Màster Universitari en Neuroenginyeria i Rehabilitació

Course on Virtual Reality & Serious Games

Session 1

Introduction and Definitions

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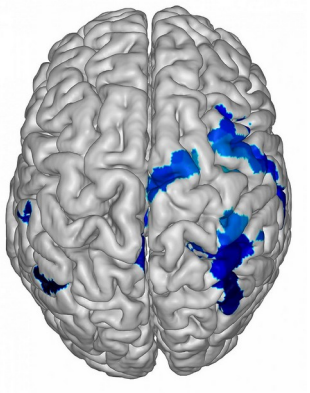
Neurorehabilitation

Neurological disorders associated to brain injury cause motor and sensory loss or dysfunction that impact on reduced daily function and quality of life

Neurorehabilitation is a medical process which aims to foster recovery from a nervous system injury and compensate the functional deficits resulting from it



Neurorehabilitation

Brain injury:

- Traumatic (TBI)

  Caused by accidents (motor vehicles, falls, blows)

- Non-traumatic (NTBI)

  Caused by stroke, hypoxia, tumors, palsy and other illnesses

Facts

Stroke is the second leading cause of death and 3rd major cause of disability. Each year, approximately 795,000 people suffer a stroke

http://www.strokecenter.org/patients/about-stroke/stroke-statistics/

Neurorehabilitation

Neurorehabilitation goals to enhance

- mobility
- sensory-perceptual skills
- physical independence
- social integration
- vocational integration
- emotional health

Difficulties of rehabilitation

- Rehabilitation requires repetitive exercises along continuous and large period of times
- Differences between patients' needs and aspirations can be frustrating
- Lack of initial attraction and then adherence

The importance of playing

The philosopher Johan Huizinga (Homo Ludens 1938) defined games as an integral part of human culture *“Civilization is, in its earliest phases, played. It does not come from play like a baby detaching itself from the womb: it arises in and as play, and never leaves it”*

The importance of playing

Les **jeux** des enfants ne sont pas des **jeux** et il les faut juger comme leurs plus sérieuses actions. Michel de Montaigne (1553-1592)

For truly it is to be noted, that children's **plays** are not **sports**, and should be deemed as their most serious actions.

Man's maturity: to have regained the seriousness that he had as a child at play. Friedrich Nietzsche, 1885

In play, children express impulses that are not accepted in a formal social context. Adapted from Freud

The importance of playing

The psychologist, biologist and philosopher Jean Piaget (1955) stated that play is the basic mechanism of children to learn and build their personality. Children learn playing (among others) to simulation games of adult lives.

The importance of playing

From Play behavior in crocodilians, V. Dinets (2015), Animal Behavior and Cognition 2:49-55

The reasons for playing

Why do we play?

An autotelic activity

To escape from reality

To realize in game what we do not dare to do in reality

To channel excess of energy

To prepare ourselves to situations to come

According to Huizinga, to play is an **autotelic** activity. Even though to play can be used to train, to evade, to socialize, it has its reason of being in itself. People like to play because they have **fun**, they feel **happy** playing

To have fun

Game characteristics

- Specific place or environment (“magic circle”)
- Rules, freely accepted
- Partial and final goals
- Interaction (moves)
- Feedback and results
- Story, narrative
- Competition, challenge with others or one-self

And overall: **FUN**, **motivation**, and even… addiction

The reasons for playing

- ✓ Games and gameful experiences are intentional activities that make us happy
- ✓ 60 percent of Americans play video games daily
- ✓ World's 3 billion gamers in 202279% of players are adults (older than 18)
- ✓ 41.5 percent are women
- ✓ Global value of the video-game market (2021): 195.65 billion $
- ✓ Most gamers feel computer and video games provide more value for they money

Data source: http://www.theesa.com/wpcontent/uploads/2018/05/EF2018_FINAL.pdf

The reasons for playing

Games makes us so happy that people even miss important activities such as eat and sleep to play

Age	A meal	Work	A shower	Sleep	Spending time with friends or going on a date
18-25	36.7%	14.2%	31.3%	55.9%	24.2%
26-35	36.7%	18.8%	29.7%	53.2%	28.5%
36-45	38.4%	16.1%	26.2%	52.6%	27.3%
46-60	31.6%	8.0%	16.4%	55.3%	25.0%
Over 60	28.6%	4.5%	14.9%	48.3%	24.0%
All	**34.3%**	**12.3%**	**23.1%**	**53.2%**	**26.0%**

Figure 42: What daily activities have you missed due to playing a video game? (Select all that apply)

Source: https://www.limelight.com/resources/white-paper/state-of-online-gaming-2019

Game characteristics

Caillois (1950) defines the activity of playing as **free** and **unproductive**

- ✓We play because we want to. No body can oblige us to play.
- ✓No goods or wealth are created outside of the game, when it's over, things start over like the first time.

