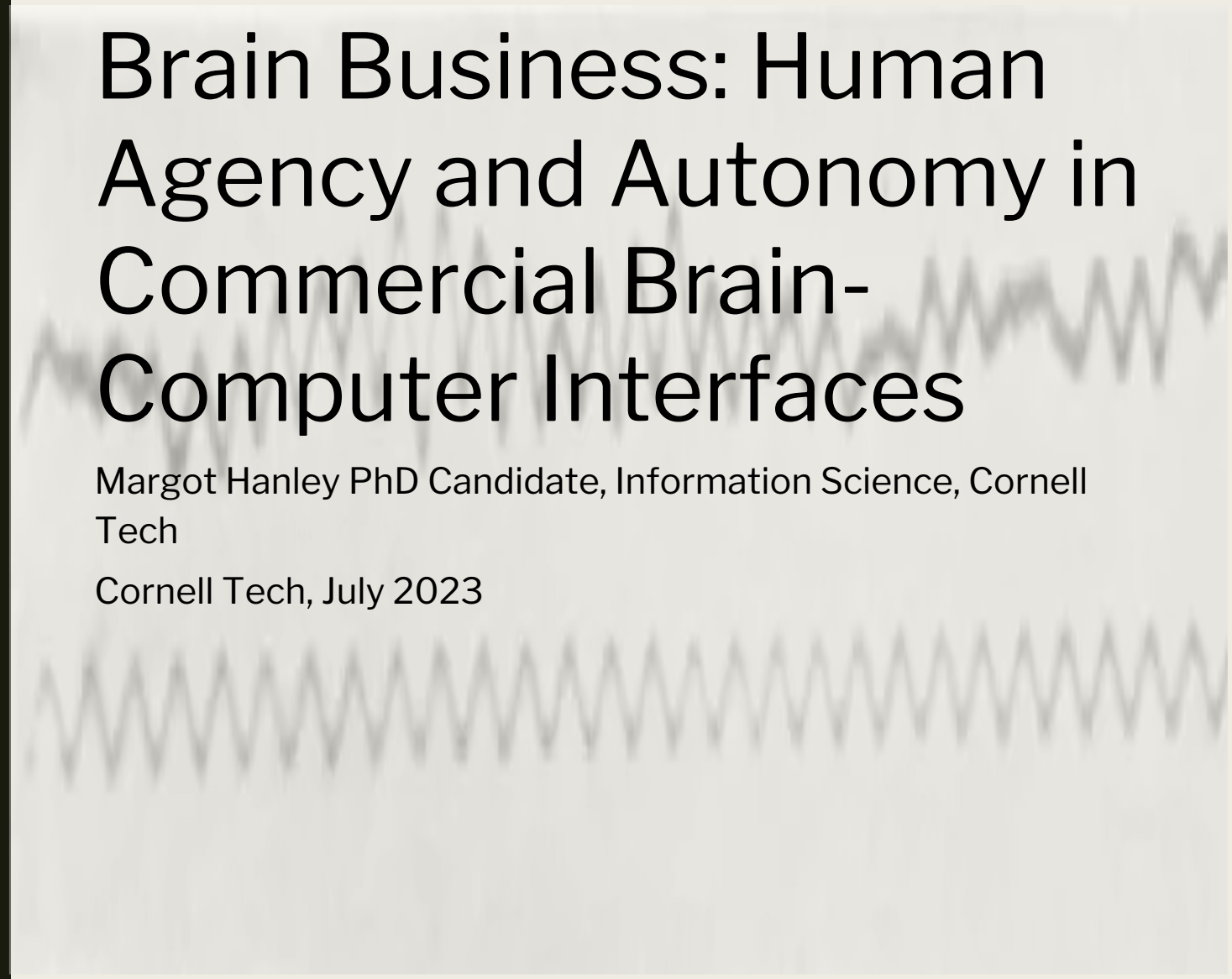
Brain Business: Human Agency and Autonomy in Commercial Brain-Computer Interfaces

Margot Hanley PhD Candidate, Information Science, Cornell Tech

Cornell Tech, July 2023



CORNELL TECH

Cornell Bowers C·IS
College of Computing and Information Science

Mind-reading technology has arrived

An AI-powered “brain decoder” can now read your thoughts with surprising accuracy.

By Sigal Samuel | May 4, 2023, 7:30am EDT

SHARE

PhD student Jerry Tang prepares to collect brain activity data in the Biomedical Imaging Center at the University of Texas at Austin. | Nolan Zunk/The University of Texas at Austin

Sigal Samuel is a senior reporter for Vox’s Future Perfect and co-host of the Future Perfect podcast. She writes primarily about the future of consciousness, tracking

May 2023

MOTHERBOARD
TECH BY VICE

Scientists Use GPT AI to Passively Read People's Thoughts in Breakthrough

An AI model similar to ChatGPT was combined with fMRI readings to non-invasively decode continuous language from subjects, a new study reports.

