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# A Viewpoint On... The Societal Impact of Everyday Augmented Reality, and the Need for Perceptual Human Rights

Joseph O'Hagan, *University of Glasgow, Scotland, UK*

Jan Gugenheimer, *TU Darmstadt, Germany*

Florian Mathis, *University of St. Gallen, Switzerland*

Jolie Bonner, *University of Glasgow, Scotland, UK*

Richard Jones, *University of Edinburgh, Scotland, UK*

Mark McGill, *University of Glasgow, Scotland, UK*

*Abstract—Everyday, ubiquitous Augmented Reality (AR), presented through wearable, fashionable all-day devices such as glasses, will become as fundamental to our daily lives as smartphones are today - empowering users, communities, business', governments, and others to alter, augment, diminish or otherwise mediate our perception of reality. In this viewpoint, we consider some of the key societal changes and challenges posed by the pervasive adoption of everyday AR and its ability to overlay shared, metaversal layers atop reality. We argue this envisioned future provokes the need to consider new human perceptual rights, governing the right to control what we perceive, and the extent to which it is permissible to augment people, places, media and more. Ultimately, we reflect on whether society is prepared for the mass adoption of a technology that will fundamentally undermine the integrity of a common objective reality we all perceive and experience.*

The personal computing landscape is on the verge of a transition: from the 2D surfaces of smartphones, monitors and other "physical" displays, to the ethereal spatial computing of Augmented, Mixed and Extended Reality (AR/MR/XR)<sup>1</sup>. Currently, AR headsets, glasses, and more (hereafter referred to collectively as AR headsets) come equipped with a variety of sensing that drives their capability to understand the world around them, for example packing eye-tracking, outward facing RGBD sensing, directional microphone arrays, etc<sup>2</sup> into wearable form factors. Coupled with their ability to render virtual visual and auditory augmentations around a user, these headsets present the foundations for a transformative

consumer technology - supporting personal augmentation of intelligence, perception, cognition and more.

In time, such devices will inevitably arrive at consumer friendly, socially acceptable form factors, designed to be comfortably worn and used all-day - what has varyingly been referred to as *everyday, pervasive, ubiquitous augmented reality*. The sheer potential utility of everyday AR may inevitably force adoption, with users being no more able to opt out from wearing AR headsets in the future than they can feasibly opt out of owning smartphones today. These headsets will place themselves between our eyes/ears and our surrounding reality, *mediating our perception of reality* throughout our daily lives<sup>1</sup>. In the process, they will empower users, communities, business, governments and others to alter, augment, diminish or otherwise mediate our perception of people, places, objects, media and more.

This capacity for revolution has been recognised

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by technology companies spending billions developing their own AR hardware, software and platforms, vying to control this future. *Facebook/Meta* invested \$10 billion dollars in 2022 alone into XR development, including AR headset R&D; *Microsoft* received \$22 billion from the U.S. army for AR headsets, software and services in 2022; *Google/Alphabet* have made multiple billion dollar AR acquisitions; and *Apple's* CEO Tim Cook has been repeatedly quoted as anticipating AR to become one of their most significant contributions to the world, having a potentially profound impact on our digital lives. Given the seemingly inevitable march towards wearable everyday AR, it becomes a pressing concern to consider the *societal* impact of this technology - meaning both the positive and negative effect everyday AR could have on influencing the behaviour and attitudes of individuals, groups, communities and more.

In this viewpoint, we first reflect on how everyday AR could immediately reshape our perception of society through augmentation of people, spaces, and media. We then highlight some of the societal challenges and harms raised by this capability for perceptual mediation, focusing on examples that transpose existing digitally-enacted harms (e.g. in social media and the web) into our perception of reality, from abuse, to manipulation, to information disorder. Reflecting on these harms, we pose the question: does the advent of everyday AR necessitate new *perceptual* human rights governing how, to what degree, and who can impose their digital will upon our perception of reality?

