Advances in Virtual Reality

New Technologies for Childhood Health Conditions

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New Technologies for Childhood Health Conditions

Talk Outline:

- Introduction to Virtual Reality
- Virtual Reality Applications for:
  - Cognitive/Functional Processes
  - SensoriMotor Interaction
  - Social Interaction
- Conclusions & Questions

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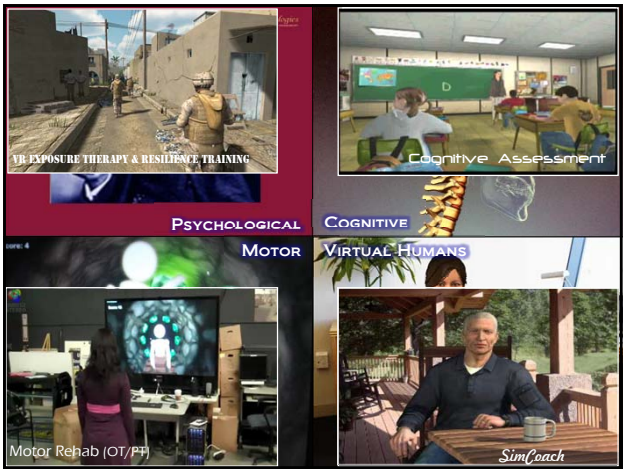
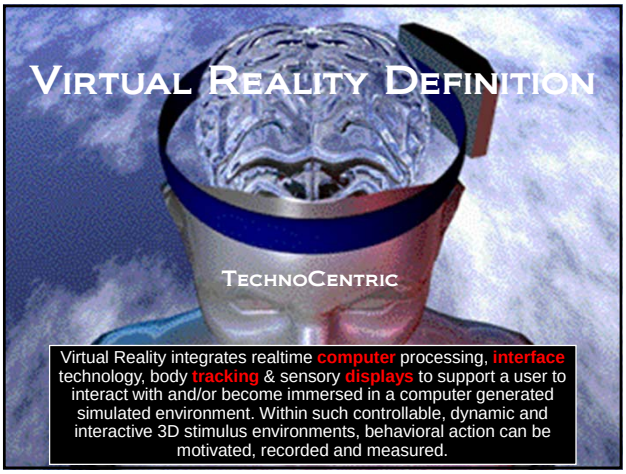


Virtual Reality Definition



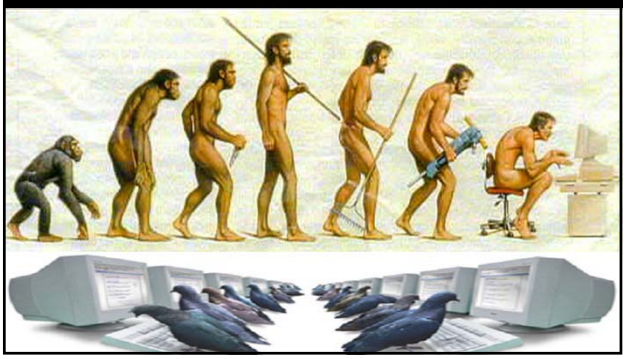
Virtual Reality integrates realtime **computer** processing, **interface** technology, body **tracking** & sensory **displays** to support a user to interact with and/or become immersed in a computer generated simulated environment. Within such controllable, dynamic and interactive 3D stimulus environments, behavioral action can be motivated, recorded and measured.

Virtual Reality Definition

HumanCentric

"...a way for humans to interact with computers and extremely complex data in a more naturalistic fashion."

The Evolution of the Tool-Using Animal



Virtual Reality as a Simulation Technology

=

1st Link Aviation Simulator (1929)

Virtual Reality (2013)

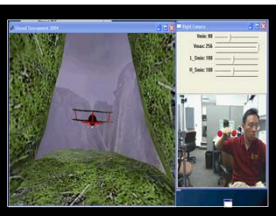
To Test and Train Piloting Ability

=

To Test, Train & Treat Psychological, Cognitive & Motor Functioning

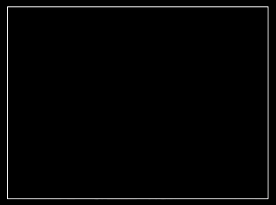
1st Link Aviation Simulator (1929)

Virtual Reality (2013)



Single Flatscreen VR Games

1996 Cost = $350k



Multi-Flatscreen VR (assistive driving trainer – Kessler Rehab.)

2013 Cost = $3k

Virtual Reality Using a Head Mounted Display (HMD)

A User Immersed in the simulation using an HMD

What the User sees in the HMD

Virtual Iraq/Afghanistan

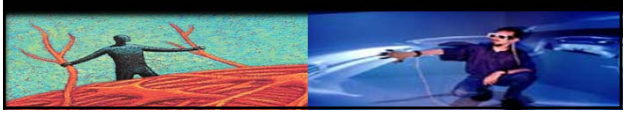
PTS Exposure Therapy

"Virtual reality arrives at a moment when computer technology in general is moving from automating the paradigms of the past to creating new ones for the future"

(Myron Krueger, 1993)

Virtual Reality Assets

- Ecological validity
- Stimulus control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for "errorless learning"
- Self-guided exploration and independent practice
- Stimulus and response modification contingent on user's impairments
- Complete naturalistic performance record
- Real time performance feedback
- Safe testing and training environment which minimizes risks due to errors
- Graduated, systematic exposure
- Distraction
- Gaming factors to enhance motivation
- Low cost functional environments that can be duplicated and distributed



"Analysis of Assets for Virtual Reality Applications in Neuropsychology"

Skip Rizzo, Maria Schultheis, Kimberly A. Kerns, and Catherine Mateer

Vol. 14(1), 207-239 (2004)

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A Revolution in Clinical VR Application R&D

2013

1994

From Simple Phobias to

- Addiction
- ADHD
- Alzheimers
- Autism
- Balance Disorders
- Cerebral Palsy
- Spatial Neglect
- Pain Distraction
- Phantom Limb
- PTSD
- Stroke, TBI, Parkinsons
- Spinal Cord Injury
- And Many More...

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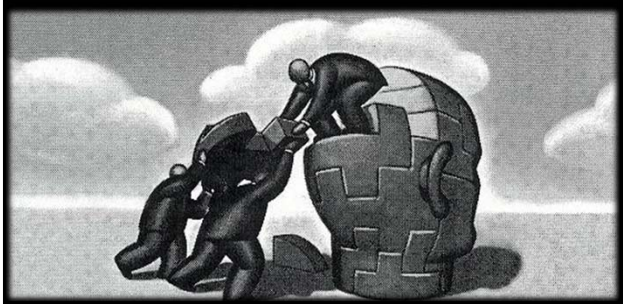
COGNITIVE/FUNCTIONAL ASSESSMENT AND REHABILITATION



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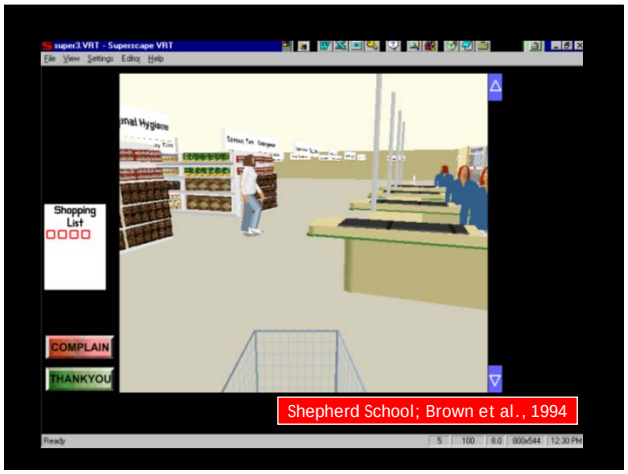
REHABILITATION TASKS MUST:

- focus on a specific targets derived from data-driven assessment to direct treatment
- be adjustable in terms of difficulty level from something simple for the patient to accomplish, to a level representing normal performance
- be quantifiable in order to assess progress
- be administered repetitively and hierarchically
- provide the client with strategic feedback as to the outcome of performance
- have some relevance to real world function
- motivate participation!

VIRTUAL REALITY SIMULATION TECHNOLOGY IS IDEALLY SUITED TO MEET THESE REQUIREMENTS

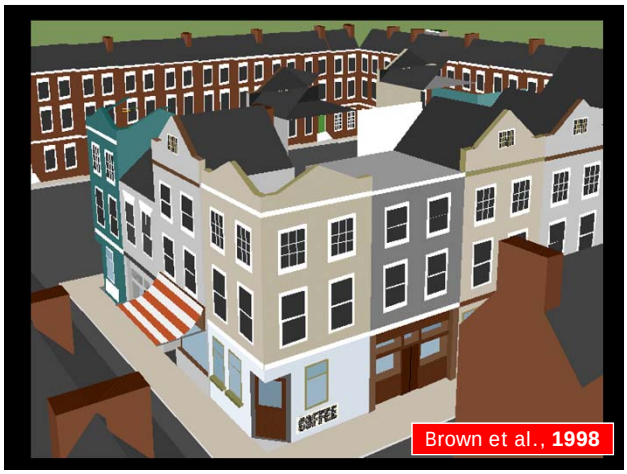
Brown et al., **1994**



Shepherd School; Brown et al., 1994

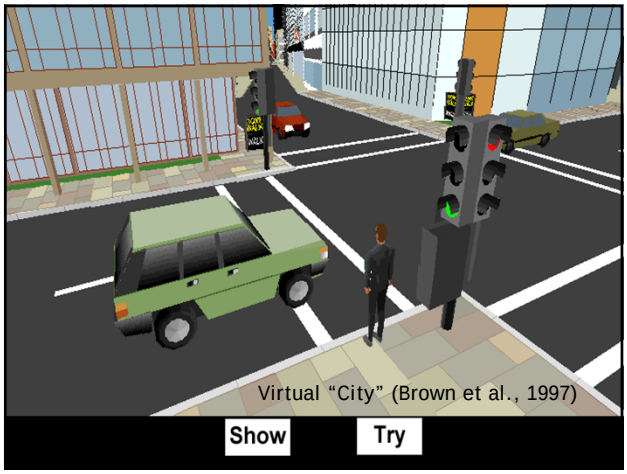
Spatial Navigation and Wayfinding

Stanton, Wilson, & Foreman **1998**



Brown et al., **1998**

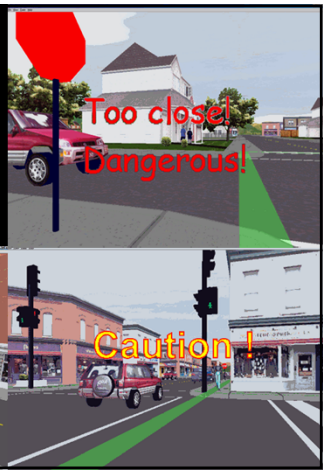
Brown et al., **1998**



Virtual "City" (Brown et al., 1997)

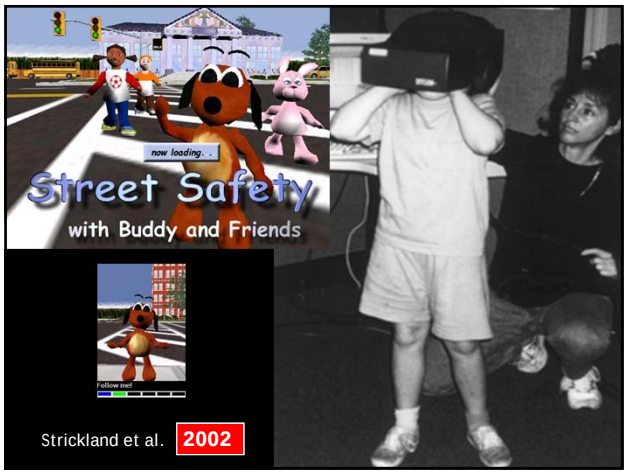
Show Try

Street Crossing
(McComas et al.)



