


METaverse: ARE THESE NEW DIRECTIONS FOR DISABILITY, INCLUSION AND LEARNING? ARE TRANSLATIONAL NEUROSCIENCES BETTER? AN CRITICAL REFLECTION

METaverso: NUOVE STRADE PER DISABILITÀ, INCLUSIONE, APPRENDIMENTO? MEGLIO LE NEUROSCIENZE TRASLAZIONALI? UNA RIFLESSIONE CRITICA


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ABSTRACT

Famous Hi-tech companies invest in the Metaverse; the term indicates virtual and non-virtual environments in which one can play, work, socialize, do business, learn or even heal. In parallel, we have Translational Neuroscience; involve the use of AI or devices typical of the Metaverse. According to A. Cerasa, Metaverse technologies are useful for therapists, neuroscientists, psychiatrists and neurologists for new rehabilitation scenarios. Let's start critical reflections with the literature present in the major search engines.

Famose aziende Hi-tech investono nel Metaverso; il termine indica ambienti virtuali e non, in cui si può giocare, lavorare, socializzare, fare affari, apprendere o anche curare. In parallelo, abbiamo le Neuroscienze Traslazionali; prevedono l'uso dell'AI o di device tipici del Metaverso. Secondo A. Cerasa, *Le tecnologie del Metaverso sono utili per terapisti, neuroscienziati, psichiatri e neurologi per nuovi scenari riabilitativi*. Avviamo riflessioni critiche con la letteratura presente nei maggiori motori di ricerca.

KEYWORDS

Metaverse, Neuroscience Traslational, disability
Metaverso, Neuroscienze Traslazionali, disabilità

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Introduction

Jules Verne is world-renowned as a prolific author of science fiction literature and also as a pioneer of techno-scientific innovations. In his books he foreshadows discoveries that would later actually be accomplished: a submarine plying the seabed (Nautilus) or a bullet leading to the moon are just a few of his fantastic stories that would later become reality. Interviewed by the Pittsburgh Gazette on July 3, 1902, he stated that he "founded his machinery on the reliable, relying on already existing inventions, half already acquired by Science, though little known, or on easily predictable techniques" (Pisani, 2006).

Bruce Bethke, a U.S. writer of science fiction novels, coined the term Cyberpunk in 1980 by combining the terms Cybernetics and Punk; later the word would become characteristic of a literary genre, thanks also to other authors such as W. Gibson and B. Sterling.

Postcyberpunk is a genre of science fiction that emerged from the cyberpunk movement. Metaverse is a term coined by Neal Stephenson in *Snow Crash* (1992), a postcyberpunk science fiction book, described as a kind of virtual reality shared via the Internet, where one is represented in three dimensions through one's *avatar*¹.

The concept of Metaverse, blends augmented reality (AR), and virtual reality (VR), to create a digital environment where users can interact and experience things as they would in the real world, usually through a VR viewer. Metaverses have existed for many years in the entertainment industry, and particularly in the world of video games.

In 1993, Steve Jackson launched a massively multiplayer game, or MMO: *The Metaverse*, an online virtual reality system in which multiple users could connect simultaneously. Metaverse has gained its popularity especially since Mark Zuckerberg announced in 2021 that the holding company that aggregates Facebook, Instagram and Whatsapp would be named Meta by investing more than \$10B.

Since then, all big tech companies, including Microsoft, have announced to have projects in the metaverse. According to studies conducted by M. Kanterman, and N. Naidu, senior analysts at Bloomberg Intelligence Industry, "if in 2020 the

¹ Stephenson describes the Metaverse as an immense black sphere measuring 65536 km in circumference, cut in two at the height of the equator by a road that can also be travelled on a monorail with 256 stations, each 256 km away. On this sphere each person can realize in 3D what they desire. The avatar indicates the technological alter ego of the users of the Metaverse.

metaverse market was worth \$478.7 bn, by 2024 it is expected to be worth nearly double that, \$800 bn” (Kanterman, Naidu; 2021).

