



Safeguarding Brain Data: Assessing the Privacy Practices of Consumer Neurotechnology Companies

By Jared Genser, Stephen Damianos, and Rafael Yuste*

April 2024

* Jared Genser is outside General Counsel to the NeuroRights Foundation and Managing Director of Perseus Strategies. Stephen Damianos is Director of Technology and Human Rights at Perseus Strategies. Rafael Yuste is Chair of the NeuroRights Foundation and Professor of Biological Sciences and Director of the Neurotechnology Center at Columbia University. For further information, please contact jgenser@perseus-strategies.com or call +1 202-320-4135.

Table of Contents

EXECUTIVE SUMMARY 2

I. INTRODUCTION 5

A. Neurotechnologies: A Primer 6

B. Conceptualizing Consumer Neurotechnologies 10

C. Regulating Neurotechnologies 12

D. The Imperative of Protecting Neural Data 16

II. METHODOLOGY..... 19

A. Methods 19

B. Description of Consumer Neurotechnology Devices 21

 1. Wellness Products 23

 2. Recreation/Entertainment Products 28

 3. Research Products 28

III. THEMATIC AREAS OF CONCERN IN CONSUMER NEUROTECHNOLOGIES 30

A. Access to Information 30

 1. Access to Policy Documents 32

 2. Ability to Contact the Company 34

 3. Notification of Policy Changes 37

 4. Access to Information: Conclusion 40

B. Data Collection and Storage 40

 1. Types of Data Collected 43

 2. Amount of Data Collected 47

 3. Data Retention and Storage Limitation 48

 4. Data Collection and Storage: Conclusion 50

C. Data Sharing 51

 1. Sharing Data with Third Parties 52

 2. Sharing Data with Governments and Law Enforcement 54

 3. Selling Data to Third Parties 55

 4. Data Sharing: Conclusion 57

D. User Rights 57

 1. Withdrawal of Consent 59

 2. Deletion of Data 60

 3. User Rights: Conclusion 61

E. Data Safety and Security 61

 1. Anonymization/Pseudonymization 63

 2. Encryption 65

 3. Notification of Security Breach 66

 4. Data Safety and Security: Conclusion 68

IV. CONCLUSION..... 68

ACKNOWLEDGMENTS..... 69

APPENDIX 70

EXECUTIVE SUMMARY

Safeguarding Brain Data: Assessing the Privacy Practices of Consumer Neurotechnology Companies is the first comprehensive report analyzing the data practices and user rights of consumer neurotechnology products. Neurotechnology refers to devices capable of recording or altering the activity of the nervous system, including the brain, the spinal cord, and the peripheral nerves. Traditionally used within medical and research settings, these devices are increasingly marketed to consumers. Today, at least 30 neurotechnology products are available for purchase by members of the public.

The human brain is unlike any other organ, as it generates all of our mental and cognitive activities. The data it produces is unlike any other data, as it reflects mental processing. Neural data, which refers to information directly reflecting the activity of an individual's central or peripheral nervous systems, is therefore capable of revealing enormously sensitive information about the people from whom it was collected, including identifiable information about their mental health, physical health, and cognitive processing. In the coming years, the sensitivity of neural data will only deepen as investments from the private sector, governments, and similar initiatives expand. This will result in improvements to the technical capabilities of neurotechnology, affording increased resolution of brain scans and larger datasets of brain data being collected, while generative artificial intelligence will accelerate the ability to accurately decode these scans. Meanwhile, implantable neurotechnologies can already accurately decode language and emotions, while wearable devices are beginning to have some of these capabilities as well. These developments have significant implications for mental privacy, highlighting the pressing importance of understanding the privacy practices and user protections provided by consumer neurotechnology companies.

This report presents an initial assessment of privacy practices in the consumer neurotechnology market. It explores the privacy policies and user agreements (referred to collectively as policy documents) of 30 companies with publicly available products that can be purchased online, benchmarking them against global data protection standards and considering the unique sensitivities of neural data. This report contributes critical information about the practices that consumer neurotechnology companies today apply to neural data and the rights that consumers have in relation to them. It aims to guide industry, investors, and consumers who seek to promote responsible innovation, protect human rights, and ensure the ethical development of neurotechnologies.

The report's analysis focuses on five thematic areas of concern in relation to consumer neurotechnology products: Access to Information, Data Collection and Storage, Data Sharing, User Rights, and Data Safety and Security. Across these five areas, broad gaps between international standards and actual data practices emerge. Key findings include:

- Based on our review of the policy documents and our correspondence with companies, **29 of the 30 companies (96.67%) appear to have access to the consumer's neural data and provide no meaningful limitations to this access.**

- Consumers do not have adequate information about data practices, privacy, or their rights as users.** Of the 30 companies surveyed, 22 (73.33%) have privacy policies on their websites that govern the use of their neurotechnology products. Eight of the companies (26.67%) have no publicly available privacy policy with relevance to the neurotechnology products that can be viewed in advance of a purchase. Out of the 30 surveyed neurotechnology companies, only 10 (33.33%) commit to meaningfully notifying consumers if there are changes to the company's data and privacy practices. And while all 30 companies (100%) provide consumers with a way of contacting them with questions, only 11 (36.67%) replied to attempts to establish contact through their identified channel of communication. Only four (13.33%) of the companies meet all of these information standards by offering relevant policy document(s), a mechanism for communication with the consumer, responsiveness to communication from the consumer, *and* notification of policy changes. These findings raise concerns about whether consumers can meaningfully exercise choice and give consent for any use of their neural data if they are not adequately informed.
- There is enormous ambiguity regarding whether companies consider neural data a form of personal data.** As a result, consumers may be confused about whether the practices outlined in the policy documents relate to their neural data or not. Of the 30 companies, only 13 (43.33%) explicitly mention neural data in one or more of their policy documents. Another nine companies (30%) have policy documents that mention the neurotechnology products but make no mention of neural data. The last eight companies (30%) have policies that only discuss the company's website. 60% of the surveyed companies thus provide no information for consumers about how their neural data is handled and what rights they have in relation to it.
- Data collection and storage practices are ambiguous.** Of the 30 companies, only four (13.3%) have policies that explicitly mention efforts to minimize the amount of data collected from neurotechnology consumers. Relatedly, 19 of the 30 companies (63.33%) explicitly discuss data retention practices. Another three (10.00%) have no reference to data retention, while the final eight (26.67%) have web-only policies whose content is irrelevant to the retention of neural data. Of the 30 companies, only two (6.67%) explicitly discuss data minimization, data retention, and neural data.
- Almost all of the companies can share data with third parties.** Over 50% of the companies have explicit provisions in their policies that allow for the sharing of data. 20 of the 30 companies (66.67%) mention in their policies that they can, under certain circumstances, share personal information with third parties. One company (3.33%) says it cannot share data, while another nine companies (30.00%) are unclear on the matter. This means that in practice, 29 of the 30 companies (96.67%) can and may transfer data to third parties.
- The extent to which companies can or cannot sell data is unclear.** Of the 30 companies surveyed, two (6.67%) imply that they sell data, while four (13.33%) state that they do not. The remaining 24 companies (80%) do not explicitly mention sale of data in their policies. It therefore appears that among over 85% of the companies, consumer data (which may include neural data) can be sold to third parties under certain circumstances.

Meanwhile, 12 companies (40%) inform consumers that their data may be transferred to a new company in case of a business merger, acquisition, or sale of corporate assets. The other 18 (60%) do not mention this issue.

- **User rights, such as withdrawing consent to data processing and requesting data deletion, are not uniformly extended.** Only 16 of the companies (53.33%) in this report explicitly mention that consumers can, under certain circumstances, withdraw their consent to data processing. Only 14 of the companies (46.67%) explicitly extend consumers the right to delete data. Of the 30 companies, only 12 (40%) appear to extend consumers both the right to withdraw consent and the right to request data deletion. Further, user rights are frequently specific to the geographic location of the consumer rather than extended to all users (e.g., they only apply to people in the European Union).
- **The data safety and security provisions of consumer neurotechnology companies are generally ill-equipped to safeguard neural data.** 17 of the 30 companies (56.67%) mention the practice of de-identifying information, though none of the companies explain to consumers the challenges of meaningfully de-identifying neural data. Only six of the companies (20%) mention encryption of data in their policies, and only five (16.67%) commit to notifying customers in the event of a security breach. Of the 30 companies, only three (10%) state that they engage in all of these data safety and security measures. The remaining 27 (90%) of the companies do not outline adequate measures to protect neural data in their policy documents. Most common across the policy documents is vague language that mentions safeguarding measures but does not describe what exactly those measures are.

This report concludes that there are substantial gaps between the privacy practices of consumer neurotechnology companies and global privacy standards. That said, its analysis is limited to the content of policy documents. As such, the Neurorights Foundation makes no claims about the intent of neurotechnology companies. In addition, the market for consumer neurotechnologies is growing quickly, has not been subject to regulation, and lacks industry-wide standards for privacy practices. This report highlights these gaps in privacy practices so companies and investors can understand the kinds of further measures that are necessary to responsibly grow the consumer neurotechnology market. The report also analyzes the unique characteristics of neural data and is intended to inform multilateral organizations and governments about how their legal and regulatory frameworks can be updated to protect mental privacy and ensure consumer neurotechnology companies properly safeguard neural data.

Ultimately, this will benefit not only companies and investors who are committed to the ethical development of neurotechnology, but also consumers. As neurotechnology devices proliferate beyond medical settings outside the strict requirements for medical devices and health privacy, it is critical that consumers comprehend exactly how companies can use their neural data and what rights they have over that usage. Without this information, consumers cannot make meaningfully informed choices about their privacy, and they may unwittingly expose their most sensitive data.

I. INTRODUCTION

For decades, scientists and healthcare professionals have employed neurotechnologies to understand the complexities of the human brain and pioneer cutting edge medical treatments. Neurotechnologies, which are devices capable of recording or altering the activity of the brain and the wider nervous systems, have wide applications in settings of research and medicine, ranging from studying Alzheimer’s to treating Parkinson’s. But with advances in artificial intelligence (AI), software development, and the commodification of brain data, neurotechnologies are increasingly user friendly, affordable, and marketed for public consumption. Technologies that were once confined to hospitals, universities, and laboratories are now available to consumers around the world, just one purchase away.

Neurotechnologies are rapidly expanding into the consumer sphere. Tech giants like Meta,¹ Apple,² and Snap³ are developing neurotechnology products, while a range of smaller companies are already selling neurotechnology devices to consumers across the world. The emergence of consumer neurotechnologies represents a new and exciting frontier of mental augmentation; in the coming years, humans will experience previously unimagined levels of connectivity, with widespread opportunities to hack their own brains and to connect them to the wider world. But while this brings rich promises of innovation, economic development, and benefits to consumers, it also raises pressing new concerns about the data and the privacy of neurotechnology users. The emergence of new technologies is always accompanied by risk, but the potential harms posed to consumers of neurotechnology products are especially concerning given the unique nature of the human brain and the extreme sensitivity of the data it produces.

The brain is the most complex organ in the human body. Together with the spinal cord, it forms part of the central nervous system, which works with the peripheral nervous system to control and regulate a variety of physiological processes. The brain itself generates all mental and cognitive activity. Neural circuits in the brain create thoughts, emotions, and memories, guide decision making, and also form individual personalities, identities, and senses of self. This means that neural data, which refers to information concerning the activity of an individual’s

¹ In 2019, Meta (then Facebook) acquired CTRL-Labs for approximately \$1 billion. CTRL-Labs is known for a wristband that captures neural activity from the wrist and allows consumers to translate intention into action (e.g., when the user imagines opening their fist, a digital fist opens on the computer). *CTRL-Labs: Capturing Intent -- User Interface Control Without Moving a Muscle*, ZDNET, available at <https://www.zdnet.com/article/ctrl-labs-controlling-a-computer-without-moving-a-muscle/>.

² In 2023, Apple filed a patent called *Biosignal Sensing Device Using Dynamic Selection of Electrodes*. The patent involves plans for next-generation AirPods with electroencephalography (EEG) sensors fitted into the earbuds. *Biosignal Sensing Device Using Dynamic Selection of Electrodes*, GOOGLE PATENTS, available at <https://patents.google.com/patent/US20230225659A1/>.

³ In 2022, Snap acquired NextMind, a Paris-based neurotechnology company, with the aim of integrating NextMind’s brain-computer interfaces into augmented reality products sold by Snap. According to Snap, NextMind’s technology “monitors neural activity to understand your intent when interacting with a computing interface, allowing you to push a virtual button simply by focusing on it.” *Snap Buys Mind-Controlled Headband Maker, NextMind*, TECH CRUNCH, available at https://techcrunch.com/2022/03/23/snap-buys-mind-controlled-headband-maker-nextmind/?guccounter=2&guce_referrer=aHR0cHM6Ly91bmrhcmsub3JnLw&guce_referrer_sig=AQAAAN7RM4aqIonMqo78_Lbty7Umc5Myw1zYAVNBrKuMjR7RY7aBZ4uC_xIftNgFS_hc8zMHpJtt8oFeTd9DOdDzs8fasdKge0zyzZlYjnfkKIDRxJSto32AjclijytTTBPN17s3WpWXkZ0eVgZbe1i4hVSUq7v8o-3v0QANhp_r8t.

central or peripheral nervous systems, can reveal deeply intimate information, including information about mental states, emotions, health, and neural processing. Non-invasive neurotechnologies also have the burgeoning ability to enable forms of mind reading, which can support the goal of converting thoughts into a continuous stream of text.⁴ As such, the privacy rights of consumers must be central to discussions of consumer neurotechnologies.

As neurotechnologies expand in technical capability and market availability, consumers increasingly invest not only their money but also their trust into neurotechnology companies. This trust may be blindly given, though, since the scale and scope of privacy concerns is unknown.

This report elucidates the risks of consumer neurotechnologies by interrogating the user agreements and privacy policies of existing consumer neurotechnology products. The following analysis refers to such agreements as *policy documents*, a term that encompasses any statement that companies publish explaining the relationship between the company, consumers, and data (examples of policy documents include privacy policies, terms and conditions, end-user license agreements, and more). To the extent of the authors' knowledge, no comparable report exists. As a result, there is little to no understanding of how neurotechnology companies manage their relationships with their customers and treat their neural data. Until now, the extent to which neurotechnology companies protect or otherwise prey upon consumers has been unknown.

By conducting a thorough evaluation of the agreements governing the use of consumer neurotechnology products, this report provides a snapshot in time as to how companies address critical issues such as user rights and data privacy in the realm of consumer neurotechnology. It also raises pressing concerns for the near future that will only intensify as consumer neurotechnologies become more widespread.

A. *Neurotechnologies: A Primer*

In this report, neurotechnology refers to devices that seek to record or alter the activity of the brain and the wider nervous system. There are many ways that neurotechnology devices can measure neural activity. A direct method is by measuring the electrical signals of neurons, such as through an electroencephalogram (EEG). Alternatively, methods can indirectly measure neural activity through non-electrical means, such as an fMRI scan measuring blood flow that is related to neural activity. Neurotechnologies employ a range of electronic, optical, magnetic, nanophysical, acoustical, and mechanical systems, and can modify the response of the individual's nervous systems to its internal or external environments.

Central to neurotechnologies are brain-computer or brain-machine interfaces (BCIs or BMIs), which, as their name implies, connect brains to computers, machines, or other devices. BCIs can facilitate bidirectional communication between the brain and the outside world, either by exporting brain data or by altering brain activity. For example, a BCI helped a man who is

⁴ Hannah Devlin, *AI Makes Non-Invasive Mind-Reading Possible By Turning Thoughts Into Text*, THE GUARDIAN, May 1, 2023, available at <https://www.theguardian.com/technology/2023/may/01/ai-makes-non-invasive-mind-reading-possible-by-turning-thoughts-into-text>.

paralyzed and non-verbal to communicate at 18 words (90 characters) per minute with up to 94 percent accuracy.⁵

BCIs can be invasive (with a chip implanted in the brain) or non-invasive (with a wearable device, such as a helmet). Invasive BCIs require surgery to implant and are regulated as medical devices with heightened health data protections.⁶ Non-invasive devices, by contrast, are typically considered consumer devices and face almost no oversight. Examples of invasive BCIs include cochlear implants, deep brain stimulators which can help people with Parkinson's disease regain mobility, brain implants which help people with missing or damaged limbs to feel heat and cold through their prostheses, and brain chips developed for nonverbal individuals with Amyotrophic Lateral Sclerosis (ALS) which enable them to fluently communicate as well as to write and send emails.⁷ Invasive devices have facilitated the sharing of images and words between two people in different rooms, allowing them to communicate without speaking or writing to each other.⁸ Last year, an invasive BCI enabled a woman who lost her speaking ability after a stroke to speak again. Using intracranial (within the skull) EEG and applying a generative AI algorithm, a research team was able to decode her inner language, emotions, and basic intended facial muscle movements. Remarkably, they built a digital avatar that replicated her own voice and facial expressions so she could communicate with the world.⁹ This breakthrough was reported in a front-page story in the *New York Times*.¹⁰

These are some of many recent breakthroughs that highlight how advances in neurotechnology are transforming the ability to access and decode mental processing. Other examples include a recent study that demonstrated speech decoding from neural data using deep learning models and high-density electrocorticography recordings from the sensorimotor cortex to decode individual words in reconstructed speech with 92%–100% accuracy,¹¹ as well as a study that saw researchers decode a Pink Floyd song that research participants were listening to by analyzing their neural activity with generative AI.¹²

⁵ Francis R. Willett, et al., *High-Performance Brain-to-Text Communication Via Handwriting*, 593 NATURE 249, 249–254 (2021), available at <https://doi.org/10.1038/s41586-021-03506-2>.

⁶ See, e.g., Anna Wexler & Peter Reiner, *Oversight of Direct-To-Consumer Neurotechnologies*, 363 SCIENCE 234, 234–235 (2019) [hereinafter *Oversight of Direct-To-Consumer Neurotechnologies*]; *General Wellness: Policy for Low Risk Devices*, FOOD & DRUG ADMIN., at 1–13 (2016), available at <https://www.fda.gov/media/90652/download> [hereinafter FOOD & DRUG ADMIN.].

⁷ Rafael Yuste, Jared Genser & Stephanie Herrmann, *It's Time for Neurorights: New Human Rights for the Age of Neurotechnology*, 18 HORIZONS 154, 154-55 (2021), at 156, available at <https://www.perseus-strategies.com/wpcontent/uploads/2021/03/Neuro-Rights-Horizons-Winter-2021.pdf> [hereinafter HORIZONS].

⁸ *Id.*, at 157.

⁹ *Brain Implants Helped Create a Digital Avatar of a Stroke Survivor's Face*, MIT TECH. REVIEW, available at <https://www.technologyreview.com/2023/08/23/1078312/brain-implants-digital-avatar-stroke/>.

¹⁰ Pam Belluck, *A Stroke Stole Her Ability to Speak at 30. A.I. is Helping Restore It Years Later*, NEW YORK TIMES, Aug. 23, 2023, available at <https://www.nytimes.com/2023/08/23/health/ai-stroke-speech-neuroscience.html>.

¹¹ Julia Berezutskaya, Zachary V Freudenburg, Mariska J Vansteensel, Erik J Aarnoutse, Nick F Ramsey & Marcel A J van Gerven, *Direct Speech Reconstruction From Sensorimotor Brain Activity With Optimized Deep Learning Models*, 20 J. OF NEURAL ENG'G 1, 1–24 (2023).

¹² Ludovic Bellier, Anaïs Llorens, Déborah Marciano, Aysegul Gunduz, Gerwin Schalk, Peter Brunner, & Robert T. Knight, *Music Can Be Reconstructed From Human Auditory Cortex Activity Using Nonlinear Decoding Models*, 21 PLOS BIOL. 1, 1–27 (2023). See also Hana Kiros, *Scientists Recreate Pink Floyd Song by Reading Brain Signals of Listeners*, NEW YORK TIMES, Aug. 15, 2023, available at <https://www.nytimes.com/2023/08/15/science/music-brain-pink-floyd.html>.

These tremendous advances were enabled by invasive neurotechnologies, but similarly promising breakthroughs in decoding thought from neural activity have occurred with non-invasive neurotechnologies. For example, a study using fMRI scans of deep neural networks to reconstruct mental images from brain activity this year achieved accuracies of 90% for seen images and 75% for imagined images,¹³ while fMRI data of participants listening to stories enabled the decoding of specific words and phrases from the source text, capturing the original meaning of the narratives.¹⁴ Another study combined non-invasive magnetoencephalography and electroencephalography measurements of neural activity with generative AI models to decode speech with up to 72.5% accuracy,¹⁵ strengthening the growing scientific consensus that neural data collected by non-invasive devices can indeed decode human thought.

This decoding function will only improve and intensify as more neurotechnology tools proliferate, especially those with higher resolutions. Take for example the Kernel Flow, a neuroimaging headset used in neuromedical research settings. Kernel Flow employs a technique called time domain functional near-infrared spectroscopy (TD-fNIRS), which uses infrared light to measure changes in blood oxygenation. TD-fNIRS has far better spatial resolution than EEG does. By combining EEG measurements with TD-fNIRS, the headset offers high spatial resolution and comprehensive neural insights from a portable device. This kind of spatial resolution will accelerate the decoding of neural activity, and it is likely that products with this type of resolution will in the coming years expand into the consumer sphere. Tools like Kernel Flow power the research and development of countless new consumer products and will transform the non-invasive brain imaging landscape.¹⁶

The current and developing capabilities of non-invasive neurotechnologies underscore a growing ability to scan and decode human brains. This is extremely relevant information given that the applications of non-invasive neurotechnologies are vast and expanding, as evidenced by the increasing availability of consumer neurotechnology products for individual use. These products have a wide range of applications. As will be discussed later in this report, existing consumer neurotechnology products can generally be categorized as relating to wellness, entertainment, or research.

Most wellness-related products involve deepening meditative and sleep states, reducing stress and anxiety, sharpening focus, enhancing productivity, or otherwise measuring and

¹³ Naoko Koide-Majima, Shinji Nishimoto & Kei Majima, *Mental Image Reconstruction From Human Brain Activity: Neural Decoding of Mental Imagery via Deep Neural Network-Based Bayesian Estimation*, 170 NEURAL NETWORKS 349, 349–361 (2024).

¹⁴ Jerry Tang, Amanda LeBel, Shailee Jain & Alexander G. Huth, *Semantic Reconstruction of Continuous Language From Non-Invasive Brain Recordings*, 26 NAT. NEURO. 858, 858–866 (2023).

¹⁵ Alexandre Défossez, Charlotte Caucheteux, Jérémy Rapin, Ori Kabeli & Jean-Rémi King, *Decoding Speech Perception From Non-Invasive Brain Recordings*, 5 NAT. MACH. INTELLIGENCE 1, 1–13 (2022).

¹⁶ It is extremely difficult to predict the pace of neurotechnology development, but there is strong reason to believe that the pace will be rapid. There are already several academic and industry partners working to build non-invasive speech decoders that could enable users to mentally dictate text; this technology will likely be available within a few years, opening the possibility of the systematic decoding of inner speech. It is likely that a 10-year timeframe will bring about the introduction of non-invasive neurostimulators to enhance memory, modulate emotions, and enable the augmentation or control of cognitive abilities. Over the coming decade(s), neurotechnology will change what it means to be human.

improving cognitive states. Current wellness neurotechnology products include an EEG headband that the company asserts can trigger lucid dreaming¹⁷ and a headset that provides home treatment for depression and anxiety using transcranial Direct Current Stimulation (tDCS).¹⁸ Other products expand into the consumer’s love life, such as a headset that links neural insights to online dating. As its website writes, “‘listen to your heart’ is not enough. Listen to your brain and swipe based on your instinctive reaction.”¹⁹ Many consumer neurotechnology devices are explicitly recreational, with entertainment-based uses including augmented engagement with video games or movies, and a BCI that allows users to fly a helicopter using their thoughts about where they want it to fly.²⁰ Other products focus on research outside of laboratory settings, allowing consumers to access raw EEG material for their own projects, software development, or gaming purposes.

Non-invasive neurotechnologies operate both within individual homes and on the global stage. For example, within the last decade, invasive BCIs enabled a person who is quadriplegic to drive a Formula One race car²¹ and a person who is paraplegic to make the first kick of the World Cup using a mind-controlled robotic exoskeleton.²² In 2022, the world’s largest cosmetics company, L’Oréal, launched a partnership with neurotechnology company EMOTIV to deploy EEG technology in its stores as part of personalized fragrance consultations that identify fragrance preferences through neural activity. As explained by Tan Le, the CEO of EMOTIV, “We’re simplifying the decision-making process by connecting emotion and scent through technology – in a way no one has done before . . . this technological breakthrough will help consumers decode what fragrances are best suited to their needs.”²³

These examples evidence the growing mass commercialization of neurotechnology. Given this landscape, it is perhaps not surprising that the last decade has seen a dramatic expansion of neurotechnology innovation and funding. The 2013 U.S. BRAIN Initiative, launched by President Barack Obama, is a multibillion-dollar initiative involving the work of three government agencies: the National Institute of Health, the National Science Foundation, and the Defense Advanced Research Projects Agency (DARPA).²⁴ Since 2013, five other BRAIN initiatives have been created around the world, including the European Human Brain Project²⁵ and China’s BRAIN Project. Announced in 2016, the latter has allocated funding of \$1 billion through 2030.²⁶ Sources reported an increase of 62% in global neurotechnology

¹⁷ *Lucid Dreaming with iBand+*, IBAND+, available at <https://www.ibandplus.com/lucid-dreaming/>.

¹⁸ *Homepage*, FLOW NEUROSCIENCE, available at <https://www.flowneuroscience.com/>.

¹⁹ *Other Areas of Use*, BRAINBIT, available at <https://brainbit.com/other/>.

²⁰ *NeuroSky Store*, NEUROSKY, available at <https://store.neurosky.com/>.

²¹ HORIZONS, *supra* note 7, at 157.

²² Alejandra Martins and Paul Rincon, *Paraplegic in Robotic Suit Kicks of World Cup*, BBC, June 14, 2014, available at <https://www.bbc.com/news/science-environment-27812218>.

²³ *L’Oréal, in Partnership with Global Neurotech Leader, EMOTIV, Launches New Device to Help Consumers Personalize their Fragrance Choices*, EMOTIV, available at <https://www.emotiv.com/news/loreal-in-partnership-with-emotiv-neurotech-leader/>.

²⁴ *BRAIN Initiative Participants*, BRAIN INITIATIVE, available at <https://www.braininitiative.org/participants/>.

²⁵ *Short Overview of the Human Brain Project*, EUROPEAN UNION (last updated 2022), available at <https://www.humanbrainproject.eu/en/about/overview>.

²⁶ *Neurotechnology for National Defense: The U.S. and China*, THE CIPHER BRIEF, July 1, 2021, available at https://www.thecipherbrief.com/column_article/neurotechnology-for-national-defense-the-u-s-and-china.

investment between 2019 and 2020.²⁷ In 2021, global investment in neurotechnology companies reached \$33.2 billion.²⁸

B. Conceptualizing Consumer Neurotechnologies

The rapid increase in neurotechnology investment reflects robust engagement from medical, government/military, and corporate actors. The growth of the consumer neurotechnology market is a clear result of this engagement, with neurotechnologies proliferating beyond medical settings and into the public marketplace. But what exactly are consumer neurotechnologies?

The answer is not immediately apparent given that the consumer neurotechnology market is emerging, lacks formal boundaries, and exhibits considerable gray zone between medical devices and non-medical devices with health-related applications. In this report, “consumer neurotechnologies” are defined as “wearable devices capable of collecting neural data from an individual’s central or peripheral nervous systems, and available for purchase by consumers without the intervention of a research, clinical, or medical professional.”²⁹ This definition derives from considerations of both access and function. In terms of access, consumer neurotechnology devices must be direct-to-consumer (DTC), meaning that they can be purchased without the involvement of clinicians, researchers, or other intermediaries.³⁰ In relation to function, they must be capable of collecting, uploading, and storing neural data.³¹ The term “neural data” refers to “information processed by or with the assistance of a device that is obtained from the direct measurement of an individual’s central or peripheral nervous system, including the brain and spinal cord.”³²

When using the term “consumer,” this report refers to “natural persons acting in a personal or household capacity.”³³ This definition excludes individuals acting in commercial or employment capacities, and thus excludes business-to-business products and transactions.

²⁷ *Global Neurotech Industry Investment Digest* (2021), DEEP KNOWLEDGE GROUP FOR EIN NEWS, July 14, 2021, available at https://www.einnews.com/pr_news/546252348/global-neurotech-industry-investment-digest-2021.

²⁸ MARKET ANALYSIS: NEUROTECHNOLOGY, THE NEURORIGHTS FOUND., Mar. 2023, at 2, available at https://www.canva.com/design/DAFKWDyTHH0/h5RgsTiQ35zWCh2IiiebSA/view?utm_campaign=designshare&utm_content=DAFKWDyTHH0&utm_medium=link&utm_source=publishsharelink#4.

²⁹ This report considers devices available for pre-order as available for purchase.

³⁰ See, e.g., Karola V. Kreitmair, *Dimensions of Ethical Direct-to-Consumer Neurotechnologies*, 10 *AJOB NEUROSCI.* 152, 152–166 (2019) [hereinafter *Dimensions*]; Marcello Ienca, Pim Haselager & Ezekiel J Emanuel, *Brain Leaks and Consumer Neurotechnology*, 36 *NATURE BIOTECH.* 805, 808 (2018) [hereinafter *Brain Leaks*]; *Oversight of Direct-To-Consumer Neurotechnologies*, *supra* note 6.

³¹ This definition includes devices that monitor and record neural data (such as neurofeedback and neuroimaging devices), but does not include wearables that exclusively monitor and record non-neural data such as biometric or physiological data (heartbeat, blood pressure, eye movement, etc.). This definition thus excludes virtual reality devices that track, for example, eye and head movement, unless those devices explicitly capture neural data or are otherwise integrated into neurotechnology products. As such, products such as the Apple Vision Pro fall narrowly outside the scope of this report, given that they do not perform brain scans or otherwise collect neural data.

³² This is a consensus view of the definition from medical professionals.

³³ This approach is informed by existing definitions of “consumer” in various consumer privacy laws, most of which come from U.S. jurisdictions. See, for example, the California Consumer Privacy Act, the Colorado Privacy Act, the Connecticut Data Privacy Act, the Delaware Personal Data Privacy Act, the Montana Consumer Data Privacy Act, and the Texas Data Privacy and Security Act, among others.

Neurotechnology devices are only considered consumer-facing if they are purchased by individuals for their own personal use,³⁴ meaning that devices sold exclusively to research institutions or businesses, for example, fall outside the scope of this report. Further, consumers are distinct from patients. While companies regularly make “para-clinical claims” regarding the health-related applications of their products,³⁵ consumer neurotechnologies are, by definition, not medical devices. This means that they can be purchased without prescription and are generally not monitored by physicians. Accordingly, they are not regulated as medical devices.

Some neurotechnology devices fall squarely into this definition. Take, for example, commercial off-the-shelf neurotechnology products that are ready for use immediately after unboxing. These products are user friendly and highly configured with hardware, software, attractive interfaces, and clear applications: consumers simply order the product, set up an account, and begin using the device. There are, however, neurotechnology devices that are less obviously oriented towards general consumers. These include research-grade tools designed for the acquisition of raw neural data. With off-the-shelf consumer neurotechnology devices, the consumer does not themselves access raw data. Instead, the raw data is collected and stored by the company,³⁶ which translates the data back to the consumer in the form of insights, graphs, or interactive games. Research-grade devices are therefore less user friendly, requiring technical and scientific expertise, and they tend to be categorized not as consumer products but as research tools designed for application in universities, labs, hospitals, and other institutions.