Street Crossing

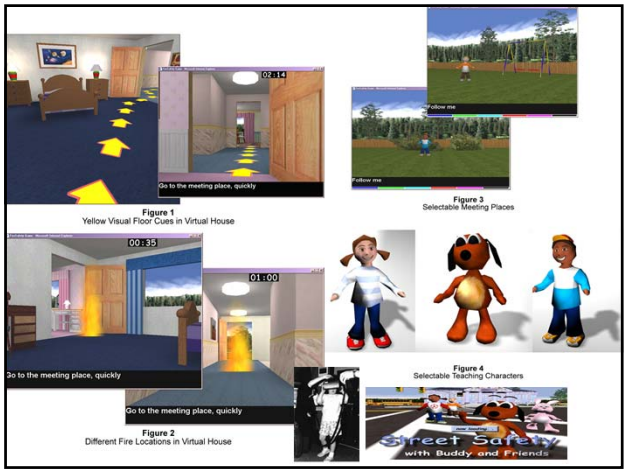
Nevah, Katz, Weiss et al 2011



Strickland et al. 2002

Asperger's Syndrome Video

Strickland et al. 2002



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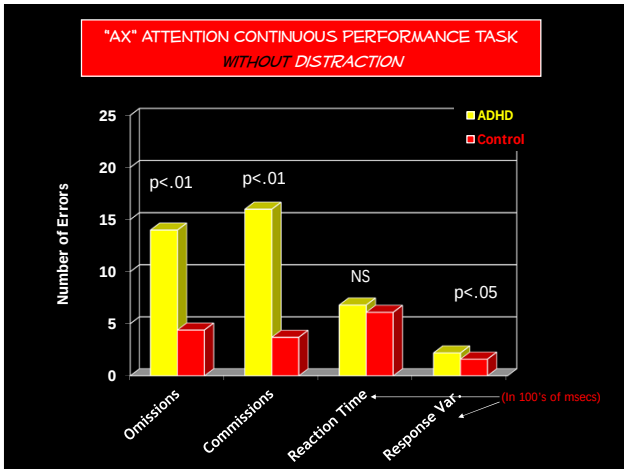
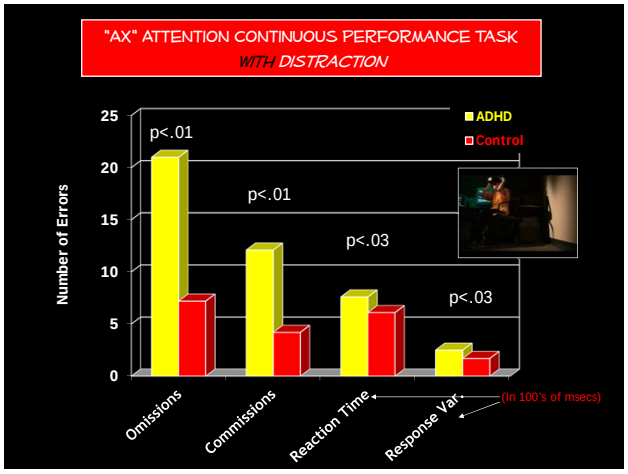
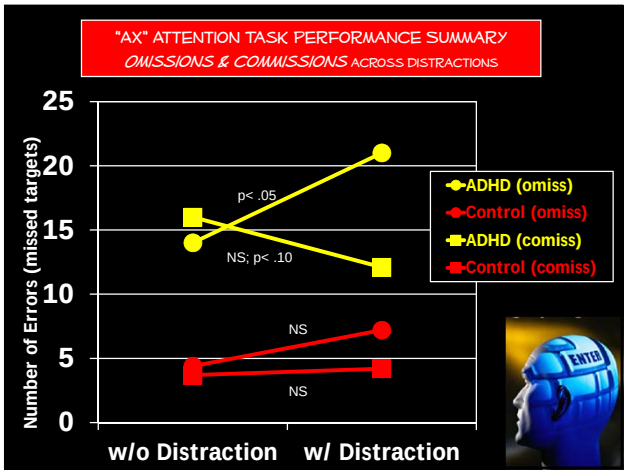
The Virtual Classroom

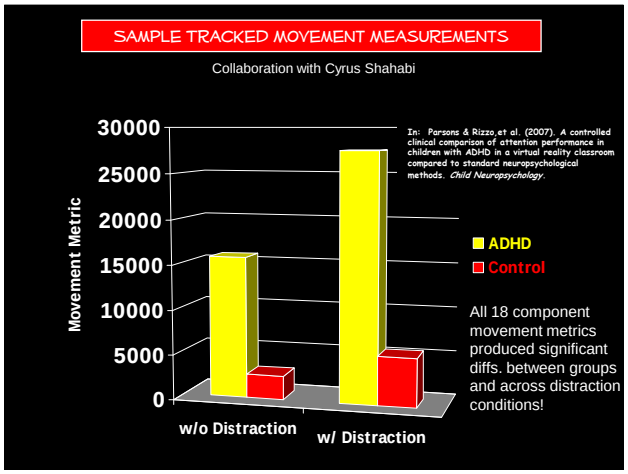
Rizzo et al., 1999

Rizzo, et al., 2003-2013

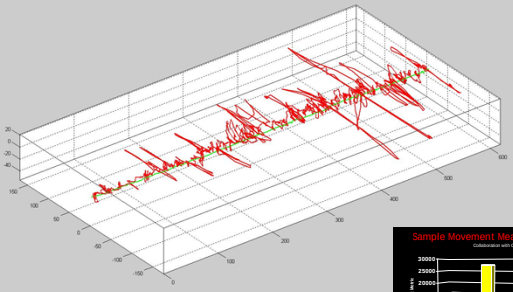

"AX" ATTENTION CONTINUOUS PERFORMANCE TASK
WITHOUT DISTRACTION
Number of Errors
25
20
15
10
5
0
ADHD
Control
p<.01
p<.01
NS
p<.05
Omissions
Commissions
Reaction Time
Response Var
(In 100's of msecs)

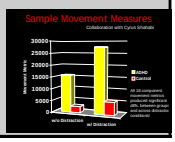

"AX" ATTENTION CONTINUOUS PERFORMANCE TASK
WITH DISTRACTION
Number of Errors
25
20
15
10
5
0
ADHD
Control
p<.01
p<.01
p<.03
p<.03
Omissions
Commissions
Reaction Time
Response Var
(In 100's of msecs)


"AX" ATTENTION TASK PERFORMANCE SUMMARY
OMISSIONS & COMMISSIONS ACROSS DISTRACTIONS
Number of Errors (missed targets)
25
20
15
10
5
0
p< .05
NS; p< .10
NS
NS
ADHD (omiss)
Control (omiss)
ADHD (comiss)
Control (comiss)
w/o Distraction
w/ Distraction


SAMPLE TRACKED MOVEMENT MEASUREMENTS
Collaboration with Cyrus Shahabi
Movement Metric
30000
25000
20000
15000
10000
5000
0
In: Parsons & Rizzo, et al. (2007). A controlled clinical comparison of attention performance in children with ADHD in a virtual reality classroom compared to standard neuropsychological methods. Child Neuropsychology.
ADHD
Control
All 18 component movement metrics produced significant diffs. between groups and across distraction conditions!
w/o Distraction
w/ Distraction

VR Classroom Head Tracking Data

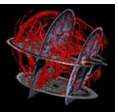




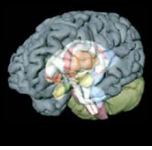
VR Classroom Head Tracking Demo

Randomly selected ADHD and Control Subject Facing Blackboard during 10 min. Vigilance trial.

Head Tracking Data



- Control (n=10 X 20 Hit Stimuli per subject)
  - Missed 1 Out of 200 Hit Stimuli
    - .05% looking away from board during Hit Stimuli
- ADHD (n=8 X 20 Hit Stimuli per subject)
  - Missed 41 Out of 160 Hit Stimuli
    - 25% looking away from board during Hit Stimuli



Varied Attention Tasks Developed

Boston Naming Task

Stroop Task

Letter Crowding Task

Flexible reconfiguration of scenario for other purposes:

Flexible reconfiguration of scenario for other purposes:

Adams, et al., in press

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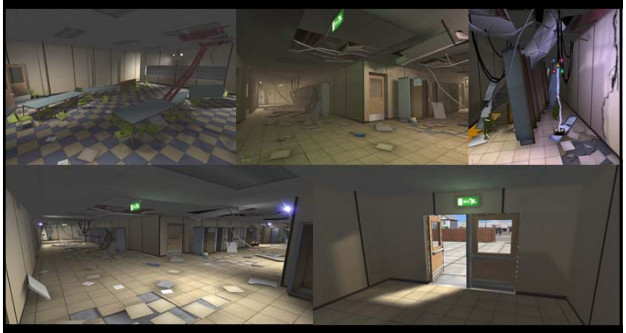
VIRTUAL EARTHQUAKE



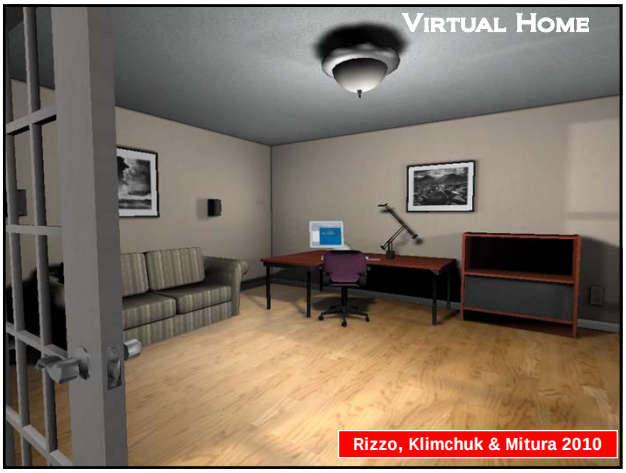
Training/Inoculation tool for children with developmental and learning disabilities

Rizzo, Mitura, Klimchuk & Tarnanis

RECENT VIRTUAL CLASSROOM PUBLICATIONS

- Rizzo, A.A., Bowerly, T., Buckwalter, J.G., Humphrey, L., Neumann, U., Kim, L., Pair, J., van Rooyen, A., & Chua, C. (2001). The Virtual Classroom: A Virtual Reality Environment for the Assessment of Attention Deficit Hyperactivity Disorder. *The ADHD Report*. 9:2, (April, 2001). pp. 9-13.
- Rizzo, A.A., Bowerly, T., Buckwalter, J.G., Shahabi, C. & Sharifzadeh, M. (2004). Results and Future Developments from a Virtual Reality Classroom for Assessing Attention Processes in Children with ADHD. *Biological Psychiatry*. 55:1S, 175.
- Rizzo, A.A., Klimchuk, D., Mitura, R., Bowerly, T., Shahabi, C. & Buckwalter, J.G. (2004). Diagnosing Attention Disorders in a Virtual Classroom. *IEEE Computer*. 37 (5), 87-89.
- Rizzo, A.A. Klimchuk, D., Mitura, R., Bowerly, T., Buckwalter, J.G. & Parsons, T. (2006). A Virtual Reality Scenario for All Seasons: The Virtual Classroom. *CNS Spectrums*.11(1), 35-44.
- Shahabi, C., Yang, K., Yoon, H., Rizzo, A.A., McLaughlin, M., Marsh, T. & Mun, M. (2007). Immersidata analysis: Four case studies. *IEEE Computer*. (April 2007) 65-72.
- Parsons, T., Bowerly, T., Buckwalter, J.G. & Rizzo, A.A. (2007). A controlled clinical comparison of attention performance in children with ADHD in a virtual reality classroom compared to standard neuropsychological methods. *Child Neuropsychology*.*13*, 363-381.
- Adams, R., Finn, P., Flannery, K., Moes, E. & Rizzo, A.A. (2009). The Virtual Reality Classroom: A Novel Approach to the Assessment of Attention Deficit/Hyperactivity Disorder. *Child Neuropsychology*. *15* (2). 120-135.
- Adams, R., Finn, P., Flannery, K., Moes, E. & Rizzo, A.A. (in press). Attention Deficit Hyperactivity Disorder and Eye-Tracking in a Virtual Reality Classroom: A Pilot Study. *Journal of Clinical and Experimental Neuropsychology*.
- Pollak, Y., Weiss, P.L., Rizzo, A.A., Weizer, M., Shriki, L., Shalev, R., Gross-Tsur, V. (2010). The utility of continuous performance test embedded in virtual reality in measuring ADHD-related deficits. *Journal of Developmental and Behavioral Pediatrics*.
- Bioulac, S., Lallemand, S., Rizzo, A., Philip, P., Fabrigoule, C. & Bouvard, M.P. (2012). Impact of time on task on ADHD patient's performances in a virtual classroom. *European Journal of Paediatric Neurology*.

