Anusha Datar

Through the SAG grant, I had the opportunity to attend the American Psychological Association's Technology, Mind, and Society conference in Washington D.C. on October 4th and 5th, 2019. At this conference, I presented a poster with Professor Dr. Sam Michalka regarding our work on evaluating the feasibility of Augmented Reality Brain-Machine Interfaces. I also attended a variety of keynote presentations, symposiums, and paper talks about the applications of hardware and software tools to the psychological sciences and the broader context in which scientific research in these fields exist.

Our poster reported on a system that we are working on in the lab where we combine both BCI and AR technologies. We presented an examination of the technical feasibility of our proposed workflow (based on the system we developed in the lab and data we collected from several experiments), and we also included an interactive component through which conference attendees could report their thoughts on the ethical and practical ramifications of the potential applications of this technology. This framework allowed us to leverage the interdisciplinary nature of the conference we were attending; the opinions of engineers, technologists, psychologists, scientists, and policymakers are both relevant and interesting when thinking about these problems, and we were able to meaningfully understand and compare their perspectives. Speaking at this poster session let me practice talking about my work (both in terms of engineering and as a concept in general) with people who often all had different levels of background knowledge and then engage in difficult (and important) conversations about the nature of that work in and of itself. It also gave me a chance to get feedback both on my technical work and on the implications of my work for those working in other disciplines, and this was an invaluable experience for my growth as an engineer who works within multiple layers of context.

The variety of talks I attended at this conference also gave me a chance to think more clearly about the nature of my role as an engineer working on systems used for scientific research. Many scientific experiments are often far more rigorously thought out than work done in industry (which I am more familiar with both because of internships and the nature of Olin's curriculum). Researchers presenting their work would carefully consider every edge case of their experiments (or, if they did not do so, members of the audience would question the validity of their procedure and the associated results) and present their methods, results, and conclusions with precision – they would not just pitch their final product and advocate for moving fast and breaking things along the way. This learning experience helps me more clearly understand the context of my Olin education – while 'do learn' is often incompatible with the long-term analysis scientific research entails, developing an appreciation and understanding of academia is certainly still possible for me and will help me grow. Some of the talks I attended focused more explicitly on the political and ethical implications of certain technologies rather than focusing on specific studies that the presenters had conducted. These discussions were especially powerful because the attendees asking questions of the experts speaking would draw from their personal perspectives, and I was able to form a more holistic understanding of the issues presented than I can when in the engineering-centric bubble of Olin.

By attending this conference, I had the opportunity to present my work to the greater research community (both within and outside of the immediate discipline my work is in), gain perspective on my own work, learn and ask questions about a variety of interesting and novel studies, and critically consider the role of policy and non-engineering perspectives in conversations about the impacts of technology.

I have attached both a copy of the section of the (one-hundred sixty-five page) program that contains our abstract and a pdf of the poster (note that because the figures are so detailed they may not load clearly, so I will also upload it separately). Please reach out to me adatar@olin.edu if you need anything else.

shyness, and perceived stress. Participants then interacted with the robot alone. Using a Wizard of Oz method, the robot was teleoperated by a hidden researcher to facilitate a short conversation (Dahlbäck et al., 1993). The robot spoke a set of self-disclosure statements, each followed by a question for the participant to answer (See documentation for script). Upon completion, the participant to fill out a post-survey which included 5-point Likert scales, such as user satisfaction (4-items, like "I feel absorbed in the conversation with EMAR"), intention for future use (4-items, like "I will use EMAR again"), robot likeability (5-items) and robot perceived safety (2-items). Participants were then given a manipulation check with the question "Which of the following best describe EMAR's style of communication?" with options: robot tends to talk about "its own emotion", "the experience of others", or "technical information about its system and programs". Then, participants were interviewed by the researcher about their interaction with the robot.

Analysis: Degree of self-disclosure were operationalized by word count and depth of participant response (Collins and Miller, 1994). A one-way MANCOVA was conducted to test if word count, disclosure depth, user satisfaction, intention for future user, likeability, and perceived safety differed based on robot disclosure conditions, with the covariates of perceived stress, shyness, and NARS. Thematic and content analysis were used to explore the qualitative data (e.g. conversations with the robot and interview responses) (Richards, 2014).

Results: Interaction time ranged between 2 minutes 21 seconds and 9 minutes 54 seconds with an average of 4 minutes and 20 seconds. Manipulation check indicates that 56% of the participants failed to correctly identify the type of robot disclosure they experienced.

