Privacy Pitfalls of Contextually-Aware AI: Sensemaking Frameworks for Context and XR Data Qualities by Kent Bye[1]

Existing privacy laws worldwide are ill-prepared to deal with the invasive types of inferences made using data from Extended Reality (XR) technologies, specifically Virtual Reality (VR) and Augmented Reality (AR) headsets. For XR devices to properly function, they need access to new types of physiological, environmental, emotional, social, cognitive, and behavioral data. Access to this data yields many real-time experiential benefits for the users. Still, that same data also serves surveillance capitalism interests by deriving psychographic inferences about our context-specific likes, dislikes, character traits, personality, and identity in what Brittan Heller has termed as "biometric psychography."[2] Additionally, the company Meta is also laying the groundwork for an omnipresent AI surveillance system that tracks the context of XR users in what they call "contextually-aware AI, "[3] which fundamentally challenges Helen Nissenbaum's contextual integrity theory of privacy[4] wherein the appropriate flow of information depends on the context. These unprecedented technologies drive an urgent need for policymakers and XR technology developers to develop a deeper theoretical understanding of the relational dynamics between context and privacy as well as between context and identity. In this paper, we will examine how an archetypal taxonomy of context can create a map to navigate how to preserve contextual integrity, how experiential design and theories of presence can help make sense of the phenomenological nature of XR data, and how human rights approaches of Neuro-Rights and cognitive liberty can create safeguards for XR data to live into the more exalted potentials of XR.

Meta's Path Towards "Contextually-Aware AI"

Meta (formerly Facebook) is one of the leading companies in the development of XR technologies starting with their acquisition of Oculus in 2014. As of early 2023, Meta had sold 20 million Quest VR headsets.[5] However, Meta's virtual reality division, Reality Labs, is still in its early stages, and over 98% of Meta's revenue as of the third quarter of 2023 still comes from advertising in their family of non-XR apps.[6] Meta is in the business of advertising. What does that mean for the

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[1] Kent Bye is an experiential journalist covering XR since 2014. His Voices of VR podcast features over 1,300 published interviews with the pioneering artists, academics, and technologists driving the development of XR. He speaks around the world on the patterns of experiential design, immersive storytelling, XR ethical frameworks, and the ultimate potential of XR.

[2] Brittan Heller, Watching Androids Dream of Electric Sheep: Immersive Technology, Biometric Psychography, and the Law, 23 *Vanderbilt Journal of Entertainment and Technology Law* 1 (2020) https://scholarship.law.vanderbilt.edu/jetlaw/vol23/iss1/1

[3] "Inside Facebook Reality Labs: Wrist-Based Interaction for the next Computing Platform." *Tech at Meta.* (March 18, 2021). Accessed November 27, 2023. https://tech.facebook.com/reality-labs/2021/3/inside-facebook-reality-labs-wrist-based-interaction-for-the-next-computing-platform/.

[4] Helen Nissenbaum. *Privacy in Context: Technology, Policy, and the Integrity of Social Life.* Stanford, CA: Stanford University Press, 2010.

[5] Alex Heath. "This Is Meta's AR / VR Hardware Roadmap through 2027." *The Verge.* (March 1, 2023). Accessed November 20, 2023. https://www.theverge.com/2023/2/28/23619730/meta-vr-oculus-ar-glasses-smartwatch-plans.

[6] "Meta Reports Third Quarter 2023 Results." *Meta.* (October 25, 2023). Accessed November 27, 2023. https://investor.fb.com/investor-news/press-release-details/2023/Meta-Reports-Third-Quarter-2023-Results/default.aspx.

future of XR? In 2021 the Vice President of Facebook Reality Labs Andrew Bosworth defended early testing of ads within VR by saying, "I've always believed in ads. I believe in great ads, and that involves ads that are contextual and relevant. And that's kind of what we do."[7] Understanding the deeper context of users is a key element to Meta's core business model of personalized advertising[8] that relies upon audience segmentation through the psychographic profiling of users.

In March 2021, Meta began to unpack their ten-year vision of "contextually-aware AI" in a series of blog posts. Their first post said, "The biggest difference between the future AR interface and everything that's come before is that there will be much more contextual information available to our AR devices. The glasses will see and hear the world from your perspective, just as you do, so they will have vastly more personal context than any previous interface has ever had."[9]
Meta's next post emphasized how they see that the future of human-computer interaction (HCI) requires contextually-aware AI:

> The future of HCI demands an exceptionally easy-to-use, reliable, and private interface that lets us remain completely present in the real world at all times. That interface will require many innovations in order to become the primary way we interact with the digital world. Two of the most critical elements are contextually-aware AI that understands your commands and actions as well as the context and environment around you, and technology to let you communicate with the system effortlessly — an approach we call ultra-low-friction input. The AI will make deep inferences about what information you might need or things you might want to do in various contexts, based on an understanding of you and your surroundings, and will present you with a tailored set of choices.[10]

Meta is saying XR devices will "have vastly more personal context than any previous interface has ever had" that persistently understand the "context and environment around you" and that "AI will make deep inferences about what information you might need or things you might want to do in various contexts, based on an understanding of you and your surroundings." This description emphasizes that there will be many new pathways for collecting new types of intimate data that come from XR.

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[7] Harry Baker. "Facebook VR Head: Quest Ads Weren't 'communicated Well' but Backlash Was 'Too Much.'" *UploadVR.* (July 2, 2021). Accessed November 20, 2023. https://www.uploadvr.com/facebooks-head-of-vr-responds-to-ad-criticism/.
[8] Steve Satterfield. "Personalized Advertising and Privacy Are Not at Odds." *Meta.* (December 16, 2020). Accessed November 20, 2023. https://about.fb.com/news/2020/12/personalized-advertising-and-privacy-are-not-at-odds/.
[9] "Inside Facebook Reality Labs: The Next Era of Human-Computer Interaction." *Tech at Meta.* (March 8, 2021). Accessed November 20, 2023. https://tech.facebook.com/reality-labs/2021/3/inside-facebook-reality-labs-the-next-era-of-human-computer-interaction/.
[10] "Inside Facebook Reality Labs: Wrist-Based Interaction for the next Computing Platform." *Tech at Meta.* (March 18, 2021). Accessed November 20, 2023. https://tech.facebook.com/reality-labs/2021/3/inside-facebook-reality-labs-wrist-based-interaction-for-the-next-computing-platform/.

In October 2021, Meta announced their Egocentric 4D Perception (EGO4D) research initiative[11] with a set of benchmark challenges across five major areas.[12] The five areas were "episodic memory" which aimed to answer questions including "Where is object X after event Y?" "Social interactions" would answer "Who is attending to whom?" "Audio-video diarization" would answer "Who said what, and when?" "Hand + object interaction" would answer "How do objects change during interactions?" Then finally "forecasting" would answer "What will happen next?"

Meta's EGO4D research agenda sets forth many of the technical foundations of contextually-aware AI that could enable a new form of adaptive-HCI for XR devices, but could also enable an omnipresent and omniscient AI surveillance system that could be used to psychographically profile its users as well as bystanders (both public and private) by this new class of XR technologies that are persistently capturing egocentric data.

How an Omnipresent Contextually-Aware AI Violates Contextual Integrity

Helen Nissenbaum's contextual integrity theory of privacy emphasizes that "What people care most about is not simply restricting the flow of information but ensuring that it flows *appropriately*, and an account of appropriate flow is given here through the framework of contextual integrity."[13] She defines "appropriate" as informational norms that are specific to a context saying:

> According to the framework, finely-calibrated systems of social norms, or rules, govern the flow of personal information in distinct social contexts (e.g., education, health care, and politics). These norms, which I call context-relative informational norms, define and sustain essential activities and key relationships and interests, protect people and groups against harm, and balance the distribution of power.[14]

Nissenbaum often provides the example of how there is specific information that you would provide to your doctor about your health that you would not share with your banker, and there is financial information that you would share with your banker that you would not want to share with your doctor. These context-specific domains of human experience have different normative standards of information flows, which Nissenbaum's theory of contextual integrity attempts to elucidate.

Another way to flesh out these different contextual domains is through the nature of the different relationships we have with people. Nissenbaum writes:

> Ferdinand Schoeman, who has developed one of the deepest and most subtle philosophical accounts of privacy and its value to humans, writes, "People have, and it is important that

[11] "Teaching AI to View the World Through Your Eyes." *Meta.* (October 13, 2021). Accessed November 20, 2023. https://about.fb.com/news/2021/10/teaching-ai-to-view-the-world-through-your-eyes/.
[12] "Egocentric 4D Perception (EGO4D)." *Egocentric 4D Perception (EGO4D).* (October 13, 2021). Accessed November 20, 2023. https://ego4d-data.org/#benchmarks.
[13] Helen Fay Nissenbaum. *Privacy in Context: Technology, Policy, and the Integrity of Social Life*. Stanford: Stanford Law Books, 2010. Page 2.
[14] Nissenbaum, *supra* note 13, page 3.