Game characteristics

Professional sports are not considered as games, although sportsmen and sportswomen have fun playing

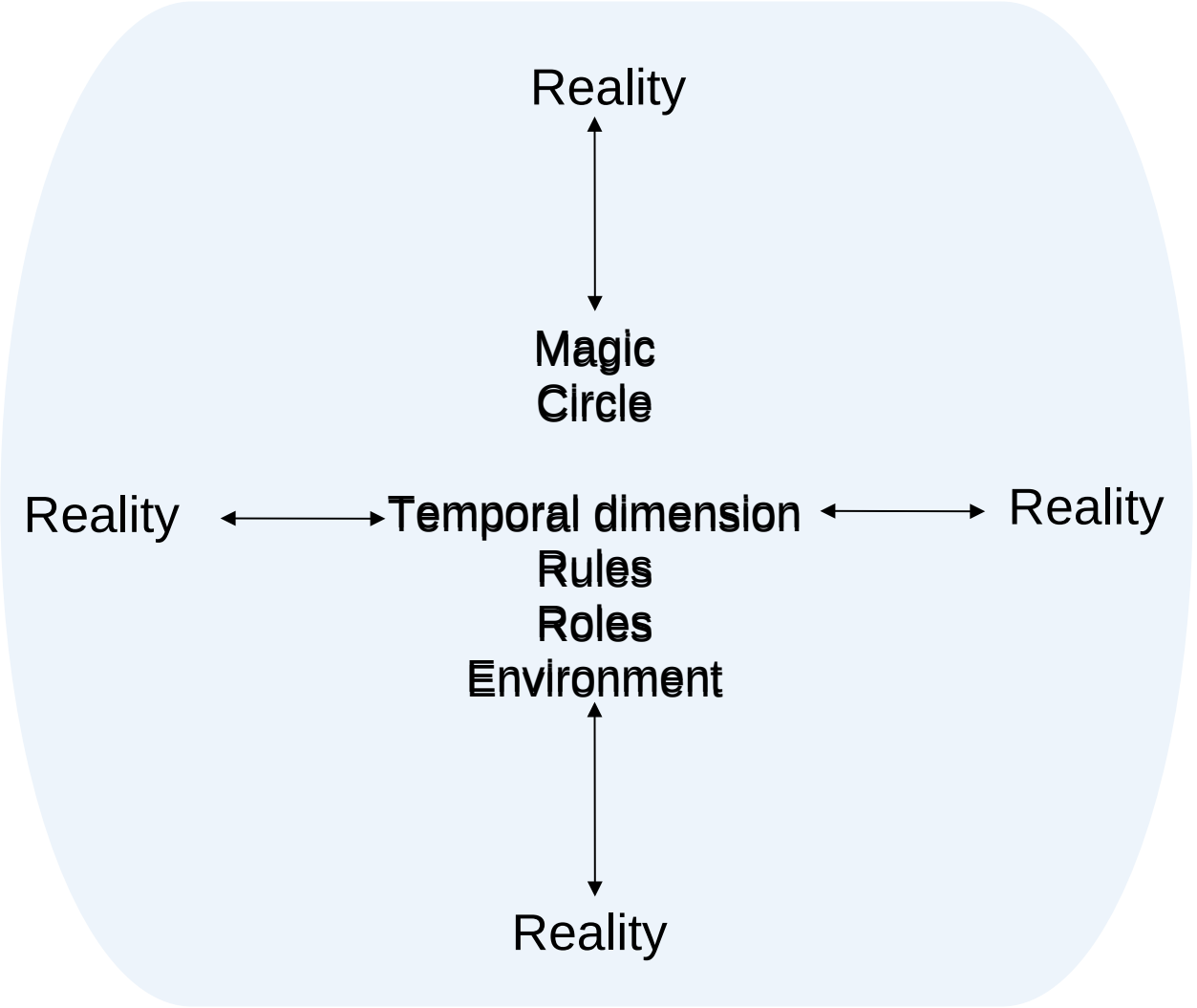
Game characteristics

To define an animal activity as a game, Burghardt states that the behavior must be **spontaneous**, **voluntary**, and **pleasurable**, that the behavior begins when the animal is adequately fed, healthy, stress-free and, therefore, **does not contribute to their survival**