We are at the dawn of the Fourth Industrial Revolution (FIR) and the concept of the Metaverse, steals the show from other “revolutionary” elements; the FIR, is well defined by Converging Technologies (CTs): Nanotechnology, Biotechnology, Infotechnology and Cognitive science (NBIC); Infotechnology is the founding matrix of the “Metaverse System”, but it is not the only branch of the FIR. Medicine 4.0 is the counterpart in science and in medical practice of the Fourth Industrial Revolution, which is characterized by the combination of physical, digital, and biological technologies capable of impacting all economic and industrial disciplines and challenging the common idea of what it means to be human (Cappelletti, 2018).

In the NBICs, Neurosciences, hold broad research spaces, particularly neurotechnologies offer explorations of the brain and the N.S., highlighting low-visible aspects of it (Castaldo F.,2022). In neuroscience, in recent years, we also hear about translational neuroscience (Cerasa, 2022). The term translational, as defined by the National Research Council (NRC), refers to a particular type of research that aims to transform the results obtained from basic research into clinical applications (*from bench to top besides*) in order to improve and implement methods of prevention, diagnosis, and therapy of human diseases.

Metaverse and translational neuroscience present aspects of verified positivity in the areas of disability, inclusion and learning; we intend to examine them and possibly give a critical analysis using the classic methodology of SWOT analysis (strengths/weaknesses, threats/opportunities).

The birth of this methodology of analysis is owed to economist Albert Humphrey as part of studies conducted for the Stanford Research Institute; the methodology allows for a rational and scientific study of internal and external contexts, making information that could influence a system systematic and easily usable.

1. Metaverse beyond gaming

The Metaverse is generally an hybridization of human and digital, through blockchain² and XR (extended reality) technologies; these is an umbrella term that includes virtual reality (VR), augmented reality (AR) and mixed reality (MR)

MR can refer to virtual interactivity in real-world environments. The term “extended reality” (XR) was later coined to describe the full spectrum of augmented, virtual and mixed reality technologies. In the last century, the *Link*

² The term blockchain refers to a digital ledger that can store data of any kind in a way that makes it difficult or impossible to change, hack or cheat the system.

*Trainer*³ was the first pioneer of these technologies, a flight simulator mechanism that, particularly in World War II, was used to train the large number of pilots needed.

Only later do we find its applications throughout the world we now call E-Sport.

Matthew Ball defines the Metaverse as «*massively scaled and interoperable network of real-time rendered 3D virtual worlds and environments which can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments*» (Ball, 2022, p.55).

The Metaverse today, is based on technologies that enable multisensory interactions with virtual environments, digital objects and people; XR systems allow active interaction with virtual elements through the use of motion controllers. That is to say, these technologies need additional devices for their use: AR/VR viewers, sensory suits, exoskeletons, haptic gloves or even footwear (Carciofi, 2022); all this to allow establishing new relationships or perceiving a different sense of self, - through one's own avatar/gem- even in shared spaces generating relationships with people/avatars from various backgrounds.

The most popular use of reality technologies is currently in the area of games, but there is great potential for this technology to create new methods of exploration, learning, socialization, and inclusion, particularly with regard to disabilities.

Back in 2003, the Italian Parliament with the *Interministerial Commission on the Development and Use of Information Technologies for the Disadvantaged people* had published a *White Paper* entitled: *Technologies for Disability - a society without excluded people*; it was stated: *There are three areas in which technologies can improve the conditions of people with disabilities: in the prevention of genetic malformations, in rehabilitation, and in achieving full social inclusion.*

Standen & Brown in 2005 conducted a review study on mental disability: they examined five groups of studies that employed virtual technology to promote skills for independent living: grocery shopping, food preparation, orientation, road safety, and work-related skills. Except for autism spectrum disorders, the results did not contradict the positivity of VR.