While many companies sell neurotechnology devices that are fully developed and user-ready, others sell open-source tools for independent researchers, developers, and hobbyists to themselves construct hardware and software solutions and apply them to their own personal projects. For example, companies may sell dry electrodes for customers to build EEG headsets, or designs that consumers can use to 3D print hardware. Often these companies sell software development kits as well, allowing consumers to access, store, and analyze the data recorded on their devices. This arrangement affords high levels of control to users who can personally select details such the number and scalp placement of electrodes, algorithm design, and data processing procedures. These companies generally do not market their products for specific applications, instead offering technical specifications and the creativity for the consumer to apply the hardware or software as they please.

In conceptualizing consumer neurotechnology, this report *does* include research-grade products available for purchase *by consumers*. This is because the do-it-yourself nature of these products allows for the collection of neural data beyond laboratory settings. Among other uses, consumers can use these tools for EEG procurement, experimental neural stimulation, algorithm development, product development, textile engineering and integration, artistic experimentation, and the incorporation of neurotechnology into virtual reality and gaming platforms. This further

³⁴ In conceptualizing consumer neurotechnology, this report does not consider the price of the product. While some of the products included in this study have price points that are prohibitive to the general public, they are still considered consumer-facing given that some segments of the consumer public are able to purchase the devices. This report includes products with a wide range of prices so as to display the diversity of the market and the range of consumers who can purchase their own neurotechnology tools.

³⁵ Marcello Ienca and Effy Vayena, *Direct-to-Consumer Neurotechnology: What Is It and What Is It For?*, 10 AJOB NEUROSCI. 149, 150 (2019).

³⁶ While the word data is plural, we present it as singular in this report due to common usage and readability.

places neurotechnology tools into the hands of consumers and highlights the ease with which individuals can increasingly access neural data outside of traditional laboratory or medical settings. In the words of Stephanie Naufel and Eran Klein, “the advent of at-home neuroscience is beginning to take shape.”³⁷ This contributes not only to an increasing diversity of consumer neurotechnology applications, but also to increasingly large volumes of raw EEG data collected through tools that are sold by private vendors.

Consumer neurotechnology can thus be considered an umbrella term that encompasses a wide and growing range of product types. By including in its definition of consumer neurotechnology all direct-to-consumer tools capable of collecting neural data, this report highlights the breadth of the neurotechnology space and the range of companies that can collect neural data from consumers. Again it is important to emphasize consumer neurotechnology companies are not health care providers, and their products are not medical devices. This has implications both on the boundaries of the consumer space as well as the regulatory landscape within which the products operate.

C. *Regulating Neurotechnologies*

All current international frameworks for *specifically* regulating neurotechnologies are soft law, which are agreements, principles, and declarations that are not legally binding on states. Among others, these include the Organization for Economic Co-operation and Development (“OECD”) Recommendations on Responsible Innovation in Neurotechnology,³⁸ the Declaration of the Inter-American Juridical Committee on Neuroscience, Neurotechnologies, and Human Rights,³⁹ the Tshwane Principles on National Security and the Right to Information,⁴⁰ the National Institutes of Health (“NIH”) Neuroethics Guiding Principles for the U.S. BRAIN Initiative,⁴¹ and the IEEE Neuroethics Framework.⁴² These frameworks do not meaningfully address the human rights challenges posed by neurotechnologies, nor do they explore their relationship to international human rights law.

³⁷ Stephanie Naufel & Eran Klein, *Citizen Neuroscience: Brain–Computer Interface Researcher Perspectives on Do-It-Yourself Brain Research*, 26 SCI. & ENG. ETHICS 2769, 2770 (2020).

³⁸ Org. for Econ. Co-operation & Dev. [OECD], *Recommendation of the Council on Responsible Innovation in Neurotechnology*, Doc. No. OECD/LEGAL/0457, adopted Dec. 11, 2019, available at <https://www.oecd.org/science/recommendation-on-responsible-innovation-in-neurotechnology.htm#:~:text=It%20aims%20to%20guide%20governments,Prioritising%20safety%20assessment>.

³⁹ DECLARATION OF THE INTER-AMERICAN JURIDICAL COMMITTEE ON NEUROSCIENCE, NEUROTECHNOLOGIES, AND HUMAN RIGHTS: NEW LEGAL CHALLENGES FOR THE AMERICAS, INTER-AMERICAN JURIDICAL COMMITTEE, CJI/DEC.01 (XCIX-O/21), Aug. 11, 2021, available at http://www.oas.org/en/sla/iajc/docs/CJI-DEC_01_XCIX-O-21_ENG.

⁴⁰ TSHWANE PRINCIPLES ON NATIONAL SECURITY AND THE RIGHT TO INFORMATION, OPEN SOCIETY FOUNDATIONS JUSTICE INITIATIVE, finalized June 12, 2013, available at <https://www.justiceinitiative.org/uploads/45d4db46-e2c4-4419-932b-6b9aadad7c38/tshwane-principles-15-points-09182013.pdf>.

⁴¹ Henry T. Greely, Christine Grady, & Khara M. Ramos, et al., *Neuroethics Guiding Principles for the NIH BRAIN Initiative*, 38 J. OF NEUROSCIENCE 10586, Table 1 (2018).

⁴² IEEE NEUROETHICS FRAMEWORK, IEEE, 2021, available at <https://brain.ieee.org/publications/neuroethicsframework/addressing-the-ethical-legal-social-cultural-implications-of-neurotechnology/>.

In 2023, Spain, which held the Presidency of the Council of the European Union, led the adoption of the *León Declaration on European Neurotechnology: A Human Centric and Rights-Oriented Approach*. This non-binding declaration affirmed the commitment of EU Member States to promote innovation in line with international human rights law by applying a rights-oriented approach to the development and deployment of neurotechnology throughout the EU. The León Declaration was signed by sitting ministers of relevant government agencies in 26 of the 27 European Union countries. Signatories included Austria’s Deputy Minister for Digitalization and Telecommunication, Denmark’s Minister of Digital Government and Gender Equality, Bulgaria’s Minister of Electronic Governance, Greece’s Deputy Minister of Digital Governance, Croatia’s Minister of Science and Education, and Spain’s First Vice President and Minister of Economy and Digitalization.⁴³

Existing international human rights treaties were developed long before major advances in neurotechnologies, meaning that they do not fully protect against the human rights risks that are rapidly emerging but could not previously have been imagined. The United Nations is undisputedly the leading body for human rights leadership and agenda setting, and it has several core human rights treaties with relevance to neurotechnology. These include the International Covenant on Civil and Political Rights (ICCPR), the Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (CAT), the International Covenant on Economic, Social and Cultural Rights (ICESCR), the Convention on the Rights of Persons with Disabilities (CRPD), the Convention on the Elimination of All Forms of Racial Discrimination (CERD), the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW), and the Convention on the Rights of the Child (CRC).

However, as revealed in a recent gap analysis of international human rights law and neurotechnologies, these treaties are currently ill-equipped to protect the rights of neurotechnology users.⁴⁴ The treaties tend to be too specific to account for the risks posed by neurotechnologies, or they otherwise lack clarity on how existing provisions do or do not extend protections to the world of neurotechnology. None of the treaties anticipate the full range of possibilities regarding how neurotechnology might change the human experience (for example, through mind reading, augmented realities, privacy challenges, etc.). There is pressing need for further interpretation of existing human rights treaties (for example, through amending of General Comments). This would clarify States’ legally-binding obligations under international human rights law while encouraging the creation of new national laws and regulations.

The protection gaps in these treaties are similarly present in other general soft law instruments such as the Universal Declaration of Human Rights (“UDHR”), the Principles of Medical Ethics relevant to the Role of Health Personnel, particularly Physicians, in the Protection of Prisoners and Detainees against Torture and Cruel, Inhuman or Degrading

⁴³ LEÓN DECLARATION ON EUR. NEUROTECH: A HUMAN FOCUSED & RIGHTS’ ORIENTED APPROACH, SPANISH PRESIDENCY OF THE COUNCIL OF THE E.U., Oct. 23, 2024, *available at* https://spanish-presidency.consilium.europa.eu/media/eqcdrfm0/le%C3%B3n-declaration-on-neurotechnology-def-21-oct_def.pdf.

⁴⁴ Jared Genser, Stephanie Herrmann & Rafael Yuste, INTERNATIONAL HUMAN RIGHTS PROTECTION GAPS IN THE AGE OF NEUROTECHNOLOGY, NEURORIGHTS FOUNDATION, May 6, 2022, *available at* <https://www.perseus-strategies.com/wp-content/uploads/2022/08/NeurorightsFoundationPUBLICAnalysis5.6.22.pdf>.

Treatment or Punishment (“Principles of Medical Ethics”), and the Universal Declaration on Bioethics and Human Rights (“Bioethics Declaration”).⁴⁵

In short, there are currently no international frameworks that adequately protect against the harms posed by neurotechnologies. But, that said, efforts to reach a global consensus on standards and regulation are growing. The neurorights movement is at the forefront of these efforts. The term “neurorights” was developed by members of the Morningside Group, a collection of 25 leading neuroscientists, neurotechnologists, ethicists, clinicians, and machine intelligence engineers working collaboratively to explore the ethics of neurotechnologies and machine intelligence. With diverse backgrounds ranging from neurosurgery to artificial intelligence to bioethics to law, the Morningside Group included representatives from international brain initiatives, academic and research institutions, and major technology companies. At their 2017 meeting in New York, the Morningside Group concluded that existing ethical guidelines were ill-equipped to protect users of neurotechnology. In particular, they advocated for the advancement of neurorights, or the application of human rights law to neurotechnology and neural data.⁴⁶

Neurorights refer to the human rights protections necessary to address the challenges presented by neurotechnologies. Advocates of neurorights are not calling for the creation of new rights, but rather the further interpretation of existing human rights law to guide the development of national legal and regulatory frameworks. The Morningside Group identified five key neurorights: (1) the right to mental privacy, or the ability to keep mental activity protected against disclosure, (2) the right to identity, or the ability to control one’s mental integrity and sense of self, (3) the right to agency, or the freedom of thought and free will to choose one’s own actions, (4) the right to fair access to mental augmentation, or the ability to ensure that the benefits of improvements to sensory and mental capacity through neurotechnology are distributed justly in the population, and (5) the right to protection from algorithmic bias, or the ability to ensure that technologies do not insert prejudices.⁴⁷ Each neuroright was developed to uniquely protect the human rights of neurotechnology users while simultaneously encouraging the ethical development of neurotechnologies. Some of these areas of concerns have also been highlighted in neuroethics literature, including proposals for human rights approaches.⁴⁸

The United Nations is increasingly engaged with the topic of neurorights. In September 2021, Secretary-General António Guterres released a report in which he called upon the international community to better implement the Sustainable Development Goals by “clarifying our application of human rights frameworks and standards to address frontier issues and prevent harms in the digital or technology spaces, including . . . neuro-technology.”⁴⁹ This was the first report from any UN Secretary-General to ever mention neurotechnology. In Fall 2022, the UN

⁴⁵ *Id.*

⁴⁶ Rafael Yuste, Sara Goering, et al., *Four Ethical Priorities for Neurotechnologies and AI*, NATURE, Nov. 9, 2017, available at <https://www.nature.com/articles/551159a>. Dr. Yuste is co-founder and Chair of the Neurorights Foundation, which authored this report.

⁴⁷ HORIZONS *supra* note 7.

⁴⁸ See, e.g., Marcello Ienca & Roberto Andorno, *Towards New Human Rights in the Age of Neuroscience and Neurotechnology*, 13 LIFE SCI., SOC’Y. & POL’Y 1, 1–24 (2017).

⁴⁹ António Guterres, OUR COMMON AGENDA, UNITED NATIONS, 2021, at 33, available at https://www.un.org/en/content/common-agenda-report/assets/pdf/Common_Agenda_Report_English.pdf.

Human Rights Council unanimously adopted a resolution requesting the Advisory Committee of the Human Rights Council to prepare a study on neurotechnology and human rights.⁵⁰ The Advisory Committee will present its report at the Human Rights Council’s 57th session, occurring in September 2024. UNESCO held an international conference on the “Ethics of Neurotechnology” in July 2023 and has published several reports on neurotechnology as well.⁵¹

At the national level, there are a handful of countries that have advanced (or are in the process of advancing) legislation and declarations aligned with the neurorights framework. These include Chile, Brazil, Mexico, Spain, Uruguay, and the United States. In 2021, Chile and Spain became the first two countries to meet the need for neurotechnology regulation with hard law approaches. In 2021, Spain adopted its Charter on Digital Rights, which references both “digital rights in the use of neurotechnologies,” and the importance of mental agency, privacy, and non-discrimination.⁵² Later that year, Chile amended its constitution to protect brain data and require that data be regulated and processed by a government agency. Both chambers of Chile’s Congress unanimously approved the constitutional amendment, protecting “brain activity and the information that comes from it” as a right of all citizens. The Chilean Senate also unanimously approved a neuroprotection bill.⁵³ In 2023, Chile’s Supreme Court ordered EMOTIV to delete the brain data it collected from a Chilean citizen, finding that the company’s data practices violated Chile’s new right to mental privacy adopted in an amendment to Chile’s Constitution.⁵⁴

In Mexico, the Senate is currently discussing the development of a constitutional amendment to protect the brain activity of neurotechnology users. In addition, Mexican authorities are working to develop and launch the Mexican Charter of Digital Rights, which incorporates considerations of neurotechnologies and rights. Meanwhile the Brazilian State of Rio Grande do Sul recently approved new legislation protecting brain activity and data, marking a landmark win for the rights of neurotechnology consumers. In Uruguay, a neurorights bill has been recently introduced in the Chamber of Deputies. Finally, in the United States, lawmakers in Colorado, Minnesota, and California are advancing state legislation to protect the neural data of neurotechnology consumers, which would be the first hard law approaches to regulating consumer neurotechnology in the country.

These efforts concern non-invasive consumer neurotechnologies, given that invasive implantable devices are considered medical devices and medical data is widely covered by health privacy laws (such as the U.S. Health Insurance Portability and Accountability Act or HIPAA).

⁵⁰ Neurotechnology and Human Rights, H.R.C. Res. 51/3, U.N. Doc. A/HRC/51/L.3, *adopted* Oct. 6, 2022, available at <https://documents-dds-ny.un.org/doc/UNDOC/GEN/G22/525/01/PDF/G2252501.pdf?OpenElement>.

⁵¹ See, e.g., *International Conference on the Ethics of Neurotechnology*, UNESCO HEADQUARTERS, Jul. 13, 2023, available at <https://www.unesco.org/en/neuroethics-conference>; THE RISKS AND CHALLENGES OF NEUROTECHNOLOGIES FOR HUMAN RIGHTS, UNESCO, May 12, 2023, available at <https://www.unesco.org/en/articles/risks-and-challenges-neurotechnologies-human-rights>.

⁵² La Moncloa, *The Government Adopts Digital Rights Charter to Articulate a Reference Framework to Guarantee Citizens’ Rights in the Digital Age*, GOVERNMENT OF SPAIN, July 14, 2021, available at https://www.lamoncloa.gob.es/lang/en/gobierno/news/Paginas/2021/20210713_rights-charter.aspx.

⁵³ Rafael Yuste, *Advocating for Neurodata Privacy and Neurotechnology Regulation*, 18 NATURE PROTOCOLS 2869, 2871–2873 (2023).

⁵⁴ *Hands Off My Brainwaves: Latin America in Race for ‘Neurorights,’* REUTERS, available at <https://www.reuters.com/article/idUSL8N3AH6D6/>.

Interestingly, many of the wearable BCIs that are deployed in unregulated consumer products could also be utilized in medical settings to gather health-related information, simply using different software. In that context, they would be collecting and processing neural data, which is protected under health privacy laws. But in non-medical contexts, the very same devices gather neural data that is not protected under health privacy laws. For example, when used in a medical context, a fMRI brain scan is heavily regulated, but when the very same technology is to scan the brains of consumer neurotechnology users, it is subjected to almost no regulation at all.

This is the result both of thin regulatory landscapes as well as the strategies neurotechnology companies use to market their products. If companies make explicitly medical claims, they subject their products to heightened regulations. In the United States, for example, consumer products intended to treat medical conditions are regulated by the Food and Drug Administration (FDA). Consumer neurotechnology companies generally state that their products are not medical products even if they have health-related implications, using a language of wellness rather than a language of health. As Anna Wexler and Peter Reiner write, “much the same way that dietary supplements can avoid being classified as drugs by refraining from making claims about treating or diagnosing disease, so, too, do most DTC [direct-to-consumer] neurotechnologies avoid classification as medical devices by limiting their claims to wellness (e.g., ‘optimizing focus’).”⁵⁵

D. The Imperative of Protecting Neural Data

Gaps in regulation are especially concerning given the extreme sensitivity of neural data. As previously explained, neural data is capable of revealing very intimate information about consumers, including information about individual mental states, emotions, and neural processing. Meanwhile, non-invasive devices are already capable of decoding human thought and visual images from neural data, a capability that will grow in the coming years. The sensitivity of neural data and the imperative of its protection heightens the privacy risks posed to neurotechnology consumers.

Consumer neurotechnology companies collect somewhere from gigabytes to terabytes of data in a catch-all approach that either captures data in a single scan or ongoing scans over time. The size of the brain scan depends on the resolution of the device and length of collection. The data is then compressed to a file that is approximately 1/100th of the original brain scan’s size before being uploaded to the company’s servers. It would not be unusual for a consumer neurotechnology device, given today’s uses, to need to only access approximately 1/100th of the compressed brain scan, or 1/10,000th of the original amount of information collected prior to compression in order to function. This means that the data collected by neurotechnology companies is more expansive than the data needed, leaving companies with an excess of extremely sensitive data.

Since every human brain is unique, neural data is uniquely specific to the individual from whom it was sourced. Because neural data contains distinctive information about the structure and functioning of individual brains and nervous systems, it always contains sensitive information that can both diagnose diseases and potentially link an identifiable individual with

⁵⁵ *Oversight of Direct-To-Consumer Neurotechnologies*, *supra* note 6. See also *Dimensions*, *supra* note 30.

their data. For example, neural data from non-invasive BCIs in consumer products, such as EEG scans, currently have the capability to reveal health-related information concerning neurological diseases like epilepsy, which is often detected in clinics by the presence of abnormal EEG patterns. It is likely that in the future, portable neurotechnology devices will aid the diagnosis of a wide range of mental and neurological diseases, including schizophrenia, depression, bipolar disorder, anxiety, post-traumatic stress disorder, phobias, panic attacks, intellectual and learning disabilities, addiction, Alzheimer's disease, stroke, amyotrophic lateral sclerosis (ALS), multiple sclerosis, paralysis, and Parkinson's disease, among others. This is deeply intimate information to entrust companies with. Currently unprotected by regulation, neural data is just as sensitive as protected medical data.

Aside from its medical importance, neural data could afford companies unprecedented levels of insight into the cognitive states and inner worlds of consumers. As bioethicist Karola Kreitmair writes, "such information arms commercial entities with knowledge and power over intimate dimensions of user's [sic] physical, mental, and social lives."⁵⁶ This raises several concerns, including that information revealing personal characteristics could lead to discrimination. There is risk that individuals with disabilities or physical and mental illnesses could receive differential treatment by companies, or that companies might disclose information that consumers wanted (or needed) to keep private, causing harmful effects on the consumer's dignity, opportunities, and social life. Neural data could illuminate and help predict personality traits, addiction, mental health, and various disorders, and it does not take an enormous leap of imagination to consider how this data could be misused by corporations.

In addition to these considerations, one of the most pressing concerns is the mining of neural data for commercial purposes. As consumers increasingly use neurotechnology devices, companies build bigger and bigger databases of brain scans and other neural data. The accumulation of neural data seems to be following the same pattern as that which has already been observed in the genetic testing world, where a "by-product of the growing DTC-GT [direct-to-consumer genetic testing] market is the accumulation of massive genetic data sets."⁵⁷ A similar by-product will emerge from direct-to-consumer neurotechnology, with the accumulation of massive neural data sets.

In coming years, these databases will function similar to how genetic and biometric databases function. Just as genetic material and fingerprints are used to identify individuals, so too will neural data, which is uniquely identifiable to a specific person as long as it is taken at a sufficient resolution. Further, advances in artificial intelligence are rapidly increasing the ability to decode information from neural data. As previously discussed, studies have found that when paired with generative AI, brain scans from non-invasive neurotechnologies allowed for the decoding of language, emotions, and imagery with high levels of accuracy. Decoding neural activity is an exciting scientific breakthrough with potential to improve daily life (imagine the benefits, for example, of typing without touching a keyboard), but it also brings a host of privacy concerns. Since brain scans are overbroad, the decoding of neural activity inevitably results in the decoding of information that was not initially relevant to the purpose of data processing. For example, neural data of sufficient quality that was collected and processed for the purposes of

⁵⁶ *Dimensions*, *supra* note 30, at 158.

⁵⁷ Remi Daviet et al., *Genetic Data: Potential Uses and Misuses in Marketing*, 86 J. OF MKTG. 7, 7–26 (2022).

analyzing attention levels could be reprocessed with different software to diagnose certain brain diseases. Neural data provides expansive and still-growing pictures of neural activity, and these broad snapshots can readily be repurposed later for uses not agreed to by the consumer.

Given the advances in generative AI, the growing quantities of neural data being collected worldwide, and the other types of data neurotechnology companies collect that connect back to individuals (such as the user's IP address), it is clear neural data will soon be widely personally identifiable. Since consumer neurotechnologies are only starting to proliferate, existing databases are small, making it unlikely that neural data from consumer devices could currently be used to identify individual users. However, the consumer neurotechnology market is rapidly expanding, and it is likely that neurotechnology companies will soon begin to amass large amounts of neural data. This would again follow a trend observed in the consumer genetic testing space.

By the start of 2019, over 26 million individuals had provided DNA samples to one of four leading commercial health and ancestry databases. The *MIT Technology Review* predicted that this number would rise to over 100 million people within the following two years.⁵⁸ As of this writing, the genetic testing company 23andMe has over 14 million customers.⁵⁹ Meanwhile the Chinese gene company BGI Group has collected 8 million samples from its prenatal genetic testing.⁶⁰ The scale of these databases is of particular note given that companies like 23andMe and Ancestry.com have widely shared genetic data with drug companies, law enforcement officers, government officials, and others. In one case, detectives caught a murderer by comparing crime scene DNA with genetic data.⁶¹ Without exploring companies' policy documents, there is no reason to believe that companies will not similarly disclose neural data to a wide range of actors.

It is important to note that in most cases, the actions discussed above would not be illegal. As long as consumers consent to policy documents, companies can use neural data for any of the purposes described in them. As noted by researchers at Neuroethics Canada, the privacy risks inherent in the use of neurotechnologies are compounded by "the behavior of consumers who accept user agreements with little regard to their terms, thereby giving access to their brain data for mining, analytics, and purchase by third parties."⁶² It is therefore crucial to examine the content of consumer neurotechnology policy documents to learn exactly how sensitive neural data is being handled by corporations.

⁵⁸ Antonio Regalado, *More Than 26 Million People Have Taken an At-Home Ancestry Test*, MIT TECH. REV., Feb. 2019, available at <https://www.technologyreview.com/2019/02/11/103446/more-than-26-million-people-have-taken-an-at-home-ancestry-test/>.

⁵⁹ *23andMe for Healthcare Professionals*, 23ANDME, available at <https://medical.23andme.com/#:~:text=23andMe%20has%20more%20than%2012,own%20homes%2C%20without%20medical%20requisition.>

⁶⁰ Kirsty Needham and Clare Baldwin, *China's Gene Giant Harvests Data From Millions of Women*, REUTERS, Jul. 7, 2021, available at <https://www.reuters.com/investigates/special-report/health-china-bgi-dna/>.

⁶¹ Kim Hart, *Genetic Testing Firms Share Your DNA Data More Than You Think*, AXIOS, Feb. 2019, available at <https://www.axios.com/2019/02/25/dna-test-results-privacy-genetic-data-sharing.>

⁶² Nicole Minielly, Viorica Hrinco & Judy Illes, *Privacy Challenges to the Democratization of Brain Data*, 23 iSCIENCE 1 (2020).

II. METHODOLOGY

A. Methods

Our research team conducted an extensive internet search to identify existing neurotechnology products available for purchase or pre-order. Two criteria governed inclusion in the report: (1) the product needed to be available to consumers; and (2) it needed to collect neural data. The sample thus excludes any devices classified as for medical use, focusing only on devices that can be purchased without the intervention of a healthcare professional. It additionally excludes business-to-business products, limiting the scope to direct-to-consumer neurotechnology devices. Lastly, it excludes devices which stimulate the brain but do not scan or otherwise measure neural activity. Note that these distinctions were not always immediately apparent: in several cases, the researchers had to engage neurotechnology companies to confirm whether their products could be purchased by consumers, and what kinds of data the products collect.

Through this search, the research team identified 30 companies. Our researchers then gathered each company's policy documents, focusing primarily on privacy policies but also including terms and conditions, terms of sale, terms of service, end-user license agreements, and any other agreements involving the company, the consumer, and the neurotechnology device. Most often these policies were available at the bottom of the company's website (for example, through a link labeled "Privacy Policy"), though they were sometimes found in the company's "Legal" page or through a Google search using the product name. The research team excluded policy documents that only discussed website activity (e.g., cookies, internet tracking), including only those policies that discussed data collected from the neurotechnology products.

To ensure that the documents were up to date and that companies did not have relevant agreements beyond those presented on their website, our research team contacted each company asking for additional information. This outreach began in August 2023 and took place over email, or, where no email address was provided, through web-based contact form. In the initial message, the researchers described the report and requested materials explaining the neurotechnology product's function, as well as copies of any policy document that consumers must sign in order to use the product(s). Each company was contacted once initially, and those that did not reply received two additional follow up emails or web-based contacts over the following months.

At this point, our researchers began analyzing each company's policy documents. After a preliminary review of all the documents, our research team decided on key thematic areas to explore. These areas were informed by international privacy standards. The five areas are: Access to Information, Data Collection and Storage, Data Sharing, User Rights, and Data Safety and Security. With these areas in mind, our researchers created an extensive code book and coded each of the company's relevant policy documents, collecting data on questions such as "*Does the policy document mention a data retention period?*" and "*Does the company allow consumers to delete their data?*"

For each policy document and thematic question, our researchers decided upon codes depending on the contents of the policies. For example, when considering whether companies allow consumers to delete data, the researcher assigned a value of “yes,” “no,” or “unclear,” before providing direct language from the policies to substantiate this coding choice. Each document was separately coded by two different researchers for purposes of cross-checking validity. In cases of disagreement, a third researcher was consulted. Each focus area in the coding process highlights potential concerns regarding the protection of privacy rights and neural data in the hands of consumer neurotechnology companies.

In analyzing the content of policy documents, this report benchmarks data practices against global data protection standards. In particular, it considers three hard and three soft-law instruments:⁶³ The European Union’s General Data Protection Regulation (GDPR),⁶⁴ the African Union Convention on Cyber Security and Personal Data Protection,⁶⁵ the California Consumer Privacy Act (CCPA),⁶⁶ the Asia-Pacific Economic Cooperation Privacy Framework,⁶⁷ the OECD Guidelines on the Protection of Privacy and Transborder Flows of Personal Data,⁶⁸ and the OAS Preliminary Principles and Recommendations on Data Protection.⁶⁹

These instruments were chosen because, together, they represent the most well-established data protection standards in the world. That said, while these instruments articulate detailed requirements or recommendations for the collection, storage, and management of data, they are not necessarily equipped (in their current form) to provide guidance on the distinct protection

⁶³ The six instruments that frame this report’s analysis are by no means the only relevant set of standards in the world. For example, China adopted its own ethical guidelines for BCI research, influenced by a previous declaration on BCIs and augmented intelligence. See Yi Zeng, Kang Sun, and Enmeng Lu, *Declaration on the Ethics of Brain-Computer Interfaces and Augment Intelligence*, AI Ethics Committee, NATIONAL SCIENCE AND TECHNOLOGY COMMITTEE (CHINA), Jan. 19, 2021, in *AI ETHICS* 1, 209-2011, available at <https://link.springer.com/article/10.1007/s43681-020-00036-x>.

⁶⁴ GDPR is a comprehensive hard-law regulation enacted by the European Union (EU) in 2018. It establishes a legal framework for the processing of personal data and is considered the gold standard in terms of data protection.

⁶⁵ Adopted in 2014, this treaty is a hard-law mechanism developed by the African Union to address cyber threats and enhance personal data protection across the continent. It outlines legal provisions and obligations for member states to ensure the security of cyberspace and the protection of individuals’ personal data.

⁶⁶ Enacted in 2018, the CCPA is the leading state-level legislation in the United States. It grants California residents specific rights regarding their personal information held by businesses. The CCPA imposes obligations on businesses to disclose data practices, allows consumers to opt-out of data sales, and provides a private right of action in case of certain data breaches.

⁶⁷ The APEC Privacy Framework is an agreement between the 21 members of the Asia-Pacific Economic Cooperation. It was signed in 2005. The Framework provides guidance to businesses as to how data can be safely collected, exchanged, and used in a way that benefits regional commerce while also protecting individuals’ rights to privacy.

⁶⁸ The OECD Guidelines on the Protection of Privacy and Transborder Flows of Personal Data were signed in 1980 by the members of the Organization for Economic Co-operation and Development. The Guidelines were the first major internationally agreed-upon privacy principles.

⁶⁹ The OAS Preliminary Principles and Recommendations on Data Protection were developed by the Department of International Law of the Organization of American States, in cooperation with the Inter-American Juridical Committee, the Special Rapporteurship for Freedom of Expression of the Inter-American Commission on Human Rights, and the Department of State Modernization and Good Governance, with the cooperation of OAS member states and civil society. Its development was commissioned by the OAS General Assembly. *Access to Public Information: Strengthening Democracy*, AG/RES. 2514 (XXXIX-O/09), OAS GENERAL ASSEMBLY, Jun. 4, 2009, at Op. 9.

needs associated with neural data.⁷⁰ As such, the purpose of benchmarking against these six standards is not to argue that data protection instruments already apply perfectly to neural data, nor is it to argue that gap between the practices of these companies and these requirements or recommendations necessarily violate the law. Instead, the narrow intent of this benchmarking is to simply compare the practices of these companies in their handling of neural data with established global standards for handling other sensitive and personally identifiable data. After all, neural data should be protected to *at least* the same extent as other such data. Thus, these global instruments do provide a set of reasonable expectations for minimum standards that consumer neurotechnology companies should provide to their users.

B. Description of Consumer Neurotechnology Devices

The following companies were identified for inclusion in this report:

1. Bía Neurotechnology Inc.
2. BrainAccess (by Neurotechnology)
3. BrainBit
4. Earable
5. EMOTIV
6. Flow Neuroscience
7. Flowtime (by Entertech)
8. FocusCalm (by BrainCo)
9. Healium (by StoryUP)
10. iBand+ (by Arenar B.V.)
11. IDUN Technologies
12. Macrotellect
13. mBrainTrain
14. Mendi
15. Muse (by InteraXon)
16. Myndlift
17. MyndPlay
18. Myneurva
19. Narbis
20. Neeuro
21. Neuphony (by Pankhtech India Pvt. Ltd)
22. Neurable
23. Neuronic

⁷⁰ This report focuses narrowly on the content of consumer neurotechnology companies' policy documents. As such, our research team did not analyze the extent to which the global standards are equipped to safeguard the unique sensitivities of neural data. Our preliminary review of these six instruments, however, did suggest that these and other global standards may require further interpretation or amendment to ensure that neural data falls unambiguously within their protections. This is in part because neural data is electrical in nature and is therefore not necessarily covered by standard definitions of biological or biometric data. While the term "biological data" is very broad, it is commonly interpreted as related to the measurement of compounds, such as DNA, from bodily fluids or secretions. The term "biometric data," meanwhile, is commonly interpreted as relating to the automated measurements of unique physical characteristics; this tends to involve scans of body parts, such as fingerprints or the iris.

