Master Thesis

On the mainstream use of AR glasses: why does it matter, what are its ethical risks, and what to do about it.

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Introduction

Augmented reality (AR) glasses are expected to become one of our main computing interface devices in the upcoming decades, with some leading scholars and industry experts speculating that they might fully replace smartphones eventually (Rosenberg, 2022b). Whether this will come true or not, that will depend on overcoming a number of technical and non-technical challenges currently in place to become a consumer-friendly product. Nonetheless, the fact that the most valuable technology companies in the world, such as Meta and Samsung, have been researching and developing AR glasses for the general consumer market gives enough reasons for an early investigation into the ethical risks that their potential pervasive use may entail.

Based on existing literature about the undesired effects that smartphones and constant internet usage have on the human brain, on its behaviour and on its interpretation of the world, I aim at making an ethical analysis using Brey's Anticipatory Technology Ethics approach (2012) of the potential risks that a pervasive, unsupervised use of AR glasses might entail to regular consumers, and, more broadly, to non-users and democracies. The context which my analysis will be based is that of the attention economy and surveillance capitalism, given their prevalence today. As I will show, there is a true possibility that these models are extended towards AR glasses for the consumer market.

Furthermore, I will argue that given the historical trend of information proximity that led us to use mobile digital devices regularly and at any given time in the day, AR glasses offer the possibility to display digital information directly at the users' field of vision, which means a higher level of proximity and digital intrusiveness in comparison to smartphones. But not only, AR glasses will make the boundaries between the digital and physical worlds become even more blurred.

From an ethics perspective, why does it matter? First, there comes the issue of distraction. Studies have shown that, due to the brain's neuroplasticity, living in a constant distracted state can undermine some important cognitive abilities that are valuable for accomplishing demanding tasks that require attention and concentration (Firth et al., 2019).

Second, there is the issue of addiction. Neuroscience studies have shown that humans, just like other primates, are "information foraging" animals due to evolutionary reasons (Gazalley and Rosen, 2016; Carr, 2020). We are biologically inclined to be curious and to seek novelty (Kidd & Hayden, 2015). We know that some technology companies, particularly the ones involved in the social media business, explore this characteristic by deliberately making use

of sophisticated design methods to get as much of our attention as possible and maximise the time we spend on their platforms, which equals more profit for them. One method that is very commonly used by them is the *intermittent variable reward*, which triggers the release of dopamine in the brain, an essential neurotransmitter that is associated with the feeling of pleasure, although if stimulated too much, it can lead to compulsive and addictive behaviour (Bhargava & Velasquez, 2021: 326-327; Lawrence, 2022: 123).

Third, there are ethical issues that can cause broader societal harms. In a post-truth era, fake news and deep fake videos are easily fabricated and shared on the web (Pangrazio, 2018). This impacts some of the premises for a well-functioning democracy, such as the importance of chance encounters (Sunstein, 2008), which entails the idea that citizens should be somehow exposed to topics, beliefs, and opinions that differ from their own. In a context of a pervasive use of AR glasses, these issues can be further expanded, contributing to the increase of epistemic filter bubbles (Pariser, 2011; Turner, 2022).

The above-mentioned ethical concerns are nothing new. In fact, they already exist in the context of smartphones and are being addressed on an ongoing basis in various scientific investigations. In this work, I aim to take this debate to the next expected level of mainstream computing experience, that is, from smartphones to AR glasses. I believe that embracing emerging digital technologies without any critical or reflective engagement can be as harmful to individuals and societies as taking new medicines that were not properly tested to check their benefits and side-effects.

The overarching structure of this thesis is as follows: in Chapter 1, I describe what AR is and explain why it matters to start discussing the issues surrounding consumer AR glasses. I provide a general historical analysis about the evolution of computing and the web, and situate technological advancements within the current economic and business landscapes, which are surveillance capitalism and the attention economy. In the final part, I highlight the unique characteristics that make an ethical assessment of AR glasses different from smartphones. These characteristics are proximity, immediacy and curation of digital information.

In Chapter 2, I apply the Anticipatory Technology Ethics (ATE) framework (Brey, 2012) to identify some of the ethical risks posed by a scenario in which AR glasses become a mainstream consumer product. I describe the envisioned functionalities and features carried by future AR glasses and identify the main ethical implications for both individuals and society. As the reader will notice, given the lack of empirical research regarding a mainstream usage of AR glasses, much of my analysis is based on existing literature surrounding the ethical issues brought by smartphones.

In Chapter 3, I evaluate the identified ethical risks, pondering competing values between private and public interests, followed by some governance recommendations to policymakers and tech companies regarding the development and deployment of AR glasses for consumers. I then conclude the chapter and the thesis with my reflections regarding the role of ethics in society and in the context of technological development.

Chapter 1 - Why does it matter?

In this chapter, my goal is to situate the issues surrounding augmented reality (AR) glasses by providing the current context and explaining the relevance of this topic for the field of ethics of technology. Then, I will provide a more descriptive account, defining what AR technology is, the existing types of wearable devices, and differentiating its possible applications.

Next, I will give a historical overview regarding the evolution of computing and the web. This is important for the following reason: I will demonstrate that, since the early stages of electronic computing, digital information has increasingly become closer to ourselves, shaping our everyday lives in more persuasive ways. I conclude this historical analysis showing that the current transition from web 2.0 to web 3.0 we are now going through is taking us to a level where the internet is potentially going to be "embodied", given the development of immersive wearable technologies.

I will then show how this historical increase in the physical proximity between users and digital technologies also came along with the fact that the information delivered to us through technological devices is also getting increasingly abundant. The widespread usage of smartphones, which has undoubtedly provided us many utilities and conveniences, also brought us some individual and social negative impacts that were not widely recognised or discussed in the earlier phases of introduction. From an epistemological standpoint, I will argue that this increased proximity of digital information has been shaping more persuasively our ways of being in the world, as well as how we understand it and navigate in it.

Why AR glasses? The expected next big jump

From developments in the fields of artificial intelligence (AI) (Baruffaldi et al., 2020), wireless communications such as 5G and 6G technology (Nakamura, 2020), blockchain and the Internet of Things (Wang et al., 2020), there are several technologies being developed simultaneously with various potential interconnected applications that are yet to be discovered. These concomitant technological developments across different industries and sectors have led Schwab (2017) to state that we are living in the age of the Fourth Industrial Revolution.

Amidst this complex tangle of technological novelties with great disruptive potential, smartphones can also become obsolete in the future. In fact, industry experts and technology companies are expecting that AR glasses will be able to replace them at some point in the next 10-15 years (Steudel, 2018).

Although these predictions could prove to be wrong, the fact is that Google, Meta, Snapchat, Microsoft, Apple, and others have already been investing for years in the research and development of these wearables, anticipating that they are going to be the next big jump in computing experience (Rathenau Instituut, 2021: 18). This provides enough reasons to analyse more closely what are the hidden and more explicit ethical risks that a potential consumer use of AR glasses might have.

For instance, it is estimated that Meta is allocating twenty percent of its annual budget towards Reality Labs, which is the unit responsible for the development of immersive technologies, such as AR glasses (Dave, 2022). Mark Zuckerberg, Meta's CEO, stated several times publicly about the company's vision for the future of computing, in which he believes that AR glasses will be the next mainstream computing platform (Heath, 2022). Another reason for looking at AR glasses is that Andrew Bosworth, Meta's Chief Technology Officer, believes that in the long-run the AR market is probably going to overcome the VR market, because "if AR ultimately is doing a lot of the jobs that today your phone is doing, that means that it's universal, and almost every person no matter what their job, no matter their walk of life, could take advantage of those tools to feel more connected to the people they care about, to feel more connected to the information that matters to them" (CNBC, 2019: 3:45-4:00).

Snapchat has already developed the "Spectacles" AR glasses, which are not commercialised to the regular consumers, but are available for developers to create immersive experiences applying AR features (Snap Inc, n.d.). Tim Cook, Apple's CEO, has recently stated during an interview 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." (Poort, 2022).[2] Amazon, on its turn, has launched in 2019 the *Echo Frames*, which, although do not fall under the category of AR glasses, are embedded with Alexa - Amazon's virtual assistant - and an audio system that allows the user to interact with it "on the go", without the need to pick up the phone (Amazon Alexa, 2019).

Google is once again working on a new wearable AR which will provide real-time translation, as announced in 2022 during the company's annual developer conference (Google, 2022). During the presentation of Sundar Pichai, Google's CEO, he stated that the company has "been building augmented reality into many Google products [...]. These AR capabilities are

[2] As I finish writing this thesis, Apple just launched its first mixed-reality headset, the Apple Vision Pro, making a significant milestone towards the era of “spatial computing”, as Apple’s website displays. The device embeds several features which I describe in Chapter 2, including eye-tracking, voice control and a virtual assistant (Apple, 2023).

already useful on phones, and the magic will really come alive when you can use them in the real world, without the technology getting in the way. [...]. It is important that we design in a way that is built for the real world and doesn't take you away from it". (Google, 2022: 1:55:14 - 1:56:24).

Besides these big technology companies, there are also several others who are investing in AR glasses. For instance, an Israeli company named EyeJets has been developing a prototype of AR glasses that will only weigh 50 grams, with several cutting-edge technologies embedded on it, including laser beams for generating virtual images and eye tracking for continuous displayed retinal images (Eyejets, n.d.).

In summary, the above-mentioned examples are to show that concrete steps are being taken by various companies towards the development of AR glasses, even though we might still have to wait for a few years or even a decade to see these devices being commercialised to regular consumers.

What is Augmented-Reality?

It is not uncommon to notice some confusion between the terms augmented reality, virtual reality (VR), mixed reality (MR) and extended reality (XR). In fact, these terms are used quite often together, like "AR/VR", which entail the idea that somehow they are the same. Although it's true that they hold lots of similarities, they are not the same. I will define each of them in the following section.

AR as part of Extended Reality technologies

Extended reality (XR) is a general term which refers to the whole set of immersive technologies, encompassing AR, MR and VR (Marr, 2019) (see figure 1 below).

In AR, the real world is enhanced by means of virtual objects, whereas in VR the real world disappears, as the user is immersed in a fully virtual environment through a headset that is closed upon itself. MR technology, instead, lies in between the features provided by AR and VR. In MR, the user can experience a higher degree of interactivity with virtual objects that are also projected onto the physical world. In addition to it, the virtual objects are "environmentally aware", since they can interact with both the user and the surrounding physical environment (Brey, forthcoming).

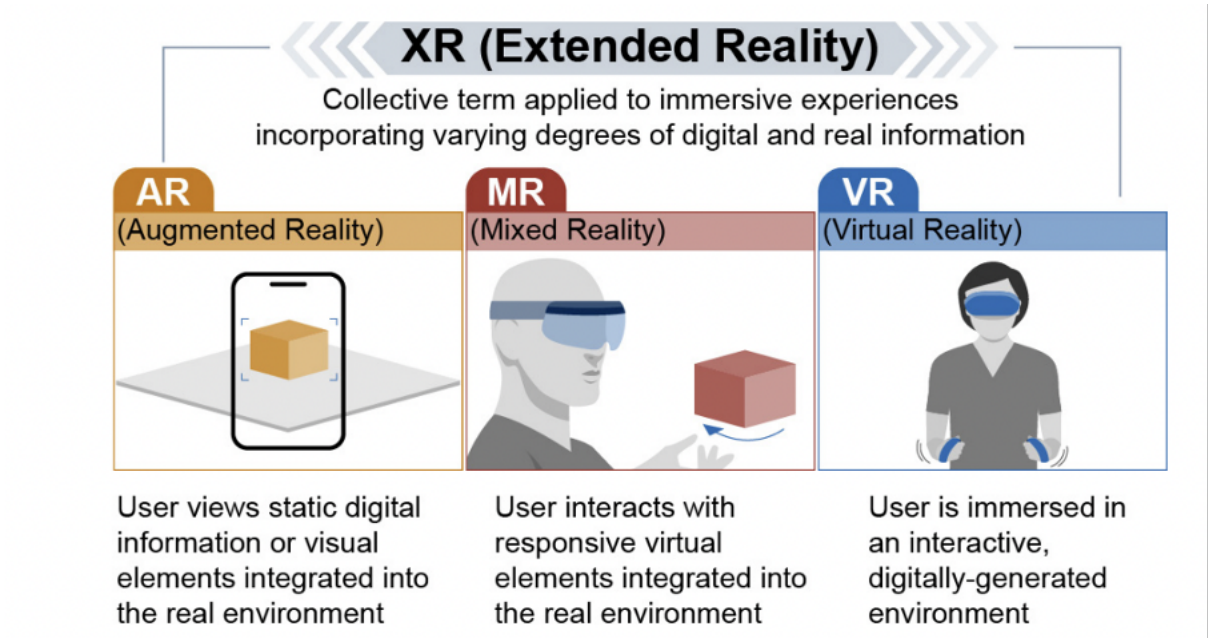

Figure 1: XR is the term that encompasses AR, MR and VR (GAO, 2022).

However, the differences between AR and MR are likely going to disappear due to expected technological advancements, and the features provided by each of them are probably going to converge at some point (Leland, 2017). As such, while I recognise a distinction between AR and VR, it is likely that AR and MR will be largely similar. I will therefore be referring to AR throughout the remainder of this thesis, which includes at least some forms of MR.

Situating AR in the reality-virtuality continuum

To define what AR is, it is important to first situate where it stands. Milgram & Kishino (1994) situate AR within the reality-virtuality continuum, where in one extreme lies the real environment, and at the other one lies a fully virtual environment. Any environment that falls in between this continuum, that is, which blends the real with the virtual, is considered to be a mixed reality environment (see figure 2 below).

AR is situated in the first stage of this reality-virtual continuum, right after the real environment. Milgram & Kishino understand AR as "any case in which an otherwise real environment is "augmented" by means of virtual (computer graphic) objects" (1994: 1322). At the exact opposite spectrum of AR lies Augmented Virtuality (AV), which refers to a predominantly virtual environment that incorporates elements of the real environment.[3] As the

[3] I won't go into further detail regarding AV since it's not relevant for the purposes of this thesis.

reader can notice, the focus of Milgram & Kishino when describing the reality-virtuality continuum is in relation to the environment, not in the artefacts per se.

