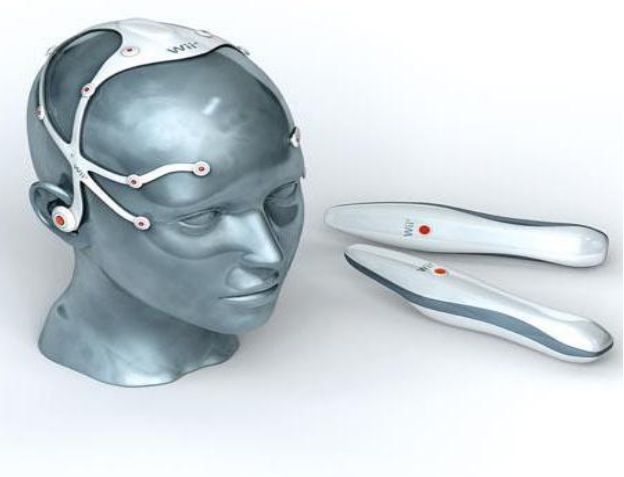
Active Video Gaming for use in the Home Setting for Children w/ Special Needs



James Every MPT

Objectives:

1. List three possible benefits when using active video gaming as a ***supplement*** to traditional physical therapy services in the home setting as it relates to the wellness and gross motor function of your child.

2. Understand that each of the commercially available video game systems described in this presentation have advantages & disadvantages based on the type of technology they utilize.

3. Recognize the various sensory systems that children use while playing video games and that they offer a wealth of feedback.

Objectives (continued)

4. Have an opportunity to play one game from each system (Nintendo Wii & Xbox Kinect) in front of the group (if time allows).

5. Acknowledge just how advanced technology has become and that active video game systems are a fraction of the cost of true, virtual reality systems that are usually not available to most children.

6. Appreciate that video game systems actively ***engage*** the learner which results in increased motivation for your child.

A *very* Brief Review on the History of Virtual Reality (VR):

- Initial investigations into a VR approach occurred in the **mid-1990's**[1]

- Historically it has been used for the ***training*** of movement tasks involving highly complex activities such as surgical techniques, flight stimulation, and military exercises[1]

*Video game systems such as the Nintendo Wii & Xbox Kinect are **not true** VR applications, but they have gained recent popularity in various rehab settings

Virtual Reality-Key Concepts

- ***Interaction*** between the computer & person is achieved by the use of multiple sensory channels to explore virtual environments (video games) through mainly sight, sound, and touch[2]
- ***Immersion*** is the degree to which the child feels engrossed or enveloped within the video game[3]

Am I Here Yet??

A Simple Equation:

- **Interaction** + **Immersion** = **Presence**

- This is the feeling of ***"being there"*** in the video game on the screen[1]

*A higher degree of presence is associated with greater **engagement**, which has been linked to better treatment outcomes[4]

Human Sensory Systems:

Special Senses:

1. **Smell**
2. **Taste**
3. **Touch**
4. **Sight**
5. **Sound**

Other Important Senses:

1. ***Proprioception-*** Awareness of where a part of your body is in the space around you

   Ex. Is my arm up or down?

2. ***Vestibular-*** The ability of the head & neck to detect changes in position in respect to gravity

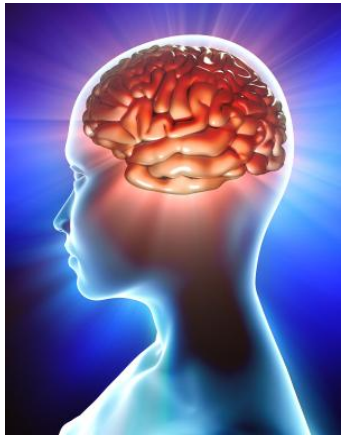
   Ex. The sensations you feel when you spin around or ride a roller coaster

Role of Sensory Information as it Relates to Movement

Sensory Input from the Environment is converted into Electrical Signals

Travels into our **Brain** (cortex) from the Spinal Cord & Brainstem

Motor Output is a message sent to our muscles to move!



A Wealth of Sensory Feedback at your Disposal

- By ***manipulating*** these sensory stimulation variables (sights, sounds, pressure/vibration) through the selection of specific video games & systems, we can obtain more **control** over the therapeutic effectiveness of a given intervention[1]

Why do we Choose to Move?