24. NeurOptimal (by Zengar Institute, Inc.)
25. Neuroosity
26. NeuroSky
27. OpenBCI
28. Sens.ai
29. Unicorn (by g.tec medical engineering)
30. URGOTECH

In examining each company and product, our research team analyzed relevant policy documents but *did not* conduct assessments to examine whether marketing claims about each device are consistent with product performance. There may be, however, the need for the claims made by neurotechnology companies to undergo rigorous scientific examination. As Karola Kreitmair writes, the claims of consumer neurotechnology companies generally “do not hold up to scrutiny.”⁷¹ Anna Wexler and Peter Reiner also find that the consumer neurotechnology space rests largely upon scientifically unsupported claims about product efficacy that may deceive consumers.⁷² In their words, “there is little evidence to support the marketing claims of consumer EEG companies regarding altering mental states and behavior.”⁷³ Questions of device functionality and the validity of marketing claims fall outside the scope of this report, and as such, product descriptions offered herein are based exclusively on the company’s own materials.

According to the product descriptions, neurotechnology devices broadly fall into one or more of the following categories: wellness, recreation/entertainment, and research.

Wellness-related products are those which are marketed as tracking or improving mental states and brain functioning. Devices in this category generally target stress and energy levels, attention levels, mood, relaxation, meditative states, and more. For example, Earable sells a headband that utilizes neurotechnology and AI to help users fall asleep more quickly and achieve deeper sleep, while the Muse headband serves as a personal meditation coach with sensors that detect when the mind wanders before directing the user back to a focused state. Neuronic’s helmet provides at home (non-clinical) treatment for memory improvement, and Flow Neuroscience’s headset provides at home treatment for depression and anxiety using a technique called transcranial Direct Current Stimulation (tDCS). The stated uses of these devices range from targeted interventions (e.g., treating depression) to more generalized applications involving brain fitness. They all include brain tracking activities (such as tracking stress levels or attention levels) as well as activities that promote brain health and wellness (such as those which decrease stress levels or increase attention levels).

Products related to entertainment involve devices which combine neurotechnology and recreational activities. Often these incorporate brain sensors with interactive video games, films, or other media. MyndPlay, for example, provides a variety of gaming options in which users

⁷¹ *Dimensions*, *supra* note 30, at 159.

⁷² See also Iris Coates McCall, Chloe Lau, Nicole Minielly & Judy Illes, *Owning Ethical Innovation: Claims about Commercial Wearable Brain Technologies*, 102 NEURON 728, 728–731 (2019); this study of consumer neurotechnology devices finds that companies make broad claims that are largely unsubstantiated and unaccompanied by warnings of risk.



⁷³ *Oversight of Direct-To-Consumer Neurotechnologies*, *supra* note 6, at 5.

influence and interact with apps, movies, and video games “using only their mind and emotions.”⁷⁴ NeuroSky’s headset also connects to a variety of games and interactive media, while additionally selling a small helicopter which users can reportedly fly using focus levels, and a hologram that changes shape depending on neural activity recorded by EEG sensors. Among many other functions, BrainBit’s headband allows for “social competition,” where groups can recreationally assess happiness levels in the room. In many cases, entertainment-related neurotechnology products are wellness oriented. Others are purely recreational.

In addition to wellness and entertainment applications of neurotechnology, consumer neurotechnology devices also have research applications. Unlike the products described above, these products exist primarily to deliver raw neural data to the user, for use in research, product development, customer development, neuromarketing, art, gaming, and more. BrainAccess, for example, sells EEG headwear and AI-enabled BCI algorithms that allow users to develop their own EEG-based applications. EMOTIV sells various EEG headsets and software packages so that users can collect raw EEG data and decode brain activity, with consumer applications including product innovation, consumer research, workplace wellness, software development, BCI development, scientific research, and education. Unicorn provides hardware and software for anyone looking to access raw neural data. Their website advertises: “Are you a neuroscientist, an engineer, an artist or a programmer? Or simply a talented open mind who wants to do awesome stuff with brain signals and brain-computer interfaces? Say hello to the Unicorn Hybrid Black, the wearable EEG headset. You want good data. Unicorn Hybrid Black will deliver. Let your ideas come true.”⁷⁵

The below tables list the companies and products included in this report (for a detailed description of products and product function, see the appendix). The tables are separated into wellness, recreation/entertainment, and research products, though some products have multiple functions that span the different categories.






1. Wellness Products





Company Name	Product Name	Summary of Product Function	Price	Technology Used
	Bía Smart Sleep Mask	A face mask to help users fall asleep and optimize deep sleep	Ranges from \$389.00 to \$1,499.00	fNIRS
	Various hardware and software products, including MINDO	MINDO is a headband intended to increase relaxation and focus	\$399.00 (MINDO)	EEG

⁷⁴ Homepage, MYNDPLAY, available at <https://myndplay.com/>.

⁷⁵ Homepage, UNICORN, available at <https://www.unicorn-bi.com/>.

 frenz [®] (Earable)	FRENZ™ Brainband	A headband to support users in falling asleep and achieving higher quality sleep	\$490.00	EEG
 FLOW NEUROSCIENCE	Flow Headset	A headset to treat symptoms of depression	€459.00 (\$495.00) for purchase; €89.00 (\$96.00) for monthly rental	tDCS
FLOWTIME (by Entertech)	Flowtime Headband	A biofeedback headband tracking improvements in attention and relaxation during meditation sessions	Ranges from \$198.00 to \$267.99	EEG
 FocusCalm (by BrainCo)	FocusCalm	A headband designed to track focus levels and improve focus capacity	\$249.99	EEG
 iBand+ (by Arenar B.V.)	iBand+	A headband designed for sleep improvement, with a focus on lucid dreaming, brain training, and sleep meditation	\$399.00	EEG
 IDUN Technologies	IDUN Guardian	In-ear headphones to measure brain activity, with functions ranging from facilitating hearing to	Prince unavailable on website	EEG



		improving sleep quality		
	Various BrainLink products	A range of wearable accessories designed to develop mental fitness skills	Ranges from \$30.00 to \$259.00	EEG
	Mendi Headset	A headband with brain training exercises designed to improve cognitive functioning	\$299.00	fNIRS
	Muse Headband	A headband to facilitate guided meditations and improve sleep quality	Ranges from €335.98 (\$362.00) to €247.98 (\$267.00)	EEG
	Myndlift Brain Training Kit	A headband which uses neurofeedback and braining training to increase levels of focus and relaxation	\$150.00 (monthly payment); or \$399.00 (payment every three months); or \$750.00 (payment every six months). Additional \$199.00 for the hardware	EEG
	Myneurva Remote Brain Station	A cap designed to provide neurofeedback to improve mental health	\$3,599.00 (10 neurofeedback sessions + 2QEEGs); or \$4,899.00 (20 neurofeedback sessions + 3 QEEGs); or \$6,199.00 (30	EEG

			neurofeedback sessions + 4QEEGs)	
	Narbis Smart Glasses	Smart glasses which employ neurofeedback to track and train focus	\$690.00	EEG
	SenzeBand 2	A headband with a range of uses including improving attention, reducing stress, and general brain training	\$429.00	EEG
 (by Pankhtech India Pvt. Ltd)	Neuphony Headband	A neurofeedback headband for brain training purposes, including improving focus and relaxation	Ranges from ₹49,000.00 (\$590.00) to ₹79,000.00 (\$952.00)	EEG
	MW75 Neuro	Headphones designed to increase focus levels and optimize work performance	\$649.00 (available for pre-order)	EEG
	Neuradiant 1070	A helmet that promotes brain health including cognitive enhancement, sleep quality, memory, and focus	Ranges from \$2,995.00 to \$4,995.00	EEG
 (by Zengar Institute Inc.)	NeurOptimal	A neurofeedback and brain	Ranges from \$7,995.00 to \$10,995.00	EEG



		training system to maximize cognitive functioning		
	Neurocity CROWN™	A headpiece that utilizes neurofeedback to increase productivity and focus	\$1,199.00	EEG
	Sens.AI Brain Training System	A headset that offers personalized treatments for a range of use cases and goals, including enhancing creativity and stress management	\$1,500.00	EEG
	Healium experience (BrainLink Lite EEG headband and a VR headset)	A headset which creates immersive VR meditation experiences to increase levels of focus and relaxation	\$199.00 + \$10.99/month (BrainLink Lite and Healium Pro App monthly membership); or \$769.00 + \$10.99/month (BrainLink Lite, VR kit, and Healium Pro App monthly membership)	EEG
	URGO night	A headband which utilizes neurofeedback to improve sleep quality	\$499.00	EEG




		and increase deep sleep		
--	--	-------------------------	--	--

2. Recreation/Entertainment Products

Company Name	Product Name	Summary of Product Function	Price	Technology Used
	Various EEG products	A variety of products that allow users to interact with and influence a series of media using their brain activity, including apps, video games, and movies	Hardware (headset) products range from £199.00 (\$251.00) to £400.00 (\$505.00); software products range from no cost to £79.99 (\$101.00)	EEG
	MindWave Mobile 2 Headset	A headset that pairs with a range of wellness, educational, and entertainment apps and physical games	\$129.99	EEG

3. Research Products

Company Name	Product Name	Summary of Product Function	Price	Technology Used
	BrainAccess	EEG hardware and software solutions for use in research, BCI development, and neuromarketing	Ranges from €400.00 (\$431.00) to €1,400.00 (\$1,508)	EEG
	Various hardware and software products, including EEG head caps, EEG headsets, and EEG earbuds	Wearable EEG products for use across a wide range of domains including research, neuromarketing, workplace wellness, etc.	Ranges from \$999.00 to \$4,794.00	EEG

 (by g.tec medical engineering)	g.tec medical	A range of “DIY” hardware and software tools allowing users to construct their own systems to collect neural activity	Hardware ranges from €979.00 (\$1,054.00) to €1,089.00 (\$1,173.00); software ranges from €330.00 (\$355.00) to €1,650.00 (\$1,777.00)	EEG
 (mBrainTrain)	Various products, including the Smarting Pro line	Portable EEG products for brain research and monitoring	Prices unavailable on website	EEG
	Various open-source neuroscience and biosensing tools; Galea	Galea is a spatial computing and neurotechnology wearable device with applications in sectors such gaming, human factors engineering, entertainment, aviation, etc.	\$25,000.00 (Galea)	EEG

These 30 companies have a range of applications, price ranges, and consumer bases. As a whole, the breadth and scale of their full reach is unclear, given that most of the companies do not provide public information about sales and the magnitude of product usage. Some of the companies, however, do provide self-reported metrics that paint a picture of how their neurotechnology products are being used.

EMOTIV’s website notes that the company has thousands of users across 140 countries and has sold over 45,000 EEG devices. These devices have already collected over 100 million minutes of EEG data across 800,000 sessions.⁷⁶ According to its website, NeuroOptimal runs 852,000 sessions per year (approximately 71,000 sessions per month) across 76 different countries.⁷⁷ And the Flowtime website notes that its products have been used in over 72,295 meditation sessions, clocking over 1.5 million hours of meditation.⁷⁸

Other companies discuss how many users their products have. These include Muse (over 200,000 users),⁷⁹ Mendi (over 34,000 users),⁸⁰ Myndlift (over 22,000 users),⁸¹ Flow Neuroscience (over 20,000 users),⁸² Neuphony (over 200 individual users and over 1,000

⁷⁶ *Homepage*, EMOTIV, available at <https://www.emotiv.com/> [hereinafter *EMOTIV Homepage*].

⁷⁷ *Homepage*, NEUROOPTIMAL, available at <https://neurooptimal.com/>.

⁷⁸ *Homepage*, FLOWTIME, available at <https://www.meetflowtime.com/en-gb>.

⁷⁹ *Press + Reviews*, MUSE, available at <https://choosemuse.com/pages/reviews>.

⁸⁰ *Testimonials*, MENDI, available at <https://www.mendi.io/pages/stories>.

⁸¹ *Homepage*, MYNDLIFT, available at <https://www.myndlift.com/>.

⁸² *Homepage*, FLOW NEUROSCIENCE, available at <https://www.flowneuroscience.com/> [hereinafter *Flow Neuroscience Homepage*].

sessions hosted at specific locations called “Brain Gyms”),⁸³ and Neuronic, which said it sold to 350 customers in its first year on the market, surpassing \$1.2 million in sales.⁸⁴

III. THEMATIC AREAS OF CONCERN IN CONSUMER NEUROTECHNOLOGIES

OVERVIEW OF THEMATIC AREAS OF CONCERN IN POLICY DOCUMENTS

Access to Information	<ul style="list-style-type: none"> • Access to Policy Documents • Ability to Contact Company • Notification of Policy Changes
Data Collection and Storage	<ul style="list-style-type: none"> • Types of Data Collected • Amount of Data Collected • Data Retention and Storage Limitation
Data Sharing	<ul style="list-style-type: none"> • Sharing Data With Third Parties • Sharing Data With Governments and Law Enforcement • Selling Data to Third Parties
User Rights	<ul style="list-style-type: none"> • Withdrawal of Consent • Deletion of Data
Data Safety and Security	<ul style="list-style-type: none"> • Anonymization/Pseudonymization • Encryption • Notification of Security Breach

Source: Neurorights Foundation

A. Access to Information

When reviewing policy documents, the first question that arises is whether consumers have sufficient access to information. Policy documents are premised upon a privacy paradigm known as notice and consent, which refers to notifying individuals of data practices before asking consent for the processing of their personal data. The purpose of policy documents, therefore, is to tell consumers exactly how and for which purposes their data will be used and what rights they have as data subjects. Without access to information about data practices and rights, consumers cannot make informed decisions about their privacy. Without access to information, consumers use neurotechnology products with no

⁸³ *Homepage*, NEUPHONY, available at <https://neuphony.com/> [hereinafter *Neuphony Homepage*].

⁸⁴ *Innovative Start-Up Company Neuronic Debuts Home-Use Brain-Enhancing Infrared Device, Surpassing \$1.2 Million in Sales*, PR NEWSWIRE, available at <https://www.prnewswire.com/news-releases/innovative-start-up-company-neuronic-debuts-home-use-brain-enhancing-infrareddevice-surpassing-1-2-million-in-sales-301737291.html>.

understanding of the sensitivity of neural data or the consequences of agreeing to use these products.

Access to information is an issue of concern addressed by both hard and soft law privacy instruments around the world. GDPR, for example, highlights how principles of transparency, fairness, and accountability form the cornerstone of data protection standards across Europe. According to the regulation, data subjects must receive information about the processing of personal data in a manner that is “concise, transparent, intelligible, and easily accessible.”⁸⁵ In addition to providing individuals with information about how much data is collected and for what purposes, GDPR also stipulates that data subjects have various rights of access, such as requesting information from the data controller about data practices, privacy, and rights.⁸⁶

The African Union Convention takes a similar approach, requiring “mandatory disclosure of information on personal data by the data controller.”⁸⁷ The Convention provides rights to information and access, stipulating that data controllers provide compressive information regarding data collection practices while remaining responsive to information requests from data subjects.⁸⁸ In California, the CCPA requires businesses to disclose through online privacy policies the categories of personal information collected and the purposes for which the information will be used.⁸⁹ The legislation mandates that businesses provide methods for consumers to submit information requests, such as through a toll-free number or a website.⁹⁰

Soft law standards mirror this commitment to providing consumers with meaningful access to information. The APEC Privacy Framework articulates that “information controllers should provide clear and easily accessible statements about their practices and policies.”⁹¹ According to the APEC Privacy Framework, the easiest way to comply with this principle is for companies to post policy documents on their websites. Further, the Framework explains that individuals subject to data processing should be provided with “clear, prominent, easily understandable, accessible and affordable mechanisms to exercise choice in relation to the collection, use and disclosure of their personal information.”⁹²

Transparency is also a core principle of the OAS Preliminary Principles, which note that at a minimum, data controllers should provide accessible information about the data controller’s identity, the intended purpose of the data processing, possible disclosures of data, data rights, and the legal authority that authorizes the data controller to process personal data. As the OAS

⁸⁵ General Data Protection Regulation (EU) 2016/679, L/119, *adopted* Apr. 27, 2016, at Art. 12(1) [hereinafter GDPR].

⁸⁶ *Id.*, at Art. 12–15.

⁸⁷ African Union Convention on Cyber Security and Personal Data Protection, *adopted* June 27, 2014, at Art. 13 [hereinafter African Union Convention].

⁸⁸ *Id.*, at Art. 16–17.

⁸⁹ Cal. Civ. Code § 1798.130(a)(5) (2018) [hereinafter CCPA].

⁹⁰ *Id.*, at § 1798.130(a)(1)(A).

⁹¹ APEC PRIVACY FRAMEWORK, ASIA-PACIFIC ECON. COOP., Dec. 2005, at 15, *available* https://www.apec.org/docs/default-source/publications/2005/12/apec-privacy-framework/05_ecsg_privacyframewk.pdf?sfvrsn=d3de361d_1 [hereinafter APEC PRIVACY FRAMEWORK].

⁹² *Id.*, at 20.

emphasizes, access to information is necessary in order to ensure the individual “has a choice as to whether to enter into a relationship with the data controller.”⁹³ The OECD’s Guidelines on Protection of Privacy also emphasize the importance of transparency, explaining that information regarding the collection and control of personal data should be “readily available” to data subjects.⁹⁴ According to the OECD’s Guidelines, rights to access “should as a rule be simple to exercise” and “should be part of the day-to-day activities of the data controller.”⁹⁵

There is strong consensus across these six global instruments that companies must provide clear and easily accessible information to individuals about the processing of their data and their rights as data subjects.⁹⁶ Each instrument emphasizes the importance of transparency and access, as well as the opportunity for data subjects to submit information requests. The following section explores the extent to which consumer neurotechnology companies meet these global standards, assessing empirical data collected from the policy documents of each company. In evaluating the access that neurotechnology consumers have to information, this report considers three fundamental questions. 1) Does the company provide easily accessible policy documents that relate to the neurotechnology product? 2) Does the company provide a way of contacting them with questions about data practices and rights, and do they respond when contacted? 3) Does the company notify users following changes to their data practices? Our analysis finds that out of the 30 companies, only four (13.33%) can answer in the affirmative to all of these questions. In other words, 26 of the companies (over 85%) do not meet the minimum standards of access to information, according to the contents of their policy documents.

1. Access to Policy Documents

This report deems accessible any policy document that is published on the company’s website at the time of purchase. Some companies may provide additional policies after shipping the neurotechnology device (for example, the consumer may need to accept a privacy agreement while making an account on the mobile application, or before setting up the device), but this would only occur after the consumer has already made their decision to buy the product. This

⁹³ PRELIMINARY PRINCIPLES AND RECOMMENDATIONS ON DATA PROTECTION, ORG. OF AM. STATES, Oct. 17, 2011, at 4, *available at* https://www.oas.org/dil/CP-CAJP-2921-10_rev1_corr1_eng.pdf [hereinafter OAS PRELIMINARY PRINCIPLES].

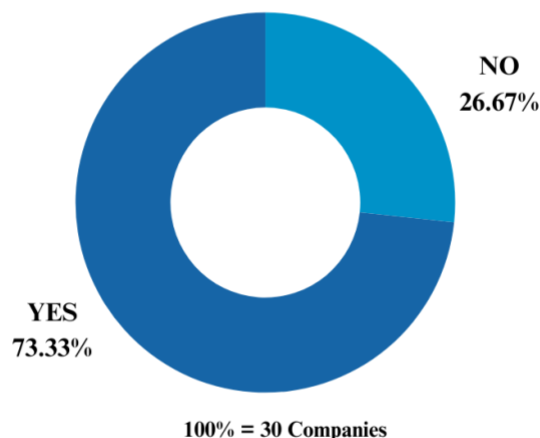
⁹⁴ RECOMMENDATION OF THE COUNCIL CONCERNING GUIDELINES GOVERNING THE PROTECTION OF PRIVACY AND TRANSBORDER FLOWS OF PERSONAL DATA, ORG. FOR ECON. COOP. AND DEV., Sept. 22, 1980, at 12, *available at* <https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0188> (amended on June 10, 2023) [hereinafter OECD GUIDELINES].

⁹⁵ *Id.*, at 13.

⁹⁶ Note, however, that there is not explicit consensus regarding whether companies must notify consumers of changes to data practices (such as changes to a privacy policy that may occur over time). The OECD Guidelines note that changes to data collection practices must be communicated to users, while the OAS Preliminary Principles stipulate that data shall be processed in ways that the individual could reasonably expect, with additional consent possibly required if significant policy changes occur. GDPR mandates that data controllers notify data subjects when they intend to process personal data for purposes other than those for which it was initially collected. Meanwhile the APEC Privacy Framework, the African Union Convention, and the CCPA do not address changes to data practices. Even among the instruments that do not explicitly discuss notifying consumers of changes to data practices, though, this principle is implied, given that all the instruments outline transparency and informational access as central tenets of data protection.

analysis focuses on access to information by exploring the policies that are available to prospective consumers and accessible by anyone who visits the company’s website.

IS THERE A PRIVACY POLICY ON THE WEBSITE?



*This question refers to device-specific privacy policies and excludes web-only policies.
Source: Neurorights Foundation

Of the 30 companies surveyed, 22 (73.33%) have privacy policies on their websites that govern the use of the neurotechnology product(s).⁹⁷ Most often these policies are easily accessible via links at the bottom of the website’s homepage, either listed independently or grouped in with other policies such as terms and conditions, warranties, shipping policies, return policies, etc. In some cases, the policy is available on the website but requires significant digging to find.

Eight of the companies (26.67%) have no publicly available privacy policy with relevance to the neurotechnology products. These companies do have privacy policies, but they are what Christopher Slobogin and James Hazel call “web-only” policies, or policies that only discuss the collection, use and disclosure of information gathered when people visit the website.⁹⁸ The web-only policies identified in this report fail to mention data collected by the neurotechnology products. In these policies, discussion of data practices is limited to cookie policies and the handling of data such as IP addresses, payment information (credit cards, billing addresses, etc.) log data, and other non-neural types of data.

This is a significant finding. Of the companies surveyed, over one in four provide no

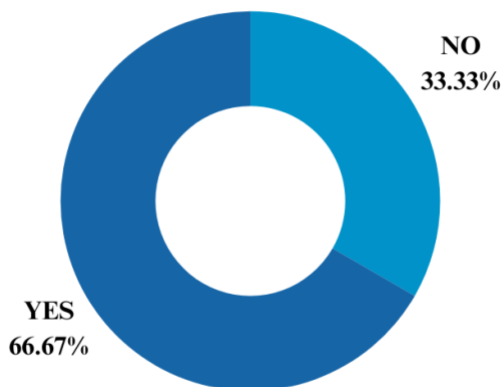
⁹⁷ One of these companies presents a complicated case. NeuroSky has many products, but only one product has a relevant policy document on the website. The website features a privacy policy titled the *Effective Learner Privacy Policy*, which involves a specific application that consumers can use with NeuroSky’s MindWave headset. None of the other products have policy documents, though, meaning that NeuroSky consumers are only aware of data practices and user rights when using one specific application, but not otherwise. With regard to the majority of products on this website, there is no information about data practices or rights.

⁹⁸ Christopher Slobogin and James W. Hazel, *Who Knows What, and When?: A Survey of the Privacy Policies Proffered by U.S. Direct-to-Consumer Genetic Testing Companies*, 28 CORNELL J OF L & PUB. POL’Y 35 – 66, 48 (2018).

information whatsoever in advance of purchase about how neural data is collected, stored, shared, or secured. Similarly, over one fourth of the companies provide no information about the rights of consumers in terms of their privacy and data. This highlights a sharp divergence from international data protection standards.

20 out of the 30 companies (66.67%) have other policy documents available on their websites in addition to privacy policies. These include terms of service, terms and conditions, terms of sale, and end-user license agreements.

ARE THERE OTHER POLICY DOCUMENTS ON THE WEBSITE THAT RELATE TO THE NEUROTECHNOLOGY DEVICE?



100% = 30 Companies

Source: Neurorights Foundation

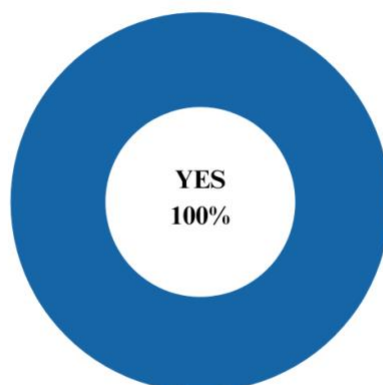
These policies tend to mention the neurotechnology devices and neural data only in passing, focusing more on legal technicalities (e.g., involving warranties, the sale of the device, restricted uses, indemnities, termination/cancellation of the service, etc.) than information relating to privacy. Regardless, these policies serve to provide more information to customers, and often provide helpful definitions and parameters that may inform purchasing decisions.

2. Ability to Contact the Company

Every company in this report has a mechanism that allows consumers to contact them, ranging from a “contact us” page with telephone and email information to submission forms where website visitors can send a message. This report, however, is concerned with whether contact information is provided in the policy documents, and, further, whether contact is reciprocated once initiated.

Each of the 30 companies provides information in their policy documents about how to contact them with questions regarding data practices and rights.

**DOES THE COMPANY PROVIDE IN ITS POLICY DOCUMENT(S)
A WAY OF CONTACTING THEM WITH QUESTIONS?**



100% = 30 Companies

Source: Neurorights Foundation

Most companies provide email addresses and/or physical addresses for curious consumers who want more information. For example, Earable’s privacy policy says that, “If you have questions or comments about this notice, you may email us at contact@earable.ai or by post. . .”⁹⁹ while Healium’s privacy policy notes that, “Questions about how personal data is processed, used, and stored can be directed to the Healium hello@tryhealium.com or by writing to 1906 Corona Rd Suite 200, Columbia, MO 65203.”¹⁰⁰ While many companies provide general contact information for the company, others provide the contact information of data protection officers responsible for responding to questions about data privacy: these include Neeuro, mBrainTrain, and BrainAccess, among others.

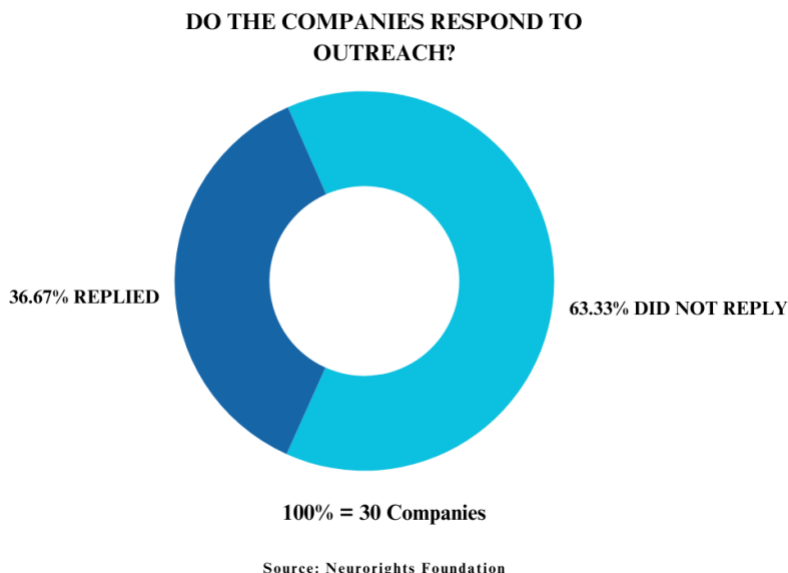
While preparing this report, our research team reached out to all 30 of the companies. This outreach served two purposes. First, it allowed the researchers to ask whether companies had additional policy documents that were not available on the websites, and second, it enabled assessment of company response rates. Starting in August 2023, our researchers contacted each company at the email provided on policy documents or, if no such email was provided, through web-based contact form. In this message, the researchers explained the scope of this report and asked for materials explaining to potential customers what the product does and how it operates, as well as the most up-to-date copies of any relevant policy document. Each company was contacted at least once, with two additional messages sent over the following months to companies that did not reply.

Out of the 30 companies, 11 (36.67%) replied to this outreach. The other 19 (63.33%) did not reply, even after three attempts to establish contact. The companies that responded did so warmly, offering information and encouraging additional outreach with further questions. Most

⁹⁹ *Privacy Policy*, FRENZ, available at <https://frenzband.com/policies/privacy-policy> [hereinafter *Frenz Privacy Policy*].

¹⁰⁰ *Privacy Policy Notice*, HEALIUM, available at <https://www.tryhealium.com/privacy-policy/#C2> [hereinafter *Healium Privacy Policy*].

often, the companies shared fact sheets or user manuals with product details and technical specifications, while others noted that all the relevant information was available on the website. None of the companies shared additional policy documents.



As previously discussed, transparency and access to information are central to data protection efforts. There is strong consensus among hard and soft law instruments that the right to access must in practice be easy to exercise and must empower the consumer to make fully informed choices regarding the collection, usage, and disclosure of their data. If companies are not responsive to information requests, consumers cannot exercise choice or informed consent. International standards make clear that consent must be meaningfully informed, freely given, and inclusive of all processing practices that will involve the data, but it is highly unlikely that consent can be either informed or freely given if consumers do not understand the policy documents and are not given the opportunity to ask for clarifications.

Note that consent is a particularly complicated issue with regard to neural data. This is because the collection of neural data always involves involuntary disclosure of information. Even if individuals consent to the collection and processing of their data, they may not be aware of what information they are sharing. Neurotechnology users cannot decide what specific neural information they would like to disclose or otherwise shield, and they will definitely not, unless it is properly explained to them, understand the extent to which collected neural data can currently or in the future be decoded. Neurotechnologies may even collect and process information about consumers that the individual did not even know existed. A central question is whether neurotechnology consumers can meaningfully consent to the processing of their neural data if they do not understand both how their data can be processed today and what information could be revealed from processing in the future.

While this question falls narrowly outside the scope of this report's analysis, it demonstrates the extreme precision that must be applied to considerations of informed consent

and neurotechnologies. The collection and processing of neural data is highly complex and likely beyond the comprehension of everyday consumers, meaning that the opportunity to ask questions about data practices and rights is particularly necessary in the consumer neurotechnology space. Without this opportunity, consumers cannot be considered meaningfully informed, and their consent cannot be considered freely given.

3. Notification of Policy Changes

It is not uncommon for companies to modify their policy documents over time. This may occur because of changes in industry standards, amendments to existing laws, rules, and regulations, new organizational leadership, or advances in technology. Genuine access to information necessitates continual access to information. It also requires that consumers are kept informed of relevant changes as they occur. The alternative is that consumers interact with companies and products under false pretenses, mistakenly believing that the conditions to which they once consented are the same conditions under which their data continues to be handled.

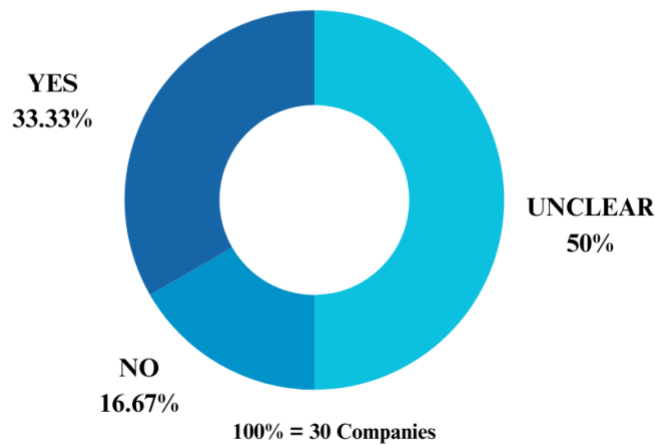
Notification of changes to policy documents is key to transparency and consumer rights. The absence of notification can signal unfair and deceptive business practices, especially because companies generally consider the continued use of a product after the new policies become effective as a form of implicit consent. The EMOTIV privacy policy, for example, says:

Any modifications to this Privacy Policy will be effective upon our posting of the new terms and/or upon implementation of the new changes on the Services (or as otherwise indicated at the time of posting) or on the Effective Date set forth in the modified Privacy Policy. In all cases, your continued use of the Services after the posting of any modified Privacy Policy indicates your agreement to the processing of your Personal Information under the terms of the modified Privacy Policy.¹⁰¹

Out of the 30 surveyed neurotechnology companies, only ten (33.33%) commit to meaningfully notifying consumers of changes to policy documents. This report considers meaningful and legitimate only those forms of notification that can be reasonably assumed to reach the consumer and translate to awareness of updated practices. For example, email updates and in-app notifications qualify as effective forms of notification given that they very likely reach the end-user of the product.