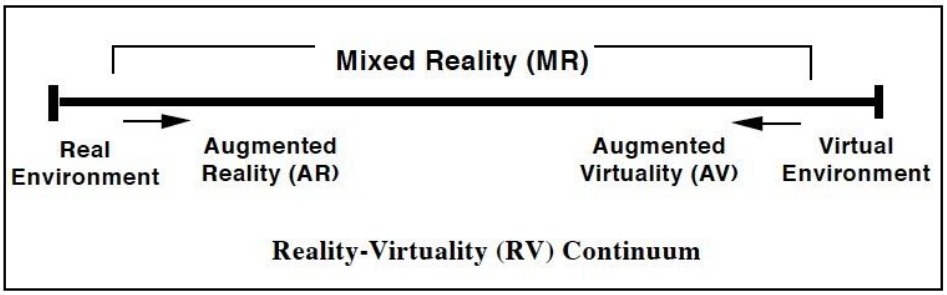

Figure 2: the reality-virtuality continuum (Milgram & Kishino, 1994)

On a different angle, scholar Azuma (1997), in his largely cited paper *A survey of augmented reality*, defines AR technology as a system that contains three characteristics. First, it can combine the real with the virtual; second; it provides real-time interaction, and, third, it is registered in 3-D (1997: 3). However, the latter characteristic is not necessarily mandatory. Apple's developer guidelines for AR applications also consider 2-D features, which can come through in the form of texts and notifications, for example (Apple Inc., n.d.)

AR technology can be deployed in handheld devices, like smartphones and tablets. For example, the camera filter options of social media platforms like Instagram, TikTok and Snapchat, which allows the superimposition of virtual filters over the physical world in real time, are a common AR feature used by millions of people around the world, mainly for entertainment purposes. TikTok has developed a hyper-realistic AR filter named "Bold Glamour", which enhances the aesthetics and contours of the person's face, making it appear younger and with a better skin, for example. Although not confirmed by TikTok, the filter reportedly uses generative AI technology, and has received some negative media attention due to the fact that it can stimulate users, especially children and teenagers, to reach an "ideal and unreachable type of beauty", which in turn can lead to adverse mental health implications (Javaid, 2023; Ryan-Mosley, 2023), and affect self-perception (Isakowitsch, 2023).

Another use of AR technology in smartphones is for shopping. For instance, IKEA, the Swedish retail home furnishing company, has developed an app which allows consumers to virtually place the furniture that they are interested in into their physical place, so that they can better assess whether the furniture fits well in their place, helping them to make a more informed decision for buying the product (IKEA, n.d).

Next to handheld devices, wearable devices provide a more immersive experience of AR. These can come either as eyeglasses and head-mounted displays (HMDs), or simply, headsets. In addition to those two, there was also one company, named Mojo Vision, which successfully developed the world's first AR contact lens, as it was tested by its CEO in 2022 (CGTN America, 2022).[4]

Based on the above definitions regarding AR technology, I propose a broader one for the purposes of this thesis. AR is a technology that combines two characteristics: the superimposition of virtual elements - such as texts, images, and other forms of audiovisual graphics, either in 2-D or 3-D - over the physical world, and the provision of real-time interaction with the user.

In the following section, I will present my case for AR glasses being more likely to gain widespread popularity for everyday use compared to headsets. However, it's important to acknowledge that the advancement of compact, lightweight, and versatile AR glasses still faces various technical challenges.

Advantages of glasses over headsets for continuous use

For consumers to embrace wearing AR glasses daily, companies like Meta have recognized the need for lightweight, fashionable, and user-friendly hardware (Meta, 2023b). This aligns with the opinions expressed by industry leaders such as Apple's CEO Tim Cook and Meta's CTO Andrew Bosworth, who acknowledge that AR glasses offer a higher competitive advantage over headsets for regular use. Unlike headsets, which are heavier and bulkier, AR glasses are more suitable for mobility, better integrating into the users' daily activities (EssilorLuxottica, 2021).

Already back in 1991, the computer scientist Mark Weiser stated that VR is diametrically opposite to his vision regarding the future of computing, since the ultimate goal of VR is to create a new world inside a computer. He said that "although [VR] may have its purpose in allowing people to explore realms otherwise inaccessible - the insides of cells, the surfaces of distant planets, the information web of complex databases - virtual reality is only a map, not a territory. It excludes desks, offices, other people not wearing goggles, [...] chance encounters and in general the infinite richness of the Universe. Virtual reality focuses an enormous apparatus on simulating the world rather than on invisibly enhancing the world that already exists." (1991: 94).

[4] Due to financial constraints, in January 2023 Mojo Vision had to discontinue the production and development of such lenses and shift its core business activity towards the development and commercialisation of micro-LED displays, which can be further applied to other wearable devices (Perkins, 2023).

This perspective is also shared by Cook, who believes that, although VR headsets allow a more immersive experience, and that people will likely use those for regular periods for entertainment or professional purposes, he is not convinced that people would prefer to live their lives wearing a headset all the time (Poort, 2022). Therefore, people might end up using AR glasses on a more regular basis, especially if companies manage to combine high computing power with aesthetically pleasant devices and deliver a good user experience.

That said, we may remember that in 2013, Google was the pioneer company launching wearable smart AR glasses, the *Google Glass*, for regular consumers. However, it turned out that consumers did not embrace the product due to a number of reasons. For instance, there were a lot of concerns surrounding privacy of non-users, since the AR wearer could take pictures and record videos without others' consent (Kiss, 2013). Another reason pointed out was that the glasses did not look fashionable enough to wear them as a daily accessory, as people reported that they looked very "geeky" (Harris, 2013). A third reason is that, put simply, consumers did not find a real need to have them, first, because people were satisfied with the utilities provided by their smartphones, second, they were very expensive (Weidner, 2022).

With this case in mind, why should we bother with a potential pervasive use of wearable AR again? Is this not just another technology hype? If it is or if it is not a hype, it does not mean that we should ignore the signals being emitted by the tech companies and younger consumers. For instance, as acknowledged by the Rathenau Instituut, Meta has "more than 3,000 employees working on AR/VR. Large technology companies applied for hundreds of AR-related patents between 2002 and 2017. Microsoft led the way with no fewer than 745 applications (Ghaffary & Molla 2020). In 2019, more than 7,000 inventions relating to AR/VR were patented worldwide. In other words, tech companies see AR – and the possibilities that this technology offers for mapping and manipulation of human behaviour and perception – as an important element of their future business model." (Rathenau Instituut, 2021: 19). In short, these large corporations are already invested in AR technology.

Furthermore, an empirical research conducted with 191 industry experts in AR and VR showed that 76% of them believe that the AR market size is likely to surpass the VR in revenue, among which 49% of those anticipate that would happen within 3-5 years (Perkins Coie et al. 2020: 14). Next, the number of B2C (business-to-consumers) market users of AR devices is expected to reach over 100 million in 2027, in comparison to 3.6 million users in 2017 (Statista, 2022).

While these numbers are much smaller in comparison to the expected number of active smartphone subscriptions, which are projected to surpass the 7.6 billion mark in 2027 (Ericsson,

2022), it is prudent to not ignore the potential exponential growth of the wearable AR market share in the upcoming years, for at least two reasons. First, there is a higher inclination among younger and future generations to incorporate immersive tech devices into their daily routines in comparison to current ones (Wertz, 2022). A survey commissioned by Snapchat on the profile of the users who belong to Generation Z - individuals who were born between 1997 and 2012 - showed that 93% of them are interested in using AR for shopping (Snap Inc. & Crowd DNA, 2022: 18).

The second reason is that the sociocultural landscape is not static. Rather, it co-evolves with technological advancements (Pinch & Bijker, 1984). There are a lot of societal, technical, and cultural variables which influence whether a certain product or technology is widely incorporated and becomes part of the daily lives of millions, perhaps billions of people around the world. In that regard, it is possible that meeting with someone wearing a pair of AR glasses in the next 10-15 years might be just as normal as when we see people staring at their smartphones nowadays. As put by Madary & Metzinger, this phenomenon of normalisation "is a complex sociocultural process by which certain new norms become accepted in societal practice, [which is] a process often mediated by the availability of new technologies, (...) that changes our very own minds and which, therefore, carries the risk of unnoticed self-deception." (2016: 17). I will hold this idea of "unnoticed self-deception" for a later analysis (see Chapter 2, section on Autonomy).

In summary, the fact that Google Glass did not succeed in the consumer market ten years ago does not mean that future AR devices, with new features, new designs, and new generations of consumers are doomed to fail again. For reasons listed above, I find it crucial to anticipate the potential ethical risks that a widespread usage of these devices might entail to individuals and society.

Last but not least, an important caveat I have to make is that my exploratory analysis on the ethical issues prompt by a regular usage of AR glasses should not be taken as isolated from concomitant technological developments at the macro, meso and micro levels, nor from the business models and sociocultural changes. The reader should bear in mind the open and yet uncertain avenues for the development of AR glasses, and if, as well as how, they will settle across society. Therefore, I am considering a whole set of technologies, especially AI, as well as design interfaces and applications which can be embedded in AR glasses.

That said, there are still several barriers for these devices to become a mass consumer product. Technically, the main difficulties are related to hardware development, short battery

life, limited number of apps and functionalities, as well as the lack of available ultra-fast broadband networks that would allow an ideal user experience (Meta, 2023a).

From a nontechnical perspective, the barriers are mainly cultural and generational, which are very closely related to each other. Culture is never static, but rather continuously co-evolves with new technologies and new generations. In that sense, consumers from previous generations might not be as willing to readily embrace AR glasses in comparison to newer generations, such as those who belong to the Generation Z onwards (Wertz, 2022), who will be the future consumers. These generational differences can be because younger generations carry different values and ideas than previous ones about how they want to live their own lives, relate to other people, form their own identities, and so on (Tootell et al., 2014; Tolstikova et al., 2021).

Professional vs Consumer Applications

As with almost every modern technology, AR technology can be applied and designed to fit in different settings, ranging from industrial ones (Danielsson et al., 2020), to healthcare (Jha et al., 2021) and education (Wang et al. 2018), to name a few. These are niche or professional applications, meaning that they usually take place in a controlled environment, with direct supervision, and have predetermined purposes of use. Professional applications are restricted to a specific domain and limited to a determined period of time. Although there are ethical aspects that also need to be considered in relation to professional applications, such as, for example, in the field of healthcare, such risks are usually restricted to pre-identified groups of individuals, such as caretakers and caregivers, for example.

In consumer applications, however, there are many more variables to take into consideration. To start with, regular consumers of AR glasses will likely not have any direct supervision or guidance regarding how to use them in a safe manner. It is feasible to expect that users could wear such devices for extended periods of time, without necessarily having a predetermined purpose or goal in mind, and without perhaps knowing the health implications that this can have to their physical and cognitive health. Users might find it useful to wear a pair of AR glasses in the same way we carry our smartphones all day long nowadays. So instead of having to pick up the smartphones hundreds of times a day, personalised and curated notifications can be directly projected onto their view. Not only are there potentially health implications for the individuals, but also an issue of power. For instance, who will be in charge to derive personalised and curated notifications that are delivered directly to people's eyes, and what will the content be like? I return to these points in Chapter 2.

As I will explain through the next section, companies who develop and commercialise AR glasses for regular consumers will likely keep track of their users' interests and preferences for obtaining economic gains. This might happen in the form of data extraction, monitoring and analysis, which could then be processed and translated into the delivery of more personalised and targeted content for their users in very persuasive ways.

The computing evolution: towards an "embodied" web experience

In this section, I shall give a brief historical overview regarding the history of computing to support my claims that, first, digital information is getting closer to us and, second, most people in the world are increasingly relying on digital technologies to conduct daily and essential tasks. This will lay the foundation for my claim in the subsequent section that AR glasses share three unique and intertwined aspects that deserve specific ethical attention, which are the proximity, immediacy and curation of digital information.

The history of computing has passed through significant milestones since its inception. The term computing should be read and interpreted here as "both a system in itself and a component of a variety of larger systems" (Mahoney, 1988: 117), that is, encompassing the hardware per se, the software technologies that applied in it, and the overall technological developments that allowed the improvement and evolution of computers. From the first mechanical computers developed in the nineteenth century, until the advent of mainframe computers in the 1940s-1960s, which occupied entire rooms and were operated by several technicians, the computer market was mainly limited to the government, the military, and to universities, for institutional purposes. At the time, the world was mostly analogue. Offline/analogue media, namely books, newspapers and magazines, as well TV's, CD rooms and radio, were still the predominant sources where people would get information from. These were unidirectional communication media, that is, consumers had a passive role in regard to content production, as they depended on these means of communication to reach a wider audience.[5]

When the World Wide Web became a public domain in 1991 (CERN, n.d), it was a game-changer in terms of computing experience. It was the beginning of Web 1.0. Tim Berners-Lee

[5] Even after the appearance of personal computers, it was only in the mid-1970s and early 1980s that home computers started to be embraced by middle-class families, predominantly in the UK and US (Mason, 2016). From that point onwards, the overall idea that people had about computers began to change. They were no longer necessarily perceived as aesthetically ugly machines with a complex set of electronic components, but more of a consumer electronic product that could fit into the living room, with better design and relatively more intuitive to use.

defined this stage of the internet as the "read-only web" (Choudhoury, 2014: 8096). That is, individuals were able to search on the internet and consume the information through static pages. In the web 1.0, individuals were mainly the receivers or simply buyers of content and basic products or services (through shopping cart applications), which were still mostly produced by businesses.

Until the early 2000's, the computer market share predominantly consisted of desktops, which meant that people had a spatial and temporal limitation to access and use them. However, with the growing spread of wireless connection and lower costs of laptops, as well as the appearance of the first smartphones in the market, users started to experience more mobility around computer usage and internet access (Srivastava, 2005). And mobile use was the first step towards ubiquitous use. This is because mobility offers the possibility to, but also the expectation from, businesspeople, knowledge workers and students, to work and perform tasks from places outside of the formal office setting or a fixed place. It was also during the first decade of the 21st century that web 2.0 came up.

Web 2.0 has been characterised as the "read-write" web (Choudhoury, 2014: 8097), given that it provided a greater degree of interaction between users and businesses, as well as between users themselves. In web 2.0, users became content creators, which demonstrates the shift from the previous uni-directional media towards a bi-directional one. Web 2.0 marked the age of the social media platforms as we know nowadays, with the emergence of Myspace and LinkedIn in 2003, Facebook in 2004, Youtube in 2005 and Twitter in 2006.

In 2007, Apple launched the iPhone, a revolutionary product that changed how individuals would consume information, access the internet, buy goods and services, and interact with people. The launch of the iPhone marked the beginning of a new era in terms of digital user experience. Interestingly, Apple was not a pioneer in the smartphone world. Previously, more established telecommunications and consumer electronics corporations, such as BlackBerry and Nokia, already commercialised smartphones for years, but none had the impact on a global scale as much as the iPhone had (Anthony, 2013). Apple's iPhone was an all-in-one device, relatively intuitive to use, and consumers soon realised the many conveniences that it offered.