> they maintain, different relationships with different people. Information appropriate in the context of one relationship may not be appropriate in another" (1984, 408). This assessment is echoed in the work of philosopher James Rachels, who attributes to privacy a key role in differentiating the variety and distinctiveness of relationships people need to maintain... "businessman to employee, minister to congregant, doctor to patient, husband to wife, parent to child, and so on. In each case, the sort of relationship that people have to one another involves a conception of how it is appropriate for them to behave with each other, and what is more, a conception of the kind and degree of knowledge concerning one another which it is appropriate for them to have."[15]

The main difference between these different types of relationships and informational norms for data flows comes down to different contexts. In a lecture, Nissenbaum says that contexts are "differentiated social spheres defined by important purposes, goals, and values, characterized by distinctive ontologies, roles, and practices, e.g. healthcare, education, family; and norms, including informational norms - implicit or explicit rules of info flow."[16] She adds at the end of her slide "Please don't ask me to define contexts!" This emphasizes how difficult contexts can be to pin down as they're a complicated set of invisible relationships not often explicitly defined anywhere.

Nissenbaum writes in her book, "By contexts, I mean structured social settings with characteristics that have evolved over time (sometimes long periods of time) and are subject to a host of causes and contingencies of purpose, place, culture, historical accident, and more."[17]

One major problem with Meta's proposed omnipresent, contextually-aware AI surveillance system is that it has no robust way of tracking these subtle contextual and relational shifts to understand what is an appropriate flow and what is not. It is intended to be an always-on, omnipresent system that's potentially monitoring and/or recording all of our interactions with the physical world across all contexts, who we are speaking with, what was said by whom and when, as well as our non-verbal interactions, and a forecasting model to predict subsequent behavioral actions across any context.

What will happen to these contextually-aware AI data streams? Will all our physical world actions and conversations be recorded so that Meta or other entities can access them? Will this data be processed in real-time and used for psychographic profiling? What about the information from bystanders who may have not consented to be captured and recorded? If some user data is used to train a large-language model (LLM), then how could sensitive and private information like personally-identifiable information be eliminated from training sets or protected from getting jailbroken from an LLM? [18]

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[15] Nissenbaum, *supra* note 13, page 85.
[16] Helen Nissenbaum."Contextual Integrity: Breaking the Grip of Public-Private Distinction for Meaningful Privacy." [Presentation] *YouTube*. The University of Washington's Department of Human Centered Design & Engineering 2021 Distinguished Lecture, Virtual. (March 9, 2021) https://www.youtube.com/watch?v=VPwmC0Sfe50&t=1240s.
[17] Nissenbaum, *supra* note 13, page 130.
[18] Yi Liu, Gelei Deng, Zhengzi Xu, Yuekang Li, Yaowen Zheng, Ying Zhang, Lida Zhao, Tianwei Zhang, and Yang Liu. "Jailbreaking ChatGPT via prompt engineering: An empirical study." arXiv preprint (2023). https://arxiv.org/abs/2305.13860.

Contextually-aware AI could enable a type of omnipresent AI surveillance that rapidly changes the normative standards of information flows across every contextual domain. This could have profound implications for the "reasonable expectation of privacy" test for the Fourth Amendment originating from the 1967 *Katz v. United States* Supreme Court case, [19] especially considering the third-party doctrine and how any information shared with a third party has no reasonable expectation to remain private.

In short, contextually-aware AI threatens to fundamentally disrupt the legal frameworks around privacy and violates the underlying principles of Nissenbaum's contextual integrity theory of privacy. The challenge is that XR and AI technologies are evolving at a much faster rate than the conceptual frameworks that could help technology developers or policymakers understand and constrain this diffusion of technology.

Gary Merchant describes this technology pacing gap dilemma by saying:

> A series of concurrent technological revolutions are rapidly transforming economic, social and personal domains... In contrast to this accelerating pace of technology, the legal frameworks that society relies on to regulate and manage emerging technologies have not evolved as rapidly, fueling concerns about a growing gap between the rate of technological change and management of that change through legal mechanisms... The consequence of this growing gap between the pace of technology and law is increasingly outdated and ineffective legal structures, institutions and processes to regulate emerging technologies.[20]

Coming up with a technological or policy solution that both overcomes the technology pacing gap and can successfully constrain an omnipresent, contextually-aware AI system driven by a surveillance capitalism company is beyond the scope of this article. However, we can start to chip away at this problem by delving into what Nissenbaum refrained from, which is to create a conceptual framework mapping out the contextual domains of the human experience. Such sensemaking frameworks will be necessary to make sense of these problems through either algorithmic or policy solutions that maintain the integrity of our contexts while these immersive technology companies are pressuring us toward context collapse.

An Archetypal Approach for Mapping Contexts

The challenge of mapping a comprehensive framework for all the contextual domains of human experience is that there are an infinite number of contexts, so any framework is inevitably either going to be inconsistent or incomplete – and likely both. However, while we must remain mindful that "the map is not the territory" as Alfred Korzybski said, the purpose of a map is to help make decisions. The utility of a map of contexts would be to help understand the relational dynamics between different contextual domains, and thereby to help determine when contextual

[19] Peter Winn, *Katz and the Origins of the Reasonable Expectation of Privacy Test*, 40 McGeorge L. Rev. (2016). Available at: https://scholarlycommons.pacific.edu/mlr/vol40/iss1/1.

[20] Gary E. Marchant. "The Growing Gap between Emerging Technologies and the Law." *The International Library of Ethics, Law and Technology* (2011): 19–33. https://doi.org/10.1007/978-94-007-1356-7_2.

integrity might be violated. It could also help policymakers create legal frameworks to ensure that the integrity of different contextual domains is maintained.

Nissenbaum's contextual integrity approach defines contexts through the informational norms that determine the appropriate flow of information within that domain. One challenge is to create a map that synthesizes the complexity of how informational norms are related while avoiding an explosion of contextual domain categories that make it untenable to use.

Another challenge of a comprehensive mapping of contextual domains is that there is no comprehensive philosophy of privacy to build upon. Anita Allen, in her 2019 presidential address to the American Philosophical Association titled "The Philosophy of Privacy and Digital Life", argued that "comprehensive philosophies of privacy and data protection are missing and scarcely attempted." She contends that there are four prerequisites for a comprehensive philosophy of privacy:

> A comprehensive philosophy of privacy needs 1) an account of definition and meaning; 2) an account of value, ethical and other values; 3) an account of political dimensions of privacy; and 4) context-specific practical applications and implications that demonstrate the explanatory power and import of the accounts defended.[21]

A comprehensive philosophy of privacy requires "context-specific practical applications" because privacy is intimately tied to context. While this article cannot provide a comprehensive philosophy of privacy, mapping out the landscape of contextual domains could be a first step in minimizing what Allen calls "the intractable vagueness of privacy" thesis. Privacy and context are really hard to pin down, which results in the "intractable vagueness" that "suits the needs of opponents of progressive privacy laws" and also "suits the needs of technologists who find privacy constraints a drag on exciting and lucrative innovation."[22] We can certainly add "contextually-aware AI" to the list of lucrative technological innovations that pesky privacy concerns could bog down.

In his *Understanding Privacy* book, privacy scholar Daniel Solove argues that "privacy should be conceptualized from the bottom up rather than the top down, from particular contexts rather than in the abstract."[23] Solove's assertion indicates that privacy can be best understood by starting from specific contexts, but how do we even begin to identify all the "particular contexts" of human activity?

One strategy for comprehensively mapping out contextual domains is to take an archetypal approach, which explicitly allows for the incomplete and inconsistent inevitability of such an attempt. Carl Jung describes the ever-evolving nature of archetypes in the following way:

> Clear-cut distinctions and strict formulations are quite impossible in this field, seeing that a kind of fluid interpenetration belongs to the very nature of all archetypes. They can only be roughly circumscribed at best. Their living meaning comes out more from their presentation as a whole than from a single formulation. Every attempt to focus them more sharply is

[21] Anita L. Allen, Presidential Address, "The Philosophy of Privacy and Digital Life," 93 Proceedings of the American Philosophical Association 21-38 (2019)., Available at SSRN: https://ssrn.com/abstract=4022657.
[22] Allen, *supra* note 21.
[23] Daniel J. Solove. *Understanding Privacy*. Cambridge, MA: Harvard University Press, 2008, page 9.

> immediately punished by the intangible core of meaning losing its luminosity. No archetype can be reduced to a simple formula. It is a vessel which we can never empty, and never fill. It has a potential existence only, and when it takes shape in matter it is no longer what it was. It persists throughout the ages and requires interpreting ever anew. The archetypes are the imperishable elements of the unconscious, but they change their shape continually.[24]

Anyone who has ever managed a taxonomy has probably experienced aspects of Gödel's Incompleteness theorem regarding the dialectic between incompleteness and inconsistency.[25] When the goal is to have a manageable number of different categories that makes a taxonomy map useful, there will always be a tradeoff between being comprehensively complete in mapping out a domain versus embracing some level of inconsistency (i.e. adding a taxonomy term within a category that does not fit, but is not significant enough to create a new category).