¹⁰¹ *EMOTIV Privacy Policy*, EMOTIV, available at https://id.emotivcloud.com/eoidc/privacy/privacy_policy/?_gl=1*1madabs*_ga*NjQ5Mjk0MDc0LjE2ODU5NzEzNzE.*_ga_5ZBWD77D89*MTY4ODE1MTkwNy4xMy4xLjE2ODgxNTE5MjUuNDIuMC4w [*EMOTIV Privacy Policy*]

DOES THE COMPANY NOTIFY CONSUMERS IF THERE ARE CHANGES TO RELEVANT POLICY DOCUMENTS?



Source: Neurorights Foundation

Ten companies in this report employ these types of notification following changes to policy documents. Bía Neuroscience Inc., for example, tells consumers that if its privacy policy changes, “we will post the new privacy policy on our web page, and we’ll be sure to alert you proactively via the email you provided to us.”¹⁰² Flow Neuroscience tells consumers that it “may update this [privacy] policy and will then notify you via email or our apps,”¹⁰³ while the Myndlift privacy policy notes that “we may change this Notice, in which case we will notify you of the updated Notice by email. The latest version of the Notice will always be accessible on the mobile application and on www.myndlift.com.”¹⁰⁴ EMOTIV informs its customers that “if we make material changes to this Privacy Policy, you will be notified via email (if you have an account where we have your contact information) or otherwise in some manner through the Services that we deem reasonably likely to reach you (which may include posting a new privacy policy on our websites).”¹⁰⁵

Some companies note that in addition to providing notice to consumers, they will also provide opportunities to re-negotiate consent. The iBand+ privacy policy notes that if changes are material, “and where required by applicable law,” the company will obtain consent for the new policies.¹⁰⁶ Flowtime takes a similar approach, telling consumers that “we will notify you

¹⁰² *Bía Privacy Policy*, BÍA, available at <https://getbia.com/policies/privacy-policy> [hereinafter *Bía Privacy Policy*].

¹⁰³ *Privacy Policy*, FLOW NEUROSCIENCE, available at https://api.flowneuroscience.com/app/sign_up/privacy/ [hereinafter *Flow Neuroscience Privacy Policy*].

¹⁰⁴ *Myndlift Privacy Policy*, MYNDLIFT, available at https://www.myndlift.com/_files/ugd/dbb688_e69718ee63714f05813095b2444941fc.pdf [hereinafter *Myndlift Privacy Policy*].

¹⁰⁵ *EMOTIV Privacy Policy*, *supra* note 101.

¹⁰⁶ *Privacy Policy*, iBAND+, available at <https://www.ibandplus.com/privacy-policy/> [hereinafter *iBand+ Privacy Policy*].

before we make material changes to this policy and give you an opportunity to review the revised policy before deciding if you would like to continue to use the Services.”¹⁰⁷

In addition to the companies that commit to emailing consumers, a handful of other companies note that they might email consumers but might not. The Narbis privacy policy, for example, says that the company will post an updated version of the policy on its website, and “depending on the circumstances, we may also notify you of an update via email or other contact information you have provided.”¹⁰⁸ Muse’s privacy policy mirrors this language, while NeuroSky’s Effective Learner Privacy Policy states that the company will provide consumers with notice by “displaying a prominent notice within the Application or Website, or by sending you an email.”¹⁰⁹

The majority of companies in this report neither inform consumers via email/app notification nor do they offer new opportunities for consent. Instead, they post the updated policies on the website and encourage consumers to regularly monitor policy documents for any changes. For example, in its privacy policy, Sens.ai “encourage[s] you to periodically review this page to ensure you are familiar with those changes. We will indicate at the top of this privacy policy when it was most recently updated.”¹¹⁰ mBrainTrain tells consumers that “This Privacy Policy may be updated from time to time. We will notify you of any material changes by posting the new Privacy Policy on our website. You are advised to consult this policy regularly for any change.”¹¹¹ BrainAccess’ privacy policy places the onus squarely on users, saying “You understand and agree that it is your responsibility to check periodically this Privacy Policy for updates to become informed about any changes.”¹¹²

While posting updated policy documents could potentially result in consumer awareness, this practice does not fully promote transparent access to information. In such cases, neurotechnology consumers are expected to regularly check policy documents for the duration of their engagement with the company, continually combing over the documents to search for changes. It is well established that consumers struggle to engage carefully with policy documents even when they first encounter them,¹¹³ and it is highly unlikely that consumers would exhibit increased vigilance with policy documents after using the company’s services. The notion that neurotechnology consumers will regularly revisit policy documents is not a realistic one.

¹⁰⁷ *Privacy Policy*, FLOWTIME, available at <https://www.meetflowtime.com/en-gb/policies/privacy-policy> [hereinafter *Flowtime Privacy Policy*].

¹⁰⁸ *Privacy Policy*, NARBIS, available at <https://www.narbis.com/legal/> [hereinafter *Narbis Privacy Policy*].

¹⁰⁹ *Effective Learner Privacy Policy*, NEUROSKY, available at <https://effectivelearnercloud.com/el/policies/?privacy> [hereinafter *NeuroSky Effective Learner Privacy Policy*].

¹¹⁰ *Privacy Policy*, SENSAI, available at <https://www.sens.ai/privacy-policy>.

¹¹¹ *Privacy Policy*, MBRAINTRAIN, available at <https://mbraintrain.com/company-privacy-policy/> [hereinafter *mBrainTrain Privacy Policy*].

¹¹² *Privacy Policy*, BrainAccess, available at <https://www.brainaccess.ai/privacy-policy/> [hereinafter *BrainAccess Privacy Policy*].

¹¹³ See, e.g., Jonathan A. Obar and Anne Oeldorf-Hirsch, *The Biggest Lie on the Internet: Ignoring the Privacy Policies and Terms of Service Policies of Social Networking Services*, 23 INFO., COMM. & SOC. 128, 128–147 (2018)

4. Access to Information: Conclusion

In considering access to information, this report has identified several gaps between international standards and data practices, as well as instances in which international standards may themselves be insufficient to keep consumers meaningfully informed. The analysis makes clear that neurotechnology companies should plainly provide consumers with all the policy documents that outline the relationship between the company and the neural data it collects. Policy documents should be provided on the company's website and on all sites that sell the product. They should be distinct from the privacy policies that govern the website. These documents should, in no uncertain terms, outline exactly which kinds of neural data is collected by the neurotechnology device, how neural data is collected, how much neural data is collected, and for which purposes. Further, they should outline the consumer's data rights. Where there are differences in data practices or rights depending on the nature of the data (for example, if neural and non-neural data are handled differently), these differences must be carefully explained and justified.

Neurotechnology companies should also provide consumers and potential consumers with a meaningful way of contacting the company to ask about their rights. Where there are ambiguities in policy documents, companies should be ready and able to provide clarity, and to do so within a reasonable timeframe. It is essential that companies remain responsive to information requests.

To keep consumers continually informed, neurotechnology companies should actively notify consumer if there are changes to the policy documents. Ideally, this would occur before the changes take place, so that consumers could, if they wished, stop using the product before their data is handled under different agreements than those under which it was initially collected. Companies should notify consumers either by email or notification in the application (if relevant), since it is quite unlikely that consumers will regularly check the web site of companies to find changes in policy documents. Companies must ensure that any changes involving privacy and data rights are communicated in a proactive way that maximizes the reach and comprehension of their dissemination.

At a minimum, each of these provisions is necessary to ensure that neurotechnology consumers have appropriate access to information. However, only four of the 30 companies (13.33%) meet this standard by offering all of the following: relevant policy document(s), a mechanism for communication with the consumer, responsiveness to communication from the consumer, and notification of policy changes. Yet even among those four companies, none explain the special sensitivity of neural data and other information that can be decoded from it today. As a result, none the surveyed companies fully provide consumers with adequate access to information.

B. Data Collection and Storage

Whereas the previous section discussed access to information about data practices, the following sections interrogate the data practices themselves. It is essential to understand data practices given that nearly all of the companies have access to their consumers' neural data.

Based on our review of the policy documents and our correspondence with companies, 29 of the 30 companies (96.67%) appear to have access to their consumer’s neural data and provide no meaningful limitations to this access.¹¹⁴

Two of the companies suggest that there may be some limits to access, but on terms defined entirely by the company. In its privacy policy, EMOTIV says that “EEG Data or Experiment Data should only be available to you, the owner of the data, and to a limited number of EMOTIV staff for the exclusive purpose of maintaining security and providing the Services,”¹¹⁵ while Mendi’s privacy policy notes that its team accesses personal data on a “strict-need-to-know-basis.”¹¹⁶ In all cases but one, then, it appears that the company has access to consumers’ neural data.

One of the most important data practices to comprehend as a consumer is the collection and storage of data. Consumers cannot be fully informed of privacy risks and rights if they do not understand the kinds or amounts of data companies collect, as well as the practices that govern its storage. Questions of data collection, processing, storage, and retention are of immense practical and ethical importance when exploring the relationship between consumers and neurotechnology companies.

As discussed in the previous section, global data protection standards are premised upon principles of transparency, emphasizing the need to keep consumers meaningfully informed of relevant data practices. The previously cited hard and soft law standards make clear that consumers should be made aware of data practices, including the kinds of data collected about them, the purposes of data collection, and measures related to storage and retention. Beyond merely mandating access to information about data collection and storage, these same global standards outline a series of best practices for how data should be collected and stored. Primary among these are data minimization and storage limitation.

Data minimization refers to the practice of collecting and processing the minimum amount of data required to fulfill the purpose of collection. Data minimization is a core principle of GDPR. GDPR states that:

Personal data should be adequate, relevant and limited to what is necessary for the purposes for which they are processed. This requires, in particular, ensuring that the period for which the personal data are stored is limited to a strict minimum. Personal data should be processed only if the purpose of the processing could not reasonably be fulfilled by other means.¹¹⁷

¹¹⁴ While there is a presumption of access to data in all of the policy documents (either by explanation or by omission), the research team learned in an email exchange with g.tec medical engineering that this company cannot access neural data from consumers using Unicorn products. In the case of Unicorn products, the data is not stored on the device itself but is transmitted to the consumer’s personal computer, where the consumer decides to either store or simply display the data. Full and exclusive access is granted to the consumer.

¹¹⁵ *EMOTIV Privacy Policy*, *supra* note 101.

¹¹⁶ *Privacy Policy*, MENDI, available at <https://www.mendi.io/policies/privacy-policy> [hereinafter *Mendi Privacy Policy*].

¹¹⁷ GDPR, *supra* note 85, at Recital 39.

The African Union Convention uses very similar language, explaining that data collection “shall be adequate, relevant and not excessive in relation to the purposes for which they are collected and further processed.”¹¹⁸ Like GDPR, the African Union Convention also emphasizes that data shall be processed only for explicit and relevant purposes, and shall be stored “for no longer than is necessary for the purposes for which the data were collected or further processed.”¹¹⁹ The CCPA mandates that businesses collect, use, retain, and share personal information in ways that are “reasonably necessary and proportionate to achieve the purposes for which the personal information was collected or processed, or for another disclosed purpose that is compatible with the context in which the personal information was collected, and not further processed in a manner that is incompatible with those purposes.”¹²⁰

Soft law frameworks mirror the approach outlined by hard law instruments. The APEC Privacy Framework holds that the collection of personal data “should be limited to information that is relevant to the purposes of collection and any such information should be obtained by lawful and fair means, and where appropriate, with notice to, or consent of, the individual concerned.”¹²¹ The OECD’s Guidelines on Protection of Privacy explains that there should be “limits to the collection of personal data,”¹²² while the OAS Preliminary Principles note that “personal data that is processed should be limited to that personal data necessary to achieve a specific purpose” and “reasonable efforts should be made to limit the processing of personal data to the minimum necessary.”¹²³

There is clear consensus among both hard and soft law instruments that the processing and storage of data should be limited by amount and purpose. This ties considerations of data minimization to questions of storage limitation, which refers to the amount of time that data can be stored.

In discussing storage limitation and data minimization, GDPR explicitly states that personal data must be kept in an identifiable form for no longer than is necessary for the purposes for which it was processed.¹²⁴ GDPR additionally stipulates that data controllers must, at the time of collection, inform data subjects of “the period for which the personal data will be stored.”¹²⁵ The African Union Convention also holds that personal data shall be kept for no longer than necessary for the purposes for which it was processed, and similarly notes that data controllers must provide individuals with information about timeframe for which the data will be stored.¹²⁶ The CCPA also emphasizes the importance of informing consumers about the duration for which their personal information will be retained by companies.¹²⁷ The OECD’s Guidelines on Protection of Privacy do not explicitly discuss retention periods, though they note that when data no longer serve a purpose, “it may be necessary to have them destroyed (erased) or given an

¹¹⁸ African Union Convention, *supra* note 87, at Art. 13.

¹¹⁹ *Id.*

¹²⁰ CCPA, *supra* note 89, at §1798.100(c).

¹²¹ APEC PRIVACY FRAMEWORK, *supra* note 91, at 15.

¹²² OECD GUIDELINES, *supra* note 94, at 7.

¹²³ OAS PRELIMINARY PRINCIPLES, *supra* note 93, at 10.

¹²⁴ GDPR, *supra* note 85, at Art. 5(1)(e).

¹²⁵ *Id.*, at Art. 13(2)(a).

¹²⁶ African Union Convention, *supra* note 87, at Arts. 3, 22.

¹²⁷ CCPA, *supra* note 89, at §1798.100(a)(3).

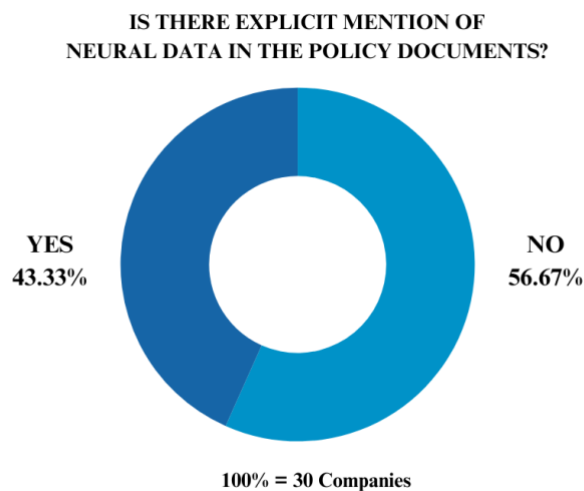
anonymous form.”¹²⁸ The OAS Preliminary Principles and the APEC Privacy Framework also do not mention retention or storage limitations. As such, there are differences between hard and soft law instruments regarding data retention, though the strong consensus regarding data minimization implies a need to implement retention periods so as to minimize data storage.

The following sections explore the data collection and storage practices of consumer neurotechnology companies. In doing so, it asks three key questions: 1) Does the company mention neural data in its policy document(s)? 2) Does the company explicitly mention efforts to minimize the amount of data collected from neurotechnology consumers? 3) Does the company explicitly discuss data retention practices? The following analysis finds that of the 30 companies, only two (6.67%) can answer yes to all of these questions. Put differently, only two of 30 companies meet the minimum standards regarding data collection and storage.

1. Types of Data Collected

Consumers must be made aware of which data practices apply to which kinds of data. This imperative is particularly pronounced for neurotechnologies, since neural data has much more sensitivity and carries far more privacy risks than the other forms of data that companies collect. To what extent do the policy documents of consumer neurotechnology explain which data practices apply specifically to neural data?

Of the 30 companies in this report, 13 (43.33%) explicitly mention neural data in one or more of their policy documents. Another nine companies (30%) have policy documents that mention the neurotechnology product(s) but make no mention of neural data. The last eight companies (26.67%) have web-only policies. In other words, the policy documents of 60% of the surveyed companies provide no information at all to consumers about how their neural data is handled, and what rights they have in relation to it. This mirrors the previous section’s finding regarding insufficient access to information.



Source: Neurorights Foundation

¹²⁸ OECD GUIDELINES, *supra* note 94, at 9.

The 13 companies that explicitly mention neural data employ a range of terminology to talk about it. Bía Neurotechnology Inc., for example, references collection of “biometric data including but not limited to brain activity, movement, light, and temperature,”¹²⁹ while the Mendi privacy policy says the company collects data on the “levels of blood oxygenation in a specific part of your brain called the prefrontal cortex.”¹³⁰ Several other companies refer to neural data as a form of “sensor data.” Definitions of sensor data in the policy documents include: “data such as brainwave patterns (through electroencephalogram or EEG) and battery status data collected through the sensors on the Notion device”¹³¹ (Neurocity); “data such as brainwave patterns and behaviors”¹³² (iBand+); and “data such as brainwave patterns (through electroencephalogram or EEG), heartbeat patterns (photoplethysmogram (PPG)), movement data, UV data, battery status data, temperature data, and pressure data collected through the sensors on the Muse device”¹³³ (Muse).

Some companies describe neural data purely in terms of EEG data. Myndlift’s privacy policy mentions collecting “electrical brain activity signals (EEG),”¹³⁴ and Neeuro’s policy explains that, “using our products will allow us to collect, store and use EEG data that include raw recordings, scores or performance data that are generated for you as part of your engagement with Neeuro’s Services.”¹³⁵ FocusCalm notifies consumers that “EEG data received from the BrainCo headband is transmitted to the FocusCalm application,”¹³⁶ while EMOTIV’s privacy policy explains that EEG “consists of electrical biosignals and motion sensor outputs collected from you when you use EMOTIV devices.”¹³⁷

The above language makes clear to consumers that the data practices and user rights outlined in policy documents describe relationships with their neural data. Specific mention of neural data — whether in the language of sensor data, EEG data, or other terminology— signals that the policy documents address the relationship between the consumer, the company, and the consumer’s neural data.¹³⁸ It additionally clarifies which data practices apply to neural data as opposed to other forms of data.

¹²⁹ Bía Privacy Policy, *supra* note 102.

¹³⁰ Mendi Privacy Policy, *supra* note 116.

¹³¹ Privacy Policy, NEUROCITY, available at <https://neurocity.co/privacy-policy>.

¹³² iBand+ Privacy Policy, *supra* note 106.

¹³³ Privacy Policy: InteraXon’s Privacy Policy, MUSE, available at https://choosemuse.com/pages/legal?_gl=1*_idmu0*_ga*MTYyNDA1MTA4NC4xNjkzMdu2OTc0*_ga_K0C08E916*MTY5NjA5OTI2OC45LjEuMTY5NjA5OTY4Ny4xLjAuMA..*_gcl_au*R0NMLjE2OTUzOTM1MjguQ2ow0NRanc5c1NvQmhDaUFSSXNBRk9pcGxuMGhYU09oQ3FNb1c5eTB6ZjgwY1phR3dGSEswV0NUbUFPMkctNUbUFPMkctdURLNGplYmMzZTRxd0RUFMd193Y0I.*_gcl_au*NDExODY0ODkzLjE2OTMwNTY5NzY.#pripriv [hereinafter *Muse Privacy Policy*].

¹³⁴ Myndlift Privacy Policy, *supra* note 104.

¹³⁵ Privacy Policy, NEEURO, available at <https://www.neeuro.com/legal/privacy-policy> [hereinafter *Neeuro Privacy Policy*].

¹³⁶ BrainCo FocusCalm Digital Application Privacy Policy Notice, FOCUSCALM, available at <https://focuscalm.com/pages/focus-calm-privacy-policy> [hereinafter *BrainCo FocusCalm Privacy Policy*].

¹³⁷ EMOTIV Privacy Policy, *supra* note 101.

¹³⁸ Although outside the scope of this report, it is worth observing that it would be incredibly helpful to advance a global consensus on the definition of neural data given how many different terminologies are employed among the companies discussed above.

The majority of policy documents analyzed in this report do not provide clarity for consumers. As previously mentioned, 56.67% of the companies lack any mention of neural data in their policies. In other words, while 100% of the companies have publicly available policy documents, only 43.33% have policies with any mention of the very data that the product exists to collect. This means that most of the time consumers are not informed about how the company uses their neural data or what options they have in terms of controlling their data.

What do the policy documents discuss if not neural data? Broadly speaking, the policy documents surveyed in this report discuss collecting some or all of the following: contact information (e.g., first name, last name, home address, phone number, etc.), payment information (e.g., credit/debit card number, security code, billing address, etc.), internet tracking and device-specific activity (e.g., browsing history, location, browser plug-ins and versions, login information, IP address, Bluetooth data, etc.), demographic data (e.g., age, gender, weight, etc.), social media login data, cookies, and user content (e.g., messages, images, comments, and materials posted through the platform).

The most common type of data mentioned in the policies, however, is personal data. Different companies define personal data (also referred to as personal information) differently. Narbis defines personal information as “information about you, that may include your name, email or other addresses, phone numbers, or other data that could reasonably be linked back to you.”¹³⁹ Muse adopts a similar definition, with “information about you, that may include your name, email or other addresses, phone numbers, or other data that could reasonably be linked back to you.”¹⁴⁰ Mendi, borrowing from the GDPR definition, defines personal data as “any information relating to an identified or identifiable natural person.” Meanwhile iBand+ draws from the CCPA to conceptualize personal information as “information that identifies, relates to, describes, is capable of being associated with, or could reasonably be linked, directly or indirectly, with a particular consumer or household.”¹⁴¹

Personal data is mentioned in every one of the surveyed privacy policies, often as a framing device for the policy document. Sens.ai, for example, opens its privacy policy with the following sentence:

Here at Sens.ai Inc. (“Sens.ai”, “we”, or “us”), we take the privacy and security of your personal information very seriously. We have prepared this privacy policy to explain the manner in which we collect, use and disclose personal information when you use our application (“App”), software, APIs, devices, products or services, visit our website located at <https://sens.ai/> (the “Website”), or otherwise interact with us.

Although the category of personal data is mentioned in every privacy policy, it is not *defined* in every privacy policy. Many of the companies discuss their data practices without

¹³⁹ *Narbis Privacy Policy*, *supra* note 108.

¹⁴⁰ *Muse Privacy Policy*, *supra* note 133.

¹⁴¹ *iBand+ Privacy Policy*, *supra* note 106.

clarifying what exactly qualifies as personal information.¹⁴² Continuing the example above, Sens.ai notes that it collects personal information when users create an account/profile, use the products and services, visit the website, sign up to receive marketing emails, enter contests or participate in promotions, apply for jobs at sens.ai, participate in surveys, or contact the company, but it does not explicitly say what does and does not count as personal information. This is very common among the policy documents, and prompts an important question: do consumer neurotechnology companies consider neural data a form of personal data? More practically speaking, do the data practices and protections extended to personal data also extend to neural data?

The answer is unclear. Even among companies that define personal data, this ambiguity persists. The root of this ambiguity comes down to a seemingly simple but technically complex consideration, which is whether neural data is capable of identifying consumers. Some companies take a clear stand on this in their policy documents. After listing forms of personal information, EMOTIV says in its privacy policy that it “also collects information from you that is not Personal Information such as: EEG Data.” In explaining the distinction between personal information and EEG data, EMOTIV notes that “EEG Data, on its own, is not Personal Information because it does not and cannot identify you.”¹⁴³ Healiium, meanwhile, takes the opposite approach, defining personal data as “information that can be used to identify someone or can be used with other information to identify someone,” before listing EEG data as a form of direct personal data that “by itself, can identify you as an individual.”¹⁴⁴

The disconnect between the approaches of these two companies (and the approaches of all the companies surveyed in this report) concerns whether or not neural data collected by consumer neurotechnology devices can be reasonably linked back to individual consumers. Scientifically speaking, the answer is that some neural data can today, in combination with other data, be linked back to individual consumers, and all neural data one day will. As explained in the introduction, neural data always contains information about the structure and functioning of individual brains and nervous systems, meaning that it inherently contains information that can link an identifiable individual with their data.

The question of whether neural data is currently personally identifiable (directly or indirectly) depends on the resolution of the data¹⁴⁵ and the size of consumer databases.¹⁴⁶ And beyond databases, there are several new and innovative ways in which personal data can connect back to brain scans. For example, a recent study reaffirmed that remote data collection of

¹⁴² It is likely that companies employ the terms “personal data” and “personal information” with GDPR and other regulatory standards (such as the CCPA) in mind, and therefore that the definitions used by those instruments are the de facto definitions of personal data and personal information in the policy documents.

¹⁴³ *EMOTIV Privacy Policy*, *supra* note 101.

¹⁴⁴ *Healiium Privacy Policy*, *supra* note 100.

¹⁴⁵ Although current EEG-based systems have not yet to our knowledge been used to identify data subjects, generative AI models are rapidly advancing the ability to decode brain activity. As a matter of science, it is indisputable that consumer neural data will soon be personally identifiable, given the advances in generative artificial intelligence and the quantities of individual brain scans with neural data that are currently being collected. In addition, commercial EEG systems can currently diagnose diseases, such as epilepsy.

¹⁴⁶ Neural databases are currently small, but they are growing. If neural data cannot yet identify individuals, it is not because of the data itself but instead because of the size of the databases to which they are added, and the resolution at which the data is stored.

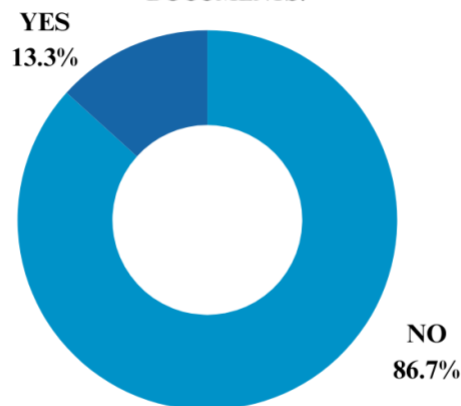
passively monitored daily interaction with personal digital devices can measure motor signs of cognitive decline from Alzheimer’s disease.¹⁴⁷ Thus, data from a consumer’s regular use of a search engine tied back to their direct IP address (which almost all companies in this report say they collect) could be used to connect back to a consumer’s neural data.

Understandably, the policy documents do not engage with the notion of personal data at this level of detail. The result, however, is lack of clarity on whether the practices governing personal data also extend to neural data.

2. Amount of Data Collected

Of the 30 companies, four (13.3%) have policies that explicitly mention efforts to minimize the amount of data collected from neurotechnology consumers.

IS THERE MENTION OF DATA MINIMIZATION IN THE POLICY DOCUMENTS?



100% = 30 Companies

Source: Neurorights Foundation

Bía Neuroscience Inc. informs consumers that the company will “work to collect as little information as needed to provide a valuable service, and we will continually look for ways to collect less.”¹⁴⁸ Flow Neuroscience explains in its privacy policy that it stores information “always in compliance with data minimization principles.”¹⁴⁹ The BrainAccess privacy policy notes that “personal data collection will be limited to what is necessary to provide requested services.”¹⁵⁰ Meanwhile, Mendi’s privacy policy explains that the company processes personal

¹⁴⁷ Similarly, information collected from a BCI could be combined with the IP address of the consumer when they uploaded their brain scan to the company’s server to identify where they physically were at that time and potentially tie that back to the person individually through property records, voter registration, credit reports, etc. See Ashley A. Holmes et al., *A Novel Framework to Estimate Cognitive Impairment Via Finger Interaction with Digital Devices*, 4(4) BRAIN COMMUNICATIONS 1-12, Jul. 28, 2022.

¹⁴⁸ *Bía Privacy Policy*, *supra* note 102.

¹⁴⁹ *Flow Neuroscience Privacy Policy*, *supra* note 103.

¹⁵⁰ *BrainAccess Privacy Policy*, *supra* note 112.

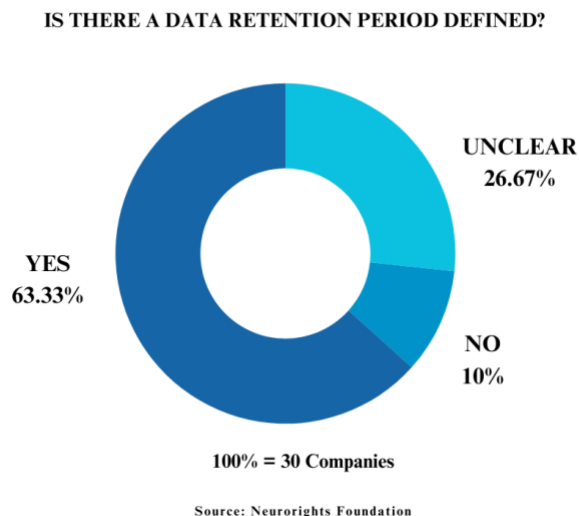
data “only to the extent necessary to provide a functional App,” while also specifying retention periods for different kinds of data.¹⁵¹

While stopping short of discussing data minimization procedures, some companies nonetheless provide useful information about the types of data collected and the purposes of each data type.¹⁵² Healium, for example, provides a detailed description of how and why the company uses each kind of data collected from its consumers.¹⁵³ In general, however, companies’ policy documents either offer vague descriptions of how the data is used (for example, “to operate the service”), or no explanation at all. None of the thirty companies identify the minimum amount of data needed to deliver their services, which again is inconsistent with international data protection standards.

3. Data Retention and Storage Limitation

Data retention policies inform consumers of how long their data will be stored by the company (and any relevant third party actors). Retention policies that implement storage limitations ensure that companies store and dispose of different kinds of data according to specific timelines so that consumers can know the shelf life of their data and trust that it will not be held longer than absolutely necessary.

19 of the 30 companies (63.33%) explicitly discuss data retention practices. Another three (10.00%) have no reference to data retention, while the final eight (26.67%) have web-only policies whose content is irrelevant to the retention of neural data. Overwhelmingly, the retention periods that are mentioned are vague and indeterminate.



¹⁵¹ *Mendi Privacy Policy*, *supra* note 130.

¹⁵² In addition, 50% of the companies inform consumers that the neurotechnology products pair with third party apps (such as Apple Music, Apple Health, Spotify, Google Fit, etc.) and/or websites (such as social media sites) that separately collect information about the consumer and process data according to their own privacy policies, which the company has no control over.

¹⁵³ *Healium Privacy Policy*, *supra* note 100.

Some companies have retention periods that are much more specific than others, such as FocusCalm, which notes that “all EEG data remains in the FocusCalm application within the user’s smart device and is purged from the application at the conclusion of each use.”¹⁵⁴ In this case, EEG data is not uploaded to the cloud and is deleted after use. In other cases, companies pledge to delete information after the consumer deletes their account. Mendi explains in its privacy policy that personal data is stored “for 60 days after your user account is deleted or the termination of the service provision.”¹⁵⁵ Muse deletes personal information when “there has been no user log-in to the account for a period set by us from time-to time (such period of non-activity will not exceed 10 years) or if you withdraw your consent to the processing of your personal information (e.g., if you delete your account).”¹⁵⁶ Muse pledges to additionally remove backup copies of personal information from its cloud storage, but notes that the copies may remain in the database for up to 30 days due to technical reasons. BrainAccess similarly erases “all personal data the User has provided” once the consumer deletes their account.¹⁵⁷

Other policies provide less specific timeframes. Bía Neurotechnology Inc.’s privacy policy states that “Bía retains member data on secure servers for the duration of its business relationship with the member, and for an indefinite period of time afterward.”¹⁵⁸ IDUN Technologies similarly informs consumers of an indefinite retention period; the company only stores anonymized data, and its privacy policy states that “the anonymized data has no retention period, and we intend to store it for a long time.”¹⁵⁹

The practice of indefinitely storing de-identified data is not unique to IDUN Technologies. Narbis, for example, deletes personal information when accounts become inactive, but “may continue to use de-identified data and aggregate information obtained in connection with your use of the Products.”¹⁶⁰ Companies like Neurocity, Healium, and Myndlift take a similar approach. EMOTIV deletes most personal information after consumers delete their accounts, but its privacy policy explains that:

EMOTIV may nevertheless retain your Personal Information to protect the business interests of EMOTIV, and some information may remain in archived/backup copies for our records or as otherwise required by law. Those interests include without limitation the completion of transactions, maintaining records for financial reporting purposes, complying with our legal obligations, resolving disputes, and enforcing agreements. We will retain pseudonymized or aggregated EEG Data and pseudonymized or aggregated Experiment Data, which is not Personal Information, for scientific or historical research purposes and to improve the Services.¹⁶¹

¹⁵⁴ *BrainCo FocusCalm Privacy Policy*, *supra* note 136.

