Augmenting People, Places & Media: The Societal Harms Posed by Everyday Augmented Reality, and the Case for Perceptual Human Rights

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ABSTRACT

Everyday Augmented Reality (AR) displays, with wearable, fashionable, all-day form factors, may one day supplant our reliance on physical displays, heralding new capabilities in augmented intelligence and perception, communication, productivity, and more. Such technology has the potential to 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. For social good, this technology can enable augmenting expression of social identity to better represent our 'authentic' self, and virtually enhancing real-world social spaces to encourage greater community ownership and social cohesion. For social harm however, everyday AR could facilitate and amplify manipulation, information disorder (e.g. dis-information), censorship and coercion in our day-to-day experience of reality. In this essay, we consider some of the key societal changes (and ethical challenges) posed by the adoption of everyday AR, and argue that everyday AR will provoke the need for new human rights to be considered alongside proposed neurorights and existing and envisaged digital human rights, around: *who* can mediate reality (perceptual autonomy); *what* elements of reality are permissible to alter/augment (perceptual agency); and governing permissible intent regarding *why* we augment the user's perception of reality, in particular considering tensions in cognitive autonomy (e.g. manipulation) and perceptual integrity (e.g. information disorder).

CCS CONCEPTS

• **Human-centered computing → Virtual reality**.

KEYWORDS

Augmented Reality; Perceptual Manipulation; Human Rights; Manipulation; Censorship; Identity;

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1 INTRODUCTION

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 and Extended Reality (AR/XR) [74, 83]. AR headsets, glasses, and contact lenses (hereafter referred to collectively as headsets) will place themselves between our eyes/ears and our surrounding reality, giving rise to digital metaversal "layers of rich virtual content overlaid upon the real world with precise spatial registration" [13]. In the coming decade AR headsets will feature ever-increasing visual and auditory fidelity [31], tending closer to *perceptual realism* [120]. Such headsets will be equipped with a variety of "requisite sensing" [89] enabling the sensing of a user's *actions* [21, 77, 99, 100], *environment* [89], and the *actions of bystanders* [78, 89–91]. And over time, AR headsets will become increasingly fashionable with *socially acceptable* form factors designed to be worn and used all-day [62].

Such headsets have the potential to supplant our reliance on physical smartphones, monitors and displays [36, 72, 73, 79], enabling users to optically and aurally track, understand, and augment the world and it's inhabitants, heralding new capabilities in augmented intelligence [133] and perception [54, 113, 114], communication [12], productivity [79], accessibility [84], augmented TV and immersive media [109, 125, 125] and more. In the process, everyday AR will empower users, communities, business, governments and others to *alter, augment, diminish or otherwise mediate our perception of reality* [85, 114]. This capacity for revolution has been recognised by technology companies who have spent billions of dollars developing their own AR hardware, software and platforms, and are vying to control this future. *Facebook/Meta* invested $10 billion dollars in the last year alone [82] into XR development, including AR headset R&D. *Microsoft* received $22 billion from the

U.S. army for AR headsets, software and services this year [110]. *Google/Alphabet* have made multiple billion dollar AR acquisitions [105]; and *Apple* anticipate AR to become one of their "most significant contributions to the world of tech and have a broader impact on our digital lives" [11].

Given the seemingly inevitable march towards wearable everyday AR, it becomes a pressing concern to consider the *societal* impact and ethics of this technology [18], given its capacity to mediate our perception of reality. While science fiction literature is rich with the envisioned harms that such technologies might bring (e.g. [126, 130]), scientific literature has been slower to envision such harms or investigate mitigation strategies for them, although some recent efforts been made towards this (e.g. [120, 131]). Given the potential impact of this technology, and lack of consumer awareness surrounding of the potential harms of it [87, 89], we argue that more is needed from the scientific and HCI community - from envisioning and discussing its potential for harm, to considering solutions to mitigate and prevent such harms.

