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Watching Androids Dream of Electric Sheep: Immersive Technology, Biometric Psychography, and the Law

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ABSTRACT

Virtual reality and augmented reality present exceedingly complex privacy issues because of the enhanced user experience and reality-based models. Unlike the issues presented by traditional gaming and social media, immersive technology poses inherent risks, which our legal understanding of biometrics and online harassment is simply not prepared to address. This Article offers five important contributions to this emerging space. It begins by introducing a new area of legal and policy inquiry raised by immersive technology called "biometric psychography." Second, it explains how immersive technology works to a legal audience and defines concepts that are essential to understanding the risks that the technology poses. Third, it analyzes the gaps in privacy law to address biometric psychography and other emerging challenges raised by immersive technology that most regulators and consumers incorrectly assume will be governed by existing law. Fourth, this Article sources firsthand interviews from early innovators and leading thinkers to highlight harassment and user experience risks posed by immersive technology. Finally, this Article compiles insights from each of these discussions to propose a framework that integrates privacy and human rights into the development of future immersive tech applications. It applies that framework to three specific scenarios and demonstrates how it can help navigate challenges, both old and new.

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> [Immersive technology] is just like the atom splitting. It can be used for helping mankind, lifting mankind, or it can be used for destroying mankind. That's where we are with virtual reality. We're on the cusp of having powerful tools like fire. What are we going to do with it? How are we going to use it? How are we going to put in safeguards so that we don't get burned?[1]

I. INTRODUCTION: OFF TO THE RACES

Imagine you are selecting your ride in a virtual reality (VR) racing game. You look down the line of cars and settle on a sleek, cherry red convertible. As you run your virtual hands along its virtual hood, your body responds with signs of excitement—your heart rate increases, your skin moistens, and your pupils dilate. The VR hardware records these involuntary biological reactions. As your gaze jumps over other cars and lingers on the one you have chosen, the VR's eye-tracking hardware records both how you react and what stimuli you are reacting to, namely a red sports car. You continue using the headset for entertainment, like watching a concert in VR, collaborating with colleagues in a virtual meeting space, or making social connections with other avatars and admiring the virtual homes they have built. All along, the VR headset analyzes what you are engaging with and how it is making you feel.

Maybe you do not make the conscious connection, but red convertibles soon begin popping up in your virtual and online spaces, along with advertisements for new car insurance and reminders to renew your driver's license. User information from the racing game has been sold to companies, advertising agencies, and government agencies. It is used to target experiences, services, or products that you are prone to like, and to predict your consumer preferences and personal opinions. There is even more personal information bundled in your involuntary reactions than you realized was discernable from playing a VR game—your sexual orientation, mental and physical health risks that you may not be aware of yourself, or when you have told the truth or lied.[2] Playing a VR racing game is like hitting a "like button" on steroids.

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1. Telephone Interview with Tom Furness, Professor, Univ. of Wash. (Aug. 4, 2019). Dr. Thomas Furness is the developer of the first immersive technology.

2. *See infra* Section III.A.1; Avi Bar-Zeev, *The Eyes Are the Prize: Eye-Tracking Technology Is Advertising's Holy Grail*, VICE (May 28, 2019, 9:48 AM), https://www.vice.com/en_us/article/bj9ygv/the-eyes-are-the-prize-eye-tracking-technology-is-advertisings-holy-grail [https://perma.cc/TM59-FEBR]; Kent Bye, *#517: Biometric Data Streams & the Unknown Ethical Threshold of Predicting & Controlling Behavior*, VOICES VR PODCAST (Mar. 20, 2017), http://voicesofvr.com/517-biometric-data-streams-the-unknown-ethical-threshold-of-predicting-controlling-behavior/ [https://perma.cc/9PJL-KA4A]; DIANE HOSFELT,

This scenario sounds like science fiction, but it may be a depiction of the near future. Marrying traditional biometrics and predictive behavioral analytics is a nascent discipline, newly possible because of technological advances.[3] This Article coins the term "biometric psychography" to account for this new phenomenon. While it is not unique to immersive technology,[4] biometric psychography is uniquely suited to a medium like VR that must track the user's eye positioning and locomotion to function and to a new industry that is looking for ways to make VR into a popular and profitable enterprise.[5] There are currently no strong legal safeguards on the use, gathering, and storage of this type of information as it is not readily covered under existing biometrics law.[6]

Insufficient legal safeguards are only one of the implications of today's rapid expansion of immersive technology. While this innovation raises incredible opportunities for good—from medical treatment to bridging distances (particularly valuable in this age of COVID-19) and improving skills training—it also presents new, complex, and groundbreaking policy challenges. This Article identifies some of the most acute and pressing challenges created by immersive technology and presents solutions that protect user privacy, safety, and human dignity.

II. A PRIMER ON IMMERSIVE TECHNOLOGY

To understand the significance of immersive technology, it is necessary to first understand how it works. Those who have tried immersive technology can attest that it is a window into another world. VR is an interface worn on the body that places users inside an

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MAKING ETHICAL DECISIONS FOR THE IMMERSIVE WEB 2 (May 14, 2019), https://arxiv.org/pdf/1905.06995.pdf [https://perma.cc/Z85P-Z49N].

3. *See, e.g.*, IMOTIONS, https://imotions.com [https://perma.cc/B9ZN-8KBV] (last visited Sept. 28, 2020).

4. For an application using gait to attempt to perceive emotion, see Matt Simon, *This Robot Can Guess How You're Feeling by the Way You Walk*, WIRED (May 18, 2020, 8:00 AM), https://www.wired.com/story/proxemo-robot-guesses-emotion-from-walking/ [https://perma.cc/BPC7-LHVB].

5. *See How Does Eye Tracking Work?*, VR.ORG (Feb. 22, 2018), https://www.vr.org/2018/02/22/how-does-eye-tracking-work/ [https://perma.cc/WY2C-AQJJ].

6. Ed Klaris & Alexia Bedat, *VR & AR: Virtual Reality, Augmented Reality & Biometric Data After 2017*, MEDIUM (Jan. 31, 2018), https://blog.klarislaw.com/vr-ar-virtual-reality-augmented-reality-biometric-data-after-2017-ed-klaris-alexia-bedat-a15e9cb000a1 [https://perma.cc/9RLE-E33V].

interactive virtual environment.[7] Putting on a VR head-mounted device (HMD) allows the user to experience the sights and sounds of a digital alternative universe.[8] These headsets use a system of cameras and sensors to track and respond to the user's eyes, movements, and gestures.[9]

Augmented reality (AR) can be defined as an interface that layers digital content on a user's visual plane.[10] AR is often accessed through glasses or a smartphone.[11] Rather than transporting the user to a new world, AR enables users to enrich the world they inhabit. Digital objects are overlaid on the user's world, but there is no occlusion, meaning that digital assets do not interact with objects in the user's environment.[12] For example, a puppy depicted in AR would generally be seen as layering over a table in the user's environment, but it would not recognize the table as a surface to go around or sit on.[13]

Mixed reality (MR) combines VR and AR experiences, displaying elements of virtual and actual environments together and sometimes switching between them.[14] Computer-generated objects will treat objects in MR like actual obstacles and interact with them accordingly.[15] For example, a virtual puppy will go under a tabletop and around its legs. New VR-web browser combinations are crossing lines between the internet and VR usage, raising expectations for further medium-spanning integrations.[16]

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7. Joe Bardi, *What is Virtual Reality? [Definition and Examples]*, MARXENT 3D COM., https://www.marxentlabs.com/what-is-virtual-reality/ [https://perma.cc/9KV3-ZL4E] (last updated Sept. 21, 2020).

8. *Id.*

9. *Head-Mounted Displays (HMDs)*, VIRTUAL REALITY SOC'Y, https://www.vrs.org.uk/virtual-reality-gear/head-mounted-displays/ [https://perma.cc/AS6S-RJZY] (last visited Sept. 28, 2020).

10. Kevin Bonsor & Nathan Chandler, *How Augmented Reality Works*, HOW STUFF WORKS (Nov. 9, 2018, 11:28:39 AM), https://computer.howstuffworks.com/augmented-reality.htm [https://perma.cc/5NUJ-MGE5].

11. *See id.*

12. Kaitlyn Irvine, *XR: VR, AR, MR—What's the Difference?*, VIGET (Oct. 31, 2017), https://www.viget.com/articles/xr-vr-ar-mr-whats-the-difference [https://perma.cc/J44Y-FAZQ].

13. *See id.* However, new advancements in AR world reconstruction may allow for virtual elements to recognize the structure of their world. *See id.*

14. *Id.*

15. *Id.*

16. *See, e.g.*, MOZILLA MIXED REALITY, https://mixedreality.mozilla.org [https://perma.cc/2KS6-62KR] (last visited Sept. 28, 2020).

Other popular terms for VR, AR, and MR are spatial computing and extended reality (XR).[17] As new interfaces between web browsers and VR content are created and eventually become commonplace, these terms may gain more traction. However, this Article refers to the collective body of innovation as "immersive technology" to better account for both the hardware and the experiential aspects of this analysis and to better incorporate new innovations that may emerge over time.

From Google's venture into AR spectacles—Google Glass[18]—to Oculus' new, wearable, wireless VR headsets,[19] immersive technology is remaking the world in its image. High-tech applications of immersive technology offer great potential in training simulators, education, travel, industry, and medicine.[20] But they also enable, for the first time, technology to ascertain sensitive personal information based entirely on users' physical engagement with it.[21] This opens up an entirely new dimension of privacy concerns, including legal questions about consent, the importance of regulation, and consumer awareness. Biometric psychography is the gathering and use of biological data, paired with the stimuli that caused a biological reaction, to determine users' preferences, likes, and dislikes. It also implicates several other critical aspects of immersive technology that warrant more attention from a consumer rights and user protection standpoint.

III. THE EMERGENCE OF IMMERSIVE TECHNOLOGY

The time to think about issues inherent in immersive technology, particularly those related to privacy and safety, is now. Because of the decreasing cost and rapid development of immersive hardware,[22] we stand at the precipice of a radically transformed world. Society is on the cusp of widespread adoption of immersive technology

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17. *What Is Spatial Computing?*, MAGIC LEAP DEVELOPER, https://developer.magicleap.com/learn/guides/design-spatial-computing [https://perma.cc/HNP2-3TFW] (last updated Mar. 29, 2019); *see also* Irvine, *supra* note 12.

18. GLASS, https://www.google.com/glass/start/ [https://perma.cc/V2DY-S3R7] (last visited Sept. 28, 2020).

19. OCULUS, https://www.oculus.com/ [https://perma.cc/RV6N-AR3F] (last visited Sept. 28, 2020).

20. *See, e.g.*, Bonsor & Chandler, *supra* note 10; Bar-Zeev, *supra* note 2; *see* HOSFELT, *supra* note 2.

21. Laurence Morvan, Armen Ovanessoff, Marc Carrel-Billiard & Francis Hintermann, *A Responsible Future for Immersive Technologies*, ACCENTURE (May 15, 2019), https://www.accenture.com/us-en/insights/technology/responsible-immersive-technologies [https://perma.cc/GYH9-TLCP]; *see also* Bar-Zeev, *supra* note 2; Klaris & Bedat, *supra* note 6.

22. *See* Morvan et al., *supra* note 21; *How Does Eye Tracking Work?*, *supra* note 5.

by consumers, educators, advertisers, artists, journalists, and mainstream computer users.[23] It is a rapidly growing player in entertainment, encroaching on other large industries, such as professional sports, video games, and film.[24] But immersive technology is about to move from a tool for gamers, early adopters, and laboratory scientists to something that average people have in their living rooms. The Oculus Quest was a top gift for the 2019 Christmas season and sold out its entire stock going forward three months.[25] It was comparable in price to an Xbox or PlayStation gaming system, positioning it as a viable competitor to mainstream gaming.[26] Over the next three years, AR and VR are each predicted to become multi-billion dollar industries,[27] with some estimates reaching $150 billion in combined revenue just in 2020.[28] Furthermore, hardware improvements have made VR more accessible to consumers and workspaces.[29]

VR's popularity continues to rise with shelter-in-place orders and quarantines due to the COVID-19 Pandemic as people figure out

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23. Morvan et al., *supra* note 21.

24. Kate Harveston, *How Virtual Reality Is Changing the Entertainment Industry*, SPREAD (Mar. 26, 2019), http://cinemajam.com/mag/features/how-virtual-reality-is-changing-the-entertainment-industry [https://perma.cc/BA8T-9SQV]; Jane Zorowitz, *It Just Got Real*, NBC SPORTS, https://sportsworld.nbcsports.com/virtual-reality-sports-arkansas-kentucky/ [https://perma.cc/S32T-SJ7G] (last visited Sept. 28, 2020).

25. Travis Hoium, *Oculus Devices Sold Out in a Positive Sign for Virtual Reality*, MOTLEY FOOL (Dec. 27, 2019, 6:25 AM), https://www.fool.com/investing/2019/12/27/oculus-devices-sold-out-in-positive-sign-for-virtu.aspx [https://perma.cc/8PFX-QA97]; Dave Johnson, *The Oculus Quest Is Sold Out Pretty Much Everywhere Right Now*, CNET (Sept. 9, 2020, 12:45 PM), https://www.cnet.com/news/where-you-can-buy-hard-to-find-oculus-quest-right-now/ [https://perma.cc/7L76-HXV5].

26. *See* Hoium, *supra* note 25; Jess Grey, *Gamers, Heads Up: There Are Some Great Holiday Deals This Week*, WIRED (Dec. 14, 2019, 9:00 AM), https://www.wired.com/story/best-videogame-sales-for-christmas-2019/ [https://perma.cc/NM65-4KLT].

27. Valuates Reps., *Augmented Reality and Virtual Reality (AR & VR) Market Size Is Expected To Reach USD 571.42 Billion by 2025*, CISION PR NEWSWIRE (Feb. 13, 2020, 10:00 AM), https://www.prnewswire.com/news-releases/augmented-reality-and-virtual-reality-ar--vr-market-size-is-expected-to-reach-usd-571-42-billion-by-2025--valuates-reports-301004582.html [https://perma.cc/9CR3-VJLT].

28. Mark A. Lemley & Eugene Volokh, *Law, Virtual Reality, and Augmented Reality*, 166 U. PA. L. REV. 1051, 1063 (2018).

29. Peter H. Diamandis, *5 Breakthroughs Coming Soon in Augmented and Virtual Reality*, SINGULARITYHUB (May 10, 2019), https://singularityhub.com/2019/05/10/5-breakthroughs-coming-soon-in-augmented-and-virtual-reality/ [https://perma.cc/WU4Q-JEW6]; Andrew Hutchinson, *The Race to Develop AR and VR Wearables Is Heating Up with New Advances from Facebook and Google*, SOC. MEDIA TODAY (June 30, 2020), https://www.socialmediatoday.com/news/the-race-to-develop-ar-and-vr-wearables-is-heating-up-with-new-advances-fro/580850/ [https://perma.cc/A3NC-XN9Y].

new ways to collaborate and socialize while distanced.[30] Resolution has increased to the point where artists can now perform concerts live in communal VR spaces before millions of fans.[31] Improvements in rendering, or the process producing an image based on data stored in a computer,[32] have made it so professional sports can utilize live VR: the National Basketball Association (NBA) broadcasts one basketball game every week in VR, and pro hockey, racing, and baseball leagues generate their own sports-based experiences for fans.[33] The release of self-contained HMDs has untethered VR from separate computer processors and freed it from cables, making the medium more affordable, portable, and easy to use for recreational users.[34] National Football League (NFL) players can now review gameplay virtually, freeing them from the risk of physical injury.[35] AR devices find new

30. *Coronavirus: VR Adult Popularity Skyrockets in Quarantined Countries*, NEWSWIRE (Mar. 13, 2020), https://www.newswire.com/news/coronavirus-vr-adult-popularity-skyrockets-in-quarantined-countries-21112002 [https://perma.cc/5UGM-R9TT].