¹⁵⁵ *Privacy Policy*, MENDI, available at <https://www.mendi.io/policies/privacy-policy>.

¹⁵⁶ *Muse Privacy Policy*, *supra* note 133.

¹⁵⁷ *BrainAccess Privacy Policy*, *supra* note 112.

¹⁵⁸ *Bía Privacy Policy*, *supra* note 102.

¹⁵⁹ *IDUN’s Privacy Policy for Mobile Applications*, IDUN TECHNOLOGIES, available at <https://iduntechnologies.com/docs/> [hereinafter *IDUN Privacy Policy*].

¹⁶⁰ *Narbis Privacy Policy*, *supra* note 108.

¹⁶¹ *EMOTIV Privacy Policy*, *supra* note 101.

Across the 30 companies, the practice of retaining de-identified data is common. Muse, for example, deletes data when the account closes or the user withdraws consent, but the parent company InteraXon “may continue to use de-identified data and aggregate information obtained in connection with your use of the Products.” 11 companies in this report say that they retain data for as long as they deem necessary for the purposes set out in the privacy policy; this is almost always followed by an assertion that the company can continue retaining data in a de-identified form. OpenBCI’s privacy policy, for example, says that it will retain personal information “only for as long as we will be required in order to fulfill the purposes outlined in this Privacy Policy . . . as soon as we no longer require your personal data to provide our services for other purposes mentioned above, we will promptly delete or anonymize it.” Several other companies, such as iBand+, Neeuro, and Earable, also dispose of data either by deleting it *or* by anonymizing it. This means that some data is stored indefinitely even after retention periods end.

4. Data Collection and Storage: Conclusion

As a whole, the policy documents provide vague accounts of companies’ collection and storage of neural data. This stems largely from ambiguity over whether neural data counts as personal data. For most companies in the report, the policy documents imply that neural data does not qualify as personal data, limiting discussion of personal information to data such as the consumer’s name, date of birth, phone number, e-mail address, and postal address. This is akin to a consumer genetic testing company describing methods of protecting your credit card information but not your genetic information, or a laboratory pledging to safeguard your home address but not the results of your bloodwork. This severely complicates comprehension of data collection practices.

This also muddies comprehension of data storage. The extent to which data retention periods actually govern the storage of neural data remains unclear. A minority of the companies in this report even mention neural data in their policy documents, and while they all mention personal data, there is considerable ambiguity regarding whether or not companies include neural data in their conceptualizations of personal data. Companies like Myndlift, Neurosity, iBand+, and Mendi, for example, all list neural data and personal information as distinct types of data, but only mention personal information when discussing retention policies. In the majority of policy documents, it is unclear whether personal data includes neural data, and therefore, whether the retention policies extend to neural data. If they do not, then neural data has no storage limitation and can be retained in perpetuity.

Some companies sidestep questions of retention by pledging to de-identify data. Although neural data can currently be anonymized and pseudonymized, it cannot be permanently de-identified. Put differently, neural data that does not currently permit identification will in the coming years be able to identify individuals and sensitive information about them as datasets grow and generative AI advances decoding through technical capability. The policy documents suggest that neurotechnology companies widely repurpose neural data (both in aggregate and disaggregated forms), which heightens the risk of further identifying consumers who were not initially identifiable, or exposing sensitive information about them that they did not consent to sharing. This increases the importance of limiting the storage of neural data.

Across the 30 surveyed companies, concerning protection gaps emerge from data collection and storage practices. Only two of the companies (6.67%) provide for all of the necessary practices discussed above, mentioning neural data, outlining data minimization efforts, and explaining data retention practices in their policy documents. Overwhelmingly, the neurotechnology companies do not fully meet international data protection standards, especially given that international standards prioritize transparency and data minimization. Consumer neurotechnology companies should specify which practices apply to neural data, how much neural data is collected, and how long neural data is retained. To meet international standards, neurotechnology companies will need to minimize the data they collect and store, to the extent that is technically possible.

C. Data Sharing

Policy documents serve two primary functions: informing consumers of how their data will be used and informing consumers of the rights they have over that usage. One of the most essential data practices involves notifying consumers of how, to whom, and under which circumstances their data can be disclosed. Without this information, customers cannot possibly make informed decisions about their privacy. Analyzing the extent to which companies can share and sell data is central to understanding the privacy risks associated with consumer neurotechnologies.

Both hard and soft law frameworks set standards regarding the disclosure of information. According to GDPR, companies can share personal data so long as the data subject is informed, has consented, and the data is not processed in a manner incompatible with the original purpose of its collection. Any sharing or sale of data must align with the lawful bases for processing and GDPR additionally grants individuals the right to object to the processing of their data, including to the sale of data for direct marketing purposes.¹⁶² The African Union Convention also ties data sharing legitimacy to consent and the purpose of processing. The Convention suggests that companies seeking to share or sell data with third parties may need to obtain explicit consent from the data subject, unless the processing falls under the specified exceptions.¹⁶³ The African Union Convention provides the right to object, giving individuals the right to be informed before their personal data is disclosed to third parties, particularly for marketing purposes, and the explicit right to refuse such disclosures or uses.¹⁶⁴ This approach is similar to that taken by the CCPA, where companies can share data with third parties, provided that they disclose this practice in their privacy policies and offer opt-out mechanisms for consumers who prefer not to have their information shared.¹⁶⁵ The CCPA additionally mandates businesses to include a “Do Not Sell My Personal Information” link on their website, allowing consumers to opt-out out of the sale of their personal information, unless certain exceptions apply.¹⁶⁶

¹⁶² GDPR, *supra* note 85, at Arts. 6, 21.

¹⁶³ African Union Convention, *supra* note 85, at 13.

¹⁶⁴ *Id.*, at 18.

¹⁶⁵ CCPA, *supra* note 89, at §1798.115(d).

¹⁶⁶ *Id.*, at §1798.135(a)(1).

Soft law instruments also emphasize consent and choice. Under the APEC Privacy Framework, data collectors can share data with third parties provided that the collectors first “obtain the consent of the individual or exercise due diligence and take reasonable steps to ensure that the recipient [...] will protect the information consistently with these [APEC Privacy] Principles.”¹⁶⁷ The OAS Preliminary Principles explain that disclosure of personal data to third parties requires explicit consent from the data subject, and notes that actors who share personal data are “accountable for ensuring the protection of the information.”¹⁶⁸ The OECD’s Guidelines on the Protection of Privacy do not address the transfer or sale of personal data to third parties.

The consensus among hard and soft law instruments is that data can be shared and at times sold, but that these actions require consent and adherence to data protection standards. Several of the standards require that consumers be given the option to reject the sharing or sale of their data, emphasizing the centrality of both consent and choice when it comes to data disclosure. In addition, all six of the instruments allow the sharing of data to comply with law enforcement or legitimate government requests.

The following sections explore the data sharing and data selling practices of neurotechnology companies.

1. Sharing Data with Third Parties

Over 50% of the companies in this report have explicit provisions in their policies that allow for the sharing of data.

CAN THE COMPANY SHARE DATA WITH THIRD PARTIES?



100% = 30 Companies

Source: Neurorights Foundation

¹⁶⁷ APEC PRIVACY FRAMEWORK, *supra* note 91, at 26.

¹⁶⁸ OAS PRELIMINARY PRINCIPLES, *supra* note 93, at 8.

Twenty of the 30 companies (66.67%) mention in their policies that they can, under certain circumstances, share personal information with third party actors. Most often, the sharing of personal information involves service providers. For example, Flowtime’s privacy policy explains that the company “transfer[s] information to our corporate affiliates, service providers, and other partners who process it for us, based on our instructions and in compliance with this policy and any other appropriate confidentiality and security measures.” BrainAccess shares personal information with “trusted third parties which help us to operate our businesses and services as long as they agree to keep Users’ personally-identifying information confidential,”¹⁶⁹ while Myndlift can share data with service providers “without limitation” to help with tasks such as database management and analytics.¹⁷⁰ In their policies, companies also frequently mention sharing data with corporate affiliates for purposes of marketing, surveys, and data analysis.

In addition to sharing with service providers, several companies also share data with research entities. Myndlift notes that it “may share your Use Information [EEG data and cognitive tests results] and additional data such as your age, gender, and health related details, with other entities for their own academic research purposes. We will only share this information after removing any data that may directly identify you (such as your name and contact information).”¹⁷¹ Muse offers customers the opportunity to participate in a research program, and those who participate consent to the “sharing of your Muse Data [including EEG data] on a de-identified basis with third parties involved in research related to improving the scientific understanding of the brain/body or to improving products and/or delivering better experiences and services.”¹⁷² A handful of other companies, including EMOTIV, also have voluntary research programs and share data with researchers.

The policy documents of nine companies (30.00%) are unclear about data sharing. Eight of these companies have web-only policies, while the ninth has a relevant privacy policy that does not mention data sharing. Consumers can assume the companies that fail to mention data sharing in their policy documents likely do share data, meaning that in practice, 29 of the 30 companies (96.67%) can and may transfer data to third parties.

It is not clear which policies govern the sharing of neural data versus other forms of data. If companies do not consider neural data a form of personal or identifiable information, then a concerning picture emerges of companies sharing neural data without limitation. For example, mBrainTrain’s privacy policy explains that the company can disclose non-identifying information to “third parties for industry analysis, demographic profiling and other purposes.”¹⁷³ OpenBCI similarly informs consumers that it can disclose information that does not identify them “without restriction.”¹⁷⁴ This practice is common among the surveyed companies.

¹⁶⁹ *BrainAccess Privacy Policy*, *supra* note 157.

¹⁷⁰ *mBrainTrain Privacy Policy*, *supra* note 111.

¹⁷¹ *Myndlift Privacy Policy*, *supra* note 104.

¹⁷² *Muse Privacy Policy*, *supra* note 133.

¹⁷³ *mBrainTrain Privacy Policy*, *supra* note 111.

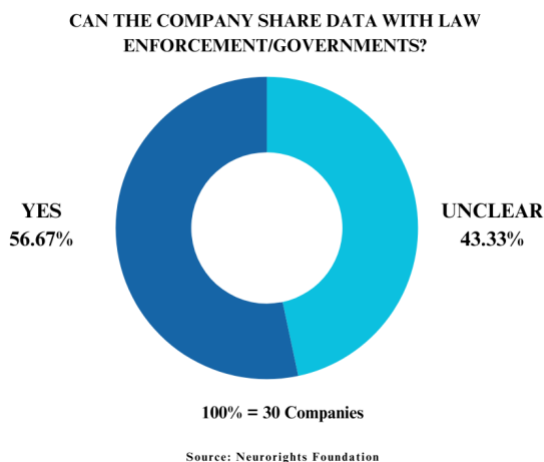
¹⁷⁴ *Privacy & Security*, OPENBCI, available at <https://docs.openbci.com/FAQ/Privacy/#:~:text=All%20transactions%20are%20processed%20through,parties%20as%20soon%20as%20possible> [hereinafter *OpenBCI Privacy & Security*].

The issue of data sharing in consumer neurotechnology is enormously sensitive. In a particularly controversial case, an investor in BrainCo (whose FocusCalm device is profiled in this report) provided 50 of its Focus 1 headbands to Xiaoshun Township Central Primary School in Jindong District in China, which reportedly used them to monitor the concentration levels of students. While the full data was transferred to the company’s server and the teacher, it was not provided to the parents. BrainCo responded by saying the product was a concentration training system and not a system for monitoring.¹⁷⁵ The program was suspended after a video report in the *Wall Street Journal* rapidly attracted more than one million viewers.¹⁷⁶

While such obviously worrying uses of consumer neurotechnology are not currently the norm, neurotechnologies are already starting to be deployed in the workplace, where employers might encourage or mandate their use. This raises an array of complex ethical questions.¹⁷⁷ For example, SmartCap’s Lifeband, an EEG headpiece, detects microsleeps and is already being deployed in the transportation and manufacturing sectors.¹⁷⁸ Business-to-business devices fall outside the scope of this report, but devices like this are mentioned to illustrate the sensitivity of neural data and how, in these contexts, they could be used to measure workplace performance and even provide a basis for employees to be disciplined or fired.

2. Sharing Data with Governments and Law Enforcement

As discussed above, the majority of companies in this report share data with corporate partners and research affiliates. Another common practice involves sharing data with governments and law enforcement bodies. Of the 30 companies, 17 (56.67%) explicitly note that they can share the consumer’s data to comply with legal requests.



¹⁷⁵ Kezia Parkins, *Primary School in China Suspends Use of BrainCo Brainwave Tracking Headband*, GLOBAL SHAKERS, Nov. 6, 2019, available at <https://globalshakers.com/primary-school-in-china-suspends-use-of-brainco-brainwave-tracking-headband/>.

¹⁷⁶ Crystal Tai, *How China is Using Artificial Intelligence in Classrooms*, Wall Street Journal, Oct. 1, 2019, available at <https://www.youtube.com/watch?v=JMLsHI8aV0g>.

¹⁷⁷ Rozena Crossman, *How Neurotech Could Boost Your Performance At Work – Or Endanger Your Human Rights, Welcome to the Jungle*, Jan. 17, 2024, available at <https://www.welcometothejungle.com/en/articles/neurotech-performance-at-work?q=8b97fe010adbc84f958d331e162606af&o=9201>.

¹⁷⁸ *Id.*

Healium explains that it “will not share data with any non-contracted third party except for the following circumstances: court order, subpoena or as otherwise compelled by law.”¹⁷⁹ OpenBCI informs consumers that it will “disclose Personal Data as we deem necessary to respond to a subpoena, regulation, binding order of a data protection agency, legal process, governmental request or other legal or regulatory process.”¹⁸⁰ The other companies that share data in these situations use almost identical language in their policies, making clear that the company will provide data in response to lawful requests from governments, regulatory bodies, and law enforcement.

While provisions authorizing the sharing of data to comply with legal requests are often found in policy documents of consumer products, it is again worth highlighting the enormous sensitivity of neural data. As such, consumer neurotechnology companies should be concerned about and prepared to address the risk that such requests could be implicated in unjust projects of policing, surveillance, and repression. None of the 30 companies say that they will resist requests from law enforcement and government actors, although it is worth noting that in the genetic testing space, 23andMe informs consumers that the company “use[s] all practical legal and administrative resources to resist requests from law enforcement, and we do not share customer data with any public databases, or with entities that may increase the risk of law enforcement access.”¹⁸¹

3. Selling Data to Third Parties

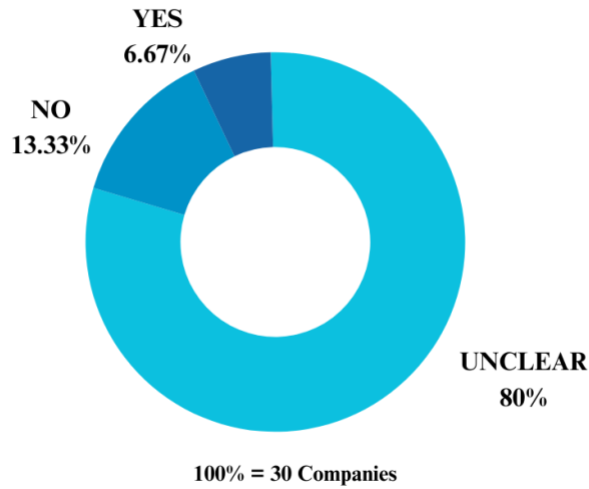
The extent to which companies can or cannot sell data to third parties is unclear. Of the 30 companies surveyed, two (6.67%) imply that they sell data, while four (13.33%) state that they do not. The remaining 24 companies (80%) do not explicitly mention sale of data in their policies.

¹⁷⁹ *Healium Privacy Policy*, *supra* note 100.

¹⁸⁰ *OpenBCI Privacy & Security*, *supra* note 174.

¹⁸¹ *23andMe Guide for Law Enforcement*, 23ANDME, available at <https://www.23andme.com/en-eu/law-enforcement-guide/#:~:text=Requests%20for%2023andMe%20User%20Information,risk%20of%20law%20enforcement%20acc>.

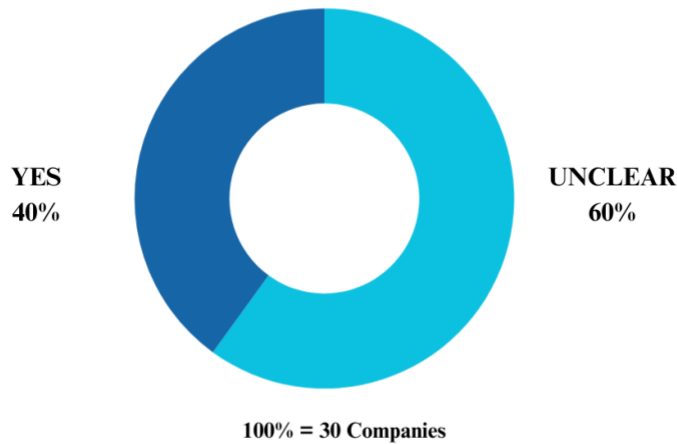
CAN THE COMPANY SELL DATA TO THIRD PARTIES?



Source: Neurorights Foundation

Consumers can thus assume that their data can indeed be sold by these companies. It therefore appears that among over 85% of the companies, consumer data (which may well include neural data) can be sold to third parties under certain circumstances. Another way of looking at the question of data sale is through the lens of business transfers. Across the 30 companies, 12 (40.00%) inform consumers that their data may be transferred to a new company in case of a business merger, acquisition, or sale of corporate assets. The other 18 (60.00%) do not mention mergers or acquisitions.

IN CASE OF SALE/MERGERS/ACQUISITIONS, DOES THE COMPANY HAND OVER THE DATA TO THE NEW COMPANY?



Source: Neurorights Foundation

Earable says in its privacy policy that the company “may share or transfer your information in connection with, or during negotiations of, any merger, sale of company assets,

financing, or acquisition of all or a portion of our business to another company.” Muse explains that it can “transfer personal information as an asset in connection with a proposed or completed merger or sale (including transfers made as part of insolvency or bankruptcy proceeding) involving all or part of our group of companies or as part of a corporate reorganization, financing, or other change in corporate control.” The other nine companies use almost identical language to discuss the matter, with OpenBCI additionally noting in its privacy policy that “when one of these events occurs, we will use reasonable efforts to notify users before your information is transferred or becomes subject to a different privacy policy.”¹⁸²

4. Data Sharing: Conclusion

Taken together, the policy documents analyzed in this report suggest that the practice of acquiring, sharing, and selling data is common. It remains unclear exactly how widespread this practice is because the policy documents do not generally differentiate between neural data and other forms of personal data, making it difficult to discern the extent to which companies share neural data. To increase transparency and privacy protections, neurotechnology companies should make clear to consumers which data sharing practices involve neural data. Further, to meet international standards, companies should give consumers the option to opt out from the sharing and sale of their neural data, and in cases of sales, mergers, or acquisitions, neurotechnology companies should not relinquish control of neural data to the new company without first obtaining consent from the consumer. If the company does not receive this consent, the company should remove the neural data from the dataset that the new company acquires.

D. User Rights

Protecting data necessarily involves protecting the rights of data subjects.¹⁸³ Among the most relevant rights concerning control over data are withdrawal of consent and deletion of data. Withdrawal of consent to data processing removes the company’s right to process and use data. In other words, it prevents consumers from being locked into a relationship with the company that they may no longer want to be in. Data deletion similarly empowers the consumer by allowing them to request that parts (or all) of their data be removed from storage, thus minimizing the information held about them.

Under GDPR, data subjects have the right to withdraw consent for the processing of their personal data.¹⁸⁴ Importantly, data subjects may withdraw consent “at any time,” and it must be “as easy to withdraw as to give consent.”¹⁸⁵ Once an individual withdraws their consent, the data controller is generally obligated to cease the processing of the personal data, unless there is another legal basis for the processing. The African Union Convention does not address the withdrawal of consent, though it does note that individuals can demand rectification or erasure of their personal data.¹⁸⁶ The CCPA also stops short of explicitly granting consumers the right to

¹⁸² *Id.*

¹⁸³ In order for consumers to exercise their rights, they must know how to contact the company (an issue discussed above) and also which legal systems any potential disputes would fall under. Of the 30 companies, 18 (60%) specify the legal frameworks and jurisdictions that govern the policy documents.

¹⁸⁴ GDPR, *supra* note 85, at Art. 7.

¹⁸⁵ *Id.*

¹⁸⁶ African Union Convention, *supra* note 87, at Art. 19.

withdraw consent. Instead, consumers are granted rights such as the right to opt-out of the sale of their personal information,¹⁸⁷ the right to request the deletion of their personal information,¹⁸⁸ and the right to know what personal information businesses collect about them.¹⁸⁹

Under the OAS Preliminary Principles, individuals must be able to withdraw consent and the “data controller should provide simple procedures for the individual to quickly and thoroughly withdraw consent.”¹⁹⁰ The OECD’s Guidelines on the Protection of Privacy do not address consent withdrawal but emphasize that consent is essential and must be informed. The APEC Privacy Framework does not address the withdrawal of consent.

While there is not a consensus among hard and soft law instruments on the question of the withdrawal of consent, it is important to note the GDPR, which is viewed as the global gold standard for data protection, articulates withdrawal of consent as a key right that must be extended to data subjects.

There is, however, a consensus view regarding data deletion. Under GDPR, data subjects have the right to request deletion of their personal data. This is commonly referred to as the “right to erasure” or “right to be forgotten.”¹⁹¹ When a data subject exercises their right to erasure, the data controller is obligated to promptly and securely delete the requested personal data unless there are legal grounds for retaining it. Data subjects may also rectify inaccurate information held about them.¹⁹² The African Union Convention similarly grants the right to demand rectification and/or erasure of personal data,¹⁹³ as does the CCPA, which empowers consumers to request deletion of personal data held by businesses.¹⁹⁴

The right to delete data is also recognized by soft law instruments. According to the APEC Privacy Framework, data controllers are responsible for ensuring personal data is accurate and complete, and individuals accordingly have the right to “challenge the accuracy of information relating to them and, if possible and as appropriate, have the information rectified, completed, amended or deleted.”¹⁹⁵ The APEC Framework notes, however, that amending or deleting data may depend on the nature of the data and other interests, and in some cases, it may be impossible or unreasonable to delete information.¹⁹⁶ Under the OAS Preliminary Principles, individuals have the right to request that the data controller “correct and delete personal data.”¹⁹⁷ When this occurs, data controllers must also notify third parties who have been given access to the data of the correction and deletion. The OECD’s Guidelines on Protection of Privacy also grant individuals the right to “challenge data relating to him and, if the challenge is successful to

¹⁸⁷ CCPA, *supra* note 89, at §1798.120.

¹⁸⁸ *Id.*, at §1798.105.

¹⁸⁹ *Id.*, at §1798.100.

¹⁹⁰ OAS PRELIMINARY PRINCIPLES, *supra* note 93, at IV.

¹⁹¹ GDPR, *supra* note 85, at Art. 17.

¹⁹² *Id.*, at Art. 16.

¹⁹³ African Union Convention, *supra* note 87, at Art. 19.

¹⁹⁴ CCPA, *supra* note 89, §1798.105.

¹⁹⁵ APEC PRIVACY FRAMEWORK, *supra* note 91, at 23(c).

¹⁹⁶ *Id.*, at 24.

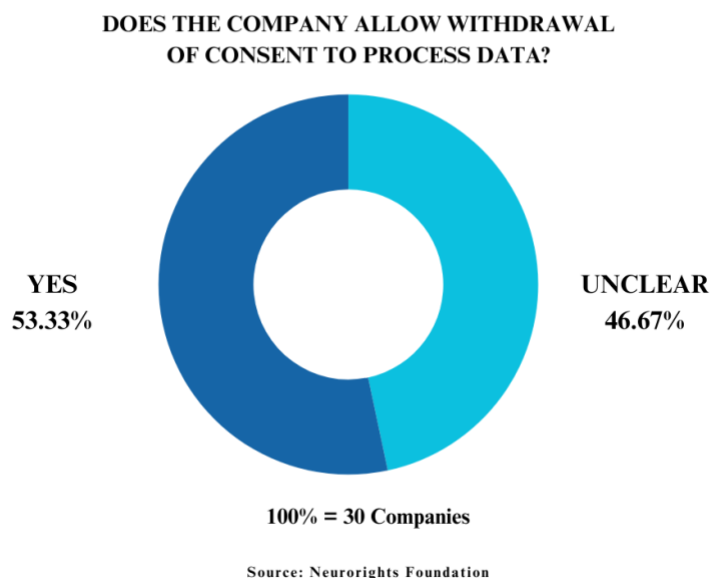
¹⁹⁷ OAS PRELIMINARY PRINCIPLES, *supra* note 93, at 10.

have the data erased, rectified, completed or amended.”¹⁹⁸ As such, there is clear consensus among hard and soft law frameworks that individuals should have the right to request data rectification and deletion.

The following analysis explores withdrawal of consent and data deletion in relation to the 30 consumer neurotechnology companies. In particular, it asks two questions. 1) Does the company allow consumers to withdraw consent to their data processing? 2) Does the company allow users to delete data? Our analysis finds that of the 30 companies, 12 (40%) allow for both withdrawal of consent and data deletion. This means that 60% of the companies do not meet the minimum standards regarding user rights.

1. Withdrawal of Consent

Slightly over half of the companies analyzed in this report explicitly mention that consumers can withdraw their consent to data processing.



Neuro instructs consumers that if they wish to withdraw their consent to Neeuro’s use of their personal data, they must “stop using our products and services immediately and write to notify us that you wish for us to stop collecting, using or sharing your personal data and we will process your request within a reasonable time from such a request.”¹⁹⁹ Narbis explains that consumers “may withdraw any consent you previously provided to us, e.g., by deleting any user account you have in connection with our Products or by contacting us by our contact information below.”²⁰⁰

Often, this right is tied to specific geographic jurisdictions, with companies noting that the rights are subject to applicable law. Myndlift and NeuroSky, for example, list withdrawal of

¹⁹⁸ OECD GUIDELINES, *supra* note 94, at 13(d).

¹⁹⁹ *Neeuro Privacy Policy*, *supra* note 135.

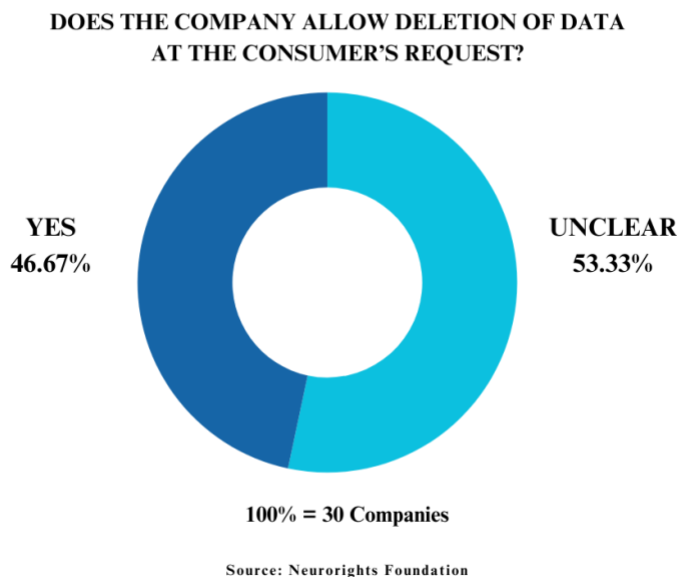
²⁰⁰ *Narbis Privacy Policy*, *supra* note 108.

consent under the specific rights afforded to consumers residing in the European Union.²⁰¹ The iBand+ privacy policy explains that consumers in the European Economic Area (EEA) may withdraw consent, while Flowtime’s privacy policy discusses consent withdrawal in relation to GDPR. Among others, companies like Mendi and EMOTIV inform consumers that they can withdraw consent if consent is the legal basis for data processing.²⁰²

None of the 30 companies in this report explicitly prohibit withdrawal of consent. However, among 14 of the 30 companies (46.67%), it is unclear whether consumers may withdraw their consent to data processing. This stems from web-only policies as well as relevant policy documents that have no mention of consent withdrawal. With almost half of the companies, then, consumers either do not have the right to withdraw their consent, or they have the right but are unaware of it because the right is not communicated in the policy documents.

2. Deletion of Data

In their policy documents, 14 of the 30 companies (46.67%) explicitly extend consumers the right to delete data.



Among these 14 companies, however, the right is not uniformly or comprehensively extended. Mirroring the above findings regarding withdrawal of consent, several companies offer consumers the right to delete data only if they reside in jurisdictions whose legal frameworks mandate the option of data deletion. In these cases, residents of specific areas are granted specific rights regarding their personal information. For example, Myndlift offers the right to “access, update, or delete” information to consumers residing in the EU, while iBand+

²⁰¹ Myndlift Privacy Policy, *supra* note 134; NeuroSky Effective Learner Privacy Policy, *supra* note 109.

²⁰² Mendi Privacy Policy, *supra* note 130; EMOTIV Privacy Policy, *supra* note 101.

and Earable grant the right to consumers who are residents of California and are thus subject to the CCPA.²⁰³

Further, almost all of the companies that grant the right to delete data note that they can retain some or all of the data after consumers request deletion. Bía Neurotechnology Inc., for example, states that “Bía is a steward of your data, and you have the right to ask us to delete it at any time.”²⁰⁴ However, it also notes that the company cannot delete payment details (including billing address) or data that is stored by third parties; in Bía’s case, third parties that handle data include Amazon, Typeform, Klaviyo, and Shopify.²⁰⁵ When describing its right to erasure, Flow Neuroscience explains that it may retain data “that the law requires us to keep.”²⁰⁶ Earable similarly discloses that the company “may retain some information in our files to prevent fraud, troubleshoot problems, assist with any investigations, enforce our legal terms and/or comply with applicable legal requirements.”²⁰⁷ Flowtime informs consumers that the company keeps backup copies of data on its cloud for a period of time, after which the company may continue to use de-identified and aggregate data.²⁰⁸ This policy of retaining data in de-identified form after deletion requests was widespread across the companies.

While the relevant policies of 14 companies mention deletion of data in one form or another, the policies of the other 16 companies do not.²⁰⁹ Among the surveyed companies, the right to delete data is not widely available.

3. User Rights: Conclusion

Analysis of policy documents reveals serious concerns regarding the data rights of consumers. In order to safeguard neural data and the privacy of consumers, neurotechnology companies should allow consumers to withdraw consent to data processing at any point, while simultaneously allowing consumers to delete their neural data (to the extent that is technically possible). Of the 30 companies, only 12 (40%) extend both of these rights to consumers, suggesting that 60% of the companies do not meet the minimum standards required for users to exercise control over their data.

E. Data Safety and Security

As discussed in the introduction, neural data is extremely sensitive. All neural data contains distinctive information about the person from whom it was collected, information that can both identify them and reveal intimate insights that consumers themselves may not even be aware of. BCIs with sufficient resolution can predict and identify conditions such as depression,

²⁰³ *Myndlift Privacy Policy*, *supra* note 134; *iBand+ Privacy Policy*, *supra* note 106; *Frenz Privacy Policy*, *supra* note 99.

²⁰⁴ *Bía Privacy Policy*, *supra* note 102.

²⁰⁵ While the data this policy discusses is unlikely neural data, it is nonetheless identifying data that could, when combined with disaggregated data, increase the identifiability of consumers’ neural data.

²⁰⁶ *Flow Neuroscience Privacy Policy*, *supra* note 103.

²⁰⁷ *Frenz Privacy Policy*, *supra* note 99.