In this essay, we outline how everyday AR could reshape our perception of society through social augmentations of people, places, and artefacts that could serve to influence social identity, behaviors, and attitudes across individuals, groups, communities, and wider society. We use this as a starting point to explore the need for what we term *perceptual human rights*. To do this, we reflect on prior works concerning the future and anticipated capabilities of AR technologies and highlight some of the societal challenges and harms raised by AR mass adoption. We consider examples that transpose known digitally-enacted harms (e.g. from social media and the web) into our perception of reality enabling identity-based abuse; persuasion, coercion and manipulation; reality censorship; and information disorder. And we also consider the impact that access inequality with respect to AR hardware, augmented intelligence and perception, and AR metaverses could have in introducing further disparities within society.

Reflecting on AR-driven harms, and drawing parallels to existing digital rights challenges, we motivate the need to consider new human rights and safeguards around *perceptual autonomy* (who can mediate your perception of reality); *perceptual agency* (what elements of reality are permissible to be augmented); and key vulnerabilities around *cognitive autonomy* (the ability to manipulate thoughts, attitudes, behaviours and actions) and *perceptual integrity* (the ability to disseminate information disorder throughout our perception of reality). We argue that existing digital human rights do not sufficiently address the exposed vulnerabilities of everyday AR, and proposed digital [29] and neuro-rights [132] do not consider the unique affordances and impact of AR and perceptual mediation in particular. Through our discussion, we call for a multidisciplinary effort to define policies and rights that can protect both AR users and bystanders from individual and institutional misuse and abuse of wide scale perceptual mediation.

2 THE CASE FOR EVERYDAY AR: RESHAPING OUR PERCEPTION OF SOCIETY

The prospect of everyday AR is considered by many to herald a new epoch in personal spatial computing, as transformative as the emergence of the web or smartphones. Apple's CEO Tim Cook noted that "AR is a profound technology that will affect everything... We are really going to look back and think about how we once lived without AR" [5]. Meta CEO Mark Zuckerberg has called everyday AR the "holy grail" device [51]. And Niantic CEO John Hanke suggested whilst "the metaverse is a dystopian nightmare" AR could be used to "build a better reality" and "enhance the human experience" [50]. Professional AR headsets are already commonplace in the market (e.g. Hololens 2, Snap Spectacles) with consumer-oriented devices soon soon arriving (e.g. Apple's "Vision Pro" set to be released next year). Consequently, the prospect of everyday AR being realised in this decade is a feasible possibility - although the form that this may take may not encompass the full capabilities of proposed "maximalist" AR [14] for some time yet.

A significant driver of adoption is anticipated to be the capability of Everyday AR to enhance intelligence, cognition and perception. For example, Everyday AR could become a large language model-driven personalised expert on our shoulder, seemingly augmenting our intelligence and cognition (i.e. supplementing our memories [19] driven by AI [133]) and our perception of the world around us [54, 113, 114] (i.e. extending our sensorial range, amplifying our existing sensing, and overcoming impairments). In doing so, the sheer utility, and eventual necessity, of AR headsets to everyday life will force adoption, with users being no more able to opt out from wearing AR headsets in the future than they can opt out of owning smartphones today [53].

This inescapable utility, and the consequent adoption of everyday AR glasses and other devices, will open the door to perceptual mediation able to be enacted *en masse*. We first discuss three examples where perceptual mediation could see widespread application: social expression of identity; augmentation of property and places; and augmentation of media and other artefacts. These are three use cases that exemplify mediation of reality, and highlight the tensions between the social benefits of AR, and its' potential for misuse/abuse leading to societal harm.

2.1 Perception of Social Identity

Figure 1: AR-enabled virtual apparel (left, right) and stylised appearance (middle) [2].

