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Gaming in Stroke Rehabilitation

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Session Objectives

1. The participant will be able to define video gaming and identify at least three issues and advantages and the evidence for the use of gaming as a therapeutic modality or adjunct in neuro-rehab.
2. The participant will be able to identify at least two unique therapeutic and motor learning features of video gaming as compared to traditional rehabilitation interventions for individuals who have had a stroke.
3. The participant will be able to apply the evidence and the framework presented to design, modify, and progress at least three video game based interventions for patients/clients who have had a stroke.

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CONTINUED™

Virtual reality (**VR**), also known as **immersive multimedia** or **computer-simulated reality**, is a computer technology that replicates an environment, real or imagined, and simulates a user's physical presence and environment in a way that allows the user to interact with it. Virtual realities artificially create sensory experience, which can include sight, touch, hearing, and smell.

Most up-to-date virtual realities are displayed either on a computer screen or with a special virtual reality headset (also called head mounted display), and some simulations include additional sensory information and focus on real sound through speakers or headphones targeted towards VR users. Some advanced haptic systems now include tactile information, generally known as force feedback in medical, gaming and military applications. The immersive environment can be similar to the real world in order to create a lifelike experience—for example, in simulations for pilot or combat training—or it can differ significantly from reality, such as in VR games.

https://en.wikipedia.org/wiki/Virtual_reality

*Virtual Reality

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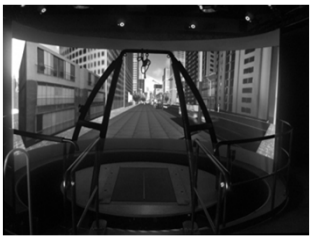
*VR Technology in Physical Therapy

"Gaming" systems created specifically for physical therapy:

- Full immersion virtual reality environments
- Haptic systems (sensing gloves)
- Simulators



http://www.motekmedical.com/products/caren/

Therapy specific systems are generally:

- **Expensive:**
  - limits # of systems a clinic can purchase/which clinics can afford them
- **Are for a smaller market than commercial gaming systems:**
  - cost a lot, or
  - are not as well made as those for large markets
- **Tailored to *very* specific therapeutic goals:**
  - not as flexible

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*VR Technology in Physical Therapy

Video

https://health.clevelandclinic.org/2014/05/virtual-reality-treadmill-helps-patients-with-parkinsons-ms/

https://www.motekforcelink.com/product/caren/

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A **video game** is an electronic game that involves human interaction with a user interface to generate visual feedback on a video device such as a TV screen or computer monitor (one that can produce two- or three-dimensional images.)

The electronic systems used to play video games are known as platforms; examples of these are personal computers and video game consoles. The input device used for games, the game controller, varies across platforms. Controllers include gamepads, mouses, keyboards, joysticks, the touchscreens of mobile devices and buttons. In addition to video and (in most cases) audio feedback, some games in the 2000s include haptic, vibration or force feedback peripherals.

https://en.wikipedia.org/wiki/Video_game

*Video gaming

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http://www.nintendo.com/wiiu
http://www.xbox.com/en-US/

*Video gaming

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Gaming Technology in Physical Therapy

Types of commercially available video gaming:

- Accelerometer (Wii)
- Motion/visual control (PSII w/ EyeToy, Kinect)
- Mechanical and game specific (Rock Band, Dance Revolution)
- Traditional controller (buttons, joystick)
- Combined (some WiiFit games w/ balance board)

Commercial video gaming used increasingly for its therapeutic potential across settings practice areas

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Some pros and cons of commercially available games

Advantages:

- Many choices
- Can address many different motor control issues
- Generally affordable and can often be bought used

Disadvantages:

- Clinician must know different games/systems to use/apply appropriately
- Not tailored to specific problems
- May need to be physically modified for specific client needs

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Systematic reviews of therapeutic exercise:

Across conditions, types of exercise, and settings

→ therapeutic EX is more effective if . . .

