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Technologically transformed experiences of nature: A challenge for environmental conservation?

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Abstract

Direct experiences of nature are increasingly being replaced by technologically-mediated ones, with unclear implications for people's attitudes toward nature and toward environmental conservation. In this essay, we argue that it is useful to think not simply about the extinction of nature-based experience, but about the specific ways in which experiences of nature are being transformed into different types of experience, in order to consider the possible effects. Two important characteristics of these transformed experiences are that they are standardized, and that they encompass less sensory richness; based on research on the positive effects of direct experience, these characteristics suggest a possible reduction in both human wellbeing and support for environmental conservation. Because the transformation of nature experience is unlikely to be reversed, we encourage formal and informal environmental education that mindfully teaches children how to think about the relationship between virtual and real environments, so that one does not completely supplant the other.

Introduction

Over recent decades, more and more people worldwide - especially children - have been interacting less and less with natural environments and their associated biodiversity, so that many human populations are undergoing what has been described as a progressive extinction of experience of nature (Pyle, 2011). Several factors underlie these changes in the experience of nature. For one, a growing proportion of the population resides in cities, where contact with nature typically has to be sought out rather than occurring routinely. In addition, technology provides people with both entertainment and information, so that they no longer need to engage with the natural world to satisfy those needs. This reduction in direct nature experience has been presented as having deleterious consequences not only for human well-being and health, but also for people's emotional, attitudinal and behavioral relations to nature and biodiversity, and thus potentially for the well-being of the planet.

Numerous studies provide evidence for this decline in direct experience. However, Clayton et al. (2017) propose an alternative conceptualization, describing it as a transformation rather than an extinction of experience. Experiences of nature are complex phenomena, embedded in social and cultural contexts, evolving in combination with political, societal changes and with technologies in human's daily life, and subject to transformation by those changes. Nature varies from remote and untouched ecosystems (though arguably these no longer exist; cf. McKibben, 2006), through parks and habitats that are managed by humans, to nature that is represented behind glass or through the medium of technology. Neither nature nor experiences of nature can be fully characterized simply as either "present" or "absent." An advantage to thinking about the ways in which experiences of nature are transformed is that it calls attention to *qualitative* rather than *quantitative* differences in the ways people encounter the natural world. Attention to these qualitative changes suggests some potential for negative consequences for human and environmental health; it may also point toward ways to mitigate them.

There is more than one type of nature experience. Kellert (2012) emphasized the need to acknowledge the fact that today's children can experience nature in a wide variety of ways, which are not simply limited to involvement with *direct* experiences of nature (involving actual physical contact), but also include *vicarious* nature experiences (involving realistic as well as symbolic and fantastic representations of nature without any actual, physical contact with natural settings, such as through magazines, books, films, television programs, and websites).

Similarly, Russel et al. (2013) propose that “benefits derived from non-material interactions with ecosystems and nature may be obtained through different channels”, from the most remote and indirect experiences to the most embodied and immersive ones. Keniger et al. (2013) also described incidental, intentional, and indirect experiences – which could include television programs – as part of the range of nature experiences that can be encountered.

In a contemporary context of transformation of nature experiences, new technologies, mostly based on screen-mediated experiences, could increasingly cause a replacement of direct and embodied experiences by indirect, vicarious and disembodied experiences. In this essay, we call attention to two important changes associated with transformed experiences of nature: reduced sensory, embodied experience, and homogenization.

Technology and experience

New technologies occupy a more and more prominent role in humans’ daily life, defining an unprecedented relationship between human and technical objects. This phenomenon, associated with an increasingly urban (United Nations, 2014) and sedentary life, is causing a significant change in the way people, and particularly children, are spending their free time. In a few decades, we thus switched from societies where children played outside to societies where they mainly interact with screens. Previous research found out that in the U.S., children spend more than 7 hours a day in front of electronic media in 2010 (Rideout et al., 2010) for only an average of 4 to 7 minutes a day in unstructured outdoor play (Juster et al., 2004). In the U.K., between 2005 and 2015, children's online time has increased from an average of 8 hours per week to almost 19 hours per week (Ofcom, 2015). Likewise, adults’ hobbies have evolved from those spent outdoors to technology mediated ones (Clements, 2004; Wilkie and Clements, 2018).