When we consider our outward presentation/expression of social identity, AR offers the possibility to control how we, as individuals, wish to be perceived by others, and also gives complete control over

how we perceive ourselves and others in turn, termed *augmented expression of social identity* [20]. Where currently face filters are applied through the lens of the smartphone [102] (see Figure 1), in time we will curate our own public-facing digitally augmented facade [44, 101, 103], much as is currently evidenced applications such as Instagram and Snapchat, as well as in social VR [43, 88, 129], but transposed to reality. For sustainable fashion, being able to augment or alter our appearance virtually could diminish the need for designer-oriented fast fashion (accounting for 10% of global pollution). However, the potential social benefits go beyond virtual apparel and augmented aesthetics. Augmenting expression of social identity unlocks the powerful capacity to help individuals better present their 'authentic self' to others, and alter how they perceive themselves. For example, this could enable virtual social transitioning around presentation of gender identity, or disclose *hidden disabilities* (e.g. autism, chronic pain, learning difficulties, sensory impairments, etc [68]) [20, 71]. Initiatives such as the sunflower lanyard indicate the wearer may need additional support or time, and augmented expression of identity could contextually make such needs more or less visible, and help others to better understand the needs of individuals. 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.

2.2 Perception of Social Spaces, Property, and Mixed Reality "Digital Regeneration"

Our environment has been repeatedly demonstrated to impact our health, well-being and behaviour - "Space mediates community, creativity, and identity" [17]. For existing spaces and architecture, the focus, at present, is on urban regeneration and renewal [104] efforts to sustainably reshape these environments in cooperation with inhabitants - often to address perceptions of dilapidation and deterioration, or break down barriers between co-located communities where residents might feel excluded from more or less prosperous areas. Underlying this is the ultimate aim of "increasing urban prosperity and quality of life". In being able to alter and augment our perception of shared spaces (e.g. Figure 2), everyday AR will offer individuals, local communities, and businesses the possibility of decentralised virtual "digital urban regeneration" [116], augmenting the look and feel of a space. 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 specific cultural metaversal layers [117]; or otherwise altering the aesthetics of a space, building or facade to encourage local events and a greater sense of local ownership and agency. In a world with everyday AR, this is all achievable at the additional cost of content curation/creation alone, with generative AI likely offering anyone the capability to author such augmentations in the near future.

2.3 Perception of Media and Artefacts

Personalised augmentations could also be applied to *any facet of our perceivable reality*. For example, our perception of both physical print and video news media could be augmented ARTV-style [107, 109] or otherwise supplemented by any third party to e.g. support information literacy through real-time fact checking and providing background information and alternate sources or counter-viewpoints [96], or otherwise aid and enhance comprehension. The mere act of looking at a known or recognisable artefact (be it an image, an object, text etc.) could reveal metadata *about* that artefact, much as apps like Google Lens does currently [22] e.g. benefiting the shopper trying to select healthier options by augmenting items in a supermarket [9] or highlighting risky items to help avoid allergies [64]. This capacity could become indispensable as a means of augmenting our intelligence and cognition - where currently information is placed at our fingertips through our smartphones, here it would be interleaved with the world around us.

3 SOCIETAL CHALLENGES AND HARMS POSED BY EVERYDAY AR

The undeniable utility of everyday AR however exposes our society to new digital vulnerabilities. For every imagined digital utopia, there is the reality of an (often unanticipated) dystopia where subversive use of technology undermines societal cohesion. This is perhaps best evidenced in recent years by the destructive impact web-based social media has had in instigating a "bitter conflict" between "technology and democracy" [16, 127]. Everyday AR is unlikely to be the exception here - the mechanisms by which social good can be enacted also pose new vulnerabilities and harms. Here, we focus on *societal* harms unlocked by the capacity for social augmentations in particular, and the resultant need for perception-oriented rights. Consequently, whilst they are important to consider for future everyday AR-oriented legislation, we exclude known XR risks around safety [49, 86, 93, 94, 124], security [32], awareness [69, 92], and privacy [7] from our discussion to focus on the potential consequences of social augmentations as our starting point.