- relatively intense
- if targeted and individualized *(Taylor et al, 2007)*

Video game and virtual reality (VR) technology offer potential to provide much higher intensity and volume of exercise, and much more targeted exercise.

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* *Features of video gaming vs. traditional rehabilitation*

Engagement and motivation

- Immersive, virtual reality nature of gaming
- Presence
- Flow / fundamental psychological need for competence

Practice: increased motivation and engagement →

- Massed practice
- More repetitions for motor learning

Transfer to real life activities

Dual task nature of gaming

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* *Engagement and enjoyment*

- Gaming is very engaging vs. traditional rehab activities *(Rand et al, 2008; Brumels et al, 2008; Betker et al, 2007; Fitzgerald et al, 2010; Reinthal et al 2012)*
- Increased practice volume and increased attention span during training *(Betker et al, 2007)*
- Selected evidence:
  - Wobble board with vs. without gaming *(Fitzgerald et al, 2010)*
    - Similar balance outcomes but more engaged, more motivated with gaming
  - Traditional vs. game based balance training protocol *(Brumels et al, 2008)*
    - Gaming more engaging, enjoyable
    - Improvement on selected balance measures

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* *Immersive nature of gaming*

Virtual reality (VR) environment:

- Three-dimensional computer generated immersion experience
- "Player" completes the task similarly to the real world
- Experience engaging, realistic, transfers to a comparable real world activity *(Sveistrup 2004)*
- Successfully used for upper extremity repetitive task practice *(Crosbie et al. 2006; Sveistrup 2004)*
- Fine tune virtual environment and virtual tasks vs. need to modify real environments and real tasks

Incorporates many more personal, task, and environmental parameters simultaneously than more traditional exercise modes, e.g.,

- Moving environments and targets with perceptual & timing demands
- Attentional demands
- Dual task demands
- Cognitive strategy demands

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* *Presence*

- The virtual reality literature discusses the concept of ***presence*** *(Riva et al. 2004)*

  - A form of positive, active engagement that occurs during the VR experience

  - Presence may help account for the engagement advantages found in gaming

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* *Flow*

Flow: match of skills to challenges (not too easy or too hard, more fine tuning):

- Flow - "compatibility of critical person (skills) and environmental factors (demands) involved in a given activity elicits subjective experiences that render the respective activity rewarding" *(Keller & Bless, 2008; 2011)*
- Flow - intrinsic motivation, staying in the zone between anxiety/frustration and boredom *(Keller & Bless, 2008; 2011)*

❖ Among older adults using video games for "brain training" . . . *(Nacke et al, 2009)*

- Young and old players more efficient using paper and pencil for problem solving
- Both groups found gaming more arousing and heightened sense of flow
- Problem solving associated with more positive feelings for older vs. young with gaming
- Gaming may have potential advantages for cognitive retraining among older adults

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Motivation – fundamental psychological needs

Competence

- Better motor learning when positive expectations set *(Wulf et al, 2012)*
- Too much help with task hinders learning *(Avorn & Langer, 1982)*
- Conception of ability affects learning *(Wulf & Lewthwaite, 2009)*

Choice

- Too big a choice leads to feelings of incompetence
- Too small a choice leads to feelings of disrespect
- Must grade task demands appropriately

Video gaming → easy to grade task difficulty

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Practice in rehabilitation

Recent research has begun to measure the ***amount of practice that occurs in a typical rehabilitation program***

Individuals post-stroke are not getting enough repetitive practice in the outpatient setting, especially upper extremity activities.