31. *Live Concerts Take the Virtual Out of Virtual Reality*, WIRED, https://www.wired.com/brandlab/2017/07/live-concerts-take-virtual-virtual-reality/ [https://perma.cc/6RGZ-JAVU] (last visited Sept. 28, 2020); Ethan Millman, *The New Reality for Concerts in COVID: Virtual Reality?*, ROLLING STONE (July 1, 2020, 2:43 PM), https://www.rollingstone.com/pro/features/virtual-reality-livestreams-covid-1021683/ [https://perma.cc/P65J-BEDQ].

32. *What Is Real-Time Rendering in 3D and How Does It Work?*, UNITY, https://unity3d.com/real-time-rendering-3d [https://perma.cc/4HZH-GBKJ] (last visited Sept. 28, 2020).

33. Men's J. Tech, *The Highs and Lows of Watching an NBA Game in VR*, YAHOO! SPORTS (Oct. 25, 2017, 9:52 AM), https://sports.yahoo.com/highs-lows-watching-nba-game-145255741.html [https://perma.cc/9K8H-CLZF]; *NHL, NextVR Partner on Unique Virtual Reality Experiences*, NAT'L HOCKEY LEAGUE (Jan. 31, 2019), https://www.nhl.com/news/nhl-partnering-with-nextvr-for-virtual-reality-at-marquee-events/c-304339710 [https://perma.cc/E5PB-EU9L]; *NASCAR Debuts Live VR, 360 Video for Fans from Homestead-Miami Speedway*, NASCAR (Nov. 14, 2017, 9:37 AM), https://www.nascar.com/news-media/2017/11/13/nascar-debuts-live-vr-360-video-for-fans-from-homestead-miami-speedway/ [https://perma.cc/E9SE-UT5C]; Steven Impey, *MLB Set to Launch Oculus VR Live Streams*, SPORTSPRO MEDIA (July 24, 2020), https://www.sportspromedia.com/news/mlb-oculus-virtual-reality-2020-live-streaming-technology-baseball [https://perma.cc/28UA-PPYZ].

34. *See* Will Greenwald, *The Best VR Headsets for 2020*, PCMAG (Sept. 16, 2020), https://www.pcmag.com/article/342537/the-best-virtual-reality-vr-headsets [https://perma.cc/W53E-3QHZ]. As of February 2020, the top untethered HMDs include Oculus Quest, Lenovo Mirage Solo, Oculus Go, Pico Goblin, RtTech, and Samsung Gear. Aimee Hart, *Best Standalone VR Headsets in 2020*, ANDROIDCENTRAL (Feb. 4, 2020), https://www.androidcentral.com/best-standalone-vr-headsets [https://perma.cc/L5Z8-T8HD]. Price points vary between $101 and $400. *Id.*

35. JEREMY BAILENSON, EXPERIENCE ON DEMAND: WHAT VIRTUAL REALITY IS, HOW IT WORKS, AND WHAT IT CAN DO 14–17 (2018); *see* Patrick Maese, *How Virtual Reality Is Being Used by Professional Athletes to Avoid Injury*, IRON EDGE (Aug. 1, 2016), https://www.ironedge-group.com/uncategorized/how-virtual-reality-is-being-used-by-professional-athletes-to-avoid-injury/ [https://perma.cc/8RQP-8URZ] (describing a VR system that provides virtual training programs in order to protect players from injuries that might otherwise occur in practice).

applications in workplaces, helping train surgeons to repair heart valves[36] and skilled mechanics to deal with complex repairs.[37] These early successes have combined to create a new sense of possibility, hope, and excitement around the adoption and uses of immersive technology.

Proponents of immersive technology point to the transformational power of the medium. The experience of being in a VR environment for the first time is like stepping into a new world where the program and HMD create a digital blank slate for experience.[38] Simply put, it feels real. Benefits like increased human connection, augmented empathy, and new opportunities for education are commonly listed as proof of VR's potential.[39] Critics caution against unfettered optimism and focus on the opportunities for misuse and abuse, like harassment and violations of consumer privacy.[40]

This transformation of the technological realm has far-reaching implications and raises questions about social interaction, military conflict, gaming and recreation, and a host of other issues. Some of these challenges are a logical continuation of technologies that society has already grappled with—just as the internet creates greater immersion than radio or written text, immersive technology extends this progression. On the other hand, immersive technology is also unique: it takes the user out of the traditional role of observer and puts them at the center of the story. To do this, the hardware must monitor the user in deeply intimate and pervasive ways.

This has serious implications for data collection. Consider this: Google knows what a user searches for by keeping track of the

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36. *See* Erin Digitale, *Virtual Reality Imaging Technology Gives Surgeons a Better View into Patient Anatomy*, STAN. CHILD.'S HEALTH, https://www.stanfordchildrens.org/en/about/news/releases/2017/virtual-reality-imaging-technology-makes-surgery-safer [https://perma.cc/3U9J-CVCP] (last visited Sept. 29, 2020).

37. *See* Marco della Cava, *Porsche Is Now Using Augmented Reality Glasses To Repair Cars*, USA TODAY (May 29, 2018, 12:00 PM), https://www.usatoday.com/story/tech/talkingtech/2018/05/29/porsche-now-using-augmented-reality-glasses-repair-cars/648673002/ [https://perma.cc/4S6X-LYGA].

38. *See infra* Section III.C.

39. *See Virtual Reality in Education: Benefits, Tools, and Resources*, AM. U. SCH. EDUC. (Dec. 16, 2019), https://soeonline.american.edu/blog/benefits-of-virtual-reality-in-education [https://perma.cc/4WUE-BSST]; *see also Our Story*, VIRTUAL WORLD SOC'Y, https://www.virtualworldsociety.org/our-story [https://perma.cc/GZ89-V9HR] (last visited Sept. 29, 2019). The Virtual World Society exists to promote affirming uses of new immersive technology to benefit humanity, with a particular focus on improving the lives of children. *Our Story*, *supra*. Please note that the Author serves on the board of this nonprofit organization.

40. *See* Ciaran Foley, *Dealing with Abuse Inside Virtual Reality*, MEDIUM (May 24, 2018), https://medium.com/vutoken/dealing-with-abuse-inside-virtual-reality-fd57a2adff5a [https://perma.cc/CK94-W8DT]; Edward James Fortaleza, *Should We Be Concerned About the Security and Privacy Risks of VR and AR?*, ARPOST (Oct. 25, 2019, 11:00 AM), https://arpost.co/2019/10/25/concerned-security-privacy-risks-vr-and-ar/ [https://perma.cc/3W9M-9NFE].

search phrases affirmatively typed in and can use that information to identify the user's preferences. But an immersive system must understand how users interact with the world at a foundational level. For example, any immersive system must track what its user looks at and for how long.[41] It can implicitly track how individuals react to things—do they stare? Do they do a double take? Do they resolutely look away?[42]

These are all behaviors that humans do as naturally and thoughtlessly as breathing. They are deeply revealing about who people fundamentally are, and an immersive system must understand them to effectively deliver its service. Data analysis based on insights from biometric psychography would build psychological user profiles based on specific data such as eye tracking, pupil dilation, and other physical analysis.[43] Importantly, as Section III.A.3 describes, while much of the data that enables this work might seem similar to biometric data, much of it is excluded from existing legal definitions, leaving a large and growing regulatory gap.[44]

Immersive technology also fundamentally transforms the using experience, embedding the user into an interactive experience that feels remarkably like the real world. As Section III.B.2 discusses, the technology is characterized by the existence of immersion—the user feeling as if he or she is actually in the virtual world; presence—the user experiencing the virtual world as real; and embodiment—the user embodying an avatar and treating its experiences as his or her own.[45] This creates incredible opportunities for education, social interaction, exploration, and healing. But it also means that traditional social harms that have manifested online in recent years, such as harassment or threats of violence land with stunning force in immersive systems.[46]

These two dimensions—data collection and user experience—pose unique challenges. And as is often the case with new technologies, there is no existing legal framework that provides a paradigm to balance these concerns.[47] New systems are being developed at a breakneck pace, rewriting the norms of human interaction and

41. *See infra* Section III.A.1.

42. *See infra* Section III.A.1.

43. *See* Hanish Bhatia, *Behavioral Biometrics: The Next Step for User Authentication*, COUNTERPOINT (Feb. 11, 2019), https://www.counterpointresearch.com/behavioral-biometrics-next-step-user-authentication/ [https://perma.cc/BDU3-UV7M].

44. *See infra* Section IV.A.3.

45. *See infra* Section III.B.2.

46. *See infra* Section IV.B.

47. *See infra* Section IV.A.3.

capturing new kinds of data.[48] If social scientists have learned anything from the development of increasingly immersive forms of consumer technology, it is that data is deeply valuable. As data is captured and processed, and more uses are discovered for it, the data enables better and better services.[49] Similarly, new experiences and their attendant wonders and ills grow and evolve at staggering rates,[50] leaving users with more than a little whiplash from the results. In other words, turning off the spigot becomes almost impossible.

While this may seem like a standard data-privacy problem, there is acute potential for severe harms inherent in the way immersive technology functions. Because of the psychological and physiological aspects of immersive technology and the potential for a new invasive class of privacy-related harms,[51] this Article recommends additional steps that lawmakers, hardware and software producers, and the immersive tech industry should take to protect users. Privacy law provides some existing models to tackle this challenge,[52] but because of the broad scope of impact and rapid pace of change, this Article recommends adding a human rights-based framework into this analysis. This will help protect the nascent industry in a changing legal landscape and ensure that the beneficial uses of this powerful technology outweigh the potential misuses.

This integrated approach embeds human dignity into the DNA of immersive systems in the same way privacy-by-design frameworks integrate privacy-related concerns at the onset of product and policy development. In implementing the approach, immersive creators and lawmakers would examine mismatches between existing privacy law and new forms of potential safety violations that implicate the users' fundamental rights, and examine risks inherent in both the interfaces and the immersive content itself.

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48. *See* Giulia Carosella, *Pandemic Tempers Growth in AR/VR Spending, but the Long-Term Outlook Is Positive, Says IDC*, INT'L DATA CORP. (July 20, 2020), https://www.idc.com/getdoc.jsp?containerId=prEUR146720420#:~:text=But%20the%20long%2Dterm%20outlook%20remains%20strongly%20positive%20%E2%80%94%20IDC%20estimates,reach%20%24136.9%20billion%20by%202024.&text=Europe%20accounts%20for%20roughly%2015,be%20%241 [https://perma.cc/2CSN-NSRH].

49. *See* Max Freedman, *How Businesses Are Collecting Data (and What They're Doing with It)*, BUS. NEWS DAILY (June 17, 2020), https://www.businessnewsdaily.com/10625-businesses-collecting-data.html [https://perma.cc/BY5S-WGG5].

50. Ricky Brigante & Sarah A.S. Elger, *2020 Immersive Entertainment Industry Annual Report*, EVERYTHING IMMERSIVE (2020), https://everythingimmersive.com/storage/website-files/documents/2020%20Immersive%20Entertainment%20Industry%20Annual%20Report.pdf [https://perma.cc/88VU-AE2C].

51. *See* Foley, *supra* note 40; Fortaleza, *supra* note 40.

52. *See* Ian Taylor Logan, Comment, *For Sale: Window to the Soul Eye Tracking As the Impetus for Federal Biometric Data Protection*, 123 PA. ST. L. REV. 779, 789–90 (2019).

Grappling with rapid innovation in immersive technology will require a consideration of the risks that emerge from the capabilities built in as standard features in immersive hardware. This inquiry should include reasonably anticipated considerations—examining potential user abuse or violations of the right to freedom of expression, freedom of assembly, and user safety. It should also ask forward-leaning questions, like understanding what content moderation looks like in an immersive environment and how privacy risks will need to be reconceived in the immersive context.

It is important to emphasize that content moderation will look different in immersive contexts than it does in social media and internet-based environments. Because of the differences in the content and nature of immersive experiences, technologists and lawmakers should not presume that content moderation frameworks will function like they currently do in social media. Because immersive technology differs from social media and the internet, it does not have to recreate some of the content-based challenges, like online harassment, hate speech, or disinformation. Content creators, policy makers, and technologists should realize that new innovation is metaphorically another bite at the apple.

With these inquiries, societies can take steps to preserve human dignity and user privacy in virtual spaces. Examining fundamental questions at this early stage in the lifecycle of immersive technology may help stave off some of the pitfalls that advocates and scholars most recently observed in the other forms of internet-based technology,[53] and may provide the opportunity to apply this new, powerful medium in socially-affirming and personally beneficial ways.[54]

This Article explains immersive technology and the challenges of immersive technology, both familiar and unfamiliar. It describes this emerging space and outlines its roots in previous technology as well as its differences. As defined by this Article, the emergence of biometric psychography may become one of the gravest avenues for violations of user privacy. This Article further describes new challenges around immersive technology in two dimensions—data collection and user experience—and emphasizes unprecedented harms threatened by these problems. It outlines how current law does and does not apply. Finally, it argues that the rapid innovation in data collection processing in this space should be controlled by law and provides some initial recommendations for specific players on how to think about biometric

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53. *See* Julian Baumrin, Note, *Internet Hate Speech and the First Amendment, Revisited*, 37 RUTGERS COMPUT. & TECH. L.J. 223, 228–29 (2011).

54. *See Virtual Reality in Education: Benefits, Tools, and Resources*, *supra* note 39.

psychography and how to evaluate legal and nonlegal control regimes and the challenges that immersive technology will likely face.

A. How Immersive Technology Works

1. VR Systems

The View-Master, a Toy Hall of Fame inductee, is one of the defining toys of the twentieth century.[55] Users look into its viewports and observe scenes rendered with a sense of depth that implies three dimensions.[56] Versions of this type of experience date back to stereoscopes invented in the 1800s.[57] Functionally, VR works similarly to a combination of this tried-and-true technology and a motion picture. A VR headset displays a video feed created by a computer processor that is either located externally or contained within an HMD.[58] The HMD creates two independent visual feeds and sends them to two LCD displays—a left and a right screen, one for each eye.[59] Inside the HMD, there are additional lenses located between the screen and the eyes, which focus the image.[60] Looking through the HMD is like wearing eyeglasses; it places the gaze through those lenses, creating a stereoscopic three-dimensional effect due to slight differences between the left and right images.[61] This is the same way that the left eye and right eye see slightly different perspectives that combine to create depth of vision.[62]

As a general rule, the wider one's field of view—the further one can look to the left and right—the more immersive the experience will be.[63] Most VR visual displays have a 100 to 110 degree range.[64]

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55. *See National Toy Hall of Fame*, CBS NEWS, https://www.cbsnews.com/pictures/national-toy-hall-of-fame/4/ [https://perma.cc/9GAV-D5CA] (last visited Sept. 29, 2020).

56. *See View-Master*, STRONG NAT'L MUSEUM PLAY, https://www.toyhalloffame.org/toys/view-master [https://perma.cc/UHF5-U4ML] (last visited Sept. 29, 2020).