Figure 2: Snap "local lenses" being used to collaboratively augment London using smartphone-based AR [2].

3.1 Identity-based Harms around Perception of Self and Others

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 [15], as already noted in AR-driven "selfie" culture [106]. And for malicious actors, this capability could enable new forms of abuse. Beyond 'identity hacks' such as identity theft [120], it is easy to envision a convergence of AR sensing and cheap/deep fake technology [28] to, for example, sexualise [60] or otherwise appropriate the identity of others for socially unacceptable reasons (e.g. blackface filters [59]). 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" [67]. Consequently, there are open questions regarding how our identity is perceived, and the extent to which we control both how others perceive us and how our identity is captured by others - suggesting the need for 'consent to augment' [25].

3.2 Persuasion, Coercion, Manipulation and Deception

We exist in a digital era of "intensive and relentless manipulation" that pervades everyday life. Consequently, the "pillars needed to support democracy—including active citizens, a shared culture, free elections, and trust in authority" are at risk [127]. This has been driven largely by the manipulation of digital sources of information to induce filter bubbles and echo chambers that "increase... the mean ideological distance between individuals" [39]. Crucially, AR technology offers an unprecedented tool for persuasion and manipulation [98] by becoming the defacto 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 (through biometric psychography [26, 52]), actions (through body tracking, context awareness, etc [89]) and even intention to act (through EEG-based readiness potential [115]), AR headsets also offer the possibility for

Figure 3: 'HYPERREALITY' [61], a rendition of pervasive AR, here redirecting attention to influence purchasing.

Figure 4: *Left*: Example of semantic segmentation-based obfuscation of others. *Right*: Example of AR-driven climate change protest [119].

enhanced behavioural nudging [55, 112], deceptive design [46, 75], manipulation of actions [124], and preference change [41]. This directed behaviour change may be voluntary (enacted through persuasion, nudging, positive reinforcement) or involuntary (via coercion or imperceptible manipulation).

3.2.1 Subsidised Platforms and Metaverses, and Consent to Manipulate. If we consider Amazon's 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 [33], force users to fixate on/interact with immersive advertising [70], incorporate peripheral background advertising for continual exposure [48], or engage in predatory pricing [95] to detect and undercut prices in-store suggesting purchases be made through the platform instead. AR also exposes new opportunities for enacting deceptive designs [35, 65] that can trick users into taking undesirable actions - for example through deceptive annotations that mis-direct users to undesirable locations or cause temporary crowd invasions, or attention-grabbing cues that induce physical danger by distracting pedestrians crossing the road [35]. These are just a few pertinent examples of the potential consequences of allowing third parties to augment and dictate our personal sensorium, introducing the ability to manipulate individuals' behaviour across society.

Legislation is emerging in this domain - the EU's Artificial Intelligence (AI) Act addresses the risk of manipulation "proposing to ban AI systems that 'manipulate persons through subliminal techniques or exploit the fragility of vulnerable individuals, and could potentially harm the manipulated individual or third person"' [40]. However, such protections fail to account for the unique affordances of everyday AR, and it's capacity to understand, manipulate, or deceive the user overtly and even consensually.

3.3 Reality Censorship and Information Disorder

3.3.1 Pepsi or Coke? Building on the advertising example above, a wearable AR headset would bestow anyone the capability to remove or obfuscate a real-world advert (diminished reality [85]

censorship), or amend it (altered reality dis-/mal-information). This could, in theory, be achieved (non-)consensually and (eventually) imperceptibly to the AR user, and be used as a mechanism for attitudinal change or instigating bias. For a benign example, consider how Pepsi might augment Coca-Cola adverts, and vice-versa - to obfuscate or diminish the existence of their competitors advert; alter or undermine the content of the advert itself (for which there is a rich history of such actions [1]), or entirely replace it with counter-advertising. The end result is that there may be an attitudinal change towards a product, and perhaps an influenced purchasing decision.

