope for instance translated brainwaves into visual form: (Walter & Shipton 1951, p.282) While these early attempts of a visual interface for brainwaves was still both erratic and not easily intelligible (compare: Lysen 2019), they point to the emerging rise in artistic visual interpretations of neuro-activity.

3. NEUROCULTURE – A (BRAIN-)WAVE OF ARTISTIC EXPRESSION

Since the 1960s artistic strategies to explore the potential of brainwaves for artistic expression, for audience interaction and for discovery of the power of the human have increased, and gained momentum, and cultural visibility – to the point that in response, researchers Frazetto and Anker (2009) coined the term Neuro-culture to describe this unfolding phenomenon. According to Frazetto and Anker, the purpose of neuro art is to serve as an interface of neuroscience to the general public (Compare: D’Souza 2015).

Artists such as Nina Sobell with her ‘Interactive Brainwave’ (1973-74) and Janine Antoni (Slumber 1993) pioneered brainwave performance art: Interestingly, early brainwave art performances
were often focused on the artistic performer and not involving the audience per se:

Janine Antoni’s *Slumber* (1993) is a continuous performance piece, which saw the artist recording her REM states through eye movements and then weaving these recordings into shreds of her nightgown to create a blanket. In a perfect feedback look, she would use this blanket at night to cover herself, during the recordings of her dreams. Artworks such as the aforementioned not only helped to demystify neuroscience, but also helped to illustrate the creative power of the human brain.

Nina Sobell translated EEG recordings of two people on an x- and y-axis of an oscilloscope respectively: Projecting the resulting shapes onto the faces of the performers, a synchronisations of brain waves would result in circular shapes.

![Figure 3: Nina Sobell: Interactive Brainwave Drawings (1973–74).](image)

In the young tradition of EEG portraits ‘Self Portrait’, the first of which was created by the artist Robert Morris (1963), Annie Leibovitz also focused on portrays and the role of the artist in her exploration of ‘neuro art’: Leibovitz artwork Laurie Anderson MRI used MRI scans to create a visual juxtaposition between the artist and her mind (Leibovitz 1987). Helen Chadwick’s ‘Selfportrait’ equally uses the symbolism of the human brain to discuss its universal visual characteristic that apply to all of humanity: The shape of the brain is identical across the globe, and thus the artist discusses not only her identity but also her human nature.

Explanatory objectives to communicate neural functionality effectively, dates back to the 1950s: With ‘The Upjohn Brain’, pioneering information designer Will Burtin attempted to communicate ideas such as consciousness to the general public (D’Souza 2015).

![Figure 4: Annie Leibovitz: Laurie Anderson MRI (1987).](image)

A decade later, the seminal exhibition ‘Cybernetic Serendipity’ curated by Jasia Reichardt at the ICA in 1968 featured two artworks that attempted to illustrate functionality (Rowland Emmett) and ‘building blocks’ of the human brain: Christopher Evan’s Cybernetic Introspective Pattern-Classifier (CIPC) planted images on the inside of the retina that could be perceived with eyes closed, so to enable audiences to glimpse at the workings of their own perceptual system.

Cybernetic Serendipity gave rise to a whole new avant-garde of artists working on the intersection between art and science, culminating in the formation of the Computer Arts Society in London: An international roof organization for artists, scientists and practitioners working on the intersection of technology, computational art and science.

Among these artists, Gustav Metzger (1926–2017) stands out as one of its first members and founder of PAGE magazine and pioneer in neuro art: His artwork ‘Null Object: Gustav Metzger thinks about nothing’ consists of the artist’s attempt to capture a cognitive void:
Thinking about nothing, Metzger’s thoughts were captured and then carved by a robot as a 3D printed object. The artwork is ground-breaking in its visionary use of technology, and its poignancy in trying to capture the impossible. Cybernetic Serendipity was the first in a line of exhibitions on art and the human brain that expanded research practices and creative explorations on the subject across the artistic and academic communities across the globe:

In Germany, the curator Hans Ulrich Obrist and the scientist Ernst Pöppel exhibited Art & Brain (1996–1997) featuring the artists Peter Kogler, Douglas Gordon, Mark Dion, and Via Lewandowsky. The 1990s were a decade of increased public discourse on insights in neuroscience, declared to be the decade of the brain:

In the UK, the Wellcome Trust’s, *Head On: Art with the Brain in Mind* (2002) managed to assemble an array of diverse artistic practices at the Science Museum, including Andrew Carnie’s Magic Forest. Artworks such as Andrew Carnie’s Magic Forest (2002) help to exemplify and communicate the complexity of the brain, and the need to visualise, and illustrate some of the multiplex beauty of its inner workings.

