Low-Cost Video Game Based Rehabilitation Therapy

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INTERACTIVE MEDIA INSTITUTE

Overview

- Walter Reed Medical Center
  - Jester Stick/ Action Stick
- Physiological Monitoring
  - VivoMetrics
- Game Applications
  - Eyetoy™
  - Dance Pad
  - Taiko Drum Master
  - Frogger

The VRMC Team

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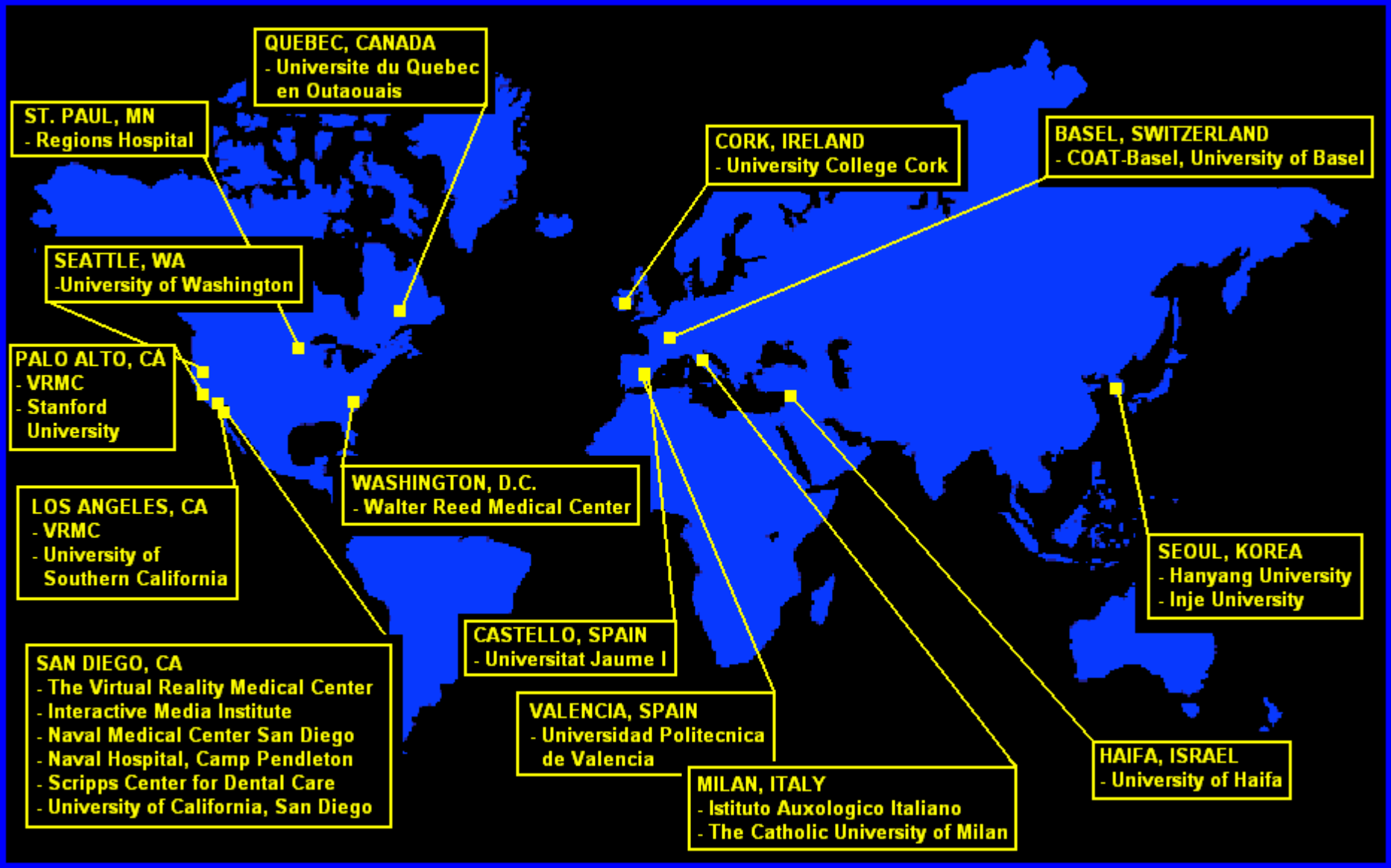
VRMC Research Collaborations

