What the Metaverse is (really) and why we need to know about it

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Abstract: The major technology companies are investing significant sums of money in the creation of the metaverse whose main feature will be the fusion between the virtual world and the physical one. To allow this possibility is one of the less obvious features of the metaverse: the metaverse works like our minds. This ability makes the metaverse a significantly different technology from its predecessors. If television and social media are persuasive technologies, because of their ability to influence people's attitudes and behaviors, the metaverse is instead a transformative technology, capable of modifying what people think reality is. To achieve this goal the technologies of the metaverse hack different key cognitive mechanisms: the experience of being in a place and in a body, the processes of brain-to-brain attunement and synchrony, and the ability of experiencing and inducing emotions. Clearly, these possibilities define totally new scenarios with positive and negative outcomes. Educating ourselves as to its promise, and the challenges it may present, is a necessity. This requires a "humane", integrated and multidisciplinary approach, with stakeholders at the supranational level joining in the conversation.

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In the next five years the major technology companies will invest an enormous amount of money in the metaverse, in the order of tens of billions of dollars. Why?

The first person to talk about the "metaverse" was a science fiction author, Neal Stephenson. In his novel Snow Crash, published in 1992, he described it as a three-dimensional digital world - a shared virtual reality experience - that allowed users to escape from a physical world that had become uninteresting. In fact, after two years in which the pandemic has forced us to replace our daily activities with telecommuting or distance learning, the prospect of spending our entire lives in a digital world doesn't seem particularly inspiring. And as much research points out, the continued use of these platforms generates physical and psychological discomfort that is commonly referred to as Zoom Fatigue [1, 2].

The most recent discoveries in neuroscience have allowed us to understand a possible cause of this discomfort [3]. Inside our brain there are a series of specific neurons - the "place cells" and the "border cells" (also called "GPS neurons" since they work in a similar way to the GPS in our cars) - that are activated when we occupy a position in the environment, allowing us to orient ourselves in space. Recently, Mr. and Mrs. Moser, Norwegian neuroscientists who won the 2014 Nobel Prize in Medicine for their research, discovered that these neurons play a key role in the construction of our autobiographical memory [4]. In fact, we build our identity through the memory of the people and events that took place within the different places we frequent. We are workers because we go to the office, we are fans because we go to the stadium, we are students because we go to school or university, and so on.

What happens to GPS neurons when instead of going to the office or school we conduct our activities on a videoconferencing platform? As has recently been shown [5], when we experience multiple locations (we are in a room, but simultaneously videoconferencing on a computer screen), our location is the space we can move through, not the space we are seeing. In sum, for our brains, videoconferencing systems and other digital social platforms are not places, and therefore do not directly connect the experiences we have within them with our autobiographical memory.

For this reason, videoconferencing platforms can be defined as "nonplaces" in continuity with the definition of the French anthropologist Marc Augé [6]:spaces of transit, focused only on the present, in which it is much more difficult to construct a shared identity. The days spent in non-places are characterized by an eternal digital present and leave no marks. For this reason, they all seem the same and, at the end of the day, they leave us empty and apathetic.

If these are the effects of living in the metaverse, why would we ever enter it? As we will see better in a moment, both virtual and augmented reality - the two technologies that are at the heart of the metaverse - are instead able to activate GPS neurons and make the subject present in digital places [7, 8]. Moreover, there is a significant difference between the metaverse described by Neal Stephenson and the one that technology companies are working on. The main feature of the new metaverse, is in fact its “"interreality" [9, 10], the fusion between the virtual world and the physical one.

In practice, in the metaverse what we do in the physical world influences the experience in the virtual world and vice versa. What makes the two worlds talk are the "digital twins", virtual clones of real objects, connected directly with their physical counterparts. Thanks to them, wearing a pair of hybrid glasses (VR/AR) all day, we will be able to see and interact in our physical environment with people and digital objects. Or, see and interact with real people and objects within virtual environments. For example, if I move in the real world, my virtual avatar will move as well. Or, if the avatar is touched in the digital world, haptic feedback is provided to the physical body. Finally, if in virtual reality I start the digital washing machine, the physical washing machine in my apartment also starts working.

Although at first glance it may seem like reading a science fiction novel, most of the necessary technologies are already available or are in advanced stages of development. In this video - https://bit.ly/3gTpLzT - made in late 2021, Mark Zuckerberg presents the different tools Meta is working on: hybrid immersive glasses that allow both virtual and augmented reality, photorealistic avatars that reproduce the subject's real body, wearable sensors that can measure the user's movements, and so on. These technologies allow the metaverse to let us experience the sense of "presence," that is, the feeling of "being there," of actually being inside a place. In fact, what makes the sense of presence possible is one of the less obvious features of the metaverse: the metaverse works like our minds [11].

For a long time cognitive sciences have described the brain as a computer capable of processing and describing the information received. Although this view continues to influence common thinking,

today neuroscience compares our brain to a simulator, a mental virtual reality system, which through a long evolutionary process has learned to anticipate sensory stimuli before they are actually perceived (predictive coding) [12, 13].

