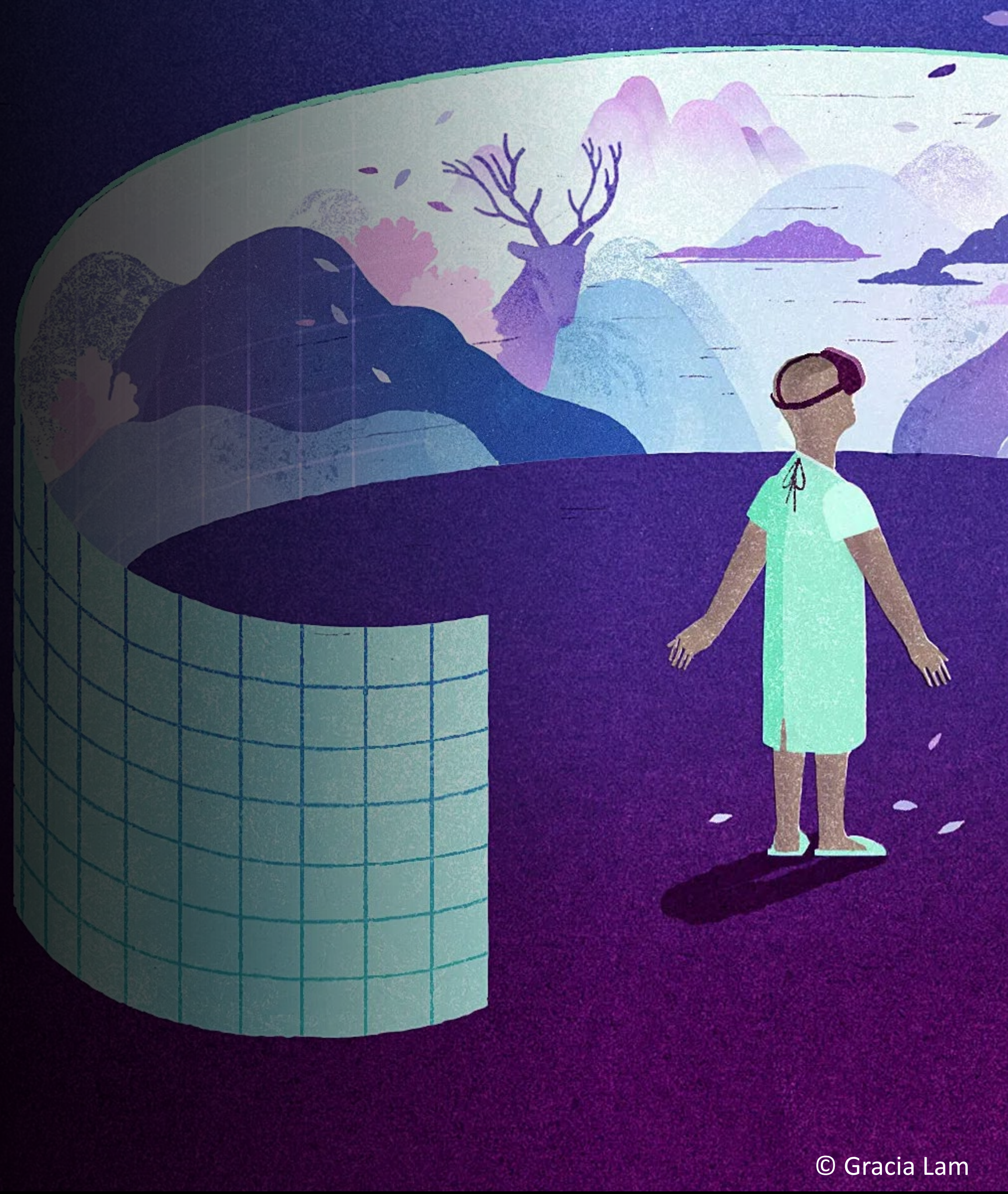
Virtual Reality for analgesia and rehabilitation