- Balboa Naval Hospital
  - Pain Distraction, PTSD
- Camp Pendleton
  - PTSD
- Region's Hospital, Minnesota
  - Pain Distraction
- Scripps Clinic
  - Pain Distraction
- Stanford University
  - Anxiety, Physiology
- UCSD
  - Pain Distraction
- University of Washington
  - Pain Distraction
- USC
  - ADHD, PTSD, Pain Distraction, Rehabilitation
- Walter Reed Army Hospital, D.C.
  - Rehabilitation
- Hanyang University, Korea
  - Smoking Cessation/Prevention, Schizophrenia, ADHD, Rehabilitation, Pain Distraction
- Inje University Paik Hospital, Korea
  - Anxiety
- Istituto Auxologico, Italy
  - Eating Disorders, Obesity, Anxiety, Pain Distraction
- University of Basel
  - Anxiety, Physiology, Addictions, Pain Distraction
- University of Quebec
  - Anxiety Disorders, Pain Distraction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- Naval Hospital, Camp Pendleton
- Scripps Center for Dental Care
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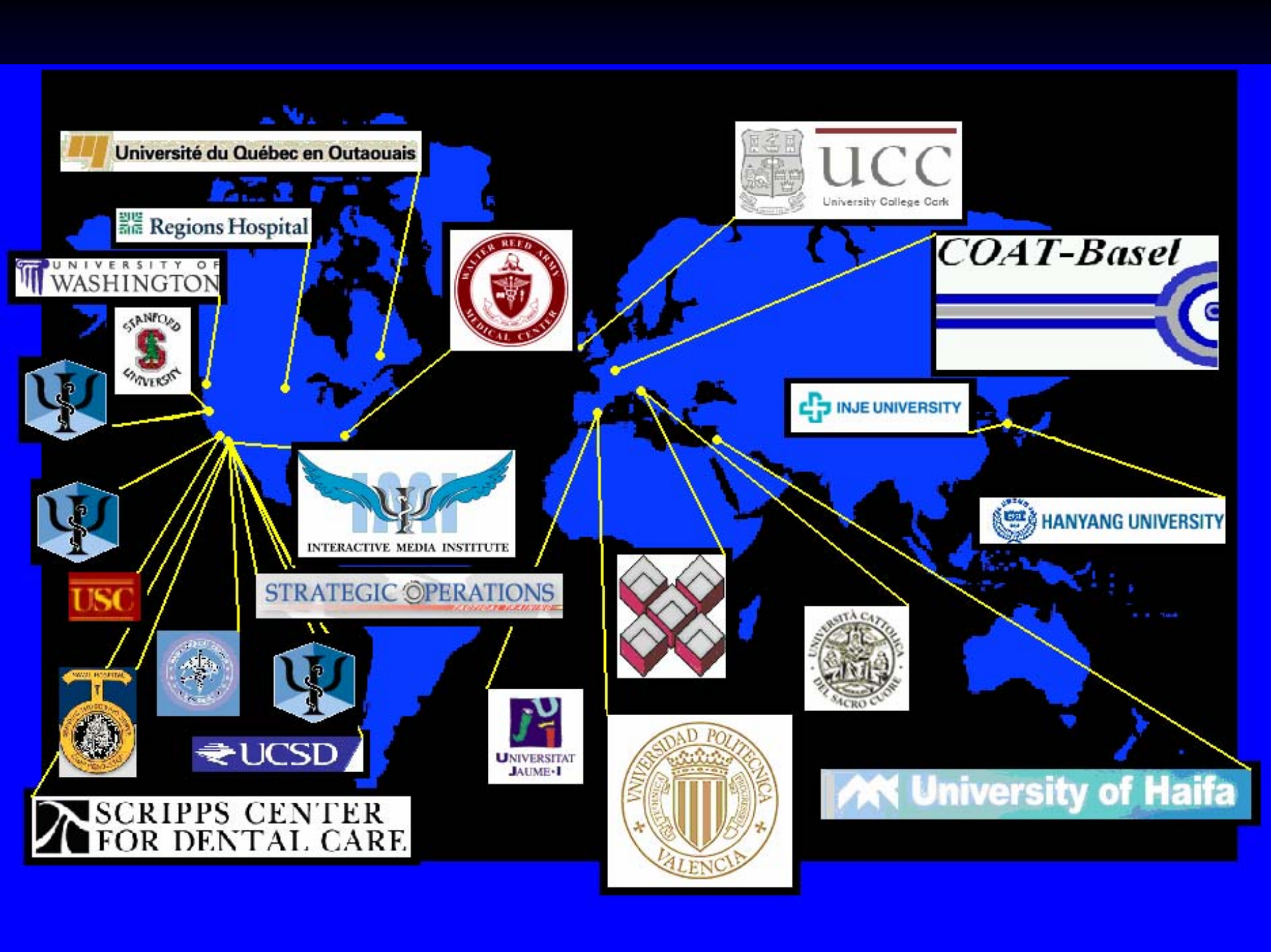
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VRMC/IMI Funding

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NIDA NATIONAL INSTITUTE ON DRUG ABUSE
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CDC Centers for Disease Control and Prevention

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TATRC

Controlled studies: Physical Rehabilitation

Author	Year	# of Pts	Equipment	Results
Hoffman	2000	12	VR Helmet	Less pain during rehabilitation
Jack	2001	7	Glove and ankle interface devices	Increased movement, strength and speed in hands
Jack	2001	3	Glove and ankle interface devices	Improved motor skills and hand-movement parameters
Holden	2001	4	VR Helmet	Improved motor skills
Sveistrup	2001	17	Interactive Rehabilitation Exercise System	Increased interaction between patient and rehabilitation environment
Weiss	2003	5	VividGroup's Gesture Extreme	Increased enjoyment of physical interaction, nurtured self-esteem
Adamovich	2003	8	CyberGlove and Rutgers Master II-ND	Improved gait and stepping movement
Broeren	2004	1	PHANToM haptic device	Improved manual dexterity, motor control, & grip force

Controlled studies: Cognitive Rehabilitation

Author	Year	# of Pts	Equipment	Results
Schreiber	1998	14	VR Memory Program	Improved specific domains of memory
Christiansen	1998	30	Head-mounted Display	VR can assess traumatic brain injury and teach basic skills
Grealy	1999	13	Virtual bicycle	Improved reaction time, con-centration, and consistency
Rose	2002	4	Enriched Virtual Environments	Stimulated brain plasticity
Brooks	2002	24	Virtual Kitchen	Increased motivation for learning
Hoffman	2003	9	Interactive Cognitive Training (ICT)	Improved navigational skills and memory
McGee	2004	30	3-D Projection-Based VE	VR allows for systematic assessment and rehabilitation of visuospatial skills

Technology	EyeToy™	Action Stick	Mandala Gesture Xtreme system	Gametrak
Supported Platform	PlayStation 2	PS2, PC	PC	PS2, PC, Xbox
Developer	Sony Computer Entertainment Europe	Hanaro Dream, Inc	Jestertek	In2Games Limited
Website	http://www.EyeToy™.com/	Http://www.actionstick.com/	http://www.jestertek.com/	http://www.in2games.uk.com
Price	N/A	N/A	Commerical: $10,000 Educational: $4000	N/A
Brief Description	The EyeToy™ features motion tracking, light sensing technology, a built-in microphone, and video messaging. The USB camera captures the player's image and the body movement is translated into on-screen action.	Action Stick is a collapsible, portable device that contains highly sensitive infrared sensors – head, arms, legs, and direction. It allows two players to experience real action moving their arms and legs – punching, kicking, jumping.	It is a gesture tracking system. It has a camera-tracking library, which includes the Camera Capture, Motion Tracking and Head Tracking. Users can develop their own applications	It is a 3D controller system for the video games. It tracks exact position in 3D space (3m cube) It can be used to track the motion of a player's hands, the movement of a golf club or baseball bat.