There was no statistically significant difference among robot disclosure conditions on the combined dependent variables after controlling for perceived stress, shyness, and NARS, $F(12, 50) = 1.689$, $p = .098$, Wilks' $\Lambda = .506$, partial $\eta 2 = .288$. However, perceived stress significantly predicted word count, $F(1, 30) = 5.674$, $p = .024$, disclosure depth, $F(1, 30) = 4.839$, $p = .036$, user satisfaction, $F(1, 30) = 8.910$, $p = .006$, likeability, $F(1, 30) = 5.376$, $p = .027$, and future intention to use, $F(1, 30) = 12.455$, $p = .001$. NARS also significantly predicted for intention for future use, $F(1, 30) = 5.879$, $p = .022$.

Preliminary qualitative analysis of the post-interview found themes, such as: desire for deeper response, attribution of childlike quality, and comparison between robot and human companionship. Content analysis showed that 38% participants (N =14) expressed desire for deeper, more personal robot responses.

Implication: The current study provides several future research directions on social robot communication design and stress intervention using HRI. Firstly, the current results expand upon the findings by Martelaro et al. (2016) by testing different types of robot disclosures with an adult sample. The result of no significant difference in reciprocal disclosure and high error rate in the manipulation check for conditions suggest that adults and high schoolers might perceive and behave towards a social robot differently. Future studies will examine how age affect perception of robot disclosure. Secondly, the finding of perceived stress as significant predictor for multiple outcomes suggest that HRI design for stress interaction will need to take account of perceived stress level of the population, especially those with high stress. Lastly, our preliminary qualitative observations suggest that robot disclosures is not only important as an opener, but also as a response. Future studies on robot disclosure should investigate on the effect of location of which disclosure occurs within a specific dialogue.

Honson Ling (University of Washington)

Human-Technology / Brain-Machine / Human Systems Integration

F-1

Exploring the Feasibility and Implications of Augmented Reality Brain-Machine Interfaces

Companies worldwide are investing in augmented and mixed reality technologies. While current consumers typically interact with augmented reality using smartphones, companies are actively working to develop consumer-adopted augmented reality headsets or smart glasses. Augmented reality headsets offer exciting new user experiences by allowing unencumbered hand movements to interact with real and virtual objects and have the potential to create more immersive experiences. However, augmented reality headsets also bring the potential for increased distraction, as virtual objects and information may automatically appear within a user's field-of-view.

One major challenge in augmented reality is to determine when and where digital information should appear. These decisions are important for both user safety and cognitive ergonomics. From a safety standpoint, augmented displays must avoid obstructing important real-world objects, such as tripping hazards or oncoming cars. Augmented reality companies are actively developing systems that recognize and react to real-world objects. Regarding cognitive ergonomics, digital information must be strategically presented to avoid mentally overloading the user. Existing design principles for human-computer interaction may face limitations when users are wearing augmented reality headsets, which may create more immersive and distracting experiences compared to smartphones (while noting that smartphones are already extremely powerful at drawing users' attention). In an ideal augmented or mixed reality scenario, virtual objects or information would naturally appear or expand when a user seeks to interact, and then naturally fade away when the user is not engaged. In order to create these natural interactions, the augmented reality system needs some knowledge of the user's cognitive state (e.g., focus of attention, alertness, etc).

In this work, we discuss strategies to predict a user's cognitive state based on existing bio-sensors, emphasizing eye-tracking and electroencephalogram (EEG) and present a prototype hardware configuration. First, we review the brain-machine interface literature as applicable for integration with augmented reality headsets, including the current scientific limitations of cognitive state detection using non-invasive technologies. Then, we discuss the specific challenges that are introduced or amplified by the use of augmented reality headsets in contrast to other brain-machine interfaces, including increased motion artifacts and electrical artifacts from display hardware. Third, we present a preliminary system that wirelessly integrates a Magic Leap ML1 augmented reality headset with an Enobio research-grade EEG (see Figure 1). Using this system, we characterize electrical artifacts and demonstrate a pipeline for interaction with simple virtual objects.

In addition to investigating the potential of augmented reality brain-machine interfaces, we raise important questions for discussion about if and how researchers should proceed with the development of technologies that can detect a user's cognitive state. These questions include: 1) what bio-sensor data should be available for consumer products, 2) who should own these data, and 3) if we can accurately predict a user's cognitive state, are there limitations on how this information can ethically be used?

