Geography and Virtual Reality (VR)

ABSTRACT:

Whilst Virtual Reality (VR) has a long history, recent technological advancements, increased accessibility, and affordability have seen its usage become wide-spread within western consumer society. Despite the relevance of VR to Geography, these more recent developments have escaped scholarly attention. This paper takes a critical perspective on the development of VR and its varied applications, and how emerging theoretical debates within cultural and digital geography (and beyond) are influencing the social and cultural implications of VR technologies. The paper begins by considering how VR spaces are imagined and communicated to publics in ways that promote popular understandings of, and desires for, virtual spaces. Next, the paper critically addresses the cultural politics of VR content, particularly drawing attention to the socio-spatial differences evoked through VR. The paper goes on to argue for the need to consider VR through the concept of interface as a way of critically attending to the broader techno-socio relations and the embodied spatial encounters they produce. Finally, some methodological implications for thinking *with* and *through* VR are outlined.

KEY WORDS

Virtual Reality (VR); Cultural Geography; Digital Geography; Representation; Interface; Embodiment

INTRODUCTION:

In March 2014, the social media organisation *Facebook* acquired *Oculus VR* for a reported $2 billion. Despite at the time having no consumer product ready, this acquisition showed the intent and expectation that Virtual Reality (VR) was going to gain increasing traction within consumer society. Recent sales forecasts appear to confirm this with the purchases of VR Head Mounted Displays (HMDs) reaching 8.9 million by 2019, an increase of 54.1% over 2018 (IDC 2019). Moreover, what has become increasingly apparent is the various organisations and actors which have appropriated VR for a range of purposes. This includes journalism (Watson 2017), culture and heritage (Carrozzino and Bergamasco 2010), health care and medicine (Ma *et al.* 2014), tourism (Bogicevic et al. 2019), and the military (Lele 2013). Whilst it is important to state that VR technologies have been around for much longer, their increased accessibility and affordability means VR has become woven into western commercial and everyday life. Yet, and comparatively to other technologies, it has received limited scholarly scrutiny from geographers.

A major reason for this dearth of critical enquiry has been because the history of VR continues to ebb and flow. Whilst there was a growing public hype coupled with scholarly geographical intrigue in the 1990s, the costings, alongside a mismatch between expectations and actual capabilities, meant that further development, and subsequent research interests receded (see Chan 2015). In conjunction, and with a few exceptions (see Hillis 1999), geographers have tended to consider VR as a *tool* for both geographical research dissemination, and for pedagogical purposes (Detyna and Kadiri 2020; Hagge 2020; Kent et al. 1997; Spicer & Stratfield 2001; Stainfield et al. 2000; Stojšić 2017; author: date). Whilst VR technologies offer much to the teaching and the dissemination of geographical research, such an emphasis overlooks the broader implications of VR concerning the mediation of

space and time, the representations of people and places, and embodiment in virtual environments.

It is the contention of this paper that the emerging debates within cultural (and digital) geography (Ash et al. 2018; Rose 2016, 2018), offer much to the critical study of VR technologies. Within cultural geography, there has been a growing interest in a wide range of popular visual media and technologies. While film has long been established as a site of geographical enquiry (see Aitken and Zonn 1994), a number of scholars have turned attention to other forms of visual spatial technologies, processes, and experiences elicited via; video games (Ash and Gallacher 2011), 3-D cinema (Jackman 2015), i-Docs (Harris 2017), digital media and imagery (Rose 2016). However, despite the exponential growth of the VR industry, and its inherent geographical qualities, it has failed to gain critical attention from geographers. This paper seeks to consider the juncture in both the technological advancements and 're-emergence of VR' (see Evans 2018), with the more recent theoretical and conceptual developments within the field of cultural and digital geography to critically attend to the wider implications of VR technologies on socio-spatial life.

The paper then goes on to argue that cultural geography can play an important role in critically attending to, firstly, how VR spaces are culturally represented, imagined and communicated to publics in ways that promote popular understandings and desires for VR, and virtual spaces. Secondly, the paper considers the cultural politics of VR content and the socio-spatial differences that are evoked. The paper goes on to considers the broader techno-socio relations, and the embodied spatial encounters VR headsets produce through the lens of the interface. Finally, some methodological implications for thinking *with* and *through* VR are outlined.