The early noughties saw a plethora of advances in neuro artistic experiments spearheaded by artists Mariko Mori, Lisa Park, and Marina Abramovic. Mariko Mori’s Wave UFO (2007), an immersive, life-sized UFO space shuttle in which visitors were invited to measure and monitor their brainwaves as screened on the ceiling played with cyber-futuristic notions of techno-utopias.

Lisa Park’s ground-breaking artwork ‘Eunoia’ (2013) is a facilitated performance, in which the artist transforms her own brainwaves into sound, which in turn vibrates water vessels to result in cymatic patterns to be observed on the water surface. The artworks by Marina Abramovic questions the sense of presence of the artist, specifically in her piece ‘Measuring the Presence of the Artist Gaze’ (2011), an adaptation of her ground-breaking artwork ‘The artist is present’ staged at the Museum of Modern Art, New York in 2010.

The 90s and early noughties heralded an era of renewed interest not just in applications for neuroscience, but also the concepts of neurofeedback, resulting in a shift of a focus on artists (60–70s), and scientific complexity (80s and 90s) towards an interest in new forms of interactions and audience participation throughout the noughties and into the present. It is in this context, that this paper discusses contemporary neuro art practices such as participatory strategies developed by the artists Dr. Olive Gingrich and Shama Rahman individually and collectively.
4. PARTICIPATORY NEURO ART: IO STUDIO

As an artist and researcher Dr Olive Gingrich’s practice has long oscillated between an interest in participatory art and neuro art. During his PhD research, an engineering doctorate in digital media, the artist focused on telepresence applications including BCI’s such as EEGs. His artwork ‘Aura’ was exhibited at Kinetica Art Gallery, at V&A Digital Futures and the British Science Festival. Aura consists of an EEG based Pepper’s ghost type hologram that displays the audience’s brainwave activity in real-time.

The resulting neuro-feedback allows for a degree of entrainment and encourages the audience to understand the mechanics of their own minds ability to focus and concentrate better. The resulting, revolving Lissajou shape changed colours, scale, and complexity in response to the audience members individual concentration values: The artwork turned into a participatory display of the audience’s mind.

Aura was a first in a series of participatory neuro art works focusing on the mind of the audience, with a series of different applications: ‘Memoria’ in response to the Grenfell tragedy invited the audience to commemorate collectively. Participants’ alpha waves – echoing their ability to focus on memories – were mapped onto a changing array of colours, projected on a canvas, thereby turning into an introspective invitation to commemorate.

Figure 9: Aura. Oliver Gingrich. 2015. Holographic display. Kinetica Gravity Exhibition.

Conceived with a similar objective, to raise awareness for humanity’s collective responsibility to look after the environment, the artwork “What we can do” (Gingerich 2020), encouraged audience members to use their brain power to consider their own contribution to the planet. Using a muse BCI, a projection of planet earth would change in real-time responding to audiences’ concentration:

Higher concentration values resulted in depictions of a prosperous globe, lower concentration values turned the planet into a dry arid, mars like landscape. All these artworks combined audience participation, biosensors such as EEG headsets and real-time visualisation, a combination that resulted in a joint collaboration between Gingrich and Rahman, and the foundation of the art studio IO.

Figure 8: The Crack. Oliver Gingrich. 2019.

Gingrich’s ‘The Crack’ created at ACAVA’s Maxilla Space focuses on the effect of concrete on the environment. The artwork playfully invites audiences to use concentration to control a projection of a crack within concrete walls. Concrete is one of the key CO2 emittants around the globe. Research at Stony Brooks University in New York points to the fact that cracks within concrete structures can help to absorb sulphur, another pollutant.

The Crack invites audiences to imagine a future where concrete can be broken apart, to serve as a means to counter air pollution. The Crack was displayed at the ‘Intelligent Matter’ exhibition at Maxilla Space and later shown at the Event Two exhibition at the Royal College of Art, curated by Art in Flux.

Dr Rahman’s PhD investigated the neural correlates underpinning different forms and stages of musical creativity (Rahman 2014 & Rahman et al. 2021). EEG recordings were collected from jazz and classical pianists within the musical creative modes of interpretation and improvisation. In addition to undertaking this research, the experimental paradigm was also re-constructed as a form of audience presentation/participation at a music festival, The Secret Garden Party, wherein
two pianists were asked to creatively perform specific music pieces selected for their unfamiliarity to the performers.