Walter Reed Medical Center

- Develop virtual reality systems for physical rehabilitation
  - Begin using off-the-shelf computer games
  - Choose the most suitable platform
  - Build a system based on the specific needs of physical rehabilitation
- Use VR system to rehabilitate injured veterans at the Walter Reed Medical Center

Walter Reed Medical Center

- Subject Population:
  - War Veterans suffering from combat injuries
- Methods:
  - Between Group design:
    - Experimental group: Video game assisted intervention
    - Control group: traditional intervention

Amputee Patients

Research Measures

- Psychometric tests
- Physiological monitoring
  - Heart rate
  - Skin conductance
  - Respiration
  - temperature
- Standardized physical therapy assessment tools

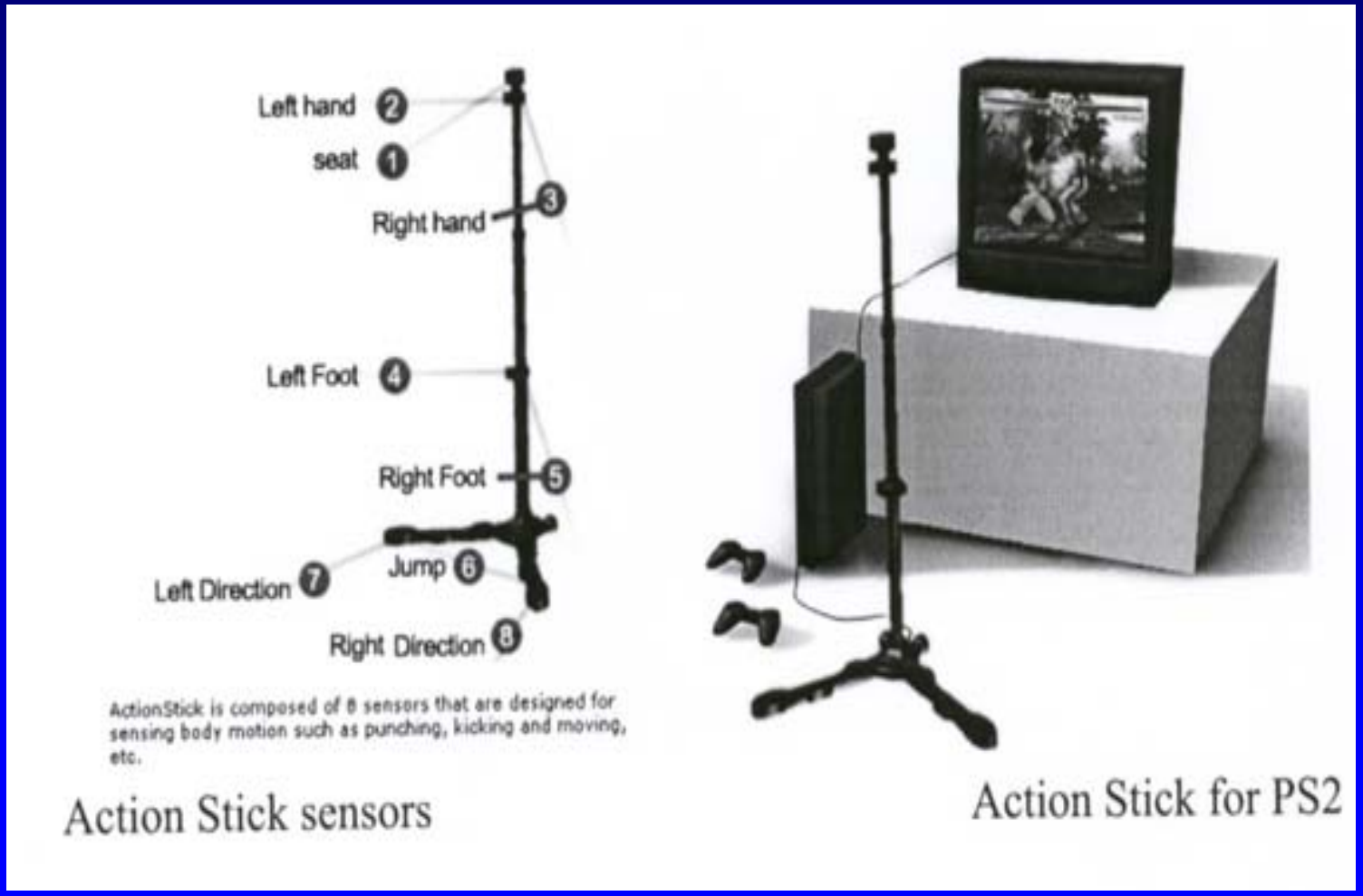
Expected Results

- Experimental group will exhibit significant improvements in depression, mobility and functional skill
- Experimental group will exhibit greater improvements in physical and psychological measures than the traditional intervention group

Action Stick by Hanaro Dream

- Game Description:
  - Allows users to play action-type video games using a player's physical action instead of conventional joysticks or key boards.
  - Uses non-contact sensors with proprietary movement recognition interface to turn a player's physical action into a real time action on the video display.
  - Composed of 8 sensors that sense motion:
    - Punching
    - Kicking
    - moving

Game has been shown to have equivalent caloric expenditure as swimming or jogging