It is not only the proportion of time spent with technology that has changed; the types of technology and the ways in which people interact with it are also transforming. Today’s generation will grow up surrounded and immersed in a digital environment. In 2018, more than 23 billion internet-connected devices were in use worldwide: almost three on average per person on the planet, a ratio that is expected to rise to 4.3 by 2020 (Mercer, 2014). In this environment, traditional media –TV, radio, and printed media – have been supplemented by new, digital and social media allowing young people to instantly access entertainment, virtual sociality, information and knowledge. Unlike traditional media, in which users are mainly spectators and consumers of finished content, those new digital media also offer the possibility

for users to both consume and actively create content, making them actors of their experience instead of being only spectators. For youngsters, this integration of interactive media and technologies in their everyday life has become seamless and natural (Reid Chassiakos et al., 2016).

These technologies have changed the experience of nature for today's children compared with their parents, or even children from a decade ago. Whereas direct experiences have declined, there is an increasing number and diversity of opportunities for people to contact with digitally manipulated images of wildlife and natural scenes. In addition, with the current progress in terms of virtual reality and virtual environment modeling, new technologies – through new media, virtual environments and video games – could play an important role in the way people experience nature in the future, as well as providing new, technology-mediated experiences and types of relationship to nature (Truong, 2017). These are not experiences *in* nature in the direct and embodied dimensions of it, but they are nonetheless experiences *of* nature in that they indirectly expose people to information about the natural environment.

With the rise of techno-nature and technology-mediated experiences of nature, vicarious experiences may constitute a more and more important part of overall experience for those living in urban areas, surpassing their direct experiences of nature. As Kahn (2011) previously pointed out, technology and technological or virtual representations of nature may thus increasingly replace actual nature. We have to examine the consequences such a shift could have on people's lives in the long run: their appreciation of the value of the natural world, their relationships to and interactions with nature, and their willingness to take part in its conservation.

More complex than an extinction of experiences of nature, which implies a lack of exposure to or knowledge about the natural world, a shift to more technology-mediated experiences of nature could create a general bias, or filter, applied to how people interact with nature or what they expect from these interactions. This in turn could have implications for environmental conservation. In this paper, we first discuss the optimized experiences of nature that accompany technologies; next, we talk about the sensory impoverishment that results when technologies are the main provider of experiences. In the last part of this article, we reflect upon the challenges these impacts of technologies on experiences of nature raise for conservation questions.

Standardizing the experience of nature

An online study led by BBC and University of Berkeley in 2016 surveyed more than 7,500 people in several countries to ask participants how they felt before and after viewing clips of “Planet Earth II”, wildlife footage, popular drama and news coverage (Keltner et al., 2017). The results showed that compared to news, drama and emotionally neutral footage, even short engagement with video clips of wildlife and nature aroused a distinct uptick in feelings of awe, curiosity, joy and amazement and reduced feelings of anger, stress, low energy and tiredness. However, if vicarious experiences with nature like this one have been proven to provide micro-restorative benefits, their effects are still less powerful (Kahn et al., 2009; Kaplan et al., 1993) than the ones obtained from direct experiences (Townsend and Weerasuriya, 2010). For example, Kahn used both field observations and experimental research methods to compare the effect of a real window overlooking a nature scene with a real-time, high-definition television transmission of the same view. His results showed that people appreciated the HDTV view, but that it did not have the significant impact on heart rate recovery after low-level stress that was achieved with the real window, and that the real window held attention longer (Kahn, 2018). In general, virtual nature does provide some psychological or physiological benefits, but not as many as those obtained in actual natural environments (Calogiuri et al., 2018; Kesebir and Kesebir, 2017).

How are the experiences provided through nature videos different from direct experiences of nature, to achieve such different results? One answer may lie in the fact that documentaries are cut and edited in order for the spectator to have the most enjoyable experience possible, eliminating uncertainty, tedium, and the possibility of negative events. The spectator is not waiting for hours in the snow with the filmmaker for a pack of wolves to come. The experience in front of a screen is the view and sounds of a pack appearing, living, and hunting, which is a scripted and optimized experience of nature far from the one you would have if you went to meet real, feral wolves. Real material is used to offer the viewers in front of their screen, an optimal, safe, visual and auditory experience, without the weeks of waiting, the bad weather and the hazardous encounters a real life wolf photo-hunt would imply.