With the arrival of the App Store in 2008, Apple opened a marketplace where developers and companies around the world could offer their services to consumers in convenient and personalised ways. Quickly, the multifunctionality of smartphones proved to be so useful for our lives that nowadays those who do not own one experience difficulties in carrying out several essential services, such as, for example, accessing online banking, email, login to online government services, and so on and so forth (Park, 2019). However, the smartphone's usefulness

has also led into some sort of dependency, which has been associated with addiction (Ahn & Jung, 2016; Oraison et al., 2020), a point I return to in Chapter 2.

Now, we are currently heading towards web 3.0. It is a new stage where online data is given a meaning by machines and software applications. This attribution of meaning happens through a process called Knowledge Representation (KR), that is, when computers "have access to structured collections of information and sets of inference rules that they can use to conduct automated reasoning" (Berners-Lee et al., 2001: 35). For this reason, it is defined as the "semantic or knowledge web" (Yen et al., 2015: 5008). Web 3.0 allows not only the exchange, processing and generation of data between individuals and machines, but also between machines and computer programs themselves. In the context of AR glasses, that means that the user will be able to receive computer-generated contextualised information "on the go". The infrastructure of web 3.0 relies on several emerging technologies, such as blockchain, XR technologies, the Internet of Things (IoT) and AI.

In addition, web 3.0 has a strong emphasis on decentralisation of data and more democratic governance of it, which is contrary to how web 2.0 governance operates, where big tech companies, like Amazon, Google and Microsoft, own physical data centres for "cloud" data storage, and therefore, play a central role in the governance of online data, making billions of dollars for it (Gross, 2022). While AR is a key technology for web 3.0, its development and deployment might still fall under the scope of web 2.0 governance, meaning that only a few technology companies that commercialise AR glasses will have access to the digital data generated by their consumers. This means that the surveillance capitalism model will most likely continue, unless regulatory measures are developed to counter it.

For instance, as of 2023, we are 8 billion people on the planet. Out of this number, 5.1 billion are internet users and 4.7 billion are social media users (DataReportal et al., 2023). For most of the world, then, it is almost unthinkable to live again without the internet and some sort of modern digital device, like computers and smartphones. Furthermore, the global smartphone users only continue to grow (Pew Research Center, 2019). As summarised by Firth et al., "this is partly due to the Internet now being unavoidable, ubiquitous, and a highly functional aspect of modern living" (2019: 120).

Today, billions of people rely on smartphones on a daily basis to go online and access essential services, such as banking and government services. In 2023, the global average of the amount of time that users between 16-64 years old spent everyday on the internet, on any device, was 6:37 hours (Kemp, 2023: 42), and the average North American checks their smartphone 344 times a day (Wheelwright, 2022).

Now, what is next? It would be naive to believe that smartphones are the ultimate frontier of mainstream mobile devices. As presented in the introduction, big tech companies are strongly investing in AR glasses, anticipating that they could be the next mainstream hardware that regular consumers will rely on, shifting the paradigm of handheld to headworn devices.

In October 2021, Meta announced the metaverse as the next frontier of the web. In the words of Zuckerberg (2021), the metaverse is "an embodied internet where you're in the experience, not just looking at it". However, the metaverse is still at its very early stages of development, which means that, to reach its ideal of becoming an "embodied internet", not only will a whole new set of hardware and software need to be developed and perfected, but, on top of it, consumers need to perceive value in adhering to it.

The evolution of computing and development of mobile technologies have significantly altered how people live, how they interact with one another, how they access information, goods and services, as well as how they work and entertain themselves. History shows that we have moved from a predominantly analogue life, where access to computers and the internet was restricted to a place and for a certain amount of time, towards a digital one, where we carry our mobile devices almost all the time.

From a macro perspective, we can see that computing has become closer and more intimate to ourselves. As scholar Farahany shows in her book *The Battle for your Brain* (2023), companies such as Neuralink and Meta have also already been working on brain-computer interface technologies that allow individuals to control machines and external devices through thinking. Despite the many potential benefits that such neurotechnologies can bring in the context of healthcare, for example, Farahany points out that some companies have demonstrated interest in its use for marketing purposes (Farahany, review of Rosen, 2023).

As I have shown in this section, when the first computers came out, they did not become a mainstream product right away. Rather, their use was limited to some domains and purposes. However, as computers got smaller and had more applications, consumer behaviour also changed, and regular consumers started to engage more and more with these machines until the current stage where "disconnecting" and going offline is getting increasingly rare.

The advent of the world wide web pushed even further the speed of which people perceived the utility of the internet. The same history happened to laptops and smartphones. At first, people would carry them mainly for working purposes. Nowadays, laptops and smartphones have an enormous variety of applications that are very useful to billions of people around the world. The development of AR glasses for consumer usage will most likely also follow this trend because while AR glasses are only perceived as valuable and useful in some specific applications

nowadays, in the long-term it's very likely that such wearables will have different functionalities, with the potential to become part of the daily lives of billions of people around the world.

Technological development as means for economic ends

So far, I have written about the evolution of computing, and how that transformed our ways of being in the world. This historical overview serves to show that, in the period between the 1960s to 2020s, most of the world's population went from a predominantly offline life to one that is predominantly online. And by all indications, it seems that we are not returning to a predominant analogue life, as the pace of technological development pushes us towards an even more hyper-connected world.

Weber once stated that "the fact that what is called the technological development of modern times has been so largely oriented economically to profit-making is one of the fundamental facts of the history of technology" (Weber, 1978, as cited in Zuboff, 2019: 16). It is a mistake, therefore, to separate technological evolution and its impact on our habits and culture, from private and commercial interests. As pointed out by Zuboff, "technology is not and never can be a thing in itself, isolated from economics and society" (2019: 15).

If technological advances go hand in hand with private interests, which are focused on profit-making, then we can expect that the incentives for the development and commercialisation of AR glasses in the regular consumer market are profit-driven. The problem begins when we analyse, in the first place, the ways that technology companies are conducting their businesses for obtaining profit, and second, whether they are concerned with the potential negative side effects that a pervasive, continuous and widespread usage of their products may have for users and societies in general. In that sense, there needs to be an ethical alignment between private interests and public interests. I explore these tensions in Chapter 2.

Another point is that, in the fast-paced world that we live in, with innovative businesses bringing disruptive products and services, the speed at which a company can become relevant is as fast as the speed at which it can become irrelevant. The pressure that big companies feel to keep up with the competition ends up leading to a race for the creation of new products and fabrication of novelties that do not necessarily have, as their main goal, the benefit of the final consumer in mind, but rather, to increase and generate value for their shareholders. So, what often happens is that, in an attempt to anticipate customers' needs, expectations and desires, combined with the pressure that the executives have to meet financial goals, the companies

themselves are the ones who create and shape consumer needs, expectations and desires in the form of new products and services.

But what are exactly these customers' needs? Does it mean that companies are anticipating that people in the future will *need* to wear a pair of AR glasses all day long? To have regular consumers wearing AR smart glasses is desirable and relevant for commercial purposes. However, from a philosophical and ethical standpoint, this might not be the case. These fields invite us to reflect about whether individuals and societies will be better off wearing or not wearing these devices all day long, and what values should guide the design, features and deployment of AR glasses. I explore these points in Chapter 3.

For businesses, what matters is whether their marketing teams can convince us that we need to buy their new products. As argued by scholar Tim Wu, "no one is born wanting 4K television, a purse branded by Hermès or Louis Vuitton, or the odour eliminator product Febreze. For the advertisers, by far the most valuable function of advertising, then, is the shaping or creation of demands that would not otherwise exist." (Wu, 2016: 79). The analogy I want to make here is that this idea also applies to AR glasses intended for regular consumers: a desire for the product does not yet exist, but can be manufactured and magnified through effective marketing. However, even though the market forces are indeed very strong, I expect that in anticipating the ethical risks of AR glasses (see Chapter 2), we can advocate for best practices and advise policy-makers (see Chapter 3).

Before doing so, let us now turn to the issues with the lucrative economic and business models that became the prevalent operating models in the technology industry.

The attention economy and surveillance capitalism

To lay out the basis for my anticipatory ethical analysis (Brey, 2012) regarding a potential pervasive use of AR glasses in the next chapter, I find it fundamental to contextualise the economic and business models that prevail today, which has been pushed to a global level by the technology industry. These are, respectively, the attention economy and surveillance capitalism. This is because the ethical risks of mainstream use are closely associated with the continuity of these economic and business models, only on a more immersive level.

The term attention economy emerged from the reflections of Herbert Simon, when, in 1971, he observed that "in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of

information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it" (Simon, 1971: 40).

In other words, since we are living in a world where information, particularly digital information, is increasingly abundant and is everywhere around us, receiving the attention of consumers has become a valuable capital asset for businesses. Therefore, in the 21st century, the businesses that can employ the most effective techniques to catch and hold consumers' attention for as long as possible are the ones who will be in a better position to advertise and sell goods and services to them.

In the past, the strategies adopted by businesses to catch consumers' attention were mainly through advertisements in analogue media - such as TV, radio, outdoor banners, magazines and newspapers (Couldry & Turow, 2014). But this traditional way of advertisement was less individualised since the media they were linked to was for mass-consumption. However, thanks to the advances of the web, the global increase in the number of people who have access to the internet and own mobile digital devices, and the popularity of social media platforms, a new way of doing marketing was coming into place, one that could specifically target potential consumers based on digital footprint of the web users (Brodherson et al., 2022). But for companies to reach potential consumers online, a well-positioned intermediary was necessary to act as a liaison between the advertisers and the consumers. It was the origin of a new business model.

Such a business model is what Zuboff describes in detail in her seminal work *The Age of Surveillance Capitalism*, where she shows that this is an unprecedented way for capital accumulation, which is based on the extraction, analysis and sale of user data in what she calls the "behavioural futures markets" (Zuboff, 2019: 96-97). It consists in the prediction and anticipation of consumers' preferences - based on their online track record, profile, and social interactions - so that the companies who manage the database can trade it to third parties interested in recommending personalised products, services, places to visit, news articles and many other things. In other words, as we have moved towards a more ubiquitous use of digital media, especially through mobile devices, targeted advertisement became possible on a much more precise level, given its ability to provide real-time impact measurability (Durmaz & Efendioğlu, 2016: 38).

According to Zuboff (2019: 91-92), Google was the first organisation that discovered and explored this lucrative market, quite by accident actually, and due to investor's pressure at the time, as she describes in the book. The same business model was then shortly followed by Meta (formerly Facebook). Before the discovery of this model, Google was not a profitable business, or at least, not profitable enough for its investors since the company was using the data input

from its millions of users only to improve their services. This is what Zuboff called the "behavioural value reinvestment cycle" (2019: 70), which was, according to her, a fair trade, since users were treated as ends in themselves. In this cycle, there was no third-party involved in the acquisition of user data for advertisement purposes.

The turning point happened when investors were pressuring Google's executives to think about how they could monetize their growing database based on what people were searching for. The solution was, as we know today, to turn Google into an advertisement marketplace. Zuboff explains that for Google to reach this new goal "the behavioural value reinvestment cycle was rapidly and secretly subordinated to a larger and more complex undertaking. The raw material that had been solely used to improve the quality of search results would now also be used in the service of targeting advertising to individual users" (2019: 74).

Today, both Google and Meta operate as global advertisement marketplaces, since the majority of their revenues comes from targeted advertisement. In 2022, Meta generated a global revenue of U$116.6 billion, out of which U$113.6 billion, or 97.4%, came from advertisements (Meta, 2023: 70), and roughly the same is for Google's parent company Alphabet, which, out of U$282.8 billion in global revenue, U$223.4 billion, or 79%, were generated from Google advertisements (Alphabet, 2023: 32). Based on these numbers, it's fair to say that these companies rely on advertisements to keep existing.

Although the advertisement model is, at a first glance, a win-win, as these companies "commandeered the wonders of the digital world to meet our needs for effective life, promising the magic of unlimited information and a thousand ways to anticipate our needs and ease the complexities of our harried lifes" (Zuboff, 2019: 53), the consequences of it go far beyond privacy concerns. To obtain profit, they need as many people to use their platforms as much as possible, so that advertisers become more interested in advertising their products on these platforms, where their potential consumers are. To captivate users, therefore, they need to offer services that are perceived as valuable and useful from the user's perspective. For example, Google offers search services and Meta provides several social media services that allow people to connect with each other. However, providing a useful service is not enough under the model of attention economy and surveillance capitalism. They need to maximise our time navigating their platforms. In that sense, they have to employ persuasive design techniques into their products and services in order to form consumer habits that will lead them to always get back and check their platforms (Eyal, 2014). In successfully doing so, this translates into more time that users' spend staring at screens and are exposed to a greater number of ads.

The ethical concerns here is that the global reach of surveillance capitalism and the attention economy is proving to be detrimental to individuals and to the collective well-being (Alter, 2017). With this in mind, I want to bring attention to the issues that can arise if such economic and business models are also extended to consumer applications of AR glasses.

The augmented attention economy

In 1991, Weiser opened his widely cited paper *The Computer for the 21st Century* with the following remarkable affirmation: "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it" (1991: 94). In the paper, he introduces the notion of "ubiquitous computing", which happens when the computing experience disappears into the user's background and merges itself with the environment. According to him, this is the real potential of information technologies, and therefore, personal computers and mobile devices as we know nowadays are only a transitional step towards truly ubiquitous computing.

The ubiquitous computing experience that Weiser envisioned translates into what he labelled as "embodied virtuality", which happens when computers are taken out of their electronic boxes and simply merge with the external environment (1991: 95). He also advocated that ubiquitous computing could solve the problem of information overload. In a later paper, Weiser and Brown (1996) suggested the idea of developing calm technology, which engages both the centre and the periphery of human attention and that can smoothly move back and forth between the two (1996: 76), reducing the user's cognitive overload. Calm technology is about delivering only the necessary information to the user, causing the least amount of interruption or distraction as possible (Case, 2015). I return to the idea of calm technology in Chapter 3.

Although we have not arrived at the stage of ubiquitous computing as envisioned by Weiser, the possibilities offered by AR glasses are certainly a step closer to it. However, Weiser's reflections on the future of computing, particularly the idea of calm technology, is diametrically opposite to the practices of the attention economy and surveillance capitalism that we have nowadays. What we might argue in the case of a pervasive use of AR glasses is that, as stated by Turner, "the attention economy will no longer be confined to the screens of smartphones but will seep out into the real world and invade visual perception itself ", for which he calls the "augmented attention economy" (2022: 9).

Furthermore, if the advertising model that currently prevails in the technology industry is not substantially reformed, it is very unlikely that companies invested in the wearable AR

ecosystem will desire to protect and preserve, so to speak, the users' attention and digital well-being for their own sake, because there is simply no financial incentives to do so (Turner, 2022: 15).