57. *See id.*

58. *See* Trevor English, *VR Headsets Work Through a Combination of Different Tracking Technologies*, INTERESTING ENG'G (May 9, 2020), https://interestingengineering.com/vr-headsets-work-through-a-combination-of-different-tracking-technologies [https://perma.cc/B6CL-9VN8].

59. *See id.*

60. *See id.*

61. *See id.*

62. *See* Zaynah Bhanji, *A New Reality: How VR Actually Works*, MEDIUM (Oct. 1, 2018), https://medium.com/predict/a-new-reality-how-vr-actually-works-663210bdff72 [https://perma.cc/3CJE-TYH7].

63. *See* Jay Uhdinger, *Field of View for Virtual Reality Headsets Explained*, VR LENS LAB (Mar. 17, 2016), https://vr-lens-lab.com/field-of-view-for-virtual-reality-headsets/ [https://perma.cc/G8HU-SHYQ].

64. *See id.*

Higher-end hardware includes a feature called foveated rendering, which blurs the periphery of the user's view in the same way everyday vision has central focus but blurs at the edges.[65] Foveated rendering works via eye tracking, where the HMD uses the position of the user's pupils to determine which areas should be in focus and which areas can be of lesser resolution.[66] This can also conserve computing energy in an experience and allow developers to create more detail inside the focus area.[67]

As the user moves, HMDs use sensors to track their motion, position them in space, and refresh their perspective.[68] Tracking is the ability for hardware to calibrate and measure a user's head and eye movements and respond accordingly with a change in the user's point of view.[69] HMDs measure head position and rotation via spatial mapping techniques, using a system called six degrees of freedom.[70] The system helps to track the position of the VR user.[71] When properly calibrated, the picture in the HMD follows the user's movement in six ways—forward, backward, up, down, side-to-side, and the tilt angle of the user's head—using X, Y, and Z axes to determine the user's position and direction.[72]

A combination of optical and non-optical sensors helps position the body in space and may prevent the user from tripping or accidentally harming themselves while in an immersive experience.[73] These sensors include accelerometers, gyroscopes, and magnetometers that convert movement into electrical signals and so track a user's

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65. *See* Jeremy Horwitz, *HTC Vive Pro Eye Hands-On: Gaze into VR's Future with Foveated Rendering*, VENTUREBEAT (Jan. 10, 2019, 4:05 AM), https://venture-beat.com/2019/01/10/htc-vive-pro-eye-hands-on-gaze-into-vrs-future-with-foveated-rendering/ [https://perma.cc/66Z7-3PHG]; Paul Miller, *Nvidia's Foveated Rendering Tricks for VR Could Improve Graphics and Immersion*, VERGE (July 22, 2016, 5:23 PM), https://www.thev-erge.com/2016/7/22/12260430/nvidia-foveated-rendering-vr-graphics-smi-eye-tracking-siggraph [https://perma.cc/AE59-4R38].

66. *See* Horwitz, *supra* note 65.

67. *See id.*

68. *See* Jonathan Strickland, *How Virtual Reality Gear Works*, HOWSTUFFWORKS (Aug. 10, 2007), https://electronics.howstuffworks.com/gadgets/other-gadgets/VR-gear6.htm [https://perma.cc/TDB5-FLR3].

69. *See id.*

70. See *id.*

71. *See* Mahima Bajpai, *What Is 6 Degree of Freedom (6DOF) in Virtual Reality (VR)?*, QUEPPELIN (Feb. 4, 2020), https://www.queppelin.com/what-is-six-degree-of-freedom/ [https://perma.cc/M2C6-L87Y].

72. *A Quick Guide to Degrees of Freedom in Virtual Reality*, KEI STUDIOS, https://kei-stu-dios.com/quick-guide-degrees-of-freedom-virtual-reality-vr/ [https://perma.cc/L6BK-C5WD] (last visited Jan. 1, 2020).

73. *See A Brief Guide to VR Motion Tracking Technology*, ANTYCIP, https://ste-antycip.com/blogs/vr-motion-tracking/ [https://perma.cc/J8VJ-DSXX] (last visited Sept. 29, 2020).

motion.[74] Hand tracking is done by a separate mechanism using optical sensors, which generally includes handheld controllers.[75] However, this is quickly evolving. Cutting-edge controller-less interfaces can interpret electrical impulses directly to enable gesture-based control of the VR software.[76] All of these sensors working together enable the technology to track the user's movements and behavior.[77]

A quick hardware response to users' movements is critical to prevent users from feeling sick from immersive experiences. Human perception is fine-tuned to use the senses to spatially orient a person in their environment; the user can experience "simulator sickness" when rendering, tracking, or display features are incorrectly calibrated.[78]

Latency describes the time delay between a user moving his or her head and eyes and the change in visual point of view.[79] At a minimum, sixty frames per second must be rendered in an HMD to avoid the user feeling a sense of nausea or disorientation, although many content providers choose to provide a higher frame rate for an enhanced experience.[80] This is important because humans have high sensitivity to latency; flight simulator experiences have shown that humans can detect latency lags of more than only fifty milliseconds.[81] In immersive environments, latency creates awareness of the artificialness of an environment and ruins the sense of an alternative reality.[82]

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74. *Understanding Sensors: Magnetometers, Accelerometers and Gyroscopes*, VIRTUAL REALITY SOC'Y, https://www.vrs.org.uk/virtual-reality-gear/motion-tracking/sensors.html [https://perma.cc/Q9AQ-VDW5] (last visited Sept. 30, 2020).

75. Rachel Lum, *A Brief History of Motion Tracking Technology and How It Is Used Today*, MEDIUM (Jan. 9, 2019), https://medium.com/@lumrachele/a-brief-history-of-motion-tracking-technology-and-how-it-is-used-today-44923087ef4c [https://perma.cc/XJ7E-DUA4].

76. *Introducing Hand Tracking on Oculus Quest—Bringing Your Real Hands into VR*, OCULUS BLOG (Sept. 25, 2019), https://www.oculus.com/blog/introducing-hand-tracking-on-oculus-quest-bringing-your-real-hands-into-vr/ [https://perma.cc/S29H-PE32] [hereinafter *Introducing Hand Tracking on Oculus Quest*].

77. Steve Dent, *What You Need to Know About 3D Motion Capture*, ENGADGET (July 14, 2014), https://www.engadget.com/2014-07-14-motion-capture-explainer.html?guccounter=1 [https://perma.cc/KQQ9-Y9UN].

78. *See* BAILENSON, *supra* note 35, at 18.

79. *Latency*, XINREALITY, https://xinreality.com/wiki/Latency [https://perma.cc/9JER-9FNF] (last modified June 4, 2015, 7:26 AM). Latency can also refer to lags in other sensory perception, beyond just vision. *Id.*

80. GamerHubTV, *Oculus Rift Condition One Preview Interview*, YOUTUBE (Mar. 30, 2014), https://www.youtube.com/watch?v=UiUqlEQPHjk&t=2s [https://perma.cc/74TU-CASS]. The HMD is what determines the required rendering rate. *See Rendering: Overview*, OCCULUS, https://developer.oculus.com/documentation/unreal/unreal-advanced-rendering/?locale=en_US [https://perma.cc/D6LR-NK5Y] (last visited Sept. 30, 2020).

81. Strickland, *supra* note 68.

82. *Id.*

Eye tracking in VR is of paramount importance. This functionality uses an infrared camera to monitor the user's eyes and the direction of the user's gaze inside the HMD.[83] Resulting sensor data translates into more precise computer reactions in VR content and a more realistic point of view.[84] Foveated rendering, as previously mentioned, can also help replicate visual realism by blurring the edges of peripheral vision and reduce simulator sickness.[85]

2. AR and XR Interfaces

AR relies on similar technology to VR but differs because it superimposes virtual layers on physical spaces rather than creating an entirely virtual world.[86] Using a system of cameras along with a mounted computer in an HMD, the device analyzes a visual field and the locations of objects within that field, then superimposes imagery or descriptions over the user's view.[87]

Phone-based AR uses an RGB color camera paired with a depth camera, if available, to execute a simultaneous location and mapping (SLAM), which it conducts via algorithm.[88] These cameras are often used in conjunction with the handset's accelerometer[89] and gyroscope,[90]

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83. *How Does Eye Tracking Work?*, *supra* note 5.

84. *Id.*

85. Horwitz, *supra* note 65. Sound that appears to emanate from a locational source and the Doppler effect can be similarly effective in aiding the user's sense of immersion. *See* Sandra Poeschl, Konstantin Wall & Nicola Doering, *Integration of Spatial Sounds in Immersive Virtual Environments an Experimental Study on Effects of Spatial Sound on Presence*, *in* 2013 IEEE VIRTUAL REALITY (VR) 129, 129 (2013), https://ieeexplore.ieee.org/document/6549396 [https://perma.cc/J46W-G6EV].

86. Nancy Gupton, *What's the Difference Between AR, VR, and MR?*, FRANKLIN INST., https://www.fi.edu/difference-between-ar-vr-and-mr [https://perma.cc/9D6Q-YPTU] (last updated Jan. 6, 2020).

87. *See What Is Spatial Computing?*, *supra* note 17.

88. Telephone Interview with Aaron Moffatt, Chief Tech. Officer, Immersion Analytics (Dec. 12, 2019).

89. Ryan Goodrich, *Accelerometers: What They Are & How They Work*, LIVE SCI. (Oct. 1, 2013), https://www.livescience.com/40102-accelerometers.html [https://perma.cc/77S9-8JHA] ("An accelerometer is an electromechanical device used to measure acceleration forces. Such forces may be static, like the continuous force of gravity or, as is the case with many mobile devices, dynamic to sense movement or vibrations.").

90. Ryan Goodrich, *Accelerometer vs. Gyroscope: What's the Difference?*, LIVE SCI. (May 31, 2018), https://www.livescience.com/40103-accelerometer-vs-gyroscope.html [https://perma.cc/FA29-UJKU] ("A gyroscope is a device that uses Earth's gravity to help determine orientation. Its design consists of a freely-rotating disk called a rotor, mounted onto a spinning axis in the center of a larger and more stable wheel. As the axis turns, the rotor remains stationary to indicate the central gravitational pull, and thus which way is 'down.'").

collectively known as an inertial measurement unit.[91] The SLAM algorithm combines these multiple sensors to determine where the phone is and in what direction and manner it is moving.[92]

Current HMDs for XR use the same orientation techniques but with even more inputs to layer digital content onto actual spaces.[93] An immersive interface can be described as "six cameras in a mounted headset."[94] Rather than a single camera, an HMD reconstructs its surroundings from several wide-angle, often lower-resolution cameras that all point in different directions.[95] AR and XR eye-tracking systems are usually cameras pointed at the viewer's eyes, some operating via infrared light.[96] Older systems combine a special infrared light field generated by external sensors called "lighthouses" with an internal measurement unit to deduce user position and angle of movement.[97] Some AR systems, like the Magic Leap, use a single handset with more embedded sensors,[98] while others, like the Microsoft HoloLens, are completely hand-input driven.[99]

The AR camera and sensors create a separate computing layer from the display system.[100] Once the device knows its location and orientation, it can render a virtual, 3D world from the user's

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91. *See* M.N. Victorino, X. Jian & C. Menon, *Wearable Technologies and Force Myography for Healthcare*, *in* WEARABLE TECHNOLOGY IN MEDICINE AND HEALTH CARE 135, 137 (Raymond Tong ed., 2018).

92. Paul Matthews, *What Is SLAM and Why It's One of the Biggest Challenges in Development*, VRFOCUS, https://www.vrfocus.com/2018/08/what-is-slam-and-why-its-one-of-the-biggest-challenges-in-development/ [https://perma.cc/FH6M-72NZ] (last updated July 17, 2018).

93. *Id.*

94. Telephone Interview with Daniel Robbins, Principal UX Designer, Sony HTC Vive (July 29, 2019).

95. *See* David Heaney, *LYNC-R1 Is a $1500 Standalone Passthrough AR Headset*, UPLOADVR (Feb. 3, 2020), https://uploadvr.com/lynx-r1-standalone-passthrough/ [https://perma.cc/T5HE-FZLH].

96. Kavya Pearlman, Regine Bonneau, Marco Magnano & Ross Newman, *The XRSI Definitions of Extended Reality (XR): Recommendations of the XR Safety Initiative*, XRSI 1, 9 (Oct. 2019), https://www.xrsi.org/wp-content/uploads/2019/10/RFC-XR-DCF-Special-Publication-0001.pdf [https://perma.cc/V72Q-GA7A].

97. Interview with Aaron Moffatt, *supra* note 88; *see Lighthouse*, XINREALITY, https://xinreality.com/wiki/Lighthouse [https://perma.cc/X7GX-V83W] (last modified July 24, 2017, 10:08 PM).

98. iFixit, *Magic Leap One Teardown!*, YOUTUBE (Aug. 23, 2018), https://youtu.be/yf1m71JuG34 [https://perma.cc/2YRQ-QHY7].

99. *See* Brandon Vigliarolo, *Microsoft HoloLens: Cheat Sheet*, TECHREPUBLIC (July 30, 2018, 7:57 AM), https://www.techrepublic.com/article/microsoft-hololens-the-smart-persons-guide/ [https://perma.cc/Z9PX-JBJJ]; *see also* Ash, *Sorry Microsoft, Controllers Are a Must for AR Smart Glasses*, MEDIUM (Sept. 13, 2019), https://medium.com/swlh/sorry-microsoft-controllers-are-a-must-for-ar-smart-glasses-e35159f6498c [https://perma.cc/2D7M-2DS2].

100. iFixit, *supra* note 98.

perspective.[101] The display system then overlays that rendering onto the user's vision.[102]

B. Comparing Immersive Technology to Traditional Online Gaming and Social Media

Important elements of immersive technology can be found in earlier technologies to varying degrees. For example, there is extensive research documenting how much more immersive video is than audio or text, and video games have already deeply developed models for user interaction with their surroundings.[103] As such, it is tempting to think of immersive media as the next generation of entertainment, gaming, or social media. However, the Author argues that immersive media is fundamentally different because of its unique social and psychological components.[104] Nevertheless, it is important to begin by understanding the similarities.[105]

1. The Social Role of Immersive Technology

Just like traditional social media and gaming platforms, many types of immersive media enable users to connect with others and communicate with people across a physical distance.[106] This interaction

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101. *Id.*

102. Interview with Aaron Moffatt, *supra* note 88; *see id.*

103. *What Is VR Gaming? What Accessories Are Used?*, LENOVO, https://www.lenovo.com/us/en/faqs/gaming/what-is-virtual-reality-gaming/ [https://perma.cc/2DD8-6RBW] (last visited Sept. 30, 2020).

104. *See* Shaun W. Jerdan, Mark Grindle, Hugo C. van Woerden & Maged N. Kamel Boulos, *Head-Mounted Virtual Reality and Mental Health: Critical Review of Current Research*, 6 J. MED. INTERNET RSCH. SERIOUS GAMES 15 (2018).

105. The most similar forum that comes to mind may be social VR, based on its intentional similarity to non-immersive social networking. However, this comparison may not hold as emergent gaming platforms, like Fortnite, blur the boundaries between online gaming, social media, and performance space. For example, musical artist Marshmello did a February 2019 concert within Fortnite, and 10.7 million people logged in and attended from all over the world. *See* Andrew Webster, *Fortnite's Marshmello Concert Was the Game's Biggest Event Ever*, VERGE (Feb. 21, 2019 2:30 PM), https://www.theverge.com/2019/2/21/18234980/fortnite-marshmello-concert-viewer-numbers [https://perma.cc/S2GT-6KUC]. More people would have been counted as attendees, if online livestreaming of the performance was tallied. *See id.* Over 27 million people watched the official YouTube recounting. *Id.* Since genres are becoming increasingly fluid, defining analogous media may be a temporary exercise, at best, to help scholars understand how immersive media functions within a society.