The same goes for the vicarious experiences of nature encountered through social media, especially on Instagram, which is mainly constituted by pictures and photographs. In the end of 2018, this app counted more than 400 million active users, and more than 100 million pictures uploaded, liked and commented every day. On this platform, among celebrities, brands, kittens

pictures and videos, a large amount of nature pictures are also posted, the hashtag #nature is associated with several hundred million pictures, #biodiversity with more than five hundred thousand, and some nature accounts are being followed every day by several million users.

The particularity of this cellphone-enabled nature is that, like nature documentaries, it offers a high degree of scenarization, optimization and control to the watcher. As it is a photo, every detail about how the image is taken can be managed; however, in the case of Instagram, there are additional standards that are not aesthetic or experience-optimization ones. There are online guides and courses telling photographers how and which picture to take, how to choose what to post, and how to make their feed “cohesive” when they post their pictures (for example, see this guide: ThePreviewApp.com, 2017) in order to attract viewers. As an example, if you just look for a few minutes at landscape pictures on Instagram, you will notice that they all look the same: they are almost all pictures taken at dusk or dawn for the contrasts to be optimal (Capretto, 2016), very symmetric, with no human presence or maybe one human, maybe a dog, and amazing weather. It rains no more on Instagram, and the pictures we see on this platform are so optimized that in the end, they are miles away from reality. Thus, a lot of accounts, images of nature and their content are taken and posted to stick to the cohesiveness of the feed, to correspond to a global tendency, not to realistically depict the natural world.

It is important to acknowledge that attraction to, and interest in, nature underlie a lot of these phenomena. Documentaries, social networks and even virtual universes may allow hundreds of million people the opportunity to find the nature they do not have in their daily life and to escape from the city. When they are asked why they play immersive online videogames, one of main reasons given by the players is “to escape from my daily life” (Yee, 2006) and when they were asked to name and describe the places they liked the most in game, places with verdant, ubiquitous and peaceful nature were the mostly cited by the World of Warcraft’s players (Truong et al., 2018). This general attraction to nature, even available through all our screens and technological devices, could be related to the Biophilia Hypothesis (Kellert and Wilson, 1993; Wilson, 1984), which proposes that humans have an innate tendency to have an emotional affiliation toward life and life-like processes as a consequence of evolution, where survival and reproduction were dependent on interactions with the natural environment. There is a great deal of research evidence supporting the idea that people like nature, seek opportunities to encounter it, and are restored by it (e.g., Martin et al., 2020). However, a general desire to affiliate with nature does not, itself, necessarily lead people to environmental conservation or even to direct experiences in nature.

Does it matter if people have mostly virtual, indirect experiences of nature? The experience obtained through screens and virtual universes is not as full and rich, or varied, as a real experience of nature. If biophilia can be satisfied with virtual experiences, reluctance to expend effort might lead people to stay inside finding nature online. If these standardized and optimized experiences of nature became the referential, normal experiences for future generations, this could add a new aspect to what Kahn (2002) called Environmental Generational Amnesia: the idea that each generation loses information about earlier states of the natural world, and perceives the environment into which it is born as the norm, no matter how developed, urbanized or polluted it has become. This norm also applies to what each generation comes to think of as “nature” and its pristine state, based on what it is exposed to. Thus, with each ensuing generation, the amount of environmental degradation increases, but each generation tends to perceive that degraded condition as the baseline condition, the normal experience. This does not characterize every culture, but in societies lacking direct experiences of nature, knowledge about the natural environment and its requirements can be lost (Tang and Gavin, 2016).

As technologically-mediated experiences become more pervasive, the reference point for evaluating the environment could be an exclusively mediated experience, standardized, unilaterally positive, and safe, which would make the gap with the previous generations even bigger. The optimized nature shown in documentaries, on social media, and in virtual universes only rarely shows the environmental issues of the real world. This could increase the overall lack of acknowledgement and engagement for the real environmental issues even more. Understandings of nature based solely on technologically optimized depictions may lead people to be less interested in, or satisfied by, messy, unexciting, local ecosystems, and thus less aware of threats to those ecosystems and less motivated to protect them.