3.3.2 Applying Your World-view to Reality. For a less benign example however, consider how major political parties and non-party campaigners might exploit such a capacity to augment our perception of reality for political gain. Where currently digital disinformation 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" [57] based on personal characteristics to confirm and amplify bias. And political opponents could be visually and/or aurally "blocked" *Black Mirror* style [123] or otherwise censored [34, 66, 80]. Consider the 2020 U.S.A. presidential election enacted in a world where everyday AR has seen mass adoption. Each candidate might create their own metaversal media layer over reality for their supporters to experience e.g. *Bidenverse* versus *Trumpverse* in 2023 U.S. political parlance. Users could consent to install/apply these curated layers of augmentations, allowing divisive political rhetoric to escape from screens/print to embed themselves in user's very perception of reality.

3.3.3 Information Disorder Everywhere. Information disorder (referring to mis/dis/mal-information collectively [128]) could be interleaved into our daily experience by augmenting informational media (newspapers, magazines, augmented TV [108]). Social augmentations of spaces could be appropriated to spread virtual political messages in targeted communities, or as a means of voter suppression through obfuscations and alterations of voting stations, ballots, etc [8]. And indeed, there may be unintentional harms caused. Eghtebas *et al.* noted the idea that AR could be used to 'beautify' the physical environment, a form of 'rose tinted glasses'. Despite the positive intention (supporting digital regeneration), this could lead to e.g. the "removal of poverty from sight", a form of censorship of the real state of a given society or community [35]. And as Skwarek notes, "the science fiction of today is quickly becoming the freeware of tomorrow", amplifying the risk posed [119]. Everyday AR will open the door to new perceptual attacks and targeted augmentation of *any perceivable visual or auditory element of reality*, and this will be supported by generative AI tools such as Stable Diffusion [6] (a deep learning text-to-image model) that, coupled with AR tracking APIs, will empower anyone to author and apply novel visual augmentations/alterations to reality [89]. This capacity has already been raised in discussions around *Augmented Reality Activism* [119], for example as part of Occupy Wall Street, *ProtestAR* augmented buildings and presented virtual avatar occupations [118]. Whilst limited by the mobile technology of the time, everyday AR will make such possibilities a feasible (meta)reality to present to the public, necessitating new research to understand how we as a society will facilitate, and moderate, such experiences *before* they reach technological maturity.

3.4 Access Inequality

There is also an inherent societal harm in considering unequal access to AR technology, given that adoption is inevitably bottlenecked by socioeconomic and geopolitical constraints [97]. If we consider the advancement of AR technology in the coming decade, we might see continuing leaps in fidelity, sensing (and consequently functionality), and form factor, coupled with a slow decrease in cost. This could introduce social stratification - with subgroups varyingly having access to advanced (e.g. having significant augmented intelligence and perception capabilities and advantageous metaversal layers), basic (e.g. having limited sensing, less capable augmented intelligence capabilities), or no wearable AR technology. These gaps in access to AR devices, and their associated metaverses and capabilities, would be likely to exacerbate previously encountered social issues around access to smartphones and the internet such as "unequal access to the opportunities, experiences, skills, and knowledge" [56]. Might unequal access to the metaverse provoke novel discrimination based on age or socioeconomic circumstances? As Franks notes "when existing inequalities are unacknowledged and unaddressed in the 'real' world, they tend to be replicated and augmented in virtual realities" [42].