So, instead of heading towards calm technology, the risk we now face is that we walk further the path of distracting technologies, being led by companies that are concerned with the challenge of how to design products and services that optimise our exposure to advertisements and increase the conversion rates of the announcers. Considering that smartphones have already exacerbated the problem of digital distraction (Leynes et al., 2018), imagine the potential that AR glasses have to make us even more distracted, with all the personalised features and conveniences that it might offer to ourselves, especially if we add to the devices the capabilities of generative AI for advertisement (Murphy & Criddle, 2023).

What is the difference that makes the difference?

Bearing in mind the context of the attention economy combined with practices of surveillance capitalism, which have become more effective thanks to the global and widespread usage of smartphones, imagine how much more persuasive, effective and lucrative the advertising and design strategies adopted by tech companies can become when they manage to have people literally seeing the world through their AR glasses on a regular basis.

One might raise the objection that such wearables are just the next, natural step in the evolution of mobile technologies, and therefore, given that we are already living in an attention economy; there is no fundamental difference that deserves greater ethical concerns than the ones we already have with smartphones. While an eventual transition from smartphones to AR glasses might seem to be only a small shift, and understood as just a subsequent event in the evolution of computing, my intention is to demonstrate that the potential individual and collective impacts derived from a pervasive use of these glasses can be significantly more profound than the already proven negative impacts that the usage - and even its mere presence - of smartphones have on individual well-being, attention, and knowledge, as I will argue in this section.

To begin with, I claim that there are three aspects that make the ethical and philosophical analysis of AR glasses different from smartphones and every other digital media that humans have ever used. These are (i) proximity of information, (ii) immediacy of information and (iii) curation of information, which need to be critically assessed in combination. Out of the three, only the proximity of information is an entirely new aspect for this analysis, as smartphones already provide immediate and curated information to ourselves. However, it's the *combination*

of these three aspects that makes it different from the ethical issues derived from smartphones and other current mobile technologies. I will go over each of these aspects next.

Proximity of information

I consider proximity of information the leading aspect that distinguishes the role that AR glasses play in shaping human perception of reality in comparison to smartphones. By proximity, I literally mean the physical proximity between AR glasses and the user's eyes. For instance, despite the fact that several users are constantly carrying their smartphones wherever they go, they are still handheld devices, meaning that people need to manipulate and stare at them, shifting their focus from the physical world towards the device. That is, the access to the virtual world is still done through a screen of a mobile device. With AR glasses, there is no longer the need to manipulate a handheld device since the virtual elements will be directly displayed to the user's field of vision. In other words, the users look to the world *through* the AR glasses, and the world *becomes* digitally augmented.

There is an element of digital proximity that influences how our brains are able to process information. For instance, in regard to smartphones, an empirical study conducted by Ward et al. (2017) tested what the researchers called the "brain drain" hypothesis, which was about analysing whether the mere presence of one's own smartphone (that is, when *not in use*) already affects users' limited-capacity cognitive resources. The results have shown that it does, and this not only reduces the available cognitive resources for conducting other tasks, but it also affects overall consumer well-being (2017: 140). The researchers mention that "[w]hat may be special about smartphones (...) is the *frequency* with which they seem to create these diversions; their *omnipresence* and *personal relevance* may combine to create a particularly potent draw on the orientation of attention" (emphasis mine, Ward et al. 2017: 142). AR glasses not only share the frequency, omnipresence and personal relevance mentioned by the researchers, but they are also likely to be more persuasive due to the proximity (and immediacy and curation) of digital information.

This is because AR glasses are made to be worn, and all the information it delivers will be displayed directly at the user's field of vision. For instance, in the context of smartphones, Ward et al. (2017) founded that when one's own smartphone is placed near the user and is in her field of vision, the cognitive costs associated with its presence are amplified, "as more attentional resources are required to inhibit its influence on the orientation of attention" (Ward et al. 2017: 143).

With AR glasses, the device will entirely (and immediately) mediate the user's field of vision, demanding even more attentional resources from the user to not be distracted. In that sense, AR glasses shortcuts normal sets of cognitive processes that other kinds of media do not. In other words, the high degree of information proximity delivered by AR glasses prevents the necessary physical distance between the user and the information to be thoroughly processed by the brain, contributing to cognitive overload (I get back to this point in Chapter 2). It is therefore this proximity, this unique aspect of AR that marks it out as both technically and ethically distinct from the computing technologies that precede it.

Immediacy of information

This takes us to the second aspect, which is the immediacy of information. By immediacy, I mean the delivery of real time and location-based information. Although smartphones already can do so, the difference to AR glasses lies in the degree of persuasiveness. Meta's *Project Aria*, which carries out research for the development of AR glasses, shows how the display of information would look like to appear to the user's sight (see figure 4 below). The goal is to enrich the user's daily experience with a smart device that "reads" and "sees" the physical world, providing an automatic and seamless flow of information, recommendations, and notifications, in a contextualised and integrated way.

Figure 4: Screenshots from Meta's *Project Aria* video about the possibilities offered by AR glasses (Bas Gezelle, 2020)

Furthermore, the immediacy of information delivered by AR glasses is different from that delivered by smartphones because the user's eyes are already directed towards the display itself. If, therefore, we consider the notifications of our smartphones to be already very intrusive, virtual elements displayed to the user's sight will likely be even more so. This, in turn, will make

it even harder for the users to ignore any new notification that is delivered, unless certain features are built into it that will allow the user to block the receival of notifications.[6]

Curation of information

Finally, we arrive at the third aspect, which is curation of information. Again, while curation of information *per se* is nothing new, since both analogue and digital media have always curated the content we see, the difference lies in the degree of impact and influence that such curation can prompt into the user's epistemic reality due to the fact that the user will be wearing the device. In that sense, the curation offered by AR glasses differs from other media because it directly mediates the user's visual perception of reality.

This curation, therefore, can be much more powerful and persuasive in shaping the user's understanding and interpretation of the world in comparison to previous forms of media. Moreover, given the aspects of proximity and immediacy, the curation is both more invisible and pervasive. As argued by Turner, "eye-tracking data could be used by advertisers to determine engagement down to where a user is looking, and physiological data could be employed to gauge a user's emotional state, so advertisers know when the user is in the most persuadable frame of mind" (2022: 10).

Rosenberg (2022c: 8) provides a solid statement on this idea of curated reality. According to him, "we find ourselves in a society where countless layers of technology exist between each of us and our daily lives, moderating our access to news and information, mediating our relationships with friends and family, filtering our impressions of products and services, even influencing our acceptance of basic facts. We now live mediated lives, all of us depending more and more on the corporations that provide and maintain the intervening layers." The questions we shall reflect in the next chapters are whether this curation of information performed by private corporations is aligned with our personal values and goals, instead of the other way round.

[6] However, the measure of blocking new notifications might not even be enough, since, in the context of smartphones, for example, Heitmayer & Lahlou (2021) have demonstrated in their study that "while users feel and think that notifications are disrupting them, and rightfully they are, in the overwhelming majority of cases it is actually the users actively checking their phones, even though they are switched to 'silent mode'." (2021: 3). Here, we see that this behaviour of having to constantly check one's own phones becomes addictive, which I will explain why in more detail in Chapter 2.

Conclusion

In this chapter, I have shown why an anticipatory ethical debate surrounding the potential general use of AR glasses is relevant, basing my argument on several empirical factors, from data on the expected growth of the AR market in the coming years, surveys carried out with experts in the sector, surveys on current and future consumer preferences, and recent statements made by executives of the leading technology companies about the trends and business vision they have in regard to AR becoming a mainstream technology.

Following this contextualisation, I defined AR technology and argued about the higher competitive advantage of AR glasses in comparison to other wearable hardware for daily usage, as well as the main technical and non-technical challenges for reaching that stage.

Then, I provided a historical overview on the evolution of the web and hardware devices, bringing into attention the growing approximation of information to ourselves. I have pointed to the fact that such evolution and production of technological novelties have also been closely associated with private and commercial interests, which contribute to driving the agenda towards an ever-increasing digitalisation of the world.

In the last part of this chapter, I devoted my attention to argue what is precisely the difference between the ethical concerns which already exist in the current context of mobile devices and the ones that AR glasses present, focussing on proximity, immediacy and curation as the three features that mark AR as something different from mobile phones and other computing technologies. As Palermos (2017) points out, "responsible theorising and future planning and design cannot therefore rest on unsubstantiated optimism, especially when relevant evidence points in the opposite direction. Future AR technologies are more likely than not to storm users' visual fields with push-on notifications, advertisements, personalised suggestions and reminders" (2017: 144).

Over the next chapter, I will address ethical risks associated with a potential pervasive use of AR glasses using the Anticipatory Technology Ethics (ATE) approach. As the reader will notice, many of the ethical implications are drawn based on the existing issues pertaining – however, having identified proximity, immediacy, and curation, I will show how these differences in combination make AR something ethically distinct from existing technologies and habits.

Chapter 2 - What are its ethical risks?

In this chapter, I outline the aspects that deserve ethical consideration in relation to the risks that an eventual widespread use of AR glasses can entail for individuals and for society. My analysis will be based on the attention economy and surveillance capitalism practices, which are employed by two of the major technology companies invested in this field, namely Google and Meta.

The methodological framework I will use for this is the Anticipatory Technology Ethics (ATE), developed by Brey (2012), which provides a systematic structure to identify and assess ethical risks of emerging technologies. I will also support my assessment by following the more detailed guidelines of the ATE as described in one of the SIENNA project reports (Brey et al., 2022).

The Anticipatory Technology Ethics approach

To begin with, the ATE identifies three levels of ethical analysis, which are: the technology, the artefact, and the application level (Brey, 2012: 7). The focus of my analysis will be on the latter, since I'm concerned with the application of AR glasses for regular consumers in the context of the surveillance capitalism and attention economy. An application, as Brey defines it, is "the concrete use of a technological artefact or procedure for a particular purpose or in a particular context, or a specific configuration of an artefact to enable it to be used in a certain way" (2012: 8).

A challenge faced by anticipatory approaches is the problem of uncertainty (Sollie, 2007), that is, one can never know exactly how an emerging technology will develop and settle in society, as different pathways are possible. The goal of anticipatory approaches, therefore, is not to tell what will happen in the future, but what is possible to happen and, based on that, conduct ethical assessments. To do so, anticipatory approaches, such as the ATE, recommends the use of a variety of foresight methods, such as environmental scanning, technology roadmaps, multiple perspectives, and future vision to minimise the degree of uncertainty (Brey et al., 2022: 48). These include the analysis of, for example, the current technological trends, consumers' preferences, experts' opinions, and business models. The aim of employing foresight methods is to minimise the degree of uncertainty. An interesting additional resource that the ATE mentions for conducting foresight analysis is imagination and science fiction stories, with the caveat that they are "subjected to scrutiny regarding their feasibility and plausibility" (Brey, 2012: 10).

One of the biggest advantages of anticipatory approaches of emerging technologies is that they allow early intervention in the innovation processes (Brey, 2017: 176). In contrast, one of their biggest weaknesses is the very fact that these approaches have to deal with the future, which is uncertain. That's the reason why foresight methods are employed, so that the projections about future developments and applications of an emerging technology are somehow grounded in current trends and data.

The ATE approach provides an ethics checklist that can be used as a guide for conducting the ethical assessment of an emerging technology, in which it is possible to compare each level of analysis - technological, artefact or application - separately, and relate to one or more values of the checklist. The checklist is based on the ethical principles contained in the Universal Declaration of Human Rights, and is divided into four overarching categories, namely: i) harms and risks; ii) rights; iii) distributive justice and; iv) well-being and the common good (Brey, 2012: 12).

Each of these categories have a set of subcategories that serve as a more narrowed guide for the ethicist to conduct the assessment. For the purposes of this thesis, I will focus on mapping the ethical issues in three of the ATE categories, which are harms and risks, rights, and distributive justice. Furthermore, the reader will notice that most of the ethical risks I'm going to address do not exclusively pertain to AR glasses, but rather the fact that such wearables can potentially extend or "augment" them. I will devote more attention to the harms and risks to human cognitive capabilities, since these are more closely intertwined with the three aspects of AR glasses that I covered in the previous chapter, namely, the proximity, immediacy, and curation of information. In doing so, I'm laying out the basis for the evaluation part of the ethical assessment, in Chapter 3.

I'm aware that ethical checklists face the objection of being a reductionist way to deal with complex socio-technical moral challenges, given that societies and technologies are co-shaped by and co-evolve with each other, and therefore, they cannot fully uncover novel ethical issues that might come in the future (Kiran et al., 2015). Nonetheless, as stated in the SIENNA report, checklists offer "some assurance that standard ethical issues are surveyed, identified, and documented" (Brey et al., 2022: 42). In that regard, they can be very helpful as a starting point for a more detailed discussion surrounding the ethical issues that a given emerging technology may prompt.

Description of the envisioned AR glasses for ethical assessment

To conduct the ethical assessment, it is important that I describe what features consumer AR glasses might be capable of displaying. I use a trend extrapolation approach to justify the presence of such features (Brey, 2017: 186; Börjeson et al., 2006). This is a method used within the field of foresight studies that takes into consideration the current developments of the chosen technology in order to project how it is likely going to develop, including their design, embedded technologies and functionalities..

Therefore, the AR glasses I'm going to describe next do not currently exist. It is neither possible to be certain about whether these glasses will embed all the features that I will present, as those depend on several technical challenges that need to be overcome. The relevance of this exercise is to anticipate potential misuses, harms and risks that they might bring in order to timely act on it before they actually materialise (Brey et al., 2022: 18), which I will do in Chapter 3.

To start off, the glasses will have to run at least one operating system, in the same way as a computer and a smartphone do. Examples of operating systems are Android (from Google), Windows (from Microsoft), and iOS (from Apple). Meta and Amazon do not have their own operating systems yet, but they could potentially develop one too. For instance, Zuckerberg announced that this is what he envisions for Meta (Hays, 2022). I understand that these big technology companies have a competitive advantage in comparison to others because of their global reach and digital ecosystems that are already familiar to billions of users and developers. The fact that such glasses will be coupled to an operating system managed by at least one of these companies is important for my assessment, given the context of the attention economy and surveillance capitalism, as this translates into a centralised governance of the digital data produced by users of AR glasses. This recognises their capacity to curate information, and will be returned to in Chapter 3.

In terms of hardware characteristics, I am taking into consideration a potential version for consumers based on Meta's *Project Aria* (Meta, n.d.). In that sense, the AR glasses will be light-weight, fashionable and intended to be suitable for everyday use, similar to the existing Ray-Ban Stories (Meta, 2023c).

