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Brainmedia

One hundred years of performing live brains, 1920–2020

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Summary

Brainmedia: One Hundred Years of Performing Live Brains, 1920–2020

Brainmedia: One Hundred Years of Performing Live Brains, 1920–2020 examines how scientists, science educators, and artists perform knowledge of the brain at work. My main argument is that approaching the history of brain and mind sciences as a history of live brains helps to see the extent of media's imbrication in thinking the brain at work – not only of (medical) media technologies, but also recording and broadcast media. By describing and analyzing assemblages of brains and media in particular historical contexts as brainmedia, I show how specific practices *of* and ideas *about* mediation impacted how scientists and science educators conceptualized and demonstrated the active human brain. My five historical case studies of brainmedia assemblages spanning the period of 1920 to 2020 substantiate my thesis. I analyze illuminated brain models from the 1920s until the 30s; staged brainwave recordings from the 30s to the 40s; live brains *on* television and conceptions of brains *as* television in the 40s and 50s; EEG feedback circuits and the rise of real-time interfaces around 1970; and “brain-to-brain” art-science experiments between 2013 and 2019.

While previous critical studies of twentieth century brain and mind sciences have emphasized the rhetoric of transparency and immediacy as having shaped the promise of watching the brain in action, my analysis of brainmedia points to the importance of liveness as a structuring element in enacting and staging the brain at work. I show how research into cerebral processes and demonstrations of active brains were impacted by different forms of liveness, that is, the different historically situated temporal-spatial configurations offered by different conceptions and practices of mediation. I argue that when brains are rendered “live,” they not only become transparent or immediate, they can also gain dimensions of directness, nearness, here-ness, aliveness, liveliness, and now-ness. In my analysis of live brains, I move away from a confined view of scientific (brain) image making. Instead, I establish the urgency of analyzing performing knowledges of the live brain. My study moves between scientists conceptualizing active brains in laboratories and scientific publications, and practices of developing, demonstrating, and exhibiting live brains in public. I thus take an inclusive and recursive approach to circulating knowledges as they are performed, mediated, and configured within and beyond the science establishment.

As a backdrop to my case studies, I first sketch how a new conception of a “live brain” developed in the early decades of the twentieth century. Drawing on Michel Foucault's work on the anatomico-clinical and neurological gaze, I start with an account of an “apparatus of neurological

capture” that emerged in the 19th century and produced a new “neurological body,” a conception of the body based on correlating examinations of dead brains with surface readings from living bodies. Around 1900, this apparatus was in crisis; neurological studies of functional cerebral localization had provided puzzling and ambiguous results. In this uncertain situation, two developments transformed this neurological body: the omnipresence of media technologies (and discourses about their ubiquity) and new (plat)forms for communicating and demonstrating scientific knowledge. This attention to media and mediation gave new impetus to the 19th century conception of the neurological body’s “correlative constitution” by emphasizing the superimposition of many mediated records. This allowed the emergence of a neurological body newly paired, I argue, with a “live brain”: a body with a nervous system that was understood as intimately imbricated with a network of mediating technologies, and a body with an active brain that was about to be captured in action. Perhaps more than ever before, active brains were articulated in relation to new media that evoked new spatio-temporal experiences – new forms of liveness. New conceptions of media and mediation thus impacted how the active brain could be thought. My narration of this history through the work of Foucault emphasizes the role of media as a structuring element for genealogical and archaeological studies of the brain and mind sciences.

Case study 1 starts in the midst of confusion about how to conceive of the active brain. I discuss 1920s and 30s attempts by scientists to envision a “dynamic” image of the brain at work, i.e. to conceptualize brain functions and nervous processes beyond functional localization and beyond static stimulus-response mechanisms. First, I discuss an illuminated model of the brain made of wires and glass tubes, *Das Leuchtende Gehirn*, built in 1931 as an educational model for popular lectures in Vienna’s *Volkshochschulen*. I situate it as part of a professionalizing (science) educational sphere that created “dynamic displays” to respond to the latest scientific insights on visual perception and to a narrative of distracted and fatigued spectators in the modern illuminated metropolis. Model-making itself, I show, was a fraught issue in relation to the search for dynamic conceptions. Adding to my analysis of media-imbricated approaches to thinking the active brain, I recount how a number of nerve physiologists in the USA and UK attempted to conceive of dynamic, spatio-temporal patterns of electrical activity in nerve-cell ensembles by comparing the brain to a “motograph” news ticker, a type of bulletin board with illuminated letters that had become a new part of modern cityscapes. By imagining the active brain in relation to these new display structures, I argue, scientists also sought to negotiate new experiences of observing nerve activities on screens. New display devices (such as light indicators, illuminated circuit diagrams, and signaling systems) allowed novel understandings of the technical mediation of physical processes. These abstractions could now be viewed as immediate while being mediated, what I call a “logic

