

Foreword by Nina Sobell

Anton Nijholt meets the pivotal need of charting the multiple ways in which artists have strategically challenged existing uses of EEG technology while unveiling its aesthetic and social implications. The term Brain Art has come to be associated with the use of Brain-Computer Interfaces (BCI) for artistic expression. It relies on the transmutation of neural signals into realms of sounds and images that render the internal workings of the mind perceptible.

A cornerstone of my career as an artist has been the exploration of what is now known as BCI, brain-computer interface. When I first heard the term, I thought it meant Brain Communication Interaction because that was what I had been working on for so long. In the early 1970s, after experimenting with an alpha wave feedback unit, I sought to create an internal and external video portrait of two people by dissolving images of their brain wave oscillations over their faces as their interaction was being simultaneously videotaped. What intrigued me was showing what often happens beneath the surface as people communicate with each other—at invisible brain level and at gestural level. I began concentrating on expressing visually the synchronous and asynchronous relations established between the brainwaves of people engaged in nonverbal communication. I invited participants in this work to engage in imaginative telepathic experimentation while embracing improvisation and indeterminacy. BCI allowed me to transcend the constraints of linguistic communication.

In 1973, together with collaborator systems engineer, Mike Trivich, we created conceivably the first BCI for two people to communicate nonverbally and telepathically via a visual feedback display. Our tools were a Grass Valley EEG connected to a DEC PDP 11 computer and a Heathkit 2 channel oscilloscope, assembled by Mike. We were expected to provide measurable outcomes of brain-to-brain communication upon being granted access to the use of an EEG machine and we fulfilled our promise. I continued to explore the realm of nonverbal communication through the 1980s and into the 1990s when I created the first interactive, multi-participant web-streaming platform in collaboration with Anatole Shaw. Since this time, my work with BCI has continued to expand, encompassing heart rate monitoring coupled with long used audio feedback and the Brain Wave Drawing Game.

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Flora Lysen's insightful observation in this collection—"The interface is the work"—is of particular interest to me as it has been fundamental to my own BCI endeavors. It gives us a useful entry point into examining how the medium shapes the social and aesthetic attributes of interpersonal exchanges, and the significance communicated by an artwork that has a technical interface as an essential component.

Artists are the clairvoyants in our society. When they embrace technology as a methodology, they make it visible to a public that has little direct contact with the daily work of scientists. The scientific rigor of artistic BCI has been questioned, but the true value of artists' use of this technology lies in the exploration of the epistemological, emotive, and educational impact of such interfaces. For BCI artists, the goal is always to move beyond the quantitative assessment of the impact of a technological apparatus.

BCI art is grounded in a shared experience of joy and creativity. When artists embrace technology, no matter how rigorous their process, their objective is the creation of an affective space meant to surpass self- or socially imposed boundaries

between individuals. Artists are impresarios of technology!

Per Laura Jade in this anthology, we are “hybrid artists.” Our work can only be understood through the interaction of artists, technology, and audience. Our passion fills that space and invites participation. Our dependence on scientists for our tools is a love affair that brings both parties closer together and inspires new and more complex collaborations.

Artists deploy BCI technology because it has the ability to render perceptible the inner workings of our deepest emotions. BCI always implies a process of externalization. It is deeply democratic in its ambitions: both demystifying technology and facilitating shared experiences. BCI artists rarely create in isolation. For them, the technological apparatus is foremost a tool of communication—whether between individuals or a multitude.

In editing this collection, Anton Nijholt has performed an invaluable service to scientists, the public and the worldwide creative community whose art finds its expression through a Brain–Computer Interface. This first overview of a field with half a century of groundbreaking collaborations and creations will be a precious guide as we adapt and expand new technologies like mobile–brain interfaces (MoBI), virtual reality (VR), and augmented reality (AR). This summing up is just the beginning!

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Nina

## Appendix

Nina Sobell, The Brain Streaming Project (2003): Proposal to the Rockefeller Foundation

In 2003 Nina Sobell submitted a proposal (N. Sobell. The Brain Streaming Project. Project proposal for the Rockefeller Foundation New Media Fellowships.) to the Rockefeller Foundation with a view on how Internet and the World Wide Web (WWW) could be used to communicate, share brain activity and engage with remote others to perform a collaborative painting task. Underlying the proposal was an earlier experiment. As mentioned on the website of the Brain Streaming Project ([www.brainstreaming.org](http://www.brainstreaming.org)): “On May 18, 2002, our first transmission operated over the Internet for the first time, letting people in Manhattan and Brooklyn create a collaborative brain-wave drawing on the Web. By making Brainwave Drawings a Web event driven by custom client-server software, a new kind of genre of telepresence will begin to emerge in a multiple-node NetArt performance with accessible physical spaces.” The costs of this proposed ‘Brain Streaming Project’ were estimated to be \$35,000. Unfortunately, it was not approved by the Rockefeller Foundation. The text of the main part of the proposal, slightly adapted, follows below.

26 A. Nijholt

### Proposal

The Brain Streaming Project presents the means for people to connect and collaborate with one another by using only their brain waves. This non-verbal communication will be represented as a continuously evolving aural and visual expression, accessible to anyone logging on. The Brain Streaming Project will premiere with a 1-h international performance at physical and virtual locations including pocket computers and cellphones at [www.brainstreaming.org](http://www.brainstreaming.org). The transformed photo booth installations for the premiere performance will remain at each location for participation for the duration of the Fellowship term. For the duration of the performance, participants

will be connected to electroencephalographs that amplify and identify their brain waves. The individual logon and brainwave data will be sent to the project server over the Internet, and entered into the server's database. The server then streams this information to the project's Web page, along with sounds and images that change dynamically as new input is received and viewed on touch screen monitors inside the booths, and on the Web. Brain Streaming is a metaphor for universal human consciousness. It reflects our similarities through the transformation of our converging thought patterns into the creation of a collaborative virtual collage.