106. *See* Sol Rogers, *Meaningful Meet Ups: Is VR the Future of Social Connection?*, FORBES (July 22, 2019, 5:22 AM), https://www.forbes.com/sites/solrogers/2019/07/22/meaningful-meet-ups-is-vr-the-future-of-social-connection/#f01883f180e2 [https://perma.cc/89VS-QK3V].

is mediated via hardware and software interfaces.[107] The online space and immersive media enable users to connect with each other and to form social groups with individuals who may be physically distant but have similar ideas and interests.[108]

To this point, gaming has been the primary sector pushed by the immersive industry.[109] Pokémon Go was the breakthrough game for mobile AR in 2016, demonstrating that users are willing to track and physically chase down virtual creatures in outdoor locations using a phone-based AR interface.[110] Lifted by gaming popularity, Facebook's Oculus has sold over 1.5 million headsets to consumers.[111] The Sony HTC Vive, a competitor VR system, has sold 1.3 million devices.[112] The top-performing HMDs focus on programming that is entertainment-based, like interactive gaming experiences for users.[113] These successes may show that consumer-based VR, bolstered by gaming, has now arrived. Other AR and mixed reality headsets have not gained the same traction, as opportunities for practical use for the average person, as opposed to enterprise business applications or commercial customers, may not yet be as clear.[114]

Despite these similarities, it is a mistake to treat immersive technology like new forms of preexisting electronic interfaces and apply

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107. *See* Kaylee Fagan, *A Large Number of People Have Come Out Saying VRChat Has Saved Their Lives - Here's What It's Like to Experience the Online Meeting Place of the 21st Century*, BUS. INSIDER (Mar. 1, 2018, 4:55 PM), https://www.businessinsider.com/vrchat-explained-2018-2 [https://perma.cc/8LXX-HHTJ].

108. Peter Rubin, *As Social VR Grows, Users Are the Ones Building Its Worlds*, WIRED (May 21, 2019, 4:00 PM), https://www.wired.com/story/social-vr-worldbuilding/ [https://perma.cc/LW28-MNCN].

109. *See Global Augmented Reality & Mixed Reality Market: Growth, Trends and Forecasts to 2025*, BUS. WIRE (May 15, 2020, 8:39 AM), https://www.businesswire.com/news/home/20200515005267/en/Global-Augmented-Reality-Mixed-Reality-Market-Growth [https://perma.cc/4SGW-XJXJ].

110. Susie Rack, *'How Pokémon Go Has Changed My Life,'* BBC NEWS (Jan. 1, 2020), https://www.bbc.com/news/uk-england-coventry-warwickshire-49731283 [https://perma.cc/74MU-9892].

111. Hoium, *supra* note 25.

112. *Id.*

113. *See* Jess Grey, *The Best VR Headsets to Try (and Some to Avoid)*, WIRED (July 23, 2020, 9:00 AM), https://www.wired.com/gallery/best-vr-headsets-in-this-reality/ [https://perma.cc/Y2BV-Q87M].

114. AJ Agrawal, *3 Reasons Augmented Reality Hasn't Achieved Widespread Adoption*, NEXT WEB (Feb. 15, 2018), https://thenextweb.com/contributors/2018/02/16/3-reasons-augmented-reality-hasnt-achieved-widespread-adoption/ [https://perma.cc/3VKQ-NGZE]. The article notes that AR technology has taken off in the form of filters for popular image-sharing and messaging apps, like Snap filters. *Id.* These are not traditionally thought of as AR, which demonstrates how the technology may have already arrived without users realizing that they are adapting to a new medium. *See id.*

the same regulatory approaches to this nascent medium. VR and AR are more than new video games or novel social networks. The same types of challenges that this Article identifies, namely user experience and data collection-related challenges, are found in internet-based platforms. However, because of the psychological aspects of immersive technology, there are important distinctions that fundamentally transform the impact of the technology on users' privacy and safety.[115]

2. Psychological Characteristics of Immersive Experiences

Several psychological characteristics set immersive technology apart from other types of innovations, including social media. First is immersion itself, meaning that users feel like they are in an alternate environment.[116] VR and AR experiences generate patterns of stimulation for the user, including light photons for the eyes, acoustic input for the ears, and tactile or haptic stimulators for touch.[117] The way these stimuli are presented will give the user a sense of immersion.[118] In short, immersive features lead to verisimilitude between oneself and the programming through an all-encompassing setting. To describe this for nonusers, immersion sets the scene. When the user puts on a headset and the experience loads—say in an underwater marine environment[119]—images of the ocean appear to surround the user in every direction.[120] Sounds from sea creatures and bubbles appear to emit from the physical location that they would be expected to if the user was actually standing on the seabed.[121] Light filters downward from the water's surface to the seafloor.[122]

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115. *See Hate in Social VR*, ANTI-DEFAMATION LEAGUE, https://www.adl.org/resources/reports/hate-in-social-virtual- reality [https://perma.cc/6THV-Z38A] (last visited Oct. 1, 2020).

116. *Id.*

117. Strickland, *supra* note 68.

118. *See id.* ("In a virtual reality environment, a user experiences immersion, or the feeling of being inside and a part of that world.").

119. For an iconic experience in VR, theBlu allows you to come eye-to-eye with a blue whale. *theBlu Franchise*, WEVR, https://wevr.com/theblu [https://perma.cc/TH6C-JG73] (last visited Oct. 1, 2020). Reviews of the products demonstrate the user's wonder and awe at their sense of immersion. *See id.*

120. *See id.*

121. *See id.*

122. *See id.* More underwater experiences are available. *See, e.g.*, Team VRGC, *Best VR Underwater Adventure Games for Deep-Sea Explorers*, VRGAMECRITIC (June 4, 2019), https://vrgamecritic.com/article/best-vr-underwater-exploration-adventure-games [https://perma.cc/DG4R-J5GE].

Second, there are specific embodiment aspects to the technology. Users must have a sense of active presence.[123] This has been defined as "the illusion of non-mediation" or the impression that users feel like they are communicating without an interface.[124] Jessica Outlaw, head of the Outlaw Lab at Concordia University, studies the design-based impact of immersive technology.[125] She illustrates this with a personal example of how she feels like she is truly interacting with another individual while experiencing VR:

> [W]hen I'm in a VR headset and I talk to people I know, I actually have the sense of being there with them and having an embodied experience. . . . I create memories with them in these virtual environments. . . . I don't feel like there's a huge difference between hanging out with my friends in a virtual space compared to hanging out with them in the actual physical world.[126]

To be fully present in a virtual world, a user must not be aware of the artificial nature of that world, stemming from differences in what the user mentally perceives and from what he or she sees or hears.[127] In order to create this presence, VR pioneer and Stanford professor Jeremy Bailenson emphasizes that content creators need to properly track, render, and display to avoid simulator sickness from cognitive disassociation.[128] Improper calibration at any of these crucial junctures will destroy the illusion that the user is in an alternate universe, abruptly yanking the user back to reality and ending the experience.[129]

The third concept that separates immersive experiences from social media networks is "embodiment," or feeling like an avatar or virtual body is one's actual physical body.[130] This is well illustrated by Mel Slater's "rubber hand illusion," where researchers placed a toy hand—or a virtual rubber hand in the VR experiment context—in a

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123. J.J. Cummings & J.N. Bailenson, *How Immersive Is Enough? A Meta-Analysis of the Effect of Immersive Technology on User Presence*, VIRTUAL HUM. INTERACTION LAB STAN. UNIV. (2016), https://vhil.stanford.edu/pubs/2016/how-immersive-is-enough/ [https://perma.cc/G2TG-2WPP].

124. Eric Johnson, *Full Transcript: Stanford Virtual Reality Expert Jeremy Bailenson on Too Embarrassed to Ask*, VOX (Aug. 4, 2016, 11:00 AM), https://www.vox.com/2016/8/4/12371450/jeremy-bailenson-stanford-university-virtual-reality-too-embarrassed-to-ask-podcast-transcript [https://perma.cc/2LMY-MADM].

125. *Outlaw Center for Immersive Behavioral Science at Concordia University*, CONCORDIA UNIV. LIBR. GUIDES, https://libguides.cu-portland.edu/OutlawCenter [https://perma.cc/M7FE-ZDFX] (last visited Oct. 1, 2020).

126. Interview with Jessica Outlaw, Outlaw Lab Dir., Concordia Univ., in Portland, Or. (July 22, 2019).

127. BAILENSON, *supra* note 35, at 17.

128. *Id.* at 17–20.

129. *Id.* at 18.

130. Michelle Cortese & Andrea Zeller, *Designing Safer Social VR*, MEDIUM (Nov. 1, 2019), https://immerse.news/designing-safer-social-vr-76f99f0be82e [https://perma.cc/D8FQ-EX4M].

user's field of vision within VR.[131] Users who watched the poking, prodding, and abuse that researchers inflicted on the toy interpreted it as real bodily experiences.[132] The brain formed a connection to the foreign body.[133] Embodiment can be beneficial, like in clinical applications where it has been shown to help alleviate phantom limb pain.[134] But it also brings a strong potential risk for virtual social experiences when considering the violence and harassment that have come to characterize many online social spaces.[135]

The combination of immersion, presence, and embodiment allows users to perceive they are in an alternative reality. In psychological research, users often report feeling completely immersed in virtual experiences.[136] Embodied experiences allow full interaction with features of the environment, and in social or multiuser environments, with other individuals in the virtual space.

It is not simply the immersive quality that defines these experiences, but the way users' minds memorialize what they perceive. Dr. Thomas Furness, one of the earliest developers of immersive technology, analogizes the "enormous power" of virtual worlds to "splitting the atom."[137] This is because of the active nature of immersive experiences and how they "awaken spatial memory like no other medium has."[138] There is no separation between the user and the objects of his or her interaction. This can be useful for certain contexts—like educational or therapeutic experiences—and more problematic in other virtual experiences—like gaming that involves committing acts of violence. Furness says these experiences are retained like they are "drawn on the brain in permanent ink."[139]

Furness' assertions are backed by neuroscience. The way in which the human brain recalls being in a virtual environment is similar

131. *Id.*

132. *Id.*

133. *Id.*

134. Aalborg Univ., *Virtual Reality Eases Phantom Limb Pain*, SCIENCEDAILY (May 31, 2017), https://www.sciencedaily.com/releases/2017/05/170531102921.htm [https://perma.cc/LWM6-6MU5].

135. *See* Maeve Duggan, *Online Harassment 2017*, PEW RSCH. CTR. (July 11, 2017), https://www.pewresearch.org/internet/2017/07/11/online-harassment-2017/ [https://perma.cc/7X36-88Q5]. According to Pew Research, four out of ten Americans report personally being harassed online. *Id.* Initial research in social VR, like that of Dr. Outlaw, shows a higher proportion in this new forum. *Id.*

136. Interview with Jessica Outlaw, *supra* note 126.

137. Interview with Thomas Furness, *supra* note 1.

138. *Id.*

139. *Id.*

to the way it creates memories of offline experiences.[140] When scientists have measured brain activity in MRIs, they have found that when a user experiences a virtual event and subsequently recalls it, the response in the hippocampus is akin to the way one would predict the brain to respond to an actual event.[141] Psychological realness also causes immersive technology users to physiologically respond to virtual simulations in ways that are similar to their bodily responses to real situations.[142] As Professors Mark Lemley and Eugene Volokh describe, immersive technology is,

> in a word, a visceral experience. Things that happen there aren't physically real: If the bad guy shoots you in Bullet Train, you don't die in real life. But they feel real indeed.
>
> And those feelings can in turn have real physical consequences. You could literally be scared to death (or at least into a heart attack) by a game that felt sufficiently real. Even if you aren't physically harmed, you will have experienced what you saw and did in VR in a way that you do not on the Internet or in a non-VR video game.[143]

Because of all these facets, immersive experiences are enormously psychologically different than socializing in video game environments or interacting with others on social networks. Naturally, these differences call for a very different regulatory legal platform.

C. The Data That Enables Immersive Interfaces

Sensory perception and the interfaces that enable it are further aspects of immersive technology that allow users to create alternative realities. Two features are essential for creating effective immersive hardware: components that allow for measurement of stimuli and components that allow for the production of stimuli.[144] Since this Article already discussed the technical aspects of how immersive hardware works, it is appropriate now to highlight the most important aspects for virtual world building.

At its core, immersive technology relies on hardware for signal acquisition. First, it measures unique functions and movements of the user's various body parts—such as the head nodding, or the eyes

140. Kathryn Y. Segovia & Jeremy N. Bailenson, *Memory Versus Media: Creating False Memories with Virtual Reality*, BRAIN WORLD (Mar. 21, 2020), https://brainworldmagazine.com/memory-versus-media-creating-false-memory-virtual-reality/ [https://perma.cc/JW7S-36SX].

141. Thackery I. Brown, Valerie A. Carr, Karen F. LaRocque, Serra E. Favila, Alan M. Gordon, Ben Bowles, Jeremy N. Bailenson & Anthony D. Wagner, *Prospective Representation of Navigational Goals in the Human Hippocampus*, 352 SCIENCE 1323, 1325 (2016).

142. BAILENSON, *supra* note 35, at 28.

143. Lemley & Volokh, *supra* note 28, at 1066.

144. Interview with Thomas Furness, *supra* note 1.

blinking—as well as functions and movements of the hands, the fingers, and the feet.[145] Second, it measures emotional or physiological states through mapping activity in the brain via electroencephalography—the measurement and recording of electrical activity in different parts of the brain—or electromyography—tracking signals that activate muscles.[146] Scholars have considered the implications of gathering biometric data for some time, but, as this Article argues in Section IV.A.2, the introduction of these techniques into HMDs fundamentally changes the implications of data collection in immersive technology.[147] The combination of metrics about one's thoughts and emotions with other physical metrics is the most important element in distinguishing personal information gathered in immersive technology from personal information gathered from pure biometric data.

Several features of content can enhance the immersive qualities of a VR or AR experience. First, a full panoramic field of view can make the user feel as if she is truly in an alternate space. The image quality does not need to be photorealistic; in fact, representative environments are often more effective for users, as the brain fills in missing details.[148] However, the graphics should be rendered with a sufficient quality to engender suspension of disbelief.[149] High graphic quality, combined with foveated rendering, is creating new excitement in the MR industry.[150] Second, as previously mentioned, programming 3D audio, including sound coming from the direction of the apparent source and varying in volume as the user approaches or walks away from it, provides more data for users to allow them to perceive environments as real.[151] Third, allowing for a sense of movement or spatial mobility inside an experience can contribute to the senses of reality.[152] Increasingly portable and affordable hardware, like the untethered

145. *Id.*

146. *Id.* These measurements and how they function will be described in depth later in this Article. *See infra* Section IV.A.

147. *See infra* Section IV.A.2.