of instant display.” By pointing to this historically situated conception of technical mediation, I nuance a dominant account in media theory that describes understandings of technical and broadcast media along the lines of either media “marginalism” or “generativism.” Instead, I see this logic of instant display as a new form of liveness that impacted the way the active brain could be thought as a new live brain, a brain as display.

My analysis in case study 2 focuses on a watershed moment in conceiving of the live brain: the discovery of electro-encephalography (EEG) and its 1930s uptake in European and American labs. I analyze an underexamined part of this history: the way scientists and educators actively sought public platforms to show this emerging technology to wider audiences, establishing its scientific legitimacy and potential for the future. By tracing the articulation of EEG in American popular science articles, a 1937 international science exhibition in Paris, and a Hollywood film in 1941, I reveal ambiguous portrayals of brainwaves and brainwave science – as both wonderful, horrible and normal – and of science spectators as both amazed and critical. In the examples I examine, performing knowledge about the brain at work invoked oscillating forms of liveness, interpretations that wavered between the “liveliness” of scientific demonstrations (life-like, direct, and vivid) and the strange “aliveness” of this new scientific phenomenon. Mapping these ambiguities, I show how supernatural interpretations of brainwaves were often rhetorically invoked so as to be dismissed, thus establishing a more modern, yet still magical attitude towards this new science. These equivocal narratives of *mystique populaire*, “white magic,” and “dark media” reverberated across different spheres of performing science. My analysis shows how drawing a rigid divide between the performative practices of “serious” scientists and “popular” science communicators is inadequate. Instead, I highlight the tropes and rhetoric the two shared.

In case study 3, I move to the historical heart of “liveness” as an idea and demonstrate how live TV around 1950 impacted the conceptualization of the active brain. Pairing an analysis of brains *on* and *as* television, I discuss brain science’s portrayal on early science-television broadcasts and the way television figured in cybernetic discourses as a diagnostic instrument and productive analogy for the active human brain. As brain science was not merely celebrated on TV, I tackle examples of experimental broadcasts in France and the USA that shaped new circuits between nearby TV screens and distant brain-measuring machines. Experimental broadcasts self-reflexively negotiated what television was – as a new medium – and the way it brought new relations between studio and world/brain into being. In turn, for cybernetic researchers in the 1950s, television mechanisms were not only employed as analogies in scientific texts, actual televisual cathode-ray tubes were also increasingly employed as displays in experimental set-ups. With William Grey Walter’s work as my main example, I trace the dizzying analogical loops by which television was

employed as tool and trope to examine the active brain, particularly in epilepsy research. Televisual brains, I argue, offered two new forms of liveness: both a networked intimacy established through brains on TV, as well as an operative accessibility through brains as TV. Ultimately, I argue brain-television analogies allowed the living brain to be understood as a black-box brain, endowed it with revelatory abilities and brain research with a new deductive logic.

Case study 4 turns to the groovy science of EEG feedback around 1970 and its imaginaries of perceiving one's own brain at work. With a specific focus on the USA, I examine the rise of EEG (alpha) feedback in relation to a cultural interest in the self and a new hope of training the brain for alpha states. I position these as part of communitarian new research spheres characterized by resonances between scientific and artistic approaches. EEG feedback was a tool of interest to artists experimenting with media systems and videography in opposition to the hierarchical structures of broadcast television. They employed EEG feedback in intricate installations and technological circuits (with flickering displays, closed-circuit television, blinking lights, alternating sounds, and colorful projections) to create visions of what I call a "circuited self," an imaginary of the self's energetic dissolve into a media-technical environment. Resonating with alpha-feedback research, I argue that such artistic experiments resulted in an epistemological focus on creating feedback scenarios and designing new interfaces. Despite increasing scientific critique, researchers continued to explore EEG feedback. At the same time, a new type of brain feedback emerged: bio-cybernetic brain-computer interfaces (BCI). I argue that the proximity of EEG-feedback and BCI discourses allowed for shared vocabularies of "feedback" and "communication," as well as a shared focus on interfaces, albeit with differing meanings and understanding of the ends to which technologies and brains were assembled. The form of liveness underpinning the BCI approach was "real-time," which shifted away from training the brain, to training computers to classify brain states.