Furthermore, the envisioned AR glasses can be paired with the user's personal smartphone via Bluetooth or also function independently, as long as they can have access to the internet - through, for example, an eSIM card (Nokia, n.d.). The glasses will have a micro-camera, which will not only function for taking pictures and recording videos, but will also be able to "read" the environment through computer vision technology, which is an emerging field

of AI that can provide contextually-relevant information to the user based on his location and preferences. Similar to Amazon's *Echo Frames* (Amazon Alexa, 2019), the AR glasses will have a microphone and speakers, so that the user can answer calls, send messages, set up appointments, and speak to a virtual assistant, who can aid the user to perform various tasks, including navigation and deliver personalised and curated content. For this to take place, the glasses will come with location tracking and artificial intelligence in-built software.

The lenses will come with a virtual retina display (VRD) and eye-tracking technology, which allow the virtual projections to constantly follow and adjust themselves to the centre of the user's retina (Eyejets, n.d.), but not only. Eye-tracking is also capable of providing data in form of heatmaps, that tells precisely where the user is looking at, which could be used for marketing and advertising purposes. Through the AR glasses, users will be able to see real-time information and receive notifications that will automatically pop-up to them. Furthermore, the glasses will have several filter options, allowing users to see superimposed virtual elements onto the real world.

The types of interactions afforded by the AR glasses I'm describing mainly have to do with contextual information displayed in real-time either in 2D or 3D through which the user will be able to read and potentially "click" and "scroll" such elements using hand-gestures (Sharp et al., 2015).

In that regard, the AR glasses will be used as a ubiquitous accessory in consumers' daily lives, seamlessly blending with their everyday routines. The relevance of describing the above features of the envisioned AR glasses is twofold. First, this is necessary to situate the reader in regard to what kind of AR glasses I am going to conduct the ethical assessment. Second, these features also relate to the aspects of proximity, immediacy, and curation of information which I have argued in the previous chapter. With this in mind, let us now turn to the proper ethical assessment following the ATE checklist where relevant for my case study.

i) Harms and Risks

When it comes to a regular use of AR glasses, it's important to anticipate some of the potential physical harms that it may cause to the users themselves in the first place. As I will point out in the following subcategories, the potential addictiveness and level of distraction that such wearables might cause are among the main issues that I understand to be at stake.

a) Harms to human cognitive capabilities

Sustained Attention and Distraction

Neuroscience studies have demonstrated how addictive the pursuit of information can be for our brains. Gazalley and Rosen (2016) say that this has to do because humans are "information foraging animals", which is a characteristic also shared by other primates. Along the same line, Carr (2020) shows that our brains have evolved to always be attentive to new information. In addition, Kobayashi & Hsu (2019) have demonstrated that this desire for consuming new information is because our brains release dopamine when encountering new information, a neurotransmitter that plays a role in our perception of pleasure.

In an interview conceded by Hsu about the study, he stated that the "way our brains respond to the anticipation of a pleasurable reward is an important reason why people are susceptible to clickbait" (Counts, 2019). A clickbait, important to define, is "something (such as a headline) designed to make readers want to click on a hyperlink especially when the link leads to content of dubious value or interest" (Merriam-Webster's dictionary, n.d.). Clickbaits are present in almost every online media article and social media platforms. Their intended goal is to increase user engagement, keeping the person for as much time as possible navigating a website (Jung et al., 2022). In the context of AR glasses, clickbaits might evolve into another kind of 'augmented' interface in order to retain and attract users' attention, although this is yet to be seen. For example, an AR app might promote a game or an experience with an attention-grabbing headline or image that promises an extraordinary encounter. This could be done to increase advertising revenue or simply to gain users' attention.

As Gazalley & Rosen (2016) demonstrate, paying attention for long-periods of time is already something very unnatural to our brains. We are biologically inclined to get distracted from the goals and tasks we have to perform, as our brains are sensitive to interference. Such interference can be either internal, generated by our own thought processes, or external, which are triggered by environmental stimuli, such as "beeps, vibrations, or flashing visual displays" (Gazalley & Rosen, 2016: 5). Interference should be understood as any interruption or distraction that diverts us from a goal-oriented task. The issue with interference is that it has negative impacts on human cognition and behaviour, affecting our "thinking, our perceptions, decision making, communication, emotional regulation, and our memories" (Gazalley & Rosen, 2016: 5).

In view of our biological predisposition for distraction, digital media and electronic devices push ourselves even further towards distraction - especially considering the attention economy and surveillance capitalism. For instance, empirical studies have demonstrated how the

possibility to access the internet at any given moment impacts our cognition and ability to hold attention for long periods of time without the urge to check our social media accounts, e-mail, or a text message (Firth et al., 2019). The endless possibilities that the online environment offers to us makes it very tempting and easy to try to multitask, that is, to switch between tasks on a regular basis. However, studies have also shown how digital multitasking negatively impacts the user's cognitive control and attentional capabilities (Van der Schuur et al., 2015; May & Elder, 2018; Baumgartner, 2022).

According to a report published by Microsoft Canada (2015) on attention spans, it was found that the Canadian's average attention span was twelve seconds long in the year 2000. In 2013, that number fell to only eight seconds. The report even mentions, for comparative purposes, that a goldfish's attention span is nine seconds (2015: 6), and concludes stating that "overall, digital lifestyles have negative impacts on prolonged focus" (2015: 23). In one section, the report recommends the following approach to catch Canadians' attention: "They're [Canadians] suckers for novelty. It's more exciting to jump from subject to subject or device to device than to concentrate on a single thing at any one time. Hook consumers right off the bat with clear and concise messaging that's communicated as early as possible." (2015: 25)

Another longitudinal empirical study conducted by Lorenz-Spreen et al. (2019) that corroborates with the above-mentioned one suggested that the collective global attention span has narrowed down over the last one hundred years, but such trend has been accelerated in the past decades due to the ever-increasing accessibility and production of new information. According to Lorenz-Spreen, the fact that content is increasing in volume around the world leads to a depletion of our attention, which is limited, while our desire for news increases, causing us to "collectively switch between topics more quickly" (Technical University of Denmark, 2019). While this study did not look at the impacts on individual attention, or even the wider effects that such acceleration and scattered attention have for societies, it is plausible to assume that involving citizens' attention in debates of public interest which require time and sustained attention is becoming increasingly difficult given our collective urge to consume and engage with new information.

Children and teenagers are particularly more vulnerable to be impacted by excessive amounts of information, digital stimuli, and the "Fear of Missing Out" (FoMO), since their brains are still in formation (Marciano et al., 2021). It has been pointed that excess amount of engagement with digital media and constant exposure to the influx of new digital information have adverse impacts on both their physiological and psychological levels, such as quality and

duration of sleep, eye fatigue and blurred vision, but also behavioural and social aspects, which can come with addictive behaviour regarding the use of digital media (Lissak, 2018).

Smartphone notifications are a normal and common thing in the lives of billions of people. Notifications interrupt us from the tasks we are conducting, and tend to make us more distracted from the real world and get back to the online, virtual world. I have shown in Chapter 1 that this is a consequence of the attention economy, which incentivises companies to design products that catch user attention. If this same model is extended in the context of AR glasses, interruptions in the form of notifications will be almost impossible for the user to ignore, since they are going to be directly projected at the user's field of vision – the features of proximity and immediacy become especially important here. In that aspect, Turner (2022) points that AR glasses are likely to increase *digital distraction*, as "superimposed virtual objects are especially distracting in virtue of being perceptual affordances that actively 'call out' for the attention of users." (2022: 2).

In a humorous, but no less serious tone, scholar James Williams writes in his book: "If you wanted to train all of society to be as impulsive and weak-willed as possible, how would you do it? One way would be to invent an impulsivity training device – let's call it an iTrainer – that delivers an endless supply of informational rewards on demand. You'd want to make it small enough to fit in a pocket or purse so people could carry it anywhere they went. [...] To boost its effectiveness, you could endow the iTrainer with rich systems of intelligence and automation so it could adapt to users' behaviours, contexts, and individual quirks in order to get them to spend as much time and attention with it as possible." (2018: 18-19) Of course, Williams thought experiment is an analogy to the impacts perceived with the mainstream usage of smartphones, which can be aggravated with AR glasses.

Interfering with people's attention is harmful from an ethical standpoint due to several reasons. First and foremost, it infringes upon individual autonomy and free will (which I will address later in this section. By deliberately capturing attention through deceptive, persuasive or manipulative means, people are deprived of the ability to make informed choices and decisions based on genuine interests. This erodes trust and can lead to a sense of exploitation, as individuals may feel their attention is being exploited for ulterior motives. Moreover, interfering with attention can disrupt important aspects of human well-being, such as focus, productivity, and overall mental health. Constant exposure to attention-grabbing tactics can contribute to attention disorders and decreased cognitive abilities. This is particularly relevant in the context of AR glasses, given their aspects of proximity, immediacy, and curation of information.

In short, if we combine our predisposition for distraction with our desire to constantly obtain new information, a potential pervasive use of AR glasses will offer the perfect formula for undermining the user's ability to sustain attention for long periods of time, unless, of course, design interventions are done, which I will bring in Chapter 3.

Addiction

Another potential ethical risk that derives from the above-mentioned concerns has to do with users developing an addiction to their smart glasses. Many studies already have shown the addictive and compulsive behaviours that users develop towards their smartphones and internet usage, given the wide variety of features that they offer (Lin et al., 2014; Pearson & Hussain, 2016; Cha et al., 2018). The multifunctionality of mobile devices facilitates the user's dependence on them, not only from a subjective, individual perspective, but also from an objective, collective one, since in many industrialised cultures it is expected that people own a smartphone for accomplishing essential and necessary tasks, such as banking, access to government services, education, healthcare information, etc. Given the ability of smartphones to also host a number of social and entertainment features, including music, gaming and social media apps, has persuaded us to be "always online". For instance, a study published in 2015 by Pew Research Center showed that 94% of Americans who own a smartphone carry their devices frequently and 82% reported to rarely or never turn them off (Rainie & Zickuhr, 2015).

Longstreet & Brooks (2017) conducted an empirical study to verify how life satisfaction is associated with internet and social media addiction. The researchers concluded that the former is inversely related with the latter, suggesting that, "as a user finds things to be happy about in their life, their life satisfaction will increase and their corresponding levels of addiction (social media & Internet) will both decrease." (2017: 75)

Another point which I would like to delve more attention into is the phenomenon of gamification, as it is a strategy that is quite successful in increasing user engagement, employee motivation, innovation, and productivity (Werbach & Hunter, 2020). As the name already suggests, gamification is the act of "taking a non-game experience and turning it into a game" and its goal is "that experience itself should be its own reward" (Alter, 2017: 200). While gamification can be employed to nudge people towards performing activities that are good for them (e.g. exercising, eating healthy, learning new skills), it also has the potential to increase user addiction (Andrade et al., 2016).

In a regular usage of AR glasses, users will experience a constant mediated and epistemically richer reality, which means that information will be delivered to their eyesight in

real time location-based. If we consider the existing data regarding the amount of time users spend on their phones and other electronic screens navigating the internet, it is reasonable to anticipate that future users of AR glasses might also find it hard, if not harder, to disconnect from the hybrid world.

Digital addiction is harmful because it undermines personal autonomy and self-control (see section of "Autonomy" below). If companies exploit psychological vulnerabilities of users by employing persuasive design techniques, AR glasses can drive them into spending excessive amounts of time and attention that is unhealthy. This in turn erodes individuals' ability to make deliberate choices and maintain a healthy balance between online and offline activities. Excessive usage of AR glasses and overreliance on its features can exacerbate the existing issues brought by smartphones, such as decreased attention spans and overall life satisfaction.

Scepticism

The potential several different hyper-realistic filters that AR glasses might offer can pose real challenges for the user's perception of physical reality and, therefore, deceive the user in a certain way. For example, the superimposition of virtual objects can obstruct the user's perception of the real world, causing the problem of "augmented scepticism", which happens when the user cannot properly distinguish what is real from what is virtual (Turner, 2022: 14; Palermos, 2017: 143).

Although AR has the possibility to extend our cognitive capabilities in some domains, it carries the potential to also undermine them, by confusing our brains' interpretation of the real world. This is because, according to Palermos, AR "is specifically designed to generate and operate on the basis of unreal yet deceivingly truth-like mimicries of the external world in a way that users won't be able to distinguish augmented images from actual images of the world." (2017: 143).

For instance, let us consider the phenomenon of deepfakes, which can be potentially exacerbated and reach unprecedented levels of realism in the context of a consumer use of AR glasses. Deepfakes refer to the production of realistic audiovisual elements generated with AI technologies (Sayler & Harris, 2022). They are a form of AI-generated synthetic media (Barnes, 2020). Nightingale & Farid (2022) have shown that AI synthesised faces have already reached a level that is extremely hard to distinguish from real faces.

Deepfakes can be used for a variety of purposes, including entertainment (see, for example, the "DeepTomCruise" TikTok profile (Metz, 2021), where the owner of the profile applies an AR deepfake filter to his face which mimics very realistic the face of the American

artist Tom Cruise. Besides entertainment, deepfakes can also be generated and used for malicious purposes, such as in non-consensual intimate imagery (Hao, 2021), in cybercrime (Stupp, 2019), and in politics (Farish, 2022), to name a few.

Deepfakes and AR have been experimentally applied in a museum exhibit (Wynn et al. 2021). In that experiment, the visitors could point to an exhibited portrait using an available tablet, and visualise the portrait becoming animated with a short monologue. While such art applications can provide interesting insights and reflections for the museum visitors, if we consider that this kind of deepfake could also be deployed in portraits and images in public spaces by private or even anonymous actors, several ethical concerns will promptly arise, not to mention the legal concerns that touch upon ownership rights. For instance, imagine that political propaganda or other kinds of business advertisements could be digitally placed in physical public spaces, such as in tourist sites and universities for example, where thousands of people may pass by every day.

That said, deepfakes can convincingly deceive people. Many scholars have devoted their attention to the epistemic threats that deepfakes pose to individuals and societies, given their power to distort reality and the ease of which they can be generated and shared online (e.g. Floridi, 2018; Fallis, 2021).

In short, AR deepfakes can contribute to an erosion of trust and have the potential to cause reputational damage. For example, someone could maliciously create an AR experience for those who wear AR glasses that displays offensive content within a person's immediate surroundings without their consent. Further, because deepfakes have the potential to manipulate perceptions and generate confusion, this can reach a higher level of scepticism in the context of AR glasses. For example, users of AR glasses may find it even more challenging to distinguish between real and fake content than in a non-AR context. This, in turn, can lead to feelings of distrust, stress and uncertainty - which are significantly individual harms.

b) Harms to society

Epistemic filter bubbles

In regard to social harms, a widespread consumer usage of AR glasses might pose the challenge of increased personalisation of content and of the phenomenon known as digital "filter bubbles" (Pariser, 2012), which brings us back to the issue of curation. As the name suggests, a filter bubble reflects the idea of individuals living in their own digital epistemic world, which is fed with algorithms that provide and recommend topics, information and content that are more

likely to match their preferences. The problems with digital filter bubbles become particularly evident in politics-related topics, and are accentuated during election periods, given their tendency of increasing levels of political polarisation in societies (Spohr, 2017). Such bubbles end up undermining trust in fellow citizens and institutions, which are negative for a well-run democracy and the public sphere (Kaluža, 2022).