Jung's archetypal approach advocates embracing more of a paraconsistent logic within the boundaries of an archetype where there may be subtle inconsistencies within a taxonomic category. This results in needing to list off an archetypal complex of significations to get a sense of the boundaries of an archetypal contextual domain, but it keeps the mapping bounded enough to remain useful.

There may be a subtle bias towards completeness, but there is still a fluid flexibility that acknowledges a fundamental incompleteness by avoiding "clear-cut distinctions and strict formulations" or being "reduced to a simple formula" because it "requires interpreting ever anew." This type of archetypal approach embraces the paradox of Gödel's incompleteness versus inconsistency by adopting more of a process-relational philosophical approach that prioritizes dynamic flux over defining fixed, static objects.[26]

With all of these caveats, the merits of any contextual domain mapping could be judged by the degree it can identify and mitigate potential contextual boundary transgressions when developing contextually-aware AI, or attempting to constrain it through policy. An archetypal mapping of contexts has already proven to be a useful tool for comprehending the promises and perils of XR technologies (detailed in the next section), and it also has the potential to be used as a sensemaking framework for getting a high-level overview on the landscape of privacy issues as well as moving closer towards a comprehensive philosophy of privacy.

Applying an Archetypal Taxonomy of Contexts to XR Potentials, Ethics, and Privacy

I use an archetypal taxonomy of contexts to map out the potential promises of emerging technologies, as well as the perils of the many ethical and moral dilemmas. It is an open question as

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[24] Carl Gustav Jung. (1968). *The Psychology of the Child Archetype*. In R. F. C. Hull (Trans.), *The Collected Works of C. G. Jung, Complete Digital Edition* (Vol. 9: Part 4 of *The Archetypes and the Collective Unconscious*, 2nd Edition, pg. 179, paragraph 301). Princeton, NJ: Princeton University Press. (Original work published in 1940).

[25] Undefined Behavior. "Math's Existential Crisis (Gödel's Incompleteness Theorems)." *YouTube*. (December 14, 2016). Accessed November 27, 2023. https://www.youtube.com/watch?v=YrKLy4VN-7k.

[26] Johanna Seibt. "Process Philosophy", The Stanford Encyclopedia of Philosophy (Summer 2023 Edition), Edward N. Zalta & Uri Nodelman (eds.) https://plato.stanford.edu/archives/sum2023/entries/process-philosophy/.

to how useful it might be for mapping all the boundaries of contextual integrity, but I find enough utility for brainstorming contextual integrity transgressions that it is worth elaborating here.

In over 1300 published Voices of VR podcast episodes, I have asked my guests, "What is the ultimate potential of virtual reality, and what might it enable?" Their answers usually fall into one or more contextual domains of human experience that range from novel innovations within the domains of identity, embodiment, sensory experiences, economics, early education, communication, home and family, entertainment, sex, medicine, romantic relationships, grieving from death, higher education, training, philosophy, religion, workplace productivity, friends, and accessibility. My 1000th Voices of VR podcast episode featured 120 quotes that can roughly be categorized into the different contextual domains visualized below:[27]

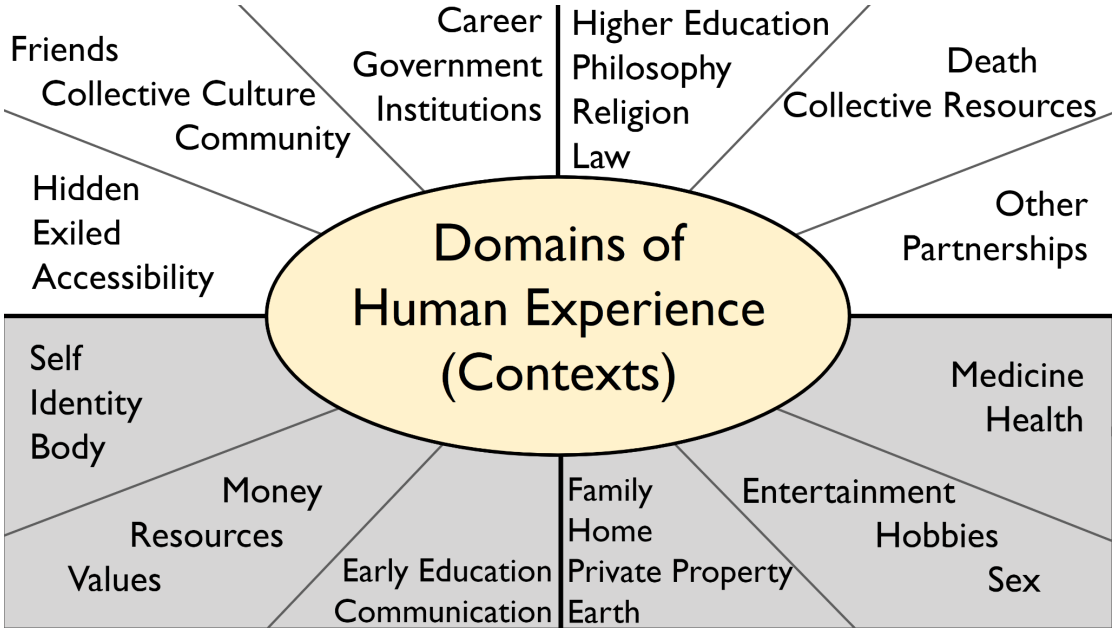

Fig. 1: An Archetypal Taxonomy of Contexts Representing the Domains of Human Experience

This archetypal contextual taxonomy has also proven useful in mapping out the perilous landscape of ethical and moral dilemmas of XR technologies. I used this contextual mapping to develop my "XR Ethics Manifesto" presented at Greenlight's XR Strategy Conference in 2019,[28] which a summary slide can be seen below.

[27] Kent Bye. "#1000: Voices of VR Retrospective on the Ultimate Potential of Virtual Reality." *Voices of VR Podcast*. (August 28, 2021). Accessed November 28, 2023. https://voicesofvr.com/1000-voices-of-vr-retrospective-on-the-ultimate-potential-of-virtual-reality/.

[28] Kent Bye. XR Ethics Manifesto [Presentation], *Greenlight XR Strategy Conference*, San Francisco, CA. (October 18, 2019) Available at https://www.slideshare.net/kentbye/xr-ethics-manifesto-updated-nov-2-2019 (Accessed November 9, 2021) and https://www.youtube.com/watch?v=CXgY3YXxqJ8.

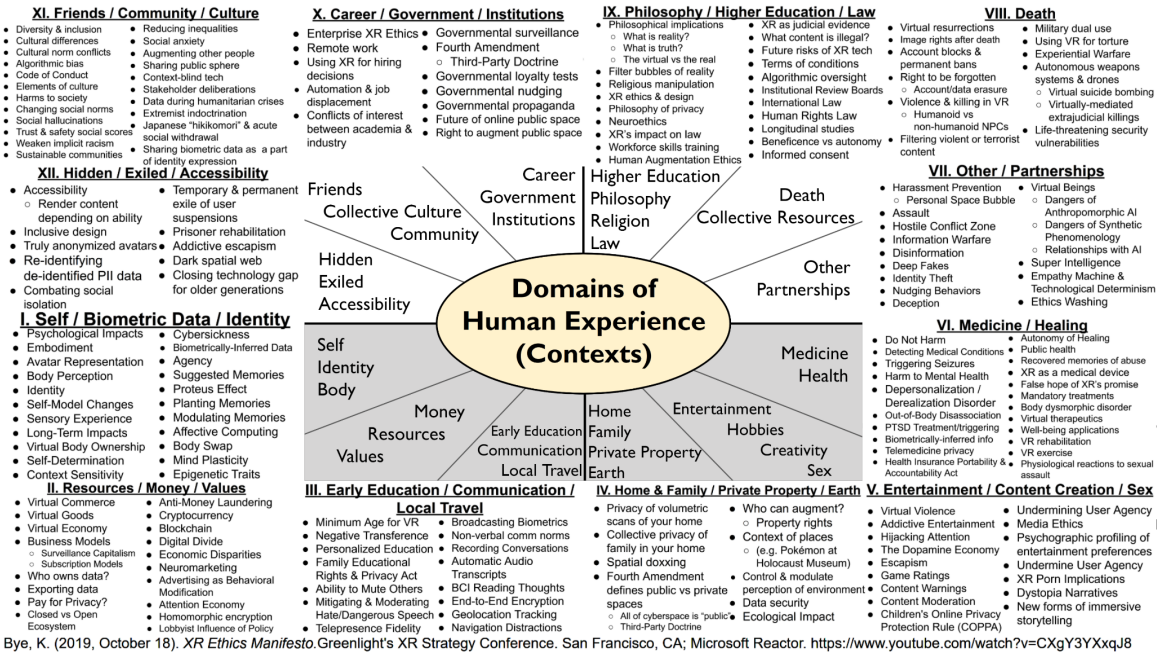

Fig. 2: Summary of Bye's 2019 *XR Ethics Manifesto* Talk Mapping the Landscape of Ethical and Moral Dilemmas of XR, which is an Application of the Taxonomy of Archetypal Contexts