DEFINING VIRTUAL REALITY (VR)

Attempts to define VR have shown limited consensus. Championed as a key pioneer and coining the term ‘Virtual Reality’, the computer philosopher Jaron Lanier's (2017), in his latest book, provides no less than 52 definitions of VR. This points to the complex and multiple ways VR is conceived and the contestable nature of the term. As Brodlie et al. (2001:7) go on to suggest "… there are as many 'virtual realities' as there are researchers actively involved with VR". Understanding VR and the experiences they generate varies in terms of the technological hardware and software, the levels of interactivity, and the virtual spaces presented to the user.

It is important to recognise that there are several prefixes demonstrating different forms of 'realities' on offer and which can be seen on a spectrum in terms of spatial affordances. Augmented Reality (AR) involves the enhancement of 'real-world' experiences via computer generated display, sound, text and effects. AR has received growing recognition by geographers and its implications for experiencing and producing places (Graham and Zook 2013; Graham et al. 2013; Zook et al. 2015). A prime example of AR can be seen in the mobile game *Pokémon Go*. Released in 2016, the game can be downloaded on to smart phones, and overlays ‘real-world’ environments with in-game content and action - in this case the location, capturing, training and battling of virtual Pokémon (see Dorward et al. 2017). Mixed Reality (MR), sits in the middle of the spectrum, combining aspects of both AR and VR and the physical and virtual worlds. The *Microsoft HoloLens*, for example, is a mixed reality smart glasses headset that not just overlays but also anchors virtual objects to the 'real' world.

Virtual Reality (VR), on the other hand, is the technological means in which a user is immersed, and interacts, within a virtually rendered environment. The term is largely attributed to Jaron Lanier from the late 1980s. A key aspect of the VR is its ability to create a sense of presence for the user – as if it is 'real' and they are a part of the virtual world presented to them (Che 2016). This has led to a seemingly amorphous definition of what VR constitutes which can includes a broad spectrum of things: "virtual reality simulations, Web pages, chat-rooms, bulletin boards, MUDs [multiplayer real-time virtual world] (both textual and visual) and 'game' spaces" (Kitchen & Dodge 2002: 341). However, more recently, a common engagement with VR has been through a dedicated Head Mounted Display (HMD). It is necessary to acknowledge that VR encapsulates a range of technological devices, forms and content which alter senses of presence, interactivity and experiences.

Following Taylor (1997), VR is constituted by three main aspects that help to delineate it from other media. Firstly, there is a computer or hardware system that allows users to interact with and see virtual space. Early iterations of VR were mediated and tethered to a computer, while more recently standalone HMD headsets can be used to run VR experiences, increasing the levels of affordability and accessibility, and expanding the geographies with which VR is engaged. Additional hardware, including data gloves, haptic controllers, and sensory masks[1] work to augment a sense of presence in virtual space through sensory and haptic stimulus. The collection of technical apparatus and hardware that make up VR have important implications for the ways in which virtual environments are mediated, and how they encourage bodily dispositions and sensuous experiences that shape how people comprehend and interact in these virtual worlds.

[1] The Feelreal Multisensory VR Mask suggests how the device enables full immersion by "simulating smell, rain, wind, vibration, punches…" (see https://feelreal.com/).

Secondly, VR presents a computer-generated 3D visual environment based on a simulation of a 'real' or a fantastical world. The VR experiences generated vary dependent on their designed purpose, and the actors and institutes involved in their production and display. In most cases, VR enables a 360 mediated visualisation of space. However, users' abilities to interact with the space varies through the 'degrees-of-freedom' offered, real-time tracking abilities, and how the virtual image is rendered.[2] Such VR experiences are usually based around individual engagement with virtual spaces. 'Social VR', on the other hand, presents a predesigned virtual environment whereby a user – through an avatar – can engage in synchronous interactions with other users. For example, *AltSpace* offers a unique social platform and means of social encounters in virtual space. In this respect, users 'embody' their avatar and can perform basic nonverbal cues, such as hand gestures, and manoeuvre within the environment to promote virtual encounters of proximity and intimacy[3] with other users (Dzardanova et al. 2018).

Finally, and perhaps what is perceived as a key defining characteristic of VR, is the level of real-time interaction enabled between the user and the virtual world. However, there is a degree of ambiguity largely animated by what has been dubbed "the VR and 360 Video Complex" (Doran & Parets 2016 cited in Van Damme et al. 2019: 3). For example, journalistic initiatives that use VR employ '360 videos'. In this instance, user's interaction with the space is limited to viewing the panoramic scene in comparison to a fully interactive VR which allows the user "to explore and/or manipulate a space" (Van Damme 2019: 3). As such, it is clear that many versions of VR are not providing 'full' immersive experiences.