Phil Austin

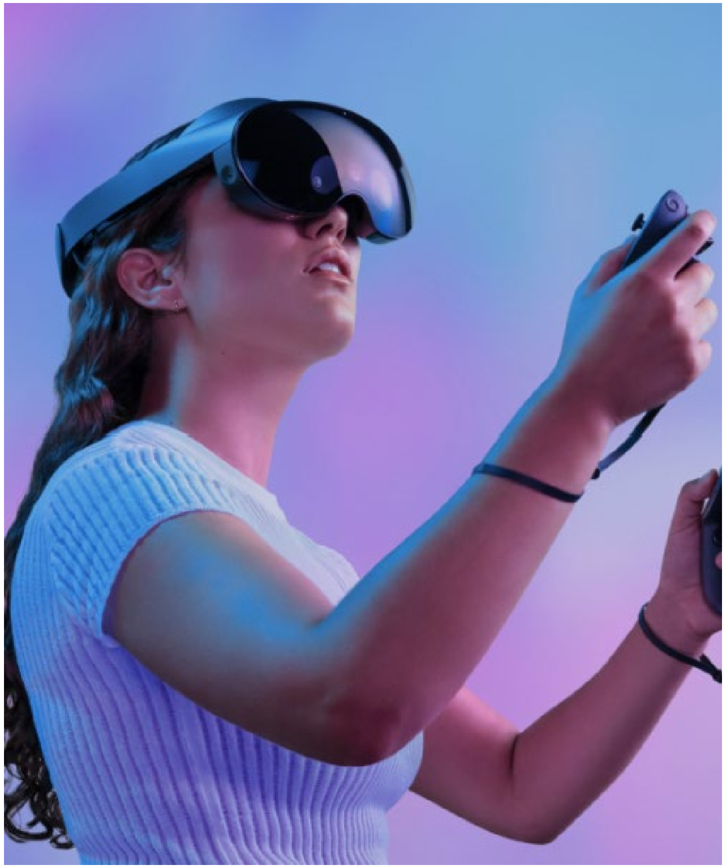


Perception of being physically present

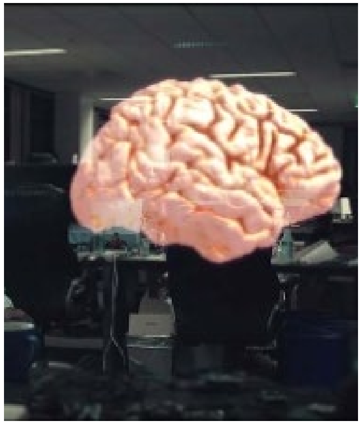
Elements of VR that increase immersiveness

- Simulated 3D environment using computer technology
- Continuity of surroundings
- Compliant with human vision
- Freedom of movement
- Physical interaction
- Physical feedback

Hardware

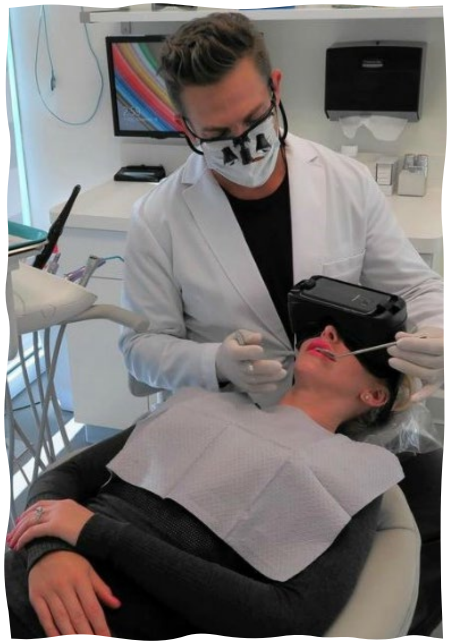


- Immersive head-mounted devices
- 3D-enabled glasses
- Auditory inputs
- Noise-cancelling
- Head/body tracking
- Data gloves / joysticks



Clinical applications

- Pain
- Rehabilitation
- Mood/stress management
- PTSD/phobias
- Palliative care
- Patient education
- Clinical/surgical training