Action Stick Pictures

Action Stick Movie Clip

Overview: VR Rehabilitation Environments

EYE

TOY

DANCE PAD

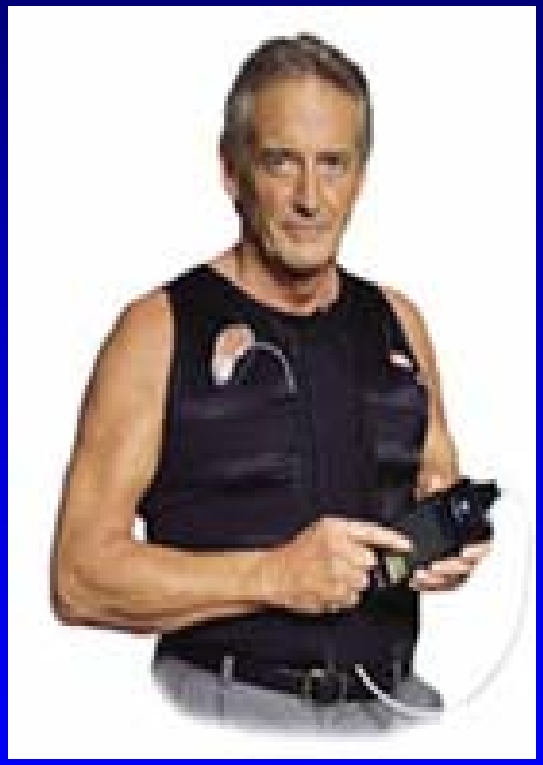
ACTION STICK

VRMC Preliminary Study

- Using Sony EyeToy™, an inexpensive camera and video game that puts the user in the virtual environment for physical therapy
- Using VivoMetrics: The Lifeshirt system as a physiological monitoring device

VivoMetrics: The LifeShirt System

- Non-invasive respiratory monitoring and ambulatory monitoring system
- Collects, analyzes and reports on respiratory pattern measures
- Includes sensors that monitor heart function, posture and physical activity
- Includes diary function to capture subjective patient experiences



Methods

- Baseline measurement was obtained for each subject while wearing the life vest
- Physiological measures were recorded using VivoMetrics while participants played Eyetoy (e.g., Wishi Washi, Soccer Craze, KungFoo) and DDR (using dance pad)

EyeToy™ Play

Game Description:

- **<u>Features:</u>**
  - Motion-tracking technology that instantly translates body movements into on-screen interaction
  - User will see him-/herself interacting with entertaining graphics on the television set.

Wishi Washi

- Player’s task is to wave their arms to clean a soaped window.
- The best game for multiplayer action.

Boxing Chump

- Enter the boxing ring and take on the maniacal Big Robo Bro

- Player's task is to knock out Big Robo Bro while avoiding his blows

Kung Foo

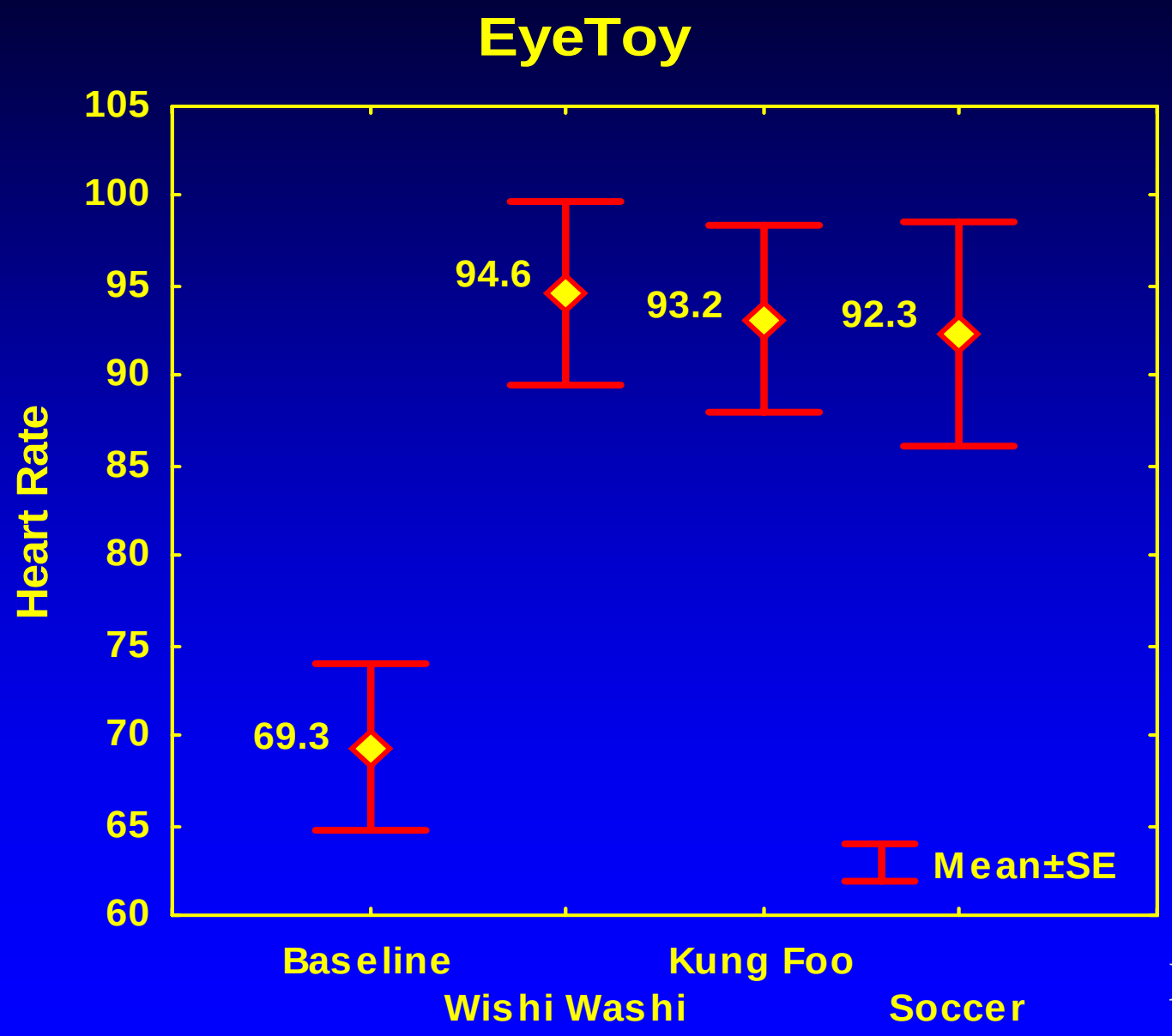
- Use your martial arts skills to fight off relentless ninjas.

