A Review and SWOT Analysis of the Field of Virtual Rehabilitation

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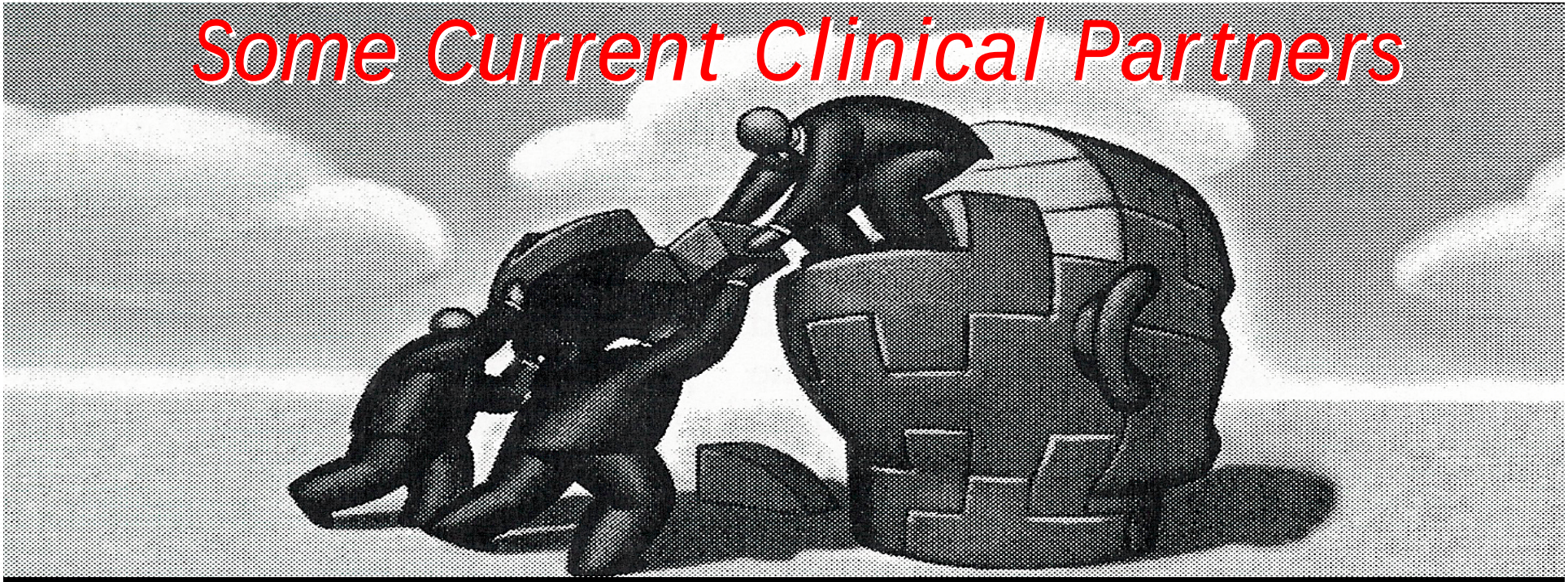
Course Outline Slide

- Introduction to VR and a SWOT Analysis of the Field of Virtual Rehabilitation – *Rizzo*
- Strengths for the Use of VR in Rehabilitation and Therapy – *Rizzo*
- Overview of Research on the Use of VR in Rehabilitation and Therapy – *Weiss*
- Weaknesses, Opportunities and Threats for the Use of VR in Rehabilitation and Therapy – *Rizzo*
- Demonstrations

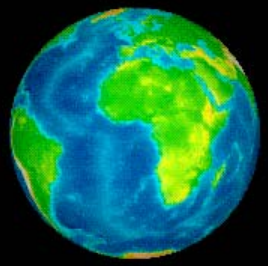
USC Collaborators

- Institute for Creative Technologies
  - Pair, Gratch, Marsala, Hill, Swartout, Morie
- Integrated Media Systems Center
  - Shahabi, Cohen, Sawchuck, Yeh, Ghahremani, LaCour
- Annenberg School for Communication/Journalism
  - McLaughlin, Pryor
- School of Biokinesiology and Physical Therapy
  - Winstein, Gordon, Schweighofer
- Children's Hospital Los Angeles
  - Gold, Katz, Reger, Kim
- School of Gerontology, Neurology
  - Chui
- Dept of Cell and Neurobiology
  - McNeill
- Dept of Computer Science
  - Arbib

Some Current Clinical Partners



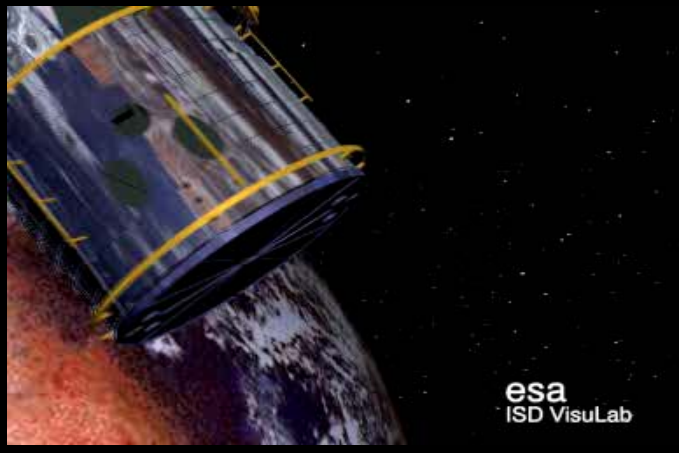
- Kessler Medical Rehab Center – Adult TBI, Stoke, MS, Attention/Memory
- University of Haifa – OT/PT applications for TBI and Spinal Cord Injury
- Virtually Better - PTSD
- VR Medical Center – ADHD, PTSD
- University of Victoria – Attention Training
- LA Children's Hospital – Pain Distraction
- St. John's University – Anger Management
- St. Anslem's College – VR EDLab research
- Baylor University – ADHD Standardization
- Utah Neurodevelopment Center – Pediatric TBI, Attention processes
- Virginia Tech – Childhood Anxiety Disorders