4 APPLICABLE EXISTING AND ENVISAGED DIGITAL HUMAN RIGHTS

The European Convention for Human Rights (ECHR) [37] contains relevant provisions regarding human rights to *Conscience* (freedom of thought, 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 both national (e.g. the UK Online Safety Bill for online harms enacted through social media [45]) and EU (e.g. the EU Digital Services Act for malicious content and deceptive designs [111]) legislation that address digital safety. Recognising existing rights do not sufficiently address *digital society* concerns, the EC have proposed a declaration on digital rights and principles [30], noting "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". However, crucially, the EC's focus is on "virtual worlds, such as metaverse". For example, the EC is instigating new initiatives addressing "a metaverse centred on Europe's values and rules" [23] with the ambition to "launch a creative and interdisciplinary movement, aiming to develop standards... maximising impact with the help of IT experts, regulatory experts citizens' organisations and youth". This emphasizes the need for research on the implications of AR technology on human rights and guidelines on its ethical use (e.g. around privacy [77], usage [94], human rights [3], neuro-rights [132], freedom of thought, etc). And, whilst our essay takes an EU-centric view of existing digital

human rights, it is of importance to consider how laws across the globe may or may not protect against the digital society concerns raised by mass adoption of everyday AR.

5 THE NEED FOR PERCEPTUAL 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 [3], neuro-rights [132], freedom of thought, etc) are beginning to emerge. However, at present, it would seem that existing digital human rights do not sufficiently address the exposed societal vulnerabilities of everyday AR. Nor do proposed digital and neuro-rights [132] 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 access inequality and the metaverse, 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:

- ***Right to Metaversal Access:*** Similarly to the United Nations Human Rights Council resolution on access to the internet [4], we could consider there being common metaverse(s) or metaversal layers that everyone has the right to access, and this might extend to fundamental capabilities around augmented intelligence and perception, minimizing access inequality in the augmented society.
- ***Perceptual Agency:*** The right to augment the AR user's sensescape i.e. ***what*** elements in reality are permissible to alter, augment, extend, or diminish.
- ***Perceptual Autonomy:*** The right to control what you perceive i.e. ***who*** can mediate your perception of reality.

There is also the overarching challenge regarding ***how*** this capacity for mediated perception will be exploited to enact and amplify abuse (e.g. manipulation, information disorder) using everyday AR, raising debates around:

- ***Cognitive Autonomy:*** Tensioning the right to free-will and independence of thoughts, attitudes, behaviours and actions against (non-)consensual manipulation through perceptual mediation.
- ***Perceptual Integrity:*** Tensioning the right to freedom of expression, and the trust we place in what we perceive, against the amplifying role perceptual mediation could play in fostering information disorder.

With a focus on perceptual rights, we reflect on why we believe they are needed, counter-arguments around their necessity given existing human rights, and ultimately how we might arrive at consensus around their definition.

5.1 Perceptual Agency - What elements in reality can we augment?

By perceptual agency, we refer to *control over how a real-world element (person, artefact, space/place) is perceived.* Consider expression of social identity: most countries in the world allow a large degree of freedom in this regard, allowing individuals to dress as they want (e.g. expressing religious beliefs, gender, political affiliations, etc) with limitations either encouraged through social/cultural norms or enacted through legislation (e.g. public indecency laws). Consequently, for everyday AR, one might argue we can augment our own social expression of identity as desired [20] - both in-line with existing norms/legislation of the country or beyond them. However, when we augment elements beyond our person, the determination of what is permissible becomes more questionable. For example, what right does a person have to augment bystanders around them (e.g. segmenting/targeting individuals if they wear clothing indicating they support some political bias)? Or, what right do they have to augment every instance of a petrol station (per Figure 4-right) as a personal form of protest? And such provocations can extend to considering the right to augment any visible element of reality that can be identified, tracked, and subsequently augmented.

5.2 Perceptual Autonomy - Who can mediate your perception of reality?

The challenge of perceptual agency is amplified when we go beyond augmentations proposed/experienced solely by the AR headset user. Consider, for example, expression of social identity where a user opts to express solidarity for LGBTQ+ through a rainbow augmentation applied to their appearance (e.g. [121]), intended to be seen by any proximate AR user. Unlike physical manifestations of this support (e.g. a physical item of rainbow coloured apparel), AR-using bystanders (e.g. attendees of a significant sporting tournament where expressions of LGBTQ+ solidarity were banned) could in theory choose not to perceive this augmentation; replace it with an augmentation with an opposing viewpoint; or even block perception of this augmentation in a given space/place - arguably a form of censorship by omission, infringing upon an assumed right of self expression. Similarly, governing bodies could choose to try to block perception of such LGBTQ+ augmentation at scale. Such an example would suggest there may be augmentations that should be treated as if real, immutable and unalterable by others, non-consensual augmentations that are "forced" to be perceived.