Game characteristics

The magic circle

- ✓ Physical or imaginary space where the game happens
- ✓ Defined freely by players
- ✓ Evolutive
- ✓ Permeable
- ✓ Players do not forget reality while in the magic circle



Game characteristics

- Specific place or environment (“magic circle”)
- Rules, freely accepted
- Uncertain (unpredictable end)
- Partial and final goals (levels)
- Interaction (moves)
- Feedback and results
- Story, narrative
- Competition, challenge with others or one-self

And overall: **FUN**, and even… addiction

Game characteristics

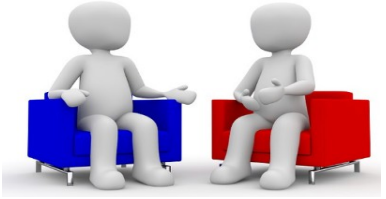
Unpredictable?

https://pippinbarr.com/lets-play-ancient-greek-punishment/info/

Funativity

According to the natural *funativity* theory (Noah Falstein, Gamasutra, 2004) there are 3 main sources of amusement:

- **Social fun**
  - Chat
  - Sex



- **Physical fun**
  - Sports
  - Dancing

- **Mental fun**
  - Problem-solving
  - Identifying patterns
  - Testing mental skills

Games often integrate one or more of these sources of fun

Impact of playing

Individual behavior

- self control
- creativity
- spontaneity
- mime

Physical development

- perceptual abilities
- response capabilities
- speed capacity
- resistance capacity
- endurance capacity

Social behavior

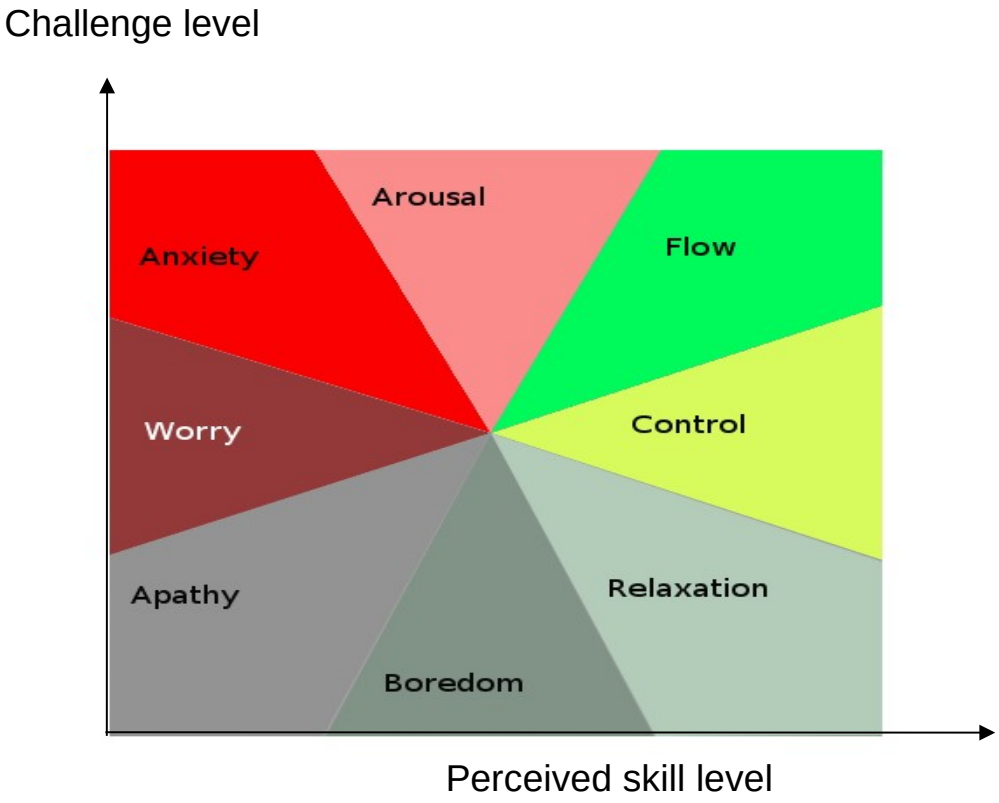
- cooperation
- trust
- problem solving
- verbal and non-verbal communication
- adaptability
- knowledge