General Introduction

Virtual Reality Applications…

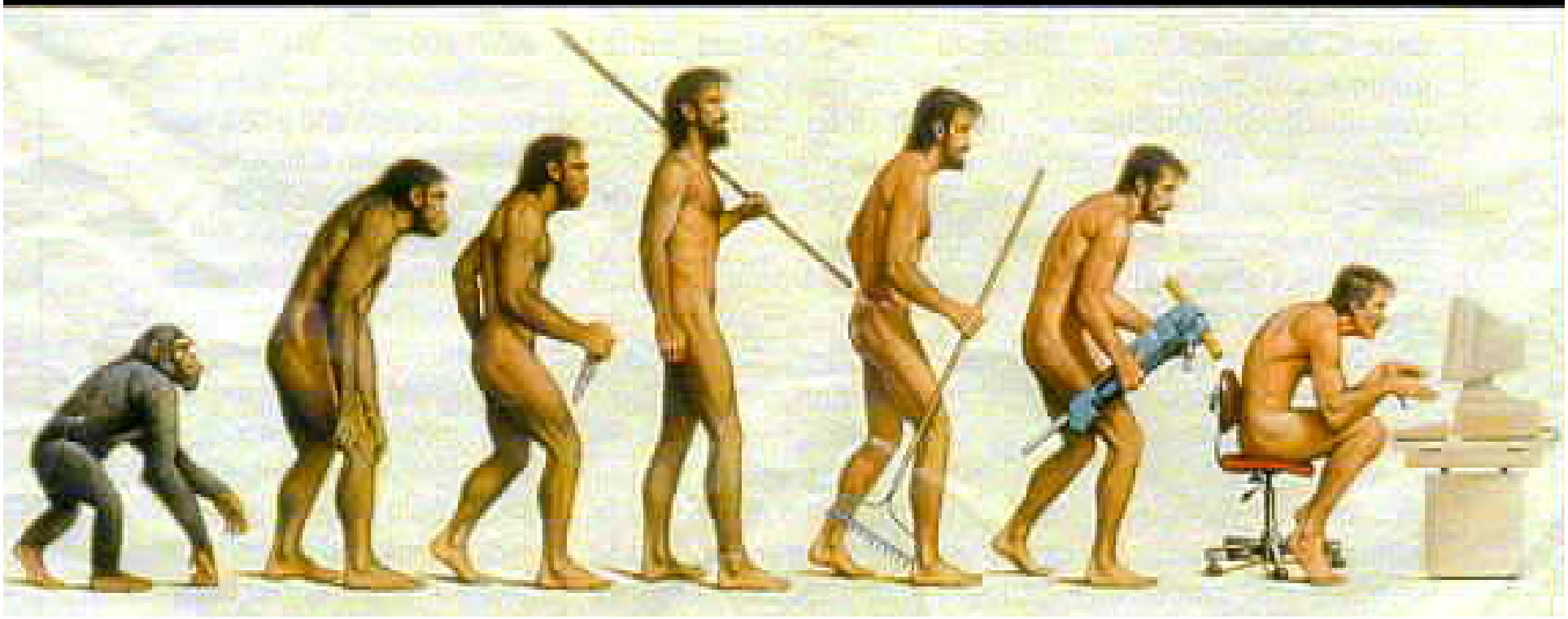
- Medicine - Surgical training
- NASA Space Program - Hubble repair
- Military - Terrain and Battlefield Sim.
- *Physical, Speech & Occupational Therapy*
- *Mental Health - Phobia, Pain, PTSD, Substance Abuse*
- *Neuropsychology - Assessment and Rehabilitation of Cognitive & Functional Behavior*
- Training – Equipment Operation
- Education – Virtual Science
- Entertainment – Digital Gaming



Virtual Reality Definition

"…a way for humans to, interact with computers and visualize 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 (2005)

To Test and Train
Piloting Ability

To Assess, Treat and
Rehabilitate Cognitive,
Behavioral & Motoric Processes

=

1st Link Aviation
Simulator (1929)

Virtual Reality (2005)

Types of Virtual Realities

Flatscreen VR
Gaming Applications

Multiple Flatscreens

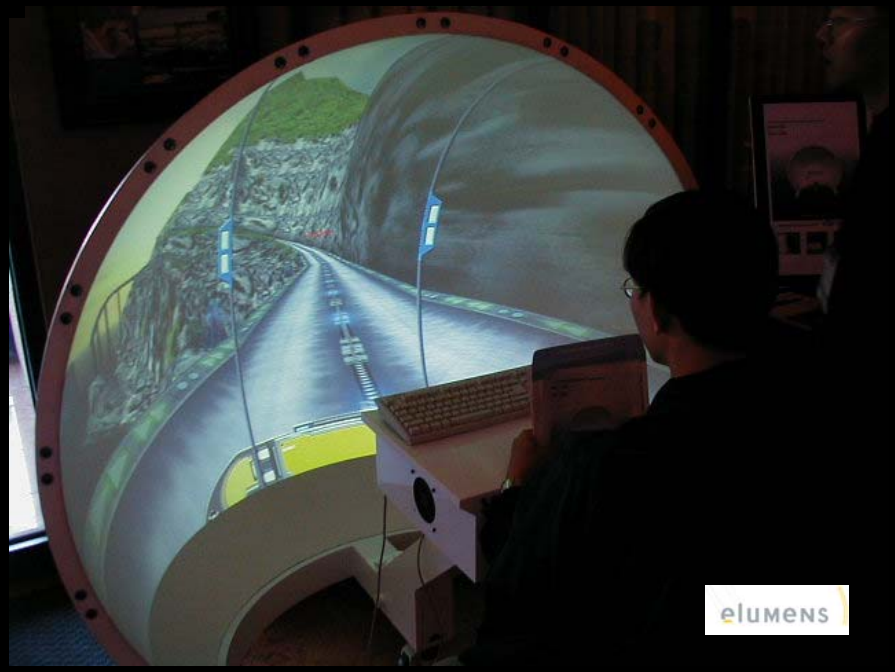
Panoram Tech 3-Screen Desktop

Veridian System

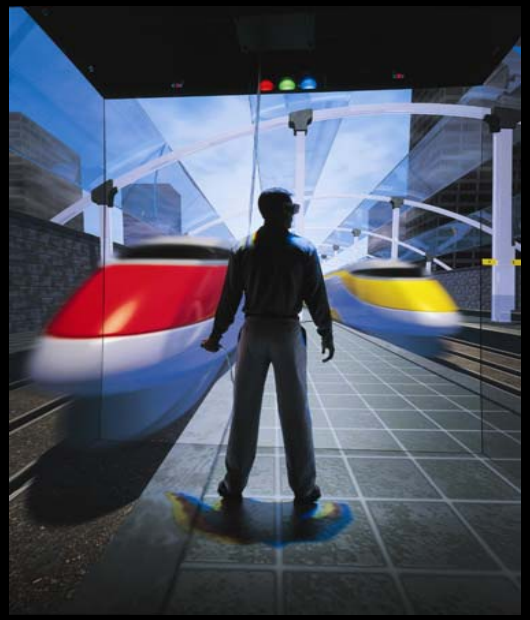
Auto-stereoscopic 3-D Display(courtesy of Dimension Technologies Co.)

Virtual Window 3-D Display (courtesy of Virtual Research Co.)

FloStation

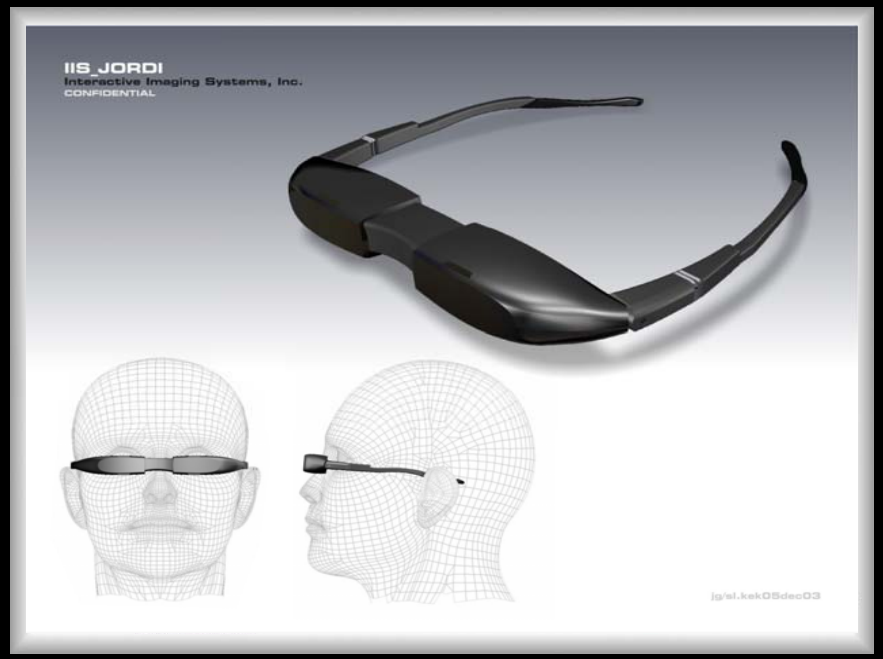


The ImmersaDesk



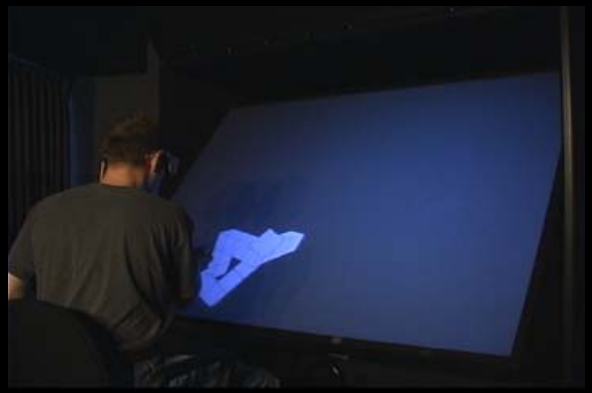
CAVE 3-D large volume display (Fakespace Co.)