VIRTUAL HOME



Rizzo, Klimchuk & Mitura 2010

VIRTUAL HOME

Rizzo, Klimchuk & Mitura 2010

VIRTUAL HOME

Rizzo, Klimchuk & Mitura 2010

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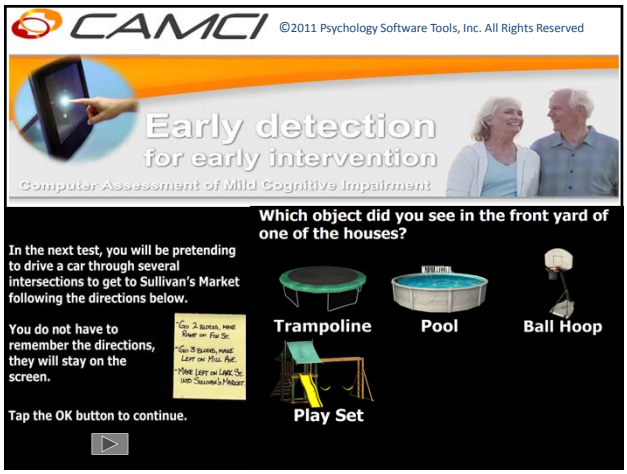
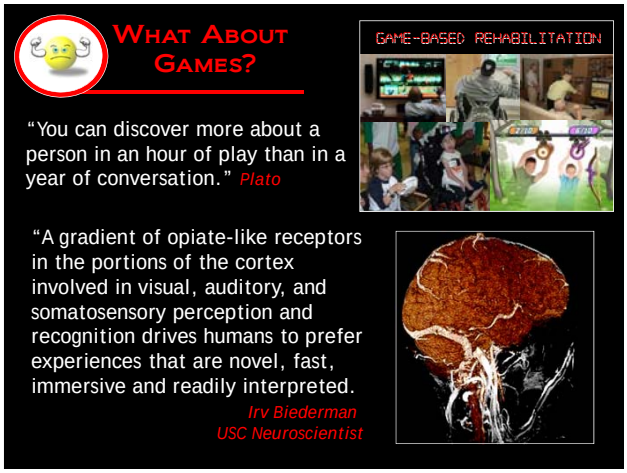
Virtual Kitchen created in 3 hours

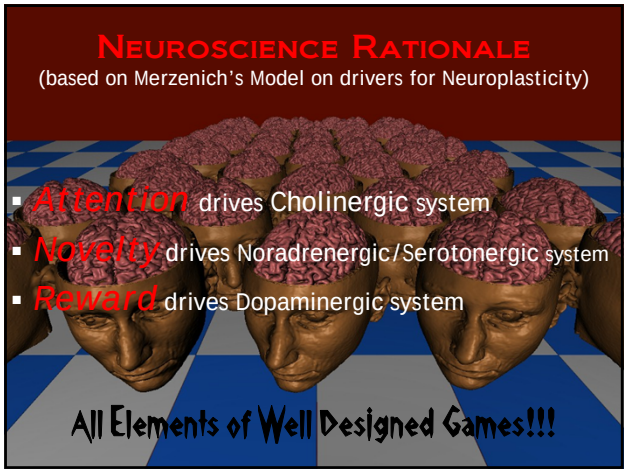
Koenig, 2013

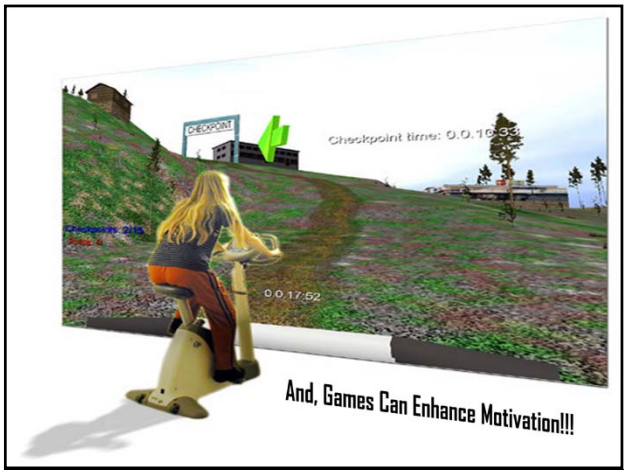
unity

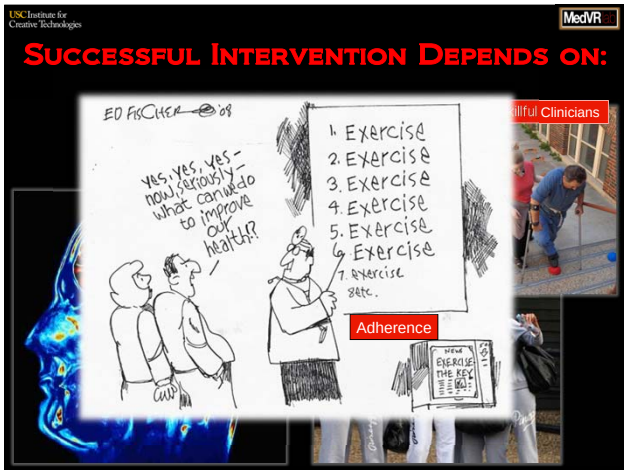

CAMCI
©2011 Psychology Software Tools, Inc. All Rights Reserved
Early detection
for early intervention
Computer Assessment of Mild Cognitive Impairment
In the next test, you will be pretending to drive a car through several intersections to get to Sullivan's Market following the directions below.
You do not have to remember the directions, they will stay on the screen.
Tap the OK button to continue.
Which object did you see in the front yard of one of the houses?
Trampoline
Pool
Ball Hoop
Play Set


What about Game-based Virtual Reality Training & Rehabilitation?
2/10
6/10


What About Games?
"You can discover more about a person in an hour of play than in a year of conversation." Plato
GAME-BASED REHABILITATION
"A gradient of opiate-like receptors in the portions of the cortex involved in visual, auditory, and somatosensory perception and recognition drives humans to prefer experiences that are novel, fast, immersive and readily interpreted.
Irv Biederman
USC Neuroscientist


Neuroscience Rationale
(based on Merzenich's Model on drivers for Neuroplasticity)
Attention drives Cholinergic system
Novelty drives Noradrenergic/Serotonergic system
Reward drives Dopaminergic system
All Elements of Well Designed Games!!!


CHECKPOINT
Checkpoint time: 0.0.16.63
0.0.17.52
And, Games Can Enhance Motivation!!!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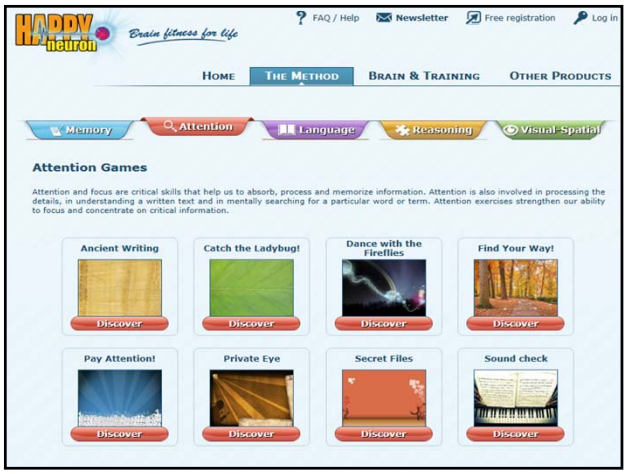
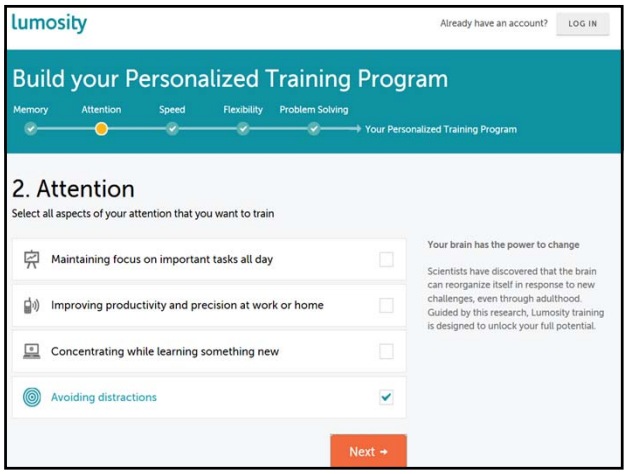
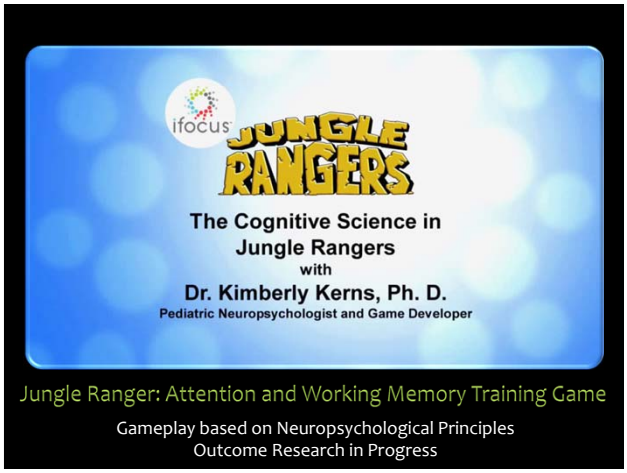
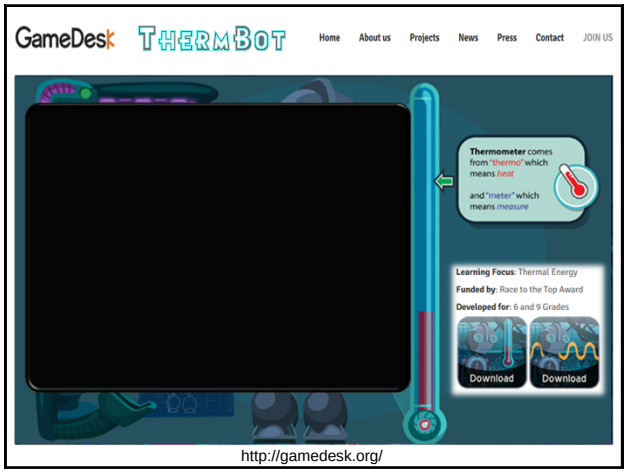
Successful Intervention Depends on:
ED FISCHER '08
yes, yes, yes - now seriously - what can we do to improve our health?
1. Exercise
2. Exercise
3. Exercise
4. Exercise
5. Exercise
6. Exercise
7. Exercise
etc.
Adherence
Skillful Clinicians