On average, in a 36 minute session addressing the UE:

- 39 active assisted UE movements
- 12 purposeful UE movement

(Boyd et al. 2009; Lang et al. 2009)

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* *Massed practice*

- 100's to 1000's of repetitions/task practice are essential to improve in a specific function post-stroke *(Kleim & Jones 2008; Boyd & Winstein 2003; Boyd & Winstein 2006; Wolf et al. 2006; Boyd et al. 2009)*
- Experience-dependent neuroplasticity
- Gaming can assist with massing practice/increasing practice volume *(Betker et al, 2007; Reinthal et al, 2012)*
- Repetitive practice of a single task is often ***boring*** for adults, patient and therapist *(Betker et al. 2007; Flynn et al. 2007; Rand et al. 2008; Yavuzer et al. 2008)*

Engagement in gaming makes massed practice less boring

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* *Video gaming as part of Physical Therapy*

Therapist must:

- identify specific goals of therapy
- structure tasks to provide appropriate challenge
- monitor performance
- evaluate outcomes
- link learning to real world context *(Levac & Galvin, 2013)*

Therapists also responsible to see that activities are:

- safe
- not detrimental
- motivating
- cost effective

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* *Video gaming as part of Physical Therapy*

VR is not "therapy" unless it can assume all the roles of a clinician

Cannot by itself:

- tailor itself to client's needs
- flexibly respond to client's changing needs
- adapt to client's learning and performance
- provide feedback
- among others….. *(Levac & Galvin, 2013)*

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* *Therapeutic modality vs. therapy adjunct*

- Even when used as an ***adjunct*** . . . still requires therapist to choose, monitor, progress and evaluate for effectiveness, similarly to a home or group exercise program

Suggest the term "VR-based therapy" *(Levac & Galvin, 2013)*

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* *Evidence for gaming as a therapy adjunct*

Evidence for effectiveness of off-the-shelf video gaming as an *adjunct* to therapy:

- In people post-stroke, better balance/gait with therapy + VG vs. therapy alone *(Kim et al, 2009)*
- EyeToy with traditional stroke rehabilitation more effective than placebo adjunct for FIM, not for Brunstrom staging *(Yavuzer et al, 2008)*
- Case study of use of EyeToy for people with chronic stroke after completion of rehabilitation – feasible and appeared effective as an adjunct *(Flynn et al, 2007)*
- Adjunct to UE rehabilitation post-stroke → changes in WMFT and FMA but not SIS *(Reinthal et al, 2012)*
- Wii gaming vs. recreational therapy, post-stroke → changes in WMFT with gaming *(Saposnik et al, 2010)*
- Wii gaming as an adjunct during inpatient stroke rehab → changes in FMA and Motricity Index *(Joo et al, 2010)*

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* *Gaming as primary therapeutic exercise modality*

Less evidence for use of gaming as a primary modality (Not all CVA related****):

- Traditional vs. game based balance program → *gaming more engaging, enjoyable,* and improved selected balance measures *(Brumels et al, 2008)*
- Wobble board with vs. without gaming environment→ *similar* balance outcomes but *more engaged, more motivated with gaming* *(Fitzgerald et al, 2010)*
- Case report of Wii bowling as Rx for balance for nursing home resident → *improved* balance measures *(Clark and Kraemer, 2009)*
- Incorporation of common objects into gaming *effective* for finger/hand motor rehabilitation *(Szturm et al, 2008)*
- In people with ABI, WiiFit platform vs. standard balance program → *improved* static balance measures; *less difference* in dynamic balance measures *(Gil-Gomez et al, 2011)*

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Recent Evidence Specific to Stroke:

* [Authors' summary] We found evidence that the use of virtual reality and interactive video gaming may be beneficial in improving upper limb function and ADL function when used as an adjunct to usual care (to increase overall therapy time) or when compared with the same dose of conventional therapy. There was insufficient evidence to reach conclusions about the effect of virtual reality and interactive video gaming on grip strength, gait speed or global motor function. It is unclear at present which characteristics of virtual reality are most important and it is unknown whether effects are sustained in the longer term. Laver KE, George S, Thomas S, Deutsch JE, Crotty M. Virtual reality for stroke rehabilitation. Cochrane Database of Systematic Reviews 2015, Issue 2. Art. No.: CD008349. DOI: 10.1002/14651858.CD008349.pub3

