SOCIETÀ ITALIANA
G.U.I.D.A.
PER LA GESTIONE UNIFICATA E INTERDISCIPLINARE
DEL DOLORE MUSCOLO-SCHELETRICO E DELL'ALGODISTROFIA

V CONGRESSO NAZIONALE

EVERYTHING
YOU NEED TO KNOW

BOLOGNA
ROYAL HOTEL CARLTON
27 Febbraio - 1 Marzo 2025

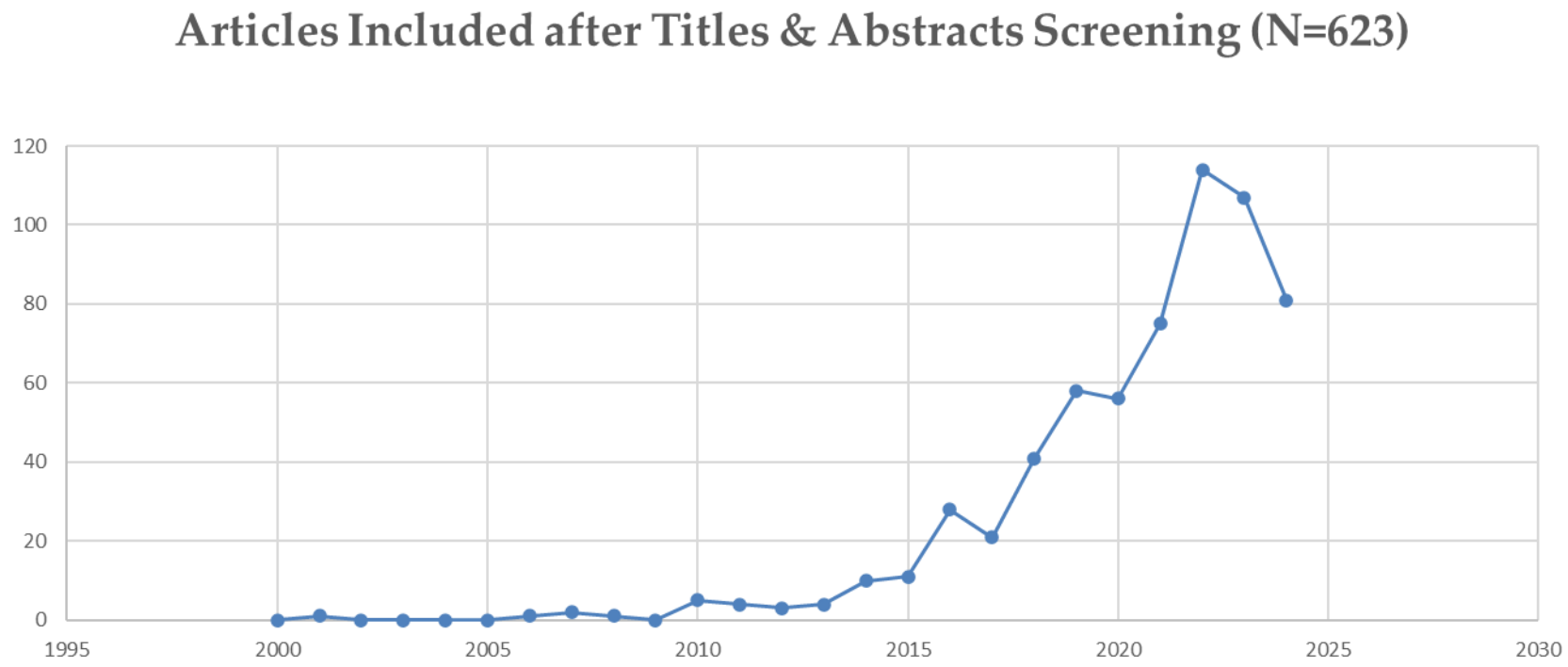
UNIVERSITÀ DEGLI STUDI DELL'AQUILA

DEPARTMENT OF LIFE, HEALTH & ENVIRONMENTAL SCIENCES

Dolore e realtà virtuale

Giovanni Morone
Professore Associato MEDS-26/C
Università Dell'Aquila
MD, Medicina Fisica e Riabilitativa

Time-dependent Evolution of Interest in Rehab Technologies



Search “tech* AND rehab*” was launched on MEDLINE on July 14th, 2024, and filtered for systematic review. 5124 records have been screened and the included studies after title and abstract screening were 623 (12.2%). (In preparation position Paper UEMS –PM&R).

Open access at https://www.minervamedica.it
European Journal of Physical and Rehabilitation Medicine 2024 June;60(3):540-3
DOI: 10.23736/S1973-9087.24.08376-X

Shaping the future: an Italian survey unveils the unmet need to empower physical medicine and rehabilitation professionals with technological skills

Capecci et al. 2024 on behalf of HTA section SIMFER

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186 responders: 70% of clinicians who gave complete survey answers reported that technology for rehabilitation was available in their clinical centre.
On average, 2.4 centers with rehabilitation technology are available for every 1 million inhabitants in Italy.

Figure 1: Technologies used for rehabilitation (% out of the total positive answers).