It could be argued that we already have strongly scenarized or homogenized experiences of nature. Wanting to bring nature experiences to city dwellers, for instance through urban parks and green spaces, city planners and managers make technical and economical choices that channel and model the experiences to which people have access. Always planting the same species for chosen functions and keeping the same space management, they focus people on what they create as nature and therefore, they affect how people perceive and what they define as experiences of nature. Indeed, research shows that, although people think they prefer wilderness, their preferred landscapes are not always the most healthy or natural (Clayton, 2019). However, if it is true that this nature is managed, there is still a significant difference

between the embodied experience of a park and a technology-mediated encounter with the natural world.

When experiences lose senses and embodiment.

As described above, with the urban way of life being more and more sedentary and with the spread of new ways of spending their time, children –especially in Western countries– spend less and less time playing outside. Even when it is possible for children to do so, the conditions in which they can experience nature are very restricted (Laird et al., 2014; McFarland and Laird, 2018), as teachers and parents are more and more reluctant to let children alone or freely experiment without any supervision (Stevenson et al., 2014). Children’s contact with natural environments has been reduced due in part to the fear of what could happen to the children (Ridgers et al., 2012), but also because their uses of the places in which they are able to encounter nature, such as woods and wild landscapes are more controlled and limited.

The consequence of all this is a restricted exposure to the random, the unforeseen, and the discovery. However, those are constitutive elements to the experience of nature, that part that awakens the imagination the most (Alexander et al., 2015; Louv, 2008), as the outdoor environment’s variable and less constraining qualities provide children conditions that require responsiveness, embodied engagement, the ability to adapt to a situation, engage in risk-taking behavior, make decisions, solve problems and think creatively. In addition, Dopko et al. (2019) also found that giving children time for unstructured activities in nature is beneficial for positive affect, attitudes towards nature, and pro-sociality.

Being deprived of this freedom of exploration also causes a loss in terms of sensory experiences of nature. For example, children spending a night outdoors might focus intensely on trying to recognize and classify the slightest light, sound, or smell. As Sebba (1991, p. 416) suggests, an important feature of nature is the way it “assault[s] the senses at an uncontrolled strength”. Through our body, its senses, its physical perceptions, and its movements, we relate ourselves to, we perceive and understand the world, as we place ourselves in a context, in a space and a time.

Humans are sensory beings (e.g., Ingold (2000)), part of a sensorily rich environment, and it is in this relation between the sensory body and the environment that individuals grow, including in this their knowledge, understanding and capacity to engage in favor of nature conservation. In this process of considering the body as the core of the experience, senses are

not isolated one from another, but work together (Ingold, 2000; Pink, 2015) as a combination of sights, sounds, textures, smells, tastes, thermal and atmospheric conditions (Howes, 2013; Thibaud, 2011). This interaction provides a coherent awareness, and representation of our environment (Fulkerson, 2013; Tilley, 2006), but also connects us to places and making us identify with them (Casey, 2009) . If the place where we experience nature anchors humans' connection to the natural environment, it is thus through our body in movement and the embodied dimension of our sensory experiences that we place ourselves in the living world (Kothencz et al., 2017). Likewise, Lumber et al. (2017) suggest that there are different modalities available in the way we can experience nature- through emotion, senses, compassion, or beauty. They add that considering these different paths rather than a single one could be a way to improve, diversify or create connections between humans and nature, when monotony of stimulation can, on the other hand, be a source of stress (Stuster, 2000).

However, in terms of new technologies or media, we are surrounded by screen-based objects and experiences. It was already the case with television and cinema, but this is even more noticeable with the spread of internet-connected objects (such as smartphones) and social media, as well as virtual universes which also mainly focus on visual or at most, visual and audio experiences. Returning to the example of Instagram, we can notice that if there is an experience of nature to be obtained through this social-medium, then we place ourselves in a vision-centered and biased way of experiencing and perceiving nature. Even as virtual technologies become more sophisticated, they are prioritizing vision as the basis for nature experiences.