This is not a comprehensive or exhaustive list of every single ethical or moral dilemma of XR, but it did establish the pertinent cartography of contexts to pay attention to while brainstorming the ethical implications of XR technologies. It was this preliminary mapping that led to the founding of the IEEE Global Initiative on the Ethics of Extended Reality where eight white papers were written elaborating on the specific ethical concerns across nine of these contextual domains including identity, economics, education, privacy, medicine, social VR harassment, metaverse governance, accessibility as well as diversity, equity, and inclusion.[29]

This map of contexts is useful for understanding different XR industry verticals, the many promising potentials of XR applications, as well as the landscape of ethical and moral dilemmas. But can it help mitigate potential contextual boundary transgressions within the context of privacy? We can test this out by classifying Personally-Identifiable Information (PII) across different contextual domains to help identify the contours of privacy. If contextually-aware AI is inevitable, then we need safeguards in place to ensure it navigates the sensitive PII or private information that might be shared within each domain but also establish a framework to prevent inappropriate leakage of PII from one contextual domain to another.

PII is defined as "information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, etc. alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual,

[29] Links to all eight IEEE white papers and podcast interviews about them can be found at Kent Bye. "#1089: IEEE Global Initiative on the Ethics of Extended Reality: Trolling, Harassment, and Online Safety." *Voices of VR Podcast.* (June 4, 2022). Accessed November 28, 2023. https://voicesofvr.com/1089-ieee-global-initiative-on-the-ethics-of-extended-reality-trolling-harassment-and-online-safety/.

such as date and place of birth, mother's maiden name, etc."[30] Using a non-exhaustive list of PII from Matomo[31] along with some additions, here is a graphic showing how these pieces of personally-identifiable information fit into this archetypal contextual mapping (entries in brackets represent information that could be used to derive PII when combined with other data).

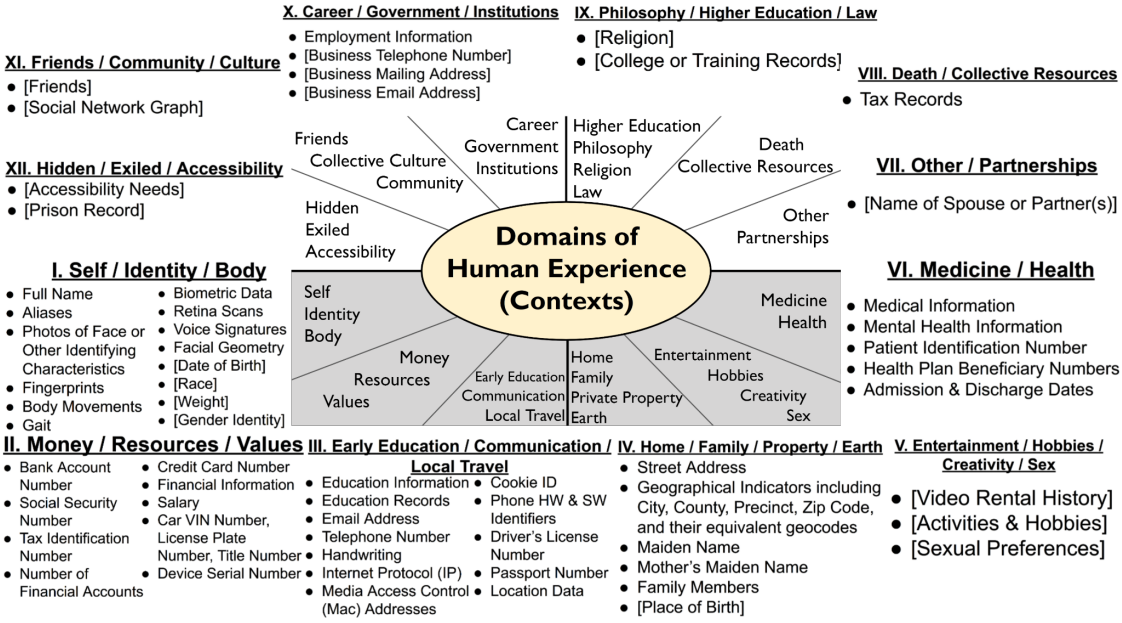

Fig. 3: Personally-Identifiable Information Categorized into the Taxonomy of Archetypal Contexts

Looking at this graph, you can see that most sensitive bits of PII are located in the bottom half of this contextual mapping, which reflects a broader split between domains that veer towards private versus domains that skew public. There will be more about the inherent polarities in this archetypal mapping within the next section.

You will observe that the first domain, Self / Identity / Body, is the one we would correlate most closely with PII. Putting this category first immediately establishes PII as the organizing principle around which all other categories are arranged and in relationship with. Creating this domain as the first and most important one underscores the autonomy of the individual and the need to protect that personhood first over any corporate interest. Every other domain then becomes a fractal reflection of that first domain and must, therefore, protect its integrity.

Clustering the pieces of PII within these archetypal contextual domains also reveals clear thematic patterns around identity, finances, home & family, and medical history as information that is important to protect. This map also illustrates the previous example of how to separate the types

[30] "Safeguarding Information." *Privacy, Office of Privacy and Open Government, U.S. Department of Commerce.* (October 14, 2016). Accessed November 28, 2023. https://www.osec.doc.gov/opog/privacy/pii_bii.html.
[31] "Personally Identifiable Information Guide: A List of PII Examples." *Matomo.* (January 23, 2020). Accessed November 28, 2023. https://matomo.org/personally-identifiable-information-guide-list-of-pii-examples/.

of information people want to share with their doctors that they would not want to share with their bankers and vice versa.

Furthermore, this map emphasizes the sensitive nature of XR data that can include voice signatures, body movements, or gait as biometric PII, which can be used by XR applications or platform holders to uniquely identify users. Most physiological data is currently considered anonymous and treated as de-identified data, but there will be more XR data that will need to be added to this list of PII as machine learning systems unveil unique identifiable signatures within biometric data streams. There are also a few caveats including how deep fake photos and AI voice cloning technologies alter how reliable voice signatures or photographs can be treated as PII, or how facial recognition systems that rely upon facial geometry are still highly dependent upon incomplete data sets that result in algorithmic biases. Even though reliable PII from body-centric data is in a state of constant flux, an archetypal mapping like this can identify where core issues of contextual integrity might be violated by XR application developers or XR platform providers.

However, this archetypal contextual mapping also has some limitations and inconsistencies that cluster together contexts that would likely require further contextual integrity mapping boundaries to be defined. As an example, educational information, communication details, and current geographic location are listed within the same contextual domain, but sharing your phone number or email with someone is not the same as sharing educational records or your current GPS location. Other inconsistencies include sexual preferences listed within the same context of entertainment preferences or hobbies as well as romantic partners grouped with enemies. In order for this contextual mapping to be truly useful for a nuanced application of contextual integrity, it would require further refinement containing more contextual domains that represent norms around information flow. Again, some of this comes back to the incompleteness versus inconsistency dilemma that all taxonomies face, but some of these inconsistencies originate within the primary source of this archetypal contextual mapping, which has some deeper philosophical underpinnings and polarities that are worth unpacking a bit more.

The Historic Basis for an Archetypal Taxonomy of Contexts

Although my application of these contextual domains to privacy, ethics, and potentials of emerging technologies may be novel, I cannot take credit for the invention of this archetypal taxonomy of contexts. Rather than relying on my singular and hence inevitably insular perspective, I turned instead to a mapping system that is over 2,000 years old and has been evolving across the span and breadth of Western civilization. In the spirit of archetypes being re-interpreted ever anew, I adapted the archetypal taxonomy of contexts above from the Hermetic tradition of Western astrology that has actively been categorizing human activity from the Golden Age of Greece through the Persian Empire and the Medieval era, to the Renaissance, and well into the Modern era. For our purposes, it is hopefully obvious that we are wholly disinterested in debating the merits of divinatory practices, an argument that is well beyond either the interests or the scope of this paper. Rather, it is the sheer utility of an archetypal contextual domain system developed cross-culturally across multiple generations explicitly to map the human condition that is of interest here.