²⁰⁸ *Flowtime Privacy Policy*, *supra* note 107.

²⁰⁹ Note that the same numbers apply to deletion of data collected from minors: 13 companies explicitly mention in their policy documents that they will delete data collected from minors using the neurotechnology product.

anxiety, bipolar disorder, schizophrenia, addiction, Alzheimer’s disease, Parkinson’s disease, and more, meaning that consumer neurotechnology devices can, in many cases, provide corporations with information about the physical and mental health of individual consumers. It is highly likely that in the coming years, as the technical capabilities of neurotechnology and artificial intelligence continue to expand, neural data collected from consumer devices will also grant corporations insight into individual thoughts, identities, and even the consumer’s subconscious mind.

It is thus necessary to understand the measures companies put in place to safeguard neural data from unintended disclosure. This is particularly important given that most consumer neurotechnology companies store data on cloud servers that are either in-house or outsourced to third party cloud providers. Cloud servers are, of course, always vulnerable to insider threats and cyberattacks, but this vulnerability is heightened by the commercial desirability of neural data. As Marcello Ienca, Pim Haselager, and Ezekiel Emanuel write, “the attractiveness and therefore risk of hacking data storage sites by nefarious and criminal actors will be greatly increased when large population EEG databases are stored and linked for analysis to other databases containing medical, social media or other sensitive information.”²¹⁰

Global data protection standards emphasize the importance of adequately safeguarding data. In addition to data minimization, accuracy, and storage limitations, GDPR highlights data protection by design and by default, suggesting privacy-enhancing measures such as pseudonymization and encryption. GDPR also establishes a framework for action following a data breach, requiring companies to notify the supervisory authority within 72 hours of learning about the breach and, when necessary, to communicate the breach to the data subject.²¹¹ Compared to GDPR, the African Union Convention provides less specificity regarding data protection practices, but notes nonetheless that data controllers must “take all appropriate precautions, according to the nature of the data, and in particular, to prevent such data from being altered or destroyed, or accessed by unauthorized third parties.”²¹² The CCPA mandates that businesses implement reasonable security measures (commensurate to the nature of the data) to protect it from unauthorized access, destruction, use, modification, or disclosure.²¹³ These measures may include, among others, pseudonymization, encryption, and rapid responses to data breaches.

Soft law instruments also articulate the importance of safeguarding data. The APEC Privacy Framework encourages the protection of personal data through reasonable security safeguards “proportional to the likelihood and severity of the harm threatened the sensitivity of the information and the context in which it is held.”²¹⁴ Similarly, the OAS Preliminary Principles note that data collectors must provide appropriate technical and organizational measures to guarantee the integrity and confidentiality of personal data.²¹⁵ The OAS Principles additionally require data collectors to notify individuals of any data breaches where the

²¹⁰ *Brain Leaks*, *supra* note 30, at 808.

²¹¹ GDPR, *supra* note 85, at Arts. 33, 34.

²¹² African Union Convention, *supra* note 87, at 21.

²¹³ CCPA, *supra* note 89, at §1798.100(e).

²¹⁴ APEC PRIVACY FRAMEWORK, *supra* note 91, at 22.

²¹⁵ OAS PRELIMINARY PRINCIPLES, *supra* note 93, at 13.

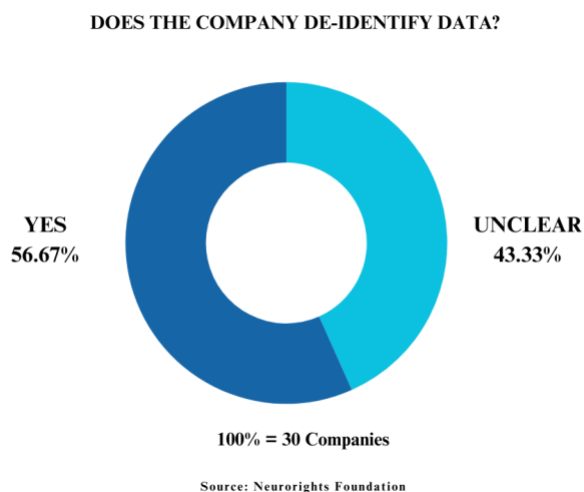
unauthorized disclosure of information may bring significant risk to the individual.²¹⁶ The OECD's Guidelines on Protection of Privacy take a similar approach, mandating reasonable security measures proportional to the risk.²¹⁷

There is overwhelming consensus among international data protection instruments that personal data must be technically and organizationally protected in ways that are comprehensive and appropriate given the type and amount of data. Sensitive personal data, in particular, requires additional safeguarding.

How, then, do consumer neurotechnology companies safeguard consumers and their neural data? An initial review of the 30 companies' policy documents shows that the answer to this question is not clear. In assessing the security protocols outlined policy documents, this report explores three practices mentioned across the documents: anonymization / pseudonymization, encryption, and notification of security breaches. It asks: 1) Does the company de-identify data? 2) Does the company encrypt data? 3) Does the company notify consumers in the event of a security breach? The following analysis finds that of the 30 companies, only three (10%) state that they engage in all of these data safety and security measures. This means that 90% of the companies do not outline adequate measures to protect neural data in their policy documents.

1. Anonymization/Pseudonymization

Removing personal identifiers through processes of anonymization or pseudonymization is one way to strengthen data security. Neural data always contains information that can be used to link data to the consumer from whom it was collected, but implementing measures to remove as much personal information as possible from the data can help minimize the likelihood of invasive data disclosures. Of the thirty companies surveyed, 17 (56.67%) explicitly mention the practice of de-identifying information.



²¹⁶ *Id.*

²¹⁷ OECD GUIDELINES, *supra* note 94, at 11.

EMOTIV discusses this practice in detail:

When you create a User Account, we also create an anonymous, unique identification number (“OwnerID”) which is associated with your EEG Data and Experiment Data. Your User Account is the only place where both your Personal Information (associated with your EmotivID) and your EEG Data and Experiment Data (associated with your OwnerID) are linked, so that you can log into your account and access your own personal data. Unless you are logged in to your User Account, it is not possible to discover or deduce your personal identity from information stored or accessed when reading your EEG Data and Experiment Data.²¹⁸

Of the 17 companies, only one notes in its policy documents that it de-identifies all data it collects.²¹⁹ IDUN Technologies’ privacy policy explains that:

IDUN collects, processes and stores only anonymized data from the IDUN Guardian . . . We do NOT collect any other personal data about you. We do NOT collect, process or store your name and surname, email address, home address, phone number, location data, IP address, cookie ID, the advertising identifier of your phone or any other personal data or pieces of information which make you identifiable.²²⁰

In this regard, IDUN Technologies is an outlier. In assessing the other companies’ policy documents, it is not apparent that de-identification of data is a default practice. In most cases, companies write vaguely about anonymizing or pseudonymizing data for specific purposes, implying that the baseline standard for data storage is one in which the data has not been subjected to de-identification. For example, Flow Neuroscience informs consumers that in addition to collecting various kinds of personal information, the company “might also store anonymised and aggregated data (which does not identify you) based on the information you provide to us.”²²¹ In this case, it is not clear whether all or only some data is anonymized, nor is it clear whether the anonymized datasets include neural data or only other forms of data.

This ambiguity is common. Healium’s privacy policy notes that “From time to time, Healium may extract an anonymized set of data from our cloud-based environment. This involves our taking a small sample of the data stored in the cloud. We then remove all of the personal data that would allow anyone to be able to identify whose data it is . . . This non-identifiable data set is then used for our internal development.”²²² Meanwhile the Narbis privacy policy explains that:

[Narbis] may also remove personal identifiers from your information to render such personal information non-identifiable. We maintain and use it as de-identified data, and

²¹⁸ *EMOTIV Privacy Policy*, *supra* note 101.

²¹⁹ Note, however, that neural data cannot be fully deidentified: growing databases and advances in artificial intelligence mean that neural data that currently cannot identify individuals will in the future be able to do so.

²²⁰ *IDUN Privacy Policy*, *supra* note 159.

²²¹ *Flow Neuroscience Privacy Policy*, *supra* note 103.

²²² *Healium Privacy Policy*, *supra* note 100.

may combine such de-identified data with other information to generate aggregated data. We use such de-identified and/or aggregated information to help us improve our product and service offerings, and may also provide de-identified and/or aggregated data to researchers in connection with research programs.²²³

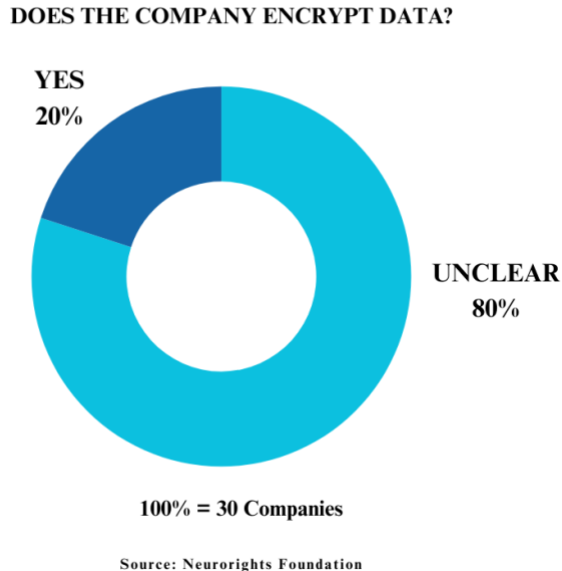
There is no explicit mention of neural data in the Narbis, Healium, or Flow Neuroscience privacy policies. As such, it is impossible to know whether the practices of de-identification mentioned above apply to neural data at all. Relatedly, most companies that mention de-identification mention it in relation to data sharing, noting that they share anonymized, pseudonymized, or aggregated information with third parties. For example, Flowtime’s privacy policy explains:

We may share non-personal information that is aggregated or de-identified so that it cannot reasonably be used to identify an individual. We may publicly disclose such information to third parties, for example, in public reports about sleep and meditation, to partners under agreement with us.²²⁴

In only discussing de-identification in relation to data sharing as opposed to data storage, companies paint a partial picture that fails to fully inform consumers of data protection practices.

2. Encryption

One of the most effective methods of protecting sensitive data is through encryption. Six of the 30 companies surveyed (20%) explicitly mention encryption of data in their policies.



²²³ *Narbis Privacy Policy*, *supra* note 108.

²²⁴ *Flowtime Privacy Policy*, *supra* note 107.

These six companies speak about their security practices with specificity. EMOTIV’s privacy policy, for example, notes that the company uses “commercially reasonable security measures to protect against the loss, misuse, and alteration of your information under our control based on the type of Personal Information and applicable processing activity, such as pseudonymization, aggregation, data encryption in transit, and data encryption at rest.”²²⁵ Flowtime mentions the usage of “Transport Layer Security (“TLS”) to encrypt many of our Services.”²²⁶ Privacy policies from BrainAccess²²⁷ and OpenBCI²²⁸ mention the use of Secure Socket Layer (SSL) technology to encrypt data, while Bía Neurotechnology Inc. notes in its privacy policy that its security practices include but are not limited to “hardware security tokens, multi-factor authentication, IP whitelists, encryption at rest, code reviews for all code changes, [and] the ability to quickly revoke access to member data as needed.”²²⁹

Most common across the 30 companies’ policies, however, is vague language that mentions safeguarding measures but does not describe what exactly those measures are. For example, BrainBit’s privacy policy notes that “We value your trust in providing us your Personal Information, thus we are striving to use commercially acceptable means of protecting it. But remember that no method of transmission over the internet, or method of electronic storage is 100% secure and reliable, and we cannot guarantee its absolute security.”²³⁰ mBrainTrain’s privacy policy states that “We employ administrative, physical and electronic measures designed to protect your information from unauthorized access.”²³¹ Almost identical language appears in several other policies, such as Earable’s privacy policy:

We have organizational and technical processes and procedures in place to protect your personal information. However, no electronic transmission over the internet or information storage technology can be guaranteed to be 100% secure, so we cannot promise or guarantee that hackers, cybercriminals, or other unauthorized third parties will not be able to defeat our security and improperly collect, access, steal, or modify your information.²³²

Similar language appears in many policies. Among others, companies like Muse, Sens.ai, and Neurable²³³ refer to technical, physical, administrative, and organizational measures to protect data but do not explain what they are.

3. Notification of Security Breach

²²⁵ EMOTIV Privacy Policy, *supra* note 101.

²²⁶ Flowtime Privacy Policy, *supra* note 107.

²²⁷ BrainAccess Privacy Policy, *supra* note 157.

²²⁸ OpenBCI Privacy & Security, *supra* note 228.

²²⁹ Bía Privacy Policy, *supra* note 102.

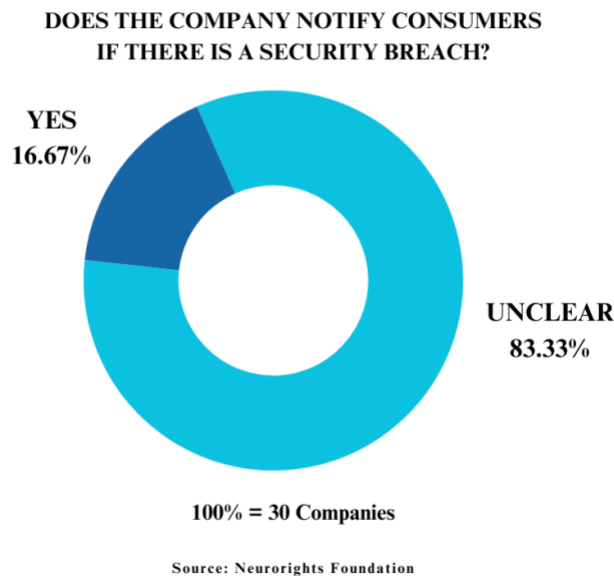
²³⁰ Privacy Policy, BRAINBIT, available at https://brainbit.com/privacy_policy/.

²³¹ mBrainTrain Privacy Policy, *supra* note 111.

²³² Frenz Privacy Policy, *supra* note 99.

²³³ While Neurable’s privacy policy speaks vaguely about data security (for example, it does not mention encryption), its website provides more detailed description, saying: “Feel secure with encrypted and de-identified data stored in secured locations. Neurable goes above and beyond with data compliance. Your data will never be sold.” *Homepage*, NEURABLE, available at <https://www.neurable.io/#smartHeadphones>.

Five of the 30 surveyed companies (16.67%) mention in their policies that they notify customers in the event of a security breach.



Neuro’s privacy policy, for example, states that “We will notify you of any data breach where your personal data has been obtained by unauthorised third parties, as required by law.”²³⁴ OpenBCI’s privacy policy employs similar language: “As required by law, OpenBCI will notify you of any data breach that occurs where your Personal Information has been accessed by unauthorized third parties as soon as possible.”²³⁵ The practice of disclosing security breaches when legally required to is also present in MBTrain’s privacy policy, which states:

We will make any legally required disclosures of any breach of the security, confidentiality, or integrity of your unencrypted electronically stored ‘personal data’ (as defined in applicable laws on security breach notification) to you via email or conspicuous posting on our website in the most expedient time possible and without unreasonable delay, insofar as consistent with (i) the legitimate needs of law enforcement or (ii) any measures necessary to determine the scope of the breach and restore the reasonable integrity of the data system.

These excerpts of policy documents suggest that among companies which disclose security breaches, the practice of disclosure is often dependent upon legal and operational obligations. One such obligation is GDPR, under which breach notifications are mandatory in member states when the breach is deemed likely to pose risks to the rights and freedoms of the data subject; in these cases, notification is to occur “without undue delay.”²³⁶ This raises concerns about companies which operate in jurisdictions where breaches are not legally required.

²³⁴ *Neuro Privacy Policy*, *supra* note 135.

²³⁵ *OpenBCI Privacy & Security*, *supra* note 180.

²³⁶ GDPR, *supra* note 85, at Art. Art. 34(1).

4. Data Safety and Security: Conclusion

The preceding analysis reveals deep ambiguity regarding data safety and security practices. In their policy documents, neurotechnology companies do not disclose in sufficient detail which measures, if any, are employed to safeguard neural data from unwanted disclosure. In general, discussions of security practices are vague at best and nonexistent at worst.

As part of their commitment to access to information, neurotechnology companies must outline their security practices with more precision. They should, to the extent possible, anonymize and pseudonymize data, and they should all encrypt neural data using the highest standards of encryption. These measures should take place immediately after the data is collected, and always before it is stored. In the event of a data breach or cyberattack, neurotechnology companies should immediately notify consumers. Of the 30 companies, only three (10%) commit to all of these data safety standards in their policy documents.

IV. CONCLUSION

The consumer neurotechnology space is growing at a rate that has outpaced research and regulation. This report is an attempt to begin closing that gap by elucidating the privacy concerns posed by consumer neurotechnology. This endeavor is both novel and necessary. This report is the first of its kind, meaning there has previously been no understanding of the practices that consumer neurotechnology companies apply to neural data, or the rights consumers have in relation to them.

To assess the data practices prevalent in the consumer neurotechnology space, this report analyzed the policy documents of 30 consumer neurotechnology companies with products that are available for purchase. When analyzing policy documents, two fundamental questions arise. First, is there sufficient disclosure about data practices and consumer rights for consumers to make informed decisions about their privacy? Second, are the company's data practices and rights affordances adequate given the unique sensitivity and risks of neural data? According to the findings of this report, the answer to both of these questions is no.

While this report finds that most existing neurotechnology companies do not adequately inform consumers or protect their neural data from misuse and abuse, it does not conclude that these practices are deficient by design. Questions of the intent behind data practices fall outside the scope of this study, which focused narrowly and exclusively on the content of policy documents.

The analysis focused on five key areas of relevance to data privacy: Access to Information, Data Collection and Storage, Data Sharing, User Rights, and Data Safety and Security. Across each of these thematic areas, broad gaps between international data protection standards and actual data practices emerged. Neurotechnology consumers overwhelmingly lack access to information, exhibiting stark inconsistency with the principles of transparency and access that international standards assert. Further, this lack of information undermines the notice and consent model upon which privacy documents are premised, rendering both policy documents and the very notion of informed consent ineffectual. At the same time, all of the

companies exercise significant control over the collection, storage, retention, and repurposing of neural data. This raises serious concerns given the extreme sensitivity of neural data, concerns that will only intensify in the coming years as the ability to decode neural data grows.

This report highlights these challenges so that companies and investors can appreciate the kinds of specific further measures that are needed to responsibly expand neurotechnology into the consumer sphere.²³⁷ In addition, the report also analyzes the unique characteristics of neural data and is intended to inform multilateral organizations and governments about how their legal and regulatory frameworks can be updated to protect mental privacy and ensure consumer neurotechnology companies properly safeguard neural data.

This will benefit not only companies and investors who are committed to the ethical development of neurotechnology, but also consumers. As neurotechnology devices proliferate beyond medical settings outside the strict requirements for medical devices and health privacy, it is critical that consumers comprehend exactly how companies can use their neural data and what rights they have over that usage. Without this information, consumers cannot make meaningfully informed choices about their privacy, and they may unwittingly expose their most sensitive data.

ACKNOWLEDGMENTS

With gratitude, we acknowledge the critical role played by Stephen Damianos in developing this report. In addition, we are grateful for the research support of Alana Gordon, Brianna Angulo, Deric Cezar, Joy Mack, Marian Da Silva, Margot Hanley, Meredith Gusky, Neesha Patel, and Zetta Mason.

²³⁷ Following this report, the Neurorights Foundation plans to develop a set of model policy documents that can provide precise guidance for companies that want to adhere to global best practices as applied to neurotechnology.

APPENDIX

Bía Neurotechnology Inc.

Location: Vancouver, Canada

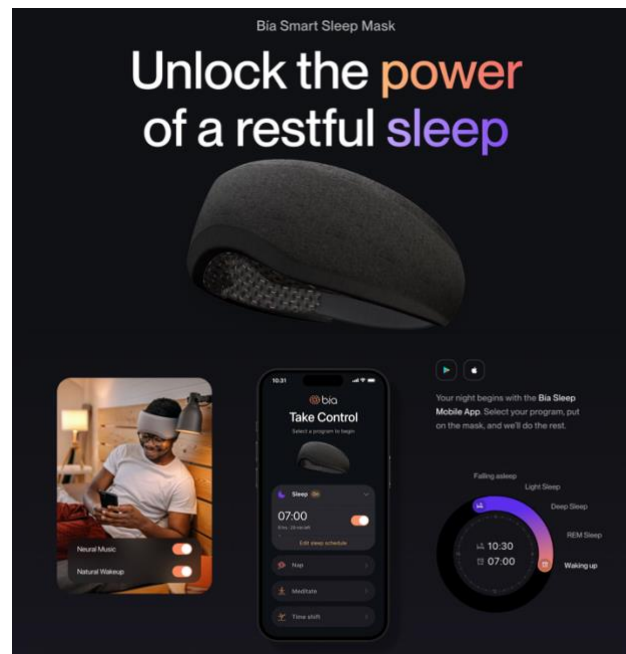
Product(s): Bía Smart Sleep Mask

Price: \$389.00 (early bird rate); \$699.00 (premium rate, includes inclusion into Beta); \$1,499.00 (ultra rate, includes personalized 1-on-1 sleep coaching and a personal meet and greet with Bía founders)

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

The Bía Smart Sleep Mask is a wearable sleep aid device. The purpose of the product is to help users fall asleep faster and increase the amount of deep sleep they attain. Utilizing Functional Near Infrared Spectroscopy (fNIRS), the device tracks sleep stages and employs vibrations and music to train the brain through neurofeedback to sleep more effectively. Bía’s website explains that the Sleep Mask “helps to reduce racing thoughts, eases you back to sleep after mid-night wake ups, and works to optimize and improve the level of deep, restorative sleep you get each night. Great sleep can be easy for you, once again. Wear the Bía Smart Sleep Mask and we’ll do the rest.”²³⁸

The Sleep Mask pairs with the Bía Sleep Mobile App, which provides sleep insights and metrics. The app assists with deep meditation, lucid dreaming, and adjusting to time zone shifts, while also allowing users to stream music as they fall asleep. In addition, the app connects users with specialists who review sleep data and offer personalized sleep recommendations. According to Bía, this allows users to “Start your day right with performance insights. Understand how you slept each night and what you can do after you wake up to have the best day ever.”²³⁹



²³⁸ Homepage, BÍA NEUROTECHNOLOGY, available at https://getbia.com/?utm_content=1/.

²³⁹ Id.

BrainAccess, by Neurotechnology

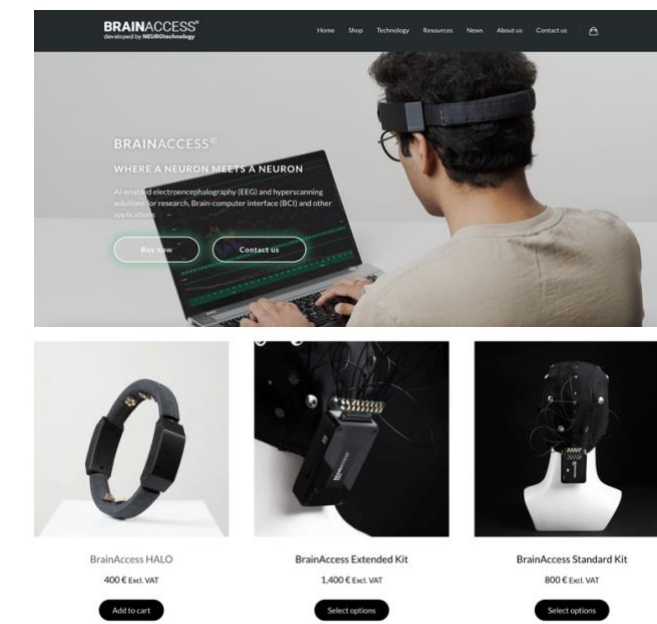
Location: Vilnius, Lithuania

Product(s): EEG acquisition devices

Price: €400.00 (\$431.00, BrainAccess HALO); €800.00 (\$862.00, BrainAccess Standard Kit); €1,400 (\$1,508.00, BrainAccess Extended Kit)

Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#)

BrainAccess sells EEG hardware and software solutions designed for use in research, BCI development, and neuromarketing. The devices have dry-contact electrodes, meaning that they do not require gel application. This makes them more user friendly and increases the likelihood of use outside of laboratory settings. BrainAccess sells three products: the BrainAccess HALO, the BrainAccess Standard Kit, and the BrainAccess Extended Kit. The HALO comes with an EEG headband, a Bluetooth adapter, and BrainAccess software, whereas the kits come with EEG caps, Bluetooth-enabled electroencephalographs, and additional software. BrainAccess software includes applications for interfacing with the BCIs, downloading AI-enabled BCI algorithms, and saving and streaming EEG data.²⁴⁰



²⁴⁰ Homepage, BRAINACCESS, available at <https://www.brainaccess.ai/>.

BrainBit

Location: Rancho Santa Margarita, California, USA

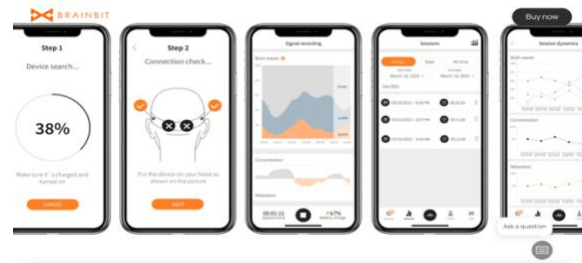
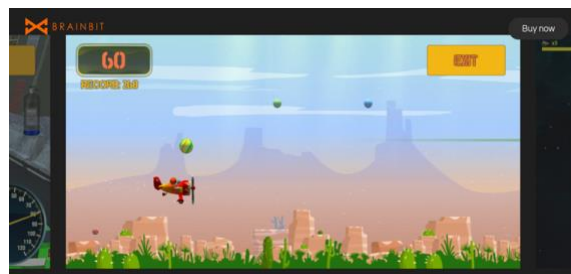
Product(s): Various hardware and software products, including MINDO

Price: \$399.00 (MINDO)

Resources: [Website](#); [MINDO Website](#); [Privacy Policy](#); [End-User License Agreement](#)

BrainBit sells various hardware and software products, including MINDO, an EEG headband intended to increase relaxation and focus. MINDO has four EEG channels, with additional reference and ground electrodes on the forehead. These channels collect alpha, beta, and theta brain rhythms.

MINDO pairs with a BrainBit application that boasts 38 free neurofeedback games in the app. The games focus on honing concentration levels, quick-relaxation skills training, anxiety control, self-regulated stress reduction, and sleep skills. The app, called EEG Waves, allows users to monitor the status of their neural activity in real time while playing games, meditating, or engaging in any other activity. The MINDO website notes that “During meditation, sports or work, your alpha, beta and theta brain rhythms, as well as emotional state are tracked in the background, and you will be able to see the results!”²⁴¹



²⁴¹ MINDO by BrainBit, BRAINBIT, available at <https://mindo.brainbit.com/>.

Earable

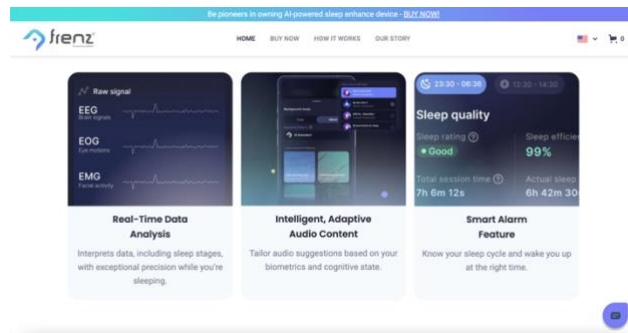
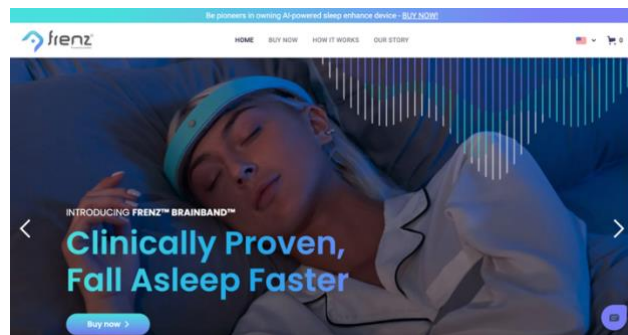
Location: Boulder, Colorado, USA

Product(s): FRENZ™ Brainband

Price: \$490.00

Resources: [Website](#); [Privacy Policy](#); [Terms and Conditions](#)

The FRENZ™ Brainband is a wearable sleep aid device marketed to help users fall asleep faster, sleep deeper, and wake up feeling refreshed. The device utilizes 7-in-1 sensing technology, with sensors tracking heart rate, head motion, breathing rhythm, EOG, EMG, EEG, and SpO2. The Brainband pairs with the FRENZ AI Sleep Science app, which provides real time EEG analysis to inform sleep scoring, sleep insights, and sleep coaching. Music is central to the FRENZ™ experience, with the app crafting “smart playlists” for sleep based on physiological activity. The website writes: “Measuring brain biometrics every second, FRENZ™ will gather feedback on what helps you relax and intelligently generate a personalized playlist.”²⁴²



²⁴² Homepage, FRENZBAND, available at <https://frenzbands.com/>.

EMOTIV

Location: San Francisco, California, USA

Product(s): Various hardware and software products, including EEG head caps, EEG headsets, and EEG earbuds

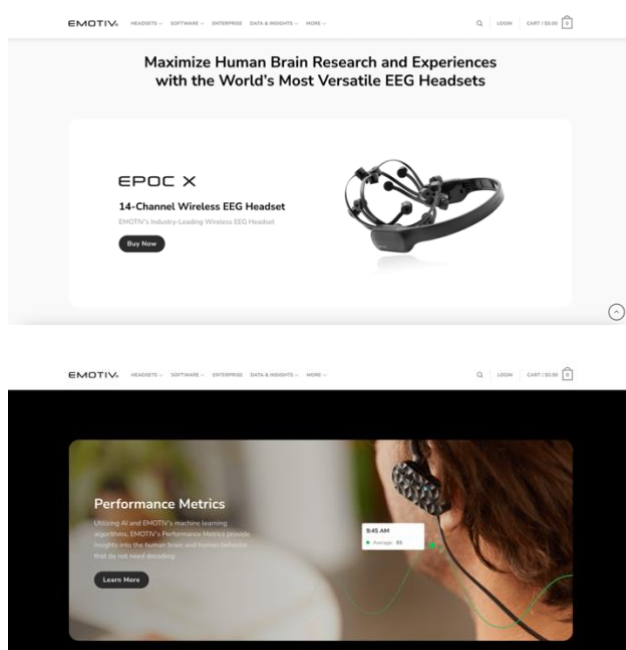
Price:

- EPOC X: \$999.00 (with no license); \$2,067.00 (with a one-year PRO Standard license); \$3,494.00 (with 3-year PRO Standard license).
- Flex Saline 32-Channel Wireless Saline EEG Head Cap System: Prices vary depending upon configuration and size, ranging from \$1,899.00 with no license to \$4,494.00 with a 3-year EmotivPRO Standard license.
- Flex Gel 32-Channel Wireless Saline EEG Head Cap System: \$2,299.00 (with no license); \$3,367.00 (with 1-year EmotivPRO Standard license); \$4,794.00 (with a 3-year EmotivPRO Standard license).
- INSIGHT 5-Channel Wireless EEG Headset: \$499.00 (with no license); \$1,567.00 (with 1-year EmotivPRO Standard license); \$2,994.00 (with a 3-year EmotivPRO Standard license)

MN8 2-CHANNEL WIRELESS EEG EARBUDS: \$399.00

Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#)

EMOTIV sells hardware and software products for measuring brain data. The company develops wearable EEG products, software, and mobile apps for brain research outside of laboratory settings. Applications include product innovation, consumer research, workplace wellness, software development, BCI-controlled apps and machines, research, and education. EMOTIV is a leading company in the neurotechnology space, having sold over 45,000 EEG devices and recorded more than 100 million minutes of EEG data across 800,000+ sessions.²⁴³



²⁴³ EMOTIV Homepage, *supra* note 76.