In effect, perceptual autonomy provokes difficulties around *undermining the existence of a common objective reality we all experience.* Consider how a real-world community, e.g. a town or village, chooses to portray itself. Within the UK, public display of flags can be a divisive issue. For example, in parts of Northern Ireland and Scotland, communities might display Union Jacks or National flags as a symbol of that area's Unionist or Nationalist leanings - a point of continuing friction [24]. Given an AR-driven metaversal layer applied to a given place, who has the right to control how this place is perceived? Arguably the government might suggest they have sole control, but given the ease with which a place could be significantly altered using AR, what was a set of flags could morph into far more onerous visual alterations, further dividing society. More broadly then, if we consider how governments, institutions, and corporations may exploit such capabilities, the challenge of who (or what) can influence or mediate your perception of the people, places, media and events we experience in reality (consensually or not) intersects with existing rights to freedom of speech, expression and more.

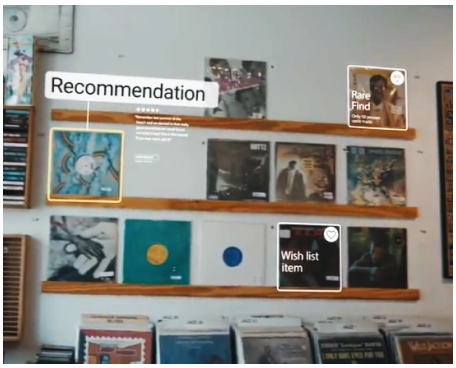

Figure 5: Example of directing a shopper's attention from Meta's Project Aria demonstrations [81].

5.3 Cognitive Autonomy - When is manipulation permissible?

When considering AR, the concept of autonomy goes beyond control over what we perceive. Autonomy is often used to refer to self-governance - that a person is independent and free from external influence. Uniquely, everyday AR will have the capacity to sense and surveil our daily experience of reality through RGBD cameras and microphone arrays [89]. This sensing will fuel the heuristics and AI that could aim to understand, and influence, our thoughts, attitudes, behaviours, and actions. In turn, approaches aiming to manipulate individuals will be possible in real-time through (visual and aural) mediation of reality - ultimately infringing upon our mental privacy and cognitive autonomy. This concept overlaps with discussion in neuro-ethics [132] and AI [58] around free-will and human manipulation, with AR effectively being a conduit for achieving and amplifying such manipulation. Crucially, this capacity will be accepted in many guises, e.g. as a means of augmented intelligence / cognitive enhancement. From AR-based navigation [84], to personalised recommendations when shopping, society may consensually endorse manipulation where benefits are seen (e.g. supporting accessibility needs [84]). Such a capacity poses challenges around consent, and intent. Consider a deceptive design exploiting the manipulation proposed by Figure 5 that directs the user only to deals regarding vinyl records from a chosen company; misleads the user as to the extent of the discount available online; or even directs the user to a different shop to complete a purchase. Here, consent may have been garnered, but the underlying intent of the manipulation may be hidden from the user.