2

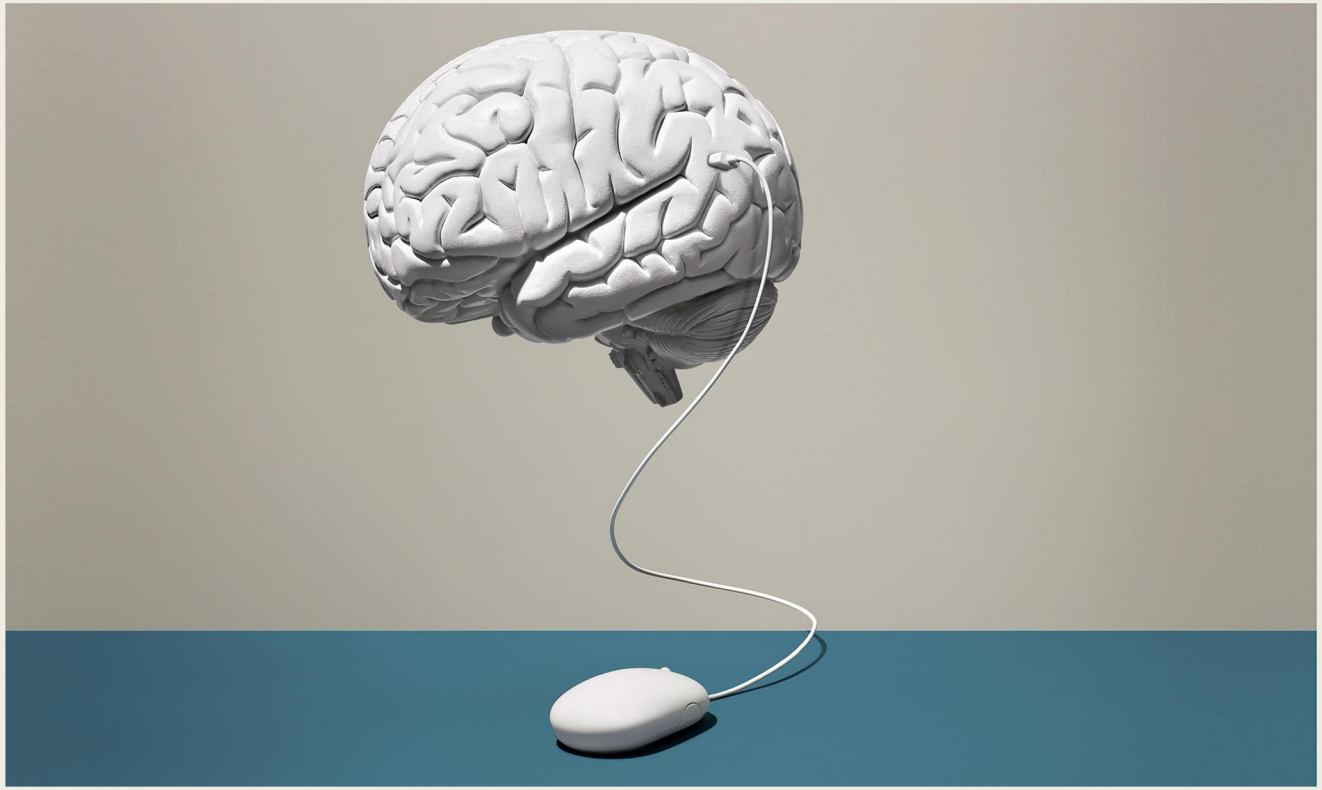
3

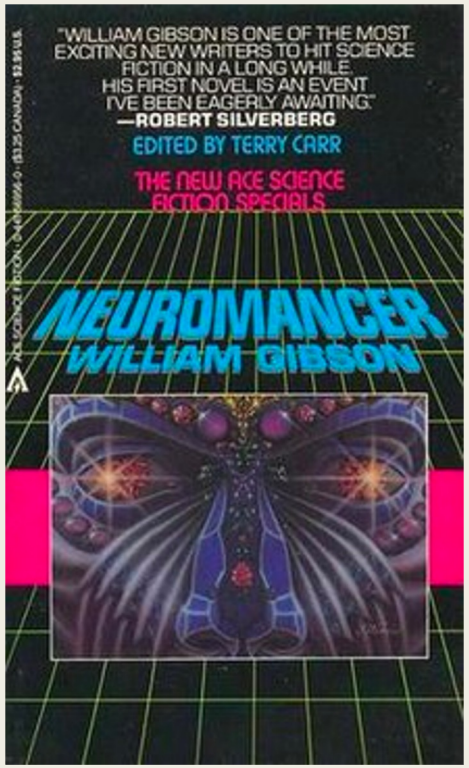
4

5

Agenda

1) Primer on Brain Computer Interfaces
2) Research Motivation
3) Methods
4) Initial Observations in the Field
5) Discussion