When we are motivated we move to ***explore*** our environment to accomplish a goal that is **meaningful** and to **participate** in society!!

Types of Video Game Systems:

- All utilize a computer interface that involve real-time simulation & interactions by using multiple sensory channels[1]
  1. **Haptic-Based** Ex. Nintendo Wii
  2. **Gesture-Based** Ex. Xbox Kinect

* Most commercially available video game systems on the market are either considered to be Haptic or Gesture-Based or a combination of the two

GESTURE-BASED

- Contain specialized cameras or tracking devices that can capture movements which are then projected in ***real-time*** onto the game screen[5]

- Does not require the use of a game controller providing a more “natural interface”[5]

How does the Xbox Kinect work?

- Uses image processing technology to detect a person's movements by incorporating infra-red light, plus a video camera to create a 3D map of the area in front of the body[5]
- Determines anatomical landmarks such as joint centers in the arms/legs/trunk close to real-time by using a complicated mathematical formula[5]

Evidence Supporting the XBox:

- A pilot study by Chang et al[6] explored the use of the Kinect to assess both performance & motivation
- Subjects included a 17 yr. old male w/ a diagnosis of cerebral palsy & 16 year old female w/ Acquired Muscle Atrophy
- The kids were first asked to demonstrate specific arm movements w/ out the use of the Kinect technology
- Next, the subjects repeated arm movements using only the Kinect game

Chang study continued:

- When they performed a movement ***accurately*** using the Kinect a whale appeared on the video game screen **swam & sang** (used as a reinforcer)

*Results showed both subjects significantly ***increased*** the **#** of **correct** movements when using the Kinect system[6]

Limitations of the XBOX:

1. Does **not** have the ability to track internal/external rotations in the arms & legs (only movements in straight planes up/down & to the sides)[5]

2. Low ***resolution*** and ***depth*** accuracy per pixel compared to a 3D camera (not as realistic)[5]

3. People w/ disabilities may not be able to perform the “calibration pose” necessary to interact w/ the system therefore they are not able to play[5]

HAPTIC-BASED

- Incorporates the sense of ***touch*** that is used as a medium through which the user can interact with the video game on the screen[1]

- The simplest available haptic interfaces include the **computer mouse**, **joystick,** and **touchscreens**[1]

How does the Nintendo Wii work??

- The players create an avatar (Mii) that personifies them in the games[1]
- Uses a Haptic-based controller that vibrates (Wiimote) an accessory joystick (Nunchuck) to control the Mii Character[1]
- An integrative tracking device detects movements of the hand-held Wiimote via motion sensors and Bluetooth wireless technology[7]

My very favorite addition to the Wii system is the Balance Board!!