5.4 Perceptual Integrity - Balancing freedom of expression against the risks of information disorder

An individual's thoughts and attitudes can also be influenced in how they are informed of the world. *Information disorder* refers to the experience of misinformation (false information not intended to cause harm), disinformation (false information intended to manipulate or cause harm), and malinformation (exaggerated or manipulated truths that cause harm). For example, deep learning algorithms could classify bystanders in terms of their personal characteristics and likely political affiliations [63], and appropriately ignore or augment them within the AR user's sensescape (e.g. augmenting red caps onto what it believes are Republican voters in the United States). Additionally, identified advertising for the opposing candidate could be augmented based on preferred messaging (e.g. augmenting President Biden with 'Z's above his head per President Trump's repeatedly employed "sleepy Joe" barb) or even replaced entirely as a form of political censorship. Similarly, entities less fearful of litigation could push the boundaries of disinformation that would be similarly writ large in one's perception of reality - censoring all instances of opposing viewpoints, pushing false narratives, etc. That everyday AR could effectively enact information disorder throughout our everyday life under the guise of free speech/freedom of expression poses a significant challenge to social discourse, particularly given how existing mass media [76] and online media have been leveraged to further divisions and extremism within society [127], and how society has struggled to legislate for this [38], often playing catch-up with the technological developments that fuel such disinformation.

6 BUILDING TOWARDS PERCEPTUAL RIGHTS IN PRACTICE

Yet, there remains a debate to be had regarding whether new *perceptual rights* are required to supplement and extend existing human, and anticipated digital, rights. Others argue that rather we are missing an appropriate interpretation of existing rights and legislation to this new technology [10]. However, legislative protections are often slow to establish. Consider for example the continuing problems with combating upskirting behaviours enabled by widespread inclusion of cameras on smartphones [47]. Furthermore, legislative protections are reactive, not proactive, serving to penalise harmful actions rather than mitigate against their occurrence.

Conversely, it could be argued that technological constraints could mitigate these anticipated harms. If we consider AR privacy for example, privacy-enhancing technologies [89] and privacy by design development standards [27] all further contribute towards protecting individuals, and we could envision similar restrictions on how perceptual mediation can be employed on these devices. Privacy-enhancing technological solutions, however, typically work by blocking all access of some aspect of an AR device's hardware - preventing not just misuse, but also valuable non-harmful use cases also [89]. And while privacy by design standards are increasingly being adopted and promoted [27], challenges remain with their use when we don't know the acceptable bounds of what such technologies should or should not be allowed to do [122]. A similar challenge remains for perceptual mediation, as we have not yet established what the baseline levels of perceptual autonomy, agency and integrity should be.

Regardless, in our view, given the potential severity of harm of this technology if adopted *en masse* without restriction, there is a pressing need to consider the challenges posed by everyday, pervasive, ubiquitous AR - considering perceptual vulnerabilities alongside risks to privacy, trust, security [32] and more. This will require a community, multidisciplinary effort to further map out the risks and harms posed by such a technology and then test the

applicability of existing rights, legislation, standards, and other protections to mitigate against these vulnerabilities. *If* gaps are identified then consensus is required on what protections are needed.

Ultimately we argue that, as a community, we must arrive at a consensus around the definition and scope of proposed perceptual rights - a core set of expectations and rights that serve to 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 of everyday, wearable AR technologies. 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.

7 CONCLUSION

This short essay outlines how everyday AR technologies have the potential to both positively and negatively challenge our perception of a common objective reality that we all experience. Through the lens of considering social augmentations and their potential misuse/abuse, we reflected on the need to explore and define new policies and rights, in particular around agency, autonomy and integrity, balancing freedom of expression and free-will against the capacity for individual and societal harm that everyday AR and metaversal layers poses. Our discussion of the vulnerabilities posed by everyday AR, and the rights that should be considered, is not, and cannot be, exhaustive. Everyday AR remains a future yet to be realised. However, this paper is a provocation. We argue society must urgently consider these challenges if we are to be prepared for the (likely sudden) advent of everyday AR. Much as the release of the iPhone dramatically changed the personal computing landscape, so too can an equivalent AR headset in the future herald a new epoch in enabling ourselves and others to augment and alter how we experience the world - how we perceive others, social spaces, media, advertising and more - whether society is prepared for it or not.

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