* Systematic review of quantitative studies determining the effects of over commercially available off the shelf gaming technology as a means of upper limb stroke rehabilitation. Conclusion found that they are feasible and effective, but because of the limitations of only low level research available, recommendations for clinical use cannot be determined yet. Casserly D, Baer G. Effectiveness of commercially available gaming devices in upper limb stroke rehabilitation. Physical Therapy Reviews. February 2014;19(1):15-23

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Recent Evidence Specific to Stroke:

* Practice Guidelines regarding virtual reality as intervention for clinicians Anderson K, Woodbury M, Phillips K, Gauthier L. Organization news: Virtual Reality Video Games to Promote Movement Recovery in Stroke Rehabilitation: A Guide for Clinicians. Archives Of Physical Medicine And Rehabilitation. May 1, 2015;96:973-976.

* Systematic review of gaming therapy for post stroke patients comparing custom built virtual reality and commercially available game systems as interventions along with conventional therapy. Results showed no difference between the two gaming interventions and overall benefit of gaming therapy compared to conventional therapy. While outcomes moderately improve when using gaming therapy, current commercially available gaming system interventions are still not well researched and larger RCTs are needed with more clearly defined methods. Lohse KR, Hilderman CGE, Cheung KL, Tatla S, Van dL. Virtual reality therapy for adults post-stroke: A systematic review and meta-analysis exploring virtual environments and commercial games in therapy. PLoS ONE. 2014;9(3):e93318

* Double blind RCT examining virtual reality balance related games, specifically using the Wii-Fit and Microsoft Kinect, integrated within conventional rehabilitation to determine if this intervention is more beneficial for dynamic balance compared to conventional rehab alone post stroke. Results indicate that indeed the integrated training does improve functional mobility and balance after recent episode of stroke. B. S. Rajaratnam, J. Gui KaiEn, K. Lee JiaLin, et al., "Does the Inclusion of Virtual Reality Games within Conventional Rehabilitation Enhance Balance Retraining after a Recent Episode of Stroke?," Rehabilitation Research and Practice, vol. 2013, Article ID 649561, 6 pages, 2013. doi:10.1155/2013/649561

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* *Why we developed this framework*

- Systems/games numerous and rapidly developing – hard to keep up/be familiar with all of them . . .

but

- For therapeutic benefit, characteristics of the system/games must match clients' functional goals, impairments and activity limitations, and must not pose risk or interfere with therapy

so…

- Therapists must be able to tailor games, use them most effectively to match and progress therapeutic aspects towards client's treatment goals

Purpose of our model. . .

. . . to manage these choices effectively

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*Clinical Decision Making Framework

- A clinical decision making framework for game selection and progression
- For the use of video games as a therapeutic exercise modality
- Especially when used to address mobility, movement, balance and motor re-learning goals

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PERSON

Realm	Category	Choice	Continuum
Posture	Base of Support	Standing vs. Seated vs. Other	Smaller → Larger *(standing/one → two feet → with hands → sitting, lying)*
Trunk	Segments involved	Head/Neck Upper Lower	
	Function at each segment	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
Upper Extremity	Joints involved	Shoulder Elbow Forearm/wrist	
	Function at each joint	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
	Overall Mode	Open Chain vs. Closed Chain	
Lower Extremity	Joints involved	Hip Knee Ankle/Foot	
	Function at each joint	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
	Overall Mode	Open Chain vs. Closed Chain	
Hand Function	Use	Free vs. In use	Free → Grasp → manipulate
	Coordination	Unilateral vs. Bimanual	Active Assist → Yoked (symmetrical vs. reciprocal) →