In case study 5 I analyze the emergence of a contemporary field of two-body neuroscience studying the brain activity of two (or more) people in social interaction. I examine its a new vision of the live brain through *Mutual Wave Machine*, an art-science experiment by a cognitive neuroscientist and a media designer. I describe such collaborations as key to future-making practices in contemporary neuroscience. *Mutual Wave Machine* is a "crowdsourcing neuroscience experiment" that partakes in a broader discourse on what researchers call "real-world" neuroscience or "neuroscience in the wild": a more ecologically valid and naturalistic-oriented experimental practice that moves "out of the lab, into the world." *Mutual Wave Machine* exemplifies how this vision of "making the world the laboratory" pairs with the promise of exploratory big-data science. Recent practices of crowdsourcing neuroscience allow scientists to link crowdsourced

(big-data) neuroscience and “citizen science.” I analyze what type of citizens – citizens with brain data – are interpellated by these artistic, “live,” crowdsourced performances and problematize the notion of engagement in this example. Next, by offering a media-historical analysis of the concept of synchronization employed in current social-interaction research, I explain how issues of harmonization, affect, and operability are sedimented in today’s conceptualizations and practices. I end with a plea for more media-historical analysis in this direction, as well as more support of new forms of art–science experimentation.

My conclusions emphasize how my historical analysis of various brainmedia assemblages foregrounded media as fields of relations, as “atmospheric media” that shape a nervous middle. My genealogy of brainmedia offers a historical background to what a number of authors have described as a contemporary “affective *dispositif*” in which sensing brains and media environments are ever-more intimately enmeshed. My approach to performing knowledges also allows for analyzing the politics of fascination that impact how publics are asked to engage with brainmedia.

Dutch summary

Breinmedia: 100 jaar conceptualisering en presentatie van het *live* brein, 1920-2020

Breinmedia: 100 jaar conceptualisering en presentatie van het live brein, 1920-2020 onderzoekt hoe op verschillende momenten tussen 1920 en 2020 wetenschappers, wetenschapsverslaggevers en kunstenaars kennis van het actieve brein hebben geconceptualiseerd en (publiekelijk) hebben gepresenteerd. Mijn stelling is dat het benaderen van de geschiedenis van de hersenwetenschap als een geschiedenis van het *live* brein bijdraagt aan een beter begrip van de verstrengeling van media bij het doordénken van het werkende brein – niet alleen van (medische) media-technologieën, maar ook van media voor het registreren en uitzenden van geluid en beeld. Door het beschrijven en analyseren van wat ik *breinmedia* noem – assemblages van hersenen en media in bepaalde historische contexten – laat ik zien hoe specifieke praktijken van – en ideeën over mediëring van invloed waren op de manier waarop wetenschappers, wetenschapsverslaggevers en kunstenaars het actieve menselijke brein vorm gaven en tegelijkertijd aanschouwelijk en aannemelijk maakten. Vijf historische casus van breinmedia in de periode 1920 tot 2020 onderbouwen mijn these. Ik analyseer oplichtende hersenmodellen in de jaren 20, publieke presentaties van EEG-opnames in de jaren 30 tot 40, live hersenen *op* televisie en voorstelling van hersenen *als* televisie in de jaren 40 en 50, EEG-feedback-circuits en de opkomst van *real-time interfaces* rond 1970, en *brain-to-brain* experimenten in kunst en wetenschap tussen 2013 en 2019.