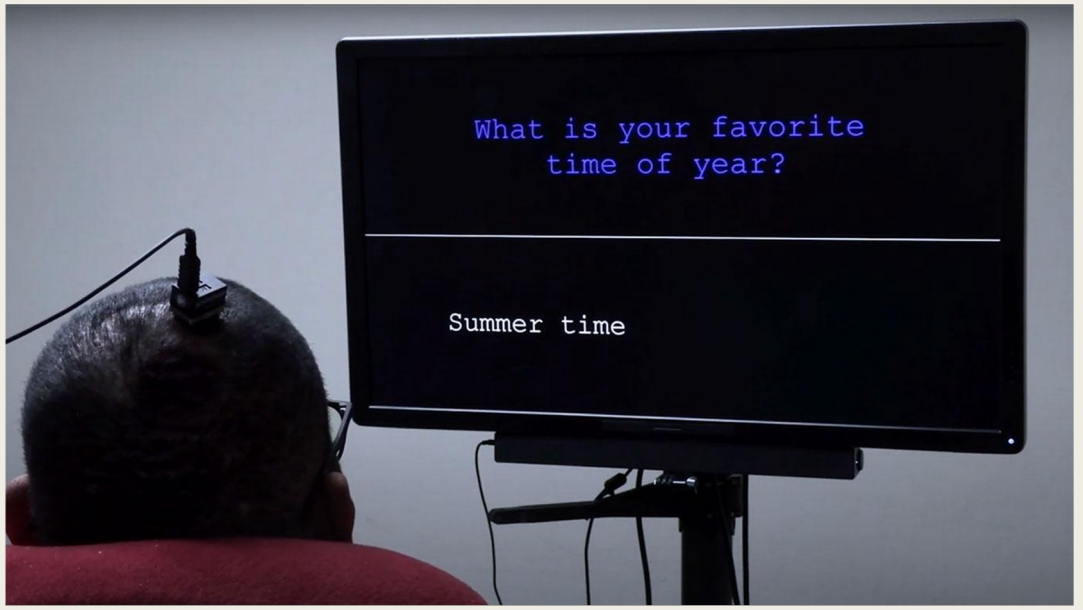


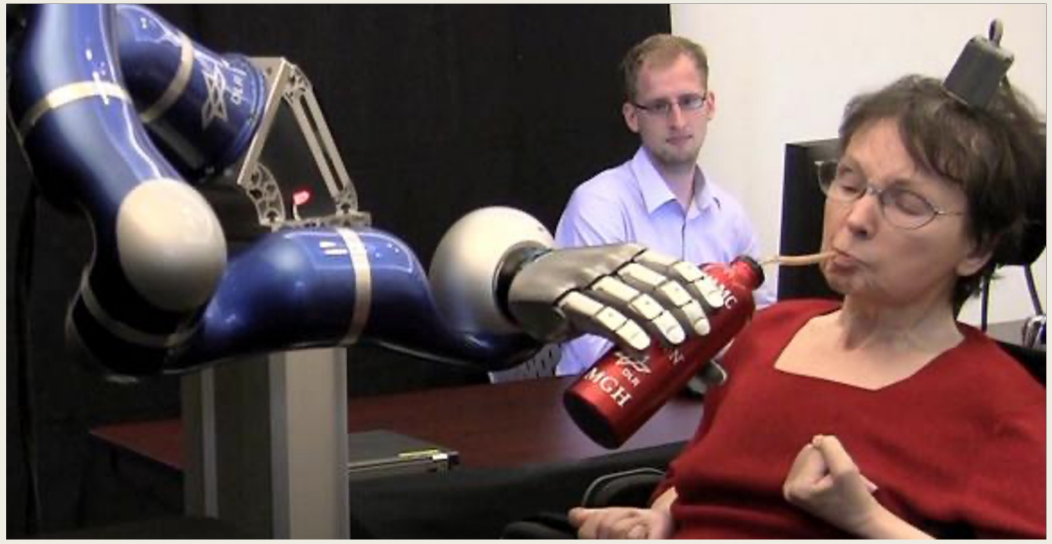


WHAT IS A BRAIN COMPUTER INTERFACE (BCI)?