In 2015 Kim MJ, undertook a study analyzing sixty articles published in Korea on the effects of VR applied to rehabilitation; most of the studies were related to stroke. The results revealed *increased social participation and improved physical function such as enhancement of upper limb function.*

³ Early airplane pilots had to rely solely on sight to guide the aircraft, and there were many accidents. A breakthrough came in 1929 when Edwin Albert Link developed a small flight simulator known as the Link Trainer (Jeon, 2015).

In 2017, Claudia Cahalane (The Guardian) wrote an article for the Abilitynet World Association, “*Eight ways virtual reality could transform the lives of people with disabilities.*”

The European Parliament, through the conference The European Parliament of Persons with Disabilities, (2020), published the study *Plug and Pray? A disability perspective on artificial intelligence, automated decision-making and emerging technologies.*

According to Abd-Alrazaq et al, (2020) given that 1 in 4 adults are potentially affected by mental health problems, and given the global shortage of mental health workers, the use of technological aids, such as *chatbots*⁴ or digital assistants or secretaries for such care is plausible.

Sghaier et al. (2022) by using *OpenSimulator* better known as *OpenSim*, -an open-source server platform used to create interactive 3D virtual worlds- analyzes two groups of 25 disabled people to test their ability in learning; the results show a difference in the results between the two groups and thus opens up a positive use of the metaverse for learning.

The metaverse allows students with disabilities -and non- to experience a situation or scene while in the classroom through 3D scenes, with sound effects synchronized with the image, giving them the feeling that the scene is real.

Recently, Tacchino et al. (2023) have been discussing the possibility of personalizing treatment in Multiple Sclerosis through metaverse technologies.

To support the validity of the Metaverse in a field of research that goes beyond gaming, we cite a very recent study by Mohamed et al. (2023), which summarizes the present literature on the Metaverse and highlights lines of further research, opportunities, and applications. Using a database of 2251 studies, and doing an initial analysis based on title, abstract and keywords, they extrapolate 75 researches; from the results, two main topics emerge: Metaverse for health care (including mental health) and Metaverse for education (which includes e-learning).

This work will have a focus on health care aspects, particularly disabilities.

2. Translational Neuroscience

**True innovation arises
when we are
confronted with
“translational” people**
G. Pioggia IRB-CNR

⁴ Chatbots-also known as conversational agents-are software that simulate and process human conversations (written or spoken), enabling users to interact with digital devices as if they were communicating with a real person. (Alexa for example).

The verb *to translate*, means to transfer, to transport from one place to another, from one location to another; translation is the action of the verb. Translational, is the adjective that relates to a translation or is derived from a translation (Treccani online vocabulary).

Medicine 4.0 is the counterpart-in science and medical practice-of the Fourth Industrial Revolution; it is characterized by the fusion of physical, digital and biological technologies capable of impacting all disciplines, even those once defined as distinct and distant, such as business and industry, and challenging the common idea of what it means to be human.

When it comes to Medicine 4.0, it is the fusion, not the addition or even the synergy, of different technologies or knowledges that is the essential element; Translational Science, is a rapidly developing discipline in the field of biomedical research, and aims to speed up the discovery of new diagnostic tools and treatments using a multidisciplinary approach that involves a high level of collaboration. It is often described as the practice of transferring scientific knowledge from the laboratory, to the patient's bedside, to the "*benchside, bedside and community*" (B2B, from bench to bedside; see, www.eupati.eu).

The term translational (translational medicine, translational science, translational research) acquires relevance because this distinctly interdisciplinary and highly collaborative approach is capable of creating a direct, bidirectional channel between two contexts that have always connected with difficulty: basic research and clinical practice.

Translation-type research then, in its various forms, represents the integration of experimental research activity and clinical practice (Hörig et al., 2005; Westfall et al., 2007; Butler, 2008; Rubio et al., 2010).

The term translational medicine was introduced in the 1990s but gained wide use only in the early 2000s. (Rubio et al., 2010; Maienschein,2008; Duyk, 2003).