To understand this concept let's start with an example. When our brain has an intention (I want to pick up a pen), it tries to predict the perceptions it expects to receive (I will see the hand reduce the distance from the pen until I reach it). These predictions allow the brain to guide the action (I move my hand towards the pen) and to analyze the result obtained (I check if the hand has reached the pen). If the prediction is correct, the action is concluded. If, on the other hand, there is a problem - for example, the pen is too far away - the brain will activate its attention and cognitive resources to find a solution.

In order to do so, our mind builds two different predictive models that interact: one of the physical world that influences our perceptions (the pen) and another of the body (the hand) that guides our actions in the world. Linking the two models together is our bodily experience. On the one hand, the body is the object of perception, and therefore our mind grasps it as one of the objects present in the world. On the other, the body is what enables us to act, and thus is the tool by which the mind enacts our intentions in the world.

For many of us, believing that our bodily experience is the result of a simulation is difficult to accept. In fact, our body is the most "concrete" and "personal" thing we have: we can touch it, we can move it, we are our body. Nevertheless, as demonstrated by research and clinical practice - from phantom limb syndrome to anorexia nervosa - the experience of our body is not direct but is the result of a simulation created by our mind through the multi-sensory integration of different bodily signals. And this simulation occasionally fails.

Phantom limb syndrome is perhaps the clearest proof of this statement[14]: amputees who suffer from this syndrome continue to perceive pain in the empty space where their limb used to be. And something similar happens in anorexia, where the altered simulation of the body is so powerful that it erases the information that the subject perceives through the senses[15].

The metaverse works in a similar way [16]. In fact, both virtual and augmented reality try to predict the sensory consequences of users' movements, constructing the same scene (visible in the helmet) and the same sensations (generated by sensors) that they would experience in the real world. In this view, the sense of presence is generated by the metaverse's ability to predict how the mind simulates reality and to generate digital content that is consistent with these predictions. The more correct the prediction, the more the subject will feel present in the virtual environment they are experiencing, even though they know that the environment is not real [11].

This ability makes the metaverse a significantly different technology from its predecessors. If television and social media are persuasive technologies, because of their ability to influence people's attitudes and behaviors, the metaverse is instead a transformative technology [17, 18], capable of modifying what people think reality is. To achieve this goal the technologies of the metaverse are able to modify different key cognitive mechanisms (see Table 1): the experience of being in a place and in a body, the processes of brain-to-brain attunement and synchrony, and the ability of experiencing and inducing emotions. And its potential can be further improved by the integration with artificial intelligence [19, 20].

Again, examples can help here. First, as demonstrated by many studies the metaverse can be used to induce both basic emotions [21] - like joy, sadness, boredom, anger and anxiety - and more profound and complex ones, like awe [22] and gratitude [23].

More, the metaverse is not only able to induce emotions by replacing the reality outside us. In fact, different researchers are starting to use it to alter our internal reality, too [24, 25]. In a recent experiment Daniele Di Lernia demonstrated that an interoceptive technology is able to significantly modify the intensity of pain in a sample of chronic pain patients [26]. Additionally, the research group headed by Pierpaolo Iodice [27] induced an illusion of perceived effort by using technology for generating false feedback about the bodily signals of the involved individuals.

Another of the possibilities that the metaverse allows is to enter a body different from one's own (body swapping) [28]. It's not just wearing a mask or a different outfit. In the metaverse, I can become just such a different person.

An experiment carried out by colleague Donna Banakou tried to put a group of subjects into the digital body of Albert Einstein [29]. By changing bodies they became significantly smarter. The same group used the same technique to change racist attitudes [30], verifying that entering the body of a black subject reduced racial prejudice. In practice, our brain, entering a different body, changes its simulations in a totally automatic way: if I am Albert Einstein, then I must be very smart. And therefore I really become smart...

Clearly, these possibilities open up totally new scenarios in areas ranging from the world of health and wellness to that of education. Yet, there are two paradoxes.

The first is that the possible positive applications of the metaverse are only one side of the coin. The other side is the risks implied by this technology. With the metaverse, I can not only change people's

behavior, but also what they feel and even their concept of reality. What if I use the metaverse to revive Adolf Hitler in my body and to associate to this experience a feeling of gratitude and joy?

In addition, the data collected in the metaverse allows corporations to collect information about users much more effectively than is possible with social media. And this makes regulation necessary, probably at a supranational level, which is totally lacking at the moment.

The second is that interest about the impact of the metaverse and its consequences – apart from the economic one - is practically non-existent. And even governments, that for other technologies such as Artificial Intelligence have been very outspoken, are virtually absent from the conversation. Research and industry today do not favor the division into disciplines. But a monodisciplinary approach does not allow us to understand all the consequences of such complex phenomena. And without a "human", integrated and multidisciplinary approach, which combines the knowledge of technological aspects with that of the processes and contexts in which the metaverse will be used, the challenge and thus the promise will be lost.

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Table 1: The effects of the Metaverse on our brain

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