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Abstract

Humanity is transforming from a pure biological organism to a biodigitally converged being. The transformation has been hastened by rapid increases in power and commercialization of advanced technologies such as brain-computer interfaces and artificial intelligence. All indicators point towards a trend of continual acceleration away from baseline biology as the human becomes the source of computing rather than simply a user. While mainstream transhumanists laud such development as exemplative of progress towards a grand vision of man and machine becoming one, a variety of concerns, both philosophical and technological, are readily observable. This paper focuses on one such concern associated with the intersection of brain-computer interfaces and embedded artificial intelligence on those devices. Within this intersection, the biodigital convergence of a brain-computer interface is known to produce issues related to user agency. However, what is not known is how brain-computer interfaces with embedded AI may dampen or amplify such issues and what potential technological solutions may exist to ameliorate the agency problems. Furthermore, there is a lack of an applied epistemology to guide any such understanding. To that end, this paper describes a propositional metadata schema which may serve as a brain-computer interface action labeling mechanism for the information output by the biodigital system. The theoretical and practical significance of the schema are explained and ideas for future work are provided.

Keywords: transhumanism, cyborg, biodigital convergence, brain-computer interface, artificial intelligence

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Introduction

We find transhumanism where biology and digital technology meet. The goal of this meeting, even if by happenstance, is to maximize the well-being and longevity of the biological. Such a meeting, or convergence, is enabled by modern society's treatment of biology as information (Reader 2022, 23). The line of reasoning then is if biology is information, and if information is the result of computation[2], then there must be a biological function capable of being the source of such computation. In the views of some transhumanists, this meeting is the essence of what it is to be both a transhuman and a cyborg. Such transhumanists perceive humanity as inevitably transforming from a purely biological create to a converged organism, part biology and part digital technology.

The position is not without merit. Today's digital technologies are accelerating away from what existed even months ago. Biology, whether integrated with digital components or modified through non-digital technology, has become intertwined with digital technology. Thus, the technologist transhumanist sees humanity as *becoming* a cyborg.

Other transhumanists, principally Sorgner (2022), emphasize carbon-based innovations such as gene enhancement over silicon-based technology. In actuality, this view creates a smoother glide path for carbon-based innovation going forward because our species has exercised it in one form or another through natural means. To this end, Sorgner points to language education and sexual selection as transhumanist, and thus cyborg, forces. To Sorgner's point, we have always been cyborgs and simply are becoming more so as we refine the tools, techniques, and technologies.

The emphasis on carbon-based transhumanism is understandable given the far future-leaning focus of mainstream transhumanists (Kurzweil 2005; Aithal and Aithal 2018) on extreme technologies such as consciousness transfer, artificial general intelligence, and technological singularities. Thus, we should not view transhumanists such as Sorgner as anti-technology. Rather, the point acknowledges a potential white space between the different views.

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[2] Perhaps more appropriately we can use the phrase *information processor*.

A recent review (Pittman 2022, 8-9) of *We have always been cyborgs* (Sorgner 2002) mentioned the augmentative role of narrow artificial intelligence as a silicon-based transhuman technology. Narrow AI encompasses the types of AI we have today and is line with Sorgner's assertion that silicon-based technologies represent a, "pragmatic necessity" (2022, 22) for increasing lifespan and general good. By extension, adjacent digital technologies which take advantage of narrow AI perhaps reveal clues about what is possible in the transhumanist white space. This is the thread I wish to pull at in this work.

An example of one such adjacent digital technology are brain-machine interfaces (BCI). Because the BCI establishes a direct link between a brain and an external computing system, I consider BCI to be a strictly biodigital converged technology. Moreover, because BCI extends baseline human biology in a "self-overcoming" (Sorgner 2022, 1) manner, the technology is transhumanistic. Ross (2020) articulated a similar philosophy with the notion, "[e]nhancement is a key idea within transhumanism since it involves the elevation of human capacities beyond a baseline of normal human limitations" (25).

There can be little doubt the BCI existing today are powerful human-computer augmentations. What is more, the BCI of tomorrow, integrated with AI (Portillo-Lara *et al*. 2021), will be demonstrably cyborg. Still, there are unique challenges in the biodigital convergence of BCI and AI, however (Zhang *et al*. 2020). Foremost of these challenges is BCI user agency. More distinctively, existing BCI are known to elicit a sense of "disembodied agency" (Steinart 2019, 459). When BCI technologically evolve to include embedded AI for delegated decision-making and autonomous *intentional* action, we must anticipate the intensification of agency issues.