Sam Michalka (Olin College of Engineering)

F-2

The Role of Clinical Psychologists in Human Biotechnology Enhancement

Statement of Problem: This poster will focus on clinical psychologists' role in human biotechnology enhancement, a gap of research that currently exists in both the fields of psychology and technology. As biotechnology sciences advance into the future, people will have more opportunities to selectively enhance their genetics, body, brain, and mind. Many benefits, such as longer life-span, increased capabilities, and alterations of appearance are becoming possible (Miah, 2016). In contrast, enhancement technology may pose increased long-term health risks, negatively impact mental health, create unwanted side-effects, and narrow the life-span. Either way, this technology will undoubtedly impact our culture, society, the human condition, and how humans function on a daily basis (Hoffman, 2017). Clinical Psychologists can be greatly used to help individuals navigate these issues as humanity draws closer to a "trans-human" era. Historically, Clinical Psychologists have played a major role in rehabilitation of physical and psychological deficits. They have taken part in the care of patients going through transformation processes, such plastic and reconstructive surgery, bariatric surgery, performance enhancing drugs, implantation of pain-relief devices, as well as those undergoing sex reassignment. However, it appears little has been discussed on how Psychologists may assist those electing to undergo human enhancement transformations. It is believed the same skillset Clinical Psychologists possess may be useful help these individuals navigate the transformation process and improve outcomes. This poster will review several methods in which Clinical Psychologists of the future can play a major role in the education, ethics, policy-making, research, evaluation, rehabilitation, and decision-making process of individuals who choose to undergo biotechnology enhancement.

Procedures: The poster will emphasize articles discussing the application of biotechnology for human enhancement and individuals electing to transform their genetics, body, brain, and/or mind. We will access major databases, including PsychINFO, Web of Science, Pubmed, and Google Scholar to acquire data on the topic. The poster will use a strategic scoping strategy developed by Arksey and O'Malley (2005) to examine the current body of literature in effort to examine existing research, illuminate gaps in published data, and generate new ideas for how Clinical Psychologists can play a role in human enhancement.

Analyses: This poster will summarize current and relevant research related to human biotechnology enhancement and discuss methods in which Clinical Psychologists can be assistive in the future. We will examine the extent, range, and nature of research and apply qualitative thematic analyses to collate and synthesize our findings. Key themes and points of discussion will be identified within the data to formulate ways psychologists can be assistive in the field of biotechnology enhancement. This will allow us to better understand how individuals can utilize Clinical Psychology to improve psychological and physical outcomes.

Results: The poster will present results from the literature review and Identify a number of topic areas in which Clinical Psychologist may become integrated into the field and science of human enhancement technology. We will include a discussion of the psychological changes individuals who undergo biotechnological enhancement procedures may encounter, such as, emotional distress, poor adjustment, problems with acceptance, and negative alterations in functioning (Brey, 2008). Furthermore, several strategies and methodologies will be proposed, which Clinical Psychologists may find useful in the future to assist individuals electing to receive human biotechnology enhancements.

Practical Implications: The results of this review will provide important considerations exploring how Clinical Psychologists can play a role in the advancement of "trans-human" technology and enhancement (Miah, 2016). The results will allow further discussion of the implications in clinical practice as it relates to expert opinions. Many questions are being raised in regard to who will be allowed to make these decisions and how these technologies should be used. These advancements will allow humans to make incredible alterations to their capabilities and appearance. However, with any major change to one's life, body, and mind, one must expect an adjustment of some kind. Here enters the Clinical Psychologist. It is expected that technology in this area will continue to grow, thus it is important to consider ways in which Clinical Psychologists will become utilized and involved so that we may be better prepared for the future.

Conclusions: Several uncertainties regarding how biotechnological enhancement will impact the individual, society, and human condition remain (Masci, 2016). This poster will promote discussion regarding the role of the Clinical Psychologist in the advancement of biotechnological enhancement. It will also illustrate ideas for future research and new directions as the field of psychology and technology become more strongly connected. It is important for Clinical Psychologist to continue expanding their roles into new areas of care. As we enter a new paradigm, where humans may choose to "upgrade" their own capabilities, Clinical Psychologists should take action by considering the roles they can play in this technological revolution.

Alex Cook (University of Indianapolis)

Judgment and Decision-Making

G-1

Development and Evaluation of a Mobile Health Clinical Decision Support Tool for Patient Migraine Management

Background: Migraine is a common disease affecting more than 1 in 10 Americans (Lipton et al 2007). Its symptoms are highly disruptive to suffers, making migraine the most disabling neurologic disease in the world (Leonardi & Raggi. 2013). Migraine is a chronic condition with episodic symptoms, which contributes to the complexity of patient decision-making regarding migraine management. Migraine management has two components: preventive and acute management. Preventive management includes routine behaviors that reduce the frequency of migraine attack onset. These include taking