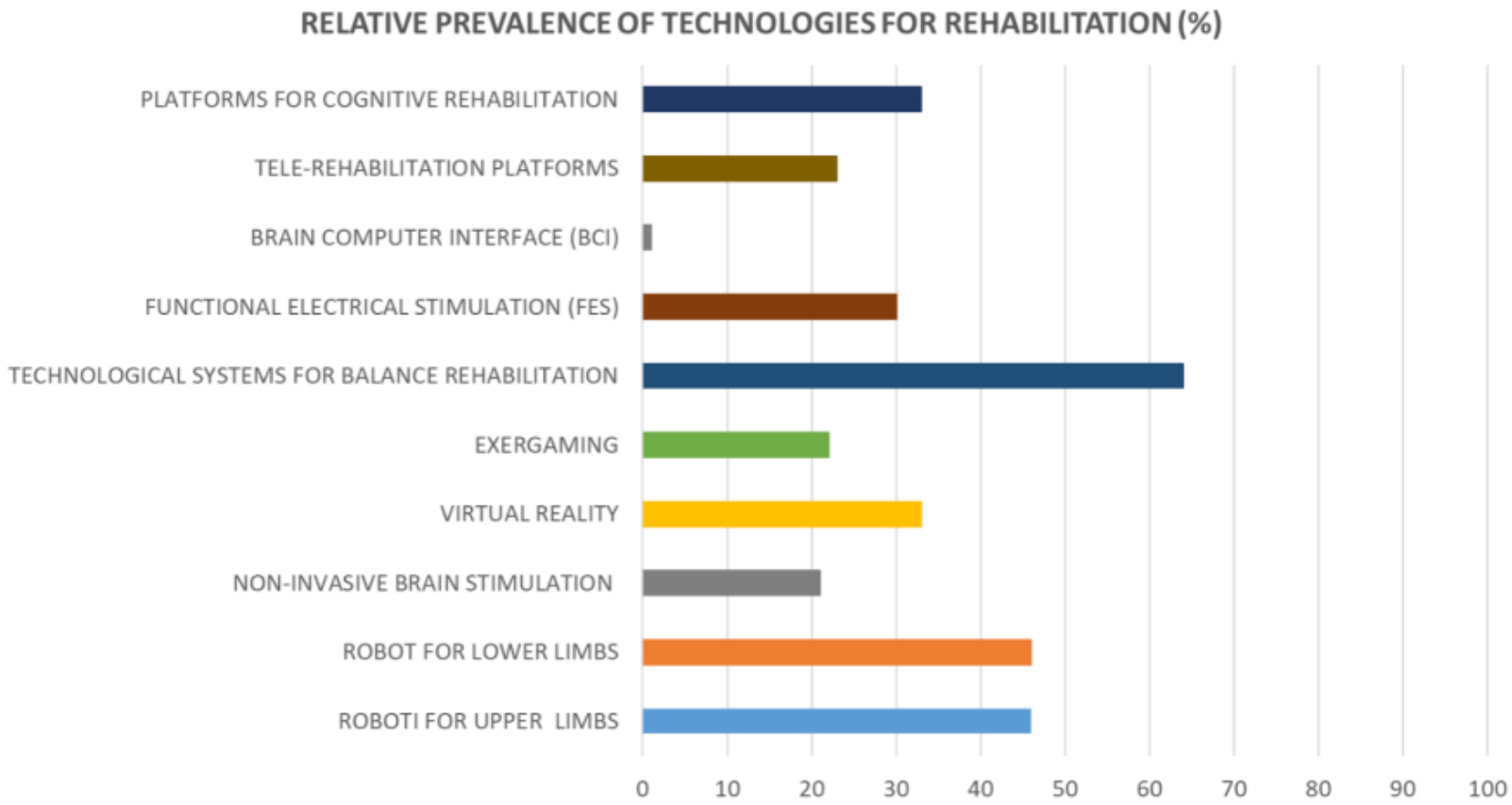

Figure 2: Distribution of technologies concerning neurological, musculoskeletal, and other conditions.

Open access at https://www.minervamedica.it
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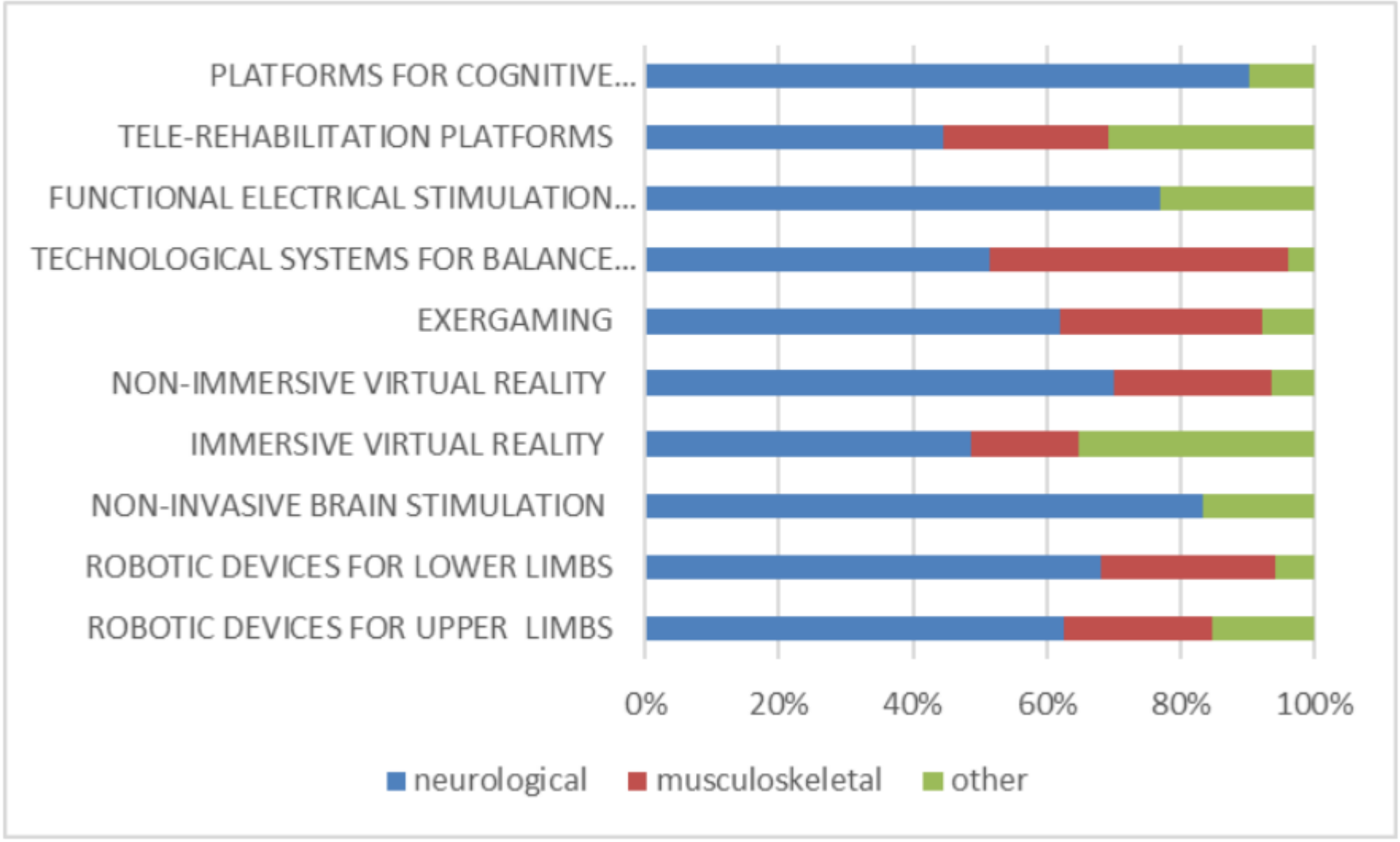

Open access at https://www.minervamedica.it
European Journal of Physical and Rehabilitation Medicine 2024 Apr 15
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Shaping the future: an Italian survey unveils the unmet need to empower physical medicine and rehabilitation professionals with technological skills