TASK

Realm	Category	Choice	Continuum
Performance characteristics	**Type**	Discreet vs. Continuous	
	Variability	Constant vs. Variable	Less → More Variable Predictable → Random
	Locus	Motions Timing	Self determined →Responsive Self determined →Responsive
Accuracy	Spatial	None Required vs. Requires spatial accuracy	Less demanding → more demanding
	Temporal	None required vs. Accurate timing required	Less → more difficult
Cognition	Decision making	None required vs. Strategy/planning involved	Simple → more difficult solutions One step → multi-step
	Attention	Quiet vs. Distractors	Less → more distraction *(visual, audio, choices, etc.)*

ENVIRONMENT

Realm	Category	Choice	Continuum
Support Surface (real)	Compliance	Firm vs. Compliant	Stable → unstable *(floor, wobble board, etc)* Less → more compliant *(floor, foam, etc)*
	Perturbation *(if unstable and/or compliant)*	Passive (nonmechanical) vs. Active *(mechanical)*	One plane → multi-plane Small → large amplitude One plane → multi-plane Small → large amplitude Predictable → random Low → high Intensity *(velocity, acceleration, etc.)*
Sensory world (virtual)	Stationary objects (vision)		Clean → Distracting
	Moving objects (vision)		Clean → Distracting Predictable → Startling
	Auditory and/or haptic stimuli	Present vs. Inactivated (not present)	Clean → Distracting Predictable → Startling
Visual flow (virtual)	Flow of field (vision)		Expected → Unexpected Predictable → Startling
Obstacles in Game (virtual)	Accommodation	Do not Require Accommodation vs. Require Accommodation	By a body part → by whole body
	Motion	Stationary vs. Moving	Slowly → Quickly Predictable → More Random

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PERSON

Realm	Category	Choice	Continuum
Posture	Base of Support	Standing vs. Seated vs. Other	Smaller → Larger *(standing/one → two feet → with hands → sitting, lying)*
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	Function at each joint	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
	Overall Mode	Open Chain vs. Closed Chain	
Lower Extremity	Joints involved	Hip Knee Ankle/Foot	
	Function at each joint	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
	Overall Mode	Open Chain vs. Closed Chain	
Hand Function	Use	Free vs. In use	Free → Grasp → manipulate
	Coordination	Unilateral vs. Bimanual	Active Assist → Yoked (symmetrical vs. reciprocal) → Independent

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TASK

Realm	Category	Choice	Continuum
Performance characteristics	**Type**	Discreet vs. Continuous	
	Variability	Constant vs. Variable	 Less → More Variable Predictable → Random
	Locus	Motions Timing	Self determined →Responsive Self determined →Responsive
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ENVIRONMENT

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PERSON

Realm	Category	Choice	Continuum
Posture	Base of Support	Standing Seated Other	Smaller → Larger *(standing/one → two feet → with hands → sitting, lying)*

Position: some systems lend themselves to postural options
- Sitting or ? lying down (Wii)
- Others do not (Kinect) – standing only/primarily

UE support (cane, etc)
- accelerometer based may be easier,
- may be possible with motion/visual (kinect)

Games may dictate BOS in standing:
- Some do not register foot position – most Wii games, kinect boxing
- Some allow stance choice – racing, reflex ridge, bowling
- Many require narrow BOS, SLS
  - 20,000 Leaks, soccer

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PERSON			
Realm	**Category**	**Choice**	**Continuum**
Trunk	Segments involved	Head/Neck Upper Lower	
	Function at each segment	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane

To emphasize or to avoid/be aware of:

Segments involved and function at each – predominantly:

- Stability at upper and lower trunk – boxing
- Movement at upper and lower and head/neck – reflex ridge
- Switches at all segments – soccer
- Both - golf

Parameters of motion

- Amplitude – arc or range of motion
- Speed – of movement
- Planes of motion required to complete game task

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PERSON			
Realm	**Category**	**Choice**	**Continuum**
Upper Extremity	Joints involved	Shoulder Elbow Forearm/wrist	
	Function at each joint	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
	Overall Mode	Open Chain vs. Closed Chain	