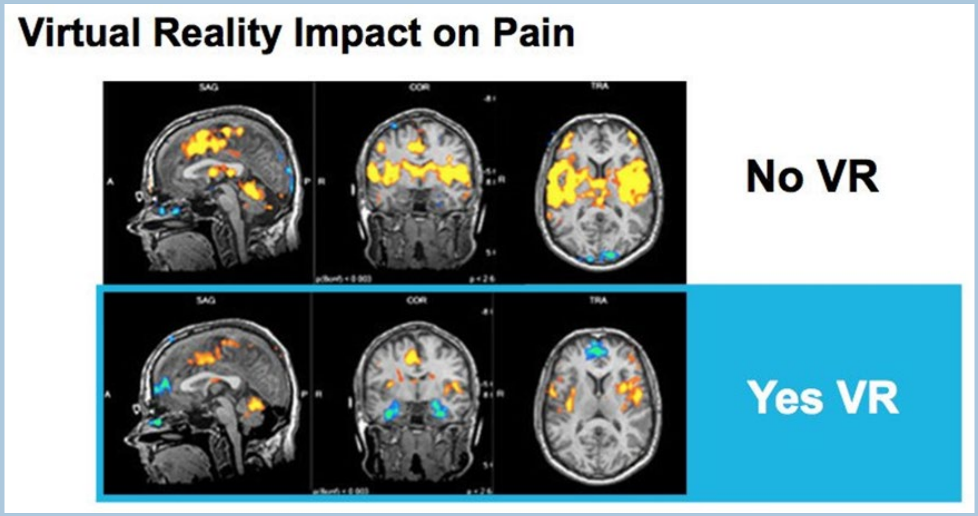


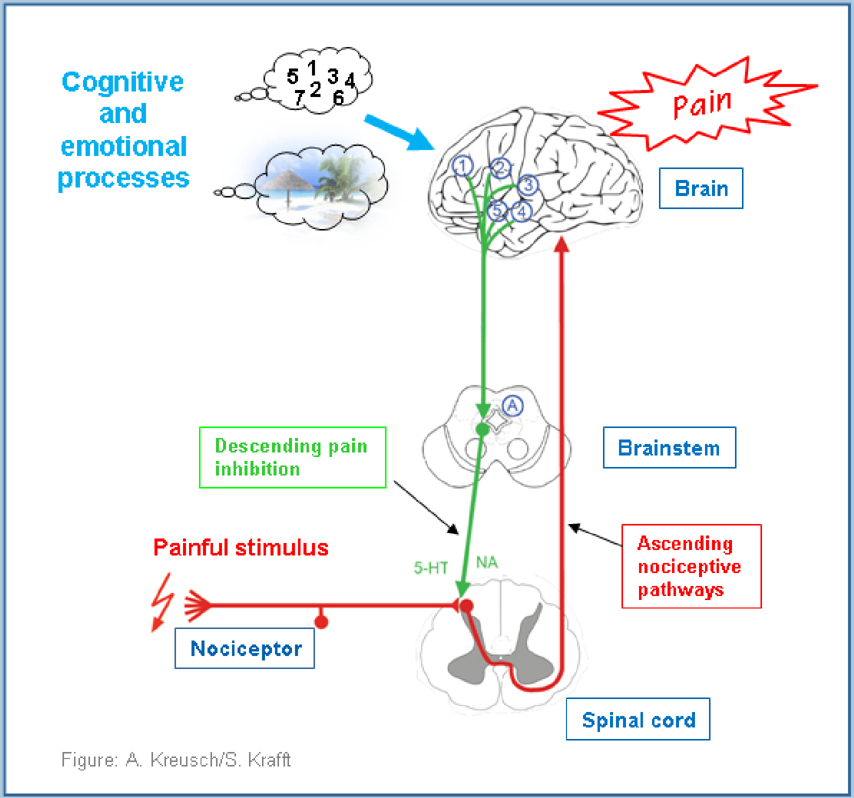
Short-term Distractive effects

Advanced form of imagery in inducing experiences and emotions

Short-term diversion of attention away from pain → alternative stimulus

Temporary alterations in excitability of neurons in pain modulatory brain regions





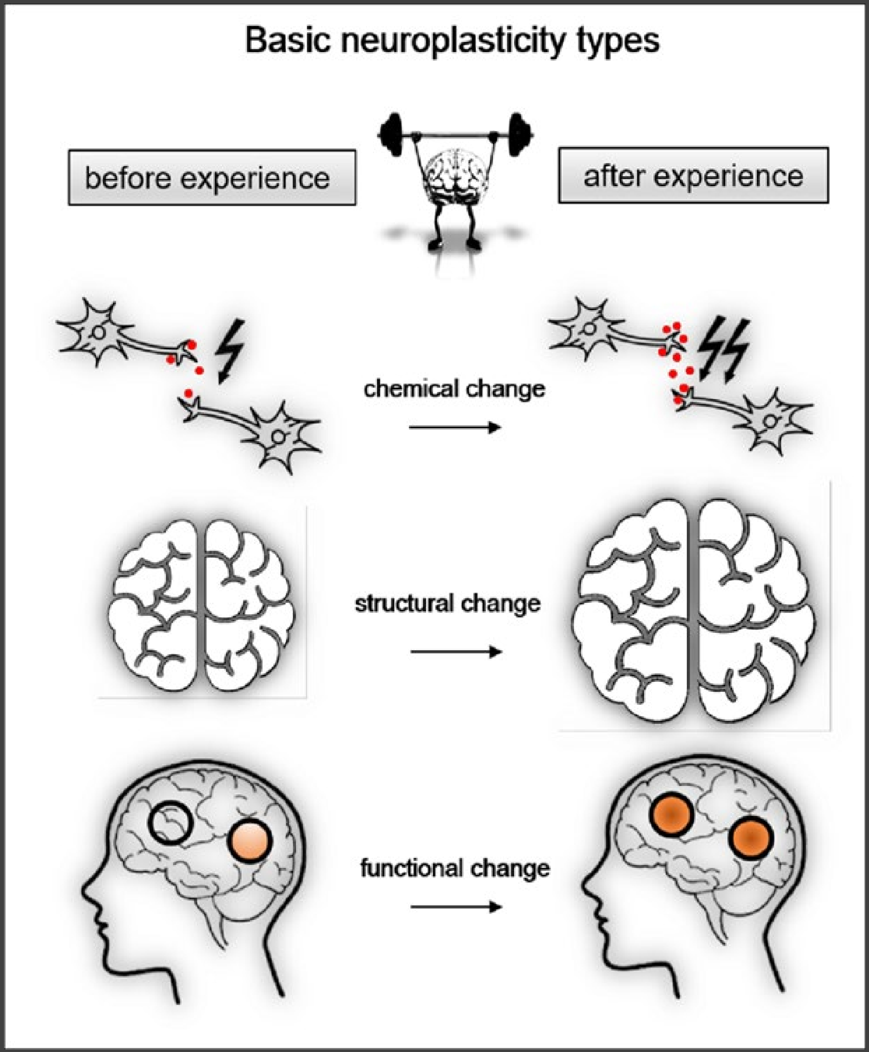
Austin PD. The Analgesic Effects of Virtual Reality for People with Chronic Pain: A Scoping Review. Pain Med. 2022 Jan 3;23(1):105-121

Long-term neuroplastic effects

The brain's ability to reorganize and adapt by forming new neural connections over time

↑ repeated stimulation of neurons in the CNS

- **Sprouting** – new axon and dendrite extension
- **Rerouting** – new connections – made between active neurons
- **Long-term potentiation** – strengthening of synaptic activity (pain inhibitory pathways)
- **Long-term depression** – weakening of synaptic activity (pain facilitatory pathways)