Basic motor skills

- run
- skip
- balance
- climb, bend, crawl
- grasp, hold

Flow

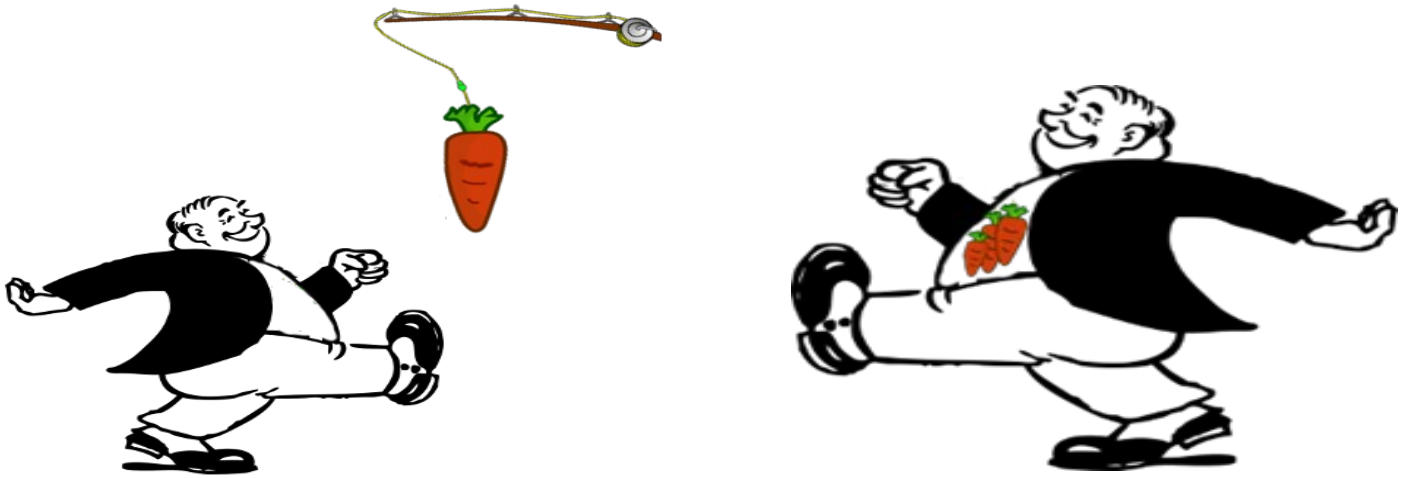
- Playing is fun!
- Playing yields to engagement
- Playing fosters flow
  - Immersion
  - Involvement
  - Focus
  - Enjoyment



From Csíkszentmihály, 1997.

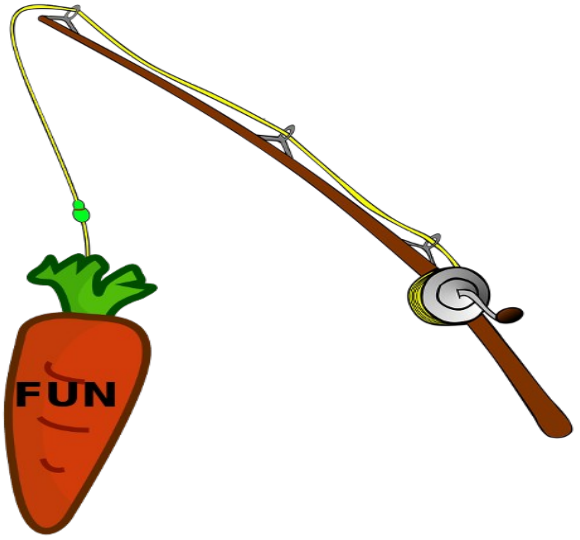
Motivation

- Desire and action toward a goal-directed behavior
- Motivation is the reason of move
- There are two main types of motivation:
  - **Intrinsic motivation**: desire for change comes from the individual
  - **Extrinsic motivation**: desire come from outside the person in form of positive (rewards) or negative (fear of punishment) incentives



Motivation

If we like to play because it's fun (and even lead us to the flow state) then let's bring fun into "serious" activities to make them more attractive, convert them into "serious games" or "gamified activities". The ultimate goal is to increase *motivation.*



Motivation

The objectives of **Serious Games** and **Gamification** is to **increase intrinsic motivation** and add extrinsic motivation to make us do “serious” activities.