As Sunstein (2008) argues, for democratic societies to function well, citizens need to regularly experience chance encounters and have exposure to opinions that are contrary and different to their own, which usually happen when individuals are in public spaces. The premise for that line of thought is that, as individuals, we naturally tend to look for communities, information and activities that match our interests, ideas and opinions. In the field of psychology, this phenomenon has been characterised as 'Confirmation Bias' (Nickerson, 1998). By being exposed to things and ideas that were not anticipated or originally intended by ourselves, our confirmation biases can become somehow challenged, which contributes to having a broader perspective of things that might influence our ideas, knowledge and behaviours (Sunstein, 2001: 8-9). The exchange and circulation of different ideas is what constitutes and fosters plural societies, which are fundamental to democracies.

However, given the ability we currently have to 'filter' what we want to see and consume on the internet, it is increasingly harder to share "common experiences" with fellow citizens (Sunstein, 2008: 95). In the 1990's, Negroponte envisioned a future where people would be able to select the news they wanted to read based on their preferences, and called this phenomena as the "Daily Me" (Negroponte, 1995). Currently, not only can we select the news we want to read online through existing applications (e.g. Flipboard, Inoreader, NewsBlur), but algorithms also already select to a great extent what we access online. Not sufficiently, we also have predictive algorithms suggesting to us what we "might like" reading and watching based on our online footprint.

The use of smartphones has led to an amplification of the "Daily Me", since personalised content is directly delivered to our pockets. If this phenomenon is extended towards AR glasses, then the "Daily Me" can be amplified even further, as more personalised and contextualised information will be directly delivered to our eyes, which are our immediate sensory experience of reality. Turner (2022) points out that this can worsen the issue of *digital divergence*, which, in the context of AR, entails that "users will not just inhabit filter bubbles in cyberspace but will come to occupy ‘real-world filter bubbles’ in the sense that they will experience the physical world differently from one another in virtue of having disparate virtual content superimposed onto sensory perception" (Turner, 2022: 21). This means that the idea of a common, shared

epistemic reality might be even harder to exist in a context of mass consumer usage of AR glasses.

Take the following example: imagine that people could opt to apply AR virtual blinders, which can hide things of the real-world that they do not want or like to see for whatever reason. This phenomenon is referred to as the "reality block" (Rosenberg, 2022c: 8). The *IRL Glasses*, which were launched in 2018, are capable of blocking the lights emitted by digital screens, as if they were simply turned-off (Pardes, 2018). In that way, its users are not exposed to the digital stimuli that they would normally be were they not wearing such glasses.

In conclusion, the emergence of epistemic filter bubbles, exacerbated by the potential widespread adoption of AR glasses, poses significant social harms. These filter bubbles create individualised digital worlds where algorithms cater to personal preferences, reinforcing confirmation biases and limiting exposure to diverse perspectives. Particularly concerning is the impact on political discourse, as filter bubbles contribute to increased polarisation during election periods, eroding trust in fellow citizens and institutions.

As argued by Sustein (2008), the detrimental effects on democratic societies are evident, as citizens require chance encounters and exposure to differing opinions to foster pluralism and maintain well-functioning democracies. With the hyper personalisation of online content, this idea of shared experiences that are necessary for societal cohesion are likely to get increasingly rare. In that sense, consumer usage of AR glasses has the potential to intensify this problem, creating "real-world filter bubbles", as put by Turner (2022), where individuals experience divergent virtual content superimposed on their perception of reality.

The emergence of real-world filter bubbles raises concerns about the potential effects of fake news delivered through AR glasses. While this is not an exclusive issue that relates to the mainstream use of AR, we must acknowledge that AR can further exacerbate the problem.[7] This is because AR allows developers to create digitally altered realities, which directly affects the reality that users will experience when wearing AR glasses (Rathenau Instituut, 2021). Coupled with the attention economy and surveillance capitalism practices, the mainstream usage of AR glasses can increase the risks of eroding trust, distort a shared understanding of truth, and amplify the issue of scepticism. In short, this intensifies the potential negative impact of fake news and deepfakes on individuals and society.

[7] The 2018 Cambridge Analytica scandal was a remarkable example about the societal harms that happen when technology is deployed to target individuals with political propaganda based on their online profiles, internet footprint, geographic information, gender and many other variables, influencing how they interpret the world (Boldyreva et al, 2018).

Harms to interpersonal communication

It's also necessary to think on the subtle, although no less important, impacts on the quality of face-to-face interactions, which will no longer be "direct", but rather technologically mediated by AR glasses. In industrialised societies, people already spend a large part of their days engaging with screens, either for work, entertainment, or relationships (see Chapter 1). In a dialogue between two people wearing AR glasses, that means that neither party will know exactly what types of information the other person is receiving, which can impact the perception of one about the other, especially if they are strangers to one another.

For instance, let's consider the impact of smartphones on interpersonal interactions. An empirical study conducted by Przybylski and Weinstein (2013) revealed that the mere physical presence of a smartphone on a table during face-to-face conversations between strangers already has a detrimental effect on interpersonal closeness, connection, and the quality of conversation, in comparison to a scenario without mobile phones. The researchers suggested that these negative effects arise from the reminder of other events and information occurring beyond the immediate conversation that individuals may be missing out on, even if the devices are not actively being used (see also Alter, 2017: 18). Simply put, the presence of digital devices during face-to-face conversations hinders genuine human connection and engagement by drawing attention away from the present interaction and redirecting it to the digital world. Bearing in mind proximity, immediacy and curation, such effects will likely be exacerbated by AR glasses.

In this context, it is relevant to mention the short futuristic film "Sight" (Robot Genius, 2023), which depicts a dystopian future where individuals utilise AR lenses to transform every aspect of life into a gamified experience, including mundane tasks and romantic encounters. The film portrays a scenario where two strangers on a date wearing these lenses receive real-time information about each other. This includes details like the other person's perceived level of interest in the conversation, personalised suggestions on how to act, and topics that the other person may enjoy discussing based on their social profiles. Although the movie presents a fictional scenario, it effectively enables viewers to visualise the potential consequences that widespread use of AR glasses might have on our lives and relationships.

While the above-described scenario already happens to some extent when smartphone notifications interrupt a direct conversion between two or more people, smartphones are still devices that can be put outside of the user's field of vision, while AR glasses are made to be worn. Although one can argue that the person wearing the glasses could always "turn them off" or take them off, it would be necessary to carry out empirical studies in the future to identify the

most common behaviours of users in these situations, especially considering that the large majority of smartphone owners in the US never do (Rainie & Zickuhr, 2015).

While future users of AR glasses may recognise the importance of establishing a "digital etiquette" during face-to-face conversations, potentially by removing and stowing away the glasses as a gesture of respect, empathy, and attentiveness towards others, I understand that further research is necessary to examine the phenomenological experience of individuals engaging with each other when wearing AR glasses. Moreover, as the ubiquity of mobile phones has shown, the social norms around such behaviours are likely to be driven in part by the technology, and the addictiveness of AR is likely to make putting one's AR glasses away hard to do, so there is a high chance that the social norms will be for people to keep the glasses on.

ii) Rights

Immersive rights

In 2022, researcher and entrepreneur Louis Rosenberg wrote an article demanding the need to develop what he calls "immersive rights" in the context of AR and VR technologies (Rosenber, 2022). He points out three of these rights, namely, the right to *experiential authenticity*, the right to *emotional privacy* and the right to *behavioural privac*y.[8] I will briefly go over them below.

The right to experiential authenticity is about ensuring that users know when they are interacting with virtual product placements (VPPs) or virtual spokespeople (VSPs), which are two unique and emerging forms of marketing strategies in the context of immersive technologies. Since I have not talked about these terms so far, a definition is required. VPPs "are simulated products, services, or activities injected into an immersive world (virtual or augmented) on behalf of a paying sponsor such that they appear to the user as natural elements of the ambient environment", whereas VPSs "are simulated persons or other characters injected into immersive environments (virtual or augmented) that verbally convey promotional content on behalf of a paying sponsor, often engaging users in AI-moderated promotional conversation" (Rosenberg, 2022). According to Rosenberg (2022a), VPPs and VSPs are going to be AI-driven, which means that they can fine-tune their deployment based on the user's preferences and online track history to deliver timely and persuasive content and advertisements. In the context of AR, depending on how similar VPPs and VPSs will be able to mimic the real world, Rosenberg (2022) understands

[8] Given the limitations of this work, I will not address all the various facets of privacy. For a comprehensive examination of privacy typology, see Koops et al. (2017).

that this could potentially undermine our ability to differentiate what is a promotional content from what it is not, leading to an augmented scepticism (see section above: "Scepticism").

Second, there is the right to emotional privacy, which is a crucial aspect that aligns with one of the central arguments presented by Zuboff (2019). In an interview with the Harvard Gazette, Zuboff expressed concern over surveillance capitalism's appropriation of private human experiences as a source of free raw material, which is subsequently transformed into behavioural data, which are then processed, packaged, and traded as prediction products in behavioural futures markets (Laidler, 2019). Emotional privacy refers to the ability of individuals to maintain autonomy over their personal emotional experiences and the freedom to decide when, where, and with whom to share them. It encompasses the right to safeguard one's inner emotional life from unwarranted intrusion, manipulation, or exploitation by external entities.

The risk of breaching individuals' emotional privacy in the context of AR glasses could occur through the collection and analysis of the users' emotional responses, potentially leading to the commodification and exploitation of their intimate emotional states. Such risk is already mentioned by Rosenberg (2022), who understands that users of AR glasses will likely have their expressions, gait and gaze monitored by such devices, which in turn will generate data that can be used in a manipulative way by brands and third parties. Such monitoring can occur due to two reasons: sensitivity and profiling.

The notion of sensitivity is related to computer technologies that are claimed to detect emotions from cues that are not perceptible to humans (Rosenberg, 2022). For instance, humans cannot detect heart rates or respiration rates of other people by simply engaging in a face-to-face conversation, and it is not easy to notice "micro-expressions" of other people's faces. However, recent developments in the field of computer vision and AI are proving that identifying people's micro-expressions is already something possible and these technologies are likely to get increasingly accurate (Li et al., 2017; Zhang et al., 2023). This means that such signals may reveal certain emotions that the individual who is being observed did not intend to convey, and which will be automatically stored in the form of data. Profiling, instead, refers to the fact that the platforms who manage users' data will be able to create profiles based on the collected emotional data and input them into AI systems, which could in turn predict the reactions of consumers when they are exposed to advertisements, products, and services (Yi et al., 2020).

So even if the technologies employed in collecting and analysing individuals' emotional data and creating profiles make errors in predicting their feelings and experiences, it is important to recognise that a fundamental right is still being violated. This is because the very act of profiling individuals based on their emotional data involves the extraction of intimate and

personal information, allowing the companies who operate in the AR landscape to develop detailed profiles that can potentially shape individuals' experiences and influence their decision-making processes. An important discussion that requires further examination in future research is whether obtaining mere user consent is sufficient for companies to engage in such practices.

This leads us to the third immersive right, behavioural privacy, which Rosenberg ties to emotional privacy. Behavioural privacy pertains to the accessibility of user-generated data within immersive environments, encompassing what they observe, access, and interact with. Preserving this privacy is critical because immersive environments rely on extensive behavioural data to provide contextually relevant information to users. However, Rosenberg highlights the potential issue of long-term storage of behavioural data, which could be exploited to develop highly detailed and invasive profiles documenting individuals' daily actions (Rosenberg, 2022).

The concerns surrounding immersive rights are intricately linked to the practices of surveillance capitalism and the attention economy. Given the limitations of this work, my main goal here was to highlight these risks. However, it is crucial for future research to delve deeper into the subjects of experiential authenticity, emotional privacy, and behavioural privacy, to ensure a more comprehensive understanding and exploration of these rights.

Autonomy

Considering the already mentioned potential addictiveness that consumer usage of AR glasses might entail to users, risks to immersive rights, and taking into consideration the context of attention economy and surveillance capitalism, then the user's autonomy can be greatly impacted. As we have seen, this is particularly important considering the proximity, immediacy and curation of information brought by AR glasses.

For instance, Lawrence (2022) understands that addiction interferes with individual's autonomy in at least four ways, which are "(1) by forcing her to think unwanted thoughts, (2) by distracting her from thinking about what she wants to think about, (3) in severe cases, by causing her to behave in ways she does not want to behave, and (4) by altering her brain structure and chemistry to do 1, 2, and 3" (Lawrence, 2022: 125-126).

In other words, such interference might lead to a situation of "unnoticed self-deception" (Madary & Metzinger, 2016: 17), that is, when the individual is deceived without being aware of it, which implies the idea that the person performs tasks that she thinks she has a legitimate intention to do it, although in fact such intention is not truly hers, but rather something external that nudged that person to behave the way she does. A study conducted by Madary (2022) on

human-computer interaction advocates shows that when we are interacting with digital technologies, particularly smartphones, genuine human agency is affected.

Madary's main claim in his article is that the "operating systems, apps, and input hardware on our electronic devices create conditions in which the sense of agency is likely to accompany actions that are not genuinely intentional. *In other words, there are times that we feel as if we are in control of our clicks and our swipes, when in fact we are not.* Rather than being in control, we are automatically reacting to stimuli in more or less predictable ways." (emphasis original, 2022: 1). He provides an in-depth analysis of the neurological aspects that occur behind the formation of our intentions and behaviours and demonstrates how smartphones and its related features are designed in ways that undermine our brain's supervisory-inhibition model of action, which relates to a state of conscious attention (Madary, 2022: 5). In that state[9], we are able to take some distance, so to speak, from our immediate desires and impulses, reflect upon them and only act after such assessment.

This point is essential to highlight. AR glasses - through the combination of proximity, immediacy, and curation of information - are likely to shortcut the "reflective distance" needed to perform certain tasks. In other words, we might be even more inclined to react to the digital stimuli delivered by AR glasses then by smartphones.