Cheung K, Tunik E, Adamovich S, Boyd L. Virtual Reality for Physical and Motor Rehabilitation. 2. New York: Springer Sciences; 2014:14–6

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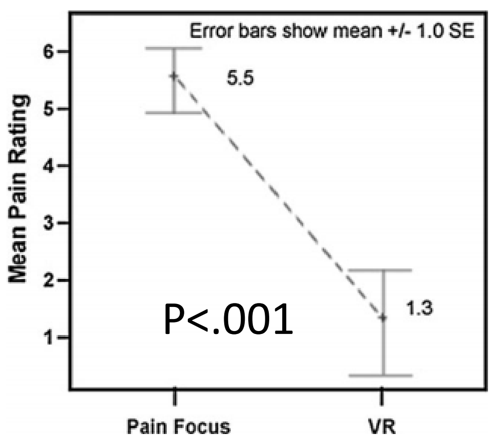
Mary Ann Liebert, Inc. publishers
Journals Search Alerts

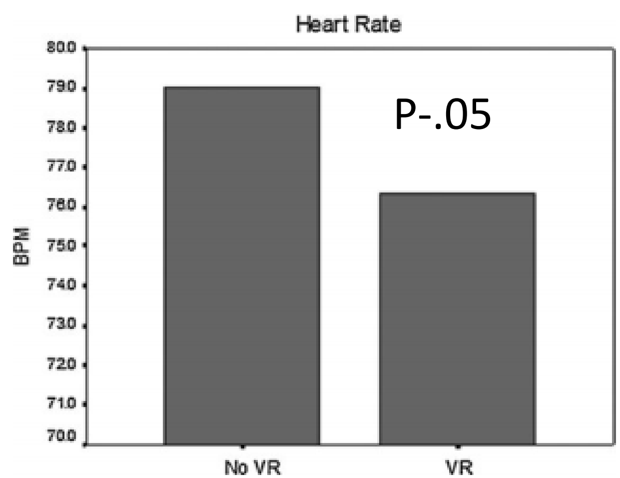
Cyberpsychol Behav Soc Netw. 2014 Jun 1; 17(6): 346–352.
doi: 10.1089/cyber.2014.0207
PMCID: PMC4043365
PMID: 24892196

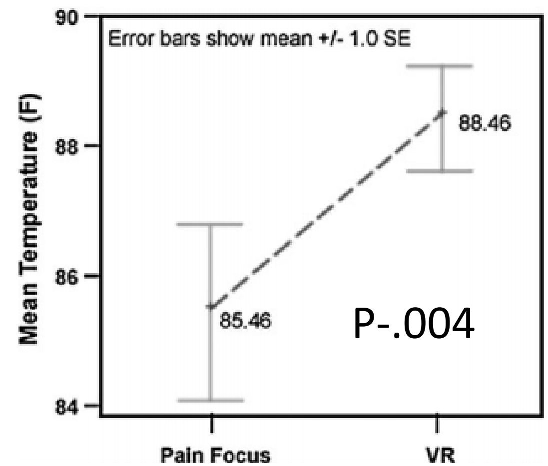
Virtual Reality as a Distraction Technique in Chronic Pain Patients

Brenda K. Wiederhold, PhD, MBA, BCB, BCN,[✉1] Kenneth Gao, BS,[2] Camelia Sulea, MD,[1] and Mark D. Wiederhold, MD, PhD, FACP[2]

15 minute VR exposure session (N=40)







Spinal Cord (2021) 59:738–746
https://doi.org/10.1038/s41393-020-00569-2

ISCoS The International Spinal Cord Society

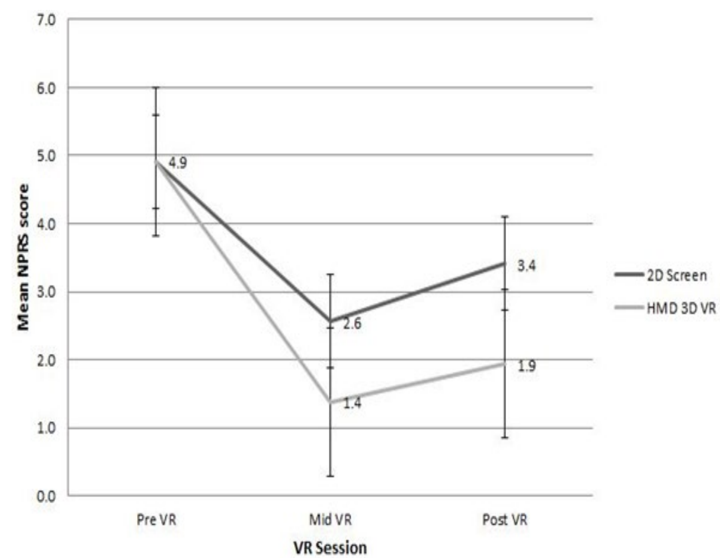
ARTICLE

The short-term effects of head-mounted virtual-reality on neuropathic pain intensity in people with spinal cord injury pain: a randomised cross-over pilot study

Philip D. Austin[1] · Ashley Craig[2] · James W. Middleton[2] · Yvonne Tran[3] · Daniel S. J. Costa[4,5,6,7,8] · Paul J. Wrigley[4,5,8,9] · Philip J. Siddall[1,6]