Flow Neuroscience

Location: Malmö, Sweden

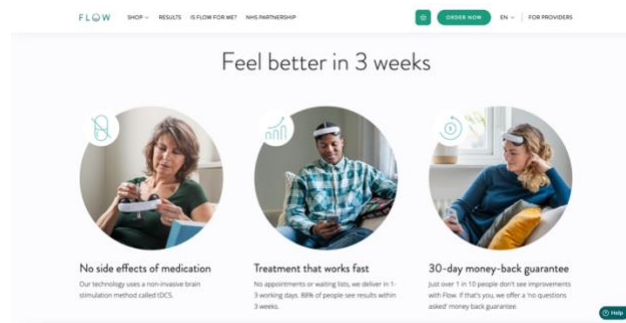
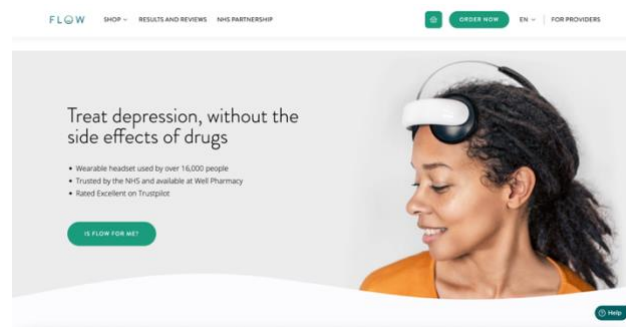
Product(s): Flow Headset

Price: €459.00 (\$495.00) for purchase; €89.00 (\$96.00) for monthly rental

Resources: [Website](#); [Privacy Policy](#); [Terms and Conditions](#)

The Flow Headset is a wearable device marketed to alleviate symptoms of depression. The Headset is designed to administer at-home treatment for depression, through 30-minute sessions occurring several times weekly. Using transcranial Direct-Current Stimulation (tDCS), the device sends electrical impulses into areas of the brain that regulate mood and motivation. The website claims that this at-home treatment is twice as effective as antidepressants and that 57% of Flow users are depression-free after 10 weeks.²⁴⁴

Flow Neuroscience is not a health provider, and the Flow Headset is not technically a medical device since anyone can purchase it without prescription or the intervention of a medical professional (note, however, that in March 2023, the United Kingdom's National Health Service began a trial to treat depression with the Flow Headset).²⁴⁵



²⁴⁴ *Flow Neuroscience Homepage*, supra note 82.

²⁴⁵ *The NHS and Flow*, FLOW NEUROSCIENCE, available at <https://www.flowneuroscience.com/nhs/nhs-flow-pilot/>.

Flowtime

Location: Hangzhou, China

Product(s): Flowtime Headband

Price: \$198.00 (headband only); \$267.99 (headband and one-year membership on the app)

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

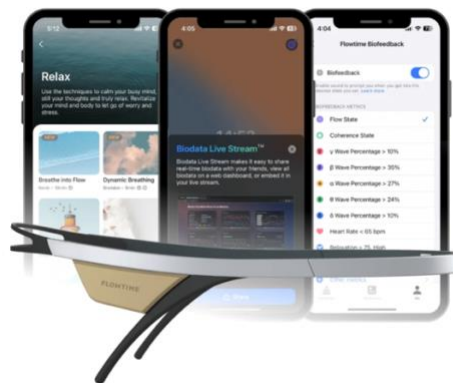
Flowtime is a Chinese startup that sells a series of meditation-related products. The Flow Headband is a wearable device that employs biofeedback training during meditation sessions. Tracking five types of brainwaves in addition to heart rate, the headband pairs with an app that provides breathing exercises and guided meditations while measuring, tracking the progress of, and visualizing levels of attention and relaxation. This allows users to engage in mindfulness training and hone their meditation skills.

The device and software are designed to show users what happens to the brain during meditation, presenting consumers with session reports quantifying neural activity and the quality of each meditation experience. In the words of the company, the device frees users from the “confusion about what meditation feels like, as you can see it.”²⁴⁶

Shop Now



Flowtime Biosensing Meditation Headband
From \$198.00 USD ~~\$216.00~~ Sale



²⁴⁶ Flowtime Technology, FLOWTIME, available at <https://www.meetflowtime.com/pages/technology>.

FocusCalm, by BrainCo

Location: Somerville, Massachusetts, USA

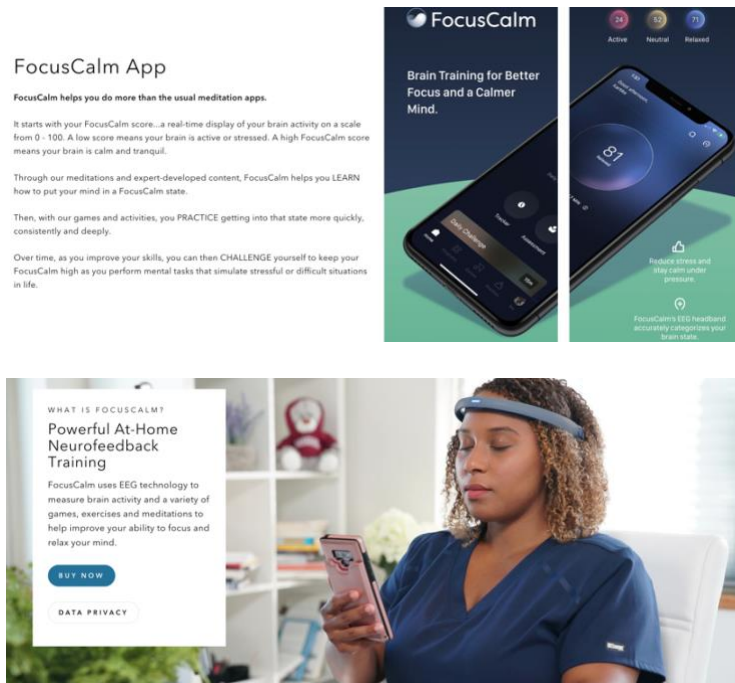
Product(s): FocusCalm EEG Headband

Price: \$249.99

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

BrainCo's FocusCalm EEG Headband is neurofeedback wearable device. Using artificial intelligence software, the headband and its associated app compare the consumer's brain activity to a model and displays a FocusCalm score that falls between 1 and 100. Consumers engage a series of games, meditations, and exercises in the app to practice raising their FocusCalm score. Once they see improvement in their ability to control their mindset and minimize stress, users continue to engage with specific games designed to practice staying calm under pressure, all while tracking their progress on the app. This process is explained on FocusCalm's website:

“Activities like meditation, neurofeedback and brain games can actually change the way your brain works. It's like learning any new skill . . . The more you practice, the better you get. With the neurofeedback in FocusCalm, your brain learns to prefer being relaxed and alert. And because the FocusCalm app tracks your score over time, you can see just how much you're improving.”²⁴⁷



The image contains two main promotional elements for the FocusCalm app. On the left is a text-based graphic titled "FocusCalm App" which explains the app's purpose and how it works. On the right is a visual graphic showing two smartphones displaying the app's interface, including a score of 81 and a "Brain Training for Better Focus and a Calmer Mind" message. Below these is a photograph of a woman wearing the EEG headband while looking at her phone. A text overlay on the left of the photo reads "WHAT IS FOCUSCALM? Powerful At-Home Neurofeedback Training" and includes a "BUY NOW" button and a "DATA PRIVACY" link.

FocusCalm App

FocusCalm helps you do more than the usual meditation apps.

It starts with your FocusCalm score...a real-time display of your brain activity on a scale from 0 - 100. A low score means your brain is active or stressed. A high FocusCalm score means your brain is calm and tranquil.

Through our meditations and expert-developed content, FocusCalm helps you LEARN how to put your mind in a FocusCalm state.

Then, with our games and activities, you PRACTICE getting into that state more quickly, consistently and deeply.

Over time, as you improve your skills, you can then CHALLENGE yourself to keep your FocusCalm high as you perform mental tasks that simulate stressful or difficult situations in life.

Brain Training for Better Focus and a Calmer Mind.

Hydrate, stress and sleep contribute to pressure.

FocusCalm's EEG Headband accurately categorizes your brain state.

WHAT IS FOCUSCALM?
Powerful At-Home Neurofeedback Training

FocusCalm uses EEG technology to measure brain activity and a variety of games, exercises and meditations to help improve your ability to focus and relax your mind.

[BUY NOW](#)

[DATA PRIVACY](#)

²⁴⁷ *How it Works*, FOCUSCALM, available at <https://focuscalm.com/pages/how-it-works>.

Healium, by StoryUP

Location: Columbia, Missouri, USA

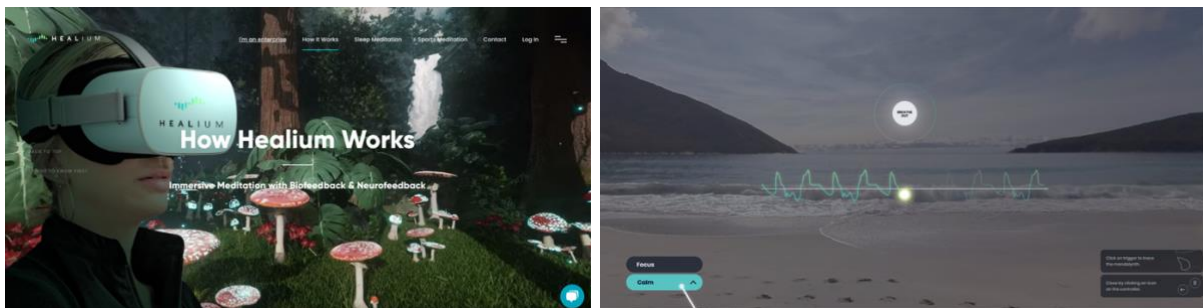
Product(s): Healium experience (BrainLink Lite EEG headband + a VR headset)

Price: \$199.00 + \$10.99/month (BrainLink Lite and Healium Pro App monthly membership); or \$769.00 + \$10.99/month (BrainLink Lite, VR kit, and Healium Pro App monthly membership)

Resources: [Website](#), [Privacy Policy](#); [Terms and Conditions](#)

Designed for use during meditation, Healium allows users to access live data about brain and heart activity, shaping immersive meditation sessions that are guided by neurofeedback and biofeedback. Consumers purchase either a standalone VR kit or a VR kit with a BrainLink Lite EEG headband. Both the VR headset and the EEG headband pair with apps that guide users through meditation sessions where detected changes in neural and physiological activity transform the VR colorscape in real time (green colors signal higher levels of focus and calm, whereas gold colors signal lower levels and the need for adjustment). Users are encouraged to “power the [VR] experiences with a BrainLink Lite EEG headband and see your brainwaves personified as an aura in virtual reality.”²⁴⁸ After each session, users receive a Healium score measuring their focus and calm, and they can additionally explore their heart rate and brainwave data. The product has applications for both sleep meditation and sports meditation, and is advertised as follows:

“Your brain is a muscle. Healium is your workout. Healium removes the mystery surrounding meditation where you wonder...am I doing this right? You finally have data to track progress, drive motivation, and train your mental fitness. But, data is only useful if you know how to use it! Healium helps you understand your brainwave data by providing a baseline, a glowing aura that changes color with your brainwaves, a Healium score after each session, and brain pattern data in your data dashboard. Keep in mind, Healium and its compatible wearables are not diagnostic. They’re self awareness tools that enable feedback so you can learn to self-regulate. Afterall, how are you supposed to learn to control what you can’t SEE? Healium allows you to see your feelings.”²⁴⁹



²⁴⁸ *Homepage*, HELIUM, available at <https://www.tryhealium.com/>.

²⁴⁹ *How it Works*, HELIUM, available at <https://www.tryhealium.com/how-it-works/>.

iBand+, by Arenar B.V

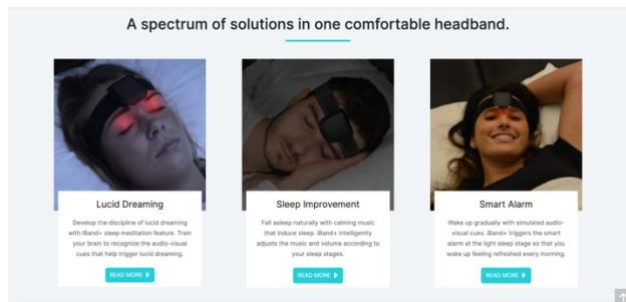
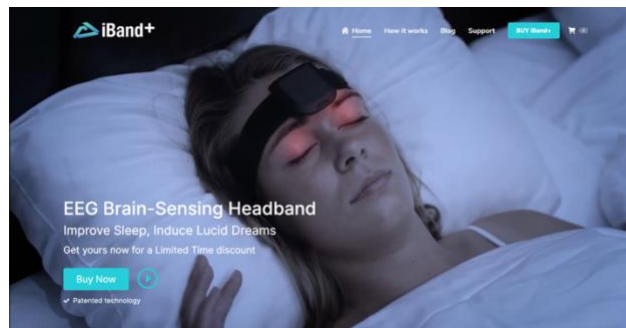
Location: Amsterdam, Netherlands

Product(s): iBand+

Price: \$399.00

Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#)

The iBand+ is an EEG sensing and motion detection headband. The device is marketed as a sleep-aid with three key functions: lucid dreaming, sleep improvement, and a smart alarm. According to its website, iBand+ is the “perfect guide to achiev[ing]” lucid dreaming, with the iBand+ app providing brain training and sleep meditation exercises specifically designed to prime the brain for lucid dreaming.²⁵⁰ To encourage sleep improvement, the device uses AI algorithms to adjust audio to different sleep stages, starting with calming music and switching to white noise once the user is asleep. In the morning, the iBand+ wakes users up with a smart alarm that stimulates sunlight at the optimal time in the sleep cycle, minimizing grogginess. The app gives users access to customized reports on sleep patterns, sleep insights, brainwave tracking of EEG bands (delta, theta, alpha, beta, gamma), and a selection of audio-visual stimulus choices.



²⁵⁰ *Lucid Dreaming with iBand+*, IBAND+, available at <https://www.ibandplus.com/lucid-dreaming/>.

IDUN Technologies

Location: Opfikon, Switzerland

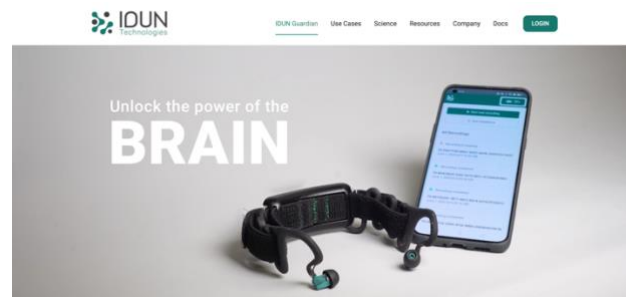
Product(s): IDUN Guardian

Price: Unavailable

Resources: [Website](#); [Privacy Policy for Mobile Applications](#)

The IDUN Guardian is an EEG headphone device with cloud-based software designed to record, download, and stream EEG Data. It has applications both for hobbyists and software developers: hobbyists can record and store data with a user-friendly, coding-free user interface, while researchers and developers can use Python SDK to design experiments and receive high quality neural data. The IDUN Guardian has two main use cases: sleep insights and hearing.

The IDUN Technology website notes that smartwatches are widely used to measure sleep quality, but they lack accuracy because they fail to measure brain activity. It also notes that earbuds are “socially accepted and widely used,” making them “the ideal modality for a non-invasive BCI.”²⁵¹ EEG sensors in the earbuds monitors brain activity during both sleep and wakefulness, while the software allows users to record, store, and download their data for personal use. The device also has implications on hearing, allowing users to access insights on how their brainwaves interact with specific sounds, rhythms, and frequencies. In addition, the in-ear EEG sensors can help facilitate conversations in loud environments, since they record both brain activity as well as electrooculography (EOG) signals from the ear canal.



²⁵¹ IDUN Guardian, IDUN TECHNOLOGY, available at <https://iduntechnologies.com/idun-guardian-in-ear-ee-platform/>.

Macrotellect

Location: Shenzhen, China

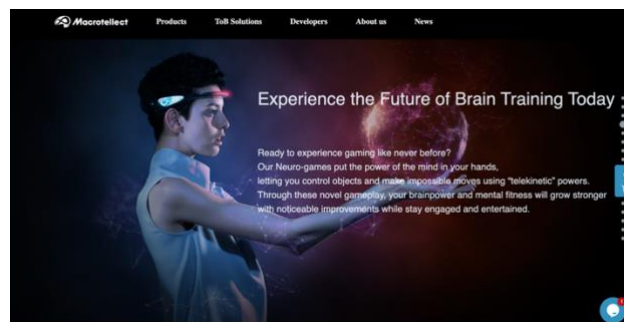
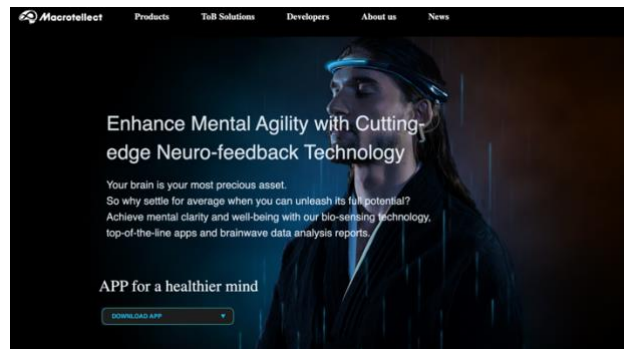
Product(s): Various BrainLink products

Price: Products range from \$30.00 to \$259.00

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

Macrotellect is a Chinese company that develops mental fitness products. The company sells hardware and software solutions, including a “mind control series” (this series includes a Brainwave Lamp, which turns different colors in response to different levels of relaxation and focus, and a Mind-Control Spider, which activates movement in response to concentration), EEG accessories (such as a sports cap and a yoga headband), and EEG-sensing headphones.²⁵²

Macrotellect also sells several smart headsets such as the BrainLink Pro 3.0, which detects brainwaves, heartrate, and forehead temperature at the same time while providing the user with data-driven insights and brain training opportunities.



²⁵² *Hardware, MACROTELLECT, available at <https://o.macrotellect.com/2020/Hardware.html>.*

mBrainTrain

Location: Belgrade, Serbia

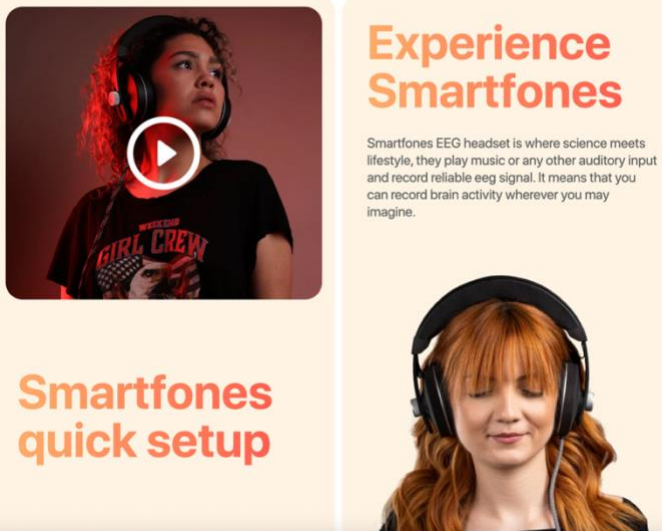
Product(s): Various products, including the Smarting Pro line

Price: Unavailable

Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#)

mBrainTrain offers hardware and software solutions for brain research and monitoring. The products are designed to be portable and accessible, allowing a range of consumers to utilize neurotechnology in their daily lives. The website explains: “With each new product, we make EEG closer to real life – we enable mobile, outdoor, and social experiments, and work on further advancement of the brain recording technology with the ultimate goal to make it a part of our everyday.”²⁵³

mBrainTrain markets itself as a mobile EEG company. Its product offerings include Smartphones, an EEG headphone set, and Smarting, a wireless EEG cap for the recording and monitoring of brain activity. Both products are intended for application outside of lab settings. Smarting devices collect raw EEG data and stream them onto the user’s cell phone for analysis. mBrainTrain advertises Smartphones on its website by saying, “We have created a powerful tool for all creative and disruptive minds who want to bring pioneering EEG work to life and apply neuroscience in an everyday setting.”²⁵⁴



Smartphones
quick setup

Experience Smartphones

Smartphones EEG headset is where science meets lifestyle, they play music or any other auditory input and record reliable eeg signal. It means that you can record brain activity wherever you may imagine.

²⁵³ *Homepage*, MBRAINTRAIN, available at <https://mbraintrain.com/>.

²⁵⁴ *Smartphones*, MBRAINTRAIN, available at <https://mbraintrain.com/smartphones-eeg-headset/>.

Mendi

Location: Stockholm, Sweden

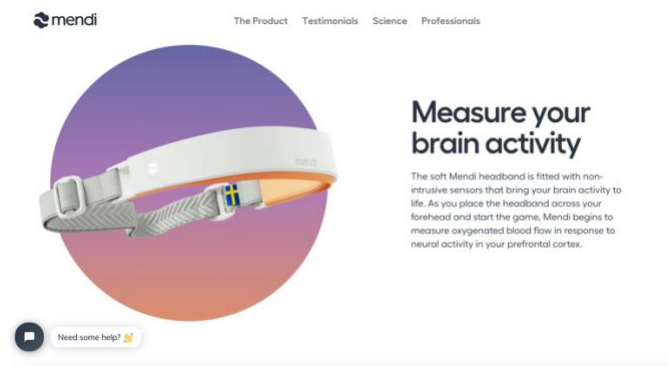
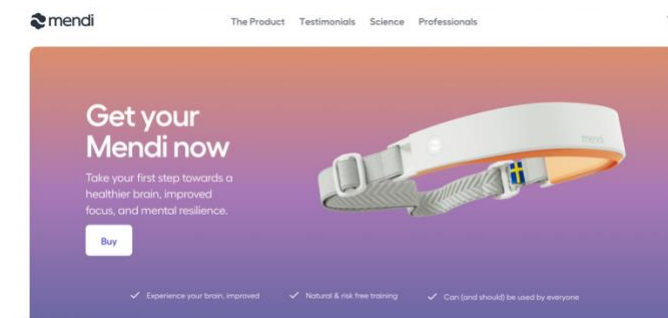
Product(s): Mendi Headset

Price: \$299.00

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

The Mendi Headband is a neurofeedback device marketed as a brain training tool. It differentiates itself from similar products by using functional near-infrared spectroscopy (fNIRS) neurofeedback instead of EEG. fNIRS uses optical sensors to measure and detect changes to blood flow and oxygenation in the brain. Mendi's fNIRS technology measures brain responses to neural activation prompted by the headband, with software translating that brain activity into graphics on the Mendi mobile app.

On the app, Mendi users attempt to move a ball across the screen using brain activity: the steeper the curve of the ball's trajectory, the more blood flow detected by the Mendi Headband in the prefrontal cortex. This allows users to visualize their brain activity, and, according to Mendi, to improve brain health by improving cognitive functioning. Mendi encourages its customers to use the Mendi device at least three times per week for ten minutes each session. As the website explains, this enables users to "strengthen your prefrontal cortex, enabling better sensory processing, heightened emotional regulation, sharper focus, and increased ability to sustain concentration."²⁵⁵



²⁵⁵ *Focus, MENDI, available at* <https://www.mendi.io/pages/focus>.

Muse, InteraXon

Location: Toronto, Ontario, Canada

Product(s): Muse

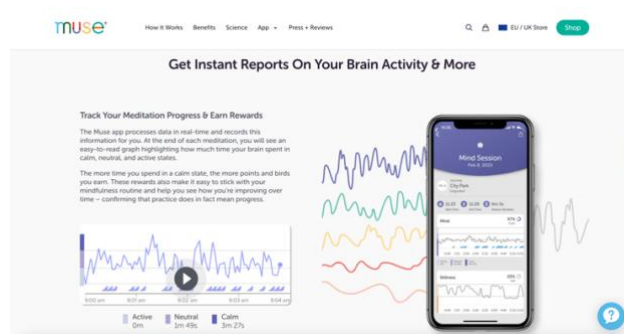
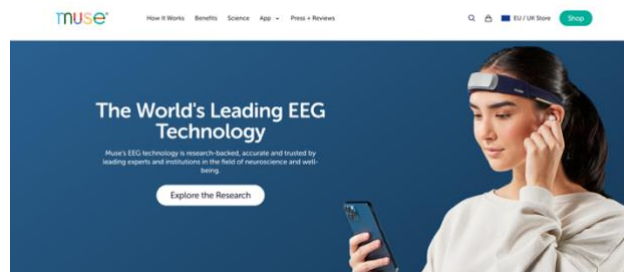
Price: €335.98 (\$362.00, Muse 2 Gen 2 Headband + Premium Subscription Bundle); €247.98 EUR (\$267.00, Muse 2 Headband + Premium Subscription Bundle)

Resources: [Website](#); [Privacy Policy](#), [End User License Agreement](#), and [Terms of Service](#)

The Muse headset is an EEG neurofeedback device for guided meditations and deep sleep. After putting on the headband, users select a meditation experience from the app and listen to audio cues intended to keep the mind focused. The device functions as a personal meditation coach. The Muse website explains:

“Muse senses when your mind is active and distracted, neutral and at rest, or calm and deeply focused and translates your brain activity into the guiding sounds of nature. When your mind is distracted during meditation, you will hear waves, wind, or rain. These gentle cues help you direct your focus back to your breath. When your mind is clear and calm during meditation, you will hear soothing nature sounds that let you know you are in a calm state.”²⁵⁶

Following the meditation session, users review data collected during meditation and track trends across sessions. The Gen 2 headband comes with over 500 guided meditations for focus, stress, and sleep, as well as personalized sleep experiences, sleep scores, tracking, and insights, and the ability to pair with various external applications.



²⁵⁶ *How it Works*, MUSE, available at <https://choosemuse.com/pages/how-it-works>.

Myndlift

Location: Tel Aviv, Israel

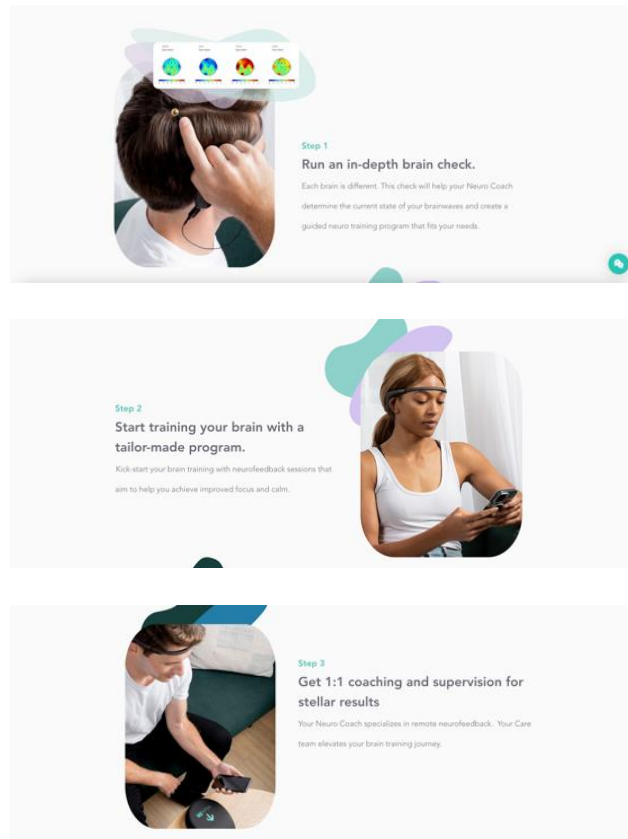
Product(s): Myndlift Brain Training Kit

Price: \$150.00 (monthly payment); \$399.00 (payment every three months) \$750.00 (payment every six months). Customers who don't already own hardware pay an additional \$199.00.

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

Myndlift offers neurofeedback training to hone states of focus and calm. It combines its own software with InteraXon's Muse EEG headband to measure brain activity and provide individualized training plans. The so-called Myndlift journey includes an EEG kit, a brain health check, an initial meeting with a Myndlift Neuro Coach, regular training sessions, and monthly meetings with the Neuro Coach to discuss progress and onward training. After the initial assessment, the Neuro Coach creates a customized training plan for the user based on individual goals and perceived mental state.

Training plans involve neurofeedback games that respond to brainwaves detected by EEG sensors in the Muse headband. The Myndlift website explains, "When your brainwaves are in the target range, you will advance in the game or have a crisper viewing experience. This real-time monitoring and rewarding is known as operant conditioning. By training consistently over time, operant conditioning can retrain your brain activity, optimizing your mental state, with implications for improved focus, reduced anxiety and more."²⁵⁷



²⁵⁷ *How it Works*, MYNDLIFT, available at <https://www.myndlift.com/how-it-works>.

MyndPlay

Location: London, United Kingdom

Product(s): Various EEG products

Price: Hardware products range from £199.00 to £400.00 (\$251.00 to \$505.00); software products range from no cost to £79.99 (\$101.00).

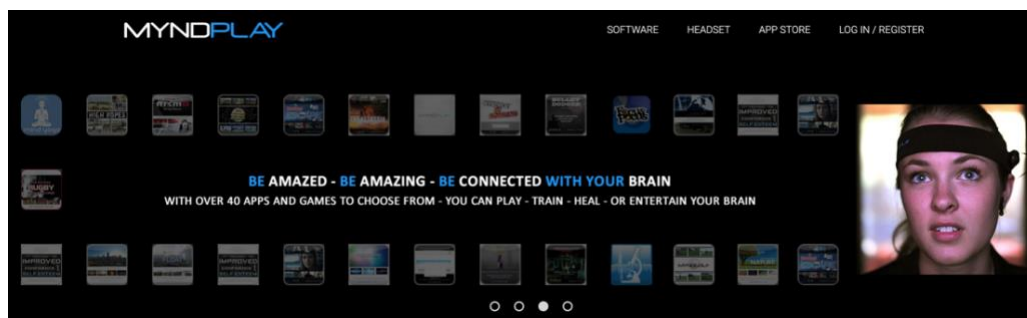
Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#)

MyndPlay offers a variety of products that utilize EEG technology to provide users with brain training and recreation. The products allow users to interact with and influence a series of media using their brain activity, including apps, video games, and movies. MyndPlay’s website writes that “the MyndPlay platform was created to empower users to train their brains to improve attention, meditation skills, and the ability to overcome mental obstacles through entertainment, simulations and guided training applications.”²⁵⁸

MyndPlay products include the Mynd-Fitness Bundle and the MyndBand BLE + GoCalm Bundle. The Mynd-Fitness Bundle offers a research-grade EEG monitor, a cap, analysis tools, and several brain fitness apps. It is “the ultimate package for training self control and mental resilience.” The MyndBand BLE + GoCalm Bundle includes an EEG headset and an app with guided trainings to minimize exam anxiety and help users perform under pressure. As advertised on MyndPlay’s online store:

“GoCalm is designed to help learners identify how it feels to be calm and focused so they can bring that state of mind into their exams. Need to relax and focus quickly? Follow the guided videos for techniques to relieve anxiety and move towards a more relaxed and focused state of mind. Want to improve focus and learn how to feel calm at times of stress? Train your brain by understanding and visualising how it feels to be calm, focused or both with a series of exercises.”²⁵⁹

In addition, MyndPlay sells a range of other EEG headsets, research kits, apps, and accessories.



²⁵⁸ Homepage, MYNDPLAY, available at <https://myndplay.com/>.

²⁵⁹ MyndBand BLE + GoCalm Bundle, MYNDPLAY, available at <https://store.myndplay.com/products.php?prod=44>.