Eyetoy Play is Monitored with Physiological Sensors

EyeToy and Dance Dance Revolution Pilot Study

- EyeToy:
  - Heart Rate increased by 34%
- Dance Dance Revolution
  - Breaths per minute increased by 76%

Preliminary Results: Heart Rate



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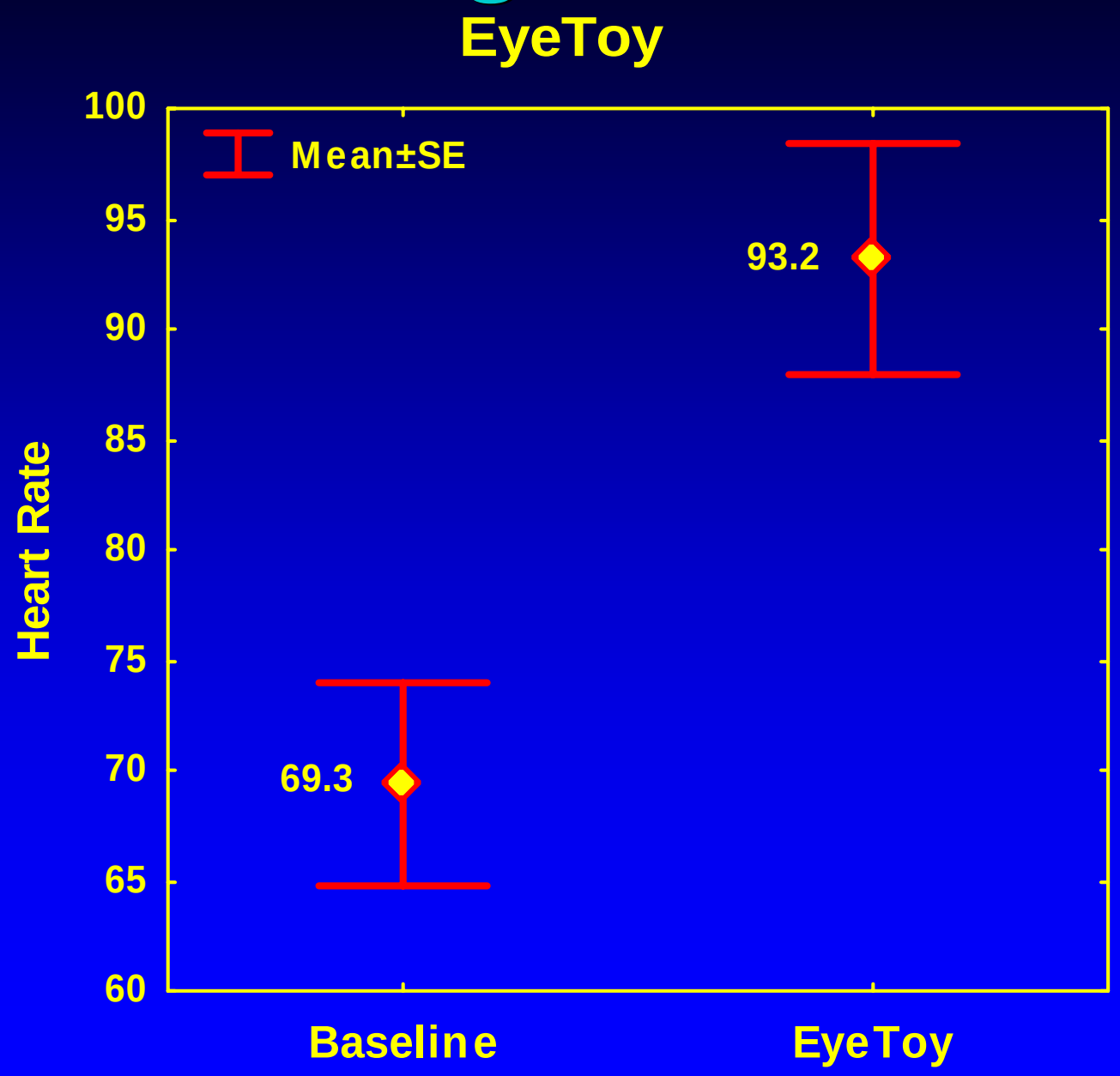
Average Heart Rate



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EyeToy applied to Rehabilitation

- Because the patient sees him-/herself on the television monitor, an internal neural loop is created, which has the potential to improve performance in complex motor tasks

- Subjects have ability to exercise upper extremities

Dance Dance Revolution (DDR)

- Exercising upper and/or lower extremities
- Dancing Game
- <u>Features:</u>
  - Licensed tracks
  - Fresh dance hits
  - Cool new songs from North American release
  - In-game videos
  - FREEZE ARROW option
    - freezes on-screen arrows and forces players to modify their dance steps
  - **Players can customize their own dance steps**
  - Special Work Out mode
    - tracks the number of calories burned with every move