To that end, this work describes a *thought metadata schema* based on emergent biodigital convergence themes. The goal is to extend the silicon-based transhumanism philosophy presented by Sorgner (2022). I attempt to provide a bridge between Sorgner's work and near-future brain-computer interface technology as a definitive cyborg augmentation. I then employ a propositional framework to describe the schema with goal of establishing a foundation for future work.

1. Related Work

Biodigital convergence is inherently a multi-disciplinary construct. The construct is sufficiently developed to warrant discussion. Additionally, we must account for the specific technology involved in the convergence. Specifically, the research domains most related to this work are artificial intelligence, brain-machine interfaces, and agency. I highlight prominent ideas from these fields as well as open problems and challenges.

Biodigital convergence

Technology, being the scientific application of a knowledge domain to address a practical challenge, marries well with an evolutionary driven field like biology. The Nature drives the latter, the former selected through market pressures and paradigmatic innovation. The similarity in forces allows *bios* and *techne* to converge into the transhuman, the cyborg.

The convergence of biology and digital technology has engendered a variety of innovations. These innovations are externally invisible in the case of gene modification by CRISPR-CAS9 and externally observable in instances such as biohacking to implant digital devices. One unifying technology layer across the majority innovations is the use of AI, machine learning specifically, to enhance the fidelity of the biodigital information.

Furthermore, as with Heidegger's views, the technology segment of the biodigital convergence shapes the biology. Such shaping, even when viewed within Sorgner's concept of positive "self-overcoming" (2022, 1), comes with trade-offs. For instance, O'Riordan (309) suggests biodigital convergence subjects the biological to the norms of the digital. Others, such as Jandrić and Knox (2021) rightfully question the assumptions inherent in assuming biodigital convergence is determinist or instrumentalist.

Interestingly, the innovations coming out of biodigital convergence, while rooted in developments from the 1980s and 1990s, have all appeared with the dawning of the 21st century. What we know think of as biology started with the human genome project (Reader 2022, 24) and evolved into advanced genetic manipulation techniques. Moreover, what we think of digital technology has transitioned from large beige boxes on our desktop to system-on-a-chip computers embeddable in the human body (Belwafi, Gannouni, and Aboalsamh 2021). Overall, the biodigital domain is in its infancy but has demonstrated an aggressive growth curve.

There can be little doubt biodigital convergence in any form will impact the individual, culture, society, and the species. To what extent and in what manner are questions open? The field is not yet close to being mapped out. Thus, answers to such inquiries necessitate being more specific with regard to the digital technologies involved in the convergence under examination. Within the bounds of this work, AI and BCI are those technologies.

Artificial Intelligence

The general notion of AI is to imitate human intelligence (Carter 2007). Thus, AI is a broad discipline and can be an ambiguous term. In the context of this work, AI can be taken as synonymous with the specific sub-discipline, machine learning (ML). I choose to narrowly scope AI in this way for three reasons.

First, other sub-disciplines such as natural language processing and computer vision are AI fields but have little or nothing to contribute to the purpose of this work. BCI benefit from learning algorithms that reliably generalize from broad inputs to specific outputs. Such algorithms are necessary to consolidate a continuous brain activity signal into a discrete compute input signal. At the same time, there is no technological impetus behind extending BCI to include other forms of AI.

Second, ML algorithms implement a specific inductive logic to achieve a limited set of outcomes. In broad terms, ML either classifies inputs into trained categories or uses statistical regression to assert predictions. Again, other sub-fields within AI do not perform function similarly. Interestingly, the algorithmic induction implemented through ML is tantamount to experimental philosophy of science (Bensusan 2000).

Lastly, stemming from the prior two reasons, the associated philosophy becomes clearer. Starting with Hume, we can trace a clear line to modern thinking as represented by Strawson, Korb, Searle, Dennett, Chalmers, among many others. To be clear, the specific line connects the Humean root of inductive reasoning to the inability for a single, universal ML capable of solving every type of learning problem.

This last point also allows us to distinguish ML from AI to avoid larger, systemic challenges in the broader AI context. For instance, a goal of transhumanists is artificial general intelligence (Kurzweil 2005). The ethics of pursuing the goal are controversial and the likelihood is hotly debated. ML avoids the controversy and debate by virtue of being a narrow AI construct. Furthermore, AI has epistemological issues related to embodiment (Luvaanjalba and Su 2022) as well as two-minds and brain-in-a-vat challenges. Again, ML avoids such issues because the algorithms do not attempt to *know*, only update previously trained values. This makes ML a powerful augmentative digital technology for biodigitally converged systems.