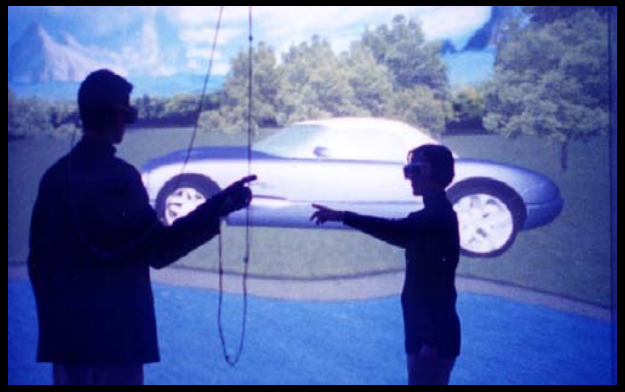
Head Mounted Displays (HMD)…



KEY ELEMENTS

- Immersion
- Interactivity





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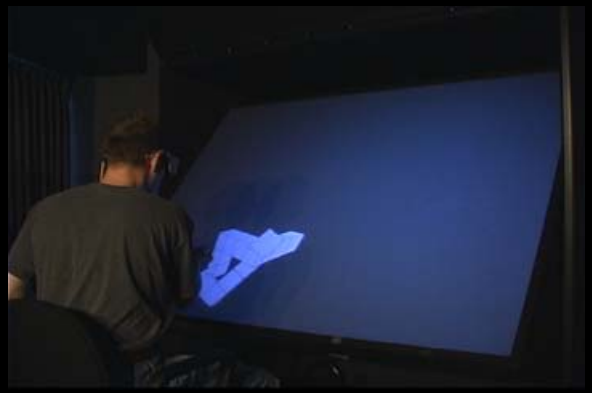

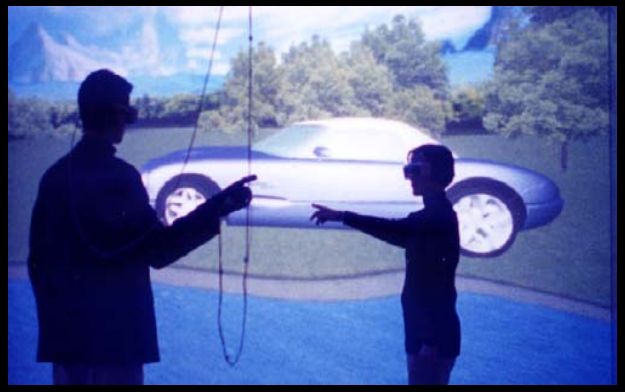

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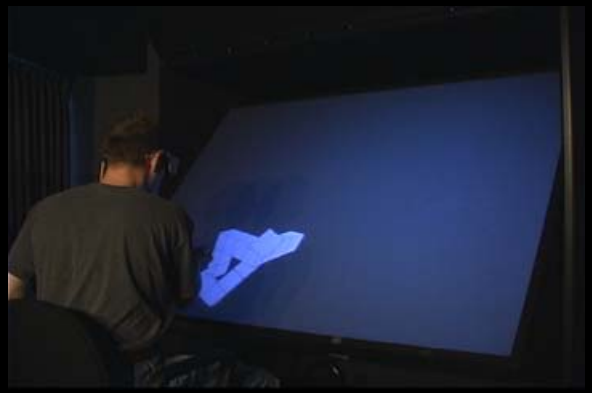

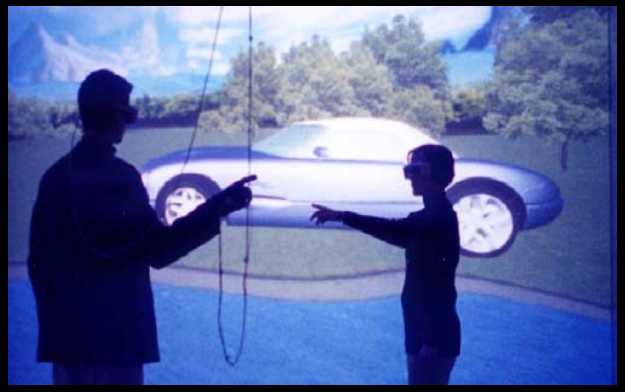

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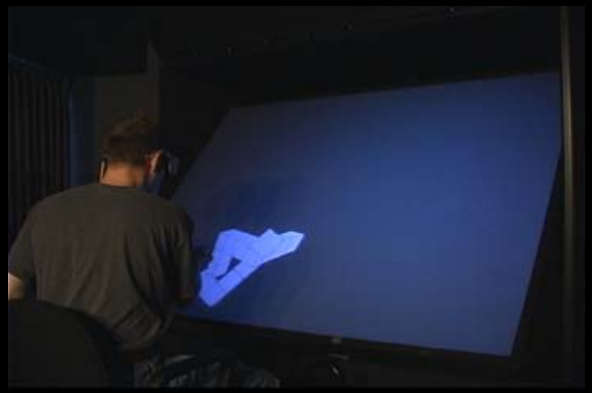
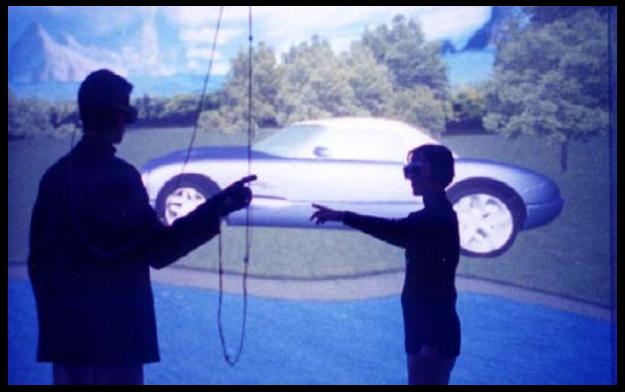
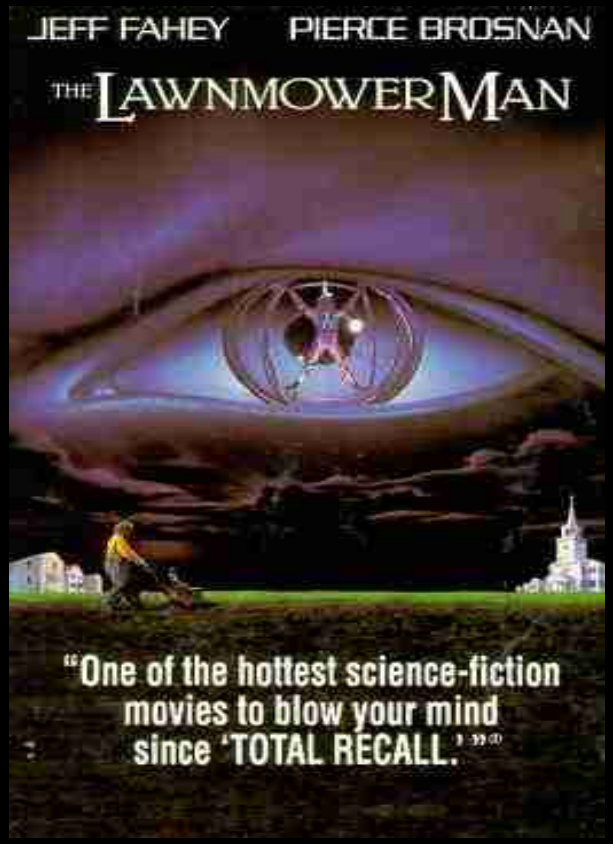




Typical comments made by people when hearing about Virtual Rehabilitation Approaches…

- Visionary!
- Too Expensive!
- Just what the field needs!
- What about the therapist's role?
- Where's da Science?
- Like the Holodeck??
- Need better interfaces.
- Hmm…interesting…
- Can they really do that?
- How is it any better than what we already do?
- Lawnmower Man???