[2] For example, monoscopic renders one image for both eyes and lacks depth whereas stereoscopic involves the rendering of two images which enables a sense of depth. This has significant implications in regards to the spatial quality of the visualisation.

[3] The level of intimacy and suggested visceral nature of VR social spaces has also promoted issues concerning online harassment. This can include verbal (personal insults), physical (unwanted touching), and spatial (displaying sexual or violent content) (see Blackwell et al. 2019).

This moves us to consider how immersion within such virtual spaces is negotiated between producers, the VR experience, technical apparatus, and users.

Ultimately, a focus on identifying and attempting to define VR through its technical make-up, belies an appreciation of both the history of VR technologies and the definitive role of "institutional and intellectual infrastructures that invent, deliver, and package them" (Hillis 1996: 71). Whilst a detailed history cannot be covered here (see Hillis 1996, 1999; Chan 2015 for a more comprehensive account of the history of VR), tracing its genesis complicates many contemporary accounts and attempts at marketisation that extoll its unique and novel properties, and instead helps reveal the material, cultural and social conditions of its production, and subsequent usage. More recently there has been increase in academic and public interest in the re-emergence of VR technologies (Cipresso et al. 2018, Evans 2018). In the following section, I outline how the cultural representations *of* VR technologies, and the kind of spatial environments they produce, played a role in the development of VR.

Cultural Representations *of* Virtual Reality

As the above brief history of VR has shown, its development and societal uptake, is not predetermined, nor given. Through tracing the historical development and emergence of technologies, cultural geographers have shown the contexts and conditions that facilitate spatial technological development (see Wilson 2014, Jackman 2015, Kinsley 2010). For cultural geographers, such representations consider the spatial values, ideologies and meanings given to technologies, the geographic knowledge they present, and, more recently, the *material* power of the visual. In other words, such representations are "not just world-reflectors, they are also world-makers" (Bissell and Fuller 2017, 2478). The politics of such cultural representations and imagined futures sets agendas for the development of VR, and how it is encountered by various publics.

The framing of VR and the spaces it generates has emerged out of a wider media ecology that has continued to discursively construct VR as a novel, emergent technology that inturn informs its developmental trajectory. Kirby (2010: 43) outlines how popular culture, in this case films, can display technical objects such as VR, as 'diegetic prototypes', "demonstrat[ing] to large public audiences a technology's need, benevolence and viability". Popular cultural and media depictions thus become productive of anticipatory futures that cultivate both consumer and industrial desire and support. As such, these visual and discursive framings are performative, enabling an understanding of the emergence of technologies within society.

For cultural geographers, literature has been a valuable source to interrogate the cultural framing of VR. The genre of cyberfiction, and cyberpunk, has been heralded as an important outlet that has provided a lens to critically attend to, and speculate on, the

spatialities of sociotechnical relations (Kneale 1999; Kitchen and Kneale 2001, 2005; Graham 2016). From an early-stage VR has long been imagined through the pages of science fiction novels (see Steinicke 2016 for an overview of science fiction novels engaging with VR). William Gibson's (1984) sci-novel *Neuromancer* is benchmarked as popularising terms such as 'cyberspace' (Batty 1993), and for foreseeing the development of VR technologies. Such literary depictions are argued to not only be reflective but are also constitutive of the technologies themselves, offering what Kitchen and Kneale (2001: 32) term 'cognitive spaces' "which are being used by individuals and institutions in conceiving and making future society". Science fiction literature continues to be referenced by the VR industry in a way that guides and legitimises its development (Steinicke 2016: 20). It is this reciprocal relationship that demands critical investigation, and how such literary works open speculation about present-day geographies and emergent human and technological relations. This focus on VR imagineries are attuned to questions of power, and the socio-economic interests they serve. Facebook's aquisation of Oculus saw promotional material that discursively framed a specific, self-serving vision of VR. These 'Oculus Imaginaries' sought to promote the geographies of usage of VR as "occupying a more mundane role, situated in everyday domestic spaces, used for purposes beyond gaming" (Egliston and Carter 2020: 11). It is important to note that such framings are not accepted by the public, and can come into direct conflict with personal values, especially concerning data and privacy and the wider cultural politics of VR and its usage (see Egliston and Carter 2020).