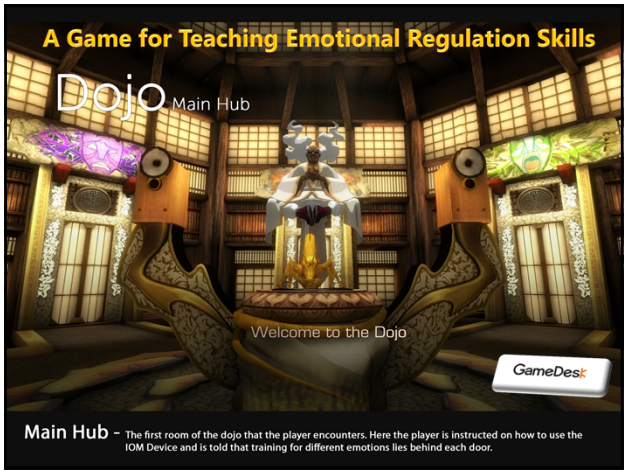


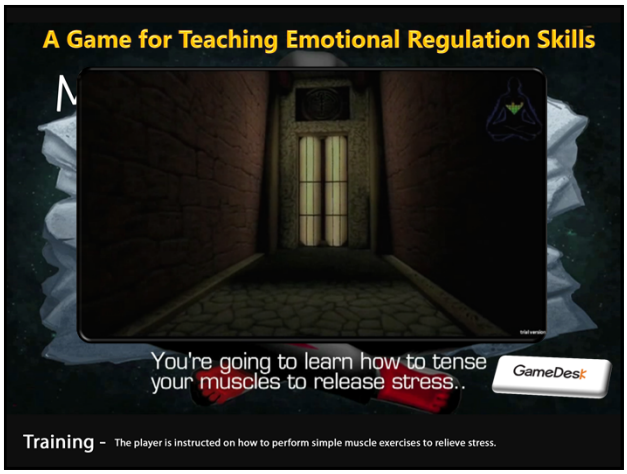




http://gamedesk.org/

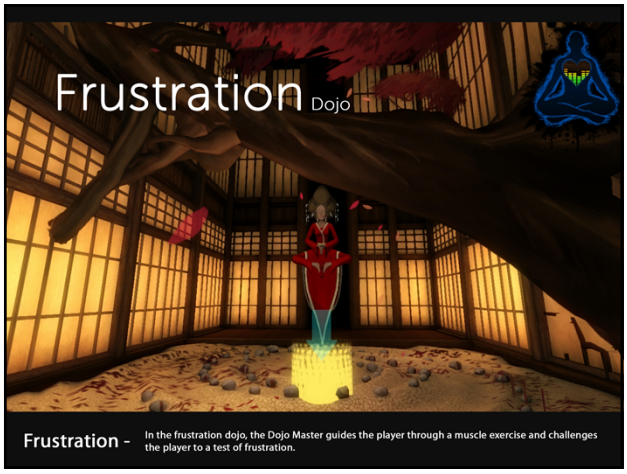
http://gamedesk.org/



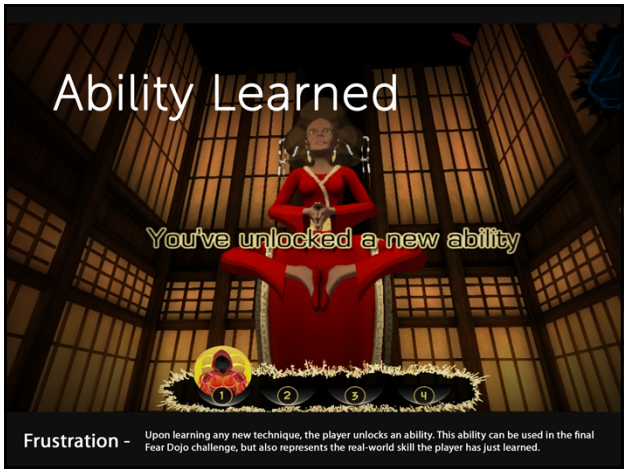


Training - The player is instructed on how to perform simple muscle exercises to relieve stress.

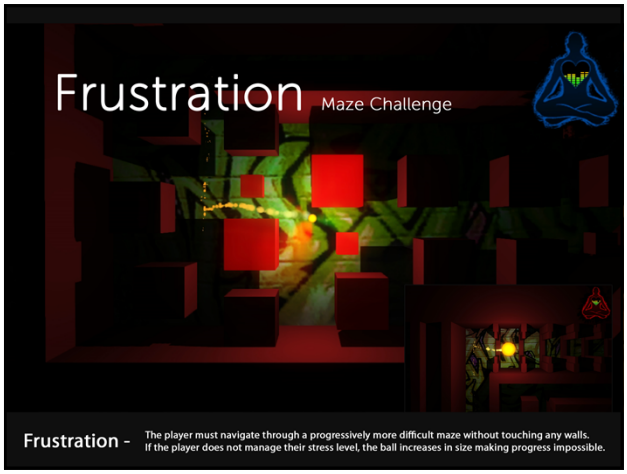
EMOTO - The player is also introduced to the EMOTO heads up display, which visualizes the player's heart rate and stress level.



Frustration - In the frustration dojo, the Dojo Master guides the player through a muscle exercise and challenges the player to a test of frustration.

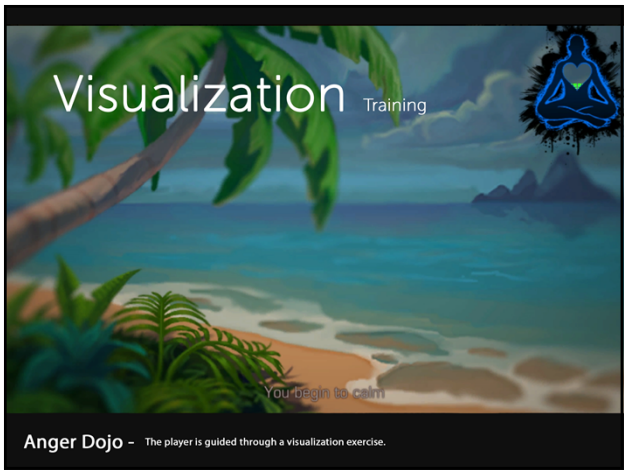


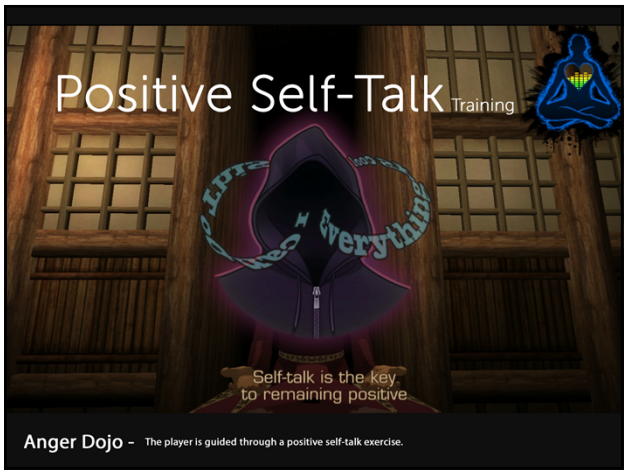
Frustration - Upon learning any new technique, the player unlocks an ability. This ability can be used in the final Fear Dojo challenge, but also represents the real-world skill the player has just learned.



Frustration - The player must navigate through a progressively more difficult maze without touching any walls. If the player does not manage their stress level, the ball increases in size making progress impossible.

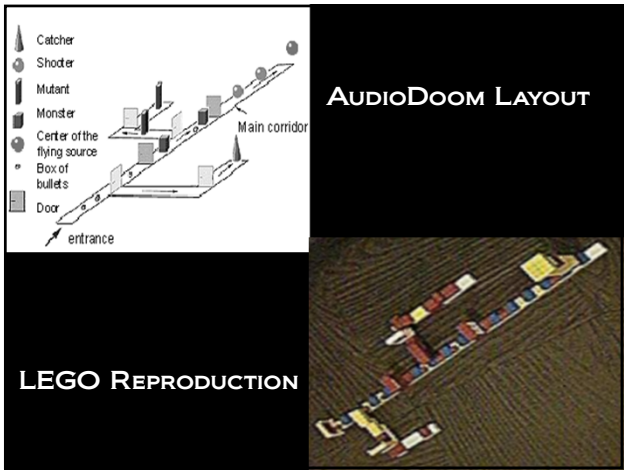
Anger Dojo - In the anger dojo, the Dojo Master guides the player through visualization and positive self-talk exercises and challenges the player to a test of anger.


Visualization Training
You begin to calm
Anger Dojo - The player is guided through a visualization exercise.


Positive Self-Talk Training
Self-talk is the key
to remaining positive
Anger Dojo - The player is guided through a positive self-talk exercise.

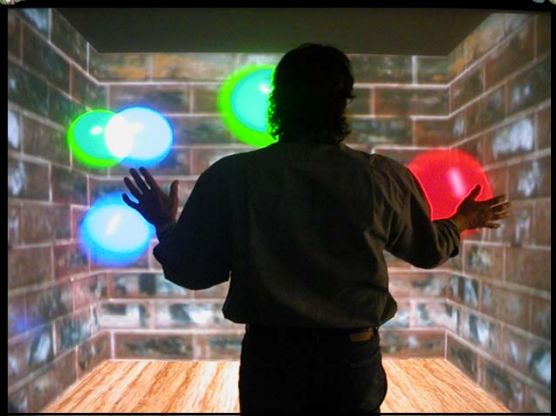

AudioDoom
Immersive Audio VR
Lumbreas & Sanchez
1998


AudioDoom
LEGO Construction Task
Lumbreas & Sanchez
1998


Catcher
Shooter
Mutant
Monster
Center of the flying source
Box of bullets
Door
Main corridor
entrance
AudioDoom Layout
LEGO Reproduction


Advances in Virtual Reality
New Technologies for Childhood Health Conditions
Talk Outline:
Introduction to Virtual Reality
Virtual Reality Applications for:
Cognitive/Functional Processes
SensoriMotor Interaction
Social Interaction
Conclusions & Questions
Virtual Reality

Sensorimotor Interaction



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MedVR

Rehabilitation Tasks must:

- focus on a specific targets derived from data-driven assessment to direct treatment
- be adjustable in terms of difficulty level from something simple for the patient to accomplish, to a level representing normal performance
- be quantifiable in order to assess progress
- be administered repetitively and hierarchically
- provide the client with strategic feedback as to the outcome of performance
- have some relevance to real world function
- motivate participation!

Virtual Reality simulation technology is Ideally suited to meet these requirements

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MedVR

Traditional Therapy

In the traditional therapy session, the patient works one on one with a therapist to address shoulder flexion and abduction, pincer grasp, forearm supination and pronation and other movement foci.

What about Game-based Virtual Reality Training & Rehabilitation?

IREX System for OT/PT after Stroke/TBI/SCI/CP

Weiss et al., 2002-2012

IREX System for OT/PT after Stroke/TBI/SCI/CP

Weiss et al., 2002-2012

IREX System for OT/PT after Stroke/TBI/SCI/CP

Weiss et al., 2002-2012

Feasibility, Motivation and Selective Motor Control: Virtual Reality Compared to Conventional Home Exercise in Children with Cerebral Palsy

Carolyn Bryanton[1], Marie Brien[2], Jennifer McLean[2], Anna McCormick[2], Heidi Sveistrup[1]

Children generate a greater range of ankle dorsiflexion, demonstrate better control of active ankle dorsiflexion movement, and report greater interest in doing the same exercise when delivered through a virtual reality system than as a stand-alone exercise. The next series of experiments will characterize the muscle activity generated during the two exercise modes as well as determine retention and transfer of effects following an intervention trial.

2006

Virtual Reality–Induced Cortical Reorganization and Associated Locomotor Recovery in Chronic Stroke

An Experimenter-Blind Randomized Study

Sung H. You, PT, PhD; Sung Ho Jang, MD; Yun-Hee Kim, MD, PhD; Mark Hallett, MD; Sang Ho Ahn, MD; Yong-Hyun Kwon, PT, MS; Joong Hwi Kim, PT, MS; Mi Young Lee, PT

Background and Purpose—Virtual reality (VR) is a new promising computer-assisted technology to promote motor recovery in stroke patients. VR-induced neuroplasticity supporting locomotor recovery is not known. We investigated the effects of VR intervention on cortical reorganization and associated locomotor recovery in stroke patients.

Methods—Ten chronic stroke patients were assigned randomly to either the control group or the VR group. VR was designed to provide interactive real-life practice environments in which practice parameters can be individualized to optimize motor relearning. Laterality index (LI) in the regions of interests (ROIs) and locomotor recovery were measured before and after VR using functional MRI (fMRI) and standardized locomotor tests, respectively. The *t* test and nonparametric test were performed to compare the mean differences at $P<0.05$.

Results—There was a significant difference in the interval change in the LI score for the primary sensorimotor cortex (SMC) between the groups ($P<0.05$), indicating that VR practice produced a greater increase in LI for the control group. However, the interval changes in the other ROIs were not significantly different ($P>0.05$). Motor function was significantly improved after VR ($P<0.05$).

Conclusions—Our novel findings suggest that VR could induce cortical reorganization from aberrant ipsilateral to contralateral SMC activation. This enhanced cortical reorganization might play an important role in recovery of locomotor function in patients with chronic stroke. This is the first fMRI study in the literature that provides evidence for neuroplasticity and associated locomotor recovery after VR. (*Stroke*. 2005;36:1166-1171.)

Key Words: g ■ rehabilitation

In: *Stroke* (2005)

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Exergaming and Older Adult Cognition

A Cluster Randomized Clinical Trial

Cay Anderson-Hanley, PhD, Paul J. Arciero, DPE, Adam M. Brickman, PhD, Joseph P. Nimon, BS, Naoko Okuma, BS, Sarah C. Westen, BS, Molly E. Merz, BS, Brandt D. Pence, BA, Jeffrey A. Woods, PhD, Arthur F. Kramer, PhD, Earl A. Zimmerman, MD

Background: Dementia cases may reach 100 million by 2050. Interventions are sought to curb or prevent cognitive decline. Exercise yields cognitive benefits, but few older adults exercise. Virtual reality–enhanced exercise or "exergames" may elicit greater participation.