Serious games and gamification

- **Serious games:** [video] Games designed for other purposes than leisure (ethym. Serio ludere)

- **Gamification:** Application of game-design elements and game principles in non-game contexts. Not creating a game but a gameful experience

- **Uses:** simulation, learning, training, rehabilitation, screening and evaluation

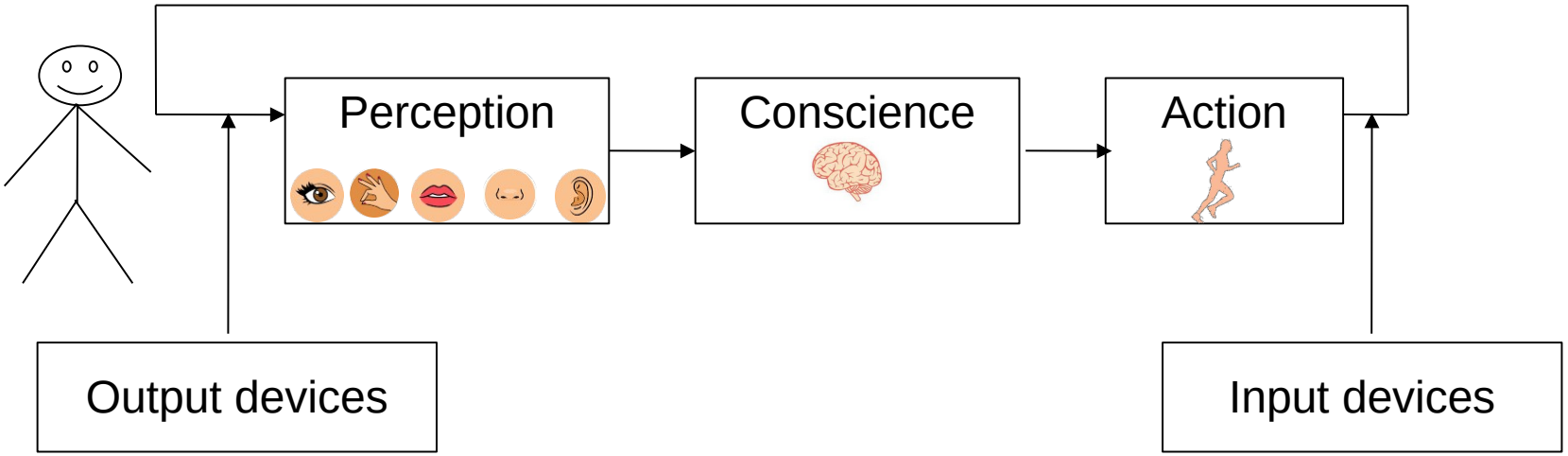
Virtual Reality

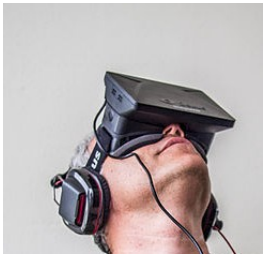
A simulated software* experience that recreates senses: sight, touch, earing, smell, taste

Virtual reality technology produces the sense of **presence**: being in a different enviroment than the actual one

*Acting, playing a role can also create a virtual reality, a term invented by the French dramaturgist Anthonin Artaud in “Le théatre et son double”

Virtual reality





Head-mounted Display (HDM)
VR headsets
Audio headset
Caves ...