Where cultural imaginaries have aimed to fulfil commercial interests, or perpetuated dystopic envisagement of VR spaces, there are growing ways in which it is being imagined otherwise. The gendered construction, depictions and experiences of virtual spaces have long been of interest within cultural and digital geography (see Elwood and Leszczynski 2018), and are important in critically attending to the ways VR not only represents but also actively

(re)produces socio-spatial inequalities. As the brief history has alluded to, the emergence of VR technologies has stemmed from a militarised and male-dominated industry. Contemporary popular imaginaries of VR, such as the film adaption of the novel *Ready Player One* (2018), are driven by masculinist narratives of conflict and heroism, and are argued to pander to a toxic masculinist 'gamer culture' (see West-Knights 2018). Whilst the wider technological industry suffers from a well-documented issue with diversity concerning gender (Boyer and England 2008; Holloway et al. 2000; Johnson 2013), there has been increasing desires to promote inclusive and progressive changes within the VR industry. [4] A 2017 survey of 70 US VR companies, for example, found that women took up 64% leadership roles (Onanuga 2019: online).

The emancipatory possibilities of VR environments have been led and imagined predominantly through the work of female artists (Morie 2012). Such modes of experimental interventions aim to disrupt gendered tendencies *with* and assumptions *of* VR spaces, and open-up new opportunities for the re-making of virtual spaces and subjects. In this vein, Brandt and Messeri (2019) have explored counternarratives in popular television shows in which VR is (re)imagined as a space of inclusivity, care and reciprocity. They discuss a range of examples including the *Black Mirror* episode *'San Junipero'* (2016) in which VR becomes a therapeutic retreat for those facing death, and enables individuals to live out aspects of their lives they were unable to do in 'reality'. In this case women whose sexuality was supressed in the 'real' world could relive and express it through VR. Allied to feminist epistemologies, such counternarratives offer an important lens in which to explore the innovative and creative ways in which VR can become "a technology of care with a capacity to improve and sustain

[4] Founded in 2018, A Vision for Women and Virtual Reality (see http://www.vwvr.org/) has advocated for greater transparency and gender balance within the VR, and wider immersive industrial sector. The social VR website AltSpace, in celebration of International Women's Day, created a monthly forum '#AltVRWomen' to provide a space to discuss the gendered experiences of VR, but also more generally the technologicalimplications for social interactivity (https://altvr.com/mrwomen/).

the lives of its users" (Brandt and Messeri 2019: 7). As Brandt and Messeri (2019: 22) continue, such imaginaries are vital as they

> "help to reorient how the VR industry imagines itself, how it imagines its own purpose and labor in building worlds for others to inhabit, and how it imagines who can participate in building and occupying these worlds".

As such the cultural geographies of the representations of VR play an integral part in understanding how the futures of VR technology, the spaces they mediate, and their socio-spatial significance, create anticipatory logics and desires which are constitutive of how, what, for whom and where such technologies are made, to matter. Discussions of representations and discursive framings of technologies, and their spatial affordances, recognise that they are neither innocent, nor passive but are actively constitutive of the technology, and societal engagement.

Cultural Representations *in* Virtual Reality

Recent critical engagement with VR within cultural geography has seen an exploration of the politics of the digital meditation and the relations of power and social difference that are evoked within such virtual environments (Rose 2019). This is exemplified in the work undertaken on videogames, which has considered the cultural politics of representations of people, places and landscapes (Ash and Gallacher 2011), their affective qualities (Shaw and Wharf 2009), and the wider practices and emerging spaces they produce (Ash 2009). However, VR offers a novel means in which place, space and landscape are mediated and represented. Geographers to date have tended to focus on VR as a means of communication and geovisualisation of data for research and teaching purposes (see Fisher and Unwin 2001), rather than acknowledging the wider cultural politics of these representations, the consequences of such immersive technologies, and their broader usage within society. There is a need to attend to the particularities and specificities in which VR operates and mediates space and time for its users.

Besides their use for entertainment purposes, VR continues to be promoted through a celebratory discourse which stresses its 'world changing' abilities. Geographers have begun to highlight the ways technologies and media can generate spaces in which social, political and environmental change can emerge within, and through, the digital realm (McLean et al. 2019; McLean 2019; Pickerel 2013). There has been a growing interest by a variety of organisations in which the construction of such virtual environments can "challenge or alter dominant, expected or accepted ways of doing society, culture and politics" (Lievrouw 2011: 19). In popular and academic discourses, VR has been understood as a technology which is

able to visualise distant geographies and encounter humans (and non-humans) in ways that can cultivate empathetic connections and relations.