Typical comments made by people when hearing about Virtual Rehabilitation Approaches…



- Lawnmower Man???

Typical comments made by people when hearing about Virtual Rehabilitation Approaches…

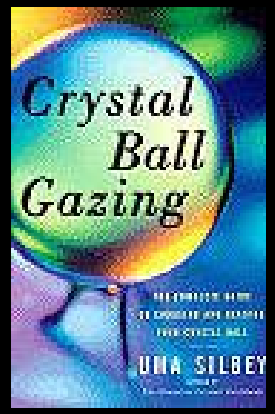
…And now the Matrix!!!

The Issues that these comments reflect:

- Faith in Technology to solve problems
- Fear & Distrust of Technology
- Economics
- Frustration with existing tools
- Popular media influences
- Scientific and pragmatic questions
- Curiosity
- Healthy Skepticism

So what do we use to consider these and the many other issues that are relevant to advancing the field into the future?

One Method:



“We are on the threshold of the Age of Magic”

Fruchterman

"This will represent the greatest event in human evolution. For the first time, mankind will be able to deny reality and substitute its own preferred version."

J.G.Ballard

"Virtual Reality won't merely replace TV. It will eat it alive."

Arthur C. Clarke

“I am in Cyberspace, a universe churned up from computer code, then fed into my eyes by a set of goggles through whose twin video screens I see this new world. All that remains of my corporeal self is a glowing, golden hand floating before me like Macbeth’s dagger. I point my finger and drift down its length to the bookshelf on the office wall…”

Barlow

New Electronic Glove Will Let You Move Robot Hand Like It's Your Own — From Miles Away!

An astonishing new electronic glove will allow us to control powerful robots many miles away with incredible precision — even when they're in outer space or on an ocean floor.

— And You'll Even Be Able to Feel Things The Robot Picked Up

The glove is worn on your hand, and every movement of that hand is picked up by tiny sensors in the glove — which send electronic signals to the robot commanding its hand to duplicate the movements.

The robot also sends signals back to the glove that create the impression of touch — letting the glove wearer actually "feel" how much pressure he's exerting on any object in the robot's hand! A TV hookup lets the human operator see what the robot is working on.

The device is called the "DataGlove," and experts told The ENQUIRER that used in conjunction with a robot it will be able to perform such mind-boggling tasks as:

- Scooping up delicate objects from the bottom of the sea while the operator sits safe on dry land many miles away.
- Cleaning up after a nuclear disaster without endangering human lives.
- Repairing satellites in outer space without leaving Earth.
- Magnifying a person's strength and power to superhuman proportions by permitting him to control a powerful robot.
- Allowing a doctor to perform specialized surgery while he's miles away from the patient — even while he's in an airplane!
- Rescuing people trapped in a raging fire.
- Allowing a government agent to carry out dangerous espionage missions — such as breaking into fortified enemy headquarters and taking files — without any risk to his life.

The "DataGlove" is already being used experimentally in two U.S. laboratories. And it could have practical applications such as controlling robots within only three to five years, says Dr. John Beidler, professor of mathematics and computer science at the University of Scranton, Pa.

In the same short span of time, the glove also will revolutionize the way we interact with computers by letting us manipulate onscreen images as if they were real!

In this application which has already been successfully done in the lab — the glove's sensors also pick up every movement of the hand and send command signals to the onscreen image.

When the user is working with a computer, he simply imagines himself holding any object that the onscreen hand is holding — such as a wrench or screwdriver — and then simply moves his gloved hand to manipulate the tool onscreen.

The "DataGlove" allows a scientist to design and work on a new invention — such as a revolutionary type of engine — on the computer without having to physically build it, says John Grimaud, president of VPL Research Inc., developers of the device.

The glove — an application of a new science called "artificial reality" — is best understood as a sophisticated type of remote control, said Dr. John King, chairman of computer science at the University of California-Irvine.

It sounds like science-fiction fantasy — but according to Dr. Beidler, it's possible that after the year 2000 we'll even see a "Data Bodyglove" which will allow a human to totally interact with a robot or computer!

— ED SUSMAN

AMAZING: Using the electronic glove (left) enables a person to "pick up" a computer-generated image (right) with a computerized replica of his hand.

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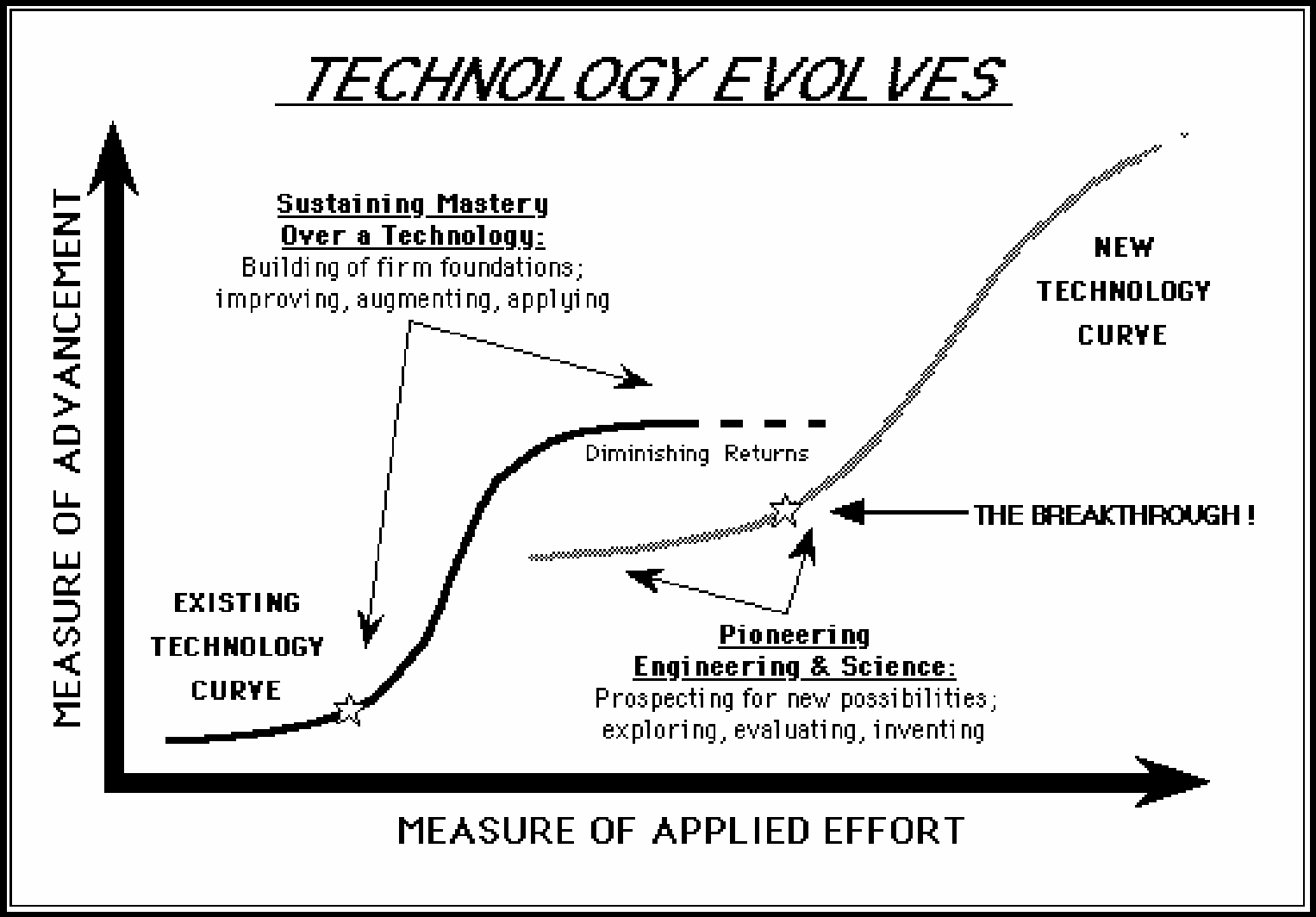
"Virtual reality arrives at a moment when computer technology in general is moving from automating the paradigms of the past to creating new ones for the future"
(Krueger, 1993 - *Presence*)