Purpose: To test the following hypotheses: (1) stationary cycling with virtual reality tours ("cybercycle") will enhance executive function and clinical status more than traditional exercise; (2) exercise effort will explain improvement; and (3) brain-derived neurotrophic growth factor (BDNF) will increase.

Design: Multi-site cluster randomized clinical trial (RCT) of the impact of 3 months of cybercycling versus traditional exercise, on cognitive function in older adults. Data were collected in 2008–2010; analyses were conducted in 2010–2011.

Setting/participants: 102 older adults from eight retirement communities enrolled; 79 were randomized and 63 completed.

Interventions: A recumbent stationary ergometer was utilized; virtual reality tours and competi-

Cybercycling older adults achieved better cognitive function than traditional exercisers (no game condition), for the same effort, suggesting that simultaneous cognitive and physical exercise has greater potential for preventing cognitive decline. 2012

In: *AJPM* (2012)

Conclusions: Cybercycling older adults achieved better cognitive function than traditional exercisers, for the same effort, suggesting that simultaneous cognitive and physical exercise has greater potential for preventing cognitive decline.

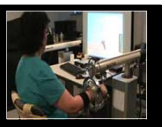
Robotically Facilitated Training of the Hemiplegic Upper Extremity as an Integrated Functional Unit in Virtual Environments

Alma Merians & Gerard Fluet
University of Medicine and Dentistry of New Jersey
Sergei Adamovich, Qinyin Qiu & Ian Lafond
New Jersey Institute of Technology

2009

Clinical Outcomes

Functional Improvement



Subjects

- **Mean age = 58**
- **7 male 4 female**
- **Mean - 6 yrs. post stroke (9 mos-15 yrs)**
- **6 right hemiplegia, 5 left hemiplegia**
- **All cortical - ischemic strokes**
- **6 Months Post CVA**
- **20° wrist extension and 10° finger extension**

Training = 20 Hours over 2 Weeks (8-10 sessions)

Four game simulations that combined arm transport and hand manipulation

Test	Percent Change (SD)	P value
Jebsen Test of Hand Function	28% (15)	P=.03*
Wolf Motor Function Test	25% (11)	P=.000025*
9 hole peg test	19% (30)	P=.08
Box and Blocks Test	12% (10)	P=.02*

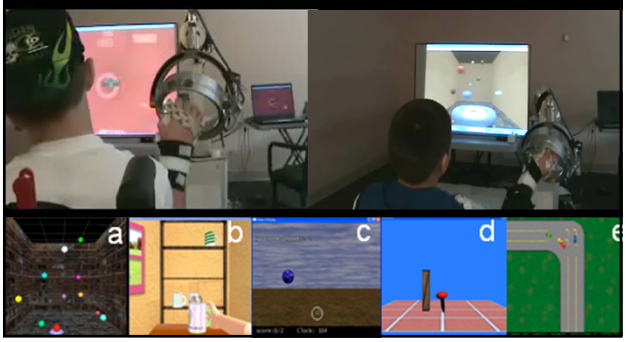
Exclusion Criteria: severe aphasia, hemispatial neglect, upper extremity botox within 3 months

Merians, Adamovich, Qiu, Lafond & Fluet, 2009

2009

Games Modified for Children with CP

Alma Merians & Gerard Fluet



Games Modified for Children with CP

Users and Training

- Nine children with Cerebral Palsy (8 boys, 1 girl; ages 7-15 years)
  - Seven with Hemiplegia (ambulatory)
  - Two with Quadraplegia (non-ambulatory)
- Practiced for one hour/day - 3 days a week - for three weeks (9 Hours Total)
- Played a combination of 3 or 4 games of the simulations depending on therapeutic goals, tolerances and their preferences.

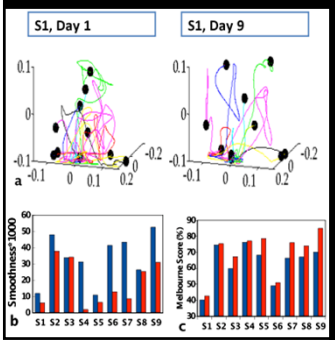
Outcome Measures

- Outcome measures included both clinical tests and kinematic measures
- *Melbourne Assessment of Unilateral Upper Limb Function (MAUULF).* (measures movement quality of 16 upper extremity activities)
- Kinematic measures included:
  - Arm Movement Speed
  - Smoothness of Endpoint Trajectory
  - Movement Duration

Merians & Fluet, 2011

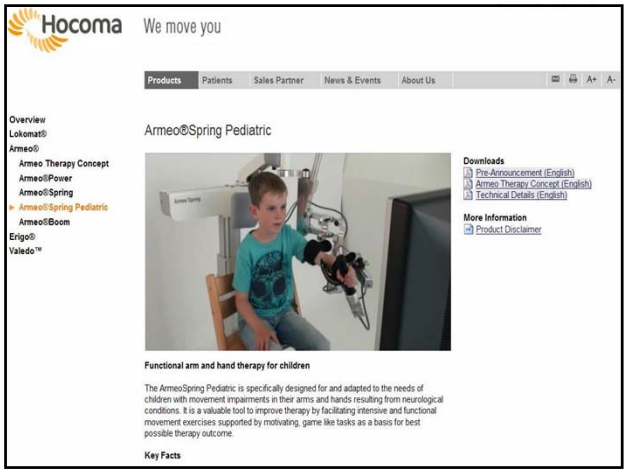
Games Modified for Children with CP

Alma Merians & Gerard Fluet



- 9 Hours Total Training time
- Trajectories of a representative subject on Day 1 and Day 9
- After training **children had a more direct path** when reaching to touch all ten targets in the Bubble Explosion game
- Each **child improved the smoothness of their trajectory** as they reached for the targets
- **Statistically significant (p<.05) improvement in the MAUULF** after training.

Merians & Fluet, 2011



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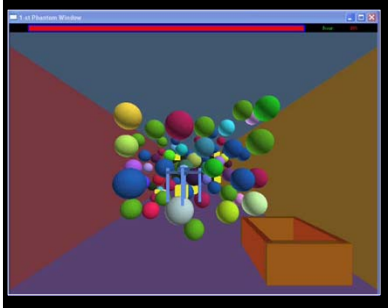
Phantom Based Motor Rehab Applications



Hand Reaching and Fine Motor Control

OPTT-RERC

Optimizing Participation through Technology for Successful Aging with Disability

USC Institute for Creative Technologies

Dual Phantom Based Motor Rehab Applications

Like traditional therapy, the Pinch Game targets a single movement focus, pincer grasp, using dual PHANToMs. The patient must grasp a cube and raise it above a bar. The PHANToMs provide force feedback (the sense of touch).

Phantom Based Motor Rehab Applications

Pronation and Supination

The Flying Plane game targets pronation and supination, using a PHANToM OMNI, a comparatively inexpensive force-feedback device.

OPTT-RERC
Optimizing Participation through Technology for Successful Aging with Disability

The Novint Falcon

The Novint Falcon is the first 3D touch interface device designed for the consumer market. The Falcon, which is designed to retail for under $200 in mass market volumes, performs comparably to commercial devices that cost thousands of dollars, letting users accurately and realistically feel shape, texture, weight, dynamics, 3D motion and force effects when playing touch-enabled games.

Bi-Manual Applications

- Novint Falcon 3 DOF (right-left, forward-backward, up-down)
- 4"x4"x4" workspace
- rumble, vibrations, texture
- Max continuous force 1 kgf
- Price less than $200

"TEETERTOTTER" PROTOTYPES

Bi-Manual Applications

Pinch Task Prototype

USC Institute for Creative Technologies

MedVR lab

NOVINT Coming Soon!

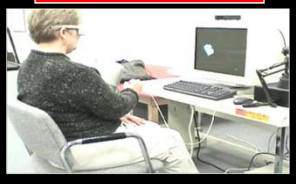
USC ICT Rehabilitation Lab Novel Interface Projects

Bi-Manual Coordination

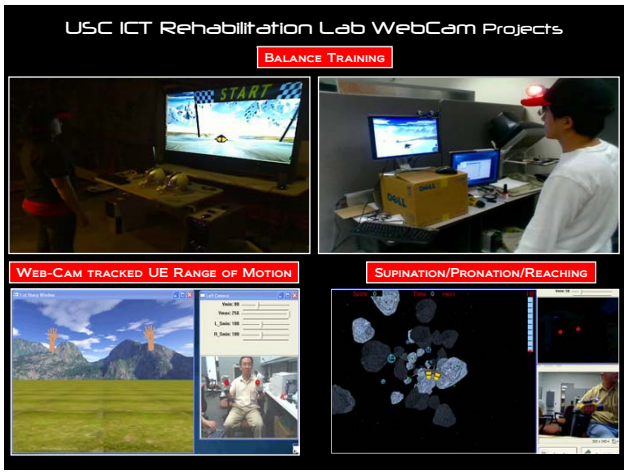
Digital Spirometer Breathing Game

Pinch and Grasp training

Supination/Pronation/Reaching




Various Labs began developing Infrared & Webcam-based Tracking Options…
UNIVERSITAT POMPEU FABRA
IMAS
Hospital de l'Esperança
Head
R.Elbow
L.Elbow
R.Hand
L.Hand
labhuman
HUMAN CENTERED TECHNOLOGY
VR Motor Assessment and Rehabilitation
Motor Rehab Lab
USC
Cameirão et al
Alcaniz et al
Yeh, Lange & Rizzo


USC ICT Rehabilitation Lab WebCam Projects
Balance Training
START
Web-Cam tracked UE Range of Motion
Supination/Pronation/Reaching

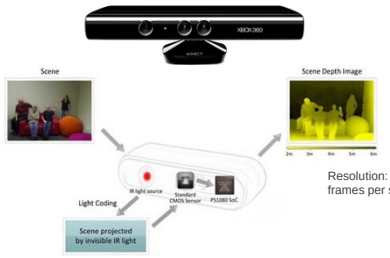

Wii
Nintendo
© 2007 Nintendo


Wii


Training
Yoga
Strength Training
Aerobics
Balance Games
Favorites
Today's Time
Games that help develop your sense of balance.
Back
Balance Games
Back
Table Tilt
Lean your body left, right, forward, and backward to tilt the balls into the holes.
Difficulty
Beginner
Back
Start
Start


Wii
WiiHABILITATION?
Nintendo
© 2007 Nintendo

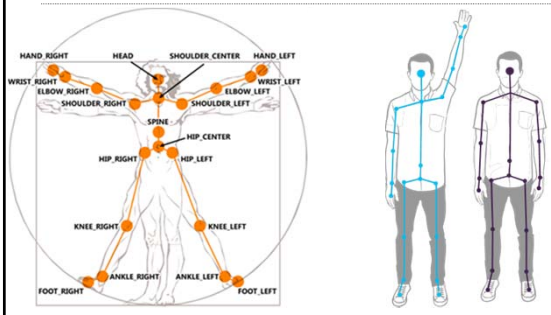
Microsoft Kinect Sensor



Resolution: 640x480 at 30 frames per second.

Field-of-view: 58 degrees horizontal and 45 degrees vertical

Microsoft Kinect Skeletal Tracking



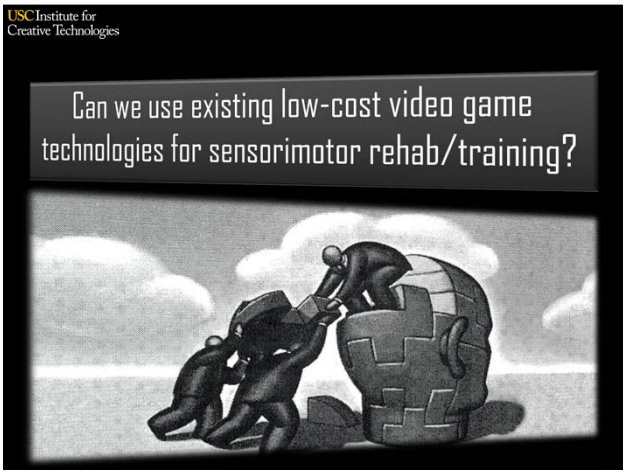
A REVOLUTION IN LOW-COST MOTION TRACKING FOR REHABILITATION

Kinect Motion Tracking Interface Project

Jewel Mine Upper Extremity Range of Motion Early Prototype

USC Institute for Creative Technologies MedVR lab

USC Institute for Creative Technologies



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Video games for Clinic and Home-based Rehabilitation

- Low-cost video game hardware
  - Wii, Wii Fit, Playstation2 EyeToy, Playstation3 MOVE, Microsoft Kinect
- Wide adoption of video games by a range of clinicians in clinical and aged care settings
- Easy to access, fun to use, well known
- Motivate patients to exercise

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What is the quality of movement we are asking our clients to do?