Brain-Computer Interfaces

Brain-computer interfaces (BCI) are an augmentative biodigitally converged technology with applicability to a variety of applied domains (Ramadan & Vasilakos 2017). Put simply, a user's brain activity is converted to computing inputs through invasive (*i.e.*, surgically implanted in the brain) or non-invasive (*i.e.*, scalp surface electrodes) devices. Applications of digital technology range from consumer toys, military-based human-machine teaming, to medical augmentation to offset various disabilities. On one hand, BCI are a form of human-computer interaction not substantively different from a keyboard and mouse. On the other hand, the material difference in BCI enables behaviors Buller (2021) described as *phenomenologically similar* to ordinary behavior. Thus, while the BCI gives us the ability to interact with a computer as if we're using a keyboard and mouse, the experience is as if we are using the keyboard and mouse, not using the BCI.

A majority of BCI research within the philosophy domain is concerned with the ethics of the technology (Burwell, Sample*, and Racine* 2017; Orito *et al*. 2020; van Velthoven 2022). Outside of ethical inquiries, work by Tamburrini (2014) explored the epistemological facets of BCI, concluding there is a, "need for effective and responsible communication strategy" (160) in relation to the human user, the BCI, and the computing device being controlled. This claim seems to stem from what Heersmink (2011) articulated as a, "strong symbiosis and reciprocity" (2) between BCI and human. In other words, without tight coupling between all three components in the BCI system, and appropriate communications therein, there may be epistemological deficiencies.

Within the technology domain, research is focused on developing the BCI hardware and increasing BCI communications fidelity. The integration of AI and BCI is solved, at least in general. Specifically, AI is used to extrapolate a user's EEG patterns into discrete computer inputs (Aggarwal, and Chugh 2022). Notably, the AI is not autonomous in these integrations. The system cannot behave independent of a user's active engagement despite what the user may believe the BCI can do.

The cutting-edge of BCI technology is represented by Neuralink (Fiani 2021). One novel aspect of the solution is the ability to carry information to the user's brain. While future-leaning and speculative, I suggest it is not far-fetched to imagine an AI embedded in the BCI. There is a limited literature supporting this suggestion (Zhang *et al*. 2020). The narrow AI would be useful in learning user patterns of computer interaction. Such an AI then might augment the interaction by providing additional signaling and the AI may act autonomously to produce interactions we offload by delegation. Such an AI will be situated to filter or otherwise mediate input to the brain. However, an open problem, and the fundamental issue addressed in this work, is the applied epistemology associated with transmitting and receiving phenomenological information[3] through a brain-computer interface with an embedded augmentative AI mediating our knowledge in a simulation. Consequently, I feel some foundational understanding of agency in this context is required.

Agency

Not only humans affect technology while using it, but also such interactions ultimately affect humans by consequences of such use. In

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[3] I purposefully avoid using the term *qualia* here because the focus is on the information, not the experience of the information.

fact, technology mediated experience and impact to one's sense of agency is an area of active research. Indeed, there have been a number of studies investigating agency in the context of BCI. Haselager (2013) provides a robust summary.

For this work, I suggest agency be conceptualized as a metadata label, applicable to the phenomenological artifact arising when one intends to act and observes the act embodied in the world. That is, we don't normally think of agency prior to acting. Rather, we ascribe agency to behaviors post hoc. The foundation for the type of agency related to the present work is Libet's (1985; 1999) experimentation. Philosophy's reaction to Libet has been to separate agency into two forms.

The differentiation is based on (a) basic versus nonbasic behavior and (b) mental versus bodily behavior. The difference between mental and bodily is defined by Mele (1997) as occurring either entirely within the mind, without involvement of the physical body or with the physical body, respectively. Both involve a sense of agency albeit with differing characteristics. For example, thinking about using a calculator to sum two integers and imagining the output gives one the sense of having used a calculator to some degree. While similar, there is a material difference in the sense of agency associated with physically using the calculator.

Importantly, Metzinger (2013, 2) further refined mental agency to subordinate *attentional* and *cognitive* types. Taking the mental-cognitive route, the agency focus shifts to planning and decision-making. Both planning and decision-making fall within the sphere of narrow AI expertise. Consequently, there may be an opportunity to attach an artifact to outbound BCI communications originating from the embedded AI which provides redress to the agency problem.