The use of VR spaces provide a unique medium for communicating awareness of socio-spatial inequalities and injustices, and are argued to become a means of generating progressive social and political change. VR technologies have increasingly been used for humanitarian initiatives, promoting a unique means of visualising people and places, and collapsing distance in ways which provoke feelings of responsibility, care and compassion, and aim to compel political action (see Nash 2018, Herson 2016; Schutte & Stilinović 2017). The United Nations (UN) – for example – has been pioneering in adopting the technology for such purposes. Founded in 2015, the United Nations Virtual Reality (UNVR) was set-up to create a range of immersive VR experiences aligned to the Sustainable Development Goals (SDGs) Action Campaign. The purpose was to promote advocacy, education and fundraising towards the different SDGs.[5] One of the most successful[6] and critically acclaimed VR experiences was *Clouds of Sidra* (2015). It puts viewers into the perspective of Sidra, a 12-year-old Syrian refugee who is housed at the Al Zaatari Refugee Camp in Jordan, home to over 80,000 Syrians who had fled from the Syrian conflict. For Awan (2016), the power of such VR experiences is their ability to offer new means of witnessing in a digital age – evoking multi-layered immersive forms of narrative and representations, presenting new possibilities for public and geopolitical engagement.

These claims concerning the political impact of VR, however, rest on two assumptions. First, that VR draws awareness and is able to visualise key global political and ethical issues, such as global warming, migration and conflict, by altering individuals' spatial

[5] As of July 2021 UNVR, has 21 VR films which cover a range of SDGs (http://unvr.sdgactioncampaign.org/vr-films/)
[6] It was suggested that after the VR film was shown at the Third International Humanitarian Pledging Conference for Syria, Kuwait City (2015), there was an increased level of donations – over $1billion compared to the previous year with 1 in 6 of attendees donating after watching.

imaginations – collapsing distance and facilitating a sense of presence. Second, VR is argued to enhance empathy, and shape empathetic responses, in regards to political issues and vulnerable and stigmatised populations and places (Schutte and Stilinović 2017; Shin 2018; Hassan 2019). However, as Rangan (2017) argues, when the camera is given to, and seen through, vulnerable populations there is a tendency for them to use *immediations* – tropes that reinforce and reaffirm their status as the 'other' and reproduce established power dynamics and spatial differentiation. As Nash (2018: 129 emphasis added) elaborates, whilst VR invokes a sense of presence and involvement in an event, in doing so it presents "a loss of perspective, an *improper distance* in which the experience of 'being in' VR, a narcissistic reflection on one's own experience, becomes the foundation for moral response". In this sense, while such experiences work to challenge a sense of user's perspective, it also reaffirms power relations and 'othering', perpetuating normative, rather than disrupting, sensibilities around such humanitarian issues.

In critically attending to visualisations within VR it is imperative to note the varying degrees of spatial interaction offered, and their implications when engaging with these representational worlds. Rather, than a boundless 360 engagement with virtual worlds, the relationship between the user and VR space is dependent on structuring devices designed and implemented by producers that guide the viewer's gaze and attention within the virtual space (see Dooley 2017). Moreover, the omnidirectional viewpoint of VR present ethico-political dilemmas, especially concerning notions of the veracity and objectivity conveyed to users in such environments. This is especially true when we consider how the use of VR invites challenges to normative institutional values, especially in the field of journalism. In this respect, Aitamurto (2019; see also Mabrook and Singer 2019) argues how the use of 360-degree videos compromises journalistic institutional norms around visual accuracy and objectivity. In the first instance, the spherical view offered in 360 videos concedes journalists

control over representations and instead encourages "more space for the viewer's subjective interpretation" (Aitamurto 2019: 16). Secondly, it is argued that journalists are more likely to manipulate and alter such experiences in ways which convey a sense of objectivity, thus compromising journalistic ethical codes concerning the alteration of visual material. Whilst such claims of advocacy for the representational power of VR, it is important to remain attentive to the design, production, and forms in which of such environments are presented.