148. Interview with Thomas Furness, *supra* note 1.

149. *Id.*

150. *See, e.g.*, Lucas Matney, *Varjo's XR-1 Puts Your Eyes on the Outside of Its High-End VR Headset*, TECHCRUNCH (May 29, 2019, 4:22 PM), https://techcrunch.com/2019/05/29/varjos-xr-1-puts-your-eyes-on-the-outside-of-its-high-end-vr-headset/https://techcrunch.com/2019/05/29/varjos-xr-1-puts-your-eyes-on-the-outside-of-its-high-end-vr-headset/ [https://perma.cc/2VKA-GL4N].

151. Interview with Thomas Furness, *supra* note 1.

152. *See* Jarl Erik Cedergren & Stian Kongsvik, *Virtual Reality and Spatial Mobility*, UIO 14–16 (Nov. 20, 2017), https://www.uio.no/studier/emner/matnat/ifi/INF5261/h17/final-report/rapport_vr.pdf [https://perma.cc/LL9S-HFVY] (explaining how spatial mobility and movement in VR allow for a much more realistic way for potential home buyers to experience a virtual open house).

HMD of the Oculus Quest and Oculus Go, helps produce the feeling that a user is really there in a virtual world, without the limitations of mediation.[153] New touch-based developments, like haptic gloves[154] and handsfree controllers, will make the virtual reality seem even more real.

D. What the Future Holds

In the next foreseeable generation of immersive media, users may start to see pupil-dilation hardware; advanced hand, limb and eye tracking; and haptic or neurological interfaces as standard features in off-the-shelf interfaces in VR and AR systems.[155] For example, Oculus has already announced hand tracking to eliminate the need for controllers.[156] In mid-December 2019, Oculus Quest launched hand tracking on its devices.[157] This feature relies on scans of the hand, plus predictive AI from neural networks, to create a 3D model of the hand in virtual space.[158]

Other companies are going even further, demonstrating prototypes of neural link sensors that use brain waves to control computer devices and eliminate the need to gesture at all.[159] In November 2019 at Slush, a major start-up conference in Finland, a company called NextMind showed a live demonstration of a noninvasive brain-computer interface.[160] On stage, the user demonstrated how he could control the movement of a cursor via his thoughts through a sensor placed against his head and mounted on the back of a VR

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153. *See Hate in Social VR*, *supra* note 115.

154. Adi Robertson, *Teslasuit's New VR Gloves Let You Feel Virtual Objects and Track Your Pulse*, VERGE (Dec. 26, 2019, 1:32 PM), https://www.theverge.com/2019/12/26/21037855/teslasuit-glove-vr-haptic-feedback-glove-announce-pricing-release-date-ces-2020 [https://perma.cc/7PDM-JVV2].

155. *See* HOSFELT, *supra* note 2 (exploring some of the advanced capabilities of immersive media).

156. *See* Cameron Faulkner, *The Oculus Quest Is Getting Controller-Free Hand Tracking This Week*, VERGE (Dec. 9, 2019, 3:26 PM), https://www.theverge.com/2019/12/9/21003333/oculus-quest-vr-headset-hand-tracking-controller-2020-update-launch [https://perma.cc/N8XE-24YQ].

157. *Id.*

158. *See* Shangchen Han, Beibei Liu, Tsz Ho Yu, Randi Cabezas, Peizhao Zhang, Peter Vajda, Eldad Isaac & Robert Wang, *Using Deep Neural Networks for Accurate Hand-Tracking on Oculus Quest*, FACEBOOK AI (Sept. 25, 2019), https://ai.facebook.com/blog/hand-tracking-deep-neural-networks/ [https://perma.cc/VP6R-8ZT3].

159. *See* Cathy Russey, *This Wearable Device Lets You Control Any IoT Device Using Only Your Thoughts*, WEARABLE TECHS. (Dec. 3, 2019), https://www.wearable-technologies.com/2019/12/this-wearable-device-lets-you-control-any-iot-device-using-only-your-thoughts/ [https://perma.cc/Q44M-E977].

160. *Id.*

HMD.[161] An HMD was placed on the back of his head and instantly translated brain signals from his visual cortex into digital commands that could be read by a computer processor in real time.[162]

Some of these developments are extraordinarily beneficial for traditionally marginalized or disabled communities; consider a haptic shirt that allows the deaf to "feel" different instruments and experience music for the first time.[163] Haptic gloves that allow the user to feel touch in virtual experiences will similarly open up new realms of verisimilitude.[164] Similarly, pupil dilation is already researched for mindfulness-related immersive therapies, in an effort to map the individual mindscape as a method to heal.[165]

Although innovation may be driven by a desire to improve user experiences and to personalize products, this could provide a slippery slope for privacy protections. New innovations will create even more challenges and ambiguities. For example, controller-less VR devices, which use varying mechanisms to create scans of "hand geometry" that allow users to create their own interfaces, are on the cusp of broader usage.[166] As Section IV.A.3 discusses in detail, there is a mismatch with existing biometric laws that provides inadequate coverage potential against harms for users of immersive technology.[167] This Article will introduce a new concept to fully encapsulate the functioning and potential dangers inherent in this line of technology.

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161. *Id.*

162. *Id.*

163. *See* Jeremy Hsu, *Real "Westworld" Haptic Vests Better Than Fiction*, DISCOVER MAG. (Jun. 8, 2018, 4:35 PM), https://www.discovermagazine.com/technology/real-westworld-haptic-vests-better-than-fiction [https://perma.cc/C9JJ-VRC7]. Take, for example, the work of Dr. David Eagleman, who is using technical interfaces to create new "senses" for the disabled. *Id.* While his haptic vest is not discussed in terms of integration with immersive technology, that is a foreseeable use, especially in conjunction with gaming or romantic applications. *Id.*

164. *See* Robertson, *supra* note 154.

165. *See TRIPP: Fitness for Your Inner Self*, TRIPP, https://www.tripp.com/ [https://perma.cc/MVQ3-TGW7] (last visited Oct. 2, 2020). Companies like Tripp are harnessing the power of immersive technology for therapeutic and wellness purposes. *See, e.g.*, *id.*

166. *See Introducing Hand Tracking on Oculus Quest*, *supra* note 76. This new innovation brings several questions involving user privacy to the forefront: Will courts consider connecting hand geometry with a user's Facebook or Oculus account a form of identification? Or is the hand measurement a physical description like height or weight that would be excluded from the definition? Furthermore, it is unclear whether the technology will work the same way across different platforms, so a judicial ruling specific to one platform would risk creating inconsistent results.

167. *Infra* Section IV.A.3; *see* Joseph Jerome, *Establishing Privacy Controls for Virtual Reality and Immersive Technology*, INT'L ASS'N. PRIV. PROS. (Sept. 9, 2020), https://iapp.org/news/a/establishing-privacy-controls-for-virtual-reality-and-immersive-technology/ [https://perma.cc/V97S-FR3D].

IV. BIOMETRIC PSYCHOGRAPHY AND OTHER CHALLENGES FOR IMMERSIVE MEDIA

Immersive technology provides much more promise than previous forms of technology but is also accompanied by previously unforeseen risks. New types of privacy violations may come from the novel capabilities of immersive technological systems to track and predict user behavior, combined with the lack of regulation in this space.[168] This is about more than just hardware. It is also about the experience-based rules governing content, data collection, data use, user behavior, and user identity—that will set the stage for concerns about privacy and user safety in immersive environments.

A. Introducing "Biometric Psychography"

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.[169]

Biometric psychography uses behavioral and anatomical information (e.g., pupil dilation) to measure a person's reaction to stimuli over time. This can reveal both a person's physical, mental, and emotional state, and the stimuli that caused him or her to enter that state. It is a combination of biometrics and psychographic information, which is a term adopted from advertising that refers to metrics that evaluate a consumer's activities, interests, and opinions through his or her cognitive attributes, like emotions, values, and attitudes.[170] To illustrate the distinction, think of traditional biometrics like static images of fingerprint swirls that connect an individual to his or her unique personhood and identity; psychographics, on the other hand, are

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168. *See* Jerome, *supra* note 167.

169. *Compare Biometrics*, MERRIAM-WEBSTER, https://www.merriam-webster.com/dictionary/biometrics [https://perma.cc/WHS5-NLWT] (last visited Oct. 5, 2020) (focusing on biometrics as a means to verify identity), *with* Ali Fenwick, *Psychographics: How Big Data Is Watching You*, HULT: BLOGS, https://www.hult.edu/blog/psychographics-big-data-watching/ [https://perma.cc/V3FS-9KCB] (last visited Oct. 5, 2020) (focusing on the shift to identifying interests).

170. *See Psychographics*, BUS. DICTIONARY, http://www.businessdictionary.com/definition/psychographics.html [https://perma.cc/UZT7-3KDL] (last visited Oct. 5, 2020).

more akin to consumer profiles that map an individual's buying preferences or shifts in opinion over time. This difference is important because of the character and implications of the information that could be included as biometric psychographics. Although limited, there is law that regulates traditional identity-focused biometrics and scholarship focusing on its impacts.[171] But there is nothing, as of yet, on the implications of biometric psychography.

Immersive technology can measure biometric information and retain data far beyond the law's focus on biometric identifiers.[172] Immersive technology is not limited to static measurements or images because sensors track how users move over a period of time.[173] Furthermore, it constantly records changes in the environment and how that change may impact the user's condition over time.[174] It is not just the user's real identity, which is mostly already known by the platforms of immersive experiences from his or her financial information and account information. Instead, it is a new quality of information that is comprised of the user's real identity combined with their reactions to particular stimuli—indicating what someone uniquely may think and like and want.[175]

What type of information would be included as part of biometric psychographics? One part is biological info that may be classified as biometric information or biometric identifiers.[176] Looking to immersive technology, the following are biometric tracking techniques: (1) eye tracking and pupil response;[177] (2) facial scans;[178] (3) galvanic skin

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171. Sharon Roberg-Perez, *The Future Is Now: Biometric Information and Data Privacy*, ANTITRUST, Summer 2017, at 60, 62–64 https://www.robinskaplan.com/-/media/pdfs/the-future-is-now-biometric-information-and-data-privacy.pdf [https://perma.cc/CM58-L2JZ].

172. *Compare id.* (discussing various state laws that define "biometric identifiers" to be retina or iris scans, fingerprints, voiceprints, scans of hand or face geometry, vein scans, or other physical characteristics), *with* HOSFELT, *supra* note 2 (explaining that immersive technology can measure a user's sexual attraction or sexual orientation through pupil dilation and skin temperature and can determine whether or not someone is a high or low performer though facial movement data during tasks).

173. *See* HOSFELT, *supra* note 2 (explaining that immersive technology sensors collect data such as pupil dilation and facial movements).

174. *See* Alexandra Kitson, Mirjana Prpa & Bernhard E. Riecke, *Immersive Interactive Technologies for Positive Change: A Scoping Review and Design Considerations*, FRONTIERS PSYCH. 14–15 (Aug. 8, 2018), https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01354/full [https://perma.cc/EH75-38LR].

175. HOSFELT, *supra* note 2.

176. Roberg-Perez, *supra* note 171, at 62.

177. HOSFELT, *supra* note 2.

178. Bye, *supra* note 2.

response;[179] (4) electroencephalography (EEG);[180] (5) electromyography (EMG);[181] and (6) electrocardiography (ECG).[182] These measurements tell much more than they may indicate on the surface. For example, facial tracking can be used to predict how and when a user experiences emotional feelings.[183] It can trace indications of the seven emotions that are highly correlated with certain muscle movements in the face: anger, surprise, fear, joy, sadness, contempt, and disgust.[184] EEG shows brain waves, which can reveal states of mind.[185] EEG can also indicate one's cognitive load.[186] How aversive or repetitive is a particular task? How challenging is a particular cognitive task?[187] Galvanic skin response shows how intensely a user may feel an emotion, like anxiety or stress, and is used in lie detector tests.[188] EMG senses how tense the user's muscles are and can detect involuntary micro-expressions, which is useful in detecting whether or not people are telling the truth since telling a lie would require faking involuntary reactions.[189] ECG can similarly indicate truthfulness, by seeing if one's pulse or blood pressure increases in response to a stimulus.[190]

It is important to note that biometric psychography is not limited to immersive technology. Video gait analysis is used to assess emotional states, and a range of similar applications may arise as technology evolves.[191] However, data that enables biometric psychography *must* be captured for immersive technology to function,[192] which means this field will likely grow as immersive tech expands.

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179. *Id.* Galvanic skin responses are changes in the electrical resistance of the skin caused by emotional stress, measurable with a sensitive galvanometer. Egert Teesaar, *Background: Lie Detection*, MEDIUM (Dec. 17, 2019), https://medium.com/lie-detector-from-emg/background-344e625b2d1f [https://perma.cc/ZS8U-4DEW]. It is used in lie-detector tests. *Id.*

180. *See* Kitson et al., *supra* note 174, at 12–13.

181. Kent Bye, *#814: Neuroscience & VR: Using Muscles & EMG for Neural Interfaces with CTRL-Labs*, VOICES VR PODCAST (Sept. 12, 2019), https://voicesofvr.com/814-neuroscience-vr-using-muscles-emg-for-neural-interfaces-with-ctrl-labs/ [https://perma.cc/YQ3J-JWWW].

182. Bye, *supra* note 2.

183. HOSFELT, *supra* note 2.

184. Bye, *supra* note 2.

185. *Id.*

186. *Id.*

187. *Id.*

188. *Id.*

189. *See id.*; *see also* Teesaar, *supra* note 179.

190. *See* Bye, *supra* note 2; *see also* Runxin Yu, Si Jia Wu, Audrey Huang, Nathan Gold, Huaziong Huang, Genyue Fu, & Kang Lee, *Using Polygraph to Detect Passengers Carrying Illegal Items*, 10 FRONTIERS PSYCH. 322 (Feb. 25, 2019), https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00322/full [https://perma.cc/X5F6-RYWF].

191. *See* Simon, *supra* note 4.

192. *See* Bye, *supra* note 2.

To further elucidate this challenge, this Article discusses the specific example of eye tracking—how it must be used for immersive technology to function and how the data it captures can be used simultaneously to generate user insights. It then focuses on the current legal framework around biometrics, and how this model does—and does not—help the legal community evaluate the risks of biometric psychography.

1. Eye Tracking and Pupillometry

Eye tracking and pupillometry are prime examples of biometric psychography and how they are used in immersive technology. Eye tracking is an anatomical measurement based on tracking the movement of the eye and where it focuses, which reveals what a person is looking at.[193] Pupillometry is "the study of changes in the diameter of the pupil as a function of cognitive processing."[194] This helps scientists study perception, language processing, memory, decision-making, emotion and cognition, and cognitive development.[195]

Pupillometry studies how the pupil dilates and contracts in response to stimuli.[196] The measurements track a physical change in the body's state over time.[197] In a VR context, the HMD will record not only the user, but also the stimuli that created the user's response.[198] This can indicate what has visual salience to a user, where the eye lingers, how much attention was paid to an object or event, and what path a user's gaze takes.[199] In short, pupil dilation can act as an "involuntary like button."[200]

How does this work? Tracking the user's gaze and eye position is typically done via projectors that create a pattern of near-infrared light on a user's eyes, gathering high-frame-rate images of the light patterns and of the user's eyes.[201] The patterns are processed by algorithms evaluating the images to calculate the eyes' position and gaze point.[202] If this information is combined with measuring minute

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193. *See* Bar-Zeev, *supra* note 2.

194. Sylvain Sirois & Julie Brisson, *Pupillometry*, 5 WIRES COGN. SCI. 679, 679 (2014).

195. *See id.* at 681; Bryn Farnsworth, *Pupillometry 101: What You Need to Know*, IMOTIONS (May 23, 2017), https://imotions.com/blog/pupillometry-101/ [https://perma.cc/ZP6U-QESC].