Myneurva

Location: Austin, Texas, USA

Product(s): Myneurva Remote Brain Station

Price: \$3,599 (10 neurofeedback sessions + 2QEEGs); \$4,899 (20 neurofeedback sessions + 3 QEEGs); \$6,199 (30 neurofeedback sessions + 4QEEGs)

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

Myneurva is a remote brain training company. According to its website, Myneurva is a global leader in neurofeedback and computational QEEG (quantitative electroencephalogram) analysis.²⁶⁰ The company offers remote neurofeedback training with the goal of improving mental health. It ships consumers a Myneurva Brain Station to operate from home, containing an EEG cap with 19 sensors, a laptop, gel, applicators, and an EEG amplifier. During sessions, consumers connect over Zoom with Myneurva staff (called Brain Tuners) who make sure that the EEG cap and connection are working correctly. The consumers then engage in hour-long sessions that are controlled remotely by the Brain Tuners.

Myneurva uploads EEG data to its cloud server, where the data is subjected to Advanced Neuro Network Analysis (ANNA), Myneurva's patented machine learning EEG assistant. Myneurva neurofeedback experts (called NeuroPractors) then discuss the data with the consumers, who continue engaging in sessions and consultations. The consumers generally complete their training after 20 sessions and return the Brain Station to Myneurva, though they have the option to continue.

Myneurva is not a medical device, and consumers can purchase neurofeedback sessions without referral from their doctors. Note, however, that the Myneurva's NeuroPractor team consists of physicians and psychologists.



²⁶⁰ *Homepage, MYNEURVA, available at <https://myneurva.com/>.*

Narbis

Location: Ambler, Pennsylvania, USA

Product(s): Narbis Smart Glasses

Price: \$690.00

Resources: [Website](#); [Privacy Policy](#), [Terms of Service](#), [Terms of Sale](#), and [End User License Agreement](#)

Narbis is a company that employs NASA-patented technology to measure levels of mental engagement. It uses operant conditioning to train users towards achieving higher levels of focus through neurofeedback. Users wear the Narbis Smart Glasses while working or studying. When the device detects shifts in attention, the color of the lenses change, alerting the consumer of their decreased attention and the need to refocus. Upon detecting more focus, the glasses change back to their original clear tint. In this way, “Narbis provides immediate and instantaneous feedback on attention, which discourages distractibility and encourages and rewards attention.”²⁶¹

Narbis Smart Glasses come with a tablet that provides training summaries with data concerning levels of focus and distraction. The glasses and tablet pair with an app that displays performance and tracks progress across sessions.

The image displays two screenshots from the Narbis website. The top screenshot features the Narbis logo and a navigation menu. The main content area includes the text: "Wear 2 or 3 times a week for 30 mins", "Feel empowered by technology that helps practice concentration.", and "While reading or working on a computer, or doing homework, Narbis provides instant feedback to recognize when you are distracted, giving you the cue to get back on task. The smart glasses help identify these behaviors which encourages you to shift into a relaxed and attentive state." To the right is a photograph of a young boy wearing the smart glasses while reading a book. The bottom screenshot also features the Narbis logo and navigation menu. The main content area includes the text: "Narbis technology tracks the brain patterns and provides feedback through the darkening and clearing of the glasses." Below this text is a diagram with five colored circles and corresponding waveforms: a red circle for "Awake, normal, alert, consciousness", an orange circle for "Calm, extremely aware, quietly alert", a yellow circle for "Relaxed, happy, calm, not thinking", a green circle for "Deep relaxation, meditation, mental clarity", and a blue circle for "Deep, dreamless sleep". To the right is a photograph of a young girl wearing the smart glasses while reading a book.

²⁶¹ Homepage, NARBIS, available at <https://www.narbis.com/>.

Neeuro

Location: Singapore

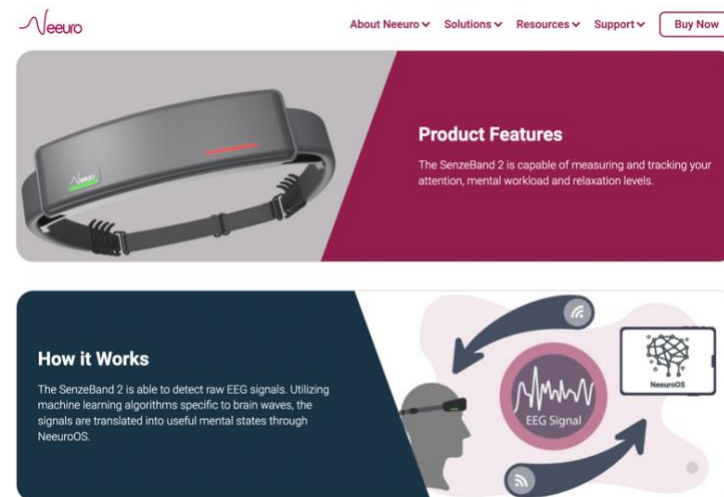
Product(s): SenzeBand 2

Price: \$429.00

Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#); [End User License Agreement](#)

Neeuro offers a series of brain training and tracking products, all of which use the SenzeBand, an EEG-sensing head device. The SenzeBand has seven dry electrodes (five on the prefrontal cortex and two on the sides of the head) and uses machine learning algorithms developed by Neeuro to derive insights on attention levels, fatigue, relaxation, stress, and other mental states. The device is marketed for application to brain fitness, attention training, stress management, software development, and brain activity visualization.²⁶²

The SenzeBand comes with a membership to the Memorie app, which provides self-directed brain fitness training across 18 mobile games (targeting attention, memory, decision making, spatial ability, and flexibility), as well as enrollment in the NeeuroFIT brain training course, which attempts to sharpen cognitive performance among students, elderly individuals experiencing cognitive decline, and professionals. Neeuro additionally offers an attention training program for children (Cogo Attention Training Program: \$1,158.00) and a stress management program (Galini Stress Management: \$429.00).



²⁶² *SenzeBand*, NARBIS, available at <https://www.neeuro.com/senzeband>.

Neuphony

Location: Uttar Pradesh, India

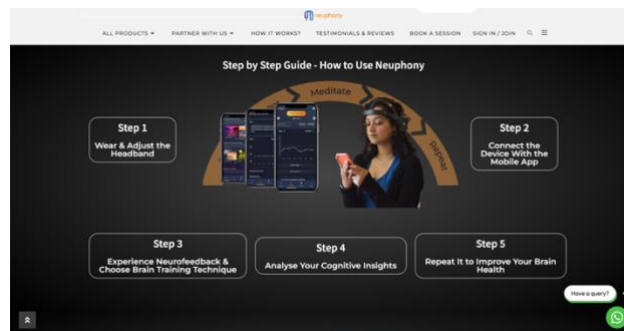
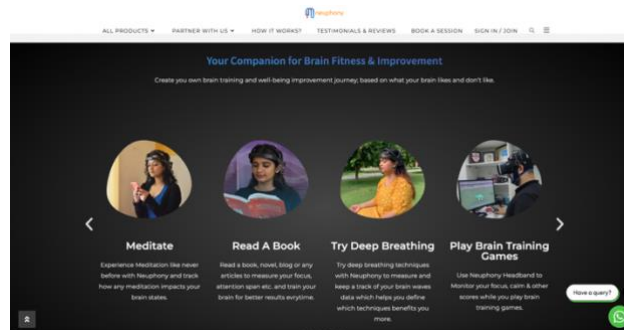
Product(s): Neuphony Headband

Price: ₹49,000.00 ((\$590.00, Neuphony Headband and mobile app); ₹79,000.00 (\$952.00, Neuphony Headband and one year desktop app)

Resources: [Website](#); [Privacy Policy](#); [Terms and Conditions](#)

The Neuphony Headband is a six-channel EEG headset designed for neurofeedback brain training. The device, which connects to a mobile app using Bluetooth, has eight dry sensors that capture data from the temporal, parietal and frontal lobes of the brain. Neuphony provides insights on focus, attention, calm, stress, mood, and posterior dominant rhythm (which is an oscillatory EEG pattern present when eyelids are closed). Through Neuphony, the website explains, “individuals are able to modify brain waves by providing feedback and rewards. For example, during meditation, music volume decreases with declining focus and increases with improved focus.”²⁶³

Neuphony markets its headband as improving focus and helping users achieve calm, relaxation, flow, and “inner peace.” The website states that over 200 customers have purchased Neuphony for their individual brain health journeys, while the device has additionally been used over 1,000 times in corporate wellness workshops and sessions at Neuphony Brain Gyms (which offer individual brain training sessions and have 30+ locations across India and Europe).²⁶⁴



²⁶³ EEG Headband, NEUPHONY, available at <https://neuphony.com/brain-wearables/eeg-headband/>.

²⁶⁴ Neuphony Homepage, supra note 83.

Neurable

Location: Boston, Massachusetts, USA

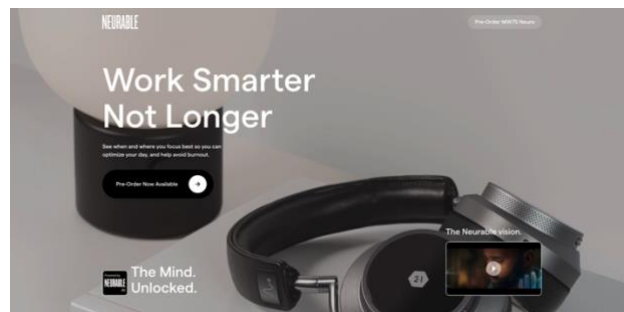
Product(s): MW75 Neuro

Price: \$649.00 [available for pre-order]

Resources: [Website](#); [Privacy Policy](#)

Neurable is a company that seeks to bring neurotechnology into everyday life. The MW75 Neuro is a smart headphone device that provides both premium sound as well as neural analysis. It has two stated goals: to help people work smarter, not longer, and to facilitate data-driven focus. Neurable's headphones have 12 EEG channels and dry sensors designed to track focus levels. The noise canceling headphones use artificial intelligence software to record and interpret EEG data, with insights displayed on a Neurable app.

The MW75 Neuro has several applications, including tracking how daily activities impact focus to optimize performance, suggesting the most optimal times for breaks, and discouraging distractions through the Neurable Focus score, which times and measures focus. The app provides both trends and informed recommendations, so that users can “see when and where you focus best so you can optimize your day, and help avoid burnout.”²⁶⁵



Introducing: MW75 Neuro



²⁶⁵ *Smart Headphones*, NEURABLE, available at <https://www.neurable.io/#smartHeadphones>.

Neuronic

Location: Wenden, Germany

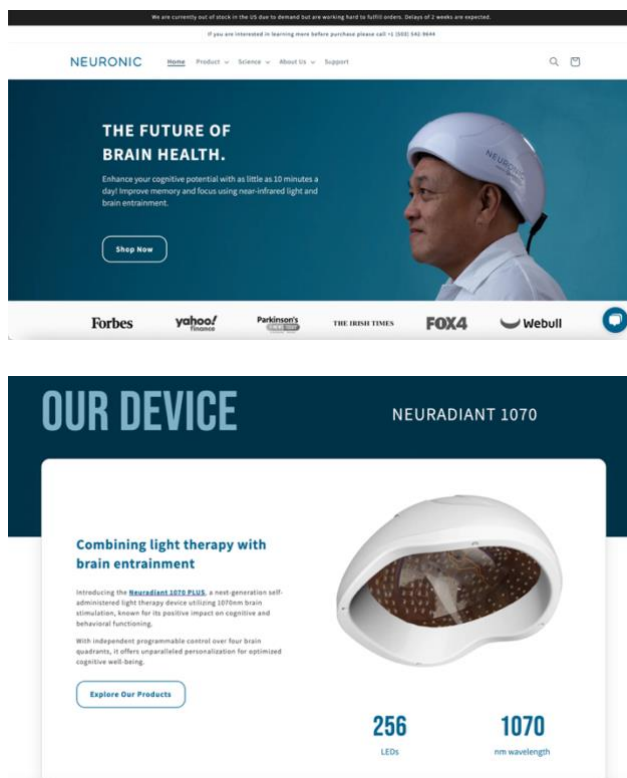
Product(s): Neuradiant 1070

Price: \$2,995.00 (The Neuradiant 1070); \$4,995.00 (Neuradiant 1070 Plus)

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

The Neuradiant 1070 is an at-home photobiomodulation device. It allows users to self-administer light therapy through transcranial photobiomodulation, whereby LEDs are placed on the scalp to project particular wavelengths of light onto specific parts of the brain. Neuronic's device uses EEG to administer transcranial photobiomodulation, with LED pulse rates synced to neural data collected by the helmet.

Neuronic's helmet is not a medical device, but the website cites a wealth of clinical studies to argue that near-infrared light positively impacts the brain with regard to Alzheimer's, Parkinson's, long COVID, autism, ADHD, PTSD, brain injuries, depression, anxiety, and wellness.²⁶⁶ The stated benefits of the Neuradiant 1070 are cognitive enhancement, immune support, sleep optimization, and blood circulation. In addition, the website notes that the Neuradiant 1070 can improve memory and focus in as little as 10 minutes per day. Reviews featured on Neuronic's website claim the helmet helps with depression, memory loss, brain fog, and mood.²⁶⁷



²⁶⁶ *Homepage*, NEURONIC, available at <https://neuronic.online/>.

²⁶⁷ *Id.*

NeuroOptimal®, by Zengar Institute Inc.

Location: Victoria, British Columbia, Canada

Product(s): NeuroOptimal® Bundles

Price: \$10,995.00 (NeuroOptimal® Tablet Bundle, unlimited license); \$7,995.00 (NeuroOptimal® Tablet Bundle, limited license); \$10,495.00 (NeuroOptimal® Tablet Bundle, unlimited license)

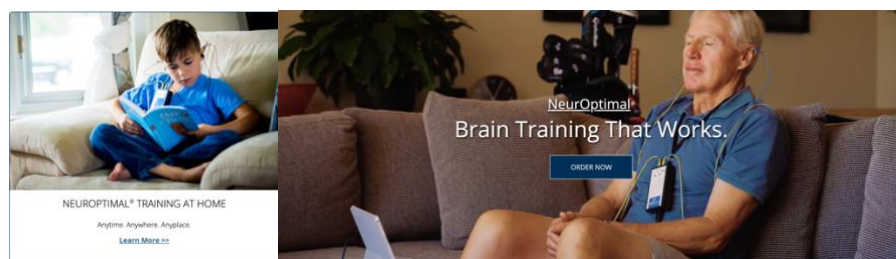
Resources: [Website](#); [Privacy Policy](#); [Terms and Conditions](#)

NeuroOptimal® is a brain training system currently used in 76 different countries. The brain training systems have logged over 3 million hours of use globally. NeuroOptimal® employs EEG neurofeedback and is marketed to both businesses and individual consumers. Consumers purchase a NeuroOptimal® bundle, which includes a laptop or tablet configured with NeuroOptimal® software and accompanied by sensors, earbuds, cables, and conductive paste. The neurofeedback system has a wide range of applications including golf, martial arts, yoga, sleep, performing arts, study, and more. Zengar Institute Inc. lists confidence, sleep management, heightened mental focus, improved relationships, and greater levels of happiness, well-being, and sense of self as benefits of NeuroOptimal®.

Unlike many of the other products in this study, this product is explicitly marketed for use by children as well as adults. The website notes that all ages can benefit from NeuroOptimal® brain training, and that current users range from infants under one years old to adults “well into their nineties and beyond.”²⁶⁸

The product’s website explains:

“NeuroOptimal® neurofeedback is the ultimate self-improvement tool because it helps your brain become more “fit” and resilient. When your brain is at its best, the inevitable life challenges and stressors are less daunting. Work tasks flow more easily. You feel happier. You live more in the present moment and less in the past or in an uncertain future. Instead, you can focus on things that matter: achieving your personal goals, attaining professional advancement, deepening your relationship with family and friends, and rolling more smoothly with life’s uncertainties.”²⁶⁹



²⁶⁸ *NeuroOptimal® Home Training*, NEUROOPTIMAL, available at <https://neuroptimal.com/home-training/>.

²⁶⁹ *Id.*

Neurocity

Location: New York City, New York, USA

Product(s): Neurocity CROWN™

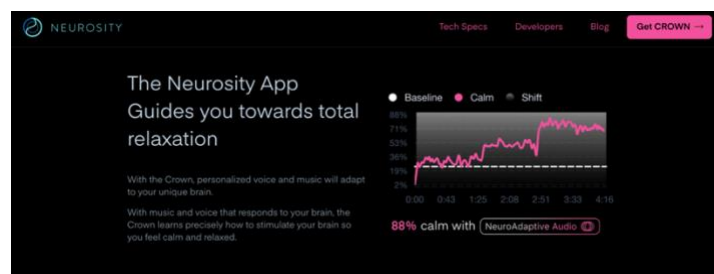
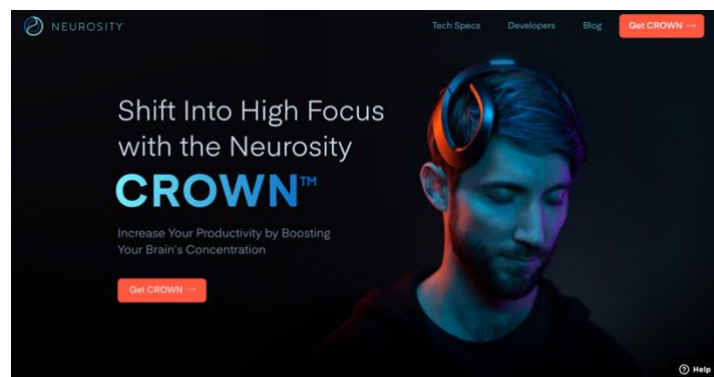
Price: \$1,199 (with no travel case); \$1,258 (with a travel case)

Resources: [Website](#); [Privacy Policy](#); [Terms of Service](#)

Neurocity's CROWN™ is a brain sensing and imaging wearable device. Utilizing eight EEG sensors, the CROWN™ provides neural insights and neurofeedback to users interested in increasing their productivity and focus levels. Neurocity's device pairs with the Neurocity App, which displays dashboards and allows users to track their levels of focus. The CROWN™ is music-based, employing audio cues to help train brain activity. The product description explains that:

“The Crown will boost your brain’s concentration by detecting your brainwaves and playing music and voice that helps you get into the zone and hyper-relax. On average it takes a person 25+ minutes to experience a Shift into High Focus, but with the Crown people regularly experience a shift in 5 minutes or less!”²⁷⁰

The Neurocity CROWN™ also includes an AI-guided meditative experience called NeuroAdaptive Meditation. With customized mindfulness training and AI-directed audio prompts, the CROWN™ supposedly helps users “dive into a deep meditative state and reach hyper-relaxation.”²⁷¹



²⁷⁰ *Neurocity Crown*, NEUROSCITY, available at <https://neurocity.co/crown>.

²⁷¹ *Homepage*, NEUROSCITY, available at <https://neurocity.co/>.

NeuroSky

Location: San Jose, California, USA

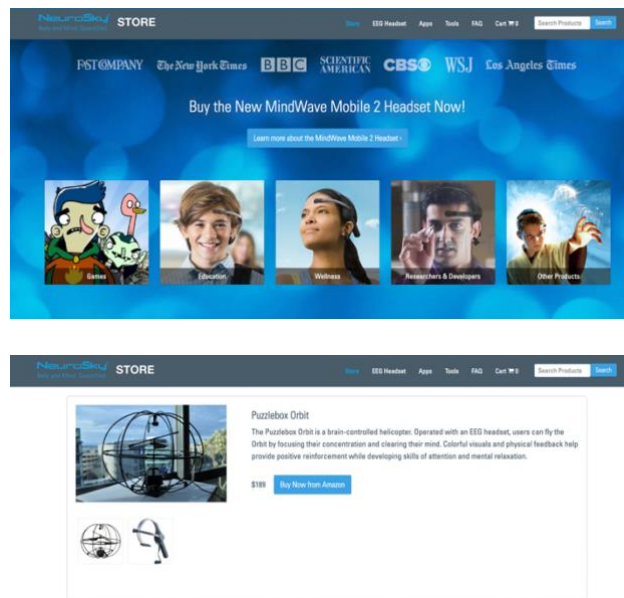
Product(s): MindWave Mobile 2 Headset

Price: \$129.99

Resources: [Website](#); [Privacy Policy](#); [Terms of Use](#)

NeuroSky sells an EEG headset alongside several apps and recreational games. NeuroSky claims that the MindWave headset is the “most affordable brainwave-reading EEG headset available,” and that it can “transform science fiction into reality from the comfort of your living room.”²⁷² The headset, which detects neural activity through EEG sensors and interprets it using NeuroSky software, pairs with over 100 apps (sold separately) developed by NeuroSky and third party developers. According to NeuroSky, these apps are “brainwave powered,” meaning that they respond to brainwaves detected by the EEG headset.²⁷³

The MindWave Mobile 2 Headset also pairs with a series of physical toys. These include the Hologram Experience (\$49.99), where detected changes in brainwaves result in changes in the shape of the hologram, and the Puzzlebox Orbit helicopter (\$129.99), which users can supposedly fly using concentration and focus.”²⁷⁴ The headset can additionally be used for those seeking to experiment with EEG data or create their own research projects.



²⁷² *MindWave Mobile 2*, NEUROSKY, available at <https://store.neurosky.com/pages/mindwave>.

²⁷³ *Id.*

²⁷⁴ *Store: Education*, NEUROSKY, available at <https://store.neurosky.com/#education>.

OpenBCI

Location: New York City, New York, USA

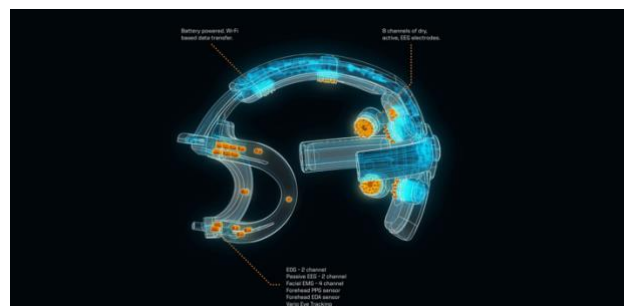
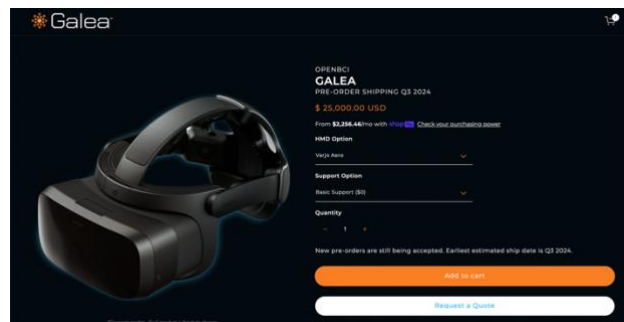
Product(s): Various open-source neuroscience and biosensing tools, including Galea

Price: Range of prices; \$25,000.00 (Galea)

Resources: [Website](#); [Galea Website](#); [Privacy Policy](#)

As its name implies, OpenBCI sells open-source brain-computer interface tools. Its products include electrodes, biosensing boards, EEG headware, VR headsets, and device accessories. It also offers a series of bundles, such as the 3D-Print-It-Yourself Neurotechnologist Bundle and the OpenBCI Instructional Bundle, which provides tools and training for beginners to collect physiological and neural data at home. OpenBCI sells research-grade products for application in research and consumer settings. The company's stated mission is to "lower the barrier to entry for brain-computer interfacing, while ensuring that these technologies are adopted into the consumer landscape in an ethical way that protects user agency and mental health."²⁷⁵

OpenBCI recently launched pre-order for its new spatial computing and neurotechnology wearable device, Galea. The product is advertised as a "bridge between mixed reality and neurotechnology,"²⁷⁶ integrating into Varjo extended reality headsets while simultaneously collecting data from the user's brain, heart, eyes, skin, and muscles using multi-modal sensors. Currently in its Beta program, Galea is expanding towards a product line called Galea Unlimited. Galea's technical combination of mixed reality, neural data, and advanced software development kits advances efforts to augment the human mind and body, and it is likely that Galea will play a central role in the consumer neurotechnology space in the coming years.



²⁷⁵ *About, OPENBCI, available at <https://openbci.com/about>.*

²⁷⁶ *Homepage, GALEA, available at <https://galea.co/#home>.*

Sens.ai

Location: Whistler, British Columbia, Canada

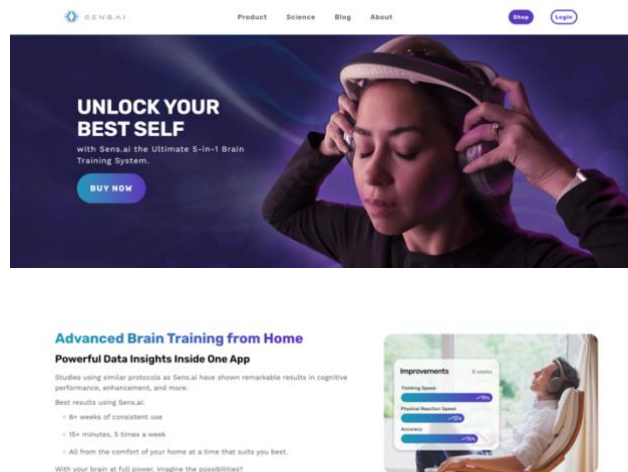
Product(s): Sens.AI Brain Training System

Price: \$1,500

Resources: [Website](#); [Privacy Policy](#); [Terms of Sale](#); [Terms of Sale](#)

Sens.ai offers an advanced neurofeedback headset system. The brain training system consists of a headset with headphones, a GeniusPulse Controller™ that plugs directly into the headset, and a mobile app that pairs to the devices using Bluetooth. The product operates through a blend of techniques, including transcranial photobiomodulation, heart coherence biofeedback (heart rate variability training), and neurofeedback. The headset has three brainwave sensors, seven LEDs, and a Pulse Oximeter for measuring heart activity. Programming can be tailored to individual goals such as stress reduction, meditation, or enhanced creativity, among others. As written on the Sens.ai website, “[the] programs allow you to train for the outcome that matters most to you. Sharper thinking? Better Focus? Calmer Mind? Sens.ai has you covered.”²⁷⁷

After each session, the app abstracts data and displays it by categories like flow (amount of time spent in flow state, longest streak of flow state, and recovery time when flow was disrupted), heart (heart rate, coherence, and HRV), and thinking speed (perception, classification, and processing). According to Sens.ai, the brain training system is “a professional-grade brain coach in your pocket. The combination of training (brain neurofeedback, heart focused neurofeedback and meditation), stimulation (transcranial photobiomodulation) and ongoing assessment is what makes Sens.ai truly remarkable. There is nothing like this in the world.”²⁷⁸



²⁷⁷ Homepage, SENS.AI, available at <https://sens.ai/>.

²⁷⁸ Id.

Unicorn, by g.tec medical

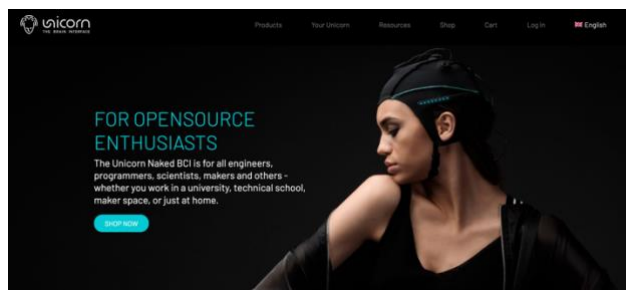
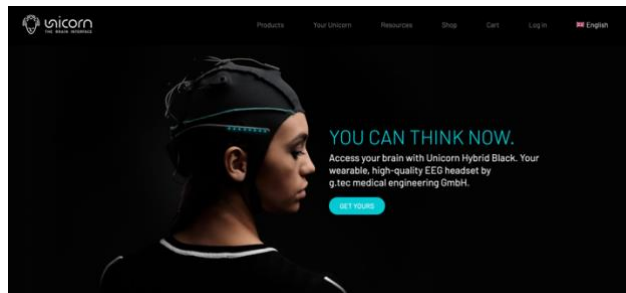
Location: Schiedlberg, Austria

Product(s): Various hardware and software products: Unicorn Naked BCI; Unicorn Hybrid Black; Unicorn Unity Interface; Unicorn Blondy Check; Unicorn Suite; Unicorn Speller; Unicorn Simulink Interface; Unicorn Python API

Price: Hardware solutions ranging from €979.00 to €1,089.00 (\$1,054.00 to \$1,173.00); software solutions ranging from €330.00 to €1,650.00 (\$355.00 to \$1,777.00)

Resources: [Website](#); [Privacy Policy](#); [Terms and Conditions](#)²⁷⁹

g.tec medical's Unicorn line offers BCI hardware and software solutions. The products are designed for researchers and hobbyists, as well as professionals who could apply neural data to their work. The Unicorn Naked BCI, for example, is a "DIY BCI" that enables users to build their own EEG headset, BCI applications, and open-source tools. This product allows users to access and process neural data for interaction with "artistic installations, toys, computer programs or applications."²⁸⁰ g.tec medical markets its hardware and software products to various kinds of consumers, such as game developers looking to integrate BCI technology into gaming experiences (single developers and large companies), students and professors engaging in BCI research, media artists integrating brainwave representations into their art, marketing professionals engaging in neuromarketing, therapists exploring new treatments, and at-home open source enthusiasts.



²⁷⁹ In email correspondence with g.tec medical, the researchers were informed the company "do[es] not have a device specific agreement, since we do not track any user data. The user has full access to all the files he records and nothing is shared at all . . . the device itself doesn't store any data; it just transmits data to the PC. On the PC side the user decides himself if he wants to store data or just display. All EEG/BCI data recordings have to be triggered by the user by will. The user has full access to all this data. There are no uploads or server interactions for EEG or BCI data. All hard-and software modules can be operated fully functional offline."

²⁸⁰ *Unicorn Naked BCI*, UNICORN BRAIN INTERFACE, available at <https://www.unicorn-bi.com/naked-bci/>.

URGOTECH

Location: Paris, France

Product(s): URGOnight

Price: \$499.00

Resources: [Website](#); [Privacy Policy](#); [Terms and Conditions](#)

URGOnight is a brain training program focused on sleep. The product is marketed to customers who struggle to fall asleep, are light sleepers, experience nighttime interruptions, or are otherwise dissatisfied with their sleep quality. URGOnight consists of an EEG headband and a paired app that offers users a sleep diary, a training calendar, sleep statistics, and customized sleep advice. Unlike several other sleep devices, URGOnight is designed for use during the day. Users do not wear the device to bed. URGOTECH refers to the product as the “world’s first daytime Sleep Training Program.”²⁸¹

URGOnight operates through neurofeedback. In particular, it attempts to train the brain to produce more brainwaves that are clinically associated with deeper sleep, occurring in the second stage of the sleep cycle. As the URGOnight FAQs explain:

“Visual and audio cues will notify you in real time when the headband detects these brainwaves. The more you train, the more you are able to identify which mental strategies or thoughts work best for you and learn to reproduce these brainwaves on demand, and you strengthen your neural network needed for sleep.”²⁸²

The screenshot displays the URGOnight website. The top navigation bar includes links for 'THE SCIENCE OF SLEEP', 'THE URGONIGHT PROGRAM', 'FAQ', 'SUCCESS STORIES', and 'BLOG'. A navigation menu below the bar lists 'Home', 'USE THE APP', 'HOW IT WORKS', and 'ORDER NOW'. The main content area features a testimonial from a user named 'Thuykhai' who reports improved sleep after 40 sessions. Below the testimonial is a section titled 'PRODUCE MORE OF THE BRAINWAVES CLINICALLY ASSOCIATED WITH SLEEP'. This section lists five brainwave types with their associated benefits and visual waveforms: Delta (4-8 Hz) for deep sleep, Theta (8-12 Hz) for reduced consciousness, relaxation, and meditation, Alpha (8-12 Hz) for alertness, High Beta (15-30 Hz) for concentration and training, and Gamma (>30 Hz) for high brain stimulation. At the bottom, two icons indicate 'Fall asleep 45% faster' and 'Reduce nighttime awakenings by 53%'. A 'Support' button is located in the bottom right corner.

²⁸¹ *The URGOnight Program*, URGONIGHT, available at <https://www.urgonight.com/na-us/en/product>.

²⁸² *URGOnight FAQs*, URGONIGHT, available at <https://www.urgonight.com/na-us/en/faqs>.