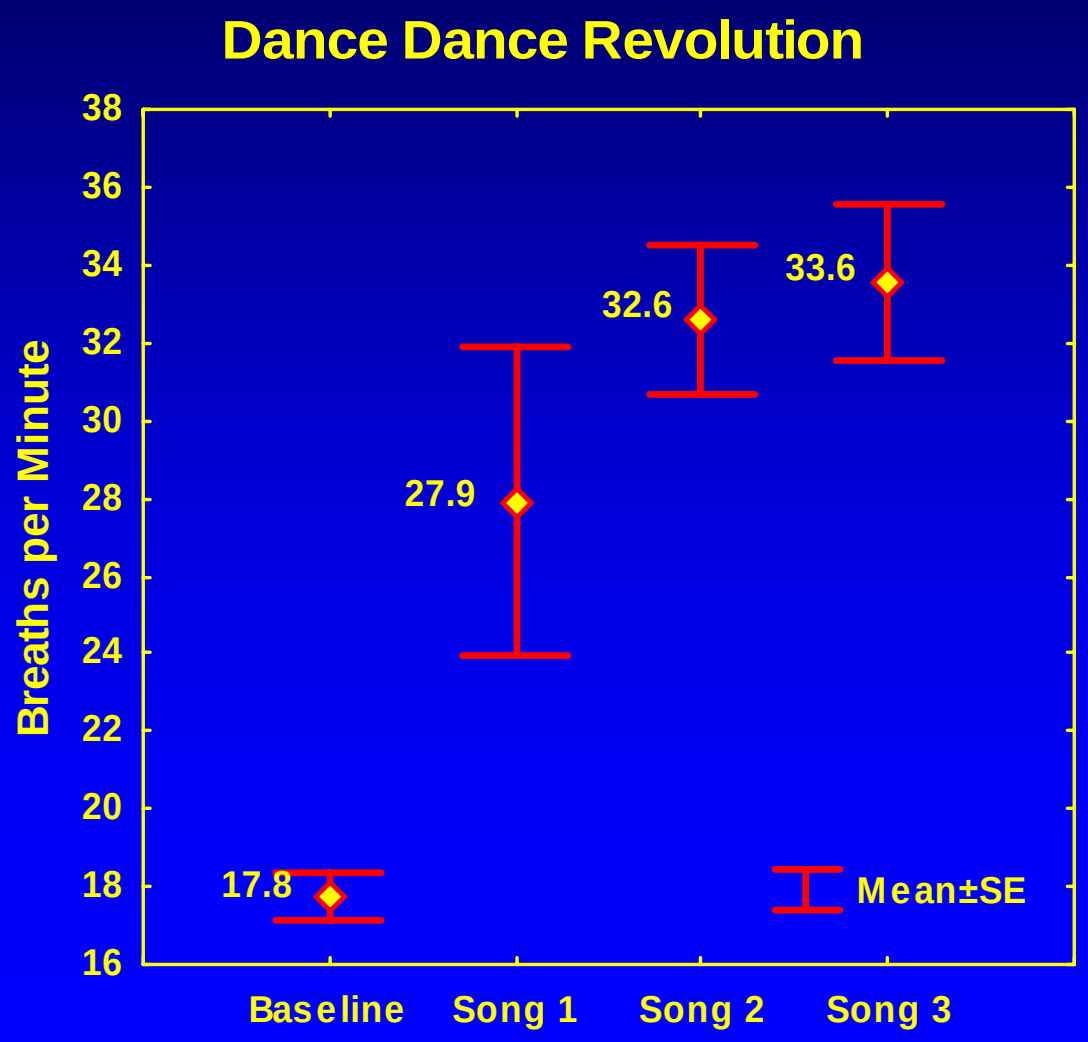
Dance Pad Users are Monitored with Physiological Sensors

Health Applications for Dance Pad

- **Diabetes** – Educate and encourage self-management of disease. Prevent diabetes through exercise and weight loss.
- **Obesity (weight loss)** – Encourage healthier and more active behaviors in adults and adolescents

DDR Video Clip

Preliminary Results: Breaths per Minute



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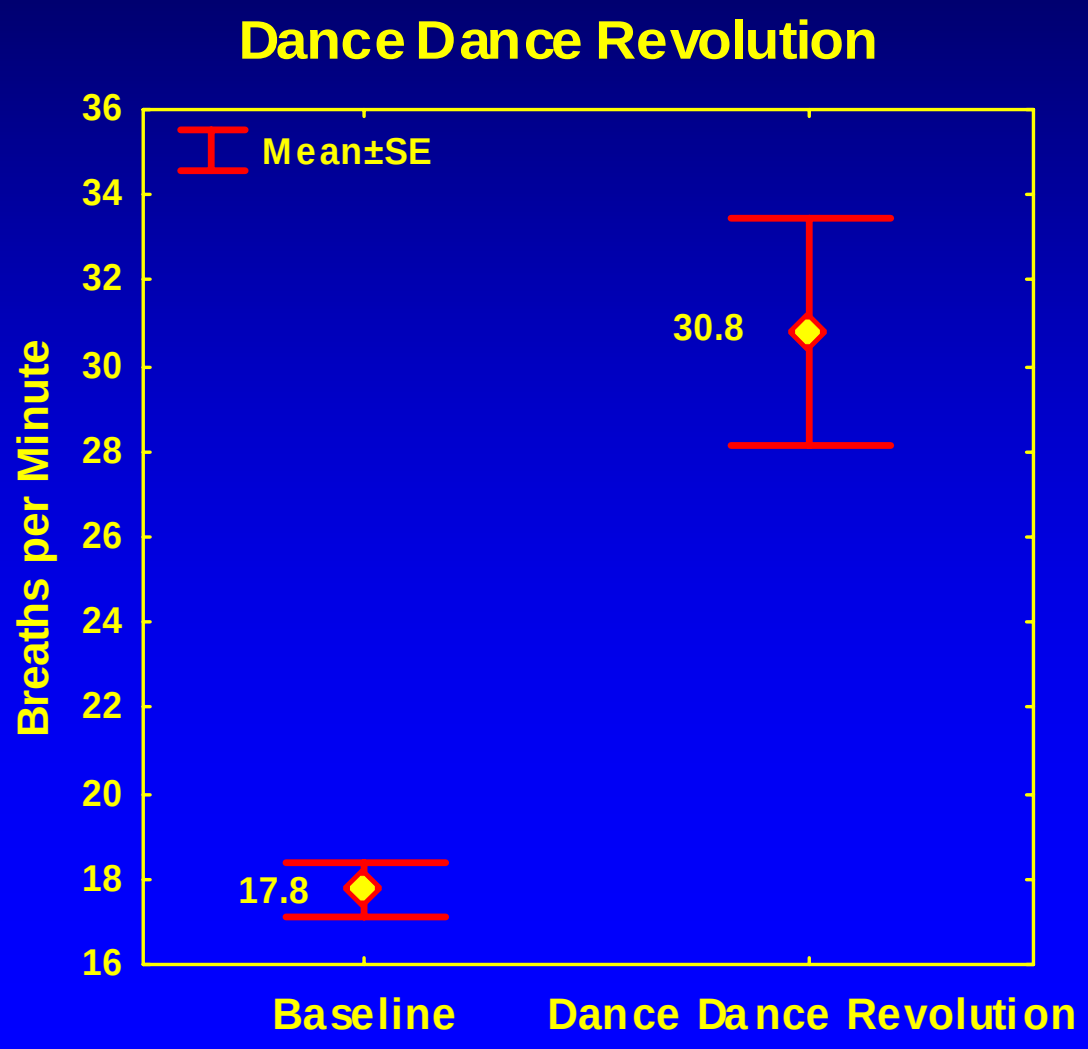
Average Breaths per Minute