196. *See* Sirois & Brisson, *supra* note 194, at 679, 682.

197. *See* Farnsworth, *supra* note 195.

198. *See* Bar-Zeev, *supra* note 2.

199. *Id.*

200. *Id.*

201. Klaris & Bedat, *supra* note 6.

202. *Id.*

movements of facial muscles and reactions of pupils, then emotional response can also be gauged.[203]

On a more technical level, most eye-tracking methods will apply a camera pointed at the eye and use infrared light (IR).

> IR illuminates the eye and a camera sensitive to IR analyzes the reflections. The wavelength of the light is often 850 nanometers. It is just outside the visible spectrum of 390 to 700 nanometers. The eye can't detect the illumination but the camera can.
>
> We see the world when our retina detects light entering through the pupil. IR light also enters the eye through this pupil. Outside the pupil area, light does not enter the eye. Instead, it reflects back towards the camera. Thus, the camera sees the pupil as a dark area—no reflection—whereas the rest of the eye is brighter. This is "dark pupil eye tracking." If the IR light source is near the optical axis, it can reflect from the back of the eye. In this case, the pupil appears bright. This is "bright pupil eye tracking." It is like the "red eye" effect when using flash photography. Whether we use dark or bright pupil, the key point is that the pupil looks different than the rest of the eye.
>
> The image captured by the camera is then processed to determine the location of the pupil. This allows estimating the direction of gaze from the observed eye. Processing is sometimes done on a PC, phone or other connected processor. Other vendors developed special-purpose chips that offload the processing from the main CPU. If eye tracking cameras observe both eyes, one can combine the gaze readings from both eyes. This allows estimating of the fixation point of the user in real or virtual 3D space.[204]

Eye tracking is seen as an increasingly important technology in VR.[205] Eye-tracking kits for developers by the start-up Tobii were announced to great acclaim in January 2018 and are currently in use.[206] Microsoft HoloLens and Magic Leap encourage their third-party developers to create applications using eye-tracking data.[207] Foveated rendering[208] is a key element for increasing the quality of immersive experiences and cannot be done without eye tracking to see what a person is looking at and which areas to enhance or blur accordingly.[209]

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203. *Id.*

204. *How Does Eye Tracking Work?*, *supra* note 5.

205. *See* Klaris & Bedat, *supra* note 6.

206. *See id.* Tobii has many offerings, including a platform-agnostic developer's kit for eye tracking, which can use any programming language. TOBII XR SDK, https://vr.tobii.com/sdk/ [https://perma.cc/A36Y-76R8] (last visited Oct. 5, 2020). For our purposes, the most interesting offering is the Tobii G2OM, a machine-learning algorithm to accurately predict what the user is looking at. *Id.*

207. Bar-Zeev, *supra* note 2.

208. *See* Horwitz, *supra* note 65 (describing that foveated rendering blurs the periphery of the user's view, in the same way everyday vision has central focus but blurs at the edges, and thus conserves substantial energy in virtual reality).

209. *See id.*

Beyond its technical value, pupil dilation measurements can be used to ascertain a frightening range of personal information, like to whom a user is sexually attracted or whether a user may have a propensity for developing illnesses like dementia.[210] HMDs that include eye-tracking capabilities can gauge what their users are looking at, how long their attention is captured, and how users may feel about what they are seeing, allowing advertisers to collect data that used to require a laboratory.[211] This "mind reading" capability, which is becoming a standard feature in new HMDs, may change the fundamental nature of the technology and put users on guard for self-censorship of their innermost thoughts, feelings, and emotions.

2. How Could Biometric Psychography Implicate Privacy?

The combination of data sets inherent in immersive technology may produce further invasive results that amount to more than a mere violation of consumer privacy—pupillometry offers the perfect illustration of this risk. Many people are surprised by how much can be revealed through evaluating the motions of the eye, like examining saccades, the scanning motions that eyes use to create a picture of the world, or "smooth pursuit" motions made by the eye in tracking a moving object.[212] Some researchers have found that autism in some young children can be gauged by irregular eye motion patterns.[213] Other serious ailments, like schizophrenia, Parkinson's disease, ADHD, and concussions can also be diagnosed though eye tracking.[214]

This could have serious implications. For example, scientists in Germany conducted a study asking subjects to complete a maze in VR.[215] They found that users' performance on the task was correlated with their risk of developing Alzheimer's disease.[216] Performance on a VR game is not the type of information that those who created health privacy laws may have anticipated as related to one's medical health. But access to such information would cause alarm to privacy and

210. Interview with Kent Bye, Host, Voices of VR Podcast, in Portland, Or. (July 22, 2019); *see* Bar-Zeev, *supra* note 2.

211. *See* Bar-Zeev, *supra* note 2.

212. *See id.*

213. *Id.*

214. *Id.*; *see also* Tia Ghose, *Eye Tracking Could Diagnose Brain Disorders*, LIVE SCI. (Sept. 18, 2012), https://www.livescience.com/23274-eye-tracking-gaze-brain-disorders.html [https://perma.cc/ST9H-SQGZ].

215. David Shultz, *Alzheimer's Disease Tied to Brain's Navigation Network*, SCIENCE (Oct. 22, 2015, 2:15 PM), https://www.sciencemag.org/news/2015/10/alzheimer-s-disease-tied-brain-s-navigation-network [https://perma.cc/QCY3-W4ZW].

216. *Id.*

consumer advocates, especially if users' results were available for purchase by third parties, like insurers, advertisers, and government agencies.

Previous examples have mentioned how pupil dilation, in particular, can help measure very intimate information like users' innermost thoughts and desires.[217] It is frightening to think that companies could use information, like a user's predicted sexual orientation, to enrich existing commercial profiles. There is a risk of self-censorship, in the most fundamental way, if users find themselves trying to limit what they feel, think, or express for fear that information will be monetized or researched. At the same time, many of these factors are subconscious, meaning that even if a user wanted to self-censor or hide his or her preferences, the user would not be able to.

If third-party or direct developers are able to integrate different data sets in ways that are unanticipated or harmful to consumers, this could reveal information that users do not intend—or meaningfully consent—to reveal. This could similarly occur with government or corporate use of VR if the technology was used in interrogations or in contexts like antibias and harassment training. Without uniform legal restrictions or voluntary constraints outside of identifying information, which is the focus of current biometrics regimes, there is the potential for companies to be susceptible to another Cambridge Analytica-type mass violation of user trust.[218] Furthermore, it is challenging to inform users of the full implications of collection of their data. Most people do not understand how involuntary bodily indicators of emotional responses, mental state, or health can disclose fundamentally private information, such as truthfulness, inner feelings, and sexual arousal. It remains to be seen what impact the newest state-level privacy regimes, like the California Consumer Privacy Act (CCPA), will have on consumers and what effect allowing consumers to voluntarily limit the sale of their personal information may have on immersive technology, where new types of data sets and personal information are evolving alongside the increased popularity of the medium.

217. Bar-Zeev, *supra* note 2.

218. *See* Alvin Chang, *The Facebook and Cambridge Analytica Scandal, Explained with a Simple Diagram*, VOX (May 2, 2018, 3:25 PM), https://www.vox.com/policy-and-politics/2018/3/23/17151916/facebook-cambridge-analytica-trump-diagram [https://perma.cc/9AUU-5D4R].

3. How the Law Understands Biometrics and Implications for Biometric Psychography

As of November 2019, three states had laws governing biometric information.[219] California followed with the CCPA on January 1, 2020.[220] At least four more states are considering laws covering biometrics.[221] In general, however, these frameworks do not reflect the development of immersive technology when considering what features are available with hardware, how those features function, what information about users is available, and how that information could be used.[222]

The nation's most robust and litigated biometric law, the Illinois Biometric Information Privacy Act, has two separate and distinct definitions for "biometric identifier" and "biometric information."[223] Under Illinois state law, a "biometric identifier" is a bodily imprint or attribute that can be used to uniquely distinguish an individual, defined in the statute as "a retina or iris scan, fingerprint, voiceprint, or scan of hand or face geometry."[224] Exclusions from the definition of biometric identifier are "writing samples, written signatures, photographs, human biological samples used for valid scientific testing or screening, demographic data, tattoo descriptions, or physical descriptions such as height, weight, hair color, or eye color" and biological material or information collected in a health care setting.[225]

The statute defines "biometric information" as "any information, regardless of how it is captured, converted, stored, or shared, based on an individual's biometric identifier used to identify an individual [and] does not include information derived from items or procedures excluded under the definition of biometric identifiers."[226] The statute protects both biometric identifiers and biometric information,[227] but the

219. Klaris & Bedat, *supra* note 6.

220. Gilad Edelman, *California's Privacy Law Goes Into Effect Today, Now What?*, WIRED (Jan. 1, 2020, 7:00 AM), https://www.wired.com/story/ccpa-guide-california-privacy-law-takes-effect/ [https://perma.cc/H5WJ-QKNP].

221. *See* Molly K. McGinley, Kenn Brotman & Erinn L Rigney, *The Biometric Bandwagon Rolls On: Biometric Legislation Proposed Across the United States*, NAT. L. REV. (Mar. 25, 2019), https://www.natlawreview.com/article/biometric-bandwagon-rolls-biometric-legislation-proposed-across-united-states [https://perma.cc/5LEV-CUE2].

222. Klaris & Bedat, *supra* note 6.

223. 740 ILL. COMP. STAT. ANN. 14/10 (LexisNexis 2020); *see* McGinley et al., *supra* note 221.

224. 740 ILL. COMP. STAT. ANN. 14/10; *see also* Klaris & Bedat, *supra* note 6 (discussing biometric classifications as applied to "hand geometry" in VR).

225. 740 ILL. COMP. STAT. ANN. 14/10.

226. *Id.*

227. *Id.* 14/15.

functioning of hardware may complicate how the statute is applied. For example, it is unclear under the Illinois law whether facial recognition software that identifies faces from photographs is subject to the law's protections. For example, scans of facial geometry are considered "biometric identifiers," but photographs are excluded under the list of biometric identifiers, and information "based on" an excluded item cannot be "biometric information."[228]

Texas and Washington are the two other states with biometrics privacy statutes.[229] Each of these are focused on the collection of biometric data for commercial purposes. The Texas statute is similar to the Illinois law, defining "biometric identifier" as "a retina or iris scan, fingerprint, voiceprint, or record of hand or face geometry."[230] The Washington statute is broader, defining "biometric identifier" as "data generated by automatic measurements of an individual's biological characteristics, such as a fingerprint, voiceprint, eye retinas, irises, or other unique biological patterns or characteristics that is used to identify a specific individual."[231] The definition of "biometric identifier" does not include items such as "physical or digital photograph[s], video or audio recording[s] or data generated therefrom, or information collected, used, or stored for health care treatment, payment, or operations under the federal health insurance portability and accountability act of 1996."[232]

At least one state, Delaware, has added "biometric data" to a list of personal information protected by a general statute relating to data security, referring simply to "[u]nique biometric data generated from measurements or analysis of human body characteristics for authentication purposes."[233] Proposed federal legislation directed toward more general protection of personal data, similar to the Illinois law, defines "biometric information" as "including a retina or iris scan, fingerprint, voiceprint, or scan of hand or face geometry."[234]

There are two problematic constraints embedded in each of these definitions. First, they rely on narrow physiological categories of data that may not cover data captured in immersive systems. Legislators may not have previously contemplated this type of information as

228. *Id.* 14/10.

229. *See* TEX. BUS. & COMM. CODE ANN. § 503.001 (West 2019); WASH. REV. CODE ANN. § 19.375 (LexisNexis 2020); The California Consumer Privacy Act (CCPA) will also cover this area, but as part of an omnibus privacy bill. *See* Edelman, *supra* note 220. As of the time of writing, it is still unclear how the bill will be enforced, and thus is it not a central part of this analysis. *See id.*

230. TEX. BUS. & COMM. CODE ANN. § 503.001.

231. WASH. REV. CODE ANN. § 19.375.010.

232. *Id.*

233. DEL. CODE ANN. tit. 6, § 12B-101 (2019).

234. Privacy Bill of Rights Act, S. 1214, 116th Cong. § 2(10)(B)(iv) (2019); *see* Roberg-Perez, *supra* note 171.

having important privacy implications, so it is reasonable that it was not included before the emergence of immersive technology. Second, and even more importantly, such data is only covered if it is "for authentication purposes."[235] This second constraint creates a huge loophole—physiological data used to determine a person's likes, interests, or motivations, rather than their identity, is almost certainly not covered. While there is limited opportunity to capture this data from non-immersive technology, the richness of immersive environments and data capture creates ample opportunity to leverage data in novel ways.

As legislators look to adapt legal frameworks for new technology, it is important to recognize that lawmakers and the public do not generally know how scans of user data are collected, how this information is stored, how often the information is updated, and how long data is retained. A court has yet to determine the difference between how users should treat a single picture and a stream of information. It is unclear whether muscle tracking over time would be considered a part of facial geometry, as described by the biometrics statutes above. Similarly, it is unclear whether a court would decide that new concepts related to biometrics are strictly limited to identity or if biometric psychography is an expansion of the concept.

As the technical capabilities change, more omissions and grey zones in the law may become clear. For example, physiological characteristics related to locomotion can be outside of legal definitions of biometric data or biometric identifiers. This would include gait tracking, where people can be identified in crowds by the way they walk.[236] Because of the length of our bones and the idiosyncrasies of our movement, the combination of a user's head tilt while in a VR or AR headset and the quality of their gestures in an immersive environment can be just as personally identifying as his or her fingerprint, retinas, or vocal patterns.[237] This blend of data sets and development of unique identifiers was not contemplated when statutes were written.

Given the drive toward consumer adoption, which will likely incorporate location-based advertising models and the sale of user data to third parties,[238] it is also foreseeable that companies will start to incorporate more and more features to delve into the physical and emotional states of their users, creating a demand for biometric

235. DEL. CODE ANN. tit. 6, § 12B-101 (2019). *See also* Roberg-Perez, *supra* note 171.

236. *See* Sophie Bushwick, *Footstep Sensors Identify People by Gait*, SCI. AM. (Apr. 30, 2020), https://www.scientificamerican.com/article/footstep-sensors-identify-people-by-gait/ [https://perma.cc/AMY2-VN77].

237. *See* Interview with Kent Bye, *supra* note 210.

238. *See* HOSFELT, *supra* note 2, at 3 (discussing the sale of users' health data to interested advertisers).

psychographics. This is not limited to immersive technology; for example, a new company proposes to use information gathered from your gait to determine your emotional state.[239]

The ability to tell advertisers more about their targeted audience—including what they pay attention to, what their emotional state is upon viewing or interacting with products, and personal characteristics about their health and well-being—is a lucrative offer. This necessitates expanding or adding to the current laws, and clarifying current statutory language in order to protect the right to privacy.

B. User Experience: Inadequate Safety-Based Features in Immersive Experiences

While this Article focuses on biometric psychography and the implications of this emerging discipline in immersive technology, it is important to note that immersive tech raises a range of other significant, new challenges. Perhaps most significantly, content moderation and the risk of harassment both pose specific and complex challenges in immersive experiences.