To emphasize, or to avoid/be aware of:

Segments involved and function at each – predominantly:

- Stability at shoulder/movement at elbow/wrist – Wii bowling, Guitar Hero
- Movement at shoulder/stability distally – driving (Mario cart)
- Switches at all segments – sword fighting
- Parameters - amplitude, speed, planes of motion required

Closed Chain UE unusual but can be done with WiiFit balance board or as an adaptation

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PERSON			
Realm	**Category**	**Choice**	**Continuum**
Lower Extremity	Joints involved	Hip Knee Ankle/Foot	
	Function at each joint	Stability Movement	Less → More challenging Small → Large Slow → Fast Single plane → multi-plane
	Overall Mode	Open Chain vs. Closed Chain	

To emphasize, or to avoid/be aware of:

Segments involved and function at each – predominantly:

- Stability at specific joints or at one LE vs. the other – soccer
- Movement at some joints or at one LE vs. the other – soccer
- Switches at all segments and b/w LE's – soccer, 20,000 Leaks
- Parameters - amplitude, speed, planes of motion required

Closed Chain possible - reflex ridge, 20,000 leaks, skiing/rafting

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PERSON			
Realm	**Category**	**Choice**	**Continuum**
Hand Function	Use	Free vs. In use	 Stabilize → Grasp → Manipulate
	Coordination	Unilateral vs. Bimanual	 Active Assist → Yoked (symmetrical vs. reciprocal) → Independent

If hands are in use:

- Kinect may not be best suited to fine motor tasks
- Ability to use controller (Wii, etc.,) or therapist can adapt controller
- Can add manipulanda (guitar, drum sticks, swords, custom adaptations to Wii controllers)

Coordination:

- Unilateral = stabilize → grasp → manipulate
- Bimanual:
  - Active assist - golf
  - Yoked/symmetrical – pumping water DIY (PS2)
  - Yoked reciprocal – driving with adapted steering wheel/Wii, golf
  - Independent – guitar hero, drumming

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TASK			
Realm	**Category**	**Choice**	**Continuum**
Performance Characteristics	Type	Discreet vs. Continuous	

For Example:

- Bowling is discrete
  - pause and reset
  - knowledge of results (KR) between trials
- Driving/racing/skiing/etc are continuous
  - motor task only stops if crash/fail
  - KR ongoing throughout/real time
  - summary KR at end

For clients:

- *Discrete* . . . need for breaks – for rest, for learning, feedback, attention, less frustration
- *Continuous* . . . need for physical (motor or cardiopulmonary) endurance, perseverance, more overall practice, more total tasks performed, engagement

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TASK			
Realm	**Category**	**Choice**	**Continuum**
Performance Characteristics	**Variability**	Constant vs. Variable	Less → More Variable Predictable → Random

Same task vs. variations of one or several different tasks interspersed

Constant

- Bowling → discrete performances of same or very similar tasks
- Boxing → more continuous, can play with very similar arm motions (little variability)

Variable – to different degrees

- 20,000 Leaks → discrete UE vs. LE tasks interspersed, variable target locations
- Soccer (kinect) → offense to defense to goalie "on the fly" – changes in: motor task (feet vs. hands), responsive vs. self-initiated, task goal (block vs. score)

Better retention/learning with **random practice** (variable tasks) than blocked

Contextual interference introduced with more variability enhances retention, learning and likely transfer must be adjusted to skill level of learner *(Guadagnoli and Lee, 2013)*

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TASK			
Realm	**Category**	**Choice**	**Continuum**
Performance Characteristics	**Locus**	Motions	Self Determined vs. Responsive
		Timing	Self Determined vs. Responsive

Self-determined: when to begin . . . specifics of the motor task determined by player

- For higher scores must meet task demands (speed/number of completions)- *but remains player driven*
- Soccer free kicks – free to choose timing and how to execute task
- Boxing – free to choose type and timing of punches, especially at lower levels