Vision holds a peculiar place among the human sensory experiences. In the recent history of the western culture, it has been considered as human's most important sense in terms of information gathering (Urry, 2012), so much that some authors described the contemporary culture in which we live as a culture of vision (Yang, 2013) and commented that a majority of academic disciplines remain vision-based, both in their study materials and in their theoretical models (Smith, 2004). Conniff & Craig (2016) argue that this restriction to visual modality could lead to miss a large amount of information about the non-visual restorative features of a natural space. Thus, if we can feel some immersion through a visual experience, isolating the eye from its natural interactions with the other sensory organs and modalities fragments and simplifies the intrinsic sensory complexity of an experience of nature. For someone who experienced a rich, multi-sensory experience of nature before, this could result in the feeling of

an incomplete experience. But what about a child who spends seven hours a day in front of a screen, and who only knows this experience through it?

While the scenarization and the optimization of the experience mediate the content given to experiences of nature, a generalized sensory limitation associated with technologically-mediated experiences changes the way the experience is embodied. Thus, with regard to environmental generational amnesia, we could say that if experiences of nature obtained through technologies become the normal experiences from now on, we would be switching from direct, multi-sensory and implaced experiences of nature to ones that are vicarious, sensorily limited, and displaced, and probably less memorable. Little is known about the repercussions this could have for people's health, well-being, stress restoration, or environmental and conservation behaviors.

Challenges for conservation

Significant and early experiences of nature, as reported by adults (Chawla and Cushing, 2007; Hinds and Sparks, 2008; Prévot et al., 2018) and children (Collado et al., 2015), have been positively associated with higher engagement in favor of biodiversity and the environment. For example, previous studies found a positive association between adults' recreational contact with nature (e.g., birdwatching, camping, and fishing) and pro-environmental behaviors (Cooper et al., 2015; Nord et al., 1998). Similarly, direct exposure to nature (e.g., hiking or camping outdoors) is associated with greater connectedness to nature and pro-environmental behaviors (Evans et al., 2018; Pensini et al., 2016). Any decline in experiences of nature could thus lead to a reduction in knowledge of environmental issues, personal connection with nature, and willingness to support conservation actions (Clayton, 2012; Miller, 2005; Soga and Gaston, 2016).

What, then, might be the consequences of an optimized and standardized nature, where only a chosen fraction of the real nature is presented to the users' eyes, on people's knowledge about biodiversity and their pro environmental behaviors? If those virtual, sensory-limited and optimized experiences of nature become the norm and are the only ones children will know from now on, there is a concern that the adults they will become will not value real nature. They may discount the value of a tangle of dense forest, or of a wetland, and decline to preserve or protect such visually unattractive sites. In this standardization of the experiences of nature by technologies, we think that there are several challenges conservation sciences need to consider.

One of these challenges is to expand what people learn about nature, so that they know about a broader range of nature that has not been carefully chosen to optimize experience (or to optimize a particular message). The standardization of the content displayed by media about nature and its consequences creates a standardization of people's knowledge about nature and conservation issues. Ballouard et al. (2011) questioned French pupils' capacity to identify a mix of 37 different local and exotic, iconic and non-iconic species, asking them if they ever observed a live specimen and to provide precisely the name for each species. They showed that the local species were less often identified than the exotic ones. Similarly, Balmford et al. (2002) surveyed UK schoolchildren, asking them to identify from flashcards 10 species of British common wildlife and 10 "species" of Pokémon. Overall, children aged 8 and over typically identifying Pokémon "species" substantially better than common organisms such as oak trees or badgers.

Those two studies highlight a disconnection between people and the real, local biodiversity, and this disconnection is accentuated by the modern vicarious experiences of nature in which biodiversity is mostly limited to a list of charismatic species, mainly large mammals and birds. If we add this knowledge limitation to the optimization of the contents we detailed earlier, we can argue that this current trend would tend to condition people to think that biodiversity is only composed by exotic, charismatic species from far-away places. This results in a global ignorance of what the local biodiversity is. In addition, if the new generation is not aware of the species they may encounter in their immediate and everyday environment, this could lead to a general indifference to the fate of this biodiversity. The global standardization of what we learn and know, what we are aware of, and that standardization has an influence on what we are willing to protect afterwards.