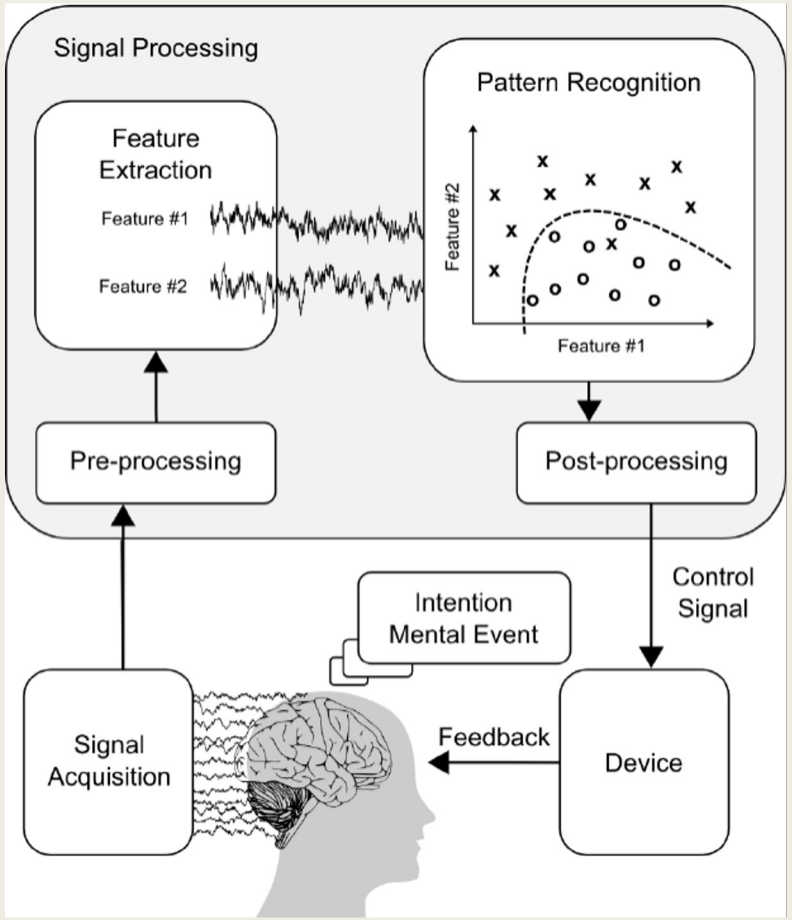
BCI at a High Level

- Intermediary between neural activity and external systems
- Assist, augment, or repair human cognitive or sensory-motor functions





2. Signal acquisition: captures neural data



1. Mental Event e.g. intention: user generates a thought or intention (can be active or passive)

3. Signal Processing: interprets neural data

4. Device e.g. application: external system connected to BCI

BCI’s aren’t new…

“Late 1990’s, first ever person in the locked-in state who communicated with a BCI” (Kubler 2020)

Significant Private Investment

WIRED BACKCHANNEL BUSINESS CULTURE GEAR IDEAS SCIENCE SECURITY SIGN IN

GRACE BROWNE SCIENCE AUG 1, 2022 7:00 AM

The Age of Brain-Computer Interfaces Is on the Horizon

Synchron has implanted its BCI in a US patient for the first time—bringing it a big step closer to distribution.

COURTESY OF SYNCHRON

MEDTECH

Gates, Bezos back $75M round for Synchron's drill-free brain-computer interface implant

By **Conor Hale** • Dec 15, 2022 01:04pm

Inner Cosmos Raises $10 Million To Treat Depression With BCI Implant

Charlie Fink Contributor

A former tech executive covering XR and The Metaverse for Forbes.

Follow

0

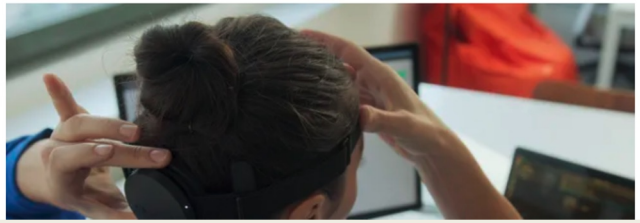
Jan 10, 2023, 06:22pm EST

TECH

Peter Thiel-backed firm takes majority stake in a brain computer interface start-up

PUBLISHED FRI, APR 9 2021•7:01 AM EDT

Snap buys brain-computer interface startup for future AR glasses



/ NextMind made a headband for controlling virtual objects with your thoughts

Musk says brain chip to begin human trials soon - and plans to get one himself

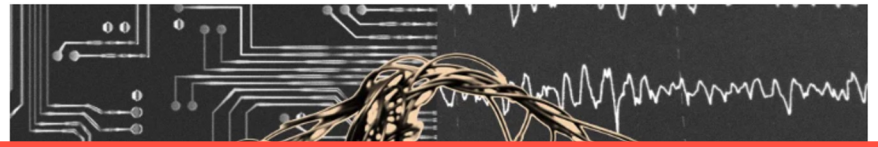
World's richest man says human trials will begin within six months during presentation at health tech company Neuralink

FAST COMPANY

12-08-22 | POV

Brain-computer interfaces could change the world—but at what cost?

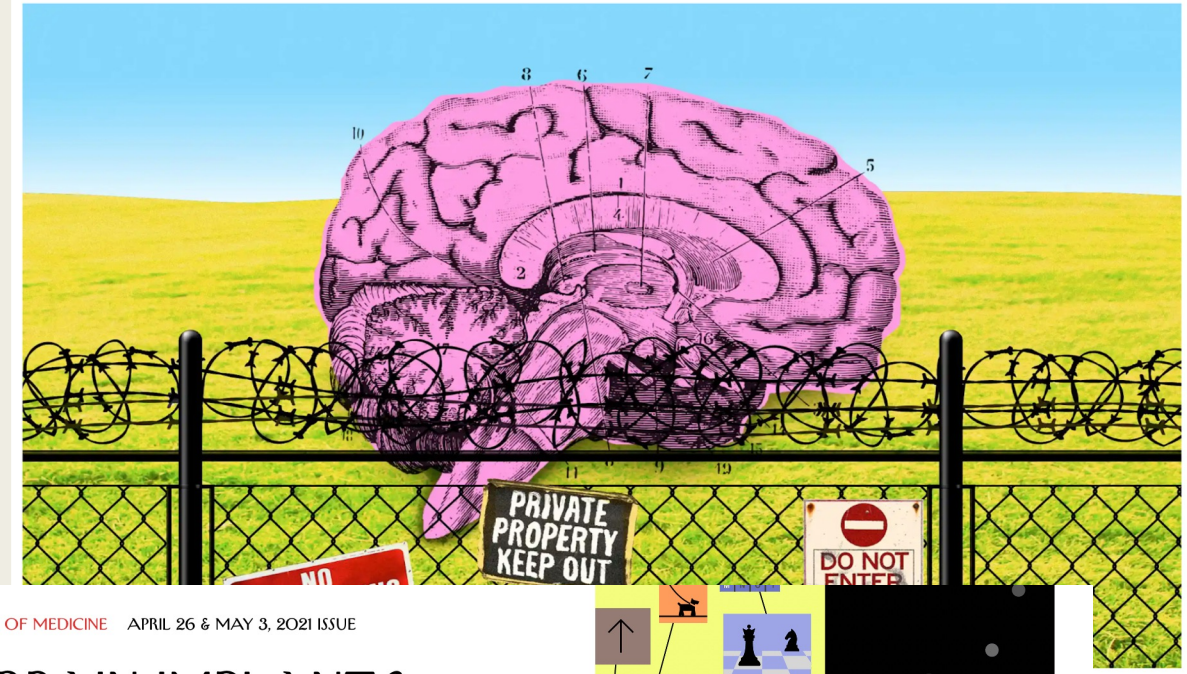
The ethics of neurotechnology lags behind the science.