Furthermore, Madary shows that the user experience guidelines for app and software developers provided by Apple and Microsoft, for example, focus on two main cues that foster the illusion of agency, which are predictability and fluency (2022: 9). Predictability is about embedding design features that make the user *feel* that he is in control, and it takes place when the user engages in an action in which the expected outcome is materialised. Fluency, on its hand, has to do with the mental states that lead us to perform an action. As Madary says, when action "is fluent, or cognitively effortless, we seem to have a greater sense of agency compared to cases in which there is disfluency between the preceding mental states and the selected action" (Madary, 2022: 7)

Madary is aware that there are many times users engage with their smartphone with clear intentions in mind, such as to check the time or specific email, and then right afterwards disengage with it. However, the author mentions a study that conducted a systematic review on the topic of problematic use of smartphones (Harris et al., 2020) in which the evidence points out that "users most often do not engage their devices with particular goals in mind" (Madary,

[9] The state of conscious attention happens in the brain's frontal lobe, which is responsible for our executive functions, such as self-control, judgement, and inhibition (Cleveland Clinic, 2022).

2022: 10), but rather, the most common trigger for smartphone engagement is to obtain a sort of emotional gain. This can be from alleviating the 'Fear of Missing Out' (Elhai et al., 2016; Wolniewicz et al., 2018), decreasing boredom (Olufadi, 2015) and loneliness (Busch et al., 2021).

Bringing the analysis carried by Madary to the context of AR glasses for regular consumers, it is plausible to expect that the above-mentioned issues can be significantly aggravated. For instance, given that AR glasses are made to be regularly worn, they add an obstacle for the user to disengage with them. Furthermore, considering the landscape of surveillance capitalism and attention economy, they will likely incorporate the design cues of predictability and fluency to offer a constant and pleasant flux of personalised information and notifications to keep the user entertained, busy and engaged with the augmented world. However, in doing so, these devices may undermine the user's autonomy, which affects their capacity to reflect about their genuine goals and tasks they want to perform. In other words, the proximity and immediacy aspects of AR glasses are strongly tied to the predictability and fluency cues. This makes AR glasses more persuasive devices than smartphones.

Again, I find it opportune to bring the provocative message of Williams (2018) about this important task of reflecting upon our own goals: "[t]hink back on your goals from a moment ago. Now try to imagine what your technologies' goals are for you. What do you think they are? I don't mean the companies' mission statements and highflying marketing messages – I mean the goals on the dashboards in their product design meetings, the metrics they're using to define what success means for your life. How likely do you think it is that they reflect the goals you have for yourself?" (2018: 8). Williams' rhetorical question serves as an alert to us about the dangers of mindlessly engaging with such devices and online platforms too often. These dangers are not just physiological, but also about what makes us realise our full potential as human beings. To understand and seek the realisation of this potential, we need the space and ability to reflect on our choices, our goals in life, and then pursue them. But to do so, it requires us to be autonomous. If we reach a point where we use AR glasses regularly and constantly, getting exposed to an ongoing influx of digital stimuli that is directly displayed into our field of vision, the more distracted we are likely to get. In other words, the use of AR glasses literally shortens the physical distance that we need to gain perspective and reflect about our genuine goals.

This, in turn, will decrease even more the occasions for down-time, which are fundamental to reflect on our genuine goals and desires (Immordino-Yang et al., 2012; Fabr, 2013). When our brains are constantly hyperstimulated, we cannot properly process all the information we are receiving, and, therefore, diligently reflect upon them and our own

behaviours. At the same time, it is very hard for us to deliberately avoid the engagement with these multifunctional digital devices, and the reason for that, again, could be due to how our brains have evolved to work, seeking novelty and information in order to help us survive and thrive as a species (Gazalley and Rosen, 2016). In that sense, a regular usage of AR glasses might make it even more difficult for us to exercise our genuine autonomy.

As the reader might have noticed, the above-mentioned aspects that interfere with the user's autonomy are closely related to the ethical issues addressed under the category "Harms to human capabilities".

iii) Distributive Justice

The potential effects that AR glasses might bring to the question of distributive justice are many. For the current analysis, I will focus on the problem of *digital divide*, as the accessibility to AR glasses in the consumer market could potentially exacerbate this issue, especially considering the constant and immediate curation of digital information (see Chapter 1). By digital divide, I mean the likelihood of an increased technological gap between users and non-users of AR glasses, which can, in turn, lead to subsequent negative social complications, such as an increased epistemic asymmetry between users and non-users.

Such asymmetry will occur because users of AR glasses will have access to new layers of information that non-users will miss out (Rosenberg, 2022b), which means that non-users will likely be in a disadvantageous position in comparison to those who have access to AR glasses. The closest analogy we can think of is in relation to the access and use of smartphones, which are regarded as essential devices in industrialised societies due its wide range of applications that bring convenience and facilitate the execution of several tasks. However, smartphones have also made us more dependent on them, both for personal and professional reasons. In that sense, it is important to consider whether a mainstream usage of AR glasses has the potential to establish a higher baseline for people to keep competitive and access essential services and information.[10]

Another related issue has to do with the power asymmetry between the companies that develop and curate the content in the AR environment, and the users of AR glasses themselves. Given that such glasses will be made to be worn all day, this means that everything the users see

[10] For instance, The International Telecommunication Union estimates that 2.7 billion people still do not have access to the internet (ITU, 2022). However, as the organisation puts it, it is not sufficient to warrant internet access, but also "meaningful connectivity", which entails that people should be able to use the internet regularly and effectively. For that to take place, there are still several barriers that need to be overcome, including internet speed, limited affordability of hardware, and inadequate digital awareness and skills (ITU, 2022).

will be constantly *mediated* by the technology. In particular, those who design and control the technology will play an increasingly important role in how that mediation occurs. If companies indeed convince consumers to constantly wear AR glasses, opportunities for direct access to the physical world will be increasingly scarce. That matters because people's opinions, beliefs and interpretation of the world is very much shaped by what they see, what types of information they access and what they consume. In short, curation is a significant issue for justice.

Wearing a pair of AR glasses that display information directly into the user's field of vision is a powerful tool to nudge people's attention to things, products and services, that otherwise the user would not necessarily notice. If, on top of that, AR glasses are also embedded with AI capabilities, which is very reasonable to expect that they will, then there is the possibility of companies and developers to hypernudge users. In the words of scholar Karen Yeung, "hypernudging relies on highlighting algorithmically determined correlations between data items within data sets that would not otherwise be observable through human cognition alone [...] dynamically configuring the user's informational choice context in ways intentionally designed to influence her decisions." (2017: 122). For instance, Meta and Google have already announced their goal to use generative AI for advertisement purposes, which can be very useful for businesses to target different audiences with a greater level of precision and personalisation (Mauran, 2023; Murphy & Criddle, 2023).

If companies end up incorporating hypernudging techniques through AR glasses for calling the attention of users to obtain profits for themselves, that puts the companies in an unequal position in relation to individual users, which can lead to potential abuse of power. To make sure that distributive justice is well balanced, it is necessary to develop regulatory mechanisms so that this disparity of power does not come at the cost of individual users and non-users.

Conclusion

In this chapter, I have described the envisioned features that such AR glasses would have, using as a reference the current and foreseeable technological developments regarding AR. Next, I have identified some of the potential ethical risks that a mainstream use of AR glasses might pose to individuals and societies, taking the ATE as the methodological framework for doing so. My assessment focused on three main categories, namely: i) harms and risks and; ii) rights and iii) distributive justice.

In regard to the first category, I have shown the potential harms to individuals, mainly related to cognitive harms, due to the likelihood to cause negative impacts to attention, increase risk of behavioural addiction, and create the problem of scepticism. In relation to societal harms, I have then analysed the risk of increasing the already existing phenomena of epistemic filter bubbles, fake news and propaganda, as well as the impact that mainstream usage of AR glasses might have for interpersonal, face-to-face communications.

Under the 'rights' category, I have dived into the forthcoming challenge of protecting the so-called immersive rights, which are applicable not only to AR, but to the whole set of XR technologies. These are the right to experiential authenticity, the right to emotional privacy and the right to behavioural privacy. Next to it, I have analysed the risks that a regular use of AR glasses might bring to user autonomy, especially considering the context of the attention economy and surveillance capitalism.

Finally, under the "distributive justice" category, I have touched upon the risk of an increase in the digital divide, meaning an increased gap between people who will have access and will be able to afford AR glasses, and the people who won't. This will not be a mere problem of hardware accessibility, but also a problem of epistemic injustice, since non-users will be missing out on a whole new layer of AR information which will be displayed to users, likely leading to a competitive disadvantage for non-users. In addition, I have addressed the problem of living in a constant mediated reality, since it increases the epistemic power of the technology companies that curate and deliver the content users see in real-time. This issue derives from the unique aspects of AR glasses, which are proximity, immediacy, and curation of information (see Chapter 1).

The reader might have noticed that the ethical issues which I have pointed out throughout this chapter are closely interconnected to each other, since, in the context of a mainstream usage of AR glasses, the implications for individual consumers are also going to have large-scale impacts on society.

Identifying and assessing ethical risks, however, are only the first stage of the ATE framework. Following it, we shall move into the evaluation and recommendation stages. Acknowledging that tackling these challenges are indeed complex, intertwined and that they do not have a straightforward or single solution is the first step towards developing responsible deployments of AR glasses in the consumer market.

While one could raise the point that users could simply "turn-off" their AR glasses to prevent all such risks from happening, in practice it might not be that easy. For instance, Palermos (2017: 144) reminds us of an already existing phenomenon: when we think of smartphones and

the dependence we have created on them, how often do we turn them off? Furthermore, turning off the AR glasses is an easy way to avoid facing the many issues with responsibility. It's like saying to turn our smartphones off so that we will be free of all the problems that come with it. To illustrate my point, studies have demonstrated the effects on anxiety of users who are asked to have their smartphones phones turned off and, or out of reach (Cheever et al., 2014; Schmidt et al. 2018). The reason for that is because such devices that we carry all day in our pockets also provide many utilities and conveniences which makes us in a harder position to opt-out, since we live in a digital society (Redshaw, 2019).

Earlier in this work, I mentioned whether developing AR glasses for regular consumers is actually desirable (see Chapter 1). If so, the question *to whom* such development is desirable shall be addressed, as this will allow the relevant stakeholders to work together with policymakers and regulators to evaluate on what ground we want this technology to be deployed. In this regard, discussing, defining and assessing which values we, at a societal level, would like to preserve in a future where mainstream usage of AR glasses could become a norm, is necessary for a responsible development and deployment of these devices.

In the next chapter, I will focus on evaluating ethical risks regarding the harms to the individual's cognitive capabilities, due to the reasons I have mentioned earlier in this work. Following this evaluation, I will provide some recommendations to avoid or at least minimise such risks to materialise.

Chapter 3 - What to do about it?

Evaluation and recommendations

In this chapter, I will evaluate the trade-offs between the harms and ethical implications I have addressed in the previous chapter, and the benefits that could be derived from regular use of AR glasses. Next, I will provide some recommendations for a responsible deployment of AR glasses to regular consumers. While we are still possibly far from a mainstream usage of such devices, the earlier we start discussions about this topic the better, and for a single reason: the speed at which technology development occurs is much faster than the speed at which society can catch up with it and understand its impacts in a proper way. I will give the following example to support my previous statement.

Take, for instance, the discussions regarding the regulation of AI in the European Union, known as the "AI Act". The European Commission proposed this Act in April 2021 (Feingold, 2023). As I'm writing this thesis, in April 2023, the AI Act has not yet been approved. In the meantime, ChatGPT-3, an unprecedented conversational AI technology, was launched in November 2022, and has suddenly brought global media attention due to its immediate worldwide impact on several domains. Not sufficient, in March 2023, ChatGPT-4, an updated version with improved capabilities was launched (Hern, 2023). The pace of AI development has been so fast that the Future of Life Institute, a US-based nonprofit organisation, wrote an open letter urging AI labs to immediately stop giant experiments involving this technology, for at least six months, given the unknown risks that AI can bring (Future of Life Institute, 2023).

Getting back to the context of AR glasses for regular consumers, it is prudent to start thinking and formulating guidelines for best practices at this initial stage of development. In fact, that's the main advantage and purpose of using the ATE approach, since it allows early design and regulatory interventions in emerging technologies. However, that task requires inputs from several stakeholders, including companies, knowledge institutes, academic and industry experts, as well as citizens. In that sense, my assessment may simply serve as a starter for such discussions, as it was not my intention - nor would it be possible - to exhaust all the ethical implications involving the mainstream use of AR glasses.

Evaluation of identified ethical risks

As prescribed by the ATE, following the identification of ethical risks, we shall turn into the evaluation part (Brey, 2012: 6). I dedicate most of this section to evaluating the ethical issues

surrounding the cognitive harms that I have identified in the previous chapter, since they are more closely connected to the aspects of proximity, immediacy, and curation of information. Towards the end of this section, however, I also briefly evaluate the ethical issues surrounding the identified societal harms.

Narrowing down my evaluation regarding the issues of cognitive harms gives me the necessary space to provide a more in-depth analysis. My aim with this evaluation is to ponder the benefits and harms of a consumer application of AR glasses and come up with practical actions that could avoid or minimise the harmful aspects. This is because simply suggesting to forbid the development and deployment of this technology for regular consumers is not realistic in practical terms. I am also cautious to not apply a conservative perspective on this evaluation, since there are many products and services that are legally commercialised but that can potentially cause harm to one's cognitive capabilities, such as alcohol and gambling. However, I believe that a responsible and precautionary approach should be taken regarding the development of AR glasses for the sake of both individual and public safety and well-being.

As I have demonstrated throughout this work, AR glasses can revolutionise the way we engage and interact not only with others but also with the world, both in positive and negative ways. On the positive side, Palermos points that AR can "enhance product previews such as allowing consumers to view what's inside a product's packaging without opening it", "provide geographic awareness of road names and locations" and "augment the effectiveness of navigation devices'' (2017: 142). AR can also "enhance a user's travel experience by providing real time informational displays of her location and its features" and "allow archaeological site visitors to experience simulations of historical events, places and objects by overlaying them into their view of a landscape." (Palermos, 2017: 143). Another potential beneficial feature that can be embedded in AR glasses is a technology that automatically adjusts the focus of the lenses based on the user's ophthalmological needs, replacing the necessity for using a separate prescription eyeglass or contact lenses (Chakravarthula et al., 2018; Aydındoğan et al., 2021). Furthermore, AR glasses have the potential to become a great calm technology tool, in line with what Weiser envisioned for the future of computing (see Chapter 1).

AR glasses can have multiple applications, serving for professional and therapeutic purposes, with the potential to augment human natural cognitive capabilities in different settings. However, my anticipatory ethical assessment shows that if AR glasses become a mainstream product, designed with features that follow the attention economy and surveillance capitalism, it is very likely that its usage will harm, or at least undermine, some of the individual's cognitive capabilities. These are, as I have addressed, the user's ability to sustain attention, the potential

increase in behavioural addiction, and the amplification of scepticism. Of course, empirical studies would be needed to measure whether such risks will actually materialise, although the main goal of carrying this anticipatory assessment is that we don't arrive in this situation in the first place.