In de afgelopen decennia zijn er verschillende beschouwende studies verschenen over de manier waarop het brein ‘in werking’ wordt bestudeerd. In deze eerdere, kritische studies wordt er nadruk gelegd op een retoriek van transparantie en directheid in het onderzoek naar het brein in actie. In mijn analyse van breinmedia wijs ik op het belang van *liveness* als structurerend element in de wetenschappelijke voorstelling en publieke presentatie van het concept van het brein in werking. Ik laat zien hoe onderzoek naar cerebrale processen en (publieke) demonstraties van actieve hersenen werd beïnvloed door verschillende vormen van *liveness*, dat wil zeggen door de verschillende historisch gesitueerde configuraties van tijd en ruimte die ons door nieuwe media en veranderende opvattingen over mediëring worden gebracht. Ik beweer dat wanneer hersenen *live* worden voorgesteld, ze niet alleen een associatie oproepen met transparantie of directheid, maar ook dimensies van nabijheid, levendigheid en hedendaagsheid kunnen verwerven. In mijn analyse van het brein in werking (*live*) ga ik een stap verder dan het louter bestuderen van wetenschappelijke beeldvorming: ik stel een methode voor die de *live* hersenen bestudeert vanuit het oogpunt van de zogenaamde *performing knowledges*. Mijn studie beweegt zich tussen de manier waarop wetenschappers actieve hersenen in laboratoria en wetenschappelijke publicaties conceptualiseren,

en de manier waarop het werkende brein publiekelijk wordt gedemonstreerd en tentoongesteld. Ik kies dus voor een inclusieve en recursieve benadering van circulerende kennis zoals die binnen en buiten het wetenschappelijk establishment wordt opgevoerd, gemedieerd en geconfigureerd.

In het eerste hoofdstuk, als achtergrond voor mijn casestudies, schets ik hoe in de eerste decennia van de twintigste eeuw een nieuw concept van een *live* brein kon ontstaan. Voortbouwend op Foucault's studie van een anatomisch-klinische en neurologische blik, begin ik met een uiteenzetting van het dispositief van neurologische toe-eigening (*dispositif de capture neurologique*) waarmee in de negentiende eeuw een nieuwe voorstelling van het 'neurologische lichaam' werd verwezenlijkt; een dispositief gebaseerd op de correlatie van observaties van ontlede (dode) hersenen en van de gebaren en het uiterlijk van levende lichamen. Rond 1900 verkeerde dit dispositief in een crisis; neurologische studies naar de lokalisatie van hersenfuncties gaven verwarrende en onduidelijke uitkomsten. In deze onzekere situatie zorgden twee ontwikkelingen voor een transformatie van het idee van het 'neurologische lichaam': de alomtegenwoordigheid van mediatechnologieën (en een vertoog over hun alomtegenwoordigheid) en nieuwe mogelijkheden voor het communiceren en demonstreren van wetenschappelijke kennis. Deze aandacht voor media en mediëring gaf een nieuwe impuls aan het negentiende-eeuwse concept van de 'correlatieve constitutie' van het 'neurologische lichaam' door een veelheid aan gemedieerde optekeningen waarmee dit lichaam werd vastgelegd en voorgesteld. Ik stel dat deze kwantiteit aan gemedieerde correlaties de weg bereidde voor een koppeling van het 'neurologisch lichaam' met een *live* brein: een lichaam met een zenuwstelsel dat werd begrepen als intiem verbonden met een netwerk van mediatechnologieën, en een lichaam met een brein dat weldra in werking aanschouwd zou kunnen worden. Misschien meer dan ooit tevoren werden de actieve hersenen gearticuleerd in relatie tot nieuwe media, die nieuwe ervaringen van ruimte en tijd opriepen – nieuwe vormen van *liveness*. Deze opvattingen over media en mediëring hadden dus invloed op hoe het werkende brein kon worden geconceptualiseerd. Mijn behandeling van deze geschiedenis met behulp van het werk van Foucault benadrukt de rol van media als structurerend element voor genealogische en archeologische studies van de hersenwetenschappen.