Computer chips that can read our brains have moved from sci-fi to reality, for better and worse

The near-term applications will mostly benefit society, but the danger of a d
is becoming more real, too.

'Our notion of privacy will be useless': what happens if technology learns to read our minds?



or alter

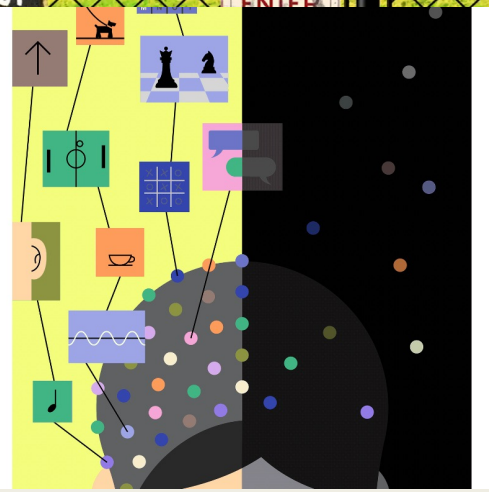
ANNALS OF MEDICINE APRIL 26 & MAY 3, 2021 ISSUE

DO BRAIN IMPLANTS CHANGE YOUR IDENTITY?

As neural devices proliferate, so do reports of personality changes, foundering relationships, and people who want to leave their careers.

By Christine Kenneally

April 19, 2021



“For three years after her operation, [Rita] Leggett lived happily with her device [which managed her epilepsy]. But in 2013 her neurologist gave her some bad news. NeuroVista had run out of funding and ceased operations. Leggett’s neural device would have to come out”

“When I met Leggett, she had been without the NeuroVista brain-computer interface for six years, but, as soon as I began asking how she felt about it, she looked out the window and started to weep. “I miss my device”

- *New Yorker*, 2017

Prior Work about BCIs

Prior work has conducted broad surveys of ethical and social implications of BCI (Royal Society of England, 2020, Yuste et al, 2017, Klein et al, 2015)

teased out the particular values at stake, such as autonomy, (Friedrich et al, 2021) agency (Schönau, 2021, Goering et al, 2021), security (Bonaci, 2014), and personal responsibility (Brown et al 2016), and privacy (Farahany, 2023)

completed market surveys on companies' marketing language (McCall et al, 2019), technical surveys on use of specific algorithms (Chu, 2015)

…and users of commercial brain computer interface systems in various domains, such as gaming (Vasiljevic, 2020), and autonomous vehicles (Castillo, 2014)

And identified the unique challenges and opportunities of regulating BCI and neurotechnology more broadly (Johnson , 2021) , including introducing a new human right to cognitive liberty (Farahany, 2023)

My Contribution

- Commercialization of BCIs, new technologies, ever-evolving actors, techniques, and applications
- Holistic approach with both original empirical findings and ethical analysis
  - *Initial focus on autonomy*

What are the technologies, ideologies, and motivations driving the emergence of the commercial BCI industry?

What are the source of variation in the development, deployment and design of commercial BCI's that can inform the implications for human agency and autonomy?

METHODOLOGY

Semi-Structured Interviews

- Conducted fourteen (17) interviews with participants from eleven (11) companies
  - *Executives and Management: Founders, Marketing, Operations*
  - *Technical: Computational neuroscientists, hardware/software/firmware developers*
  - *Investors*
- Multi-sited ethnography
  - *Onsite visits at multiple companies across the US (and hopefully Europe!)*
  - *Trade shows and conferences*

Building Relationships with the BCI Community

Initial Observations in the Field

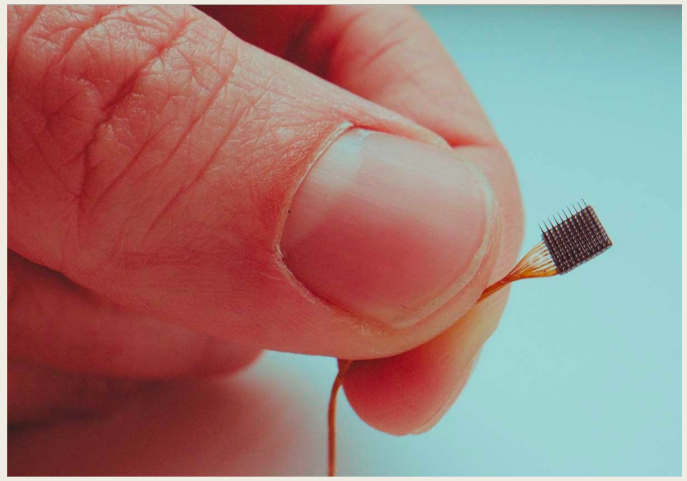
Observation 1: Shift from invasive to non-invasive BCI