Can Games designed for Entertainment be used out of the Box?

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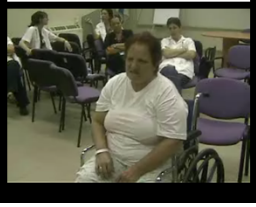
SONY EyeToy Example



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User testing of Video games in the Clinic Setting

- Clinician does not have control over game components
- 'Easy' levels too difficult for many patients
- Level of difficulty increase does not match clinical goals
- If difficulty too high, causes compensatory movements
- Difficult for clinicians to choose appropriate games
- Games do not have specific movement focus
- Game score is not representative of motor performance

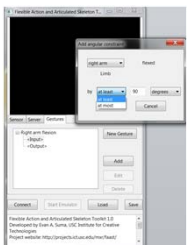
Games designed for Entertainment do not meet Criteria for good rehabilitation tasks out of the Box!

Flexible Action and Articulated Skeleton Toolkit (FAAST)

(Suma, Lange, Rizzo & Bolas)

- How can we build a middleware with a flexible user interface to allow access to wider population of programmers?
  - Software OpenNI PrimeSense
  - Hardware: PrimeSensor or the Microsoft Kinect sensors
  - FAAST is middleware to facilitate integration of full-body control with games and VR applications
  - FAAST includes a custom VRPN server to stream the user's skeleton over a network, allowing VR applications to read the skeletal joints as trackers using any VRPN client

FAAST System: Middleware



OPTT-RERC PrimeSense

MxR Lab OpenNI

University of Southern California USC SCHOOL of CINEMATIC ARTS

FAAST- Keyboard Emulation Feature

Body Sway = Missile Launcher Control
Right Arm Movement = Firing

Left Arm Movement = Missile Launcher Control
Right Arm Movement = Firing

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MedVR lab

FAAST- Keyboard Emulation Feature

Tux Racer Balance Game Prototype

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MedVR lab

FAAST- Keyboard Emulation Feature

Play World of WarCraft using your Body to Emulate Keyboard

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MedVR lab

University of Southern California

Dissemination USC

Software Tool Dissemination

- FAAST Software downloads (>2000!)

Improving Upper Extremity Functioning for Children with Cerebral Palsy through Internet Virtual Reality Gaming Therapy

Marisa Sevick OTD/S, Allison Mensch MSOT/S, Matt Foreman PhD/S, John Standevan PhD, Jack Engsberg PhD
Washington University School of Medicine- Program in Occupational Therapy
Marisa.Sevick1@gmail.com

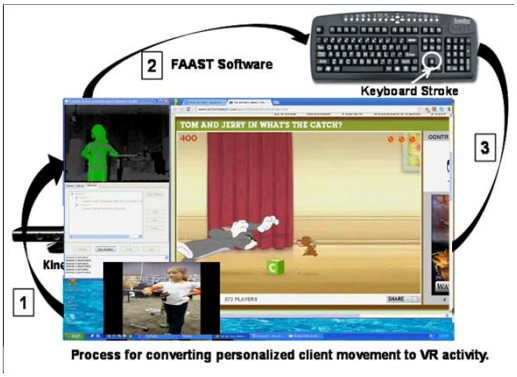
- 12-week intervention (in the lab & at home)
- Utilized Kinect and Flexible Action Articulated Skeleton Toolkit (FAAST) for conversion of game controls from keystokes to upper extremity movements
- Games (from internet) based on the child's interest
- Target movements based on targeted difficulties of child

	Wks 1-3	Wks 4-6	Wks 7-9	Wks 10-12
Training days in lab per week	3	2	1	0
Training days at home per week	0	1	2	3

Phasing rehabilitation activities into the home via Internet Virtual Reality Gaming Therapy

Improving Upper Extremity Functioning for Children with Cerebral Palsy through Internet Virtual Reality Gaming Therapy

Tom and Jerry Online Game Play



Process for converting personalized client movement to VR activity.

Improving Upper Extremity Functioning for Children with Cerebral Palsy through Internet Virtual Reality Gaming Therapy

Status

- Have currently completed intervention with two children with spastic hemiplegia cerebral palsy; continuing with additional children with cerebral palsy who demonstrate more functional limitations in their upper extremities

Results and What We Have Learned

- Able to obtain a high number of repetitions in a one hour session (~500)
- Participants highly motivated to complete training (36-37/37 on Intrinsic Motivation Inventory)
- Demonstrated participant specific changes in upper extremity movement patterns toward more typical
- Demonstrated ability to transfer intervention to home


USC Institute for Creative Technologies
MYSTIC ISLE
MOUNTAIN ROAD
Venture if you dare!
Lange et al.
unity


USC Institute for Creative Technologies
MYSTIC ISLE
THE CANYON
Venture if you dare!
Lange et al.
unity


USC Institute for Creative Technologies
MYSTIC ISLE
THE BARN
Venture if you dare!
Lange et al.
unity


USC Institute for Creative Technologies
MYSTIC ISLE
THE CASTLE GATE
Venture if you dare!
Lange et al.
unity


USC Institute for Creative Technologies
MYSTIC ISLE
THE CASTLE
Venture if you dare!
Lange et al.
unity


USC Institute for Creative Technologies
MYSTIC ISLE
THE WITCH TOWER
Venture if you dare!
Koenig, 2013
unity


Jewel Mine Deluxe Edition
Select a region on the map and click PLAY to start the game.
1 - Landing
2 - Swamp
3 - Beach
4 - Graveyard
5 - Maple Forest
6 - Pine Forest
7 - Plains
8 - Canyon
9 - Crater
10 - Mountain Road
11 - Barn
12 - Watchtower
13 - Castle Road
14 - Castle Gate
15 - Castle
16 - Cave
17 - Island
PLAY
MYSTIC ISLE
Back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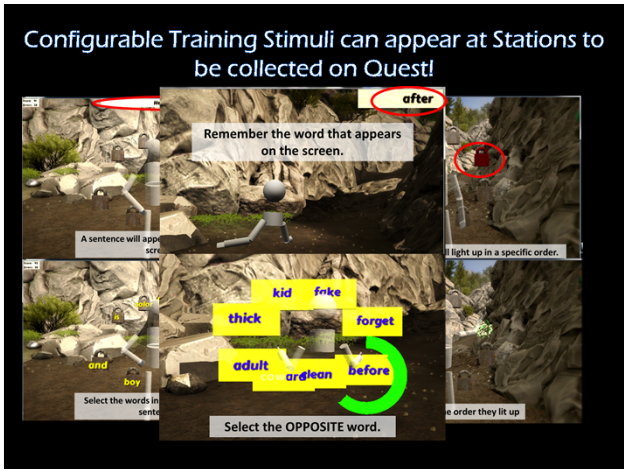
Clinician Control Panel
TASK Editor
Task Name: Sequential
From Sequential
1. Mode: Sentence
2. Number of Trials 3
3. Show item labels/numbers all the time: False
4. Sequence/order of items
Location for each game object
General Settings:
1 - Hand discrimination
2 - Target hint
3 - Disable circle color
4 - Full-body avatar
Touch Timer: 0.5 secs
Save
Back


Configurable Training Stimuli can appear at Stations to be collected on Quest!
after
Remember the word that appears on the screen.
kid
fake
thick
forget
adult
clean
before
and
boy
Select the OPPOSITE word.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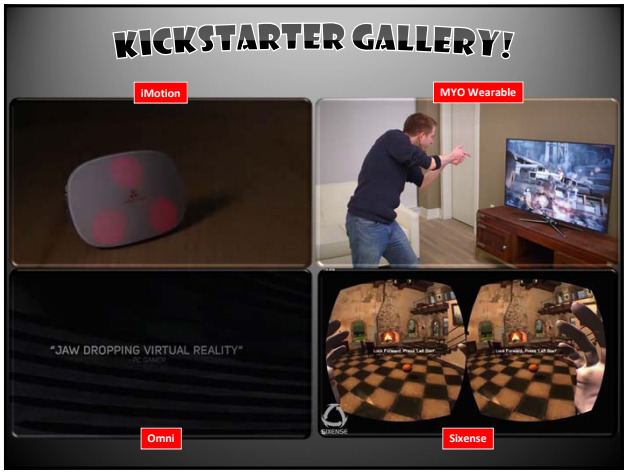
Multiple User Options


KICKSTARTER GALLERY!
iMotion
MYO Wearable
"JAW DROPPING VIRTUAL REALITY"
Omni
Sixense


Kinect One!

Advances in Virtual Reality

New Technologies for Childhood Health Conditions

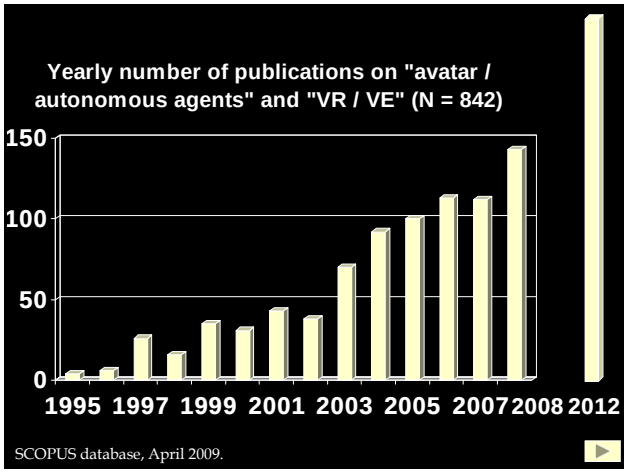
Talk Outline:

- Introduction to Virtual Reality
- Virtual Reality Applications for:
  - Cognitive/Functional Processes
  - SensoriMotor Interaction
  - Social Interaction
- Conclusions & Questions

What about Virtual Humans?

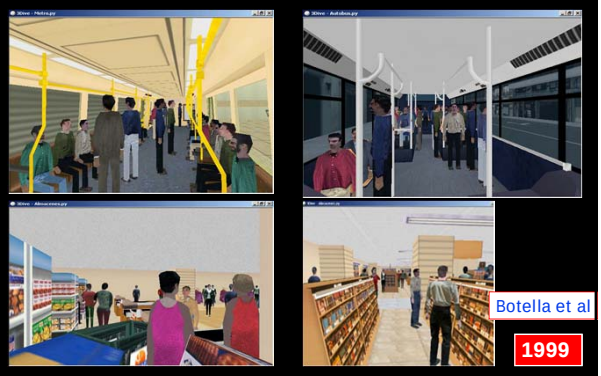
What about Virtual Humans?

Yearly number of publications on "avatar / autonomous agents" and "VR / VE" (N = 842)



SCOPUS database, April 2009.

Panic disorder and agoraphobia



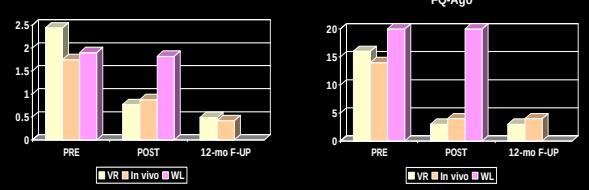
Botella et al

1999

Panic disorder and agoraphobia

N = 36. All p < .001. 90 and 91% panic-free at follow-up.

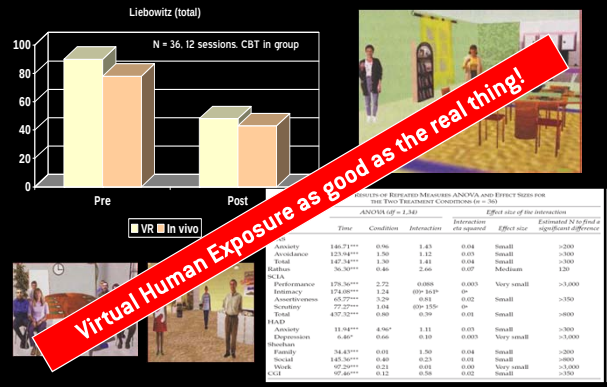
Botella et al. (2007)



Virtual Human Exposure as good as the real thing!