Demetra George is a professional astrologer and researcher who has synthesized the primary contextual domain significations across the Hellenistic (200 BCE - 0 CE), Medieval (700 CE - 1140 CE), Renaissance (1400 - 1600 CE), and Modern (1900 CE - today) eras of the astrological tradition. She explains how astrologers originally connected spatial contexts with the domains of human experience by saying:

> Astrological systems divide the space encircling the Earth into twelve sectors. In modern astrology, each sector is called a house, but the ancient Greek term was topos, meaning "place". Topos is the root of the word "topography", the lay of the land... As terrestrial locations, they specify the various places where humans engage in the activities of the human condition. The houses describe the major topics of life, such as parents, children, marriage, profession, wealth, friends, illness, suffering, and religion.[32]

The astrological houses are functionally equivalent to what I have been calling the contextual domains of human experience or an archetypal taxonomy of context. Below is a table that compares my lists of contextual domain keyword significations with primary sources of traditional and modern significations of astrological houses that George aggregated from astrological literature spanning more than 2,000 years. Note that there are many more significations for each house that are not listed in this table, but can be found in the cited pages in George's *Ancient Astrology: In Theory & Practice. A Manual of Traditional Techniques, Volume II*.

Contexual Domain Summary	House	Primary Source of House Significations from Demetra George (2022)
Self / Identity / Body	1	Body, Appearance, Temperament, Character, Identity, Physical Constitution (pg. 647)
Resources / Money / Values	2	Money, Possessions, Resources Used to Maintain Manner of Life, Values (pg. 659)
Early Education / Communication / Local Travel	3	Travel and Short Journeys, Transportation, Neighborhood, Community, Immediate Environment, Communications, Primary School & Local Lower Education (pg. 674)
Home / Family / Private Property / Earth	4	Family & Parents, Home & Hearth, Land, Real Estate, Property, Foundations, Buildings (pg. 688)
Entertainment / Creativity / Hobbies / Sex	5	Pleasurable Pursuits, Romance & Sexuality, Creative Arts (pg. 703)
Medicine / Health	6	Illness & Disease, Health (pg. 717)
Other / Partnerships	7	Marriage & Spouse, Business Partners, Enemies & Opponents, The Other Party in All Negotiations & Bargains (pg. 731)
Death / Collective Resources	8	Death, Loss & Grief, Inheritance, Taxes (pg. 746)
Higher Education / Philosophy / Religion / Law	9	Religion & Spirituality, Wisdom, Philosophy, Law, Higher Education (pg. 761)
Career / Government / Institutions	10	Profession, Occupation, Vocation, Public Role in Society, Rank, Honor, Reputation, Social Status, Relationship with Authority & Authority Figures (pg. 774)
Friends / Collective Culture / Community	11	Friends, Friendships, Companions, Their Nature & Characteristics, Social Acquaintances, Associates, Colleagues, Social Participation in Groups, Clubs, Teams, Organizations, Political & Spiritual Communities, & Group Identity (pg. 788)
Hidden / Exiled / Accessibility	12	Isolations, Imprisonment, Great Illness, Misfortunes, & Exile (pg. 801 & 804)

Table 1: Comparison of Taxonomy of Archetypal Contextual Domain Significations Derived from Astrological House Significations as Aggregated by George (2022)[33]

[32] Demetra George. *Ancient Astrology in Theory and Practice. A Manual of Traditional Techniques, Volume II.* Auckland, New Zealand. Rubedo Press, 2022, page 597.
[33] George. *supra* note 32, pages 647, 659, 674, 688, 703, 717, 731, 746, 761, 774, 786, 801, & 804.

These domains, even if used generally, have proven an unparalleled, robust, and very useful map of human contexts. It is the most ambitious attempt to create a comprehensive contextual mapping of the human experience that I have come across, and it does not require adopting the metaphysical presuppositions of the astrological tradition to use as a baseline to form a secular mapping of contextual domains. Given the urgent need for such a cartography and the absence of any serious competition for it, it seems logical to use a system tested by generations of people for the last two millennia. It provides, at the very least, a powerful starting point.

There are a few philosophical and symbolic underpinnings of the astrological map of contexts that are worth unpacking to explain its utility as an archetypal taxonomy from a privacy perspective. The symbolic meanings of four key astrological houses are tied to the diurnal motion of the sun over a day. It starts with the sunrise in the East at the end of the 1st house (representing the self), and then the polarity point of the sunset in the West at the end of the 7th house (representing the other). The sun hits the solar noon on the local meridian due South in the northern hemisphere and the highest point of the day, which is at the end of the 10th house (representing your public & professional life and reputation). Then the polarity point of solar midnight when the sun is the closest to the nadir, and completely occluded by the earth at due North in the northern hemisphere, which is at the end of the 4th house (representing your private and home life and family heritage). The sun moves backward through the 12th to 7th houses during the day when the sun is above the horizon line, and then through the 6th to 1st houses during the night when it is below the horizon line. The 1st to 6th houses all represent the more personal and private contextual domains when the sun has set at night whereas the 7th to 12th are more public when the sun is visible in the sky during the day. If you go back to the mapping of PII, you will notice a critical mass of PII that is concentrated within the 1st to 6th houses. This emphasizes the symbolic power of using the archetypal taxonomy of contextual domains from the astrological tradition where these night-time houses are symbolically the more private ones.

The complementary correspondences between day versus night with public versus private brings up another philosophical point around polarities. George elaborates on the polarity relationships between opposite houses by saying:

> The sets of houses that oppose each other in the zodiacal wheel have opposite, but complementary meanings regarding some of their significations. The archetypal relationship between the first and seventh houses as self and other, image and reflection, is the paradigmatic example for each of the other pairs. Valens alluded to this mirroring process when he wrote that the nature of an opposite house cooperates in helping a house to bring forth its own significations.
>
> Because each house has its own unique set of meanings drawn from various sources, it is important to recognize that not every signification will have a precise complementary opposite in the opposing house.[34]

[34] George, *supra* note 32, page 813.

The first contextual domain is Self / Body / Identity while the seventh domain, the domain on the opposite end of the circle from the first, is Other / Partnerships / Enemies. In other words, the seventh domain contains the very people an individual might most depend upon to mirror them, for good or bad. These polarity relationships can explain some of the paradoxical significations such as how your romantic partner could be in the same contextual domain as your mortal enemy. While the astrological tradition can tolerate this level of inconsistency, this is an example where the archetypal, paraconsistent logic explodes into a contradiction and would require new contextual integrity boundaries to be set for the context of privacy. Table 2 below shows a selection of complementary opposite house significations from George.

House (Private)	Signification	Polarity of Signification	House (Public)
1st	Self	Other	7th
2nd	Gain	Loss	8th
2nd	Earned Income	Income from Others	8th
3rd	Primary Education	Higher Education	9th
3rd	Short Journeys	Long Journeys	9th
4th	Home	Career	10th
4th	Private / Home Life	Public / Professional Life	10th
5th	Personal Self-Expression	Collective Identity, Expression	11th
5th	Intimate Relations	Non-Intimate Relations	11th
5th	Pleasures, Recreation, Enjoyment	Ideals, Aspirations	11th
6th	Physical Illness, Infirmities	Non-Physical Illness, Sorrows	12th

Table 2: Sampling of Astrological House Signification Polarities Aggregated by George (2022)[35]

There are only twelve houses within the Western astrological tradition, which results in some paraconsistent logic of archetypal significations for each contextual domain. Therefore, when it comes to being able to successfully apply this contextual mapping to matters of contextual integrity, we will need additional contextual integrity boundaries that reflect the informational norms of that context. The example provided above is that education records, email addresses, and current location are all contained within the 3rd astrological house, but these represent different informational norms for the appropriate flow of this information, which would require further subdivisions of these contexts.

In order to move towards a comprehensive philosophy of privacy, this archetypal mapping requires further refinement with additional subdivisions reflecting modern-day information norms. However, contextual mapping inspired by the historied astrological tradition is a solid place to start, providing a baseline reference to be used for inspiration and comparison when mapping out the contextual domains of the human experience for privacy purposes.

[35] George, *supra* note 32, pages 814-815.

This archetypal approach has already proven a powerful and useful tool in mapping out the promises and perils of XR. It could also potentially function as a high-level brainstorming tool for technology implementers and policymakers to mitigate potential contextual integrity transgressions. Importantly, if the baseline implementation of omnipresent contextually-aware AI has the potential to violate the principle of contextual integrity by having a third-party platform with complete access to all private information across every domain of human experience, then either algorithmic protections need to be implemented on the technological level or policymakers will need to figure out how to define the boundaries of contexts to reign in these contextual integrity transgressions.

While this current archetypal mapping of contexts is necessarily inconsistent and incomplete, hopefully, its utility as a historical map of past human endeavor can serve as a proto-map to make future privacy-preserving decisions and as a sensemaking framework to understand the landscape of contexts as we navigate the new paradigm of omnipresent AI surveillance.