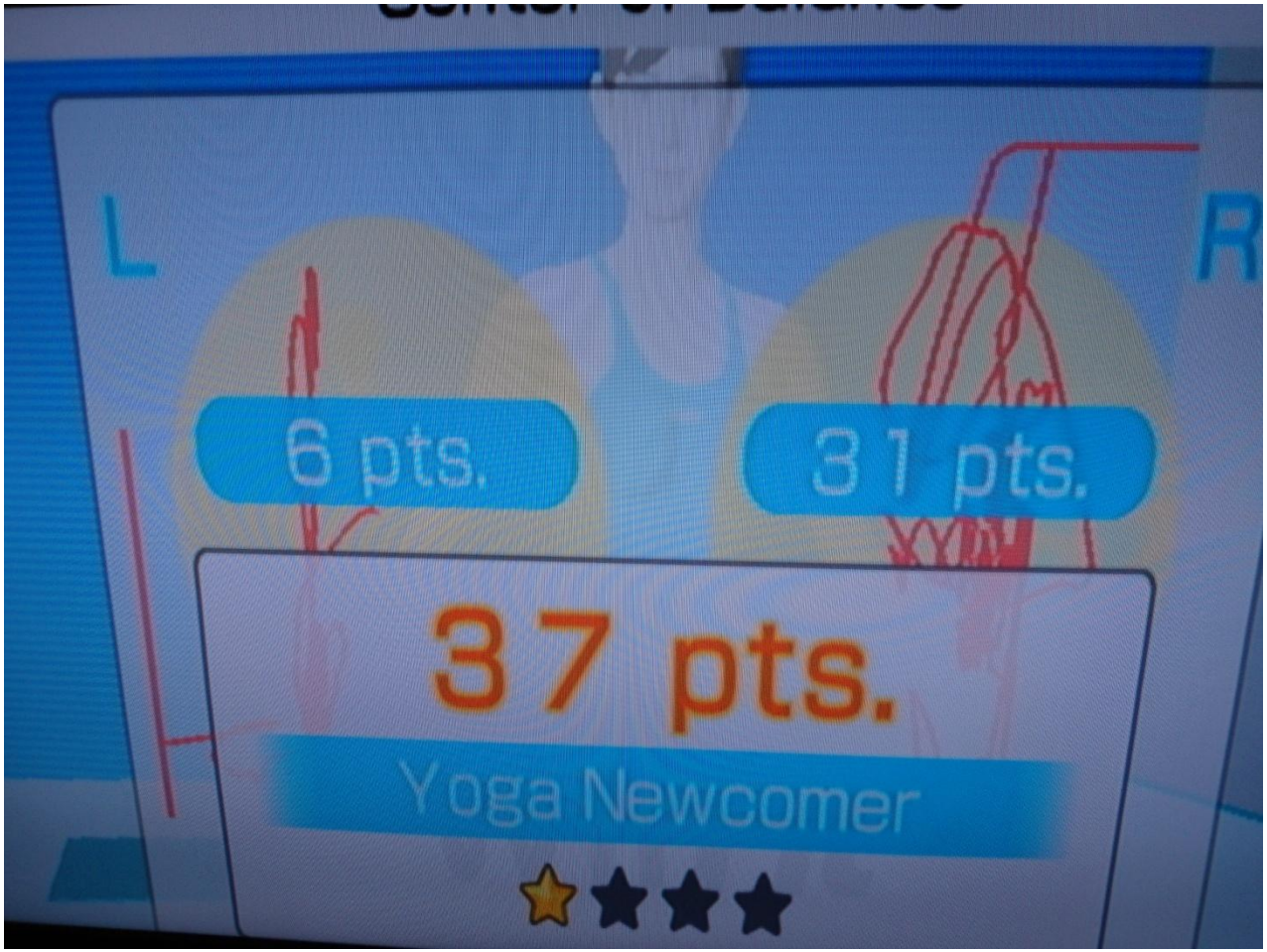
- Pressure on the Balance Board from your feet translates to the movement of the Avatar/Mii on the screen in certain games[8]

Solid Evidence exists among the rehab community regarding the Wii Balance Board:

- Performance of the Nintendo Wii Balance Board compares very well against a gold standard (force platform found in university movement lab settings)[8]

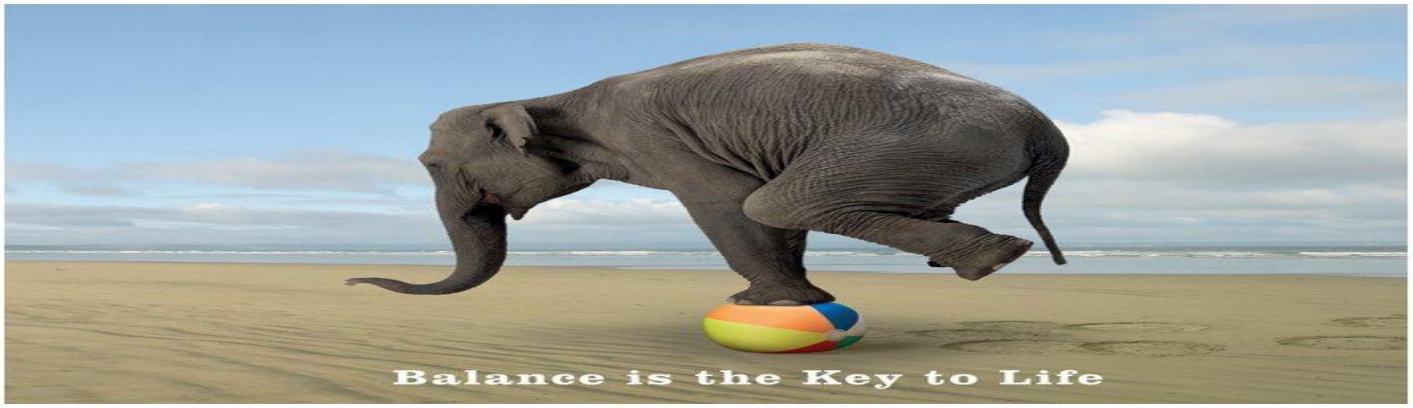
- Research indicates that the Wii BB is both ***accurate*** & ***reliable*** and may be of use in balance measurement[8]