From an Engineering Innovation Perspective…



An Adoption of Technology Curve
for Instructional Technology

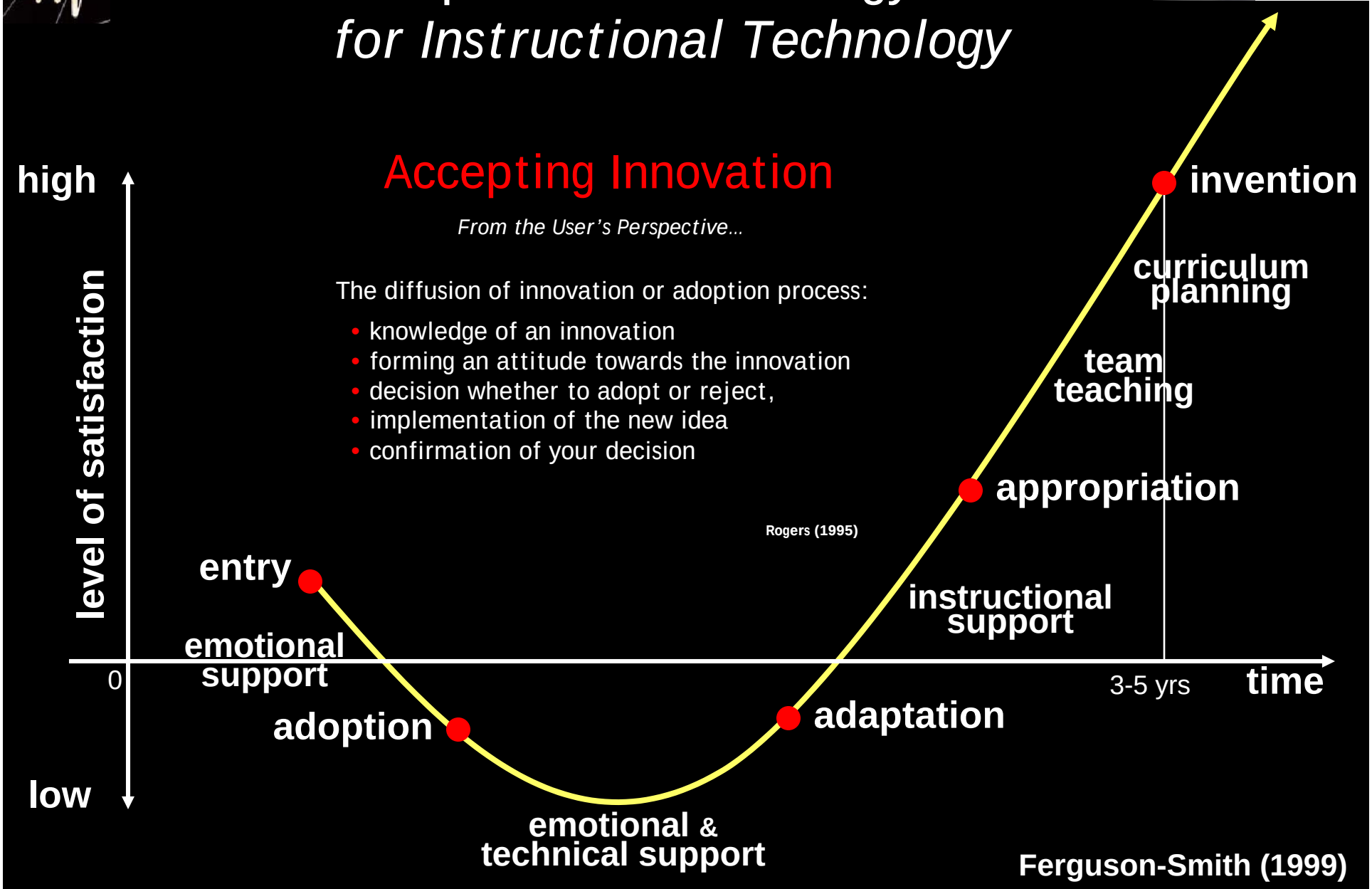
Accepting Innovation

From the User's Perspective…

The diffusion of innovation or adoption process:

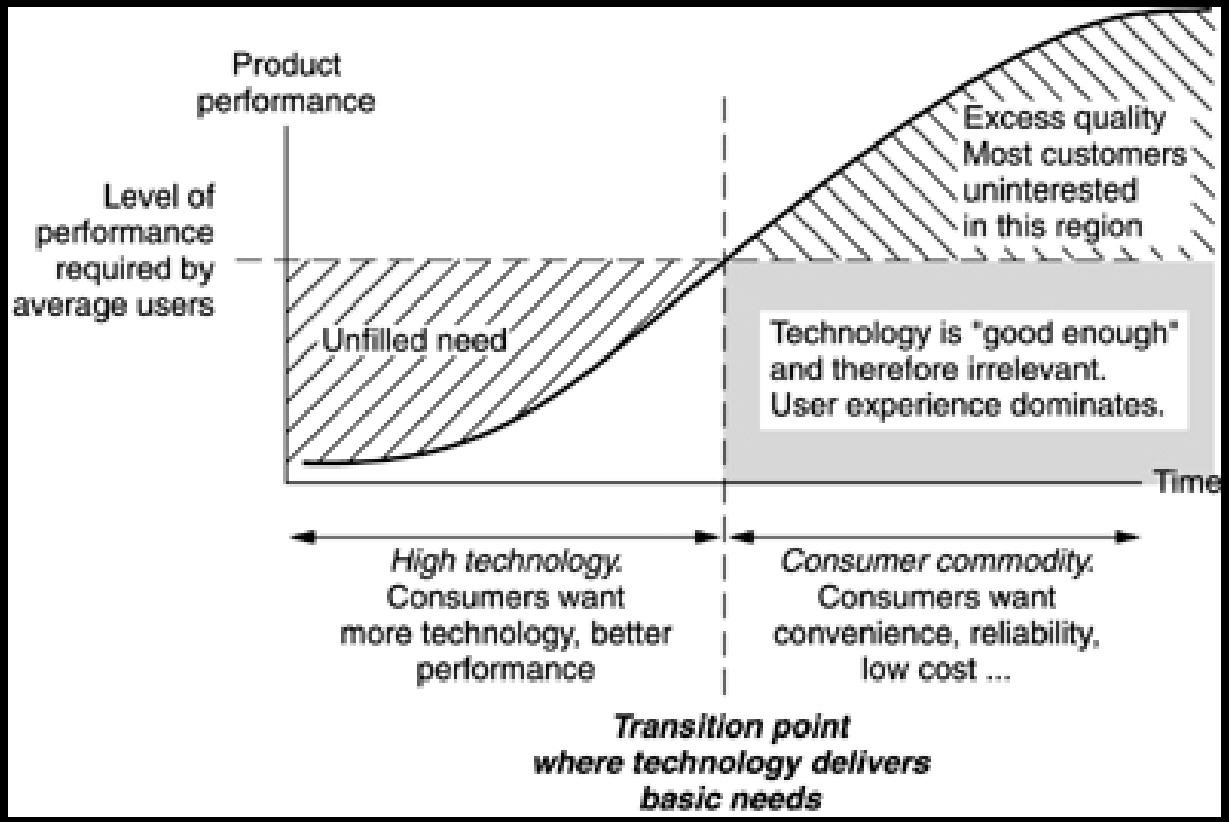
- knowledge of an innovation
- forming an attitude towards the innovation
- decision whether to adopt or reject,
- implementation of the new idea
- confirmation of your decision