Casus 1 begint ten tijde van verwarring bij wetenschappers over hoe zij zich het brein in werking moeten voorstellen. Ik bespreek pogingen van wetenschappers uit de jaren 20 en 30 om een 'dynamisch' beeld van de actieve hersenen te verwezenlijken, dat wil zeggen om hersenfuncties en zenuwprocessen voor te stellen voorbij het idee van functionele lokalisatie en voorbij eendimensionale stimulus-respons-mechanismen. Eerst bespreek ik een verlicht model van de hersenen gemaakt van ijzerdraden en glazen buizen, *Das Leuchtende Gehirn*, gebouwd in 1931 als een educatief hulpmiddel voor openbare lezingen in *Volkshochschulen* in Wenen. Ik situeer dit educatieve

model als onderdeel van een professionaliserend veld van wetenschapsonderwijs voor welvarende burgers, waarin werd getracht de belangstelling van toeschouwers te wekken door middel van zogenaamde ‘dynamische displays’. Deze nieuwe tentoonstellingsvormen werden vervaardigd naar de nieuwste wetenschappelijke inzichten over visuele perceptie en maakten deel uit van een vertoog over de moderne, verlichte metropool waarin de aandacht van overprikkelde stadsbewoners nog maar moeilijk te vangen leek. Daarnaast laat ik zien dat in de context van dynamische benaderingen in de hersenwetenschap het maken van modellen zelf een beladen kwestie was. Naast mijn analyse van de invloed van *display media* op het conceptualiseren van de actieve hersenen, analyseer ik hoe neurofysiologen in de Verenigde Staten en het Verenigd Koninkrijk probeerden om dynamische, ruimtelijke en tijdsgebonden patronen van elektrische activiteit in (groepen van) zenuwcellen voor te stellen door de hersenen te vergelijken met een elektrische lichtkrant (*motograph*), een mededelingenbord met verlichte letters dat een vast onderdeel van de moderne stad was geworden. Door het actieve brein te verbeelden in relatie tot deze nieuwe presentatievormen, zo beweer ik, probeerden wetenschappers ook tot overeenstemming te komen over hun nieuwe ervaringen met het observeren van hersenactiviteit op technologische schermen. Nieuwe apparaten voor de visuele weergave van activiteit (zoals lichtindicatoren, verlichte schakelschema’s en signaleringssystemen) boden nieuwe mogelijkheden voor het begrip van technische mediëring van fysieke processen. Deze abstracties konden tegelijkertijd als direct en als gemedieerd worden beschouwd, een dualiteit die ik een *logic of instant display* noem. Door op deze historisch gesitueerde opvatting van technische mediëring te wijzen, nuanceer ik een overheersende redenering in de mediatheorie waarin media worden beschreven binnen het spectrum van media ‘marginalisme’ of media ‘generativisme’. In plaats daarvan zie ik deze *logic of instant display* als een nieuwe vorm van *liveness* die invloed had op de manier waarop het actieve brein kon worden voorgesteld als een nieuw *live* brein, een brein als *display*.

Mijn analyse in casus 2 richt zich op een keerpunt in de conceptualisering van het levende brein: de ontdekking van elektro-encefalografie (EEG) en de ontwikkeling van deze techniek in Europese en Amerikaanse laboratoria in de jaren dertig. Ik beschrijf een onderbelicht deel van deze geschiedenis: de manier waarop wetenschappers en wetenschapsverslaggevers actief naar openbare platforms zochten om deze opkomende technologie aan een breder publiek te tonen, waardoor ook de wetenschappelijke legitimiteit en potentie ervan kon worden bekrachtigd. Door middel van een analyse van beschrijvingen van EEG in Amerikaanse populair-wetenschappelijke artikelen, de internationale wetenschapstentoonstelling van 1937 in Parijs en een Hollywood-film uit 1941, laat ik de ambiguïteit zien waarmee hersengolven en hersengolfwetenschap werden voorgesteld. Niet alleen werd deze nieuwe wetenschap gepresenteerd als verbazingwekkend, angstaanjagend en

normaal, ook haar wetenschappelijke toeschouwers werden beschreven als tegelijkertijd verbaasd en potentieel kritisch. In de voorbeelden die ik onderzoek, roept het demonstreren van kennis over de actieve hersenen steeds wisselende vormen van *liveness* op; interpretaties die heen en weer schommelden tussen de ‘levendigheid’ van wetenschappelijke demonstraties (levensecht en direct) en het vreemde ‘levend zijn’ (bezield) van dit nieuwe wetenschappelijke fenomeen. Door deze ambigüiteiten in kaart te brengen, laat ik zien hoe bovennatuurlijke interpretaties van hersengolven vaak retorisch werden opgeroepen om vervolgens te worden verworpen, waardoor een modernere, maar nog steeds magische houding ten opzichte van deze nieuwe wetenschap kon worden aangenomen. Deze dubbelzinnige oproep van *mystique populaire*, ‘witte magie’ en ‘duistere media’ zijn zichtbaar in verschillende publieke en minder publieke demonstraties van de EEG-wetenschap. Mijn analyse laat zien hoe het idee van een kloof tussen de voorstellingen van ‘serieuze’ wetenschappers en ‘populaire’ wetenschapsverslaggevers geen recht doet aan deze ambigüiteit. In plaats daarvan benadruk ik de retoriek die door deze velden wordt gedeeld.

