Reference

Ortiz-Catalan M, Guðmundsdóttir R, Kristoffersen M, Zepeda-Echavarria A, Caine-Winterberger K, Kulbacka-Ortiz K, Widehammar C, Eriksson K, Stockselius A, Ragnö C, Pihlar Z, Burger H, Hermansson L.

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Phantom motor execution facilitated by machine learning and augmented reality as treatment for phantom limb pain: a single group, clinical trial in patients with chronic intractable phantom limb pain

Lancet 2016; 388: 2885–94.

Products

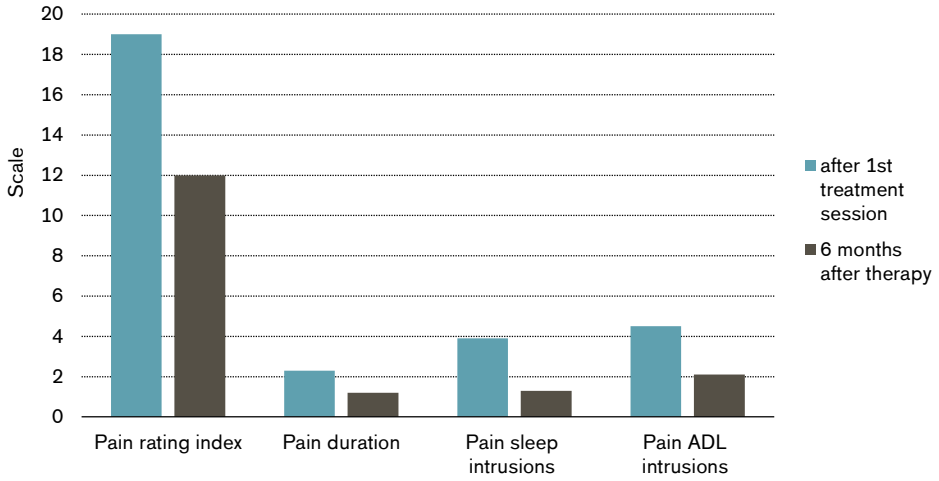
Machine learning, augmented reality and gaming vs. traditional treatment for phantom limb pain

Major Findings

With machine learning, augmented reality and gaming compared to traditional treatment for phantom limb pain:

- → **Pain intensity was decreased by 51%.**
- → **Pain duration was reduced by 47%.**
- → **All patients experienced reduction in quality of pain.**
- → **Pain sleep and activities of daily living intrusions were reduced on average by 61% and 43%, respectively.**
- → **Pain sensations, such as stabbing and tiring–exhausting, were significantly less prevalent after treatment.**
- → **Improvements remained 6 months after treatment.**

Perception of phantom limb pain intensity, duration, ADL and sleep pain intrusion



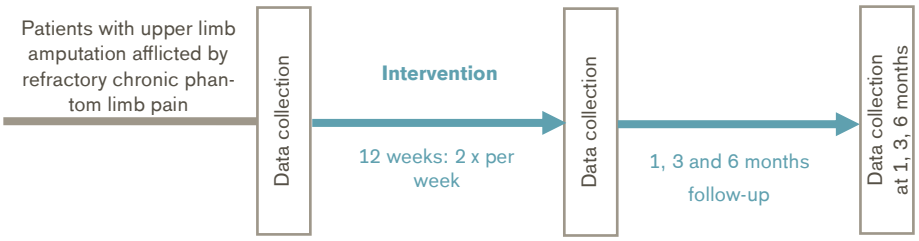
On the graph, the perception of phantom limb pain intensity, weight distribution, activities of daily living (ADL) and sleep pain intrusion are compared after the 1st treatment session and 6 months after therapy. The pain intensity (measured by pain rating index) was decreased by 51%, weight pain distribution by 47%, while pain sleep and activities of daily living intrusions were reduced on average by 61% and 43% respectively.

Population

Subjects:	14 (7 transhumeral, 2 of them bilateral; 7 transradial) patients with upper limb amputation afflicted by refractory chronic phantom limb pain
Previous prosthesis:	n.a.
Amputation causes:	12 trauma, 1 infection, 1 tumor
Mean age:	50.3 years (± 10.3 years)
Mean time since amputation:	10.4 years (± 11.1 years)

Study Design

Interventional pre- to post-test design:



All patients received an intervention twice per week except for one who had it daily. Each session lasted 2 h and consisted of (1) pain evaluation, (2) placement of the electrodes and marker, (3) practice motor execution in augmented reality, (4) gaming by racing car using phantom movements, and (5) matching random target postures of a virtual arm in virtual reality.

Results

Body Function		Activity			Participation	Others	
Mechanics	Pain	Grip patterns / force	Manual dexterity	Activities of daily living (ADL)	Satisfaction and Quality of life (QoL)	Training	Technical aspect

Category	Outcomes	Results for machine learning, augmented reality and gaming vs. traditional treatment for phantom limb pain	Sig.*
Pain	Pain rating index	**Significant reduction of pain intensity by 51%.**	++
		All patients experienced reduction in quality of pain. Pain sensations, such as stabbing and tiring–exhausting, were significantly less prevalent after treatment.	++
		Reduction in pain intensity was maintained at all of follow-up visits. The average improvement measured at the last treatment session decreased by 2%, 6%, and 24% at 1, 3, and 6 month follow-ups, respectively.	++
	Numeric rating scale of phantom limb pain	**Significant reduction of pain intensity by 32%.**	++
		9 patients (64%) experienced reduction of pain intensity.	++
		Pain sleep and activities of daily living intrusions were reduced on average by 61 and 43%, respectively.	++
	Weighted pain distribution	**Significant reduction of pain duration by**	++

Category	Outcomes	Results for machine learning, augmented reality and gaming vs. traditional treatment for phantom limb pain	Sig.*
		47%.	
		12 patients (86%) experienced reduction of pain weight distribution.	**++**
	Pain medication	Intake of pain medication was reduced at last treatment in 2 of 4 patients.	+
		Intake of pain medication was reduced at last treatment in 2 of 4 patients.	+

*no difference (0), positive trend (+), negative trend (–), significant (++/––), not applicable (n.a.)

Author's Conclusion

"We introduce a novel plasticity-based, non-invasive treatment for phantom limb pain, in which phantom motor execution is decoded via machine learning, while visualisation of the phantom is accomplished via augmented and virtual reality. These technological features overcome previous limitations of plasticity-based treatments, such as mirror therapy, while enhancing patient engagement via serious gaming. Reversal of cortical reorganisation and competitive plasticity are hypothesised to be the mechanisms of action of the approach presented here." (*Ortiz-Catalan et al. 2016*)