Towards Biometric Psychography Definitions of Privacy Beyond Identity and PII

Brittan Heller's paper "Watching Androids Dream of Electric Sheep: Immersive Technology, Biometric Psychography, and the Law" explicitly breaks down the specifics of how most biometrics laws worldwide focus solely on identity and personally-identifiable information while entirely new classes of intimate physiological and biometric data from XR are completely overlooked. The new types of XR data can reveal all sorts of intimate information that may not be technically identifiable, therefore most of it falls through the cracks of broader privacy protections. This inspired Heller to define a new class of XR data she has coined as "biometric psychography." She writes:

> Biometric psychography is a new concept for a novel type of bodily-centered information that can reveal intimate details about users' likes, dislikes, preferences, and interests. Immersive technology must capture this data to function, meaning that while biometric psychography may be relevant beyond immersive tech, it will become increasingly inescapable as immersive tech spreads. This is important because current thinking around biometrics is focused primarily on identity, but biometric psychography is the practice of using biometric data to instead identify a person's interests.[36]

Currently, nothing is constraining Meta or any other XR company from drawing any type of inferences derived from XR data precisely because most XR data is not identifiable in any fashion. Or at least not identifiable yet as there may be invisible identifiable signatures hidden in the data that require the right machine learning training to unlock it. Consequently, as of this writing, it is the Wild West in terms of what data can be collected, and subsequently what inferences can be made from this data.

[36] Heller, *supra* note 2.

To glean some idea for the types of inferences that may result from XR technologies like eye tracking, we can turn to Kröger et al., who found in their literature review that:

> Our analysis of the literature shows that eye tracking data may implicitly contain information about a user's biometric identity, gender, age, ethnicity, body weight, personality traits, drug consumption habits, emotional state, skills and abilities, fears, interests, and sexual preferences. Certain eye tracking measures may even reveal specific cognitive processes and can be used to diagnose various physical and mental health conditions.[37]

Within this list of psychographic traits that can be inferred from eye tracking data, you can see a combination of PII that can be extrapolated across different contextual domains (age, gender, weight, ethnicity, sexual preferences) along with character traits (skills and abilities, fears, and interests) as well as with more ephemeral phenomenological states (emotional states, cognitive processes and mental health condition, behaviors such as drug consumption habits, and physiological states including physical health or current level of sleepiness). All of these psychographic traits are being inferred algorithmically, which may have different legal implications than if they were self-disclosed, especially as there are a lot of inferred pieces of PII. Some inferences are not necessarily identifiable and currently do not receive any additional legal protections.

Kröger et al. warn that "while the widespread adoption of eye tracking holds the potential to improve our lives in many ways, the rising technology also poses a substantial threat to privacy." They conclude by saying:

> The findings compiled herein are significant enough to warrant a warning to users whose privacy could be affected, as well as a call for action to the public and private actors entrusted with protecting user privacy in consumer electronics. Considering the rapid proliferation of eye tracking technology, existing technical and legal safeguards urgently need to be assessed regarding their ability to avert undesired inferences from gaze data, or to at least prevent the misuse of sensitive inferred information.[38]

They are calling for existing privacy laws to be assessed because existing laws do not currently prevent "undesired inferences from gaze data" or "prevent the misuse of sensitive inferred information." Again, part of the reason why inferred data is falling through the cracks is that the underlying philosophy of privacy has been focused on static and immutable aspects of identifiable information specific to different contextual domains while the more ephemeral phenomenological states or psychographic character traits have not been legally defined and subsequent inferences protected in any way. This emphasizes the need to further formalize Heller's concepts around biometric psychography through the lens of context, character, and qualities of presence.

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[37] Jacob Leon Kröger, Otto Hans-Martin Lutz, and Florian Müller. "What Does Your Gaze Reveal about You? On the Privacy Implications of Eye Tracking." *Privacy and Identity Management. Data for Better Living: AI and Privacy* (2020): 226–241. https://doi.org/10.1007/978-3-030-42504-3_15.

[38] Kröger, *supra* note 37.

Eye tracking is just one of many new physiological and biometric sensors that will be integrated as a baseline feature within XR devices within the next 5 to 10 years, but there will be many more channels of physiological streams from different types of sensors as they are developed. OpenBCI's Project Galea is a VR headset that integrates all sorts of different sensors including eye tracking, electrooculogram (EOG), Electromyography (EMG), electrodermal activity (EDA), electroencephalogram (EEG), temperature, and heart rate.[39] It was after seeing a presentation by OpenBCI in 2021 that I surveyed different physiological and biometric sensors from the medical field[40] that could potentially be used within an XR context over the distant future over the next 5, 10, 20, or 50 years.

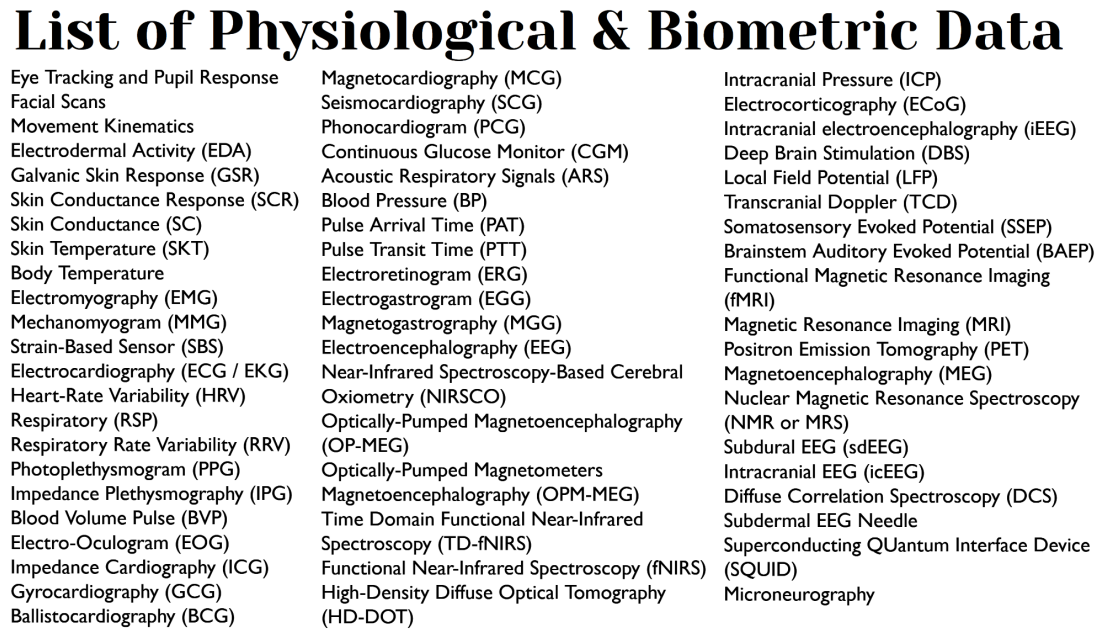

Fig. 4: Sampling of Medical Sensors that May or May Not Be Integrated into Future XR Devices

Many of these sensor technologies are too expensive or will be completely impractical to ever be used within a consumer XR context. However, these sensors will inevitably enable some, if not all, phenomenological qualities within experiential design contexts. To understand the impact of these new sensors within XR, we need to understand VR presence theory and experiential design. This will allow us to successfully predict the different types of inferences that could be made from XR sensors, even if it is impossible to know which specific sensors will be used in the future. It will also serve to further formalize Heller's concept of biometric psychography through these more

[39] Bye, Kent. "#996: OpenBCI's Project Galea Collaboration with Valve & Neuro-Privacy Implications of Physiological Data." *Voices of VR Podcast*. (June 22, 2021). Accessed November 28, 2023. https://voicesofvr.com/996-openbcis-project-galea-collaboration-with-valve-neuro-privacy-implications-of-physiological-data/.

[40] Kent Bye. State of XR Privacy: Conceptual Frames [Presentation], VRARA Global Summit, Virtual Conference. (June 2, 2021) Available at https://www.slideshare.net/kentbye/state-of-privacy-in-xr-neurotech-conceptual-frames (Accessed November 28, 2023) and https://www.youtube.com/watch?v=pIpD4-gYImU.

ephemeral phenomenological states that can be used to profile a user's likes, dislikes, preferences, and interests within the context of an immersive experience.

Understanding XR Data Inferences through Presence Theory and Experiential Design

In order to understand the nature of data available to XR devices, it's helpful to look at the phenomenological experiences of XR through the lens of VR presence theories as well as the types of data necessary to cultivate these qualities of presence. Mel Slater originally defined two primary illusions of presence through the place illusion and plausibility illusion in 2009. The place illusion is "the strong illusion of being in a place in spite of the sure knowledge that you are not there." And the plausibility illusion is "the illusion that what is apparently happening is really happening (even though you know for sure that it is not)."[41] It's a combination of being transported to a virtual place, and having a suspension of disbelief that makes the experience feel real and plausible.