In casus 3 richt ik me op het historische middelpunt van het concept *liveness* en laat ik zien hoe *live* televisie rond 1950 de conceptualisering van het brein in werking beïnvloedde. Ik combineer een analyse van hersenen *op* en hersenen *als* televisie. Eerst bespreek ik de weergave van de hersenwetenschap in vroege televisie-uitzendingen over wetenschap en daarna beschrijf ik de manier waarop televisie in cybernetische vertogen werd voorgesteld als een diagnostisch instrument en een productieve analogie voor het actieve menselijk brein. Op televisie werd de hersenwetenschap niet alleen geprezen en gevierd. Ik bespreek voorbeelden van experimentele televisie-uitzendingen in Frankrijk en de Verenigde Staten waarin werd geprobeerd om nieuwe verbindingen te leggen tussen tv-schermen thuis en medische machines verder weg van de kijker. Zulke televisie-experimenten gaven niet alleen vorm aan wat er op televisie te zien was maar versterkten ook het nadenken over het nieuwe medium televisie en over de manier waarop het nieuwe relaties tussen studio en wereld/hersenen tot stand bracht. Op een andere manier werd het medium televisie in de jaren vijftig door cybernetische onderzoekers niet alleen gebruikt als een analogie in wetenschappelijk onderzoek naar perceptie maar ook in toenemende mate als een fysiek apparaat dat diende als beeldbuis in experimentele opstellingen. Met het werk van William Grey Walter als mijn belangrijkste voorbeeld, volg ik de circulaire analogieën waarmee televisie door cybernetische denkers werd gebruikt als instrument én retorisch hulpmiddel om de actieve hersenen te onderzoeken, met name bij epilepsie-onderzoek. Uiteindelijk boden televisiebreinen, zo beweer ik, twee nieuwe vormen van *liveness*: zowel een genetwerkte intimiteit die via het brein *op* tv tot stand kwam, als een notie van toegankelijkheid via het idee van de hersenen *als* tv. Concluderend betoog ik dat hersenen-televisie-analogieën er voor zorgden dat het levende brein

kon worden opgevat als een ‘black-box brein’: een idee van het onderzochte brein als een entiteit behept met onthullende vermogens en van een specifiek begrip van hersenonderzoek, gekenmerkt door een nieuwe deductieve logica.

Casus 4 onderzoekt de opkomst van de ‘hippe’ (*groovy*) wetenschap van EEG-feedback rond 1970 en een nieuwe opleving van de wens om het eigen brein ‘aan het werk’ te zien. Met een specifieke focus op de situatie in de Verenigde Staten onderzoek ik de opkomst van experimenten met EEG -(alfa)feedback in relatie tot een culturele belangstelling voor het ‘zelf’ en de hoop dat de hersenen getraind zouden kunnen worden om in een staat van ‘alfa’ (een specifieke staat van EEG-activiteit) te verkeren. Ik situeer deze belangstelling en hoop als onderdeel van gemeenschapsgerichte, nieuwe omgevingen voor onderzoek waarin wetenschappelijke en artistieke benaderingen elkaar doorkruisten. EEG-feedback was een interessant hulpmiddel voor kunstenaars die experimenteerden met mediasystemen en videografie, in tegenstelling tot de hiërarchische structuren van televisie. Zij gebruikten EEG-feedback in ingewikkelde installaties en technologische circuits (met flikkerende schermen, *closed-circuit* televisie, knipperende lichten, veranderend geluid en kleurrijke projecties) om visies te creëren van wat ik een *circuited self* noem, een verbeelding van de manier waarop het zelf oplost in een media-technische omgeving. Ik betoog dat net als bij ander alfa-feedbackonderzoek, dergelijke artistieke experimenten resulteerden in een epistemologische focus op het creëren van feedback-scenario’s en het ontwerpen van nieuwe *interfaces*. Ondanks toenemende wetenschappelijke kritiek bleven onderzoekers EEG-feedback bestuderen. Tegelijkertijd ontstond een nieuw type feedback: bio-cybernetische brain-computer-interfaces (BCI). Ik beweer dat de verwantschap van vertogen over EEG-feedback en BCI zorgde voor een gedeeld vocabulair van ‘feedback’ en ‘communicatie’, evenals een gedeelde focus op *interfaces*, zij het met een verschillend gebruik van deze termen en met een ander doel bij de verbinding van technologieën en hersenen. De vorm van *liveness* die aan de BCI-aanpak ten grondslag lag, was een *real-time* dimensie. *Real-time* betekende een verschuiving van het trainen van hersenen naar het trainen van computers om hersentoestanden te classificeren.