Social Phobia

Social Phobia



Fear of Public Speaking

Fear of Public Speaking

43 fear of public speaking patients

Static audience

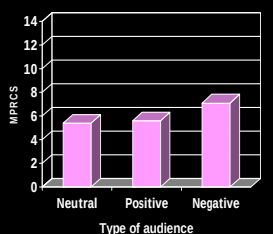
Positive audience

Negative audience

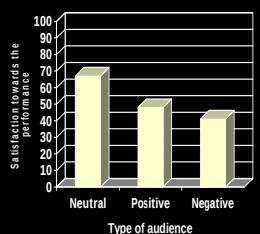
Reaction of socially anxious people to autonomous agents

(Pertaub, Slater, & Barker (2001, 2002)

Fear of Public Speaking



ANCOVA (estimated from data in the paper)
Type of audience, $p < .05$
Negative > positive = neutral.

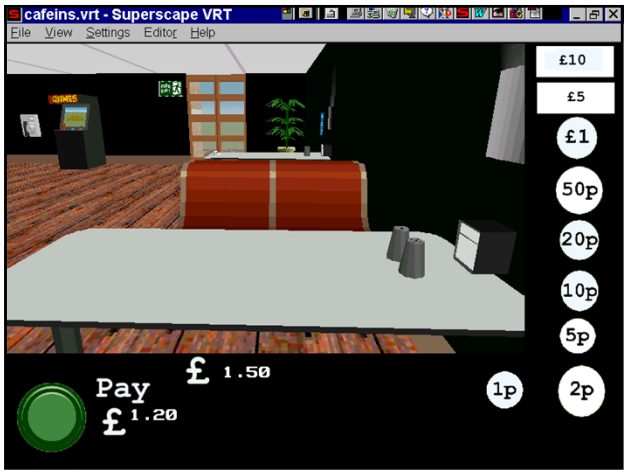


Anova
Type of audience, $p < .05$
Neutral > Positive = Negative, $p < .05$

Phobics React to Variations in Virtual Human States

Virtual "City" (Brown et al., 1997)


cafeins.vrt - Superscape Visualiser
File View Settings Help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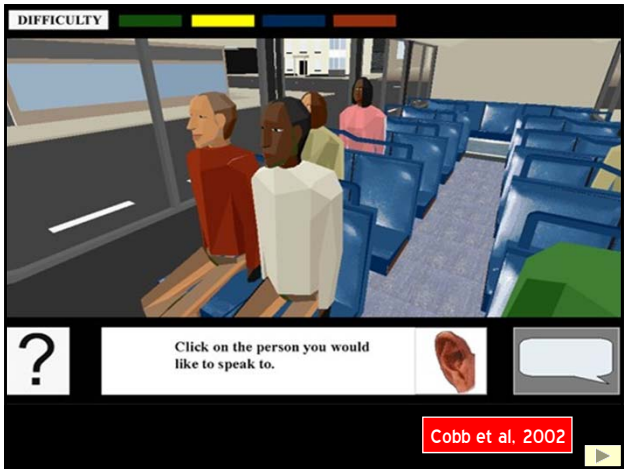
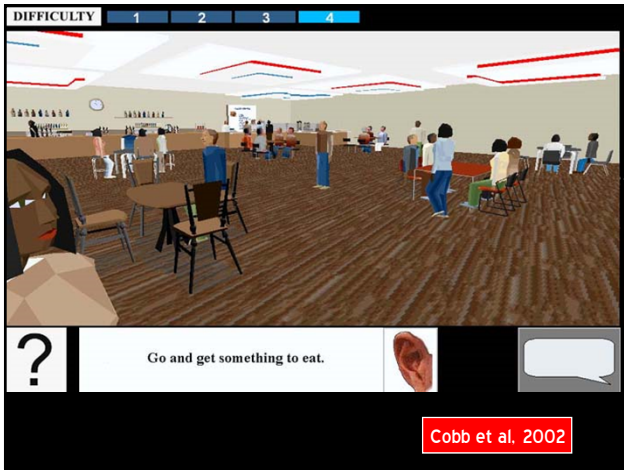
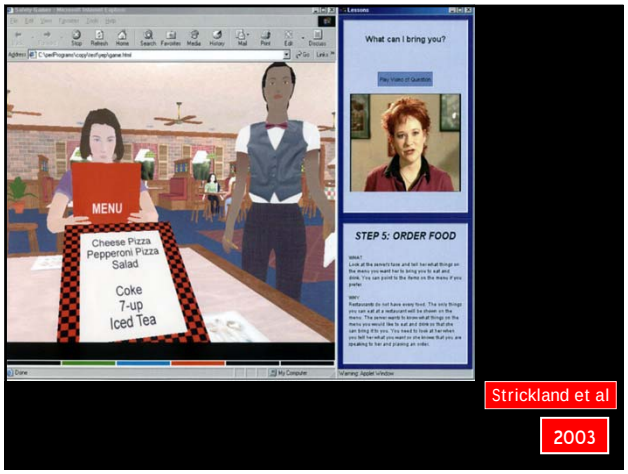

DIFFICULTY
Click on the person you would like to speak to.
Cobb et al. 2002


DIFFICULTY
1
2
3
4
Go and get something to eat.
Cobb et al. 2002


What can I bring you?
MENU
Cheese Pizza
Pepperoni Pizza
Salad
Coke
7-up
Iced Tea
STEP 5: ORDER FOOD
Strickland et al
2003

Childhood Social Anxiety & Bullying

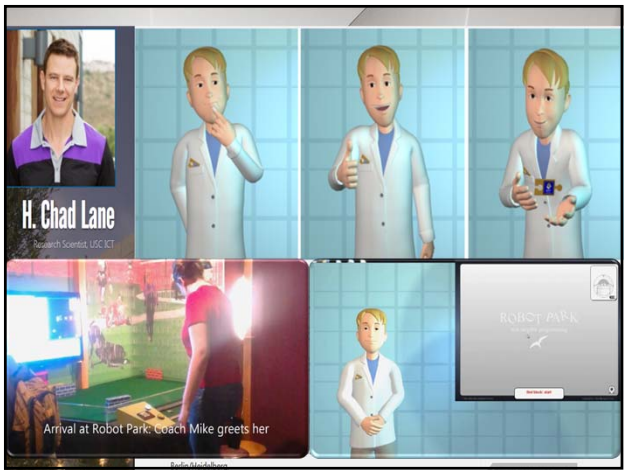
Web-Based and Interactive Virtual Environments for Children with Food Allergies

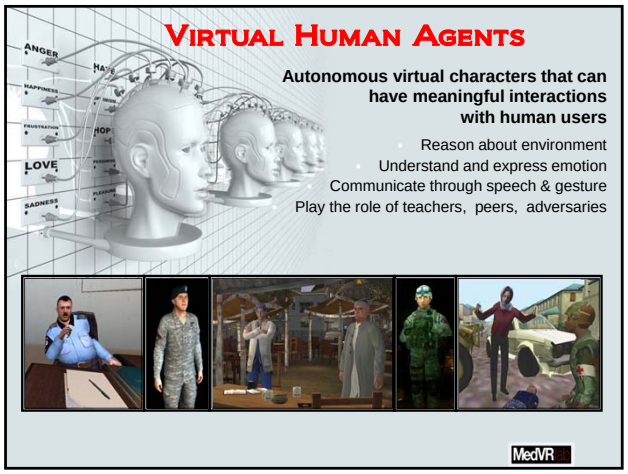
Choose your own adventure—
With Consequences

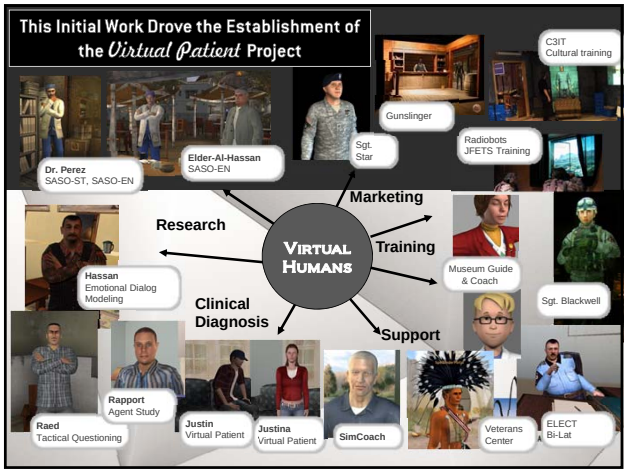

Treasure Map
Start
Deserted Island
Volcano Island


Secret
Pirate
Church


Shop


H. Chad Lane
Arrival at Robot Park: Coach Mike greets her


VIRTUAL HUMAN AGENTS
Autonomous virtual characters that can have meaningful interactions with human users
Reason about environment
Understand and express emotion
Communicate through speech & gesture
Play the role of teachers, peers, adversaries
MedVR


This Initial Work Drove the Establishment of the Virtual Patient Project
C3IT Cultural training
Gunslinger
Sgt. Star
Radiobots JFETS Training
Dr. Perez SASO-ST, SASO-EN
Elder-Al-Hassan SASO-EN
Marketing
Research
Training
VIRTUAL HUMANS
Museum Guide & Coach
Hassan Emotional Dialog Modeling
Clinical Diagnosis
Sgt. Blackwell
Support
Rapport Agent Study
Raed Tactical Questioning
Justin Virtual Patient
Justina Virtual Patient
SimCoach
Veterans Center
ELECT Bi-Lat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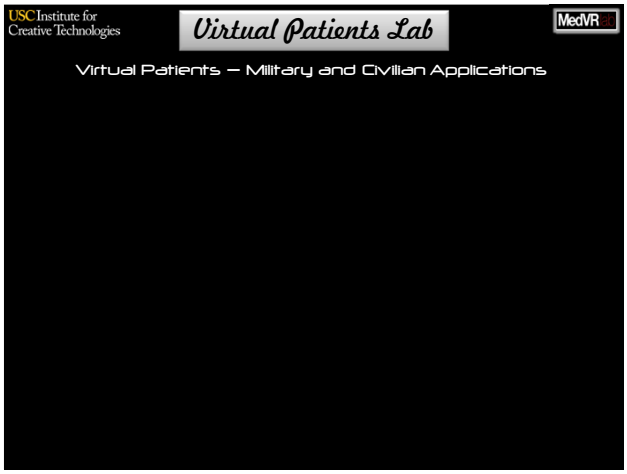
Virtual Patients Lab
Virtual Patients – Military and Civilian Applications
Collaboration with the USC School of Social Work Masters in Military Social Work Program
JUSTIN
JUSTINA
SICKCALL
VIRTUAL PATIENTS W/USC PSYCHIATRY
MedVR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Virtual Patients Lab
MedVR
Virtual Patients – Military and Civilian Applications


SimCoach - An Intelligent Virtual Agent for Healthcare Support
USC Institute for Creative Technologies
Breaking Down Barriers to Care in Service Members, Veterans and their Families

One Solution: SimCoach

Beta Test Site: http://www.simcoach.org

The Future

- Driver for Military & Civilian Health Care Research
- Voice Recognition
- Toolkit for Clinician Authored Expansion
- Expansion of Military Health SimCoach Characters/Topics
  - Sexual Assault, Depression, Suicide, Family Issues, TBI, Addiction, Fitness
- Expansion of Mil & Civilian Health SimCoach Applications
  - Clinical Training – online virtual patient training
  - BraveHeart (MLB/Atlanta Braves Welcome Back Vets Program)
  - Job Interview Training with Autism Spectrum Disorder
  - AMEDD Professional Quality of Life Assessment
  - Northwestern P20 Assertiveness Role Play Agent
  - DCAPS/RUSS Testbed!
  - Caretaker & Special Needs Support
  - Stress Resilience Mentoring
- Use of SimCoach Web Architecture for Other Purposes

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Mobile SimCoach

DARPA: Detection and Computational Analysis of Psychological Signals (DCAPS)

SimSensei

A Kiosk-Based Intelligent Healthcare Guide that can Sense your State

Using a WebCam, Kinect and a Microphone – to give "eyes" and "ears" to a SimCoach!!!