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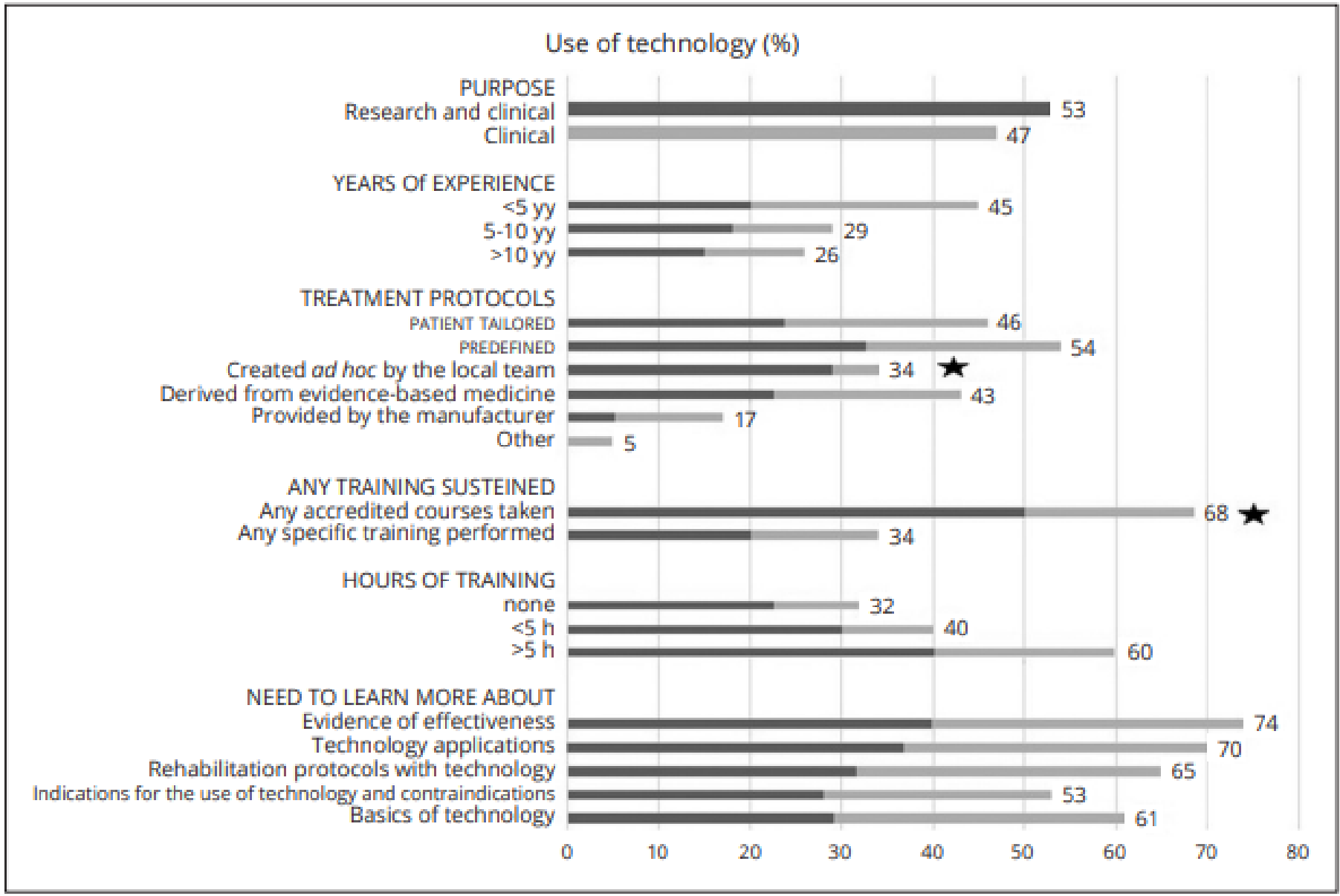


Other Aspects of Health Technology Assessment (N=30; 4,8%)

Health Technology Assessment	cost-effectiveness	12
	acceptability	17
	organization	1

Cosa è la Realtà Virtuale

La Realtà Virtuale è un interfaccia uomo-computer di alta qualità con stimoli ed interazioni in tempo reale del soggetto immerso, attraverso canali sensoriali multipli (visivi e acustici, a volte tattili, raramente anche olfattivi e di gusto) in un ambiente virtuale nel quale il soggetto si immagina e si percepisce presente

[Burdea & Coiffet, 2003]

Serious game/exergame – non-, semi- ed immersive virtual reality

What is VR and what is most often identified in medicine for VR? (e.g. Video-game based rehab, Nintendo Wii, Kinect X-Box that provide 2D virtual environments on a standard monitor) used to carry out cognitive and motor neurorehabilitation.

Immersive VR should be more than a screen that shows virtual images, it should be able to bring the observer into the virtual environment and respond in real time to body movements in a natural way (sense of presence)