Ballouard et al. (2011) also studied this question, asking schoolchildren which species they would spontaneously consider as deserving priority protection. Simultaneously, the researchers looked at the representation of threatened species on the internet, and compared both datasets. They found that the diversity of the species declared "priority protection species" was broadly similar between the internet and schoolchildren samples. In addition they found that among the children's answers, the diversity of species that should actually need protection was low compared to the over-citation of a very few charismatic species. Finally, they also tested this question with children from several countries, and they found that whatever the country, children essentially refer to the same few iconic mammals, such as the polar bear or

the panda, suggesting that the internet and modern media have a strong and uniform influence on shaping children's awareness of conservation issues.

Thus, these results could illustrate another standardization of the experiences coming from the messages about conservation issues addressed to children, but also to adults. Nowadays, following the flagship species approach, messages about conservation issues are based on a few charismatic, flagship species with high likeability such as polar bear, orangutan or big felines (Clucas et al., 2008; Riley Koenig et al., 2019), and focus rarely on local or less likable species, neglecting most of the biodiversity. The worrying point about this is that communicating only about a short list of species could add to the general standardization of the content given as nature to people, making it even poorer. Conservation becomes something that is engaged in by NGOs on the other side of the world, not something that people can participate in at home, through management of their own local landscapes; and not something they can feel personally responsible for or capable of advancing.

In this process of making biodiversity real, meaningful experiences of nature and their sensory complexity could be of prime importance. Hosaka et al. (2017) asked Japanese citizens to assess the likeability of 29 wild animals, as well as their willingness to live among these animals in their neighborhood. Their results showed that local childhood experiences of nature, particularly collecting insects and plants, were more important factors than socio-demographics for positive attitudes towards wild animals. These collections promote an intellectual experience in the identification of species, but also a strong sensory component (notably the tactile dimension). Unsupervised activities like collecting and foraging of natural objects have been shown to be fundamental nature activities in childhood, promoting a psychological connection to nature (Lekies and Beery, 2013) and better cognition about biodiversity (Chipeniuk, 1995). In addition to this, Soga et al. (2016) demonstrated that 9 to 12 year-olds' direct experiences with nature (e.g., picking plants or flowers) would effectively promote their understanding, affective attitudes towards living organisms and natural world, as well as their willingness to conserve biodiversity.

Given the increased distance from nature and reliance on technology, another challenge for conservation scientists is to find a way to efficiently use technologies and media to communicate and raise the public awareness about conservation issues. Tags shared about biodiversity and its conservation could be educational rather than sensational or oversimplified. Rather than communicating about a few charismatic and likable species, it is important to make biodiversity more real by drawing attention to local issues that affect people personally, and by

giving children the opportunity to meet and interact with local species (Lindemann-Matthies, 2005). In this matter, citizen sciences might help, as it has been shown that they can generate new knowledge about common species (Deguines et al., 2018), enable learning at the individual level (Turrini et al., 2018), increase emotional and cognitive connections to nature (Schuttler et al., 2018), and foster children's participation in conservation actions (Ballard et al., 2017). Among them, programs such as BirdLab (Museum National d'Histoire Naturelle, 2019), a French project in which users indicate the bird species visiting feeders during the winter in real-time, use mobile games and apps to record data, and could be a bridge between mediated and direct experiences of nature, as well as a way to fill the public's knowledge gap in terms of common fauna and flora and the issues regarding their conservation.

Kahn and Weiss (2017) write: "if we just try to teach people the importance of nature, that's not going to work. They have to interact with it." And as Crowther states in the introduction of her book: "through our stories, shared experience, and collaboration in making our secret hideaways, we made the spaces in which we interacted with friends, our place. Through touching, smelling, climbing, poking around, eating, and breaking bones outside, we developed a part of who we were to become" (Crowther, 2019, p. 1). Childhood memories have that strength to have been our first experiences; when we remember them, they are strengthened by the fact that we relive them through the senses of our childhood. Chawla (2002) describes these "especially resonant spots of time", "moments that merit our return and meditation" (2002, p. 200). According to her, "the characters of nature mark our memories, which have a reality of their own that we carry with us, forming resources or risks that we later draw on." These early, emotionally-rich experiences indeed form a core part of our identities, or sense of ourselves (Clayton, 2012).