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DARPA: Detection and Computational Analysis of Psychological Signals (DCAPS)

Using OTS sensors to track Facial Expression, Body Posture, Hand Gestures and Vocal Prosody to Infer User State

USC Institute for Creative Technologies
University of Southern California

SimSensei:
Virtual Human for Healthcare Support

& MultiSense:
Multimodal Perception and Learning

Albert (Skip) Rizzo, PI
Louis-Philippe Morency, PI

As part of DCAPS program:
Detection & Computational Analysis of Psychological Signals
(3rd Interim Progress Video)

The work depicted here was sponsored by the U.S Defense Advanced Research Projects Agency. Statements and opinions expressed do not necessarily reflect the position or the policy of the United States Government, and no official endorsement should be inferred.

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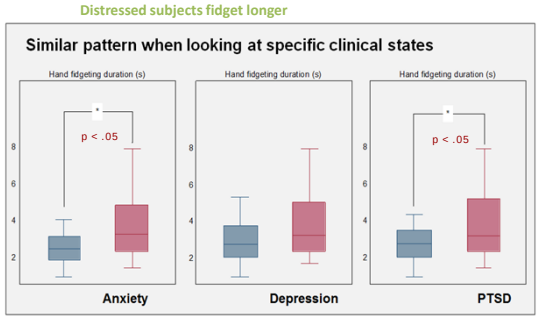
Association between distress and fidgeting

Distressed subjects fidget longer

Similar pattern when looking at specific clinical states



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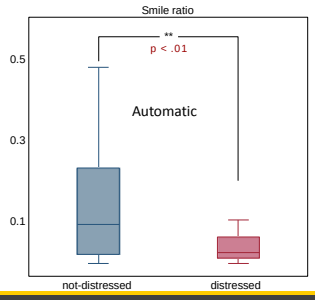
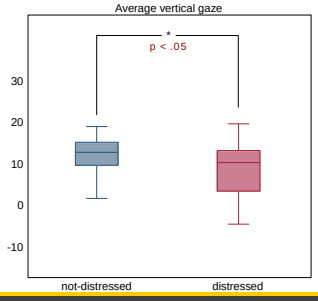
Association between distress and smiles

Distressed subjects use shorter smiles.



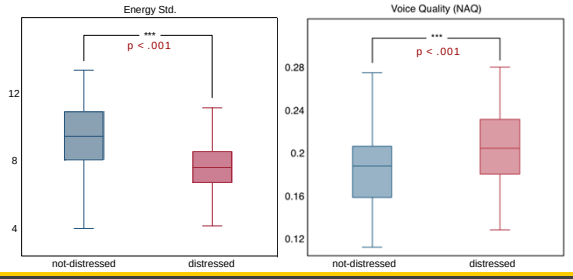
Association between distress and gaze

Distressed subjects look towards the ground more on average.



Association between distress and audio features

Distressed subjects vary their speech intensity less, and use more breathy voice.

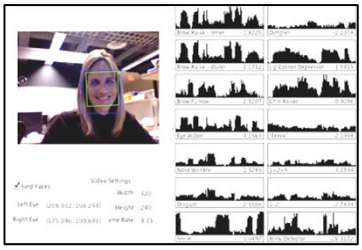


Can we train facial expression production in children with autism?

Jim Tanaka, Director of Centre for Autism Research Technology & Education (CARTE) University of Victoria;

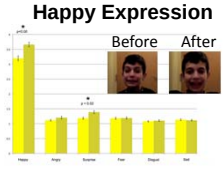
Centre for Autism Research, Technology and Education (CARTE)

Marni Bartlett, Institute for Neural Computation University of California,

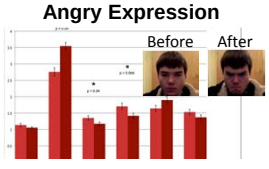


Computer Expression Recognition Toolbox (CERT) decodes facial expressions in real-time. Developed by Dr. Marni Bartlett, UCSD, Machine Perception Lab

Happy Expression



Angry Expression



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On the horizon…

Asperger's & Alzheimer's
Depression & Epilepsy

Soon to become a Job Interview Training System for Persons with Asperger's Syndrome

VIRTUAL BUDDY FOR IN HOME COMPANIONSHIP AND SUPPORT FOR PERSONS WITH MILD DEMENTIA

USC Institute for Creative Technologies

Partnership with:
Boris R. Bracio, Prof. Dr. rer. nat., Dipl.-Ing.
Head of Biomedical Engineering
Anhalt University of Applied Sciences

Assessment of Expressive Changes in Intractably Depressed Patients following Ongoing Deep Brain Stimulation

USC Institute for Creative Technologies

Partnership with:
Dr. Steven Garlow, M.D.
Dept. Psychiatry Emory Univerity

Assessment of Epileptic Foci with Indwelling Brain Recording

USC Institute for Creative Technologies

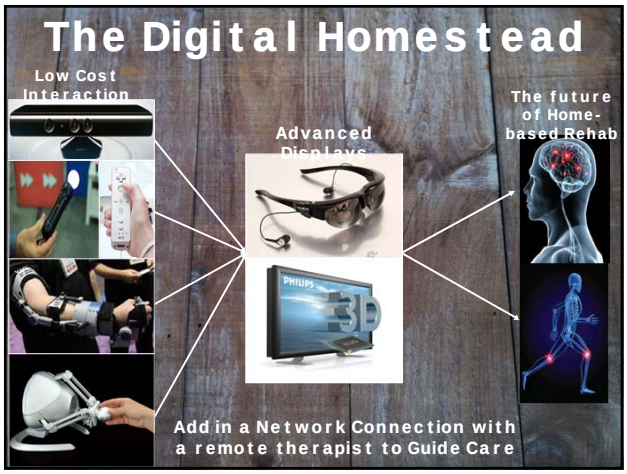
Partnership with:
Dr. Robert Sachdev, M.D.
Dept. Psychiatry Yale Univerity

Advances in Virtual Reality

New Technologies for Childhood Health Conditions

Talk Outline:

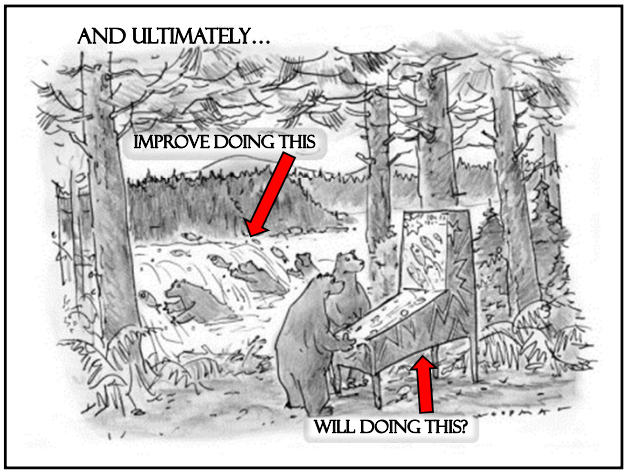
- Introduction to Virtual Reality
- Virtual Reality Applications for:
  - Cognitive/Functional Processes
  - SensoriMotor Interaction
  - Social Interaction
- Conclusions & Questions


The Digital Homestead
Low Cost Interaction
Advanced Displays
The future of Home-based Rehab
Add in a Network Connection with a remote therapist to Guide Care


The Digital Homestead
Low Cost Interaction
Advanced Displays
The future of Home-based Rehab
Or maybe an AI Virtual Agent as a Therapist Guide and Friend


So, Tell me about your mother?
Traditional Approaches


VR Tools are NOT designed to eliminate the need for a Well Trained Clinician
SO, TELL ME ABOUT YOUR MOTHER?
Technology doesn't "fix" anyone, it is simply a tool for extending the skill of a clinician.


AND ULTIMATELY...
IMPROVE DOING THIS
WILL DOING THIS?


ISVR
International Society for Virtual Rehabilitation
www.isvr.org


ISVR
International Society ~ neurological
for special needs ~ visual
Virtual Rehabilitation ~ art
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Welcome to the
International Society for Virtual Rehabilitation
A Society for
Professionals in Virtual and Tele- Rehabilitation
The society provides a multidisciplinary forum for engineers, scientists and clinicians who are interested in employing new technologies for physical, psychological, cognitive, and social rehabilitation applications. The purpose of the society is to facilitate interaction between the communities interested in the field in order to:
promote discussion of key issues
devise a common reference set of terminology/standards/definitions
encourage clarity in research paradigms
create opportunities for collaboration and networking through newsletters, discussion forums, jobs advertising/jobs wanted, general news, member news, project partner finding and more
represent the community with respect to funding, government policies, consumer groups and other bodies
provide recognition through awards for exceptional member activities
Nomination Call
October 2011
NOMINATIONS ARE NOW OPEN
Sponsored Conferences
International Conference Series on Disability, Virtual Reality & Associated Technologies
International Conference on Virtual Rehabilitation
International Conference Series on Virtual Rehabilitation


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Since 1992, this conference has brought together developers and end-users who are committed to progress in


International Conference Series on
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An International Society for Virtual Rehabilitation Sponsored Conference
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DEADLINE FOR FULL PAPER SUBMISSION will be 28 Feb, 2014
DEADLINE FOR SHORT PAPER SUBMISSION will be 31 May, 2014


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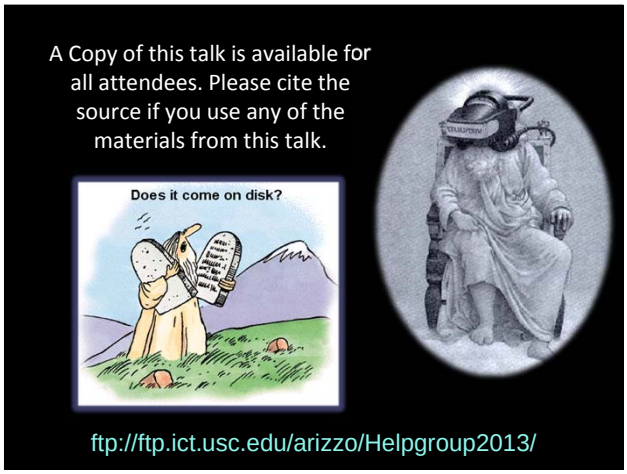
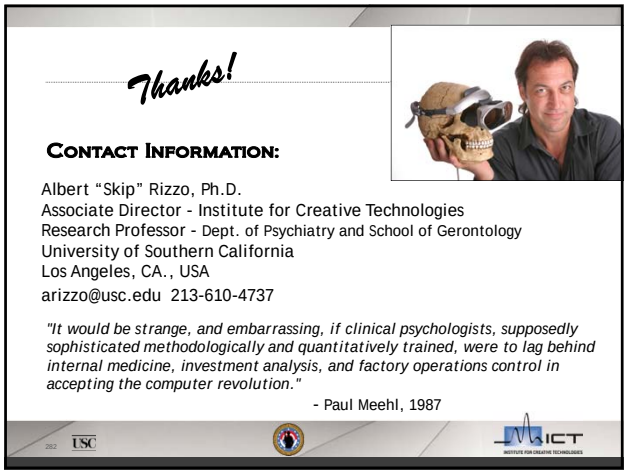
New APA Division Forming
Please sign our petition!
http://stp-apa.net/
"It would be strange, and embarrassing, if clinical psychologists, supposedly sophisticated methodologically and quantitatively trained, were to lag behind internal medicine, investment analysis, and factory operations control in accepting the computer revolution."
- Paul Meehl, 1987
American
Psychological
Association


A Copy of this talk is available for all attendees. Please cite the source if you use any of the materials from this talk.
Does it come on disk?
ftp://ftp.ict.usc.edu/arizzo/Helpgroup2013/


Thanks!
Contact Information:
Albert "Skip" Rizzo, Ph.D.
Associate Director - Institute for Creative Technologies
Research Professor - Dept. of Psychiatry and School of Gerontology
University of Southern California
Los Angeles, CA., USA
arizzo@usc.edu 213-610-4737
"It would be strange, and embarrassing, if clinical psychologists, supposedly sophisticated methodologically and quantitatively trained, were to lag behind internal medicine, investment analysis, and factory operations control in accepting the computer revolution."
- Paul Meehl, 1987
USC
ICT

Questions?

"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

The End (for now)

"No, this is the afterlife. Cyberspace is over there."

"It would be strange, and embarrassing, if clinical psychologists, supposedly sophisticated methodologically and quantitatively trained, were to lag behind internal medicine, investment analysis, and factory operations control in accepting the computer revolution."

- Paul Meehl, 1987

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