Evaluating the Feasibility of Augmented Reality Brain-Machine Interfaces

Sam Michalka, Anusha Datar, Ava Lakmazaheri

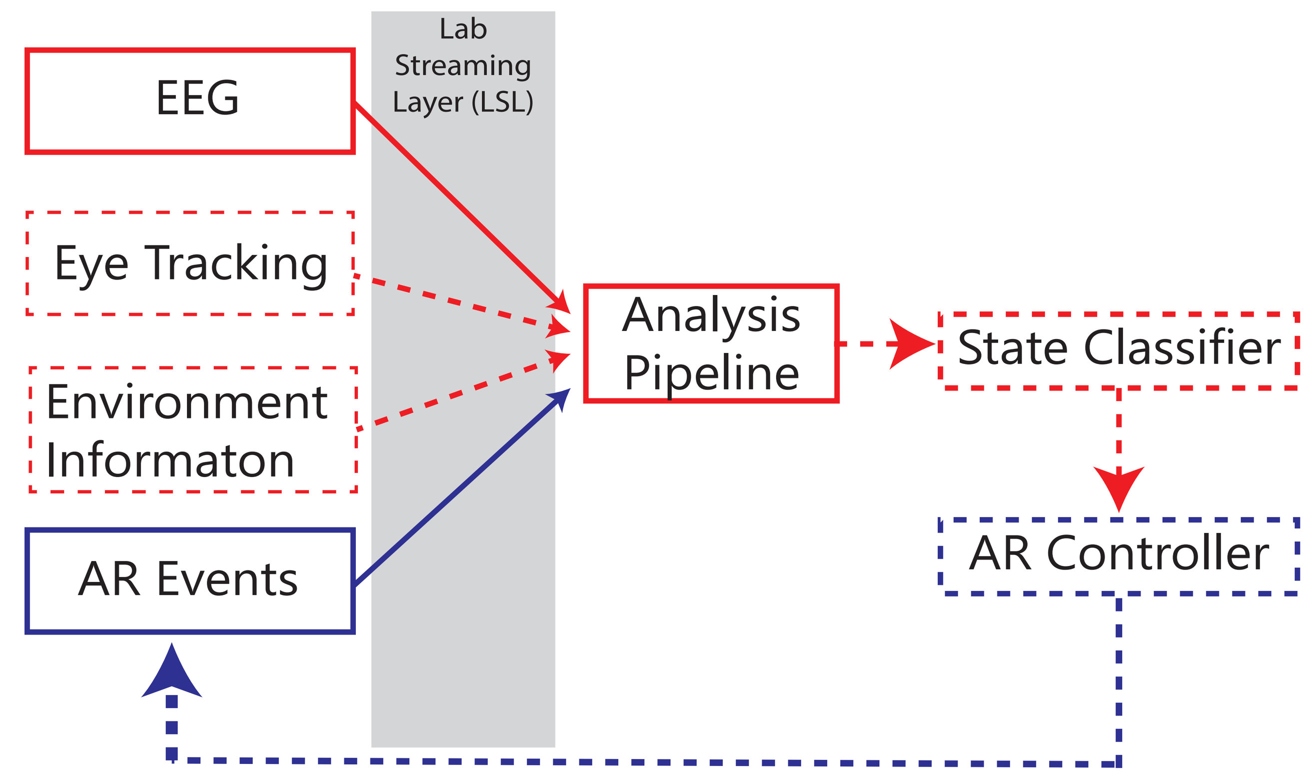
Olin College of Engineering

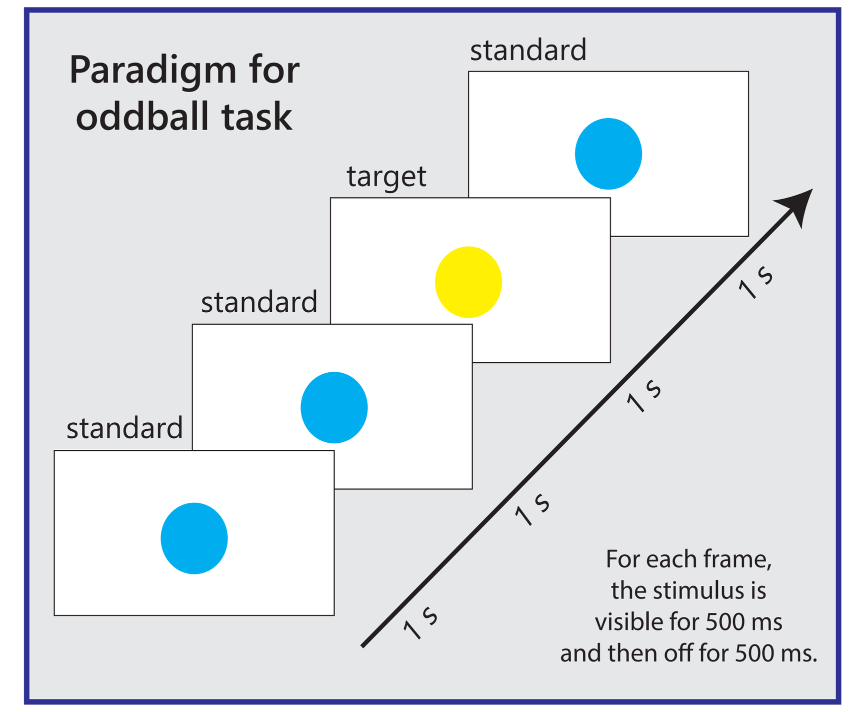
humanaugmentationlab.github.io

Can We?

EEG (electroencephalogram) devices can non-invasively measure small voltages from the brain. These measurements can be used to detect focus and attention.

However, EEG measurements are susceptible to noise from motion artifacts and external computing near the sensors. Using AR (Augmented Reality) technology alongside EEG has many applications, but we must ensure that the electrical noise generated by an AR headset will not obscure the EEG measurements in frequencies of interest.