Having recapitulated these three ethical issues regarding the harms to cognitive capabilities, let me turn to the evaluation part. In relation to the first issue, which is the inability to sustain attention due to the increase of distraction, Bombaerts et al. (2023: 5) refer to scholar James Williams (2018), who differentiates between three types of distraction that are problematic from an ethical standpoint, which are functional, existential, and epistemic distractions. Functional distraction is about any internal or external interference that we may suffer which disrupts our focus when executing a specific task. Second, there is existential distraction. This type interferes with our desires and goals that we value most. According to Williams (2018), existential distraction happens "when we become aware that our actual habits are in dissonance with our desired values", which leads to an uncanny feeling that challenges our own identities (Williams, 2018: 56). Finally, there is epistemic distraction, which interferes with our ability to reflect about these desires and goals that we value most.

Taking into consideration the use of AR glasses by regular consumers in the context of the attention economy and surveillance capitalism, we arrive at a very persuasive form of undermining people's attention towards things that matter to them and for them, since the expected constant mediated reality that users will experience is likely going to undermine their ability to reflect about their genuine desires, goals and intentions. As Bombaerts et al. (2023) assert, Williams' understanding of attention "highlights the ways in which attention is not merely a resource, but a mode in which we ascertain values and make judgments of worth." (Bombaerts et al., 2023: 6). This, again, is likely to be aggravated by AR glasses given their aspects of proximity, immediacy, and curation of digital information.

Moving forward, I have also pointed out the likelihood of AR glasses to increase user's addiction towards it, particularly addiction to information and novelty. This has to do, as I have shown, to evolutionary aspects regarding the human brain, which has not adapted to the rapid changes that modern society brings with its digital technologies. As the subtitle of Gazalley & Rosen's book states, we have "ancient brains in a high-tech world" (2016), which causes a certain mismatch between our will to keep ourselves up to date with the newest technologies and information, and our actual cognitive capacity to do so, undermining our overall well-being (Rathenau Instituut, 2021: 68).

On the other hand, those who are inclined to advocate AR glasses for consumers might state that digital information will be delivered seamlessly and contextualised to the needs and preferences of each user, *reducing* the phenomena of cognitive overload. AR is – in this view – the ideal calm technology. While access to information is a human right (OSCE, 2016) and therefore, we should not deny individuals and citizens to seek information that they want, a systematic literature review conducted by Buchner et al. (2021) has shown that optical see-through AR devices (e.g. glasses; headsets) lead to a higher cognitive load in comparison to Spatial AR (SAR), which is a type of AR technology where "augmented digital content is superimposed onto the object of interest via a camera or projector" (Buchner et al., 2021: 290), without requiring the user to wear it on their face. Furthermore, precisely considering that information is going to be delivered in a constant, contextualised and personalised way to each user of AR glasses, the issues are not only related to accessibility of information, but rather to the negative implications to individual well-being (e.g. cognitive harms) and to democratic societies, especially in regards to a potential increase in the phenomenon of epistemic filter bubbles, the spread of fake news and AR deepfakes.

Looking at smartphone usage, one may object that, overall, smartphones brought more advantages than disadvantages to individuals and societies. In other words, the benefits and conveniences that smartphones provide to users extrapolates the harms that they cause to human cognition shown by scientific studies, and therefore, we should nevertheless "accept" that these problems exist and therefore we need to learn how to best cope with them. Looking from this perspective, the same is likely to occur with AR glasses for regular consumers.

Nonetheless, I must reply that this is a complacent position that shies away from an ethical attitude that entails responsibility and care towards individuals and society, since it does not provide alternative solutions to overcome these issues. For instance, using the context of smartphones again, we still don't fully know exactly what are the long-term cognitive implications that the ubiquitous usage of smartphones may bring to cognition, especially in toddlers, kids and adolescents. After all, smartphones have only been around for about fifteen years, and researchers are still identifying their harms to our health. So far, the scientific studies that I presented throughout this thesis that analysed the cognitive implications posed by smartphones (e.g. Wilmer et al., 2017; Ward et al. 2017) and AR glasses (e.g. Buchner et al. 2021) have shown that their impacts on human cognition might be significantly negative.

In fact, it is crucial that scientific studies like the ones above-mentioned are conducted, since they can help ethicists of emerging technologies when conducting the ATE, and inform policy-makers to draw legislation and regulate the development and deployability of these

devices. For example, in 2018 France passed a bill banning smartphones at schools, given the correlation between the usage of smartphones by children in school grounds and the negative impacts on their academic performance, and due to supporting research that pointed to issues of screen addiction (Ledsom, 2019). Before France, though, other schools have adopted a ban on smartphones and other digital devices.[11]

Despite these ongoing societal measures to counter the negative implications that smartphones can have for human cognition, several technology companies are already working on the development of AR glasses. The fact that corporations are also autonomous and enjoy freedom to conduct their businesses, this does not give them the right to sell a product or service that can cause harm to consumers in several ways, especially if consumers are unaware of the risks involved.

If researchers, policy-makers and scientists arrive at the conclusion that a regular usage of AR glasses can negatively affect human cognition, and hence, also their autonomy to some extent, then regulatory boundaries need to be established. The logic should be the same as the rules applicable to the allowance and commercialisation of alcoholic beverages, tobacco, and gambling. Let's say, for example, that a minimum age for wearing such glasses would be required.

Pondering competing interests

In evaluating ethical risks to understand what kinds of recommendations and design interventions can be made, it is necessary to acknowledge the competing interests of businesses, whose primary goal is making profit, and individual as well as collective well-being, which have to do with avoiding negative impacts that the commercialisation of AR glasses for regular consumers may bring to individuals and society.

Due to such differences, the set of values that companies may prioritise might not be the same set of values that individual consumers will. However, it is important that these different values coexist in a harmonious way. For example, the European Charter of Fundamental Rights states that individuals are free to conduct a business, but it also states that personal data shall be

[11] A school located at the heart of Silicon Valley became popular among parents who work in the tech industry due to the fact of being a "tech-free" school (Jenkin, 2015). According to the school's website statement: "Brain research tells us that media exposure can result in changes in the actual nerve network in the brain. This can affect such things as eye tracking (a necessary skill for successful reading), neurotransmitter levels, and how readily students receive the imaginative pictures that are foundational for learning. Media exposure can also negatively affect the health of children's peer interaction and play." (Waldorf School of the Peninsula, n.d.). If parents who work in the high-tech industry prefer to have their kids stay away as much as possible from the technologies they develop, why should we immediately welcome these devices in our lives?

protected, alongside the individuals' freedom of thought, conscience and religion (FRA, n.d). As previously addressed, the commercialisation of AR glasses for regular consumers in the context of the attention economy and surveillance capitalism has the potential to pose several risks to people's cognition and fundamental rights since they might be able to influence in an unprecedented and sophisticated level people's intentions, desires and behaviour, with physiological implications to the brain. The right to business autonomy must not override the right to individual autonomy, especially when the business model of some technology companies apply persuasive techniques aiming to nudge user's behaviour. Therefore, businesses investing in the development of consumer AR glasses should apply design features that do not undermine people's cognitive capabilities or their fundamental rights.

That said, from the perspective of the public interest, private monetary gains must not come at the expense of the well-functioning of democratic societies. In this regard, if consumer applications of AR glasses follows the attention economy and surveillance capitalism model, the phenomenon of epistemic filter bubbles is likely to be further exacerbated, people's immersive rights are likely to be breached, and the power asymmetry between tech companies and users is likely to grow due to the increasingly persuasive and hypernudging techniques that could be potentially explored through the use of AR glasses.

So the challenge for regulators is to arrive at an optimal situation in which companies are able to foster the research and development of devices like AR glasses, as long as they do not harm individual rights nor the ethical values that orient democratic societies. This is why the ATE approach can be useful for policy makers, companies and the civil society, as it allows ethicists to identify and evaluate potential ethical risks, as well as to ponder what values are at stake. Based on that, ethicists can recommend actions at an early stage of technological development to prevent the assessed risks from materialising. In saying so, this is precisely what I am going to address in the next section.

Recommendations

The question this chapter tries to answer is, what can we do to prevent or minimise the ethical risks? I have pointed to the potential benefits that AR glasses can bring to users, particularly in the professional and therapeutic domains. Furthermore, I have demonstrated that while AR glasses have the potential to become a great calm technology tool, which intends to *not* distract users, this is unlikely to happen given the predominant operational model of the attention economy and surveillance capitalism. Additionally, it is not realistic to expect

companies to stop the research and development of AR glasses for regular consumers with this model in mind in the absence of regulatory measures and public scrutinity.

Considering the issues related to proximity, immediacy and curation of digital information brought by AR glasses and their potential impact on the user's cognitive capabilities, namely, sustained attention and distraction, addiction, and scepticism, I will draw a few governance recommendations aiming to counter such risks.

Let's start with one overarching recommendation provided by the Rathenau Instituut (2021), which states that AR technologies should "protect the *mental* and physical health of AR users" (emphasis mine, 2021: 80). As simple as it might sound, this already sets a foundation for policymakers to reflect on the cognitive implications for users of AR glasses, especially because of their proximity, immediacy and curation of information.

To protect the capability of sustained attention and reduce user distraction, future users of AR glasses should be able to determine and control what kind of notifications and recommendations they want to get, and *when* they want it. Taking a user-centric perspective, the default operating mode of AR glasses should be to display as minimal information as possible, unless the user explicitly sets the glasses to do otherwise. This goes in line with the principles of calm technology, initially addressed by Weiser (1996) and further expanded by Case (2015). One of these principles is that "technology should require the smallest possible amount of attention" (Case, 2015: 17), which promotes an opposite understanding of how technology should be designed in comparison to the attention economy model.[12]

Next, we have seen that the risk of addiction brought by consumer AR glasses can pose a threat to users' cognitive autonomy. To avoid that, the Rathenau Instituut advises policymakers to prioritise the development of AR technologies that safeguard individuals' cognitive autonomy (2021: 81-82). One specific aspect of this issue involves the manipulation of perception and behaviour, as developers of AR applications possess the ability to control and influence what users see, hear, and feel, consequently shaping or exerting a great level of influence over their knowledge, thoughts, and actions within the world (Rathenau Instituut, 2021: 19).

Last, to minimise the risks of an augmented scepticism brought by future AR glasses, it is crucial to ensure that the AR content displayed directly at the user's field of vision does not undermine their cognitive capacity to distinguish what is physical from what is digital. The Rathenau Instituut suggests that AR technologies should aim to enhance human abilities in an

[12] Although a paid-subscription model could be a way to avoid the user's exposure to advertisements, we then touch upon the question of distributive justice, which is, what about the users who cannot afford to pay for it?

equitable and respectful manner (2021: 81). This implies that companies should refrain from treating future users of AR glasses solely as "data sources" to exploit for the purpose of advertising services and products in increasingly manipulative ways.

Governance measures should preferably be taken in broader contexts, such as at the European level, and in a coordinated way (Rathenau Instituut, 2021: 84). An analysis provided by Deloitte Insights regarding how to regulate AR at its early stage of development suggests that policy makers, in collaboration with private and public organisations, should make use of various tools to better assess and evaluate the risks that could be brought up by a mainstream usage of AR (Cook et al, 2019). For instance, they can establish policy labs, create regulatory sandboxes, make use of crowdsourcing policymaking, and incentivise companies to develop standard-setting bodies. These are adaptive approaches that can prove to be very helpful given the ongoing advancements of AR technology. In short, regulation regarding the development and commercialisation of AR glasses needs to be based on a multi sectoral participation, including different actors and stakeholders interested in the debate; from the technology companies themselves to civil society.

The above recommendations are not conclusive. Rather, they are starting points for initiating debates with the relevant stakeholders, such as companies, policymakers, ethicists, and citizens.

Conclusion

In this chapter, I have evaluated the identified ethical risks in relation to the cognitive harms that AR glasses can pose to regular consumers. I have done so by recapitulating its main risks as presented in Chapter 2 and then proceeding with the actual evaluation. I have argued that while AR glasses can bring numerous benefits for their users, we shall not overlook its potential harms to human cognitive capabilities. This is not a simple utilitarian equation where we will be better off if the benefits outweigh the harms. The short and long-term implications that a regular usage of AR glasses might bring to consumers in the context of the attention economy and surveillance capitalism can negatively impact human natural cognitive attributes that we find valuable to preserve, such as the ability to sustain attention to execute tasks that require time and concentration. For this reason, I have provided a few governance recommendations which were aimed at countering some of the cognitive harms that AR glasses can potentially pose to regular consumers.

Let me now go back to one of the reflections I have brought in Chapter 1, which is about the desirability of having regular consumers wearing AR glasses. A couple of questions that policymakers and citizens need to think of are whether it is desirable to wear AR glasses in the streets, in our homes, during our leisure time? What will society look like in that case, and what are the trade-offs? While I'm certainly not in a position to give any final answer on that account, nor I believe that any single person or a corporation is, the aim of this question is to incentivise public debate about how we want to incorporate emerging technologies like AR glasses in our everyday lives. I believe that for-profit organisations should not onboard humanity onto their digital disruptive devices without democratic dialogue.

These questions are of ethical importance. And the task of ethics is central to living in society in a sustainable and harmonious way. Ethics is not a static guide or checklist that we can always look at to determine what is right or wrong, what we should permit or prohibit. This is because our moral values are constantly evolving, and no one can predict with full certainty what moral values will predominate in the future. Ethics, instead, is an ongoing and demanding activity at the service of a harmonious coexistence, and it goes far beyond complying with established norms or checklists. Ultimately, ethics is a disposition of the collective intelligence, a struggle of the whole society to achieve a fairer coexistence.

As emerging technologies develop, our existing moral values are affected and co-shaped by them, which in turn prompts the need for ethical reflection. Such reflection allows us to critically think and question what goals we want to reach by using a specific technology in ways that are not purely driven by consumerism.

I began this thesis calling the attention of the reader about the current developments of AR glasses for regular consumers and why we should already start addressing the ethical risks posed by this emerging technology. Then I have mapped a few of these risks and finally provided some recommendations. If AR glasses will become our next mainstream device, only the future will tell. However, what motivated me to carry out an anticipatory assessment of this technology is to promote the importance of critical reflection about what we understand as technological development, which does not automatically translate into societal progress. In that sense, I would like to conclude this thesis with the message conveyed by Hannah Arendt to all of us: "What I propose, therefore, is very simple: nothing more than to think about what we are doing." (1998: 5).

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