Rogers (1995)



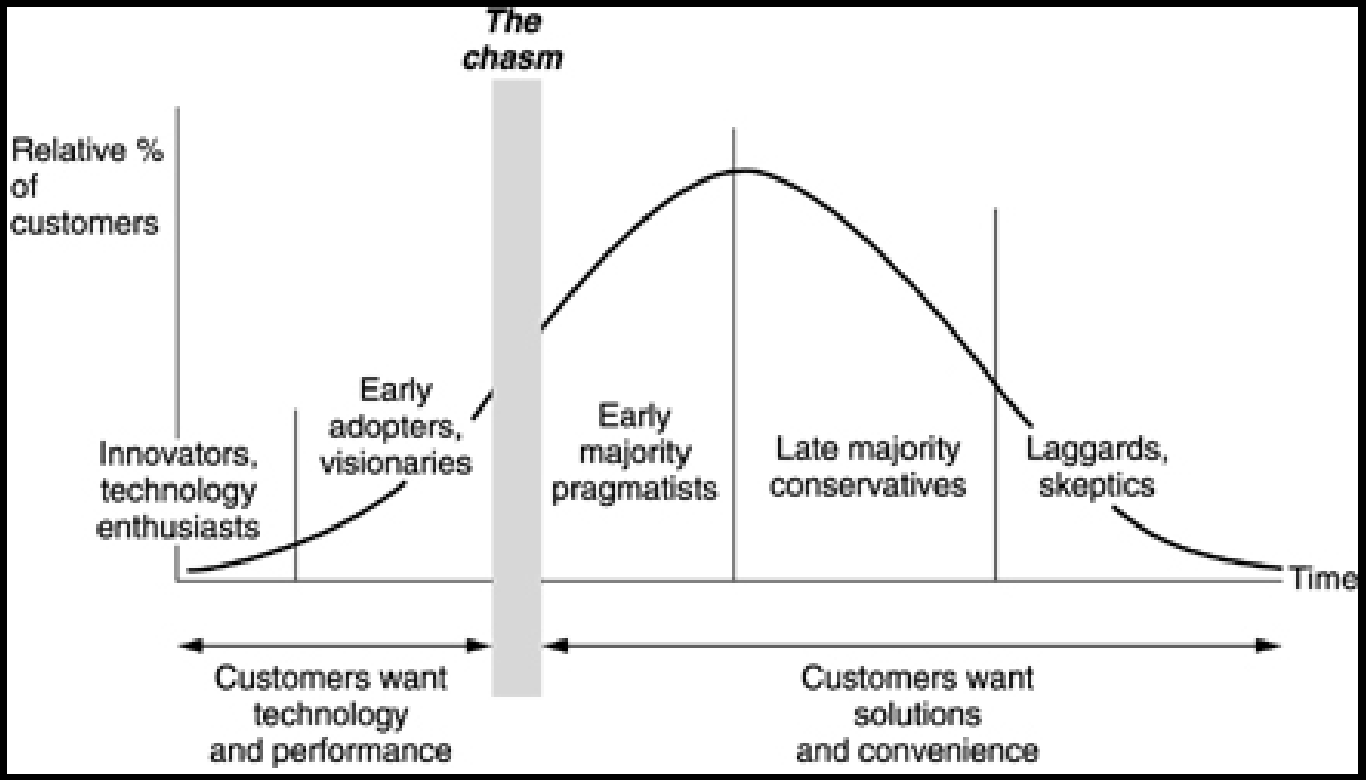
Ferguson-Smith (1999)