In Italy, the main institutes and research centers engaged in translational research are united in a non-profits association founded in 2015 and which is coordinated by the Istituto Superiore di Sanità: A_IATRIS (Associazione Italiana Ricerca Avanzata Traslazionale). As another Italian example, we have the University of Siena, which in 2018 decided to establish the Department of Medical, Surgical and Neuroscience Sciences under a single area; the action responds to the objective/need to overcome the disciplinary fragmentation among the different organizational articulations, favoring a broad aggregation in a context of organic continuity among the Scientific Disciplinary Sectors.

According to DeMaria Marchiano et al., (2021), *translational applications based on real-world data represent a promising alternative to traditional Evidence-Based Medicine (EBM) approaches that rely on randomized clinical trials to test the selected hypothesis.*

On Sept. 16, 2022, it was announced that "Cattolica TJU Research" was created; this center would promote scientific research in the field of Neuroscience through the creation of the Brain Center "Vickie and Jack Farber Institute for Neuroscience at Policlinico Gemelli in Rome," to enable the conduct of translational and clinical research on the most important diseases of neuropsychiatric interest (Ilsole24ore, 2022-09-16)

In this "cultural soup" an Italian researcher, Antonio Cerasa (2022), suggests- given his achievements- the birth of a specific field of translational research: translational Neurosciences. Cerasa ranks 229th among Italy's Top Scientists and in high rank also in the Top International Scientist; his competences are multiple in the wide range of neuroscience and also include wide convergences on Artificial Intelligence applied to Neuroscience. He is also credited with the emergence of the figure of the Translational Neuroscientist.

According to the author, *"The translational neuroscientist is a researcher in the field (not in the laboratory) who is able to grasp the strong connection between that particular need that society complains about and the presence in the field of research of resources, ideas or tools that could meet that demand."* A new "hybrid" form that enables those involved in studying and treating mental illness to move "transversally" across all scientific fields, without barriers or impediments. In general, the translational neuroscientist starts from a clinical question within his or her field (Life Sciences) and then moves into the other domains (Physical science Engineering or Social Sciences Humanities) to search for a useful method/tool/application to translate his or her findings into the field of application. (CNR Almanac 05/10/2022)

Translational neuroscience sees the application of predictive tools based on artificial intelligence or other technological devices even in areas other than those for which they were created.

We find a significant example of translational neuroscience in the recent project of the Institute for Biomedical Research and Innovation IRIB-CNR of Messina, "Arcadia Vr"; the title is an acronym that stands for Assistance and Rehabilitation of Eating Behavior through Devices Based on Artificial Intelligence and Virtual Reality.

According to G. Riva -co-author of the project for UniCatt. Milan- *"Virtual reality reinforced by artificial intelligence methodologies can offer innovative solutions to cope with different key symptoms of eating disorders [...] the translational clinical approach with VR, is able to bring a significant advantage, compared to traditional cognitive-behavioral therapy: an effectiveness in modifying the experience of the body, improvement of multisensory integration processes, and finally reduction of attentional bias towards body-related stimuli."*

This is not the only example; Translational Neuroscience is also applied in cases of autism, and rehabilitation; in fact, back in 2013 with the Prima Pietra⁵ project and later with the InterPares⁶ project -funded by the municipality of Messina and with the scientific support of the IRIB CNR-, the construction of a space to merge the most modern clinical treatment techniques for children with autism, using modern technologies, was launched to allow families, to have advanced treatments using *tablets, virtual reality, augmented reality, and robots*. (Calabrò et al., 2022; Cerasa et al., 2022a, b; Yang, Lee et al., 2022).

From the blending of Translational Medicine and Metaverse Cerasa et al., (2022) created the term MEDverse. Translational Science is easily considered in the field of medicine, but it is not the only field; it is needed-for the future-that all disciplines must be made translational or studied from this perspective. (Ed.)

Discussion/Conclusion.