## The Case for Everyday AR: Reshaping our Perception of Society

### Augmented Social Expression of Identity

If we are to understand the potential societal impact of everyday AR in the future, one starting point is to examine how smartphone AR is currently used. Consider our outward presentation/expression of *social identity*. In a world where an AR-driven metaverse is a reality, this technology offers the possibility to control how we, as individuals, wish to be perceived by others, and also provides complete control over how we perceive ourselves and others in turn<sup>3</sup>. Where currently face filters are applied through the lens of the smartphone, in time we could curate our own public-facing digitally augmented facade, as is currently evidenced through applications such as Instagram and Snapchat, but transposed to reality. This could have notable implications for sustainable fashion (what could be faster fashion than the instantaneous change of

an augmentation?), and unlock a powerful capacity to help individuals better present their 'authentic self' (in terms of outward presentation of gender identity, hidden disabilities and more) through shared, social augmentations perceived by all those wearing AR glasses. More generally, augmented identity could benefit a breadth of other social interactions, by allowing people to selectively convey information about themselves to others, and adapt their appearance to the context, breaking down interpersonal barriers.

### Augmentation of Public Spaces

With precise localization driven by Visual Positioning Systems (VPS), AR could also be used to augment our perception of shared, social real-world spaces. In doing so, everyday AR will offer individuals, local communities, and businesses the possibility of decentralised virtual digital urban regeneration. Consider virtual 'pop-up' hubs in open spaces to encourage intra/inter-community engagement; "digital placemaking" where a community can identify, and promote specific values and the preservation of local cultural heritage through cultural metaversal layers; or otherwise altering the aesthetics and feel of a space to enhance well-being and encourage visitation, exploration, and a greater sense of local ownership and agency.

### Augmentation of Media

And personalised augmentations could be also applied to *any facet of our perceivable reality*. For example, our perception of both physical print and video news media could be supplemented to support real-time fact checking; provide background information and alternate sources or counter viewpoints; and otherwise aid and enhance comprehension. Everyday AR would become a large language model-driven personalised expert on our shoulder, seemingly augmenting our intelligence and cognition<sup>1,2</sup>.

## The Case Against: Perceptual Vulnerabilities and Harms

However, for every imagined digital utopia, there is the reality of an (often unanticipated) dystopia. Everyday AR is unlikely to be the exception here - the mechanisms by which social good can be enacted also pose new vulnerabilities and harms. Whilst the potential for undermining privacy<sup>2</sup> and security<sup>4</sup> is well understood, it is the emerging *perceptual* harms that are our focus.

## Identity-based Harms

For individuals, the capacity to augment how we, and others, are perceived could risk provoking a range of psychologically damaging reactions as users feel a pressure to conform their appearance to perpetuated ideals, as already noted in AR-driven “selfie” culture<sup>3</sup>. And for malicious actors, this capability could enable new forms of abuse<sup>5</sup>. It is easy to envision a convergence of AR sensing and cheap/deep fake technology to, for example, sexualise or otherwise appropriate the identity of others for socially unacceptable and abusive reasons<sup>3</sup> (e.g. racism and blackface filters). Lemley *et al.* considered the legality of this ability to augment our personal sensescape and the sensescapes of others, asking: “What if people use this... to make [you] appear ridiculous... without your knowledge or consent? Or what if they want to make you appear naked”<sup>6</sup>.

## Persuasion, Coercion and Manipulation

AR technology also offers an unprecedented tool for persuasion and manipulation by becoming the de-facto gatekeepers of our perception of people, places, events, and information - which could be altered based on user preferences/attitudes (e.g. reinforcing political leanings and bias), the desires of AR platform gatekeepers such as technology companies (e.g. for advertising), governmental mandates (e.g. for propaganda) and more. In being able to track and understand our pre-existing likes and attitudes<sup>7</sup> and actions<sup>2</sup> AR headsets also offer the possibility for enhanced behavioural nudging and manipulation of movements or memory<sup>8</sup>.

And if we consider the common use of advertising to subsidise the cost of hardware, and extend this approach into everyday AR hardware/platform subsidy, there are immediate anti-consumer risks. For example, a corporation might target virtual advertising based on contextual and psychographic data<sup>2</sup>, force users to fixate on/interact with immersive advertising<sup>1</sup>, incorporate peripheral background advertising for continual exposure<sup>9</sup>, or engage in predatory pricing to detect and undercut prices in-store suggesting purchases be made through the platform instead. Advertising is just one pertinent example of the potential consequences of allowing third parties to augment and dictate our personal sensorium, introducing the ability to manipulate individuals’ behaviour across society.