Concurrently, we must be cognizant of the in-kind difference between actions happening to us and actions we cause. This *philosophy of action theory* is relevant to the unique mediation of action BCI provides. As Steinert *et al*. (2017) explained, "[a] motionless body, the epitome of inaction, might be acting" (457). Therefore, according to Lynn *et al*. (2010, 5) it is possible to craft an illusory sense of agency in BCI users. This effect has been replicated and expanded upon (Lopez-Sola, Moreno-Bote, and Arsiwalla 2021).

Haselager (2013, 415) suggests a root cause of negative BCI agency phenomena is a lack of reliability in users' determination of causation. Some work (Vlek *et al*. 2014; Haselager, Meacacci, and Wolkenstein 2021) has explored options to extend BCI to include some form of self-recognition for the user. Put differently, work is underway to develop a means for a BCI user to recognize the result of an action as the effect of his or her intent to action in the same way. This is meaningful work, but it has considerations for us to explore. To be precise, the cutting-edge of BCI agency solutions do not account for the presence of an augmentative AI with semi-autonomy (Haselager 2013, 416).

2. Thought Metadata Schema

If we assume a near-future possibility of brain-computer interface with an embedded AI, we need to begin developing a metadata labeling schema. The initial goal of the schema is to provide a metadata level differentiation between:

(1) an action stemming from BCI user intent;
(2) an action stemming from BCI user intent and filtered by the embedded AI and
(3) an action stemming from the BCI AI absent BCI user intent.

It follows the schema requires three functions, mapped one-to-one with the above goals. One function is bound to actions originating from user brain activity wherein the BCI embedded AI sends the communications without modification. A second function is bound to those actions which originate from the BCI user but are *filtered* by the embedded AI. Here, we take filtering to mean *classification* in the ML context for example. Lastly, a function is required for communications the AI sends autonomously. In all three cases, I assume the receiving computing system is capable of receiving the communication and reacting according to the schema.

Overall, I describe *actions* using the set $\mathbb{A}$. This is the set containing both user intended actions as A_u as well as embedded AI intended actions as A_i. Additionally, the embedded AI possesses a set of filters as $\mathbb{F}$. Meanwhile, the receiving computing systems have a companion set $\mathbb{R}$ containing $\mathrm{A_u}, \mathrm{A_f}, \mathrm{A_i}$ that have a relation to the stated goals. These will be used by the receiving system to signal source of action to the BCI user.

Then, more specifically, when the BCI communication passes through the embedded AI without modification, we can apply the following propositional description.

$$(1)\ \forall a \in A_u \land \neg A_i :\ \mathrm{a_u} \rightarrow \mathrm{a}$$

The (1) function encapsulates the need for a BCI user to act without the BCI with embedded AI augmentation and while acknowledging the mediation of the biodigital convergence. Principally, the function communicates all actions in the set of user intended actions – and not embedded AI intended actions – as *actions* to the receiving system. This is necessary because in advanced applications the BCI cannot be shut down without severing all communications. However, the embedded AI can forward actions without modification. I anticipate the receiving computer system will display a notification indicative of $\mathrm{A_u}$ being the cause of the action.

In the event a user intended action needs to be mediated by the embedded AI, the BCI can leverage the following propositional description:

$$(2)\ \forall a_u \in A_u \land \exists f \in \mathbf{F} :\ a_u \cup f \rightarrow \mathrm{a_f}$$

This (2) function is operationally similar to the prior. However, the addition of at least one *filter* is meaningful because the output $\mathrm{a_f}$ is not the original intent of the user. Rather, $\mathrm{a_f}$ is a synthesis of user intended action. This is necessarily so because the embedded AI abstracts fuzzy intent into discrete computer input. For example, the continuous EEG values for moving a mouse cursor up on a screen must be synthesized into the discrete *up* input code. Indeed, such synthesis is how existing BCI operate. Here, the function is (a) executed within the BCI and (b) attaches the $\mathbf{a_f}$ marker to the output. Reciprocally, the receiving computer system can display a $\mathbf{A_f}$ notification.