The Wii Balance Board measuring Balance on each leg in standing:



Evidence that we can possibly improve Weight-Bearing Symmetry..

- McGough & colleagues determined in their 2012 study that normal, healthy adults have a “weight bearing asymmetry” or WBA[9]
- WBA means that we ***shift*** our weight toward one side of our body (left or right) w/ out realizing it
- Can be assumed that WBA would be even more ***pronounced*** in children w/ special needs



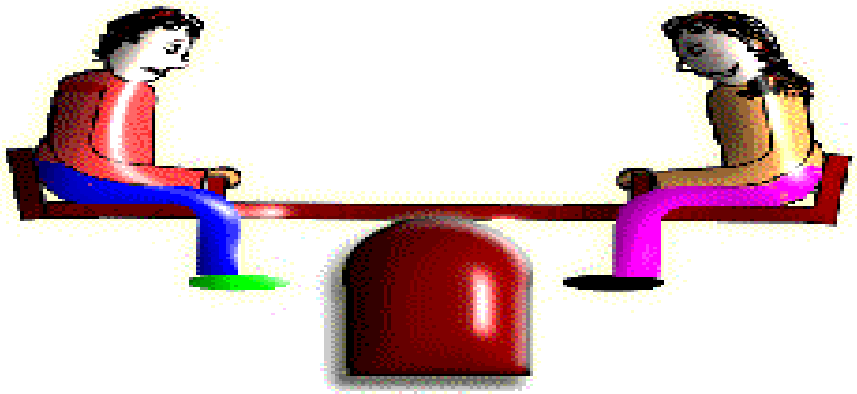
McGough Study:

- Subjects were required to perform a squatting exercise to a self-determined (natural) depth

A. ***Without*** the use of visual feedback

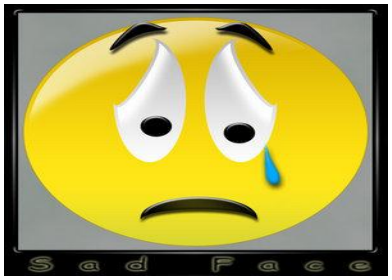
B. **With** the **use** of **visual feedback** displaying left & right weight bearing distribution

Results of McGough Study:



*Major finding was that the Wii Balance Board along w/ a custom software program ***significantly*** reduced **WBA** and **improved** symmetry between the legs in standing when using **real-time visual feedback**[9]

Technical Problems & Limitations of the Nintendo Wii Gaming System:



1. The Wiimote responds to ***acceleration*** more than positional changes (kids may actually "cheat")[10]

2. Customization and adjustment of game is difficult and limited[10]

3. The **star system** (reward) provided by the game requires substantial improvement between levels of games and may not be easily achieved by people who have motor control deficits[10]

Technical problems of Wii continued..

4. The **Haptic** feedback (vibration) comes solely from the Wiimote (not the Nunchuck or Wii Balance Board)[10]

5. Since the Wii BB is sensitive, children who have difficulty weight-shifting smoothly may attempt to play the game by using sudden, jerky movements (issue of quality)[10]

6. Patients with neurological deficits or processing delays may not be able to move ***fast*** enough to successfully play the game[11]

Training in a Real World vs. the Virtual World

*Studies comparing the components of movements such as direction, amplitude, and speed performed in a virtual environment to those when acting in the real world have shown remarkable similarities[1]

Video gaming incorporates many principles of Motor Learning[3]