## Reality Censorship and Information Disorder

Building on the advertising example above, an everyday AR headset would bestow anyone the capability to remove or obfuscate a real-world advert (diminished reality censorship), or amend it (altered reality dis-

/mal-information). This could, in theory, be achieved (non-)consensually and (eventually) imperceptibly to an AR user, and be used as a mechanism for attitudinal change or instigating bias<sup>1</sup>. For a benign example, consider how *Pepsi* might augment *Coca-Cola* adverts, and vice-versa. For a less benign example, consider how major political parties and non-party campaigners might exploit such a capacity for political gain. Where currently digital dis-information is at least limited to the sphere of web-based social media, AR would enable this to be writ large and embedded in our everyday experience. A real-world political advert by one party could be rebutted, undermined, or obfuscated by another. Social groups could be visually “othered” based on personal characteristics to confirm and amplify bias. And elements of reality could be visually and/or aurally “blocked” or otherwise replaced, for example removing or altering visible signs of poverty in a public space<sup>10</sup>. And an ability to augment existing print and video media could be used to reinforce perceived filter bubbles and bias, censor information, and undermine the credibility of the media itself.

In effect, everyday AR will open the door to new perceptual attacks and targeted augmentation of *any perceivable visual or auditory element of reality*. Generative AI content creation tools, coupled with AR tracking APIs, could empower anyone to author and apply novel visual augmentations/alterations to reality. This capacity has already been raised in discussions around *Augmented Reality Activism*<sup>11</sup>, for example as part of Occupy Wall Street, *ProtestAR* virtually augmented buildings and presented virtual avatar occupations.

## Existing and Envisaged Digital Human Rights

In terms of existing rights, the European Convention for Human Rights (ECHR) contains relevant provisions regarding human rights to *Conscience* (freedom of thought, conscience and religion, ART. 9), *Expression* (“freedom to hold opinions and to receive and impart information and ideas without interference by public authority and regardless of frontiers.”, ART. 10) and *Property* (Protocol 1:1). Building on this is a complex web of national and international legislation addressing digital safety. For example, the EU *Digital Services Act* in-part addresses malicious content and deceptive designs; the EU *AI Act* addresses manipulation by AI; whilst the International Covenant on Civil and Political Rights (ICCPR) (of which 173 nations, including the United States of America, are parties) also contains *an article relating to freedom of expression*. But it

remains unclear how such protections would apply to the *everyday AR* world<sup>12</sup>. The EC, recognizing that existing human rights do not sufficiently address *digital society* concerns, recently proposed a *declaration on digital rights and principles* (<https://digital-strategy.ec.europa.eu/en/library/declaration-european-digital-rights-and-principles>), noting that “democratic oversight of the digital society... should be further strengthened” by “making sure that technological solutions respect people’s rights”. This includes “safeguarding fundamental rights” around privacy and “freedom of expression and information”, and “mitigat[ing] the risks... including for disinformation campaigns”.

### The Need for Perceptual Human Rights Governing Everyday AR

As AR headsets are an emerging technology, guidelines regarding ethical usage of this technology (e.g. around XR privacy, human rights<sup>13</sup>, neuro-rights<sup>14</sup>, freedom of thought, etc) are beginning to emerge, although there remain questions whether new rights are indeed required, or whether we are missing an appropriate interpretation of existing rights and legislation to this new technology<sup>15</sup>.

However, at present, it would seem that existing digital human rights do not sufficiently address the exposed vulnerabilities of everyday AR. Nor do proposed digital and neuro-rights<sup>14</sup> take into account the unique affordances and impact of AR and perceptual mediation. The societal benefits and challenges discussed thus far raise fundamental questions around the permissibility of applying, and perceiving, a given augmentation, and to what extent everyday AR might be allowed to surveil, react to, and mediate our perception of reality. Consequently, we could imagine defining a host of new human rights to govern this technology, around: *perceptual autonomy* and the right of individuals to control what they perceive; *cognitive autonomy*, tensioning the right to free-will and independence of thoughts, attitudes, behaviours and actions against the use of cognitive enhancements that influence or manipulate our behaviour; and *perceptual integrity*, establishing what stakeholders have the right to augment property, media, people, places and more, and whether there is a need to preserve a common objective reality that we all perceive.