The Fourth Industrial Revolution is characterized by the so-called Disruptive technologies (Christensen 2017; Rahman et al., 2017; Castaldo, 2020); a disruptive technology replaces an established technology or rocks the industry with a revolutionary product that creates totally new segments.

The Metaverse, with its applications, uses the majority of them (Metz & Gurău, 2022); it is the progress, and it require to avoid looking at the future naively, imagining or hoping that these can be a continuation of the present.

We surveyed through the most popular search engines (Scopus, Web of science, Pub Med) the terms in question, particularly from 2013 to 2023; there is a florilegium of quotations, although in the last year there has been a decrease. Moving beyond the gaming aspects, the Metaverse offers considerable possibilities in the health field. According to G. Pozza, (2022) at the moment at least four can be highlighted:

1) Rehabilitation.	2) Mental health and well-being.
3) Telepresence.	4) Clinical collaboration.

⁵ Program for research, integration, improvement, assistance and education for the innovation of autism rehabilitation services and technologies. By creating an interactive, tele-rehabilitation technology environment, the project reinterprets the Esdm-Early Start Denver Model (Esdm), a therapeutic treatment for Autism Spectrum Disorders (ASD).

⁶ InterPares, is a project for Autism, a combination of Research, E-health and Social; it involves the integration, development and implementation of innovative assessment and intervention pathways, for people with Autism Spectrum Disorder, with tele-abilitation methodologies and technologies, robotics and serious games to support learning, communication and social inclusion.

Also for the health care field, we highlight the recent study by the Boston Consulting Group entitled *The Health Care Metaverse Is More Than a Virtual Reality*. (Adigozel, 2023).

By analogy, companies in the health care world have also begun to focus on these technologies; Accenture's report, sect. Digital Health Technology (*Meet me in the Metaverse*, report 2022), highlights this.

The Metaverse, however, is not a controlled clinical environment; users may have-in the virtual world where everyone is perfect, beautiful and ideal-a preference toward idealized, more beautiful avatars. What self-esteem problems are waiting for a person's return to real life? (See: Barreda-Ángeles &Hartmann, 2022)

From personalized avatars, anthropological problems may arise, a road to the trans-human or post-human: Catriona Campbell (2022), discusses the emergence of *Tamagotchi Kids*, to give adult users the idea of 'procreating' in the Metaverse.

These are not the only issues; Adam Smith in 1776, wrote that when two industrialists meet, they plan something that can harm the public interest *All for ourselves and nothing for other people* thus expressing the idea that individuals often act for their own self-interest, even at the expense of others. The Big4 (Amazon, Apple, Facebook and Google) have invested huge sums in recent years, acquiring even small hitech companies.

Profit plays a key part in the Big4's race to imagine their place in the Metaverse; there is an acronym, *FOMO*, which stands for *Fear Of Missing Out*: the fear of being cut off, in the world of the digital economy where people live with dread the possible loss of competitiveness.

There are still unresolved issues related to rights, data security, the risks of radicalization and misinformation, and the uncontrollable power of platforms and algorithms (Cucci, 2015; 2023); G. Floridi, famous Italian philosopher in the section of new technologies, speaks of *algocracy* (2020) (the domain of algorithms and artificial intelligences), while Paolo Benanti (2018; 2019) associates to this term that of *algoretic*, (algorithm and ethics).

In fact, the Metaverse "question" is essentially an ethical affair; it is not a matter of using it or not, but it is about introducing rules that establish its limits or responsibilities or transparency.

For this reason, our conclusions, are directed toward a known and already tested ethics: medical ethics, which starting from the Hippocratic Oath, has marked www.eupati.eu the history of medicine.

Translational neuroscience, belongs to this field, having as values, first care and then profit, therefore the filter we would apply to the use of the Metaverse in the medical field we would like to stem from this Culture.

In a correlated way we add -speaking of Western Culture- that it arises from the Polis, from the square, from the comparison with others; for this reason,

particularly during the FIR, it is necessary to transfer our knowledge so that Science is effective and not just a bench of exercise or profit.

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