The audience were able to simultaneously listen to the spontaneous performances, and view live EEG recordings subjected to real-time signal processing of different frequency bands (delta, theta, alpha, beta, gamma) varying throughout the performances. Post-performance, the audience were asked to rate each performance on a scale of 1-5 (1 being very poor, 5 being excellent), their assessment of level of creativity. Over 100 people significantly converged on their subjective ratings of each performance, and importantly there were accompanying frequency signatures for the two performances.

Figure 10: Remember the Good Times.

As a discovery of the PhD, there was also a signature brain pattern in terms of activity location for performances rated highly creative by external musical assessors (academics from music conservatoires and other professional musicians). These accompanied a stage in creativity classified as the Flow state, which leads to high creative output due to increased cognitive flexibility and simultaneous focussed/ broad attention. Flow states are also characterised by increased intrinsic motivation and a sense of joy and meaning.

Dr Gingrich and Dr Rahman, utilised these findings within the neuro-art piece Zeitgeist (Gingrich & Rahman 2021). Flow state classifications were done by a real-time deep-learning algorithm (developed by Rahman’s startup NeuroCreate) and were represented by two morphing intertwined ‘mobius strip’ visualisations of both Gingrich and Rahman’s Flow states whilst they collaborated. Zeitgeist has taken various guises from a 3D online representation within online galleries (Ars Electronica and National Gallery X), to AR and holograms (Poole Museum and Hasso-Plattner Institute).

Zeitgeist has sometimes been accompanied by audio which is not yet linked to the Flow classifications. Dr Rahman has continued to link audio to brainwaves, across a number of projects including the artwork iBoS (‘In Brain, Out Sounds’). Therein, her brainwaves are sonified utilising a number of different musical parameters such as linking the presence of frequency bands to different notes, filters or FX such as arpeggiation.

Expanding the concept of neuro-art within the sonic space, Dr Rahman has produced science theatre on the subject of the neuroscience of memory, wherein the sonification of brain activity during the specific memory stage of recall was integrated into an audio-visual mixed media theatre show, ‘Rhythms of the Brain’ probing memory loss, dementia and Alzheimers, which was staged at Richmix in 2015. Neuro-art show ‘Remember the Good Times’ involved audience participation at the British Science Festival 2016, by implanting ‘false memories’ through linguistic narrative and video.

Figure 11: Rhythms of the Brain.

The artworks ‘Brainfuck’ and ‘Zeitgeist’ can be seen as the culmination of the artists Gingrich and Rahman’s individual strategies to explore the fields of audience participation, neuro visualisation and sonification: Both artworks engage with a hybrid space of exhibition, having been shown virtually, as well as print, 3D sculpture and even as NFT (Zeitgeist 2021).

Brainfuck was originally conceived as an installation for Burning Man’s online festival during the national lockdown in 2020 and was later shown at Art in Flux’ Reclaimed exhibition (2021) and Ars Electronica. After its inception at EVA 2020, Zeitgeist has now been profiled at numerous institutions as holographic installation as well as premieres at Festivals such as Ars Electronica and Art Fairs (Deeep Art Fair and The Other Art Fair).
Having recently been awarded AHRC funding by UKRI, Zeitgeist will now be developed into a fully functional online platform: Together with NHS researchers and a team at Roehampton, Bournemouth University and UCL, Gingrich and Rahman will measure the effect of audience interaction on social connectedness.

5. CONCLUSION

Since its inception in the 1960s, the emerging genre of Neuro Art has played a vital role in bringing science, arts and public together and communicating neuroscientific and neuroaesthetic research insights as well as artistic propositions to the public. From an early discourse focusing predominantly on music, to questions of self-portrayal in the 1960s and 1970s to a more nuanced science focused wave of artistic engagement throughout the 1980s and 1990s, artists have increasingly been scrutinising questions of audience perception of their own mind, the potential of neurofeedback as an introspective tool, an instrument for self-reflection and artistic expression. From an infancy that was encompassed by public scepticism about accuracy, and technical limitations of EEG measures, to contemporary discussions and critique around gamification, gimmicks and techno-fetishism, the discussion has continued to encourage processes of self-reflections and led to new forms of artistic expression.

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