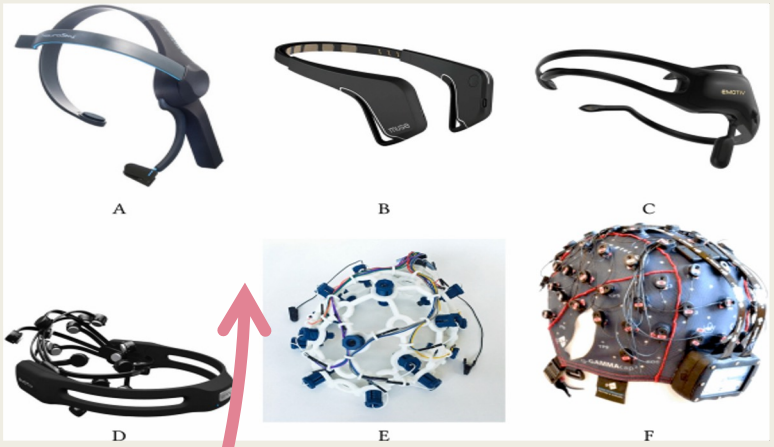
Observation 2: Broadening out from medical to general applications of BCI

Observation 3: Locating issues of autonomy in current BCI systems

#1: Shift from Invasive BCI to Non-Invasive BCI's

- Trend in the commercial BCI industry is a move from invasive hardware to non-invasive hardware
- Producers describe this shift as:
  - *Democratize healthcare*
  - *Provide consumers more choice and options*





“The problem is, nobody wants to get surgery, ever. I mean, nobody wants to get something stuck in their body [...] And you can't take it off the nerve, once it's implanted [...] you can’t take it out if you want to, it's gonna stay on your nerve forever, you can't take it off [...] But we can do it without surgery. “

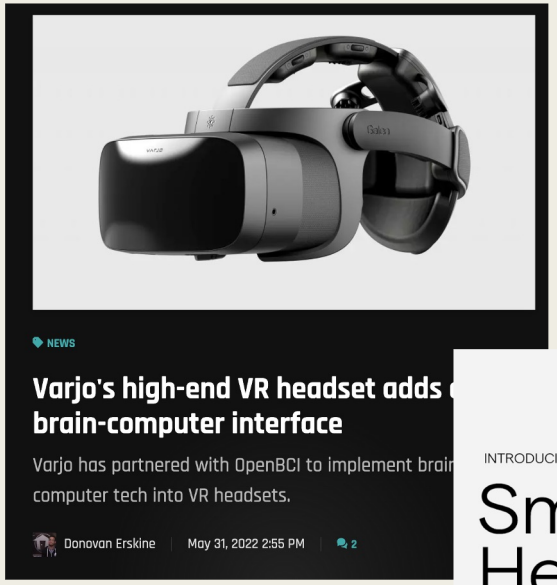
- Male, Startup founder, non-invasive system