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Other Potential Video Game Applications

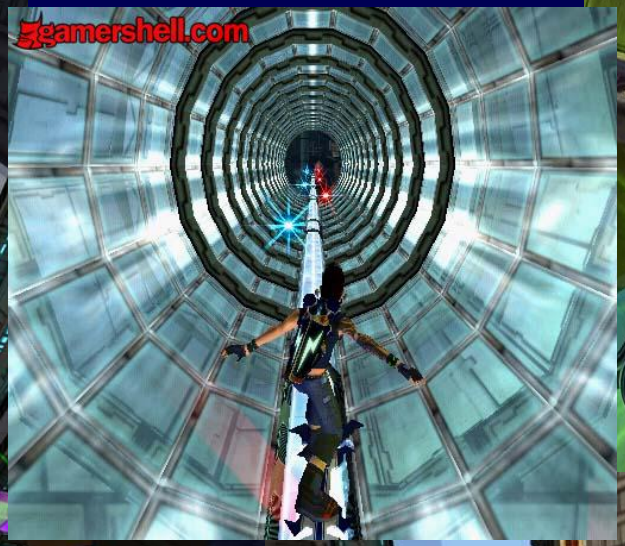
- EyeToy Play 2
- EyeToy Groove
- EyeToy AntiGrav
- Nicktoon EyeToy
- JesterTek’s Mandala Gesture Extreme
- Taiko
- Frogger

Eyetoy Play 2

Eyetoy Groove Screenshots

Groove Video Clip

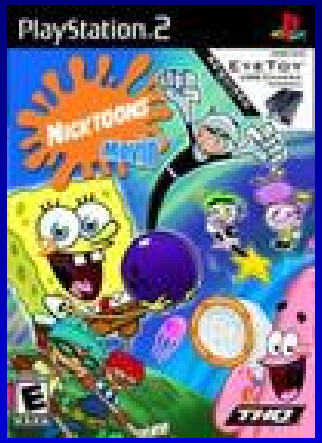
Eyetoy AntiGrav Screenshots



AntiGrav Video Clip

Nicktoon's Movin' EyeToy

- **Game Description**
  - Players will see him-/herself interacting with entertaining graphics on the TV set
  - Hand and arm movements needed to play



- **Features**
  - Features Nicktoon characters (e.g., Spongebob Squarepants and Jimmy Neutron)
  - 13 mini games based on Nicktoon cartoon series
  - 3 difficulty levels

Nicktoon's Movin' EyeToy Screenshots

Mandala Gesture Extreme (GX)

- Primary an game engine for a number of commercially available video games that have tracking capabilities
- Uses video camera to drop a players' image into fact action games and fun virtual environment

Taiko Drum Master

- **Game Description:**
  - A traditional Asian style of drumming and dance where players will tap on the surface and the edge of the Taiko controller
  - Players can choose songs at varying difficulty levels
  - Players will use hand and arm movements while playing the drum.

- **Features:**
  - Multiple Play Modes
  - Multiplayer Features
  - Mini Games
  - 31 songs (e.g., ABC)

Taiko Drum Master Movie Clip

Frogger

- **Game Description:**
  - Player's must guide the frog through a multitude of environments
  - Obstacles include:
    - Climbing perilous cliff faces
    - Swinging on dangling vines and maneuvering across platforms
    - Crossing a raging river full of tricky diving turtles and frog-eating creatures.
    - Face gigantic beetles, dragons and slew of fierce sea creatures.
  - Frogger also has the ability to spit goobers at enemies
  - Frogger can also bloat himself with air to float over longer distances when jumping.
  - Game involves fine motor skills (e.g., fine hand movements)
- **Features**
  - 16 levels in 4 dynamic worlds
  - Battle 20 enemies

Frogger Screenshots

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- MedLine
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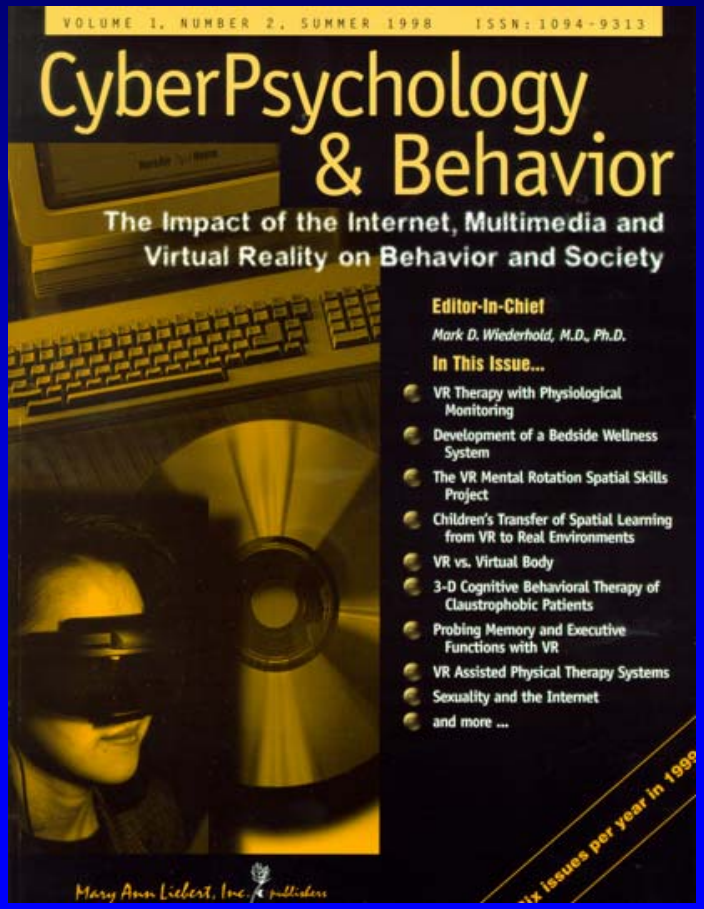