We argue that there is a pressing need to consider the challenges posed by everyday, pervasive, ubiquitous AR. This will require a multidisciplinary effort to further map out the vulnerabilities and harms posed by such a technology. We then must test the applicability

of existing rights and legislation to mitigating against these vulnerabilities. *If* gaps are identified, ultimately we need to arrive at a consensus around the definition and scope of proposed perceptual rights that can protect both AR users and bystanders from individual and institutional misuse and abuse of widescale perceptual mediation. And, crucially, we must do this *before* fruition and mass adoption - with the clock now ticking. Otherwise everyday AR risks opening up a new front in the conflict between technology and society, enhancing bad-actors capabilities to enact technology-based coercion, manipulation, deception, censorship and information disorder, and we will find ourselves unable to look away.

### REFERENCES

- [1] J. O’Hagan, J. Gugenheimer, J. Bonner, F. Mathis, and M. McGill, “Augmenting people, places & media: The societal harms posed by everyday augmented reality, and the case for perceptual human rights,” in *Proceedings of the 22nd International Conference on Mobile and Ubiquitous Multimedia*, ser. MUM ’23, Vienna, Austria: Association for Computing Machinery, 2023. DOI: [10.1145/3626705.3627782](https://doi.org/10.1145/3626705.3627782). [Online]. Available: <https://doi.org/10.1145/3626705.3627782>.
- [2] J. O’Hagan, P. Saeghe, J. Gugenheimer, D. Medeiros, K. Marky, M. Khamis, and M. McGill, “Privacy-Enhancing Technology and Everyday Augmented Reality: Understanding Bystanders’ Varying Needs for Awareness and Consent,” *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, vol. 6, no. 4, 177:1–177:35, Jan. 2023. DOI: [10.1145/3569501](https://doi.org/10.1145/3569501). (visited on 01/25/2023).
- [3] J. Bonner, F. Mathis, J. O’Hagan, and M. McGill, “When Filters Escape the Smartphone: Exploring Acceptance and Concerns Regarding Augmented Expression of Social Identity for Everyday AR,” in *ACM Symposium on Virtual Reality Software and Technology (VRST 2023)*, 2023. [Online]. Available: <https://eprints.gla.ac.uk/304939/> (visited on 08/26/2023).
- [4] K. Lebeck, K. Ruth, T. Kohno, and F. Roesner, “Towards Security and Privacy for Multi-user Augmented Reality: Foundations with End Users,” in *2018 IEEE Symposium on Security and Privacy (SP)*, 2018. DOI: [10.1109/sp.2018.00051](https://doi.org/10.1109/sp.2018.00051).
- [5] J. W. Chung, X. J. Fu, Z. Deocadiz-Smith, M. F. Jung, and J. Huang, “Negotiating Dyadic Inter-