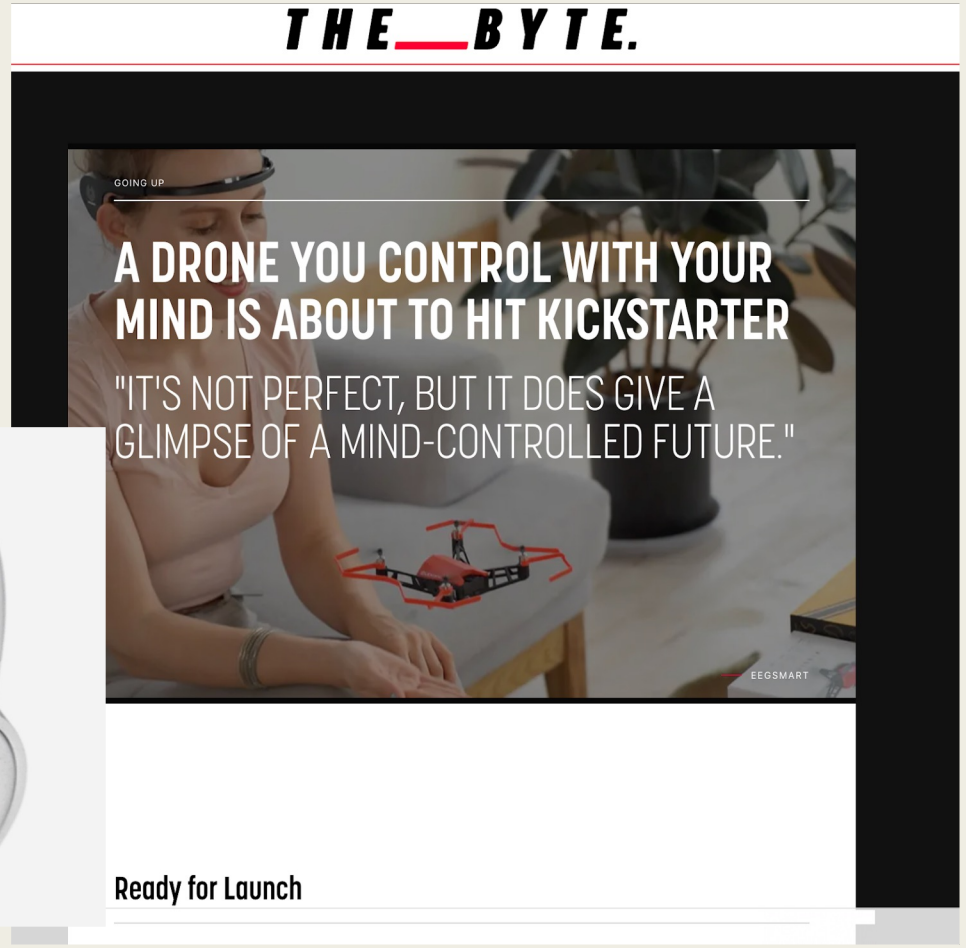
Ex: OpenBCI's Galea

Galea is a hardware and software platform that merges next-generation biometrics with mixed reality.

- sensors for EEG, EMG, EDA, PPG, and eye-tracking into a single headset.

#2: Move from Medical to General Applications

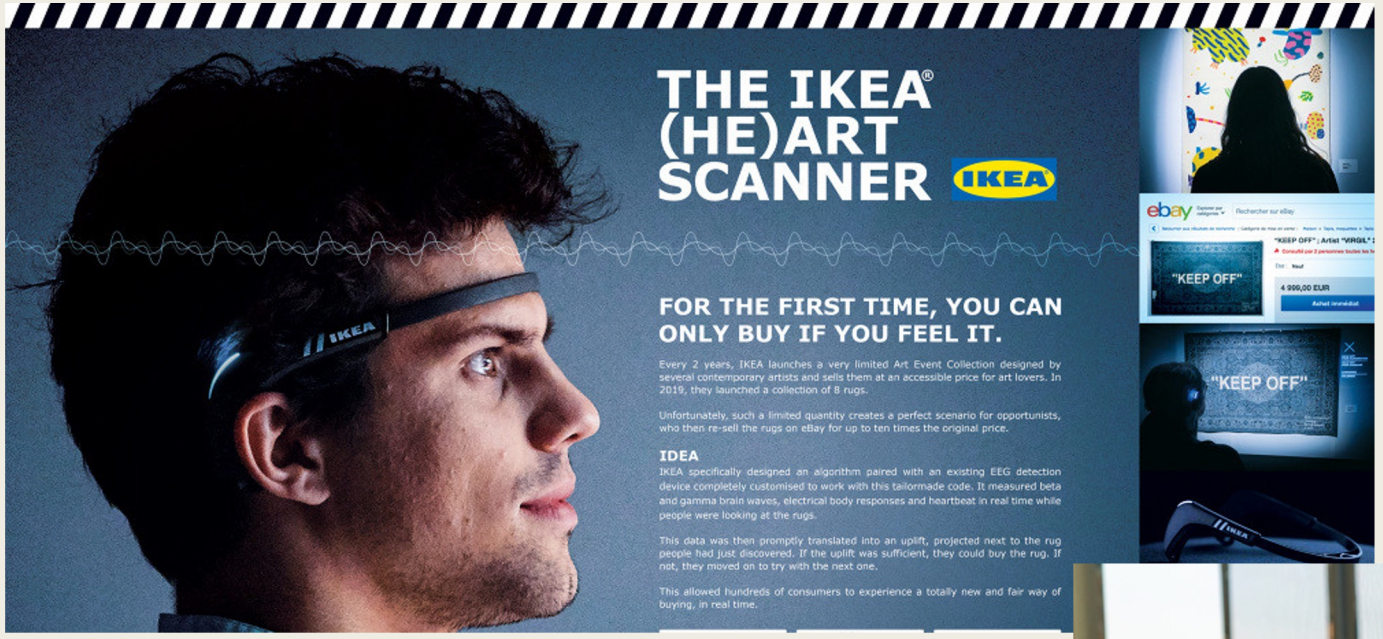




At Work

- Trucking, construction, mining
- Measure fatigue, both for ”employee safety” and public safety