In casus 5 analyseer ik de opkomst van een nieuw veld in de hedendaagse neurowetenschap waarin de hersenactiviteit van twee (of meer) mensen wordt bestudeerd terwijl zij in sociale interactie zijn. Aan de hand van een specifiek voorbeeld onderzoek ik hoe er in dit veld van *brain-to-brain synchronization* een nieuwe visie op het levende brein wordt gevormd: *Mutual Wave Machine*, een kunst-wetenschappelijk experiment uitgevoerd door een cognitieve neurowetenschapper en een media-designer. Ik beschrijf dergelijke samenwerkingen als kenmerkend voor op de toekomst gerichte werkwijzen in de hedendaagse neurowetenschap. *Mutual Wave Machine* is een neurowetenschappelijk experiment op basis van *crowdsourcing* dat onderdeel uitmaakt van een breder

vertoog over wat onderzoekers *real-world* neurowetenschap of ‘neurowetenschap in het wild’ noemen: een meer ecologisch verantwoorde en naturalistisch georiënteerde experimentele praktijk die ‘uit het lab, in de wereld’ beweegt. *Mutual Wave Machine* illustreert hoe deze visie – ‘van de wereld een laboratorium maken’ – samengaat met de belofte van verkennende *big data*-wetenschap. Recente praktijken van (en verhalen over) crowdsourcing neurowetenschap stellen wetenschappers in staat om crowdsourced, big-data neurowetenschappen en het concept van *citizen science* met elkaar te verbinden. Ik analyseer welk type burgers –burgers met hersendata – worden ondervraagd door deze artistieke, *live, crowdsourced* voorstellingen en ik problematiseer de notie van ‘engagement’ in dit voorbeeld. Vervolgens bied ik een mediahistorische analyse van het concept ‘synchronisatie’ dat wordt gebruikt in huidig onderzoek naar sociale interactie en betoog dat noties van harmonisatie, affect en instrumentaliteit een onderdeel vormen van het onderzoek naar synchronisatie. Ik eindig met een pleidooi voor een uitgebreidere mediahistorische analyse in deze richting, evenals meer steun voor nieuwe vormen van kunst-wetenschap-experimenten.

Mijn conclusie benadrukt hoe mijn historische analyse van verschillende breinmedia media op de voorgrond heeft gebracht als een veld van relaties, als *atmospheric media* die een zenuw-achtig midden vormen. Mijn genealogie van breinmedia biedt een historische achtergrond voor wat een aantal auteurs heeft omschreven als een hedendaags ‘affectief dispositief’ waarin voelende hersenen en media-omgevingen steeds nauwer zijn verweven. Mijn benadering van *performing knowledges* maakt het ook mogelijk om de fascinatiewetenschap te analyseren die van invloed is op de manier waarop het (leken)publiek wordt gevraagd om te gaan met breinmedia.

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Chapter 6 contains parts of “Kissing and Staring in Times of Neuromania: The Social Brain in Art-Science Experiments.” In *Artful Ways of Knowing, Dialogues between Artistic Research and Science & Technology Studies*, edited by Trevor Pinch, Henk Borgdorff and Peter Peters. Routledge Advances in Art and Visual Studies, 167-83. London & New York: Routledge, 2019.

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