- actions through the Lens of Augmented Reality Glasses,” in *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, ser. DIS '23, 2023, pp. 493–508, ISBN: 9781450398930. DOI: [10.1145/3563657.3595967](https://doi.org/10.1145/3563657.3595967).
- [6] M. A. Lemley and E. Volokh, “Law, virtual reality, and augmented reality,” *U. Pa. L. Rev.*, 2017. [Online]. Available: [https://scholarship.law.upenn.edu/penn\\_law\\_review/vol166/iss5/1/](https://scholarship.law.upenn.edu/penn_law_review/vol166/iss5/1/).
- [7] B. Heller, “Reimagining Reality: Human Rights and Immersive Technology,” *Carr Center Discussion Paper Series*, no. 2020-008, 2020. [Online]. Available: <https://carrcenter.hks.harvard.edu/publications/reimagining-reality-human-rights-and-immersive-technology>.
- [8] E. Bonnail, W.-J. Tseng, M. McGill, E. Lecolinet, S. Huron, and J. Gugenheimer, “Memory Manipulations in Extended Reality,” in *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, ser. CHI '23, New York, NY, USA: Association for Computing Machinery, Apr. 2023, pp. 1–20, ISBN: 978-1-4503-9421-5. DOI: [10.1145/3544548.3580988](https://doi.org/10.1145/3544548.3580988). (visited on 05/14/2023).
- [9] J. Gugenheimer, M. McGill, S. Huron, C. Mai, J. Williamson, and M. Nebeling, “Exploring Potentially Abusive Ethical, Social and Political Implications of Mixed Reality Research in HCI,” *Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI EA '20, 2020. DOI: [10/ghd5xc](https://doi.org/10/ghd5xc).
- [10] C. Egtebas, G. Klinker, S. Boll, and M. Koelle, “Co-Speculating on Dark Scenarios and Unintended Consequences of a Ubiquitous(ly) Augmented Reality,” in *Proceedings of the 2023 ACM Designing Interactive Systems Conference*, ser. DIS '23, 2023, ISBN: 978-1-4503-9893-0. DOI: [10.1145/3563657.3596073](https://doi.org/10.1145/3563657.3596073). (visited on 08/28/2023).
- [11] M. Skwarek, “Augmented Reality Activism,” in *Augmented Reality Art: From an Emerging Technology to a Novel Creative Medium*, ser. Springer Series on Cultural Computing, V. Geroimenko, Ed., 2018, ISBN: 978-3-319-69932-5. DOI: [10.1007/978-3-319-69932-5\\_1](https://doi.org/10.1007/978-3-319-69932-5_1).
- [12] F. Roesner, T. Denning, B. C. Newell, T. Kohno, and R. Calo, “Augmented reality: Hard problems of law and policy,” in *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct Publication*, ser. UbiComp '14 Adjunct, 2014, ISBN: 978-1-4503-3047-3. DOI: [10/gmmd9x](https://doi.org/10/gmmd9x). (visited on 08/27/2021).
- [13] *RightsCon: As AR/VR becomes a reality, it needs a human rights framework*, 2021. [Online]. Available: <https://www.eff.org/event/rightscon-arvr-becomes-reality-it-needs-human-rights-framework> (visited on 08/05/2021).
- [14] R. Yuste, J. Genser, and S. Herrmann, “It’s Time for Neuro-Rights,” *Horizons: Journal of International Relations and Sustainable Development*, no. 18, 2021. [Online]. Available: <https://www.cirsd.org/en/horizons/horizons-winter-2021-issue-no-18/its-time-for-neuro-rights>.
- [15] S. Alegre, *We don’t need new ‘neurorights’ — we need to know the existing law*, 2023. [Online]. Available: <https://www.ft.com/content/e8fcb5f2-94a2-4b2f-94f5-bc6e27d7c136> (visited on 08/25/2023).
- Joseph O’Hagan** is a Lecturer in the School of Computing Science at the University of Glasgow. His research is in human-computer interaction, extended reality technologies, and cross-reality interactions. Contact him at [joseph.ohagan@glasgow.ac.uk](mailto:joseph.ohagan@glasgow.ac.uk).
- Jan Gugenheimer** ([www.gugenheimer.com](http://www.gugenheimer.com)) is an Assistant Professor (W2 TT) for Computer Science at TU Darmstadt. His research focuses on upcoming social challenges for mixed reality technology and how to embed XR safely into the fabric of our daily lives. Contact him at [jan.gugenheimer@tu-darmstadt.de](mailto:jan.gugenheimer@tu-darmstadt.de).
- Florian Mathis** is a Senior Researcher at the University of St. Gallen. His research explores how assistive mixed reality technology can support people with visual, cognitive, and hearing impairments to participate fully and autonomously in society. Contact him at [florian-mathis@outlook.com](mailto:florian-mathis@outlook.com).
- Jolie Bonner** is completing her undergraduate degree at the University of Glasgow (MSc Computer Science). Alongside her studies, she has found a focus on researching HCI topics relating to responsible and impactful innovations in the tech field. Contact her at [joliebonner@gmail.com](mailto:joliebonner@gmail.com).
- Richard Jones** is a Senior Lecturer in Criminology at the School of Law, University of Edinburgh. His research interests include cyber security, cybercrime, surveillance, and the use of new technology in crime prevention, policing and criminal justice. Contact him at [richard.jones@ed.ac.uk](mailto:richard.jones@ed.ac.uk).
- Mark McGill** is a Lecturer in the School of Computing Science, University of Glasgow. His research



anticipates and explores the societal impact, benefits and harms that mass adoption of wearable Mixed, Augmented and Extended Reality technology pose, from productivity to privacy. Contact him at [mark.mcgill@glasgow.ac.uk](mailto:mark.mcgill@glasgow.ac.uk).