Neuropathic pain – at and below level of lesion

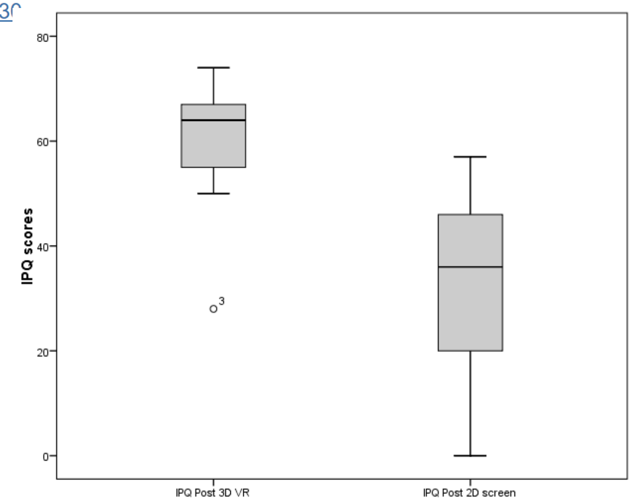
Parameter	Mean 95% CI (covariate-adjusted)	Significance
Effect of VR conditions on post VR reported pain intensity		
• 3D HMD VR vs 2D screen application	1.50	<.0001*
• Sequence (between subject)	0.90	0.34
• Time (within subject)	0.00	1.00
Effect of VR conditions on post VR reported levels of presence		
• 3D HMD VR vs 2D screen application	16.57	.0001*
• Sequence (between subject)	4.87	0.28
• Time (within subject)	0.27	0.93
Effect of reported levels of presence on post VR reported pain intensity		
• IPQ score	0.06	.004*
• Sequence (between subject)	0.62	0.48
• Time	-0.15	0.68



Support Care Cancer. 2022; 30(5): 3995–4005. PMCID: PMC8782583
Published online 2022 Jan 21. doi: 10.1007/s00520-022-06824-x PMID: 3506433[illegible]

Feasibility and acceptability of virtual reality for cancer pain in people receiving palliative care: a randomised cross-over study

Philip D. Austin,[1] Philip J. Siddall,[2,3] and Melanie R. Lovell[1,3]



Mean (SD)			3D Head mounted VR				2D computer screen			
	Baseline	During and post-treatment	Mean (SD)	Mean diff (SD)	95% CI of difference	P-value	Mean (SD)	Mean diff (SD)	95% CI of difference	P-value
Cancer pain intensity	3.6 (1.4)	**Average pain during**	1.6 (1.6)	2.0 (1.7)	.98–3.1	.001	1.9 (1.7)	1.7 (1.4)	.87–2.5	.001
		Least pain during	.9 (1.5)	2.7 (1.8)	1.6–3.8	.0002	1.2 (1.8)	2.5 (1.6)	1.5–3.4	.0001
		Immediately post	1.8 (1.5)	1.9 (1.8)	2.9–3.8	.003	2.2 (1.8)	1.5 (1.6)	2.4–3.3	.007
		5 min post	2.3 (1.5)	1.3 (1.8)	.19–2.4	.025	1.9 (1.9)	1.8 (1.9)	2.3–3.3	.005
		10 min post	2.5 (1.7)	1.2 (2.2)	–.17–2.5	.082	2.1 (1.7)	1.5 (1.3)	.74–2.3	.001
		20 min post	2.2 (1.8)	1.4 (1.7)	.38–2.4	.011	2.4 (1.8)	1.2 (1.4)	.37–2.1	.009
Tiredness	6.1 (2.3)		2.2 (2.8)	3.8 (3.9)	1.5–6.1	.004	3.2 (3.1)	2.8 (3.9)	.47–5.2	.023
Drowsiness	5.4 (2.8)		1.5 (2.2)	3.9 (3.3)	1.9–5.9	.001	2.8 (2.9)	2.6 (3.8)	.35–4.9	.027
Nausea	1.5 (2.5)		1.9 (2.9)	–.39 (3.3)	–2.1–1.4	.64	1.0 (2.2)	0.5 (1.8)	–.55–1.6	.30
Lack of appetite	4.4 (3.9)		4.9 (4.2)	–.53 (1.2)	–1.3–.23	.15	4.2 (4.1)	0.2 (2.0)	–1.1–1.4.	.79
Shortness of breath	2.8 (2.4)		.77 (1.1)	2.0 (2.3)	.63–3.4	.008	1.1 (2.0)	1.7 (1.7)	.66–2.7	.004
Depression	2.2 (2.7)		0 (0.0)	2.2 (2.7)	.52–3.8	.014	0.2 (0.4)	.19 (2.6)	.35–3.5	.02
Anxiety	1.9 (2.5)		0.2 (0.6)	1.8 (2.6)	.23–3.3	.028	0.4 (0.7)	1.5 (2.1)	.27–2.8	.02
Wellbeing	3.4 (1.9)		1.2 (1.8)	2.2 (2.5)	.66–3.7	.009	1.8 (1.6)	1.6 (2.1)	.34–2.9	.02

The RelieVRx Program

RelieVRx engages pain centers through various ways:

Mindful Escapes	Pain Education	Diaphragmatic Breathing	Relaxation/ Interoception

Dynamic breathing

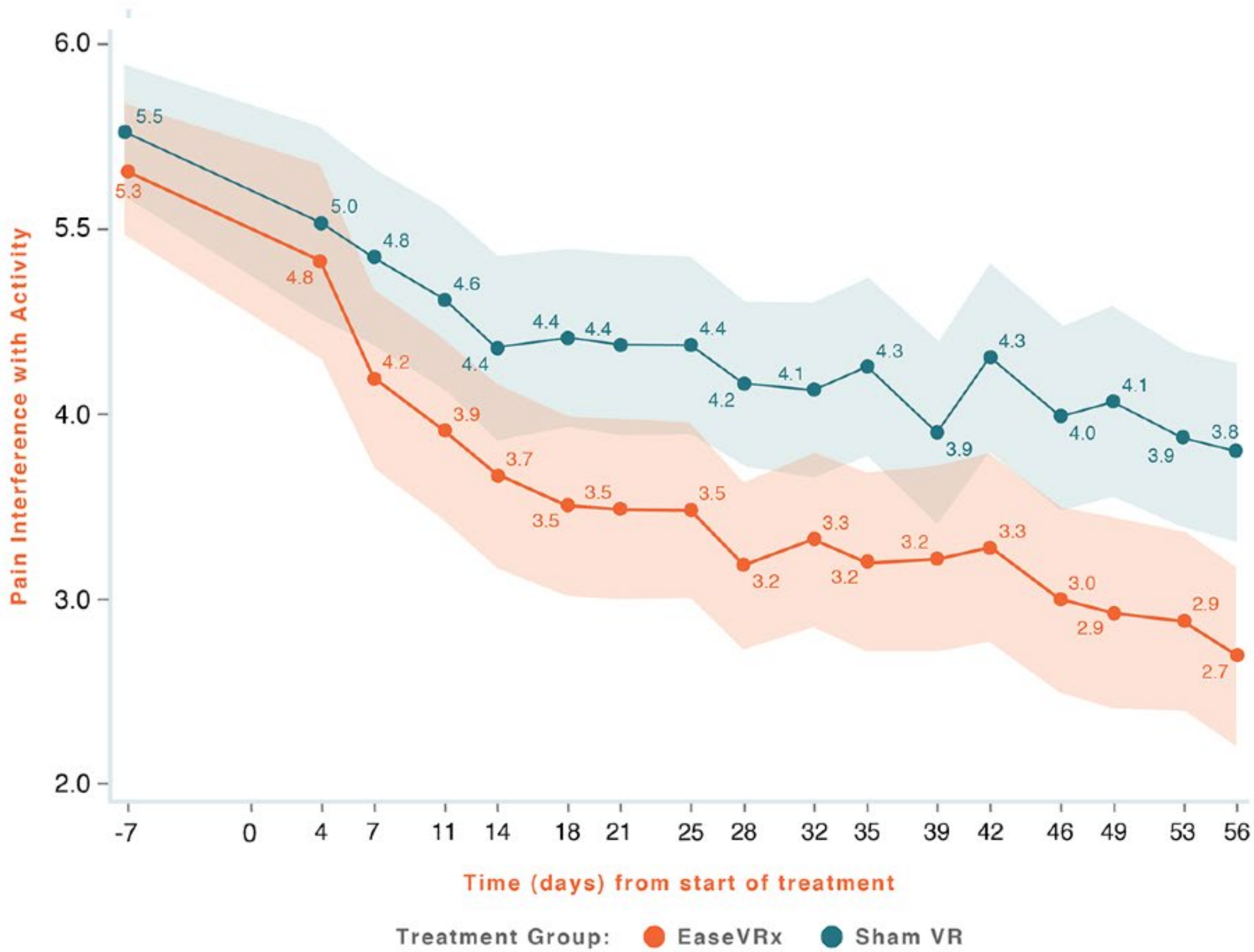
Cochrane Central Register of Controlled Trials

An 8-Week Self-Administered At-Home Behavioral Skills-Based Virtual Reality Program for Chronic Low Back Pain: double-Blind, Randomized, Placebo-Controlled Trial Conducted During COVID-19

Garcia LM, Birckhead BJ, Krishnamurthy P, Sackman J, Mackey IG, Louis RG, Salmasi V, Maddox T, Darnall BD

Journal of medical Internet research, 2021, 23(2), e26292 | added to CENTRAL: 31 March 2021 | 2021 Issue 3
https://doi.org/10.2196/26292

Sourced from: PubMed | Links: PubMed, PubMed Central, ClinicalTrials.gov



Simulated VR motor patterns for rehabilitation

- Orthopaedic
- Stroke
- Spinal cord injury
- Traumatic brain injury

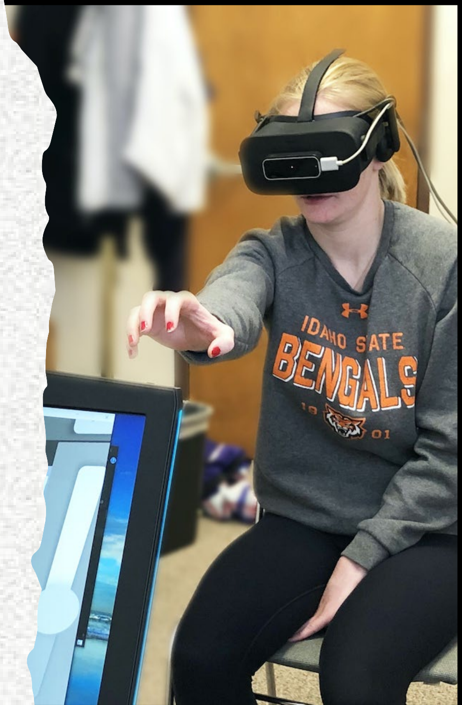
Motor Impairments →

Type of rehab
Coordinated arm and shoulder movement
Coordinated thumb and index finger movement
Coordinated wrist and arm movement
Isolated finger movement
Hand opening
Bimanual operations
Body balance