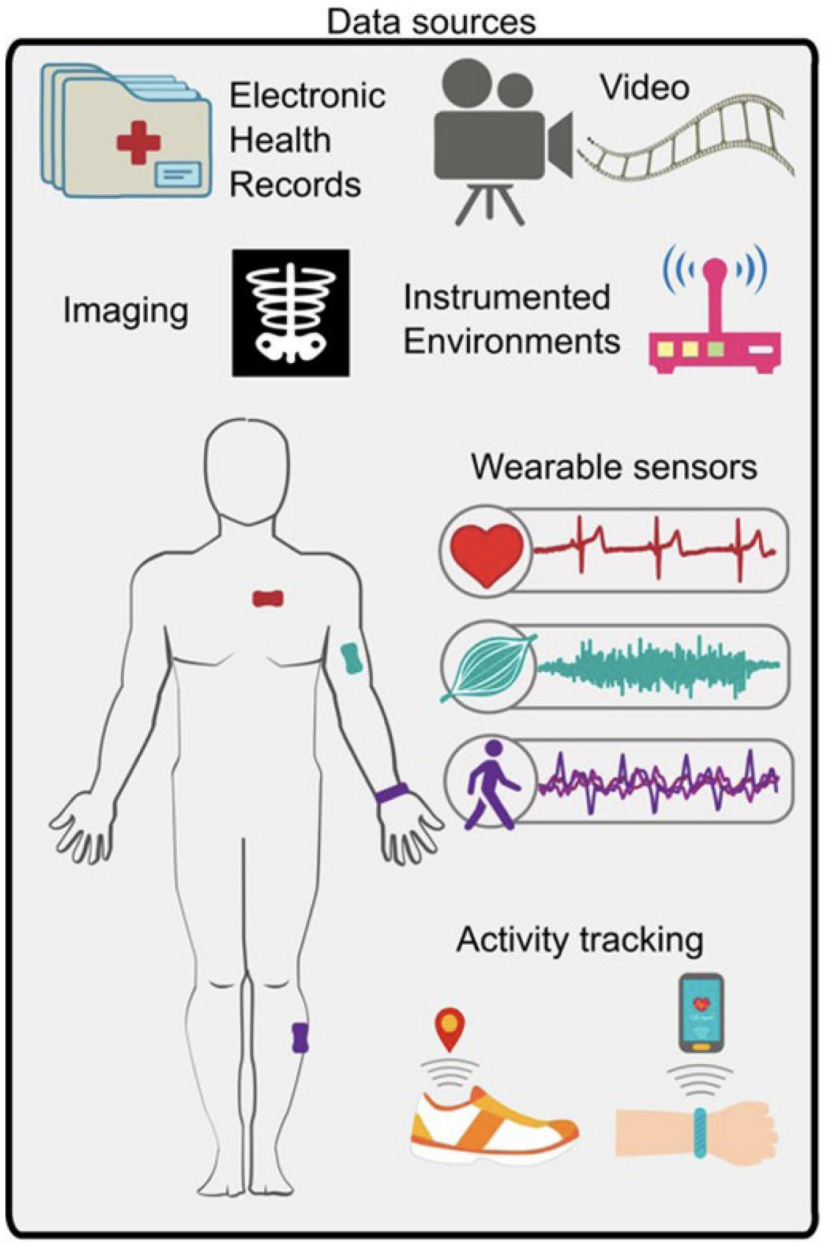
IMMERSIVE VR

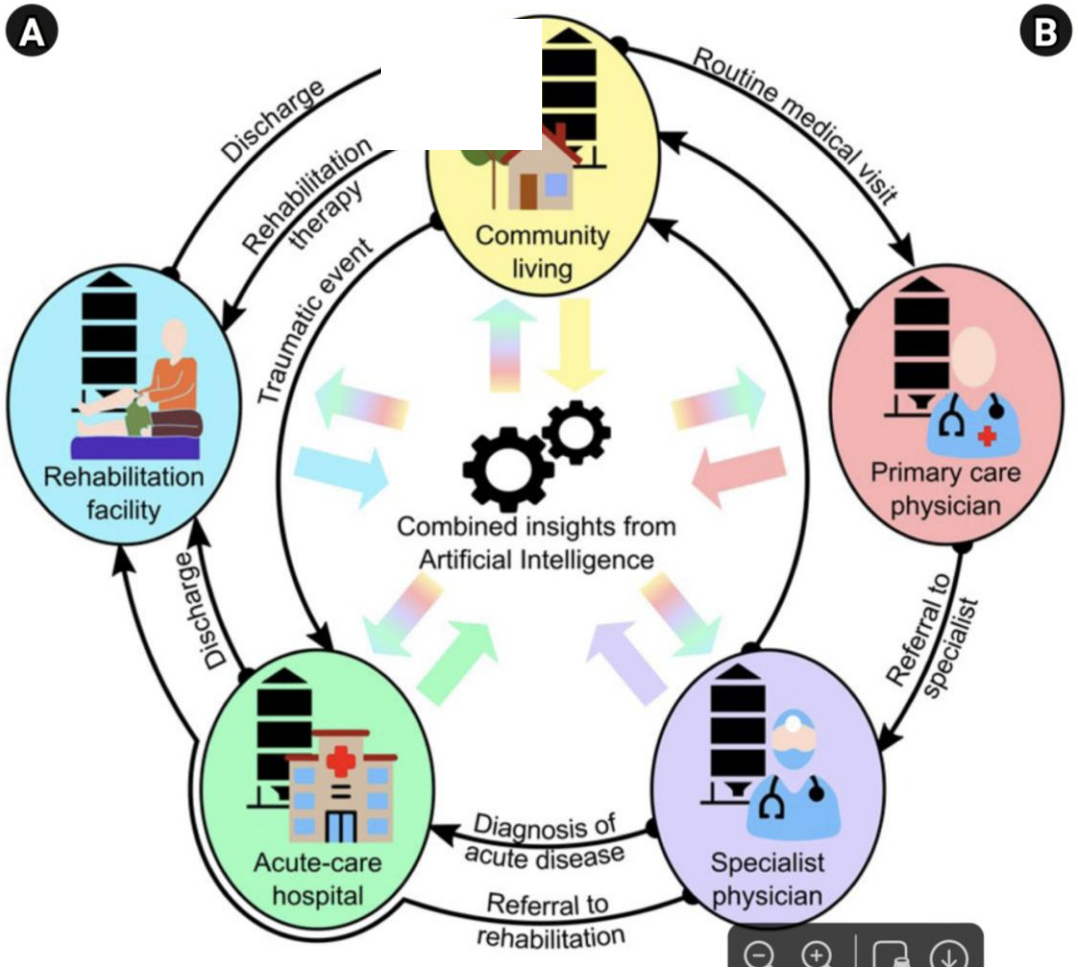
SEMI – IMMERSIVE VR

NON IMMERSIVE VR

SERIOUS-GAME

Sensor – based rehabilitation - Artificial Intelligence - Metaverse





Lanotte et al 2023

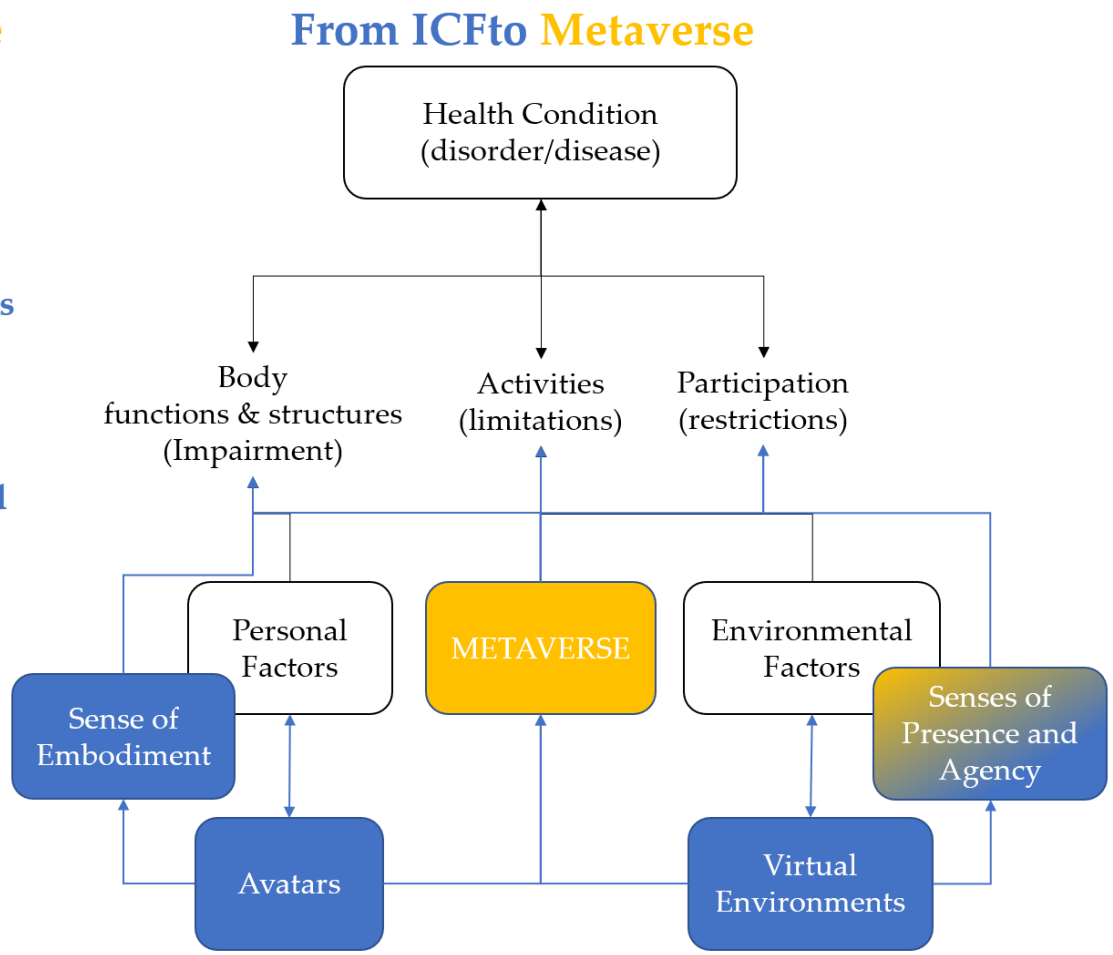
Neurorehabilitation and Neural Repair

ASNR WFNR

Impact Factor: 3.7 / 5-Year Impact Factor: 4.9 Journal Homepage Submission Guidelines

MetaRehabVerse: the great opportunity to put the person's functioning and participation at the center of healthcare.

Giovanni Morone, Irene Ciancarelli, Rocco Salvatore Calabrò, Antonio Cerasa, Marco Iosa, Francesca Gimigliano.