Concluding thoughts

Despite the above discussion, this is not a blanket condemnation of technology. Technologies now form an important part of our daily life, and are also a source of progress in many areas, including nature-related ones. For example, White et al. (2018) published a review about the potential for using nature in virtual reality as a way to bring nature, and its associated benefits, to people who are unable to go outside or to experience it firsthand. There is evidence that even viewing nature documentaries is associated with pro-environmental behavior (Martin et al., 2020). Technologically mediated experiences of nature are here to stay, in the absence of

any fundamental change in demographic trends. Our essay is designed to call attention to the limitations of such experiences, particularly the existence and the spread of standardized and sensorily-limited human-virtual relationships, and to consider the possible consequences on real-life related questions of nature, including conservation issues.

Further research is needed to understand how technologies are creating and formatting experiences of nature. For example, content creators such as Instagram photographers, filmmakers and games designers should be asked about their creative process, and about the finalities of their work. Are they aware of the experience their work provides to people? Perhaps they could more deliberately use their art to convey some specific messages, or have some specific effects. (Moss, 2019). Social networks can, if used well, be a very powerful means of alerting people to environmental issues. A good example is how images of the destructive fires in Australia in January 2020 signaled the disaster to a very large audience as it was happening and enabled wildlife conservation groups to raise funds from all over the world. Similarly, there are social media accounts, such as those of some NGO's, which are showing conservation programs (e.g. animal sanctuaries) and field actions (e.g. removal and destruction of illegal fishing nets, destruction of poached trophies) that could inspire people to act in favor of biodiversity conservation. It should be interesting to compare the attitudes and creative process of these conservation-minded producers to those associated with some more trendy nature accounts that are simply focused on attracting an audience. We also need more research into the possible effects of these efforts. This reflection on the importance and role of nature experiences mediated by new technologies opens the door to many research questions in the conservation sciences, as indicated by the recent publication of articles on how virtual immersion experiences or real-time nature feeds can foster feelings of commitment in environment (Breves and Heber, 2019; Hanisch et al., 2019), the role of nature documentaries in nature connectedness and pro-environmental behavior (Arendt and Matthes, 2016; Janpol and Dilts, 2016) or the importance of conservation messages in these documentaries (Jones et al., 2019).

Addressing the question of the technology-mediated experiences of nature should take place amidst a broader reflection on the human-technology relationship. For the first time in human history, children are born and are growing in a world where they will have to manage not only their self, their actions, and their consequences in the real world, but also their virtual self, as well as the representation of others and of the world as a whole, online, on social media, and on every new platform that will appear in the future. The same way young people must

learn how to manage their cyber-alterity, the pictures of themselves on the net and the messages they send, they also need to learn how to be aware of what real nature is, of what is real and what it is not, to be conscious that reality is out of this virtual alter-world, outside, sensory, before being modeled and optimized for virtual worlds and Instagram feeds: being aware of this cocoon in which we are caught, and being able to get out of it. The educational aspects of technology toward nature should thus be developed to create interest but also to teach children how to disconnect, but also how to identify the codes and the standards behind the content they experience.

As Kahn (2002) writes, development arises not simply by nature or nurture (or some combination of both) but by the active mental constructions of children and the ways in which children organize and act on their knowledge and values. Understandings of nature and attitudes towards its protection and conservation are formed by sensory experience, whether technologically mediated or not, but they are also built in interaction with other human beings. Notably, they are built with resource persons, such as parents or teachers (Chawla, 1998). As Maris et al. (2016, p. 34) write, «the will of protecting biodiversity is above all a question of preserving the world in which we constituted ourselves as individuals and as a society, a world that is full of meaning, connections, shared experiences and attachments». Thus, adults should help or encourage children to have free, multi-sensory experiences of nature. A challenge conservation sciences, as well as all of us, are facing is the need to find a way to promote social interactions in nature, which may help to highlight the boundaries between real and virtual.

If we want real and local nature to actually take part in the new generations' building process, we need to ensure that they will have the opportunities to learn about it at school, with referent adults, as well as on available media. We also need to make sure that they will have the opportunity to get outside and live rich, embodied and significant experiences *in* nature. In this, there is a real question that needs to be addressed about how nature experiences mediated by new technologies could, rather than becoming a replacement for direct experiences, constitute a bridge between real and virtual, a way to make people want to go out, to experience nature first-hand in all its messiness and discomfort. The hope is to ensure that encounters with nature in the virtual world can become the starting point to experiences people will look for in the real world, experiences of real nature that will encourage them to value, protect, and restore it.

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