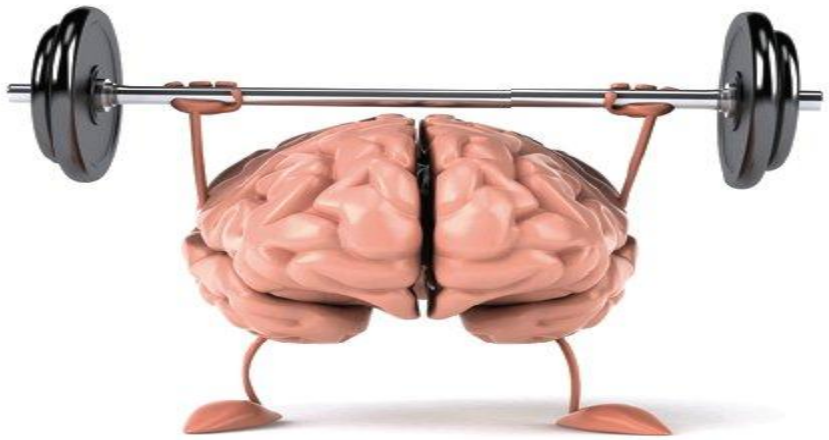
- Motor Learning can be defined as: "a relatively ***permanent*** change in regard to the acquisition of a new motor skill"[12]

Ex. Learning how to sit, crawl, walk, skip, jump, catch a ball, etc.

*Cannot be **directly** observed within the brain, but the outward behavior can be seen by us as PTs & parents[12]

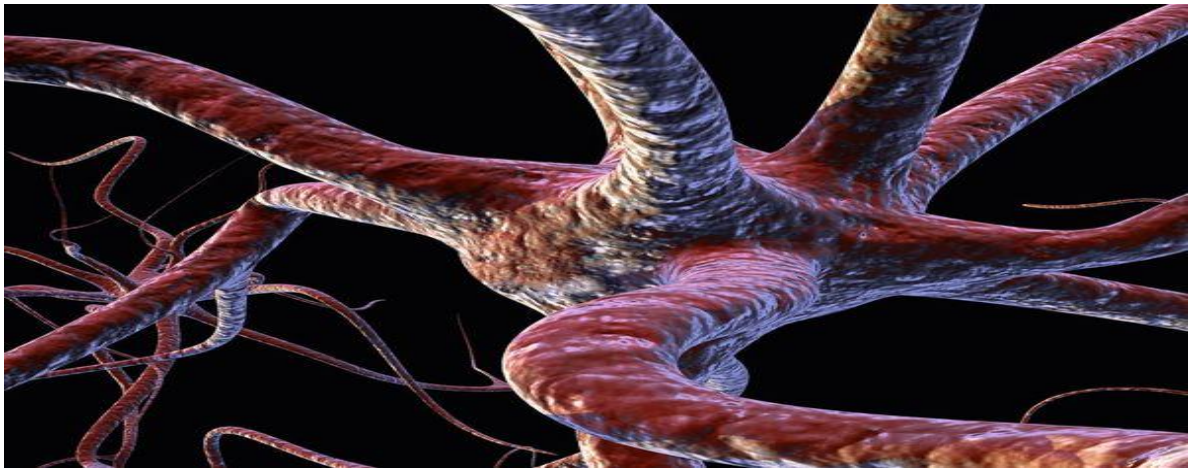
Research that Supports Motor Learning

Quantity*, *intensity*, and *duration* of training sessions are the important **variables that animal and/or human studies have consistently shown in learning and re-learning motor skills & changing the neural architecture in the brain (neuroplasticity)[13]



What is Neuroplasticity?

- This occurs when our brains adapt to various movement experiences and *new* **connections** are made ***between*** nerve cells or "neurons" located within the brain[14]
- The *actual* physical **number** of nerve cells do not increase (after a certain point in development our nerve cells stop dividing)[14]



Evidence on Neuroplasticity:

*Sufficient evidence exists to support the concept that plasticity is “use dependent” and ***intensive,*** and ***repeated*** practice may be necessary to modify the way neurons are organized in the brain[15]

Visual Feedback is Powerful!!

- Brain wiring lends nicely to using visual feedback to augment interconnected cortical regions[13]
- Studies show rich connections between the visual portion of the brain and other areas related to sensory (sensation) & motor (movement)[16]
- Visual information can provide a ***potent*** signal for re-organization of the circuits between these sensori-motor areas[13]

How do we as PTs & Parents ***encourage*** Motor Learning for our Children w/ Special Needs??