Special article

Arch Argent Pediatr 2024;e202310218

FIGURE 1. *EndeavorRx*

FDA NEWS RELEASE

FDA Permits Marketing of First Game-Based Digital Therapeutic to Improve Attention Function in Children with ADHD

For Immediate Release: June 15, 2020

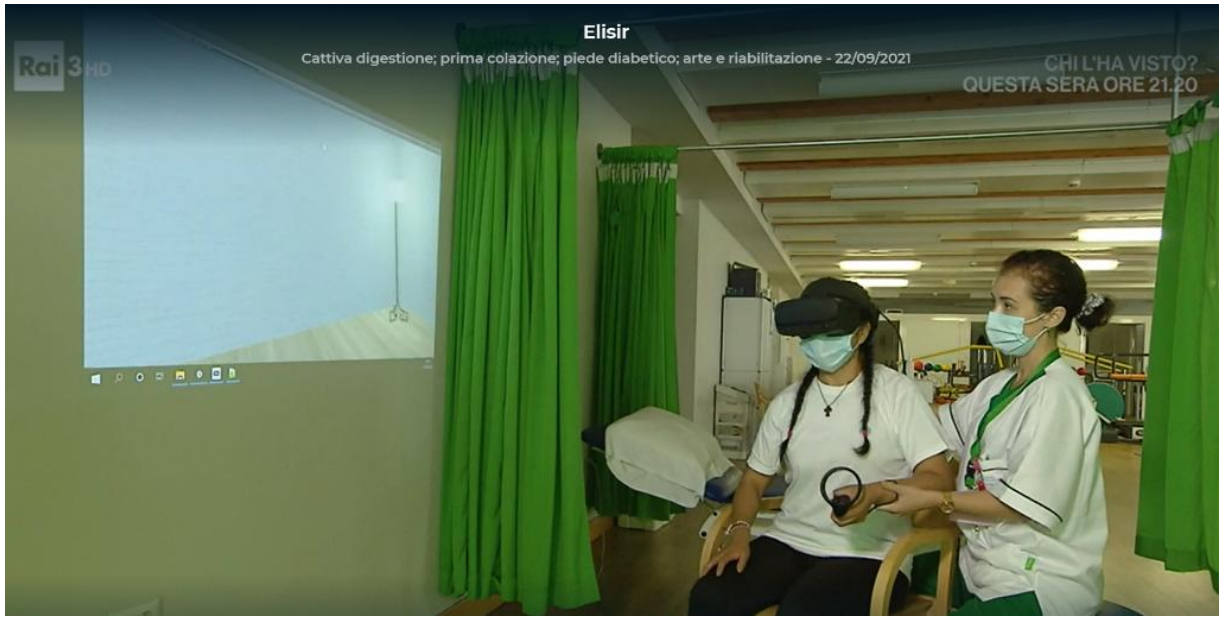
Caratteristiche VR

Caratteristiche della Realtà Virtuale:

- Interaction
- Immersion
- Content

sensi della Realtà Virtuale:

- sense of presence
- sense of embodiment
- sense of agency



«Effetto Michelangelo»
VR and Ictus

Sense of Presence

Sense of Presence (determinato da ambienti 3D)

Necessario mediatore per permettere le reazioni fisiologiche in ambiente virtuale

Reazioni fisiologiche:

- Risposte autonomiche (Aumento frequenza cardiaca, temperatura cute, EEG)
- Risposte percettive
- Risposte emozionali e comportamentali
- Risposte psicologiche e neuropsicologiche

Expert Review of Medical Devices

ISSN: 1743-4440 (Print) 1745-2422 (Online) Journal homepage: https://www.tandfonline.com/loi/ierd20

Rehabilitative devices for a top-down approach

Giovanni Morone, Grazia Fernanda Spitoni, Daniela De Bartolo, Sheida Ghanbari Ghooshchy, Fulvia Di Iulio, Stefano Paolucci, Pierluigi Zoccolotti & Marco Iosa

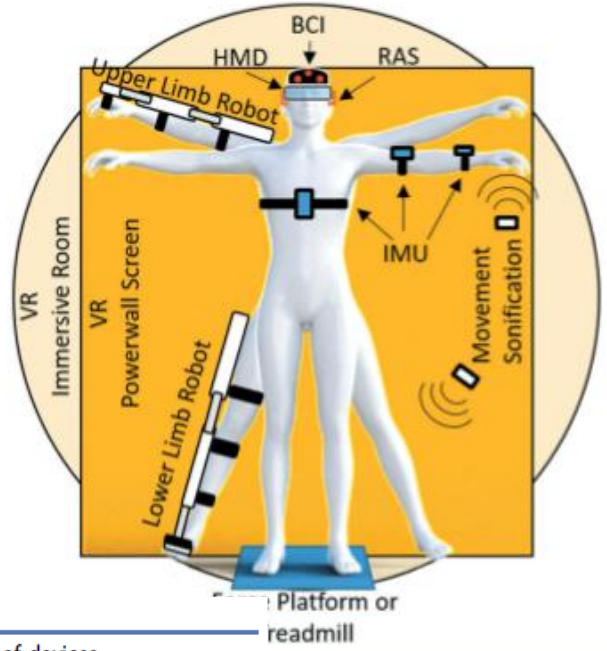
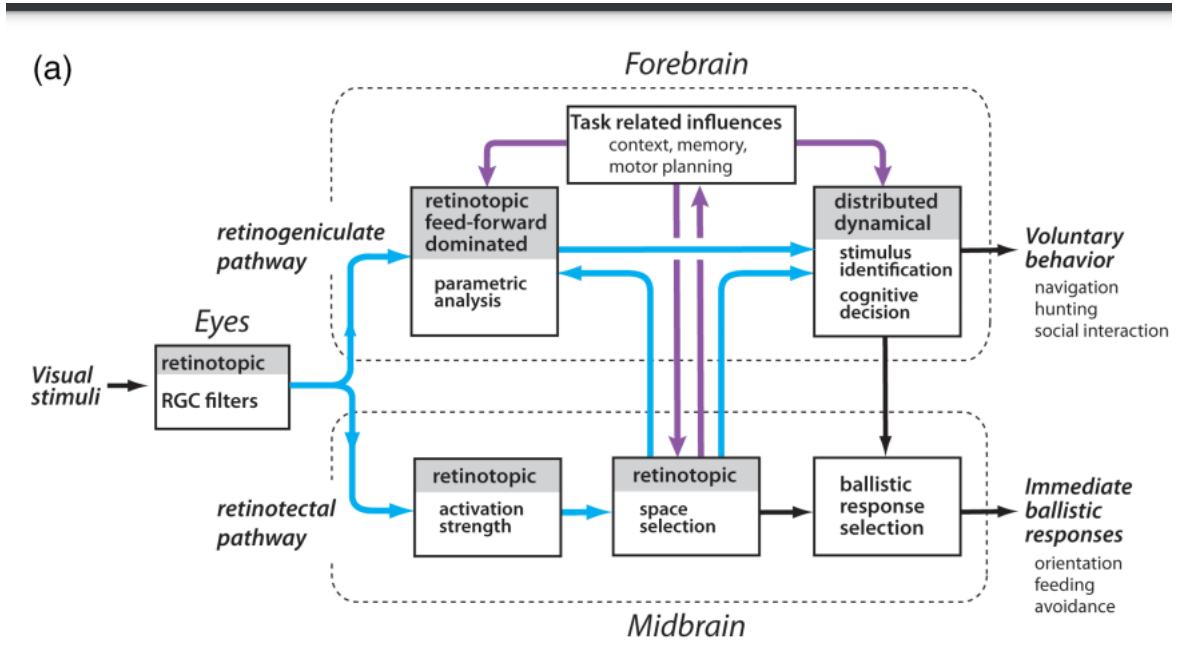


Table 1. Most recent and promising devices developed in accordance with a top-down approach.