Coordinated arm, wrist and leg movements

Life task simulations

- Reaching
- Catching
- Pinch/squeeze
- Balance



Feng H, Li C, Liu J, Wang L, Ma J, Li G, Gan L, Shang X, Wu Z. Virtual Reality Rehabilitation Versus Conventional Physical Therapy for Improving Balance and Gait in Parkinson's Disease Patients: A Randomized Controlled Trial. Med Sci Monit. 2019 Jun 5;25:4186-4192

Tokgöz P, Stampa S, Wähnert D, Vordemvenne T, Dockweiler C. Virtual Reality in the Rehabilitation of Patients with Injuries and Diseases of Upper Extremities. Healthcare (Basel). 2022 Jun 16;10(6):1124

Coordinated wrist and hand movement

Pinching / Squeezing

Twisting / Supination

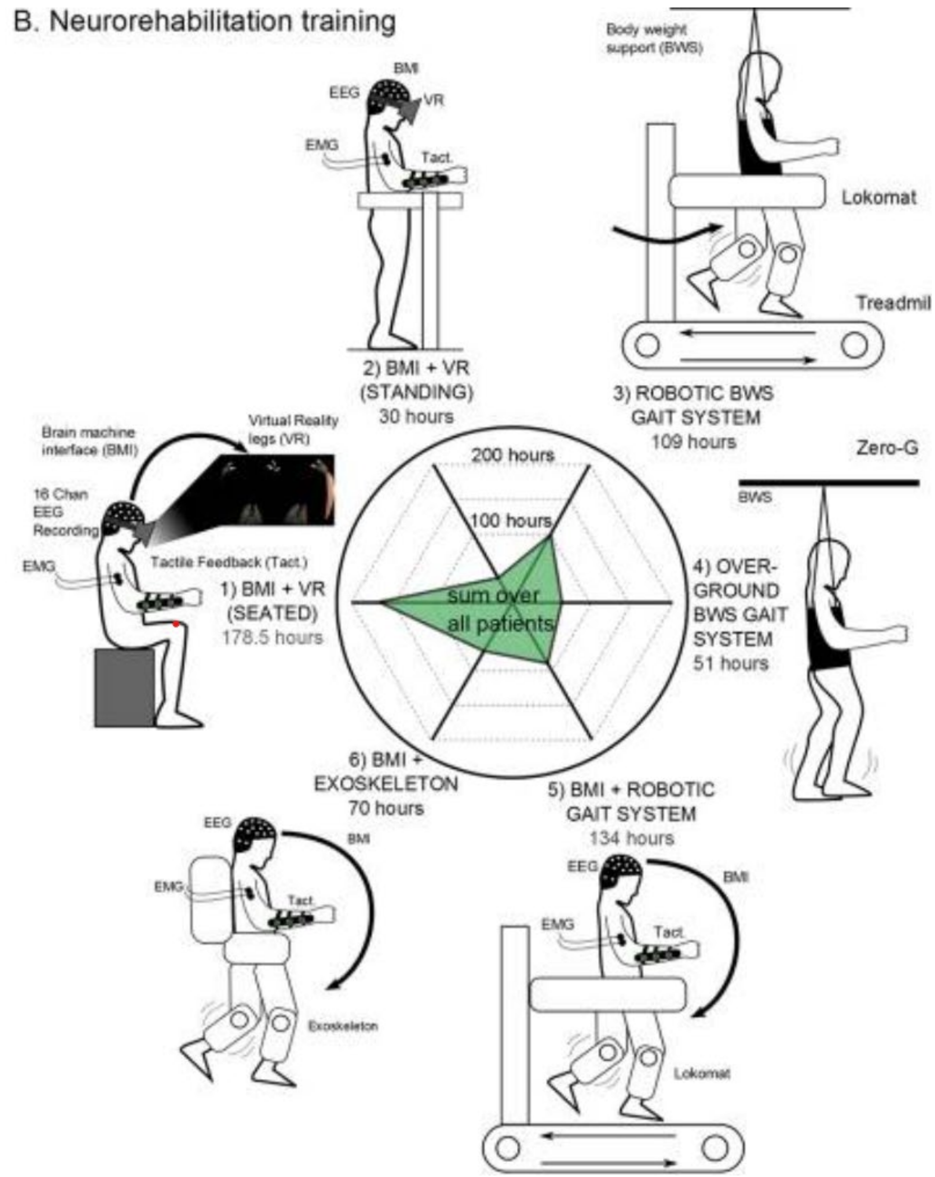
OT VR innovations

Hwang NK, Shim SH. Use of Virtual Reality Technology to Support the Home Modification Process: A Scoping Review. Int J Environ Res Public Health. 2021 Oct 21;18(21):11096