Because of active presence, embodiment, and the all-encompassing nature of immersive experiences, visceral content like threats of violence can feel more real in a virtual space because it is not abstract; it is more than just words on the screen. Safety-based transgressions of community norms can implicate users' rights to freedom of expression and freedom of assembly similar to how online harassment silences voices and forces underrepresented voices off social media.[240]

Social VR, which refers to interactive forums where users gather to socialize in virtual communal spaces,[241] provides numerous examples of such targeting. Almost as soon as social VR came into being, reports of harassment followed.[242] Such reports have documented sexual, gender-based, racial, ethnic, religious, and homophobic targeting.[243] In 2018, the research firm The Extended Mind produced a study of the experiences of women in social VR.[244] The results were not surprising

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239. Interview with Tom Furness, *supra* note 1.

240. *Cf.* Danielle Citron, *Cyber Civil Rights*, 89 BOS. U. L. REV. 61 (2009) (making this same argument about online harassment on social media and how it impacts the freedom of expression-based rights of the targets by attempting to silence their voices).

241. *See Hate in Social VR*, *supra* note 115.

242. *Id.*

243. *Id.*

244. *Virtual Harassment: The Social Experience of 600+ Regular Virtual Reality (VR) Users*, EXTENDED MIND (Apr. 4, 2018) [hereinafter *Virtual Harassment*], https://extendedmind.io/blog/2018/4/4/virtual-harassment-the-social-experience-of-600-regular-virtual-reality-vrusers [https://perma.cc/93H5-LEZT].

and quite discouraging: 49 percent of women reported experiencing at least one incident of harassment in VR.[245] Many of them never went back to the virtual experience. The harassing results were not just limited to women, as 30 percent of male respondents reported racist or homophobic content, and 20 percent experienced violent comments or threats on the platform.[246]

In response to concerns about user behavior, companies have started to create content moderation features that take into account user control, volition, and consent.[247] Many platforms now generate an intimate buffer that matches offline cultural approximations, such as providing an approximately twelve- to eighteen-inch zone around a user for a private area.[248]

This type of preventive development—shaping immersive experiences so that high-risk forms of harassment are simply not permitted—will be increasingly important as immersive spaces evolve beyond normal social VR platforms and into interactive communities.

If the initial challenges of social VR cannot be dealt with, they will likely be exacerbated—and evolve into new challenges, where user-generated content will open additional avenues for innovation and expression but also exploitation and abuse. The implications that this distinct set of challenges raises for immersive technology will be considered in more detail in a future article.

V. IMPLICATIONS FOR EVALUATING IMMERSIVE HARMS AND POTENTIAL SOLUTIONS

For a fast-changing area like immersive technology, identifying and analyzing the risks society will face as technology evolves can be incredibly difficult. One reason for this challenge is that analysts often assess risks based on old frameworks that are ill-adapted for new technology. For example, most people focus primarily on the privacy harms of data gathering on new platforms.[249] Immersive technology raises important privacy concerns, but it can impact every dimension of

245. *Id.*

246. *Id.*

247. *See* Cortese & Zeller, *supra* note 130.

248. *Id.*

249. *See, e.g.*, *Privacy and Data Protection by Design – From Policy to Engineering*, EUROPEAN UNION AGENCY FOR NETWORK & INFO. SEC. (Dec. 2014) [hereinafter *Privacy and Data Protection*], https://www.enisa.europa.eu/publications/privacy-and-data-protection-by-design [https://perma.cc/XN8Q-ALE9]; Ann Cavoukian, *The 7 Foundational Principles: Implementation and Mapping of Fair Information Practices*, PRIV. BY DESIGN (Jan. 2011), https://iab.org/wp-content/IAB-uploads/2011/03/fred_carter.pdf [https://perma.cc/JF5Z-T56B].

our lives with consequences that implicate, but also go well beyond, privacy.[250]

This Part proposes a framework to analyze risk from immersive tech based on both privacy and human rights law. Applying this hybrid framework ensures that legislators and consumers will have a fulsome understanding of the harms and a broad set of tools to draw on to respond. Based on this framework, this Article then outlines steps that legislators, product developers, and the immersive tech industry can take to mitigate some of the key identified risks. The risks and mitigations discussed below are only a starting point. Additional scholarship will be required, particularly as immersive technology matures to more completely document key risks and mitigation strategies.

A. A Risk-Based Framework for Immersive Technology from Privacy and Human Rights Law

Experts have looked to international human rights law[251] for consensus-based guidance on how to approach protecting human dignity in the face of emerging technology.[252] This is quite clear in discussions around the governance, constraints, and usage of artificial intelligence (AI), along with the potential risks and harms that may emerge from the data in these systems.[253] A human rights-based framework for immersive technology could draw from these discussions centering on AI, as well as ground discussions in the central rights of users. According to Professor Mark Latonero, "[i]n order for AI to benefit the common good, at the very least its design and deployment should avoid harms to fundamental human values. International human rights provide a robust and global formulation of those values."[254] He continues and acknowledges the challenges and benefits of such a foundation: "The field of human rights has limitations . . . [y]et

250. *See, e.g.*, Eileen Donahoe & Megan MacDuffee Metzger, *Artificial Intelligence and Human Rights*, 30 J. DEMOCRACY 115, 115–26 (Apr. 2019), https://www.journalofdemocracy.org/articles/artificial-intelligence-and-human-rights/ [https://perma.cc/LU9L-VECZ].

251. *See* Donahoe & Metzger, *supra* note 250, at 118–23. Human rights in this case means the rights found in the UDHR and the most significant human rights treaties: The International Covenant on Civil and Political Rights (ICCPR) and the International Covenant on Economic, Social and Cultural Rights (ICESCR), which have been ratified by roughly 170 countries. Together, these three documents make up the International Bill of Rights, which illustrates that human rights are "indivisible, interdependent, and interrelated." G.A. Res. 217A (III), The International Bill of Human Rights (Dec. 10, 1948); *see* Donahoe & Metzger, *supra* note 250, at 119.

252. *See, e.g.*, Donahoe & Metzger, *supra* note 250, at 115–26.

253. *See id.*

254. *See* Mark Latonero, *Governing Artificial Intelligence: Upholding Human Rights & Dignity*, DATA & SOC'Y 5 (2019), https://datasociety.net/wp-content/uploads/2018/10/DataSociety_Governing_Artificial_Intelligence_Upholding_Human_Rights.pdf [https://perma.cc/QX2W-KSBG].

it offers a strong value proposition: an approach to AI governance that upholds human dignity based on international human rights law."[255] For example, when evaluating immersive technology, applicable human rights could include, but are not limited to, privacy, equality, freedom of association, and freedom of expression.[256]

As such, a human dignity-based core can help provide guidance to those developing immersive systems for the toughest technical and policy challenges. This framework would have the benefit of applying universally agreed-upon standards in areas with no legislation or regulation. However, no single paradigm can encompass both the unforeseeable future risks of immersive tech and the present challenges that need urgent attention. Therefore, this Article proposes a hybrid approach: combining the practical focus of a privacy-centric framework, such as elements of policy, practice, and design, with the ideological and consensus-based grounding of a human rights-based framework.

This type of blended approach will be essential for immersive technology, as privacy is often discussed as a fundamental right,[257] but what counts as a privacy violation is challenging to define with precision. There are a myriad of actions that may encompass violations of privacy, from reputational harms to breaches of anonymity to data collection without consent.[258] Among scholars, there is a consensus that violations encompass disparate and broad-based harms.[259]

Specifying the scope of violations can be particularly challenging when trying to operationalize what privacy means in practice, especially when addressing fast-paced technology. There are preexisting privacy-based frameworks, such as the well-known privacy-by-design principles often applied within the tech industry.[260] From this perspective, engineers, designers, and tech product teams are gaining familiarity with incorporating privacy into fundamental systems and processes. However, there is no one comprehensive overarching privacy framework.[261]

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255. *Id.* at 7.

256. *See* G.A. Res. 2200A (XXI), International Covenant on Civil and Political Rights, art. 19 (Dec. 19, 1966). ("Everyone shall have the right to hold opinions without interference. . . . Everyone shall have the right to freedom of expression; this right shall include freedom to seek, receive and impart information and ideas of all kinds, regardless of frontiers, either orally, in writing or in print, in the form of art, or through any other media of his choice.").

257. For example, the right to privacy is found in Article 12 of the Universal Declaration of Human Rights, Article 17 of the International Covenant on Civil and Political Rights, and in a number of other human rights documents, national constitutions, and national laws. *See, e.g.*, *id.*, art. 17; G.A. Res. 217A (III), The Universal Declaration of Human Rights, art. 12 (Dec. 10, 1948).

258. *See* Daniel J. Solove, *Conceptualizing Privacy*, 90 CAL. L. REV. 1087, 1130–31 (2002).

259. *Id.*

260. *See, e.g.*, Ann Cavoukian, *supra* note 249; *Privacy and Data Protection*, *supra* note 249.

261. *See generally* Alan F. Westin, *Privacy and Freedom*, 25 WASH. & LEE L. REV. 166, 166 (1968); Ken Gormley, *One Hundred Years of Privacy*, 1992 WIS. L. REV. 1335 (1992); Jerry Kang, *Information*

When thinking about emerging technology and other quickly evolving paradigms, the most useful models may be frameworks that help lawyers and technologists understand privacy in concrete ways. According to a taxonomy developed by Professor Dan Solove, it is possible to understand privacy based on an analysis of "a privacy violation or problem" defined as "the existence of a certain activity that causes harms or problems affecting a private matter or activity."[262] Solove's approach of focusing on activities that invade privacy is instructive in the immersive context, as the problems are still nascent and evolving, and multiple interests must be balanced by potential regulators or legislation.

Even still, this alone may not be sufficient to address the described harms under both user experience and data collection. However, anchoring a privacy-centric framework to a core human-rights-based approach can both encompass a variety of applicable harms and place universal values at the heart of immersive technology.[263]

Applying this combined approach highlights key potential risks in immersive technology, which may implicate privacy, equality, freedom of association, and freedom of expression: how data is gathered and stored; how users consent to data collection and exert control over their data; how to ensure users have freedom from unwanted contact and identity-based harassment in immersive environments; and encouraging designers to give thought to these issues, as they would manifest within the full technical stack of immersive technology, to ensure human rights are protected. This Article will conclude with specific advice and areas of inquiry for legislators, product developers, and the immersive technology industry, especially in light of the risks of biometric psychography.

B. For Legislators: Protect User Privacy in Data Gathering and Storage

Legislators are one critical community that is empowered to mitigate the risks of immersive technology. Law is often a blunt instrument to face the nuanced challenges of complex innovation, but

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Privacy in Cyberspace Transactions, 50 STAN. L. REV. 1193, 1202–03 (1998); JUDITH W. DECEW, IN PURSUIT OF PRIVACY: LAW ETHICS, AND THE RISE OF TECHNOLOGY 75–77 (1997); William L. Prosser, *Privacy*, 48 CAL. L. REV. 383, 389 (1960); Samuel D. Warren & Louis D. Brandeis, *The Right to Privacy*, 4 HARV. L. REV. 193, 195–96 (1890).

262. *See* Daniel J. Solove, *A Taxonomy of Privacy*, 154 U. PENN L. REV. 477, 484 n.27 (2006).

263. Solove, *supra* note 258, at 1130. In contrast to attempts to conceptualize privacy by isolating one or more common "essential" or "core" characteristics, Solove concludes that there is no singular essence found in all "privacy" violations. *See id.* at 1095–99 (concluding that "the quest for a common denominator or essence . . . can sometimes lead to confusion").

as more sensors are built into HMDs, thorny questions about data storage will emerge that may be particularly suited to address by statute. How—and where—is the massive flow of data that powers an immersive experience processed and stored? Critically, will users be able to control whether that data is transmitted or stored remotely? Is it even possible to keep data local, given the amount of data generated by immersive experiences and the industry's goal of platform interoperability? Seeing as complications may emerge from moving from one medium to another and potentially back again, how does mixed reality internet browser-HMD interactivity complicate the issue?

Immersive technology is still in the early stages of development,[264] which means extreme care should be taken when considering legislation. The risk of derailing rapid innovation is high. At the same time, areas like biometric psychography are particularly ripe for uncertainty and exploitation—and if left unchecked, could easily become sufficiently entrenched as to make legislation much more difficult. Therefore, even at this early stage, it is important to assess where legislation would be valuable.

Care should be taken to evaluate how preexisting data laws will apply in an immersive context, especially given the risk factors that exist with networked data and the potential for bodily and psychological impacts stemming from immersive systems. Additionally, looking forward to likely legal developments, there is a strong potential for conflicts of law, especially in the United States, where so few states have biometric laws on the books.[265]

The gradual codification of online harassment laws, which has been full of missteps and growing pains, may offer clues about the challenges ahead for immersive technology. At first, early efforts to combat harassment demonstrated a fundamental gap in understanding, with some legislators simply adding "cyber" or "online" to existing statutes in ways that did not comport with how the technology functioned.[266] For example, some state-based harassment laws require abuse to be directly communicated between the target and the perpetrator, which may not be applicable to some online interactions.[267] This did not adequately protect user rights like privacy, equality, and human dignity.

The same danger about misapplication of law or ill-fitting laws would apply to effective user consent, especially when considering

264. *See* Harveston, *supra* note 24.

265. *See supra* Section IV.A.3.

266. *See* Cassie Cox, Comment, *Protecting Victims of Cyberstalking, Cyberharassment, and Online Impersonation Through Prosecutions and Effective Laws*, 54 JURIMETRICS J. 277, 285 (2014).

267. DANIELLE CITRON, HATE CRIMES IN CYBERSPACE 124 (2014).

biometric psychography. Consumer advocates have made critiques about the length, complexity, and lack of clarity of terms of service, especially for online products and services.[268] The same critique could be leveled against immersive technologies. True informed consent should require a level of genuine understanding by the users about how their data is collected, applied, stored, and brokered. In addition, users should have control over how these processes occur, with opt-out being the default setting instead of opt-in. This approach is often discussed, but it poses a specific challenge in the context of AR and VR. The illusion of consent can be particularly tricky in the case of immersive technology, where such data collection may be necessary for it to function. While laws like the CCPA are beginning to make progress in online spaces,[269] users should be informed in clear simple language about the trade-offs they are making in choosing to use immersive technology. This is especially the case with technology like the HMDs used by AR and VR, which require eye tracking and sensors to effectively operate.[270]

As will be discussed below, this may move the industry to define what is necessary data processing for the provision of its service. Unnecessary computation may warrant different treatment than necessary computation, and the industry may wish to place voluntary constraints or further transparency requirements around these additional processes (especially in lieu of data applications like biometric psychography).

Finally, as much as possible, sensitive user data should be contained in the HMD itself, not sent, stored, or retained on external servers. Where transmission of this data is computationally necessary, it should be done in the narrowest possible way, and the data should not be stored longer than necessary to provide the service. This way, fundamentally private information can be gathered, saved, and even applied to improve users' experience, while still remaining in the possession of the user alone, and not impinging on the functioning of the device. Authorities would have to convince a judge to issue a warrant for a specific piece of hardware and then send law enforcement to the location of that specific HMD to execute it. If necessary, the information in immersive technology could be accessible by authorities, but the difficulty of doing so would ensure that this is done only in extraordinary circumstances. Much of this would fit well in an

268. *See* Nicholas LePan, *Visualizing the Length of the Fine Print, for 14 Popular Apps*, VISUAL CAPITALIST (Apr. 18, 2020), https://www.visualcapitalist.com/terms-of-service-visualizing-the-length-of-internet-agreements/ [https://perma.cc/XG5X-NF8S].