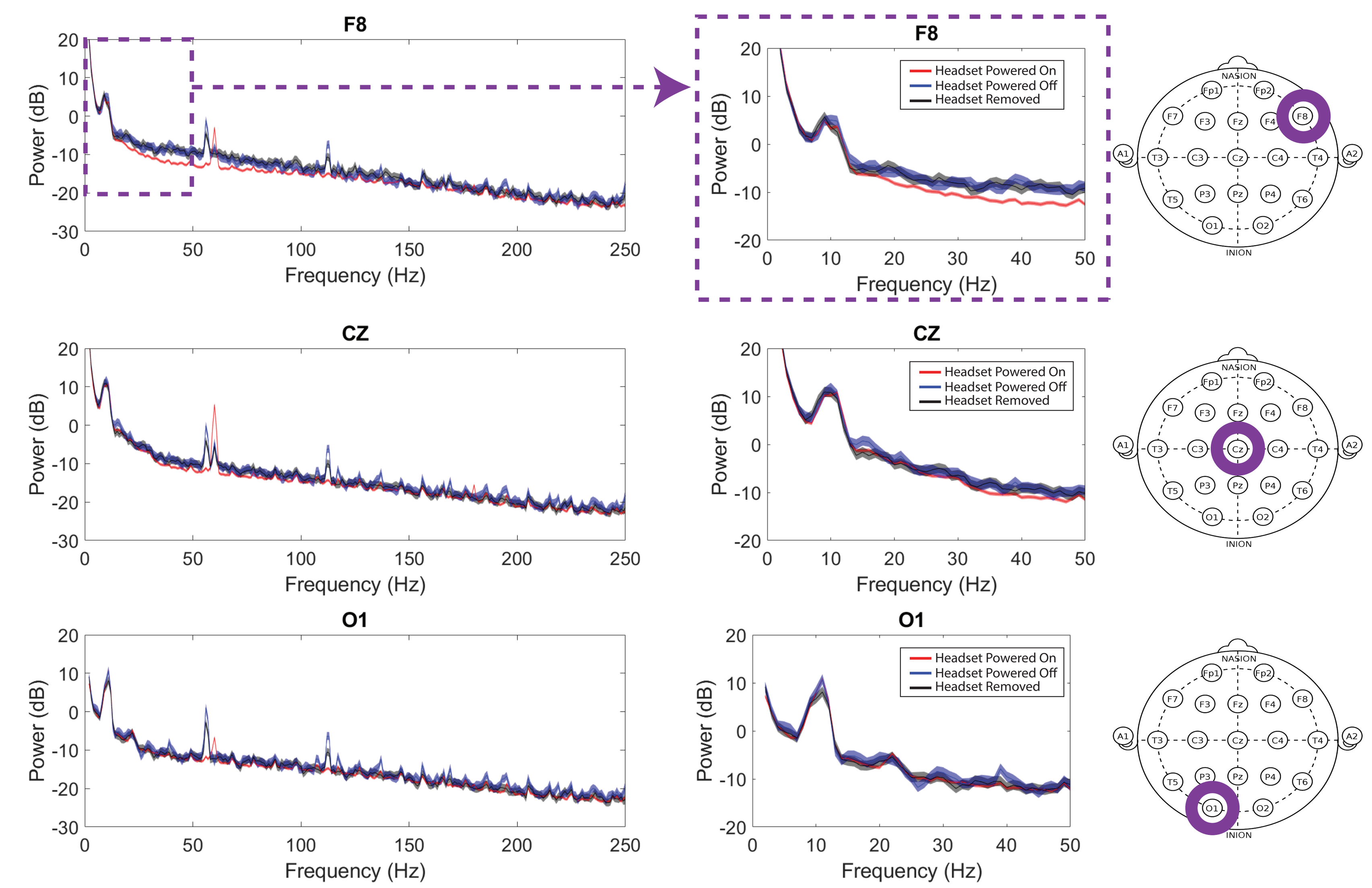




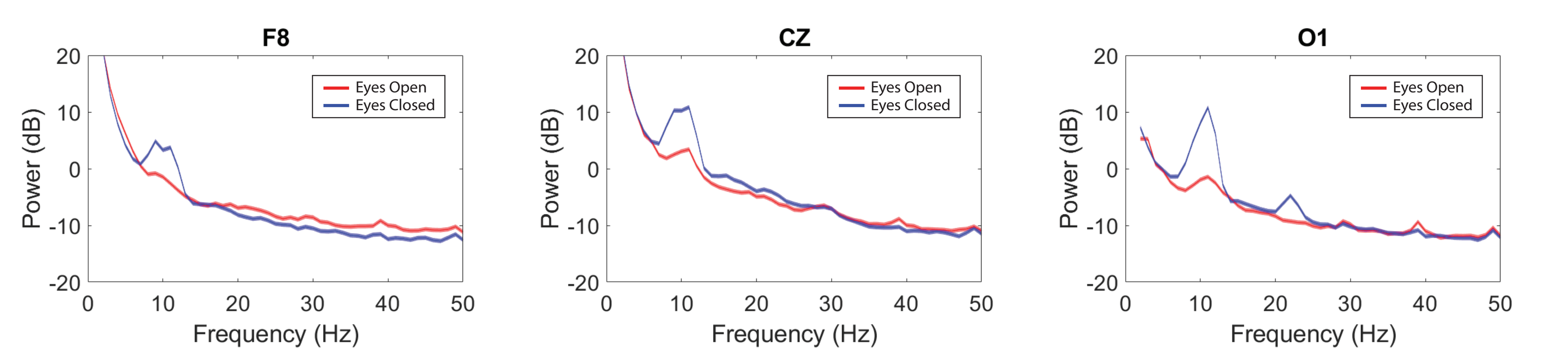
Investigating Frequency Domain Noise Caused by AR Headset

When people close their eyes for a sustained period of time, we expect to observe an increase in power at ~10 Hz.

We compared the power spectral density of the EEG signal from the brain while a participant sat with their eyes closed when:
- the headset was powered on and presenting unobserved stimuli and worn by the participant [Headset Powered On],
- the headset was powered off but worn by the participant [Headset Powered Off] , and
- the headset was powered off and NOT worn by the participant [Headset Removed].