In an effort to broaden the scope of presence research, Dustin Chertoff wrote his Ph.D. dissertation titled "Exploring Additional Factors of Presence" in 2009. He made a compelling argument for how the marketing concepts of experiential design could add insights into presence research by saying, "Experiential design was introduced as a way to connect the concept of presence to a variety of dimensions of experience." He was frustrated that "many existing questionnaires utilized in presence research rely too heavily on measuring the perceptual factors of the experience... even these questionnaires do not take into account the multitude of dimensions that contribute to an experience."[42]

Chertoff drew upon the experiential marketing literature from the marketing world. In 1999, Bernd Schmitt defined "different types of experiences, or strategic experiential modules" where experiential marketers can create "sensory experiences (SENSE); affective experiences (FEEL); creative cognitive experiences (THINK); physical experiences, behaviours and lifestyles (ACT); and social-identity experiences that result from relating to a reference group or culture (RELATE)."[43] Also, Brakus et al. in 2009 looked at measuring the impact of brand experiences through the Sensory, Affective, Behavioral, and Intellectual dimensions.[44]

Chertoff created a Virtual Experience Test to "fill the need for a generalizable questionnaire focused on measuring the dimensions that contribute to holistic experiences in virtual environments. Each dimension of experiential design has associations to known presence factors."[45] He elaborated on what he called the sensory dimension, affective dimension, cognitive dimension, active dimension, and relational dimension, which closely mirrors the broader framing of experiential design and experiential marketing.

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[41] Mel Slater. "Place Illusion and Plausibility Can Lead to Realistic Behaviour in Immersive Virtual Environments." *Philosophical Transactions of the Royal Society B: Biological Sciences* 364, no. 1535 (2009): 3549–3557. https://doi.org/10.1098/rstb.2009.0138.

[42] Dustin Chertoff, "Exploring Additional Factors Of Presence." *Electronic Theses and Dissertations*. 3910. (2009) https://stars.library.ucf.edu/etd/3910.

[43] Bernd Schmitt. "Experiential Marketing." *Journal of Marketing Management* 15, no. 1–3 (1999): 53–67. https://doi.org/10.1362/026725799784870496.

[44] J. Joško Brakus, Bernd H. Schmitt, and Lia Zarantonello. "Brand Experience: What Is It? How Is It Measured? Does It Affect Loyalty?" *Journal of Marketing* 73, no. 3 (2009): 52–68. https://doi.org/10.1509/jmkg.73.3.052.

[45] Chertoff, *supra* note 42.

After seeing many consumer VR experiences of interactive gaming, the emotional impact of immersive storytelling, the social dimensions of social VR, and the range of sensory and embodied experiences, I independently developed a presence framework that was strikingly similar to Chertoff's approach. I first presented this elemental theory of presence in 2017,[46] and since have been developing it into a more complete experiential design and immersive storytelling framework through numerous XR industry talks culminating in a presentation delivered at Storycon in 2022.[47] The list below details the archetypal significations of active presence, mental & social presence, embodied & environmental presence, and emotional presence:

> Active presence (fire element): Agency, interactions, dynamics, action, locomotion, exploration, spontaneity, creativity, will, engagement, gameplay, intention, & live performance
>
> Mental & Social presence (air element): Thoughts, language, choices, expectations & novelty, mental models, plausibility, coherence, attention, suspension of disbelief, puzzles, mental friction, rules, social presence, & virtual beings
>
> Emotional presence (water element): Emotional immersion, feelings, mood, vibe, color, lighting, consonance & dissonance cycles, music, story, time, flow, narrative presence, empathy, & compassion
>
> Embodied & Environmental presence (earth element): Self-presence, body, embodiment, sensory experience, biometric & physiological data, BCIs & neural inputs, haptics, immersive sound, spatial presence, environmental immersion, & architecture[48]

VR presence researcher Richard Skarbez originally alerted me to Chertoff's work, and described the similarities of our approaches within his 2017 survey of presence theories:

> Kent Bye proposed a theory of presence with a metaphor inspired by the four elements of natural philosophy: earth (embodied [and environmental] presence), fire (active presence), air (social and mental presence), and water (emotional presence). The similarity of these elements to the dimensions of experiential design used by Chertoff et al. is notable, as the two models were developed independently.[49]

I discussed these similarities directly with Chertoff during the Game Developers Conference in 2017, and we agreed that our frameworks are functionally the same with his sensory dimension

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[46] Kent Bye. "#502: An Elemental Theory of Presence + Future of AI & Interactive Storytelling." *Voices of VR Podcast.* (February 8, 2017). Accessed November 28, 2023. https://voicesofvr.com/502-an-elemental-theory-of-presence-future-of-ai-interactive-storytelling/.

[47] Kent Bye. "A Primer on Presence, Immersive Storytelling, & Experiential Design" [Presentation]. Storycon: A collision of (he)art and technology. Brussels, Belgium; BOZAR - Centre for Fine Arts. (May 5, 2022). Available at https://www.slideshare.net/kentbye/a-primer-on-presence-immersive-storytelling-experiential-design-kent-byes-storycon-keynote (Accessed November 28, 2023) and https://www.youtube.com/watch?v=n_2_qvIymt4.

[48] Bye, *supra* note 47.

[49] Richard Skarbez, Frederick P. Brooks, Jr., and Mary C. Whitton. "A Survey of Presence and Related Concepts." *ACM Computing Surveys* 50, no. 6 (2017): 1–39. https://doi.org/10.1145/3134301.

being the same as my embodied presence, his affective dimension equivalent to my emotional presence, his cognitive dimension the same as my mental presence, his active dimension the equivalent as my active presence, and his relational dimension being the same as my social presence.[50]

In 2022, Slater et al. published "An update on place illusion and plausibility in virtual reality" where they added aspects of copresence and embodiment as additional primary illusions. Slater et al. added the "body ownership illusion" as a primary illusion by saying, "When participants wear a wide field-of-view head-tracked stereo head-mounted display and they look down towards themselves, they will see a life-sized virtual body substituting their own, from their first-person perspective." They also refer to this as "embodiment," which "involves multisensory integration of the [first-person perspective] view of the body, and visuomotor or visuotactile synchrony, which will typically lead to the illusion that the virtual body is their own."[51]

Slater et al. also added the experience of "copresence" by saying "When in a virtual environment simultaneously with other remotely located people copresence refers to the extent to which the participant has the illusion of being there with the others."[52] This has also been referred to as social presence elaborated by Nowak & Biocca[53] in a VR context that builds off of social psychology work of Short et al. who define social presence as "the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships."[54]

Schmitt (1999)	Act	Think	Relate	Feel	Sense	
Brakus et al. (2009)	Behavioral	Intellectual		Affective	Sensory	
Chertoff (2010)	Active	Cognitive	Relational	Affective	Sensory	
Bye (2017)	**Fire**	**Air**		**Water**	**Earth**	
	Active Presence	Mental Presence	Social Presence	Emotional Presence	Embodied Presence	Environmental Presence
Slater (2009) & Slater et al. (2022)		Plausibility Illusion	Co-Presence Illusion		Body Ownership Illusion	Place Illusion

Table 3: Comparison and Parallels Between Theories of Experiential Design and VR Presence

It should be noted that Slater differentiated his theory of presence from my elemental theory in an interview in 2017 where he stated, "I'm specifically and only interested in this perceptual illusion that I am in this place, that's it. And I'm only interested in the perceptual illusion that the events taking place in this place are really happening. So whether the events have an emotional

[50] Kent Bye. "#557: Using Experiential Design to Expand VR Presence Theory." *Voices of VR Podcast*. (July 19, 2017). Accessed November 28, 2023. https://voicesofvr.com/557-using-experiential-design-to-expand-vr-presence-theory/.
[51] Mel Slater, Domna Banakou, Alejandro Beacco, Jaime Gallego, Francisco Macia-Varela, and Ramon Oliva. "A Separate Reality: An Update on Place Illusion and Plausibility in Virtual Reality." *Frontiers in Virtual Reality* 3 (2022). https://doi.org/10.3389/frvir.2022.914392.
[52] Slater, *supra* note 51.
[53] Kristine L. Nowak and Frank Biocca. "The Effect of the Agency and Anthropomorphism on Users' Sense of Telepresence, Copresence, and Social Presence in Virtual Environments." *Presence: Teleoperators and Virtual Environments* 12, no. 5 (2003): 481–494. https://doi.org/10.1162/105474603322761289
[54] John Short, Ederyn Williams, and Bruce Christie. *Social Psychology of Telecommunications*. London, 1976.

impact on me is a completely separate question."[55] Because Slater's narrowed definitions of presence ignore the types of inferences that contextually-aware AI might make based on the behavioral or emotional responses of someone using an XR headset it is less useful for creating bounded privacy safeguards.