Device category	Subdivision	References reported in this review	Example of devices
Virtual Reality	Head-Mounted Display	[31,32]	Oculus RIFT, HTC vive,
	Powerwall screen	[33]	VisWall-LCD™
	Immersive room	[35]	VisCube™ M4
			CAVE Immersive 3D Display
	Virtual Reality for Rehabilitation	[30,29]	BTS-Nirvana
Serious exergame	Using platforms for balance	[12,15]	Khymeia VRRS
			Tymo Tyromotion
	Using joysticks for arm rehabilitation	[15,16,17]	Pablo Tyromotion
			VRRS
			Reha-slide
	Using IMUs	[19]	Riablo
Audio systems	Acoustic external cues	[42,44]	Rhythmic Auditory Stimulation
	Acoustic feedback	[47]	Walk-Even
	Movement sonification	[52,48]	PhysioSonic
			Sonichand
	Music-therapy	[53]	Biodex Gait Trainer 3.
Robots and mechatronic devices	Plus visual top-down approach	[61,63]	Lokomat with serious exergame, Percro Lab Robot
	Plus acoustic top-down approach	[59]	Acoustically paced treadmill
	Plus virtual reality	[37]	Training with treadmill in VR
Brain connected devices	Neurofeedback	[65]	NeurOptimal®
	Brain Computer Interfaces	[66,73]	Mental imagery BCI assisted



Visual perception involves both sensory information processing and attention.

In primates, attention has been shown to alter or modulate the representation of information even at early stages of visual processing, and all classes of vertebrates possess circuits that mediate attention

Nocchi et al. Journal of NeuroEngineering and Rehabilitation 2012, 9:49
http://www.jneuroengrehab.com/content/9/1/49

JNER JOURNAL OF NEUROENGINEERING AND REHABILITATION

RESEARCH Open Access

Brain network involved in visual processing of movement stimuli used in upper limb robotic training: an fMRI study

Federico Nocchi[1,2*†], Simone Gazzellini[3,4†], Carmela Grisolia[3,4], Maurizio Petrarca[3,4], Vittorio Cannatà[1], Paolo Cappa[4,5], Tommaso D'Alessio[2] and Enrico Castelli[3,4]

This study identified the **neural pathway associated with visual processing of movement stimuli** used in upper limb robot-mediated training and investigated the brain's ability to assimilate abstract object movements with human motor gestures. In both conditions, activations were elicited in cerebral areas involved in **visual perception, sensory integration, recognition of movement, re-mapping on the somatosensory and motor cortex, storage in memory, and response control.**

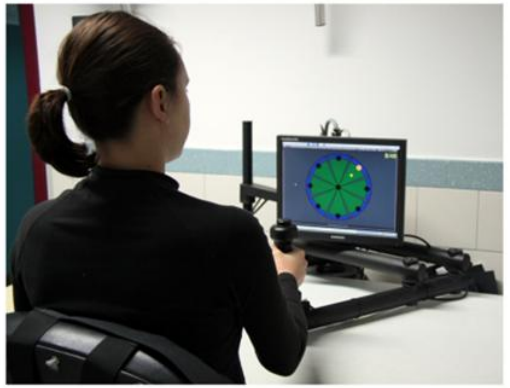


Figure 1 InMotion2 robotic setting.

doi:10.1093/brain/awp135 Brain 2009: 132; 1693–1710 | 1693

BRAIN
A JOURNAL OF NEUROLOGY

REVIEW ARTICLE

The use of visual feedback, in particular mirror visual feedback, in restoring brain function

V. S. Ramachandran[1] and Eric L. Altschuler[1,2]

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2 Department of Physical Medicine and Rehabilitation, University of Medicine and Dentistry of New Jersey, Newark, NJ 07103, USA

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This article reviews the potential use of visual feedback, focusing on mirror visual feedback, introduced over 15 years ago, for the treatment of many chronic neurological disorders that have long been regarded as intractable such as phantom pain, hemiparesis from stroke and complex regional pain syndrome. Apart from its clinical importance, mirror visual feedback paves the way for a paradigm shift in the way we approach neurological disorders. Instead of resulting entirely from irreversible damage to specialized brain modules, some of them may arise from short-term functional shifts that are potentially reversible. If so, relatively simple therapies can be devised—of which mirror visual feedback is an example—to restore function.

"Apart from its clinical importance, visual feedback paves the way for a paradigm shift in the way we approach neurological disorders."

Differentiation among bio- and augmented-feedback in technologically assisted rehabilitation

Giovanni Morone, Sheida Ghanbari Ghooshchy, Angela Palomba, Alessio Baricich, Andrea Santamato, Chiara Ciritella, Irene Ciancarelli, Franco Molteni, Francesca Gimigliano, Giovanni Iolascon, Pierluigi Zoccolotti, Stefano Paolucci & Marco Iosa

Importanza feedback nella pianificazione motoria

Modality

Valenza

Timing

Engagement!!!