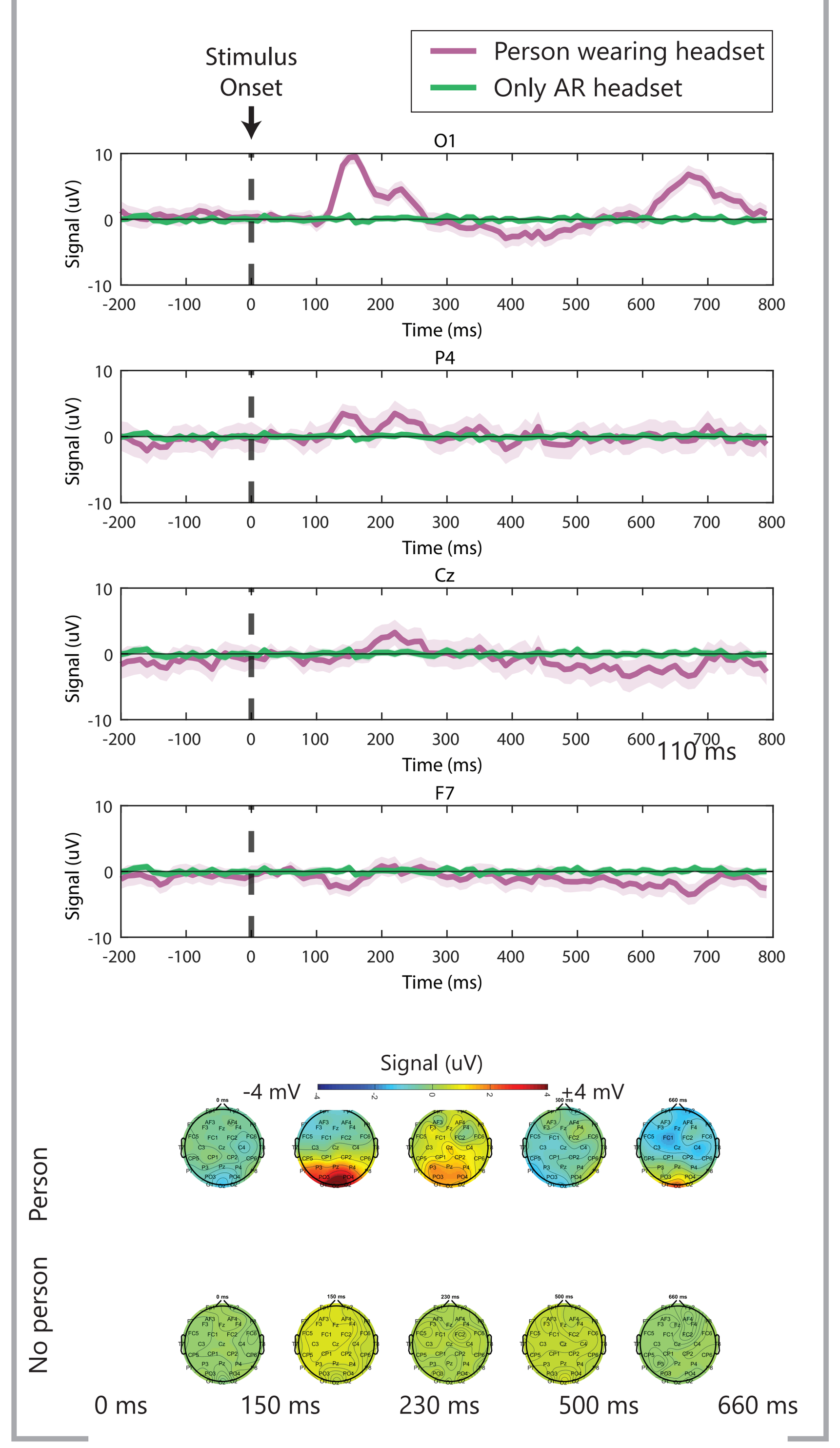


We are able to easily distinguish between eyes open and eyes closed at ~10 Hz with the headset powered on.