Virtual Reality Interface Envelopment

Critically attending to the visualisation of people and places in VR presents challenges to both the theoretical and methodological foundations of cultural geography. Rose (2016a) argues, more traditional approaches promoted by cultural geography struggle to account for the mutable, multimedial, and mass nature of cultural images and objects in the current digital juncture. Indeed, rather than offering a fixed viewpoint to its user, VR invites navigation. It presents a "space that is fluid, scalable and malleable" (Rose 2016a: 340). Such varying modes of visualities and how they are produced, displayed, experienced and circulate, present pertinent questions.

Cultural and digital geographers have advocated an approach which goes beyond identifying and analysing a stable visual image, but instead attempts to consider the complex human and non-human relations in which digital mediated spatial experiences emerge (Rose 2016a; author: year; Mabrock and Singer 2019). This approach focuses on the relationships between the different actors, such as hardware and software producers, and users. Such a standpoint addresses issues of technological determinism (see Bingham 1996) and –how VR technologies are understood, used and affect individuals, and wider social, cultural and political life. Drawing on Actor Network Theory (ANT) in relation to journalistic usage of VR technologies, Malbrock and Singer (2019: 2099) detail how such an approach enables a consideration of technical apparatus, user agency, and the production network which "impact on the content, structure, affordances, and experience of a ‘journalistic’ VR narrative". Indeed, it is important to note the manner and technical equipment in which VR is engaged with, whether this is through a computer screen, a *Google Cardboard* headset, or a dedicated standalone headset, has implications for the quality of the visualisation of the virtual

environments, the possible interactions provided to users, and the overall spatial experience subsequently encountered. Whilst the use of HMD presents an enclosed mediated encounter with virtual spaces, such encounters are shaped and framed by the spaces in which they are consumed. More recent VR HMD, such as Oculus Quest, allows '6 Degrees Of Freedom' (6DOF), and are not tethered to a personal computer. Saker and Frith (2020) show that such systems now mean physical space is increasingly being incorporated into the digital space to create what they term coextensive space "a symbiotic relationship between physical and digital that is increasingly proximate, extensive and transformative" (Saker and Frith 2020: 1436).

Within geography there has been a growing focus on the role of interfaces as a lens in which to explore digital forms of socio-technical relations and the spatial and temporal embodied encounters they produce (Ash 2015; Rose 2016a; Adams-Hutcheson & Longhurst 2017; Anderson 2019). The increasing ubiquitous nature of interfaces especially within western society, have become complicit in the production of what Ash (2015) terms 'interface envelopes', localised folding of space and time that calibrate particular skills, habits, affects, actions and engagements organised around, and often understood in relation, economic profiteering (see Langley et al. 2019). Such mediation of virtual environments plays an important role in cultivating affective and emotive relations and emphasise the performative relationship between technologies, space, screens, and bodies (Longhurst 2013, Bonner-Thompson 2017). This requires an acknowledgement of what bodies are engaging with VR, how VR is (re)making digital subjects, and how they respond and engage with VR environments (see Elwood & Leszczynski 2018). This raises important questions around the agency of the users and embodied encounters that are initiated within and through VR spaces. As indicated, this extends beyond an immediate concern with the representational, and

includes the broader socio-spatial relations that enable such encounters. In considering the politics and power of such virtual visual regimes and the work they do requires, as Sumartojo and Graves (2019: 7) go onto argue;

> "[…] accounting for the sensory and perceptual alongside the representational, narrative, algorithmic or codebased aspects of the digital, and interrogating how they work together to shape the ongoing experience of the world".

However, to examine the role of the VR interface is not just to consider the ways they shape spatial and temporal perceptions, but also how such interfaces are implicated into broader political-ethical questions around individual privacy, data protection and security (Kenwright 2018; Madary & Metzinger 2016). There is growing fears, for example, how eye-tracking capabilities are being increasingly incorporated into HMD interfaces. VR is argued to become "the most detailed [form of] intimate digital surveillance yet" (Kopfstein 2016: online). Following Kinsley (2014), the use of VR can illicit spaces of calculation, monitoring and analysing intimate bodily dispositions, and setting users within algorithmic regimes of power, serviceable for commercial and governmental interests (Adey 2009, Celis Bueno 2019). A focus on VR needs to attend critically not only to how digital ways of seeing are constructed, but also to note how such private and intimate human connections with interfaces "both enable and seek to *control* the production and performance of space and place" (Kinsley 2014: 369 emphasis added). Cultural and digital geographers offer important critical insights into how such digital wearable interfaces are initiating private forms of surveillance, and in which the perceptual engagement with virtual spaces become implicated within biopolitical regimes.