Atwal A, Money A, Harvey M Occupational Therapists' Views on Using a Virtual Reality Interior Design Application Within the Pre-Discharge Home Visit Process J Med Internet Res 2014;16(12):e283

Long-term gain in analgesia and motor control

- 12 months training
  - using zero G treadmill, VR walking, Exoskeleton
- Improvements below lesion
  - Crude/fine touch
  - Proprioception
  - Voluntary motor control
- 50% participants upgraded from complete to incomplete paraplegia



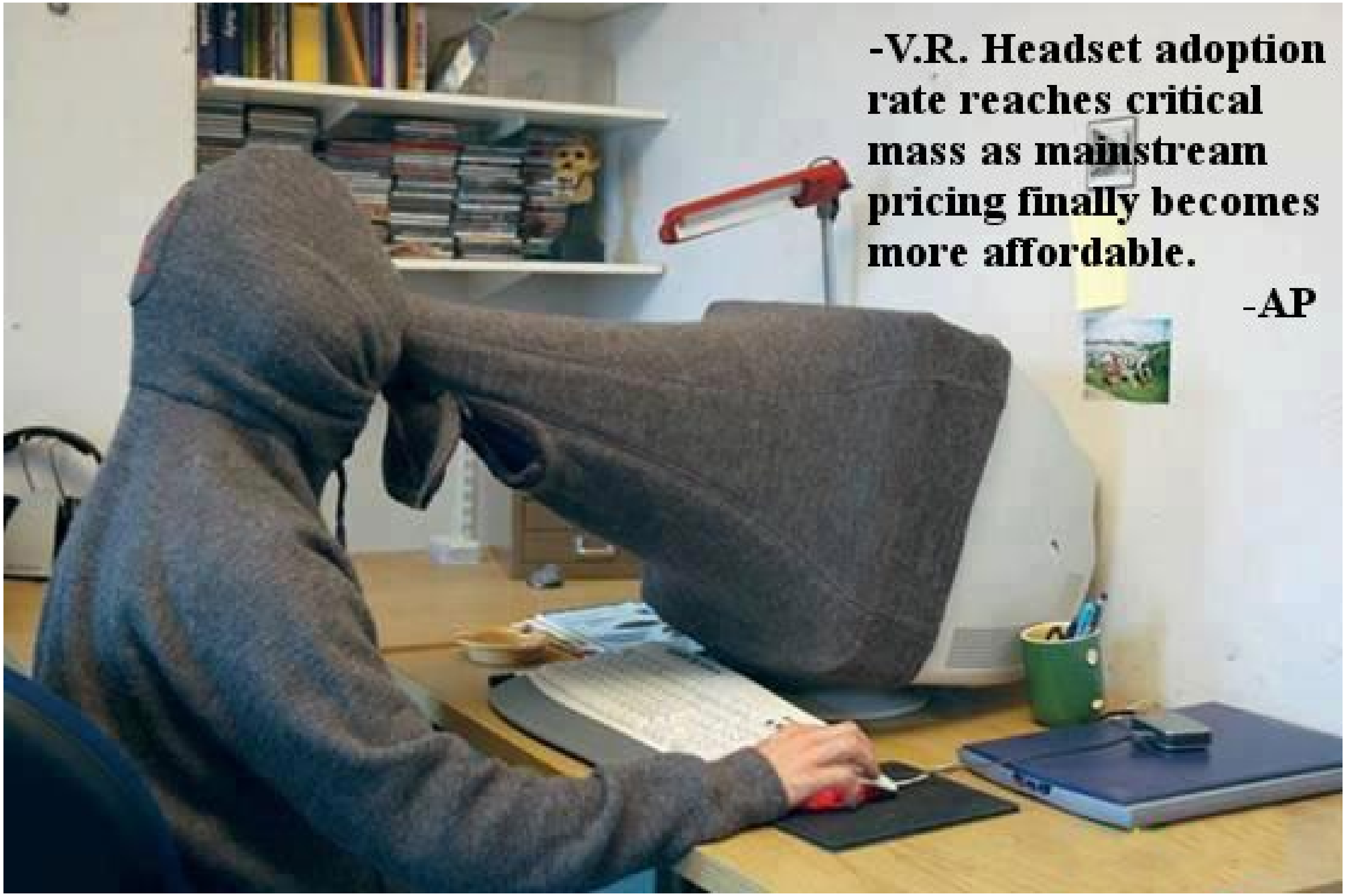
Donati AR, et al. Long-Term Training with a Brain-Machine Interface-Based Gait Protocol Induces Partial Neurological Recovery in Paraplegic Patients. Sci Rep. 2016 Aug 11;6:30383

The future: (HCI) “The avatar will see you now”

- VR
  - Full immersion, multi-sensory experience
- Artificial intelligence (AI)
  - Personalisation of VR experience
    - Creation of own visual/audio environments (e.g., beach, forest, childhood home)
- AI Chatbots
  - Provides real-time, intellectual communication between system and user
    - Emotional support in specialised care settings (Palliative services)

Pauw, L. S., et al. (2022). "The avatar will see you now: Support from a virtual human provides socio-emotional benefits." Computers in Human Behavior **136: 107368.**

Thank you


-V.R. Headset adoption rate reaches critical mass as mainstream pricing finally becomes more affordable.
-AP