Finally, we have a function (3) for when the BCI embedded AI acts autonomously. Importantly, this function describes the means for the biodigital convergence to integrate with an external computing system without user intent or intervention. Importantly, the function blocks any potential inclusion of user intended action in the same operation as autonomous AI action by negating the A_u set. Further, I want to point out prior training is a strong constraint on the function. That is, the set A_i contains only those actions the AI is trained to perform. Thus, I suggest the receiving system notification of $\mathbf{A_i}$ is sufficient to avoid a truly disembodied sense of agency for the user.

$$(3)\ \forall a_i \in A_i \land \neg A_u : a_i \rightarrow \mathrm{a}$$

I anticipate the reasonable question at this point, *how does the embedded AI understand which function to apply*? The simple answer is the AI does not understand. In fact, understanding is not required. Instead, the AI classifies input according to the categories established through previous training. The basis of the classification is nothing more than a computational instantiation of the mapping between *relata*. More completely, the information processing (*i.e.*, classification) lacks a distinct epistemology on its own. This is expected because the AI augments the human user, it does not replace him or her.

Therefore, based on the goals and schema, I suggest we can harness the embedded AI to produce a recognizable artifact in the communication streams between human and computer. I would point out again the value of using a narrow AI (*i.e.*, ML) algorithm is we can sidestep the host of (legitimate) philosophical issues related to artificial general intelligence. Thus, there is little danger in adding our metadata schema functions to the embedded AI[4].

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[4] I recognize machine learning, despite being a mature technology, has challenges such as bias, adversarial attacks, and so forth. However, there is an active research literature

In a similar manner, I suggest the outcome of this metadata schema is a narrow, but sound applied epistemology. The applied epistemology is narrow insofar as the metadata schema leads to true beliefs about the user's actions and the embedded AI's actions *only* in the set of BCI use cases. Further, the soundness of the metadata schema approach is substantiated in associated literature. For instance, the metadata schema encodes a *cybernetic reflexive* relation between human, BCI, and actions consistent with Glanville (1975). As well, the metadata schema facilitates *self-organisation* (Espejo 2015) through *self-observation* (Krippendorf 1984) and a *self-steering* positivism (Sorgner 2022).

3. Conclusion

Humanity is transforming into a biodigitally converged organism. To mainstream transhumanists, this development points towards progress on the way to silicon-based cyborg goals such as mind transfer and digital immortality. Like Sorgner, I view mind uploading or consciousness transfer as unnecessary as a defining feature of transhumanism. There are a variety of non-extreme biodigital technologies contributing to our continued evolution as cyborgs. More importantly, whether the ultimate mainstream transhumanism goals are obtainable or not does prevent other innovations from being realized.

For instance, BCI are available today. These devices use brain activity to control computing systems. While the noninvasive type may not seem like a transhumanist silicon-based technology, the invasive type certainly should since it is implanted into the user's brain. The future-leaning innovation in this space is represented by Neuralink which is notably planned to allow bidirectional- brain to system and system to brain- communication.

BCI are not without challenges, however. Users can develop an illusory sense of agency. While not conclusive, the literature suggests problems related to agency stem from how the BCI mediates the users'

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developing countermeasures to these issues. My intention here is to delineate between technological issues and philosophical issues.

experience of their own behavior. More specifically, users can become decoupled from the experience of causing a change in the external environment because it is not perceptively clear whether intent to act resulted in the act.

Concurrent to BCI, AI has emerged from the scholarly realm and become a mainstream talking point. Further, the cutting-edge of BCI technology already incorporates AI to limited degrees. In particular, ML has demonstrated a capability to augment decision-making and planning mechanisms because of the constrained classification and regression algorithms present.

This paper explored the intersection of BCI with an embedded AI. I described a propositional metadata schema which may serve as a decision labeling mechanism for the information output by the biodigitally converged system. My goal was to provide a potential mechanism to bridge the gap between the underlying philosophy of transhumanism, the problem of user agency, and advancing biodigital convergence.

With this in mind, the metadata schema has theoretical significance as it represents a foundational knowledge architecture for addressing agency issues with BCI as well as BCI with embedded AI. The architecture can be used by philosophers and technologists alike to establish more extensive logical frameworks. Moreover, as a propositional artifact, the schema has practical significance as it can be readily translated into a programmed algorithm. Experimentation building from the baseline provided in the literature for BCI agency may be of interest to computer scientists and technologists.

Additionally, future work is necessary in this area. BCI and related biodigitally converged transhumanist technology will not cease to advance in sophistication. On one hand, a systematic review of open challenges and issues will benefit tomorrow's research by providing a stable foundation. As well, because biodigital convergence and BCI are multi-disciplinary endeavors, all relevant knowledge domains should come together to develop a general taxonomic road map for critical technologies, terminology, and transhuman objectives. Such necessarily includes computer science, information technology, philosophy of science, philosophy of technology, and social epistemology and perhaps should also adopt futurists, ethicists, and biologists as well.

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