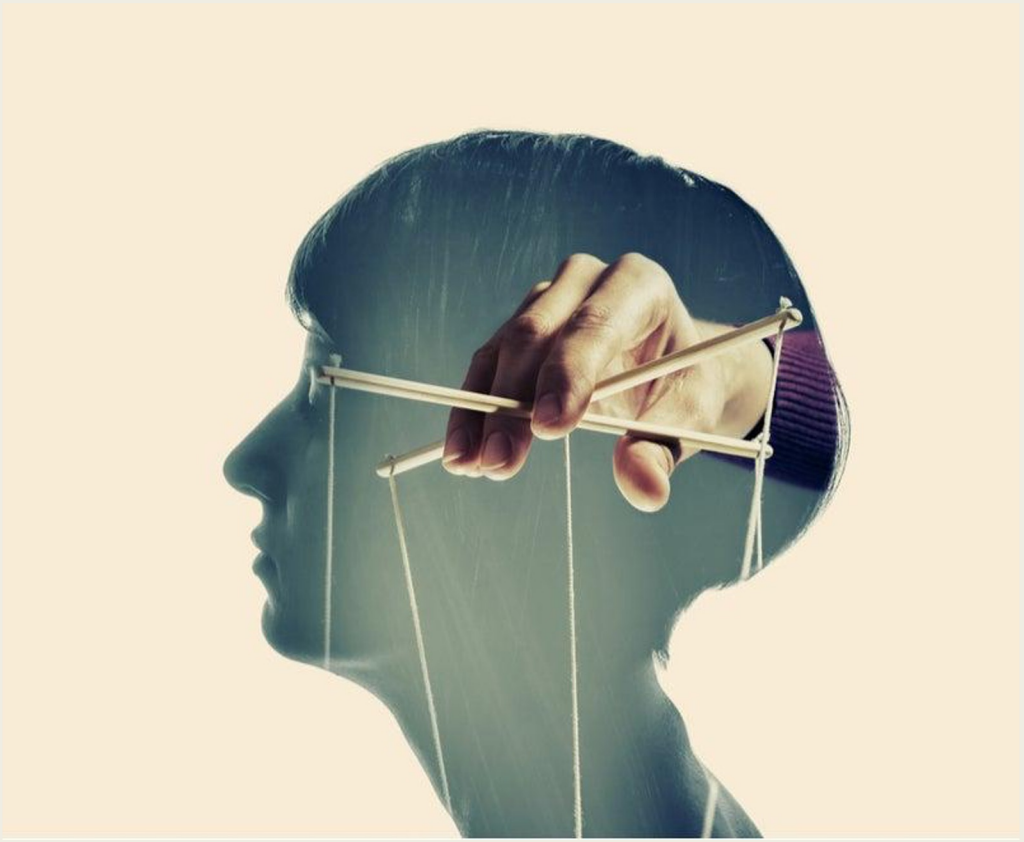
Experiential Marketing



- “take whatever big, big name BCI company you can think of, if you notice, like the way that they market it to the external world is like we're going to help paraplegics. […] But that is definitely not what they're telling investors […] what they're telling these [investors] […] ‘we're gonna have this thing, it's going to integrate with a phone, that is going to read your brain that's going to let you do thought-to-text and like thought to image and thought to video and like interface with your brain so that we can communicate with these crazy bandwidths and like, we're going to completely eliminate the cell phone.’
    - *Male, startup founder, non-invasive BCI*

Observation 3: Locating Autonomy in the Public Imagination vs in the Field

- Common conception
  - *Mind reading: thoughts read against your will*
  - *Mind control: thoughts implanted without your awareness or consent*
- In practice
  - *… a number of different ways*



“but also like, anyone who's like practicing a task over and over again, you know, giving them like a little red, yellow, green light [on their headset] of the physical data state of when you perform your best is very helpful for them to like, sort of imprint like, ’this is this is me at peak performance’. And non invasive sensors are just easier for people to, you know, tolerate in in everyday settings.”

- *Male, Chief Marketing Officer, non-invasive BCI*

“That's all I want them to see is oh, ‘I'm putting my [device] on for the night. Yeah, I'm looking at pushing go on my [device].’ I don't want them to know anything else is happening. I'm debating whether I even let [the users] change their setting on the [device], right? Because I just, I'm kind of trying to take a Steve Jobs approach to medical device design, right, and so it's what it what are the consumer need? And you know, they don't need all the buttons. They don't need all the crazy stuff [...] keep it easy. Keep it simple for the patients.”

- *Male, startup founder, non-invasive neuromodulation to treat sleep apnea*

Normatively Desirable?

- Positive account
  - *Empowering self knowledge*
  - *Ensuring physical safety*
- Dystopian account
  - *Workplace surveillance*
  - *Opaque, black box systems*

Mapping to Conceptions of Autonomy

- Providing a user information about themselves
  - *Enhance by "articulate and grapple with our [their] ideas, goals, and desires (Roessler, 2021)*
  - *Diminish our ability to act in self determination, act as instruments of surveillance and social control (MacKenzie, 2014)*
- Treating a health condition (sleep apnea)
  - *Enhance self determination or the "freedom and opportunity to make choices of practical import to one's life" (MacKenzie), 2014)*
  - *Reduce obstacles and increase their horizon of choices (Roessler, 2021)*
  - *Challenge the authenticity condition of autonomy (MacKenzie, 2014) when devices are opaque and "black box"*

The Details Matter…

- The domain: is this for the workplace or personal use?
- The application: medical or gaming or advertising?
- The design: transparent to user or not?
- The company’s business model…

Conclusion

- Companies are developing and selling these devices **now**
  - *Despite lack of regulatory and legal frameworks in place*
- Critical that we acknowledge ethical stakes and conduct empirical work
- Details matter:
  - *Invasive vs non-invasive, in different domains, design details*
- Empirical work to drive law and policymaking, such as Farahany's proposed new human right to cognitive liberty (Farahany, 2023)

Thank you!

Margot Hanley
Email: Mh2446@cornell.edu