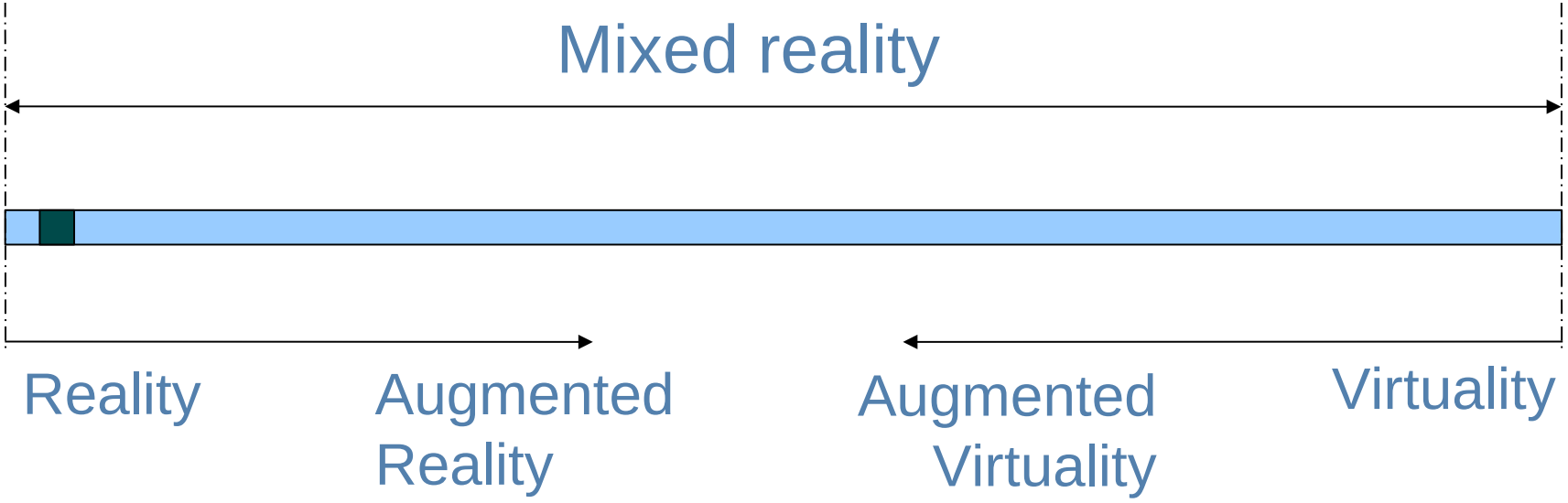
Haptic gloves

Gyroscopes

Haptics

Mixed reality

The reality continuum Milgram, 1994



Transreality games such as Pokemon GO combine playing in the virtual world and in the real world.

Virtual & Game-based rehabilitation

Virtual Rehabilitation is defined as the use of virtual environments in a rehabilitation process, to provide feedback and /or entertainment.

In papers, there is a lot of confusion with the term **Virtual Reality.** Often papers refer to it when they realy talk about **2D games**.

Immersive virtual reality is a term used to refer to a stereoscopic vision of a 3D virtual environment that users see with 3D glasses and interact with haptic devices.

Non-immersive virtual reality is often used to refer to 2D or 3D graphics projected in a a 2D screen.

However the quality of **immersion** in a virtual environment does not depen only on the technology (stereoscopic or not), but on other factors such as the level of interactivity, the quality of the narrative and the fact that the action is gamified or not, and how.

Game-based rehabilitation can be 2D or 3D immersive or not. What makes it a game is the fact that it has rules, goals, challenges and other “gamification” mechanisms.

Virtual & Game-based rehabilitation

Reading

System Immersion in Virtual Reality-Based Rehabilitation of Motor Function in Older Adults: A Systematic Review and Meta-Analysis, Emil Rosenlund Høeg et al., 2021

“Nevertheless, VR remains an umbrella term within the field of rehabilitation, used to describe many and vastly different technologies, from “non-immersive” single desktop displays to “immersive” high fidelity motion-sensing input devices and wearable technologies such as head-mounted displays (HMDs) (Tieri et al., 2018). Hardware aside, variations between software solutions used to study the efficacy of “VR-based” rehabilitation (Burdea, 2003) (VRBR) is equally pluralistic. Hence, attempting to define VR, entails a certain ambiguity across a large body of research. However, interventions rarely use immersive VR (IVR)-technology as a facilitator (Tieri et al., 2018).”

Games for rehabilitation?

Games can bring motivation to rehabilitation and thereby have a positive influence in patients pursueing rehabilitation as long as needed.

*"VR or gaming interventions produced **an improvement of 28.5% of the maximal possible improvement**. Dose and severity of motor impairment did not significantly influence rehabilitation outcomes. Treatment gains were significantly larger overall (10.8%) when the computerized training involved a gaming component vs just visual feedback. VR or gaming interventions showed a significant treatment advantage (10.4%) over active control treatments."*
Karamian et al., 2020[1]

1 Effectiveness of Virtual Reality- and Gaming-Based Interventions for Upper Extremity Rehabilitation Poststroke: A Meta-analysis, Karamian et al., Archives of physical medicine and rehabilitation, 2020-05, Vol.101 (5), p.885-896

Games for rehabilitation?

Games can bring motivation to rehabilitation and thereby have a positive influence in patients pursueing rehabilitation as long as needed.

"*We found evidence that the use of virtual reality and interactive video gaming* ***was not more beneficial*** *than conventional therapy approaches in improving upper limb function. Virtual reality may be beneficial in improving upper limb function and activities of daily living function when used as an adjunct to usual care (to increase overall therapy time).*" Laver et al. 2017[1]

1 Virtual reality for stroke rehabilitation, Laver et al. 2017, https://doi.org/10.1002/14651858.CD008349.pub4

Thank you