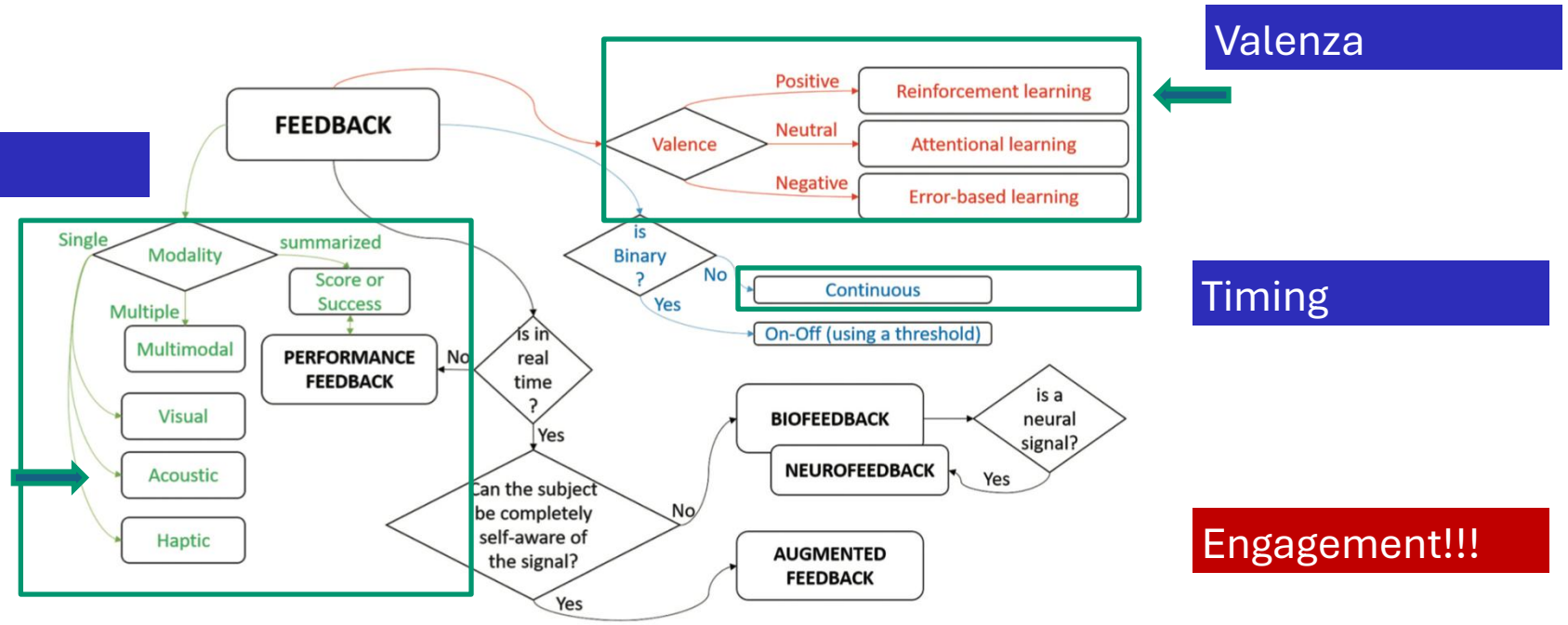

Figure 3. A visual snapshot of possible types of feedback, their modality, and their valence.

The **self-attribution of body parts is mediated by correlated multisensory feedback** *(Armel, 2003; Ramachandran et al., 2000).*

Information arising from **limb proprioceptors contributes importantly to the planning and ongoing control of movements** *(Sainburg et al. 1993; Sanes et al. 1984; Scheidt et al. 2005;Sober and Sabes 2003).*

VR and Pain

VR acts as a nonpharmacologic form of analgesia by exerting an array of emotional affective, emotion-based cognitive and attentional processes on the body's intricate pain modulation system.

Virtual reality has been found to attenuate pain, and this effect has been called 'VR analgesia'

Li A, Pain Manag. 2011 Mar;1(2):147-157.

To date, in addition to the **distraction** of attention, studies have associated cognitive analgesic effects to

cognitive task loading [Seminowicz DA, Davis KD. Interactions of pain intensity and cognitive load: the brain stays on task. Cereb Cortex. 2007]

mood [Villemure C, Mood influences supraspinal pain processing separately from attention. J Neurosci. 2009],

expectancy [Keltner JR, Furst A, Fan C, Redfern R, Inglis B, Fields HL. Isolating the modulatory effect of expectation on pain transmission: a functional magnetic resonance imaging study. J Neurosci. 2006]

frontiers | Frontiers in Medicine

TYPE Mini Review
PUBLISHED 14 July 2023
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OPEN ACCESS

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Virtual reality for pain management: an umbrella review

Dmitriy Viderman[1,2]*, Karina Tapinova[1], Mukhit Dossov[3], Serik Seitenov[3] and Yerkin G. Abdildin[4]

[1]School of Medicine, Nazarbayev University, Astana, Kazakhstan, [2]Department of Anesthesiology and Intensive Care, National Research Oncology Center, Astana, Kazakhstan, [3]Department of Anesthesiology and Critical Care, Presidential Hospital, Astana, Kazakhstan, [4]School of Engineering and Digital Sciences, Nazarbayev University, Astana, Kazakhstan

It is a non-invasive, drug-free, and user-friendly analgesic approach.

Virtual reality may alter the behavior of the pain modulation system **by lowering the concentration on pain resulting in a stimulus not being perceived as painful. By activating the visual cortex and integrating additional senses, virtual reality alters the handling of nociceptive stimuli.**

Brain functional magnetic resonance imaging (fMRI) confirms that **virtual reality influences the insular and sensory cortex similar to opiates.**

VR for acute pain management

Burn care

pain and anxiety attenuation during burn care procedures and rehabilitation of burn survivors

Cancer pain

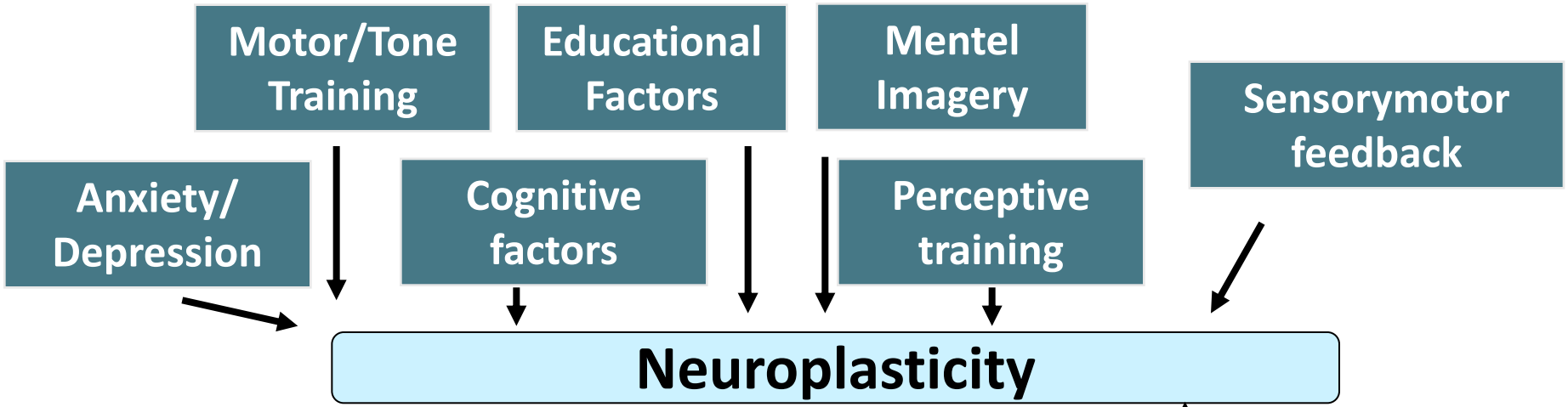
Virtual reality technology has also been studied as a way to decrease pain, unpleasantness and anxiety associated with common painful cancer procedures and treatments, such as chemotherapy, lumbar puncture and port access

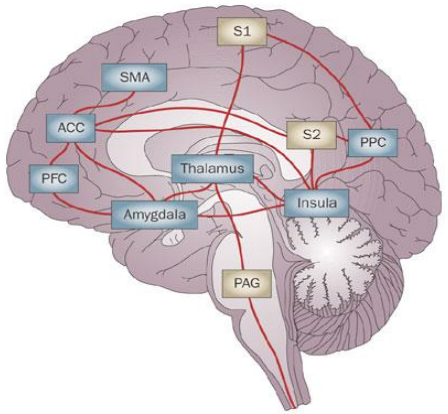
Routine medical procedures

Many routine medical procedures, such as a blood draw, intravenous placement and immunization can be painful and anxiety provoking.