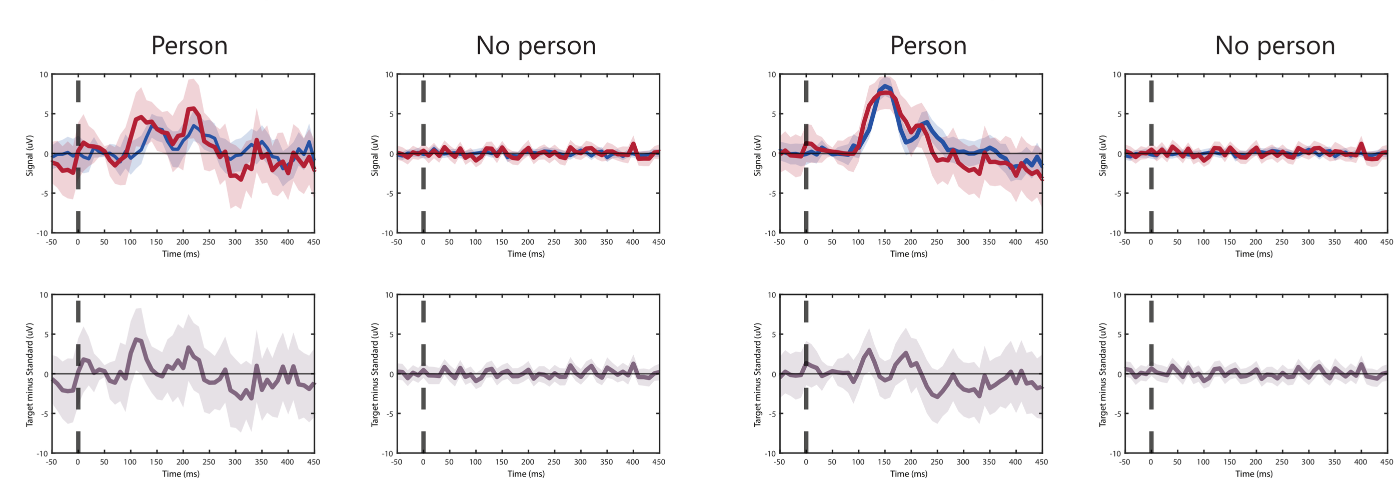


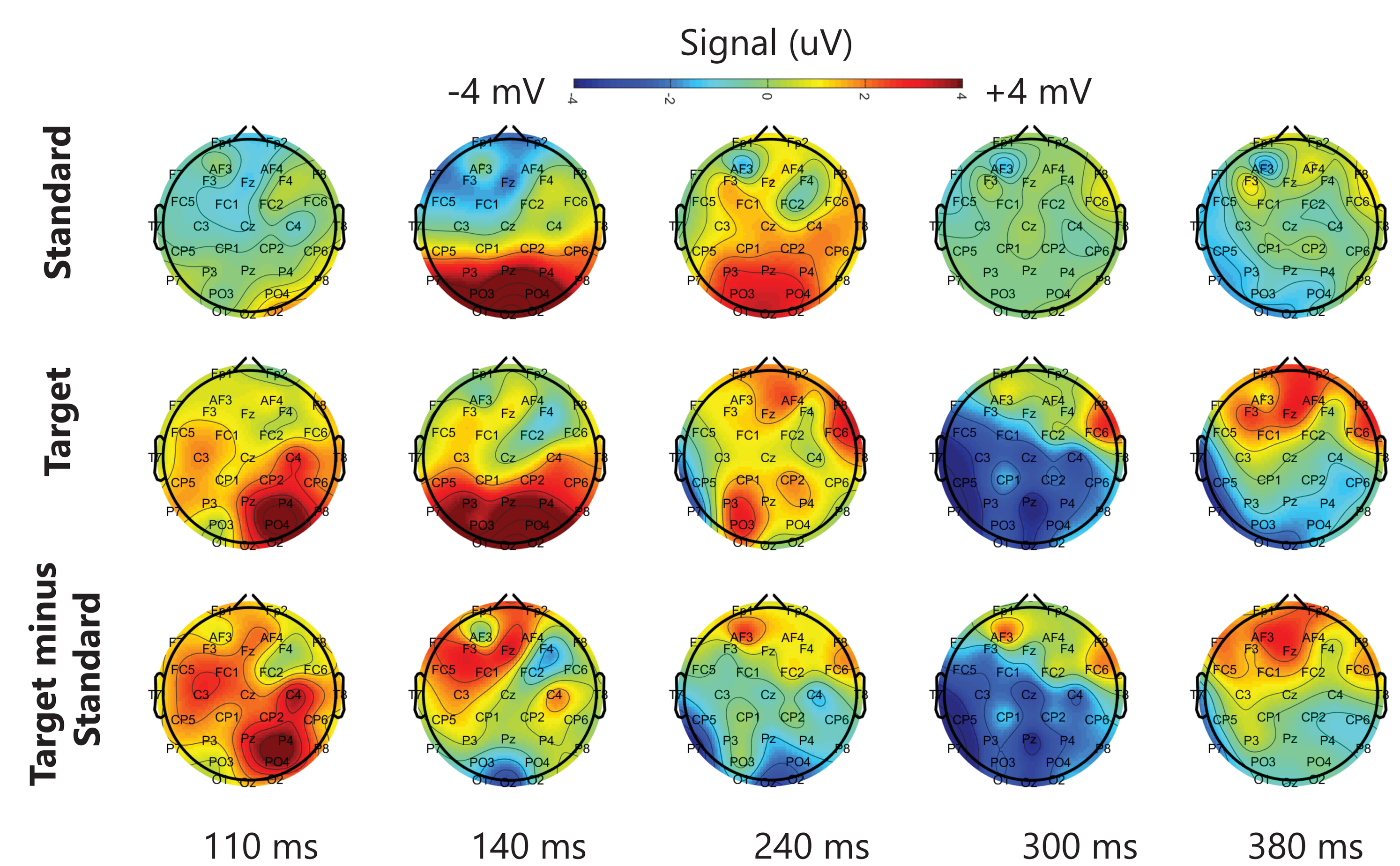
Detecting Event-Related Potentials in the Oddball Task

The presentation of the stimulus evokes a response in the brain, but does not evoke a response when only measuring the AR headset.



Minor differences in brain response between the standard and target stimuli.





Should We?

If it is possible to build robust EEG and AR applications, there are important questions to consider regarding the nature of the data collected and the potential use cases of this data.

Please share your thoughts below on how likely (in the next ten years, assuming that it is technically feasible) these applications are and how comfortable you are with them.

- **Drivers of non-autonomous trucks are required to wear wakefulness-monitoring devices.**
- **Students' attention levels in the classroom are monitored, and teachers have access to data for each student.**
- **Consumers using a streaming platform are required to pay attention when viewing advertising content and the platform validates that they do so.**

What are the potential applications that would make this technology worth pursuing?