Responsive – game drives the timing and motor task

- At higher difficulty – boxing requires response to opponent's punches
- Rally ball - player must respond to the game in task and timing

For client's therapeutic goals

- Responsive – perseverance, endurance, faster responses, automaticity
- Self-initiated - motor planning, initiation

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TASK			
Realm	**Category**	**Choice**	**Continuum**
Accuracy	Spatial	None Required vs. Requires spatial accuracy	Less demanding → more demanding
	Temporal	None required vs. Accurate timing required	Less → more difficult

Spatial – need to match the location of the target in 3D, but no timing component

- 20,000 Leaks, golf

Temporal - most also have a spatial component but the timing may predominate (spatial may be much easier/more leeway)

- Reflex Ridge

Fitt's Law – Speed Accuracy trade-off for tasks that involve both

- Tennis, defense in soccer, Rallyball
- must match both the timing and point in space

What is more important for your client?

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TASK			
Realm	**Category**	**Choice**	**Continuum**
Cognition	Decision Making	None required vs. Strategy/planning involved	Simple → more difficult solutions One step → multi-step
	Attention	Quiet vs. Distractors	Less → more distraction *(visual, audio, choices, etc.)*

Decision making

- Gold rush mountain - simply respond
- Rally ball – choose most likely possibility
- 20,000 Leaks – no choice, no planning
- Soccer, racing – plan one to several moves ahead → game strategy

Will these be beneficial or detrimental to your client?

Attention

- distractors in the audio or visual environment
- may be just distractors or may be relevant (require attention)

All present a dual task component to the session/activity

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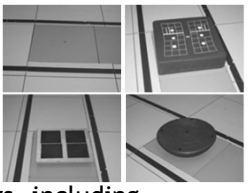
ENVIRONMENT			
Realm	**Category**	**Choice**	**Continuum**
Support Surface (Real)	Compliance	Firm vs. Compliant	Stable → unstable *(floor, wobble board, etc)* Less → more compliant *(floor, foam, etc)*
	Perturbation *(if unstable and/or compliant)*	Passive vs. Active *(mechanical)*	One plane → multi-plane Small → large amplitude One plane → multi-plane Small → large amplitude Predictable → random Low → high Intensity *(velocity, acceleration, etc)*

***Not a function of the game** –set up by therapist to augment game for therapeutic goals



- *Compliance* – hard floor, rug, gym mat, foam
- *Perturbation* –
  - bosu ball (multi plane, passive, large amplitude)
  - wobble board (single plane, passive, moderate amplitude)
  - mechanically moving surface – can typically choose parameters, including randomness

Gaming constitutes a dual/secondary motor and potentially motor and cognitive task to the balance/postural control task

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ENVIRONMENT			
Realm	**Category**	**Choice**	**Continuum**
Sensory World (Virtual)	Stationary *(visuals)*		Clean → Distracting
	Moving *(visuals)*		Clean → Distracting Predictable → Startling
	Auditory and/or haptic stimuli	Present vs. Inactivated (not present)	Expected → Unexpected Predictable → Startling

Visuals are what make it "virtual reality"

- More or less realistic (i.e., match what one would expect in real life) – boxing doesn't match well
- Very few are truly stationary
- Virtual Motion in and/or of the environment – ***may be a perturbation itself***

Moving objects –

- Player/avatar stationary – objects move around – 20,000 Leaks, boxing
- Moving objects are of interest or are distractors

Considerations for clients should also include sensitivity to visual postural control input, especially mis-matched information.

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ENVIRONMENT			
Realm	**Category**	**Choice**	**Continuum**
Visual Flow (Virtual)	Flow *(of field)*		Expected → Unexpected Predictable → Startling

Flow of the field:

- Including looming or receding as person leans forward/back, changes as head turns
- Riding the raft/racing
- "Jumps" – soccer – avatar switches sides suddenly – new environment appears without visual flow

Considerations for clients should also include sensitivity to visual postural control input, especially mis-matched information.