1. **Eliminate** the issue of non-compliance or poor adherence

-Children are often not compliant in following a more traditional home PT program b/c they find the exercises “meaningless” and “boring”[17]

-Studies of therapy programs that incorporated video games have demonstrated high levels of interest, fun, and motivation[18]

(Motor Learning Continued)

2. ***Increase*** the amount of **time** & the number of **repetitions** your child spends exercising or "playing"

*Active video games have been shown to maximize **engagemen**t, which is one of the *strongest* predictors of successful learning.[19]

(Motor Learning Continued)

3. ***Enhance*** the level of **motivation** through individualization of a video game intervention

*This can be achieved by integrating the child's own ***interests*** & ***preferences*** into the program and by modifying a particular game[1]

Energy Expenditure:

- Increased rates of obesity-related diseases in the last decade is well documented.[20]
- Sedentary behaviors include hand-held video gaming, surfing the Internet, watching TV/movies, etc[21]
- Positive relationship between obesity and sedentary behavior[22]
- Activity promoting games may increase energy expenditure vs. sedentary games[20]

Study by O'Donovan et al in 2012:

Purpose- To compare energy expenditure between the Wii and Xbox systems

Results:

1. Energy expenditure during all gaming conditions was of **light intensity**[20]
2. Xbox Kinect elicited ***greater*** energy expenditure vs. the Wii[20]
3. Playing games in **multiplayer** mode led to greater energy expenditure than **single** game mode[20]

SAFETY!!!!!

Provide an opportunity for your child to play games or sports in a safe environment

*Video game systems allow the child to perform tasks that they may not be able to execute safely or perform at all in real-world situations.[10]

Ecological Validity:

-The fact that video game applications are fundamentally designed to simulate real-life situations means that there is a high degree of ***ecological validity***.[23]

*High ecological validity ***increases*** the probability that skills learned in a simulated environment will **transfer** or generalize into the real world.[23]

*Please realize that this technology is **not** meant to replace ***traditional*** Physical Therapy interventions..

- At this time, studies have not yet ***fully*** verified the ability of commercially available video game systems to lead to actual functional gains [1]
- Future studies should include ***specific*** measurements of skill transfer[1]

Shout Hooray for FEEDBACK!!!

- Feedback provided by the games is rich and varied[10]

- There is ***positive*** feedback not directly linked to performance which can ***enhance*** the motivation level & engagement of the child[10]

  Ex. Cheering in the stands in most Wii sport games

- Other forms of positive feedback linked to success such as showering of ribbons or playing music when a game is won[10]

The Value of Feedback

*According to Schmidt, “Information that is provided to the learner about performance when attempting to learn a skill may be the single *most* important variable with the exception of practice itself.”[24]

Focus of Attention

Internal Focus

-Performer's attention is directed to the *action* itself **inside** of their body[25]

External Focus

-Performer's attention is directed to the ***effect*** of the action as it relates to their immediate surroundings **outside** of their body[25]

(**Focus of Attention Continued**)

- Previous research has suggested that using an ***external*** focus can help individuals acquire higher levels of skill faster b/c the body's natural processes are not disrupted.[26]

- Video game systems are known to provide an *external* focus of attention which has been shown to be **superior** to an *internal* focus in regard to balance retraining.[27]

Environmental Factors to Consider when Designing a HEP using Gaming Systems:

- When first introduced to a new game (DDR) children were more likely to participate if they did **not** have ***other*** video games in their homes[28]

- Traditional, sedentary video games in the home may act as **competitive interests** for children choosing an active game[28]

- **Social interactions** (parental and peer participation) may play a role in children's ***initial*** and ***sustained*** participation in DDR[28]

In Summary:

- Using active video gaming in the home setting to ***supplement*** PT received at school or in the outpatient clinic offers many **benefits** from both a **gross motor** & **psychosocial** standpoint
- **Collaborate** with your **PT** to determine which system & specific games may be *most* appropriate based on your child's abilities & limitations
- Technology is only going to **improve** in the **future** & the role of active gaming may become even more prominent!

Hoorah!! We are finished!
Any Questions?