My collaborators, M. E. Trivich, a systems engineer, Dr. John Dubberstein, a neurosurgeon and a musician, Sun Qing, a programmer and a theoretical physicist are committed to building our new form of universal language. Now that our custom client/server software has been successfully developed, we can devote our attention to discovering new ways of representing the EEG data into dynamically changing sounds and images, and designing a meaningful graphical user interface. Together we seek to create the meeting point at the intersection of art and technology.

Installation Plan: The Brain Streaming project will take place on pocket computers, cellphones, home computers and installed at three art/academic spaces located in three different cities. Three typical passport photo booths will be installed at the physical spaces. The exterior visual appearance of the booths will remain the same, the interior of the photo booths will appear much like their initial form but be equipped with web cams, monitors, and headgear with EEG (wireless electrodes) and headphones.

- A visitor approaches the photo booth with typical instructions posted outside that include extra features about the piece. They enter by pulling back the curtain, and adjusting their seat, so the web cam can see them. They put on the headgear equipped with EEG (wireless electrodes) and headphones.
- They enter the name of the city and the country they are from on the touch screen monitor facing them; longitude and latitude are automatically registered.
- They see their web cam image placed on their registered geographic location.
- They see the color of their faces change in accordance with the output of their own brain waves, and hear the output of their brain waves through the headphones.
- On the same login screen, they touch a button, which brings them to a collaborative painting and composing site.

1 Introduction: Brain-Computer Interfaces for Artistic Expression 27

- Then they hear and see the transformation of their brain wave output mixed with other participants. Volume as dynamics; Beta as rhythm; Alpha as tempo; Theta as pitch, and other parameters expressing the complexity of harmonics.
- The installation will remain open during gallery hours, and 24/7 for those with the headgear on the web at home, cellphones or pocket computers with built-in webcams, and those who logon to observe.
- Those who logon to observe will be identified by a color they choose from a color wheel.

In this interface, three typical passport booths in three cities are represented by the yellow circles. The yellow circles are placed at locations where photo booths will be hooked to EEGs. Surrounding them are expanding and contracting circles which illustrate amplitude through size and brainwave types and color. Red squares indicate the locations of visitors. Dimming and brightening of the map is a rough illustration of one way to aggregate the data from the EEG participants. In this illustration, when the circle is brighter, it is intended to illustrate when their brain waves are in sync. This diagrammatic page leads both physical and virtual participants to a full screen

painting and music composition they are creating together, as illustrated in the model below.

Brain Streaming Project 2003

By Flora Lysen (excerpt)

In 1974, when artist Nina Sobell saw a friend carry such a consumer audio alpha wave device, she started to include EEG as part of her video installations with elements of time-delay and closed-circuit systems (Stermitz and Sobell 2007). Sobell experimented with feedback video images in the EEG-laboratory of Barry Serman and subsequently created Interactive Brainwave Drawing: EEG Telemetry Environment (1975) (Harzell and Sobell 2001) (Fig. 2.4). In the latter, two subjects placed in a living room-setting could look at direct video feedback of themselves on a monitor while their EEG-activity was recorded and translated into a zigzagging line figure, a visualization of the measured combined brain activity of both participants. Outside the room, five television monitors displayed their EEG recordings as well as activity from previous participants, which was superimposed on the live video. Both in Sobell's work, as in Rosenboom's work, notions of 'synchrony' of brainwaves become intuitively aligned with cooperation in person-to-person communication, the circuited self was envisioned as enabling new versions of communicative harmony, circuits allowed for the playing, connecting, tuning and merging of different selves. Moreover, the circuited selves proposed by artists in the early 1970s are indicative of the importance that was placed on participation, experiencing and performing by users, more so than the elucidation of particular EEG-measurements.

In these installations, different disembodied 'energies' were extracted from participants and re-routed, displaced, manipulated, and merged into a bigger circuited whole. Writing one decade after his first EEG-experiments, Rosenboom emphasized the way that artists had thus become instrumental in designing the "interface" of these "transformations of information," to "create observable, symbolic representations of activity" through communications media (Rosenboom 1983, p. 32). Hence, artists' performative approaches to circuited selves in media ecological installations around 1970 must be understood as giving shape to notions of 'interfacing' and 'interfaces',

46 F. Lysen

Fig. 2.3 Richard Lowenberg, Environetic Synthesis, drawing in Radical Software 1972, volume 2, nr. 1, page 47, courtesy of Richard Lowenberg

Fig. 2.4 Nina Sobell & Michael Trivich, stills from A Video Brainwave Installation, taped in the laboratory of Barry Serman, Veterans Hospital Sepulveda, California, 1974, part of "Electroencephalographic video drawings," video produced by Nina Sobel and LBMA Video, 1992, [https://archive.org/details/XFR\\_2013-08-23\\_1B\\_16](https://archive.org/details/XFR_2013-08-23_1B_16), courtesy of Nina Sobell

and were part of an increasing interest in questions of designing the experimental environments that supported EEG-feedback research.

2.6