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ENVIRONMENT			
Realm	**Category**	**Choice**	**Continuum**
Obstacles in Game	Accommodation	Do not Require Accommodation Vs. Require Accommodation	By a body part → by whole body
	Motion	Stationary Vs. Moving	Slowly → Quickly Predictable → More Random

Virtual obstacles have no physical consequence/harm if hit . . . advantage of gaming

Accommodation:

- Obstacles are distractors or minimally relevant
- Obstacles, if hit, cause game to stop/pause/reset - racing, rafting

Motion:

- Obstacles may be stationary with avatar moving toward them (racing/rafting/skiing)
- may also move (increasing difficulty of visuo-perceptual task and cognitive demands)

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*PT getting immersed in the game vs. watching the pt

*Pt needs to do motions correctly – "cheats" possible

*Use of "score" from game as an outcome measure

*Is a dual task already

*Monitor Vital Signs

*Things to watch out for…..

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* **Case Description:** a 52 year old woman 18 months post left CVA. She exhausted her insurance covered therapy a year ago, but remained profoundly limited in gait and activities by a painful, spastic equinovarus foot. Her goal was to walk independently with more tolerable pain levels in order to participate more fully in family, community, and further rehab opportunities.
* She had been employed in health care and was an avid golfer prior to her stroke. She expressed loss of hope due to her inability to work towards recovery. The most immediate therapy goal was to increase her ability to bear weight on her right foot with tolerable pain and maintenance of foot flat vs. equinovarus.
* Some game choice factors: she moved fairly slowly, req contact guard/supervision for standing with, some expressive aphasia and some slowness of processing multiple visual or auditory stimuli at once, very poor fine motor function of right UE but intact function of left UE.
* We chose Wii golf with hand over hand on controller and stance/swing to emphasize right foot/LE weight bearing

*Case 1

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* **Case Description:** a 46 year old woman 4 years post right cerebellar CVA. Most limiting impairments were ataxia of her left UE and LE and trunk but some right side also. She had been an art teacher prior to her stroke. Now employed part time dog walking/dog-sitting.
* Her goals were to improve fine motor and UE control to allow her to work in cake decorating part time, and to improve gait/decrease gait ataxia to allow recovery from losses of balance or to avoid falls while walking multiple dogs.
* Some game choice factors: she was easily distracted by visual or auditory stimuli and experienced LOB with quick head turns while walking. She experienced greater gait instability if using UE's while walking and greater difficulty with UE tasks if her gait or balance were challenged.
* We chose kinect games such as rally ball or reflex ridge because they challenged UE target reaching, full body movements while maintaining balance, LE reaching/kicking target or target avoidance. They both also involved increasing levels of visual input as the game progresses, including visuals that must be chosen/reached, or ignored, or actively avoided. They also promoted head turning and challenged UE and LE movement individually at times and simultaneously at other times.

*Case 2

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* **Case Description:** a 72 year old man, 11 years post left CVA. He was able to stand and walk independently, though with diminished weight bearing and stance time on his right LE. His right shoulder lacked full active motion and became stiff and more difficult to move with disuse between therapy appointments. This limited his ability to dress and do self care activities independently. He had some impairment to his fine motor abilities in his right hand but was able to grasp and grossly manipulate a Wii controller. He was retired and lived with his wife. He had played tennis recreationally prior to his stroke.
* Some game choice factors: He did not have difficulty with visual distractions or flow or decision making/processing. He very much enjoyed playing Wii tennis and was quite competitive when playing (i.e., he became engaged to the point that he would play past the point of a safe level of fatigue)
* He wanted to play Wii tennis at home as it helped decrease his shoulder stiffness and maintained motion between therapy sessions. Our therapy goal was to make this part of his home exercise plan and to work out strategies that would allow him to do this safely.

*Case 3

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