Chronic Pain

- Il dolore induce una **riorganizzazione dell'area corticale motoria e somatosensoriale primaria, anteriore del cingolo e dell'insula**.
- **Maggiore è il dolore e maggiori** sono le modificazioni corticali
- La **plasticità** corticale è coinvolta nella **memoria del dolore** e nella risposta motoria al dolore
- La **plasticità** cerebrale è un **ostacolo alla guarigione**.
- La **plasticità** corticale offre tuttavia **possibilità terapeutiche**.





nature REVIEWS NEUROLOGY

Review

Virtual Reality Interventions and Chronic Pain: Scoping Review

Michael E Ding, MD; Hajar Traiba, MD; Hector R Perez, MD, MS

Department of Medicine, Division of General Internal Medicine, Montefiore Medical Center, Bronx, NY, United States

(J Med Internet Res 2025;27:e59922)

(1) pain types are highly heterogenous in the literature to date,

(2) VR design was highly variable,

(3) secondary and exploratory outcome choice was highly variable,

(4) VR immersion was infrequently assessed, and

(5) side effect monitoring was limited.

sensors

MDPI

Review

Efficacy of Sensor-Based Training Using Exergaming or Virtual Reality in Patients with Chronic Low Back Pain: A Systematic Review

Giovanni Morone [1,2,†], Foivos Papaioannou [3,†], Alberto Alberti [3], Irene Ciancarelli [1], Mirjam Bonanno [4,*] and Rocco Salvatore Calabrò [4]

VR rehabilitation therapy, augmented by sensor based technology, shows significant potential as an adjunctive intervention for patients with CNS-LBP.

VR rehabilitation therapy, particularly through exergames, can effectively reduce pain and disability while also addressing psychosocial factors such as kinesiophobia.

Neuroscience 552 (2024) 29–38

Contents lists available at ScienceDirect

Neuroscience

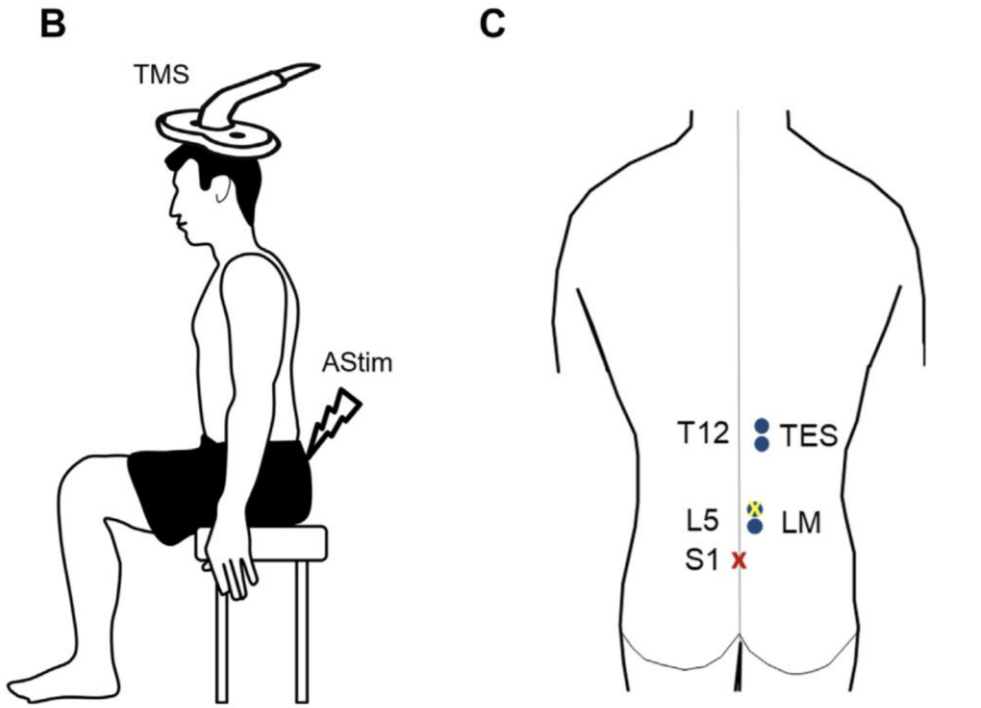
journal homepage: www.elsevier.com/locate/nsc

Research Article

Sensorimotor Integration in Chronic Low Back Pain

Hugo Massé-Alarie [a,b,*], Muath Shraim [a], Paul W. Hodges [a]

[a] The University of Queensland, NHMRC Centre of Clinical Research Excellence in Spinal Pain, Injury & Health, School of Health & Rehabilitation Sciences, Brisbane, QLD, Australia
[b] Centre Interdisciplinaire de Recherche en Réadaptation et Intégration Sociale (CIRRIS), Université Laval, Québec, Canada



Cybersickness (letteralmente, cybermalattia)

Cybersickness è un termine ombrello che indica tutti di disagi creati dall'utilizzo di un display computerizzato.

Simile alla chinetosi (nausea che si prova per il mal d'auto o mal di mare) – include sintomi come vertigini, nausea, discomfort visivo e disorientamento. E' data da una ***mancata corrispondenza sensoriale tra quello che vediamo e quello che gli altri sensi ci dicono*** *a proposito del nostro movimento.*

Ipotesi: Latenza tra movimenti del capo e latenza delle immagini anche 5 msec.

Adverse Events of VR

Prolonged use of VR headsets can result in headaches, dizziness, nausea, eye discomfort, strain, fatigue and blurred vision.

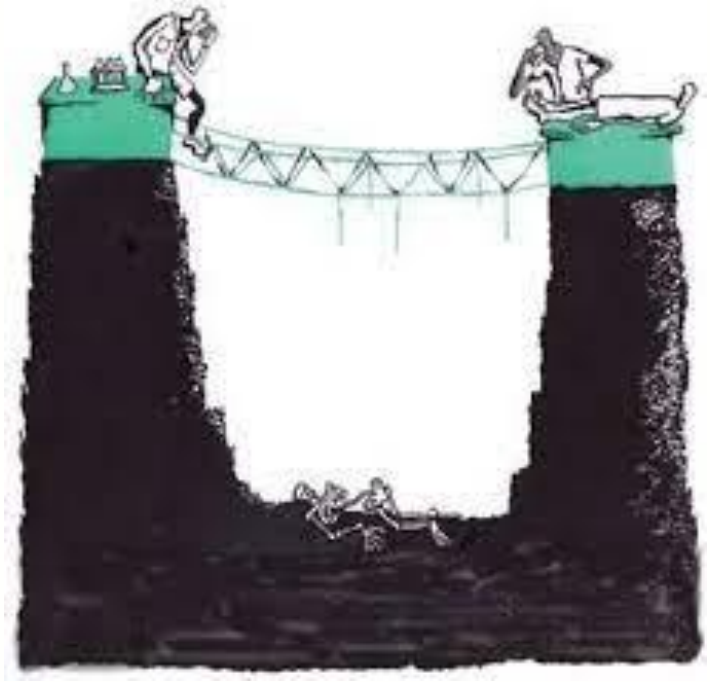
Myopia, a leading burden in ophthalmology with 32% of the world's population affected in 2019, will become even more prevalent.

In the elderly population, discomfort, notably dizziness, following prolonged use of VR headsets may also lead to reduced interaction and conversation with their families.

Additionally, the use of VR has been noted to cause disruption of normal development of coordination strategy in children of ages 1–7 years with regular

Kataria et al 2023

Conclusions



"A chasm has opened up between biomedical researchers and the patients who need their discoveries"

Declan Butler. Translational research: Crossing the valley of death. Nature, 2008.

- VR genera analgesia
- Migliore comprensione dei meccanismi di analgesia mediata da VR
- Traslazionalità è sempre un grande problema
- Adeguare piani di formazione: accademia, società scientifiche, linee guida

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G R A Z I E !

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