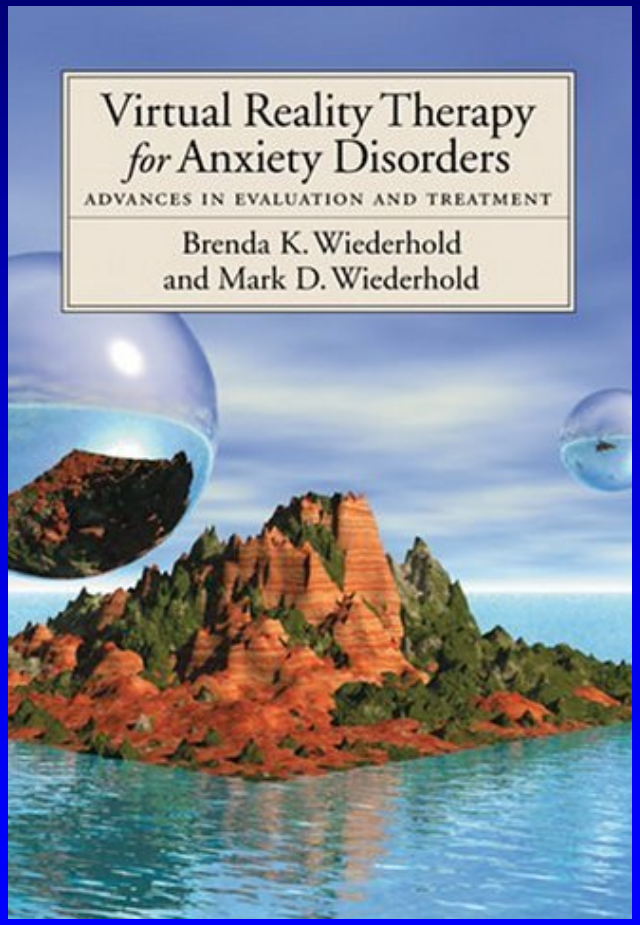

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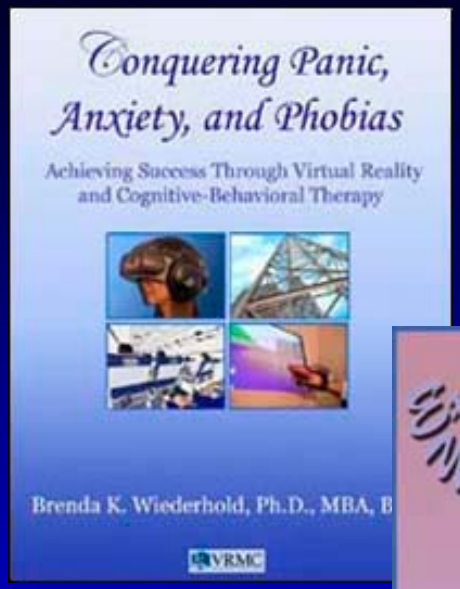

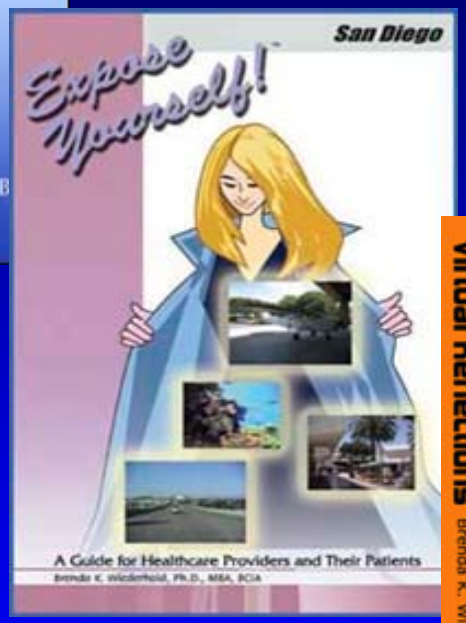

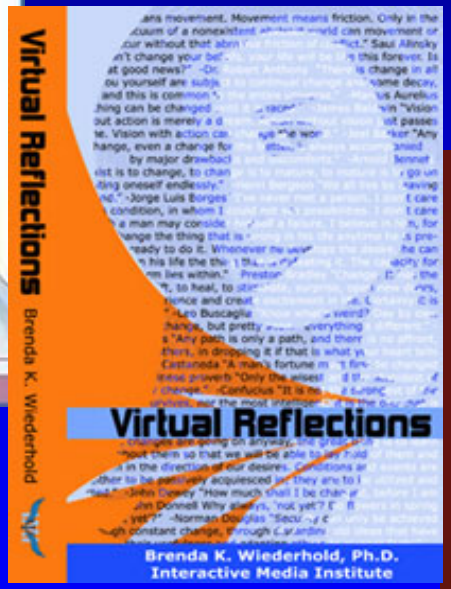

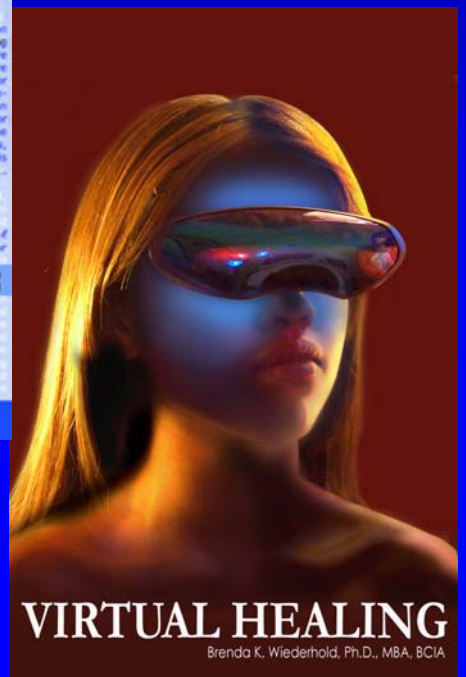

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