269. *See* McGinley et al., *supra* note 221.

270. *See* Bar-Zeev, *supra* note 2.

expansion of existing biometrics laws to address the new types of data, and the new uses for that data, offered by biometric psychography.

C. For Product Developers

A second critical community is that of the developers themselves. While they may not act consistently across platforms and applications, they are closest parties to the systems and thus can have the most direct impact on how immersive technology can be built to respect the rights of its users.

1. Embed Different Levels of Specification in Content Moderation Layers

Looking at the different technical systems that come together to make an immersive experience, there are different avenues that product developers should consider when designing to mitigate user risk. This is similar to the challenge posed by content moderation on the internet, where there are different options and questions about power, actors, and responsibility based on the different layers of the internet stack where moderation may occur.[271] The internet stack is a construct that defines the computing layers on which networked systems like the internet are built.[272] For example, the base of the internet stack is hardware, and built on top of that are a series of layers that include data, network, transport, all the way up to the application itself.[273] Engineers can impact a process at different layers, and an intervention that might be effective at one layer might not be practical at another.[274]

A similar concept can apply to the degree of control that developers can give to users over their personal biometric psychographic data.[275] Developers should build in mechanisms to help users understand what personal data is captured, and the trade-offs they will be making by choosing to participate in immersive environments, since this may not be negotiable.

271. For more information on what is meant by the internet stack, see Henrik Frystyk, *The Internet Protocol Stack*, W3 (July 1994), https://www.w3.org/People/Frystyk/thesis/TcpIp.html [https://perma.cc/P8L4-CS3B].

272. *See id.*

273. *See id.*

274. *See id.*

275. One of the first public conversations about layers of the internet stack and how they impact content moderation was the debate around Cloudflare terminating its services for the infamous white supremacist website, the Daily Stormer. Matthew Prince, *Why We Terminated Daily Stormer*, CLOUDFLARE (Aug. 16, 2017), https://blog.cloudflare.com/why-we-terminated-daily-stormer/ [https://perma.cc/5B35-XY5X].

Looking to how content moderation operates can also be useful in considering how content moderation could be used in immersive technology to ensure user equality and safety. For immersive content, the first layer of potential moderation space would be looking at user behavior itself via the actions and choices that one's avatar projects in the virtual world. The second layer would be the content of the virtual environment. The third layer would be functionality, or the features that are built into user interfaces and platform architecture. Some of these layers, like avatar behavior, will pose a more foreseeable risk than others.[276]

Online harassment in virtual worlds and digital communities has been well documented,[277] and one could imagine problems and solutions that impact different immersive stack layers of user behavior, content, and platform features. Just like with social media, underrepresented groups in VR—primarily racial minorities, women, and marginalized communities—are disproportionately targeted.[278] Because of this, to take a human rights and privacy-centric hybrid approach, harassment in immersive spaces should be a problem that developers consider from the onset of the design process.

The behavioral layer of immersive experiences may be the most challenging level to navigate because there are many actors and factors, including significant freedom of association and freedom of expression implications. To examine this, gaming may be an instructive paradigm. Online games frequently have peer-operated reporting of violations of rules and terms of service, as well as platform-administered enforcement.[279] Social VR platforms have experimented with live moderators, but reports from initial experiments showed that this ended up like the hall monitor in middle school with misbehavior resuming and even increasing once the monitor was out of sight.[280]

An additional behavioral hurdle that may implicate human rights is establishing how moderators should function with the expectation of privacy in public VR spaces with private rooms within. Platforms must venture to make live moderation not seem like a Big Brother-like presence that impinges on the privacy of users in online spaces, while simultaneously not creating spaces that sanction abuse.

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276. *See* Michelle Cortese & Andrea Zeller, *How to Protect Users from Harassment in Social VR Spaces*, NEXT WEB (Jan. 1, 2020, 6:00 PM), https://thenextweb.com/syndication/2020/01/02/how-to-protect-users-from-harassment-in-social-vr-space [https://perma.cc/KQ62-WMDV]. Thanks to Nathan White for discussions which brought forth these ideas.

277. *Virtual Harassment*, *supra* note 244.

278. *See id.*

279. *See* Taylor Lorenz, *Virtual Reality Is Full of Assholes Who Sexually Harass Me. Here's Why I Keep Going Back*, MIC (May 26, 2016), https://www.mic.com/articles/144470/sexual-harassment-in-virtual-reality [https://perma.cc/4RRL-FHZA].

280. *See id.*

As will be discussed, community-based moderation solutions have shown success in creating bespoke and inclusive spaces that regulate online spaces with the consent of the users therein.

Mitigating abuse in VR can be done by modeling beneficial social behaviors and increasing diversity. Social norms in VR could more closely mirror what social norms are in a physical environment in terms of how to model appropriate social behaviors. However, there are admittedly preexisting issues with how existing social norms function as many people from vulnerable populations, such as women and members of other groups who experience offline harassment, will not want to see that behavior legitimized in new online arenas.

An alternative vision for immersive technology would be value driven by discrete online communities, with overlap between multiple different groups to counteract filter bubbles. Research done by scholars of behavioral interaction in online spaces have found that community-driven moderation regimes have had a degree of success because they can personalize rules for forum purposes, user expectations, and the shifting desires of the group.[281] This could be a valuable governance mechanism for immersive spaces, if combined with user information and consent.

Security-based audits could also be important for user privacy. This could apply to redlining, or testing for security risks and operational user vulnerabilities, in immersive content because of the possibility for impacts to cross over into offline environments. For example, imagine the risks inherent in experience-based virtual economies that allow users to purchase upgrades and additional features to enhance their interaction with others and the immersive architecture.[282] In a VR game, in the age of biometric psychography, this marketplace could include intimate information such as offline location, media engagement, and even who users are communicating with and how. Furthermore, intra-experience transactions and subscriptions for games may mean that financial information is bundled with a user's data.[283]

To protect vulnerable users and populations, companies should examine some of the strategic vulnerabilities in the features of immersive experiences just as they do in other online environments.

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281. *See, e.g.*, J. Nathan Matias, *Posting Rules in Science Discussions Prevents Problems & Increases Participation*, CIVILSERVANT (Apr. 29, 2019), https://civilservant.io/moderation_experiment_r_science_rule_posting.html [https://perma.cc/CAB5-PEMY].

282. *See* John William Nelson, *The Virtual Property Problem: What Property Rights in Virtual Resources Might Look Like, How They Might Work, and Why They Are a Bad Idea*, 41 MCGEORGE L. REV. 281, 285–86 (2010). A virtual economy is an emergent economy existing in a virtual world, usually exchanging virtual goods in the context of an online game, particularly in massively multiplayer online games. *See id.*

283. *Id.*

These include mass exposure to screennames facilitating password hacking and the use of names or locations for phishing and social engineering.[284] Additionally, companies should be looking to the security records and practices, like breach notification and response, malware protection, and multifactor authentication availability, of third-party content providers, like Steam or other user-generated content marketplaces, to avoid bringing bedbugs into their house. Overall, companies should respond promptly and thoroughly to insecurities in infrastructures and applications, whether or not they are immersive experiences, in order to protect user privacy.

2. Provide Clear Introductory Experiences That Set Expectations

In addition, creators of hardware systems and immersive content alike can make user behavioral expectations clear in platform onboarding experiences, alongside information about data storage and consent. To do this will place other human rights on the foreground with privacy and create an environment more conducive to respecting the full range of human rights. This can be done from the very start of an immersive experience. Oftentimes this introductory programming is the first exposure that users will have in a virtual world[285] and can be formative in their expectations of how to behave, what to expect from others, and what their relationship will be with the data required to make the hardware work.

One thing that could be included in an on-boarding experience would be adding information about data usage and storage. This could be a value-add, especially if addressing necessary data capture or biometric psychography. On-boarding is the moment where users will pay most attention, as they orient themselves to the new technology and environment.[286] Placing privacy information upfront, alongside physical safety, would demonstrate that immersive companies are serious about their commitments to user consent and data autonomy.

It can also help improve overall user experience and platform civility. Level setting can take different forms, and designers will need to choose if they want to penalize users who violate the norms of behavior they wish to instill, apply positive reinforcement for users who demonstrate pro-social behaviors, or combine the two approaches. Whatever the case, clarity is paramount. For example, the now-defunct

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284. *See What Is Social Engineering*, WEBROOT, https://www.webroot.com/us/en/resources/tips-articles/what-is-social-engineering [https://perma.cc/VYF2-UMK6] (last visited Oct. 5, 2020). Social engineering is the use of deception to manipulate individuals into divulging confidential or personal information that may be used for fraudulent purposes. *See id.*

285. *See* Cortese & Zeller, *supra* note 276.

286. *See id.*

Facebook Spaces had its users, upon entering a new social space, view a set of expectations for conduct within the room, reading: "Be welcoming. Be respectful. Be kind."[287] Reminders that there is a person on the other side of the experience could do much to set the mold for cultural conditioning and recalibrate user expectations about what is and is not allowed in virtual spaces. Making sure that non-player characters, with whom users will interact, also conform to these norms will further reinforce socially desirable behaviors.

Experimentation on social media has shown that prominently displaying rules for users, alongside making clear expectations about positive user behavior, can deter casual misbehavior and inadvertent harms.[288] A study on abuse in Reddit forums showed that prominently displaying rules in a short, digestible format increased compliance and greatly reduced accidental or careless violations.[289] It is reasonable to expect that communicating the rules of virtual experiences in a short, clear, cogent, and user-friendly way would have a similar impact.

D. For Industry: Value-Based Heuristics and Clear Experience Rules

Finally, the immersive tech industry as a whole could adopt consistent approaches that help users navigate potential threats to their privacy and safety. Virtual spaces may engender new types of social experiences due to their ability to personify inanimate objects, create new environments, manipulate the laws of physics and nature, and embody different types of physical forms. However, few people know what social conventions are applicable when interacting with someone who appears to be a talking flying toaster.

Beyond inter-game communication challenges, the immersive technology industry is still new enough that inter-platform operability is an unresolved issue.[290] As HMDs and systems evolve, users will develop distinctive ways to gesture, interact, and navigate spaces, which will be tied to the specific immersive content they are experiencing and the technical limitations of the platforms that host this content. For example, Beat Saber is the most popular and commercially successful VR game, where a player can slice blocks flying

287. *Id.*

288. *See id.*

289. Matias, *supra* note 281. Based on insights like these, Twitter revamped its community standards to distill rules into Tweet-length missives that can be prominently displayed. *See* Rachel Kaser, *Twitter Now Shows if a Tweet Was Deleted for Policy Violations*, NEXT WEB (Oct. 18, 2018), https://thenextweb.com/twitter/2018/10/18/twitter-delete-tweet-policy-violations/ [https://perma.cc/B4LA-PPVX].

290. *See* Cortese & Zeller, *supra* note 276.

at them with light sabers in time to a musical soundtrack.[291] It is available in 90-degree and 360-degree formats on the Oculus Quest.[292] However, users of the PSVR, another gaming system, will find Beat Saber is only available in the original head-on format and cannot be updated based on the technical limitations of the PSVR.[293]

Another foreseeable example, where technical specifications shape and modify user interaction, is that foveated rendering on certain VR systems will train users to engage in certain behaviors, like looking directly at what they are interested in to get a more detailed view. Users have different ways of interacting with Beat Saber than the PSVR user,[294] and thus different ways of communicating with each other. While this is natural in a nascent industry without standardized hardware, it is a potentially large challenge in immersive media where there may be a disconnect between communication strategies and common assumptions users hold as to how to interpret communication. As such, the technical-social aspects of product design should be considered when evaluating potential risks to user safety and human rights. Until there is a common vernacular and physical vocabulary of how to interact in virtual spaces that encompass variable elements of expected behaviors, interactivity, and the heuristics—or unspoken rules—of the environment, a clear statement of norms will help limit harmful behaviors.

Furthermore, civil society and industry should collaborate on an approach that is useful for biometric psychography. For example, design choices that require user attention, as described above, could be valuable data if that information is able to be monetized, processed, and sold. Companies should consider a moratorium on the sale of information that users cannot opt out of, like that required for operation, if that information would pose risks to privacy. To take actions like this to benefit user privacy and safety in a faster manner than new legislation or regulation, voluntary internal constraints could be developed by companies.

Stakeholders could join to create a Code of Conduct spanning across the immersive industry on the types of things they will and will

291. Lucas Matney, *How Beat Saber Beat the Odds*, TECHCRUNCH (May 8, 2019, 5:57 PM), https://techcrunch.com/2019/05/08/how-beat-saber-beat-the-odds/ [https://perma.cc/2P27-EGYB].

292. Sean Endicott, *Beat Saber Adds 360-Degree and 90-Degree Levels on All Platforms*, ANDROID CENTRAL (Dec. 13, 2019), https://www.androidcentral.com/beat-saber-adds-360-degree-and-90-degree-levels-all-platforms [https://perma.cc/HH8G-7VL9].

293. David Jagneux, *VR Hit Beat Saber Is Getting a Multiplayer Update*, VENTUREBEAT (June 30, 2018, 7:03 PM), https://venturebeat.com/2018/06/30/vr-hit-beat-saber-is-getting-a-multiplayer-update/ [https://perma.cc/C65Y-2AKZ].

294. *See, e.g.*, Gabriel Moss, *What Differentiates Beat Saber's PC and PSVR Ports?*, VR FITNESS INSIDER (Jan. 25, 2019), https://www.vrfitnessinsider.com/beat-saber-pc-psvr-ports/ [https://perma.cc/LT59-W2CG].

not infer from biometric psychography. The parties could also collaborate on a joint commitment to be transparent about how they engage with biometric psychographic information. In this Code, the industry could align on what biometric psychographic data will be shareable across platforms and what will not, and platforms can make that context clear to users. These measures would demonstrate a commitment to human rights by the creators of immersive technology and allow users to make mindful decisions about how they want their data to be used.

VI. CONCLUSION

New forms of innovation open up new realms of possibility and new frontiers where society should exercise caution. The immersive technology space is no exception. User-based concerns like privacy, safety, and security should be serious considerations in immersive technology based on the way it interacts with users' bodies and minds. In no place is this dilemma as clear as biometric psychography.

Regulators and legislators have faced similar problems balancing public safety and freedom of expression when trying to integrate emerging online media into our social fabric and legal paradigms.[295] Looking to social media, gaming, online harassment, and other challenges with user safety and speech-related harms in online spaces may offer a cautionary example for anticipating and addressing emerging problems with immersive experiences.

Anticipated fit, or misalignment, with current conceptions of privacy laws can help scholars foresee challenges regulating the storage, application, use, and sale of personal information in immersive environments. Solutions would include updating biometrics laws to encompass new innovations like immersive technologies or encouraging the immersive industry to self-regulate to get ahead of the potential harms of biometric psychography. Additionally, placing privacy-based constraints not tied to the development of new technology, but rather to the type of harm advocates wish to prevent, would create a safeguard for users.

Finally, there are things that can be done today to protect users in immersive spaces from future harms. Looking to how online data is best protected from exploitation can serve as a model for new immersive interfaces with the potential for strong physical or psychological impacts. Industry should integrate privacy-based and human rights-based considerations into their product development to help

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295. *See* CITRON, *supra* note 267, at 200.

them understand risks and provide remedy when harms occur. The immersive tech industry should take heed—especially in the context of biometric psychography—and do the same at this pivotal moment. Doing so would allow users to benefit from the advances of immersive technology while mitigating the potential for foreseeable harms to society.