When we apply the elemental theory of presence and theories from experiential marketing to the types of inferences that can be made from XR data, we can see that it is a mix of our behavioral interactions, cognitive processes, social interactions, emotional states, sensory and physiological states, and our relationship to physical environments. The following list elaborates on different components of presence that could be used to psychographically profile users:

> Active presence: Our behaviors, intentions, actions, & movements
>
> Mental presence: Our mental thoughts, cognitive processes, choices, & cognitive load
>
> Social presence: Our communications and relations with other people
>
> Emotional presence: Our affective state, emotional sentiment, facial expression, & microexpressions.
>
> Embodied presence: Our stress, arousal, physiological reactions, eye gaze, attention, body language, & muscle fatigue
>
> Environmental presence: The internal experience of virtual spatialized contexts, but also the external environments of our current physical context[56]

If looked at in isolation, then any of these new types of XR data may not be cause for concern. However, there may be additional inferences that are made possible by fusing these data streams together given the additional spatial context of the XR experience. For example, head and hand movements are something that six degrees of freedom (6-DoF) VR technologies need as a baseline to operate. Meta has published research showing that they can extrapolate and estimate eye gaze data with a machine learning model that only uses the head pose, hand pose, and the spatial and contextual information about the virtual environment as inputs.[57] We previously discussed the intimate types of inferences that can be extrapolated from eye gaze data, but this usually requires additional eye-tracking technologies that are not widely available yet. However, if Meta can extrapolate eye gaze data from analyzing other embodied movements of hand pose and head pose (something included within all 6-DoF XR technologies), then there may be other psychographic

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[55] Kent Bye. "#556: Mel Slater's Theory of VR Presence vs an Elemental Theory of Presence." *Voices of VR Podcast*. (July 14, 2017). Accessed November 28, 2023. https://voicesofvr.com/556-mel-slaters-theory-of-vr-presence-vs-an-elemental-theory-of-presence/.

[56] Bye, *supra* note 40.

[57] Kara J. Emery, Marina Zannoli, Lei Xiao, James Warren, and Sachin S. Talathi. "Estimating Gaze from Head and Hand Pose and Scene Images for Open-Ended Exploration in VR Environments." *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)* (2021). https://doi.org/10.1109/VRW52623.2021.00159.

inferences that are possible just by analyzing embodied movements with an awareness of the virtual context.

This is cause for alarm because when you fuse the new XR and neurotechnology data streams with AI sensemaking capabilities, it points to a world where Meta and other XR technology companies will have unprecedented insights about the nuances of our behavioral interactions, cognitive processes, social interactions, emotional states, sensory and physiological states, and our relationship to physical environments. These could be used to infer many dimensions of what Heller calls biometric psychography including a user's likes, dislikes, preferences, and interests, as well as character and personality traits, behavioral habits, intentions, internal cognitive processes, mental and physical states, emotional triggers, and also other sensitive and personally-identifiable information including sexual preferences, health conditions, age, gender, etc.

In short, the XR data that makes immersive presence so vital is the very thing that makes it so dangerous. XR platform companies start with access to novel types of physiological and biometric data streams, but developing neurotechnologies like EEG-embedded headphones combined with other new XR data streams processed through machine learning could result in our private mental thoughts and internal cognitive processes being inferred and used to nudge our behaviors without our awareness, let alone permission. Corporations could access vast amounts of intimate information through inferences from XR data to the point that we may be sleepwalking toward a dystopian future of unprecedented surveillance. Whether this dark potential will be averted is unclear, but there are people working towards that end. Luckily we can look to technology ethicists who have been sounding the alarm about the potential human rights implications of XR and neurotechnologies from both the Neuro-Rights movement as well as the push to establish cognitive liberty as a new human right.

Human Rights Privacy Approaches of Neuro-Rights and Cognitive Liberty

In May 2017, a group of neuroscientists, neurotechnologists, clinicians, ethicists and machine-intelligence engineers met at Columbia University to consider the possible privacy ramifications of neurotechnologies. They called themselves the Morningside Group and described their ethical concerns in *Nature* in the November 2017 issue by saying"

> It might take years or even decades until BCI and other neurotechnologies are part of our daily lives. But technological developments mean that we are on a path to a world in which it will be possible to decode people's mental processes and directly manipulate the brain mechanisms underlying their intentions, emotions and decisions; where individuals could communicate with others simply by thinking; and where powerful computational systems linked directly to people's brains aid their interactions with the world such that their mental and physical abilities are greatly enhanced.[58]

[58] Rafael Yuste, Sara Goering, Blaise Agüera Arcas, Guoqiang Bi, Jose M. Carmena, Adrian Carter, Joseph J. Fins, et al. "Four Ethical Priorities for Neurotechnologies and Ai." *Nature* 551, no. 7679 (2017): 159–163. https://doi.org/10.1038/551159a.

The Morningside Group concluded that the "existing ethics guidelines are insufficient for this realm" and "To begin to address this deficit, here we lay out recommendations relating to four areas of concern: privacy and consent; agency and identity; augmentation; and bias."[59]

By 2021, they added another area of concern and elaborated on these five basic Neuro-Rights as:

> The right to identity, or the ability to control both one's physical and mental integrity
>
> The right to agency, or the freedom of thought and free will to choose one's own actions
>
> The right to mental privacy, or the ability to keep thoughts protected against disclosure
>
> 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.
>
> The right to protection from algorithmic bias, or the ability to ensure that technologies do not insert prejudices.[60]

If XR or neurotechnologies violate our right to mental privacy, they can map out the nuances of our identity, which they can then use to nudge us in ways that violate our rights to agency and intentional action. The first three Neuro-Rights address this potential injustice. The last two Neuro-Rights are connected to broader socioeconomic and political issues around equitable and fair access to neurotechnologies that can augment sensory and cognitive capacities, as well as other aspects of diversity, equity, and inclusion to ensure that the data sets used in neurotech and XR minimize the harms from algorithmic biases.

In 2021, Chile became the first country in the world to amend its constitution to protect these fundamental Neuro-Rights. The European Union has also taken a human rights approach to developing technology legislation, so these principles can be used to shape future legislation on XR, neurotechnology, and AI.

There remains one more human rights distinction worth drawing attention to. Nita Farahany is a Duke University professor of law and professor of philosophy who wrote a tour de force book titled *The Battle for Your Brain: Defending the Right to Think Freely in the Age of Neurotechnology*. She argues that we need to establish a new human right that she calls cognitive liberty by saying,

> We must establish the right to cognitive liberty—to protect our freedom of thought and rumination, mental privacy, and self-determination over our brains and mental experiences. This is the bundle of rights that makes up a new right to cognitive liberty, which can and should be recognized as part of the Universal Declaration of Human Rights, which has established mechanisms for the enforcement of international human rights and creates

[59] Yuste, *supra* note 58.

[60] Rafael Yuste, Jared Genser, and Stephanie Herrmann. "It's Time for Neuro-Rights: New Human Rights for the Age of Neurotechnology." *Horizons: Journal of International Relations and Sustainable Development*, no. 18 (2021): 154–65. https://www.cirsd.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro--rights.

> powerful norms that guide corporations and nations on the ethical uses of neurotechnology.[61]

Farahany spent a decade tracking the evolution of neurotechnologies with her extensive background in philosophy and law, and she articulates some of the underlying legal and philosophical foundations that would be required to establish cognitive liberty as a fundamental human right to create protections for our freedom of thoughts, mental privacy, and self-determination. She expertly combines law, philosophy, and emerging neurotechnologies to develop underlying conceptual frameworks around cognitive liberty that should be a vital part of future policymaking around the vast privacy implications of XR and neurotechnologies.

Conclusion

This article surveys the privacy pitfalls of emerging technologies like XR and contextually-aware AI, and provides some sensemaking frameworks for context and the qualitative dimensions of XR data. Meta is leading the development of contextually-aware AI, but it violates the basic principles of Nissenbaum's contextual integrity theory of privacy. If contextual-aware AI becomes an omnipresent and omniscient surveillance presence in our lives, it will almost inevitably threaten some of the normative foundations of privacy law around reasonable expectations of privacy. An archetypal taxonomy of the contextual domains may provide some utility in understanding the relational dynamics of contextual integrity and how it might be preserved at either the technological implementation or policy level. There is a significant connection between privacy and context, and by mapping out personally-identifiable information into archetypal domains of human context we can better think about preventing context collapse from omnipresent contextually-aware AI as well as ethical and privacy transgressions. Existing privacy laws around the world are not yet prepared to deal with the types of inferences made with data from XR, but Heller's concept of biometric psychography provides a necessary perspective shift from privacy defined by identity and PII to identity being defined by context-specific behavioral interactions, cognitive processes, social interactions, emotional states, sensory and physiological states, and our relationship to physical environments. Insights derived from theories of presence help elaborate on how aspects of active presence, mental & social presence, embodied & environmental presence, and emotional presence are related to the intimate types of inferences that can be made from XR data. Finally, the Neuro-Rights movement by the Morningstar Group and Farahany's efforts to define cognitive liberty as a new human right might be used to shape the ethical development of XR and neurotechnologies so that we can all live into the promises of the many ultimate potentials of XR while mitigating perilous ethical and moral dilemmas.

[61] Nita A. Farahany. *The Battle for Your Brain: Defending the Right to Think Freely in the Age of Neurotechnology*. New York: St. Martin Press, 2023, page 11.