CONCLUSION

As the VR industry continues to grow, and the technological applications of VR increasingly seeps into institutional and leisurely life, this paper has argued that geographers need to undertake a critical examination of the wider social and cultural spatial significance of these technologies. This paper has outlined several trajectories, which draw on emerging concerns within cultural and more recently digital geography, to consider the interplay between technologies, representation, space, and embodiment. Tthe paper has highlighted the need to attend to the discursive construction of the technology, and how the spatial properties of VR are portrayed. In considering the ways VR is represented to publics, it provides important insights into how, what, where, and for whom, such technologies are made to matter. Secondly, it is imperative for cultural and digital geographies to attend to the power relations and socio-spatial differences that are evoked *within* and *through* VR content. Whilst VR technology has been celebrated for its transformative potential, there is a greater need to examine critically the people, spaces, and objects depicted; the scopic regimes that are produced; and to empirically account for the socio-spatial effect it has upon people. Finally, the paper, has examined how recent interests into the role of interfaces are needed to consider the broader techno-socio relations, and the embodied spatial encounters they produce.

To end, if cultural and digital geography offers the conceptual and theoretical vocabulary to think critically around the socio-spatial implications of VR, they are also present potential methodological approaches to the study of VR. However, few empirical studies address contemporary digital geographies (see Kinsley 2014) and VR more specifically. Such questions remain imperative in investigating claims of the application, utility and embodied spatial experiences VR offers. There is a growing recognition of the various methodological

challenges that have emerged concerning the changing nature of digital imagery and technologies (Rose 2016b; Leszczynski 2018), therefore, there is a need to consider the specificities in how VR operates, how it is displayed, and how it is consumed. This means there are practical questions concerning how researchers *look at* and *with* VR. A focus on how VR communicates meaning is imperative. It will need to consider critically not only the visual-audio representations, but also the field of vision, the degree of interaction, the interface design and functionality (see Ash et al. 2018b), forms of haptic feedback (see Paterson 2009) and the visual and narrative grammar utilised (see Dooley 2017). This would demand the researcher's reflexivity – acknowledging *what* and *how* the VR experiences are encountered, recorded, and subsequently analysed.

In attempting to account for the experiences of virtual spaces, and the difficulties faced in interpretting the immersive, veiled and highly idiosyncratic experiences, scholars have called for the use of autoethnography (see Jones and Osborne 2021). Drawing on and reflecting on personal experiences of the agricultural video game *Stardew Valley*, Sutherland (2020), demonstrates the potential of autoethnographic research for analysing digitalised spaces. This is a time intensive approach, but enables direct intimate accounts with virtual space, documenting personal reflections and interactions within digitalised environments and the relations between self and virtual space, and the emergent affective encounters this facilitates.

As discussed, VR is argued to persuade and challenge subjectivities and attitudes on various political, environmental and social issues. Such assumptions have lacked critical investigation of the efficacy and impact that VR has on individuals (although see de la Peña *et al.* 2010). If geographers are to consider the relations between embodiment and VR interfaces, methodological approaches need to consider further the ties between bodily,

visceral and affective interactions and how VR spaces are encountered (see Sexton et al. 2017). Arguably, this also requires an ethnographic sensibility which identifies how place, whether this is the domestic setting, the museum, or the workplace, is shaped by and shapes encounters with VR experiences and practices (see Hitchings and Latham 2019; author: date; Pink 2015). Where VR operates can unveil rich insights into the wider socio-technical ecology and the relations which contextualize that experience. Digital visual technologies have become tools for capturing, presenting, and disseminating geographical knowledge and data (Ernwein 2020; Offen 2013). The use of 360 cameras offers a mobile form of data collection, documenting and presenting information-rich environments amenable to detailed situational analysis. Pretlove et al's (2020) preliminary research indicate that 360 footage of runners in action enables insights into such embodied sensory practices in-situ. The subsequent footage can be analysed utilising the expanded field of vision to elicit "elusive knowledge" (Pretlove et al. 2020: 1). Furthermore, the use of VR headsets allows the researcher to immerse themselves in the experience furthering more intimate encounters with situational data. Yet, as this paper has discussed, careful consideration needs to be placed on how exactly such spatial knowledge and data is created, experienced and made sense of by academics and the public alike.

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