From the User's perspective…



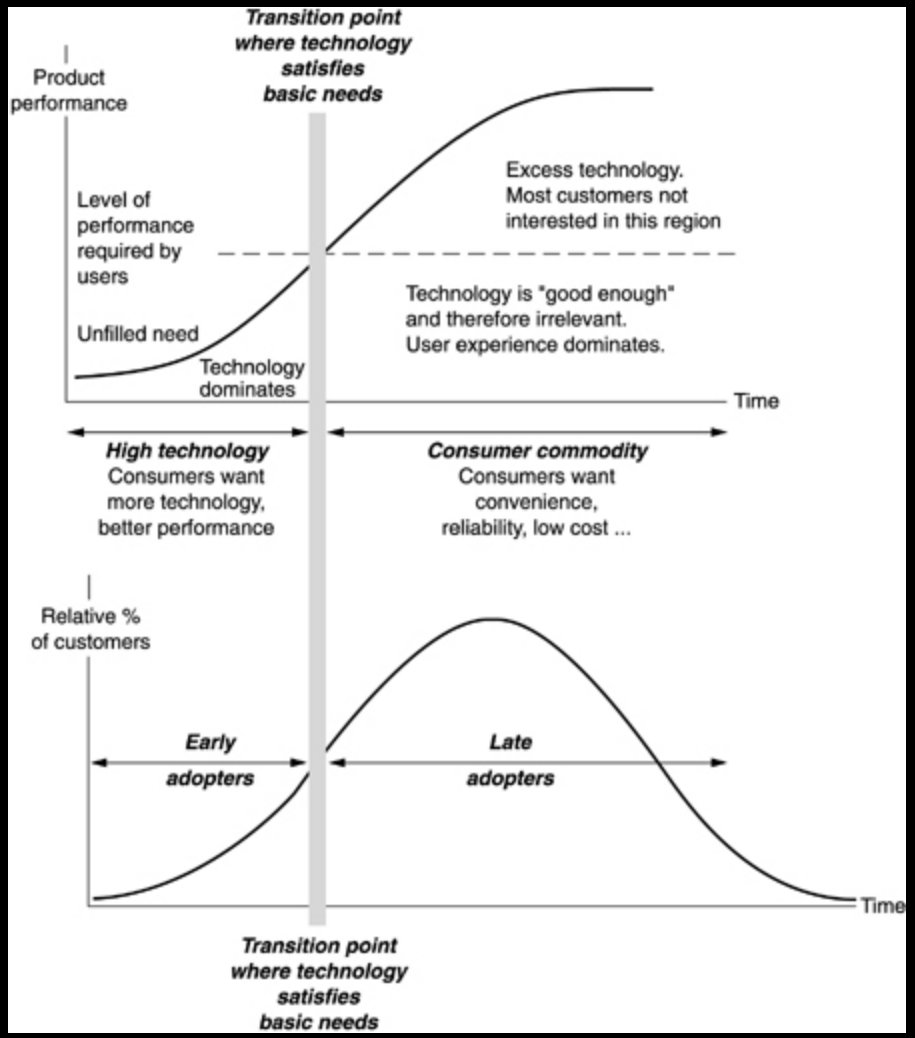
Don Norman, 2001

From the User's perspective…



Don Norman, 2001

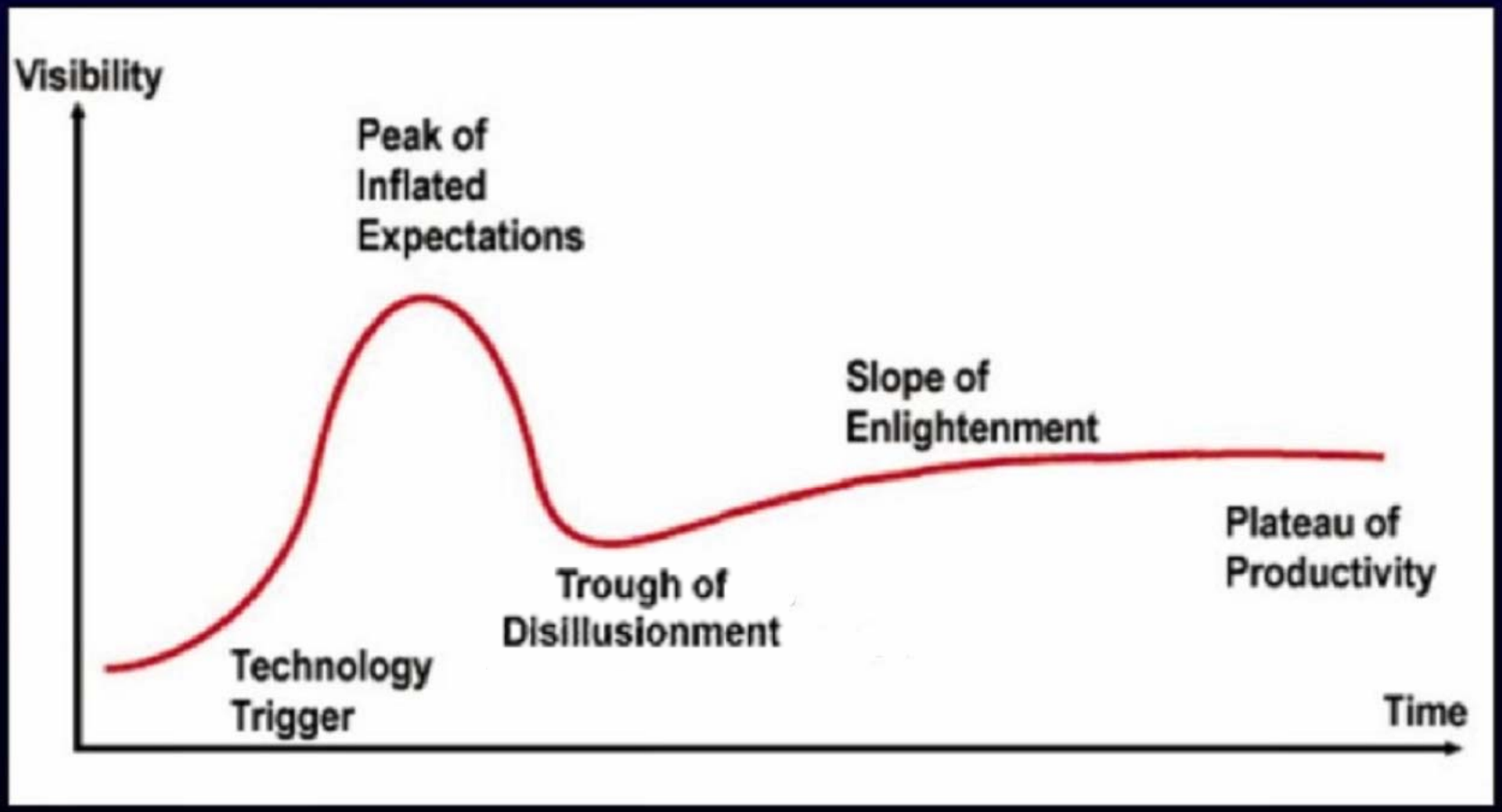
From the User's perspective…



Don Norman, 2001

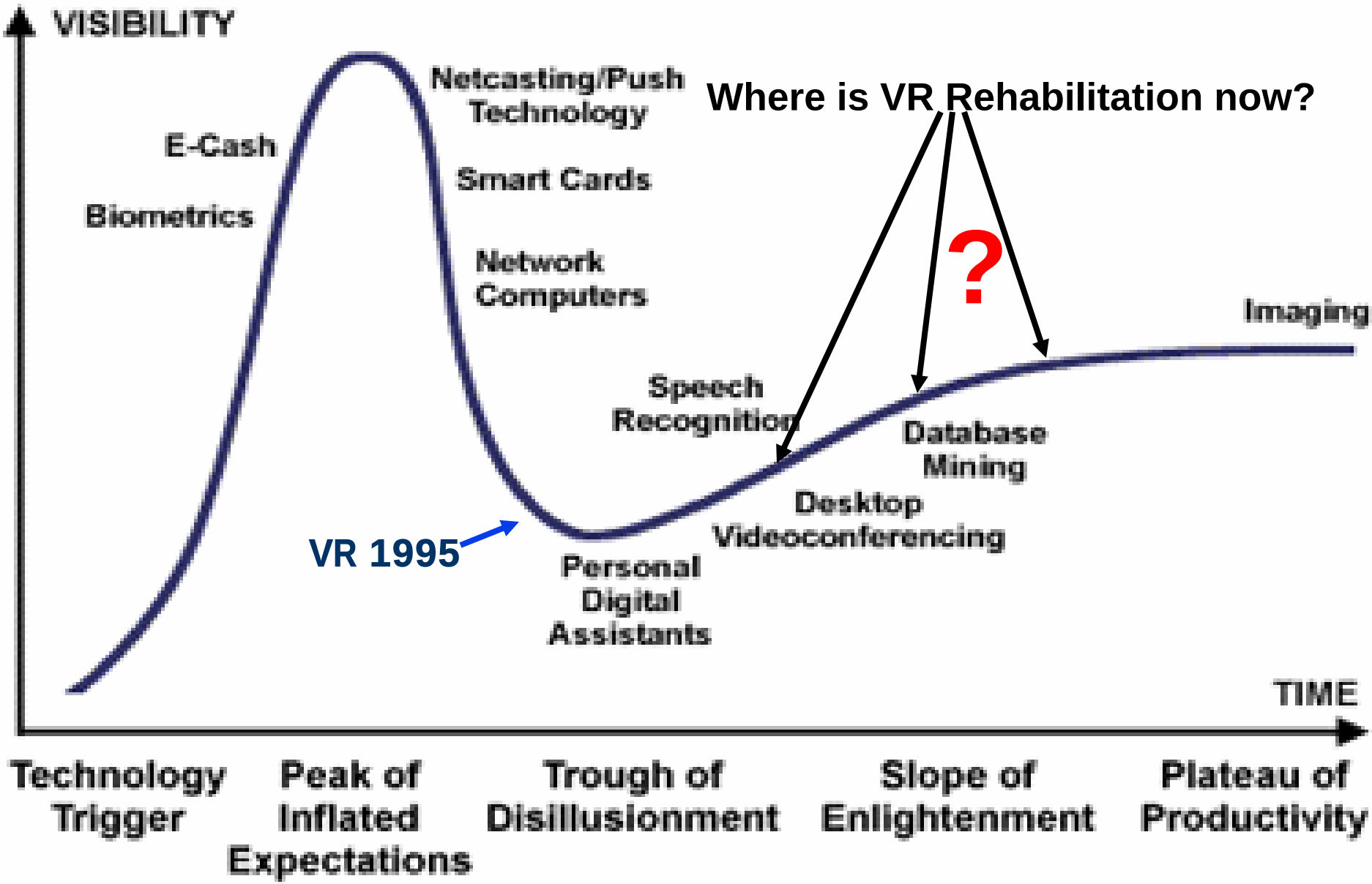
From a Business perspective:

The Gartner Group's "Cycle of Hype"



Source: Gartner Group

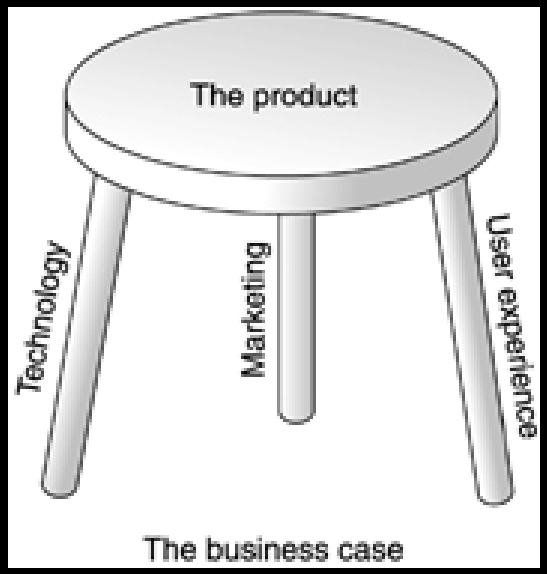
Hype Cycle of Emerging Technology - 1998



Source: GartnerGroup

From a Business perspective:

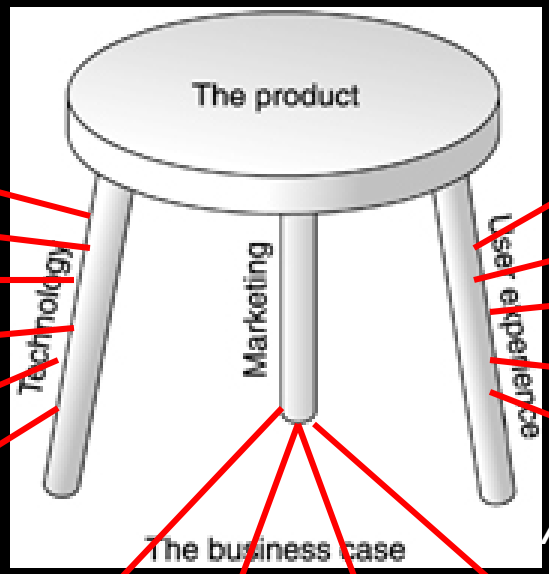
Technology moving to the Marketplace



The three legs of product development in the mature, customer-centered phase of a product. When the technology matures, customers seek convenience, high-quality experience, low cost, and reliable technology. A successful product sits on the foundation of a solid business case with three supporting legs: technology, marketing, and user experience. Weaken the foundation or any of the legs and the product fails.

Don Norman, 2000

It is going to take more than three legs for the VR/Rehab stool to stand firm!



Displays

Interfaces

Usable Software

Data Analysis

Platform Compatibility

And a buncha other stuff too!

Comfort/Ease of use

Preference

Side Effects

Real world gains

And a buncha other stuff too!

And a buncha other stuff too!

Cost/Benefit Proofs

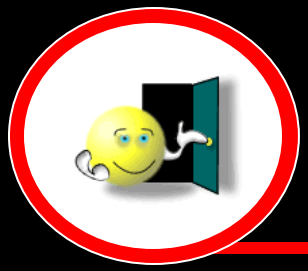
Usability

Expectations and impressions

SWOT

Strengths

Weaknesses



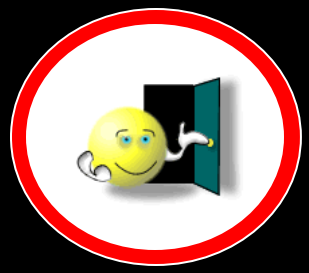
Opportunities

Threats

SWOT

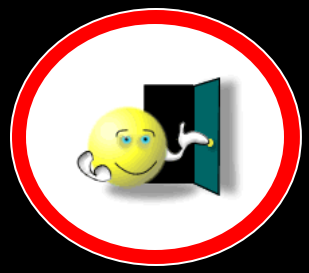
A commonly employed framework in the business world for analyzing the factors that influence a company's competitive position in the marketplace with an eye to the future.

Success Story: *Dell Computers – SWOT Analysis lead to strategic decisions to implement mass customization, just-in-time manufacturing and direct internet sales.*



SWOT

In a nutshell: *A tool for developing strategies to take advantage of an entity's opportunities by employing its strengths and by proactively addressing threats, by becoming aware of and correcting and compensating for weaknesses.*



VR/Rehab Strengths

- Ecological validity
- Stimulus control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for "errorless learning"
- Real time performance feedback
- Self-guided exploration and independent practice
- Stimulus and response modification contingent on user's impairments
- Complete naturalistic performance record
- 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

Weaknesses

- "Perceived" and Actual Costs
- "Perceived" and Actual Complexity
- Platform Compatibility
- Wires!
- The Interface Challenge
- Display Hardware
- Side Effects
- Front End Flexibility
- Back End Data Extraction, Management, Analysis, Visualization

Opportunities

- Processing Power/Graphics/Video Integration
- Academic and Professional Acceptance
- Well-Matched VR Rehab apps also have widespread intuitive Appeal to the public
- Close Knit VR Community
- Gaming and Entertainment Industry Drivers
- Game-Based Educational Drivers
- Vision-Based Tracking
- Integration with Imaging and Psychophysiological Approaches
- TeleRehabilitation
- Virtual Humans
- The Psychological Corporation!

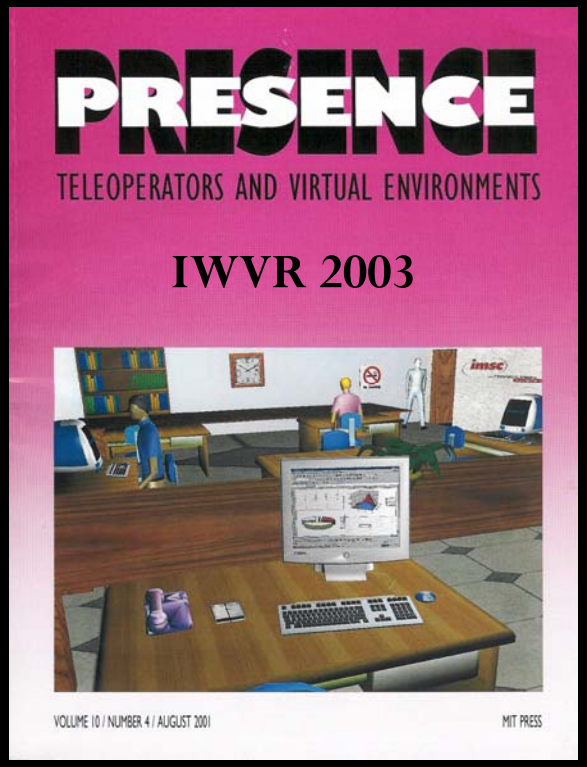
Threats

- No Moore's Law Operating in the area of HMDs and other quality peripherals
- Need Cost/Benefit Proofs!
- Aftereffects Lawsuit Potential
- Ethical Challenges
- The Perception that VR Tools will eliminate the need for the Therapist
- Limited Awareness/Unrealistic Expectations

"A SWOT Analysis of the Field of Virtual Rehabilitation and Therapy"

Full article in:

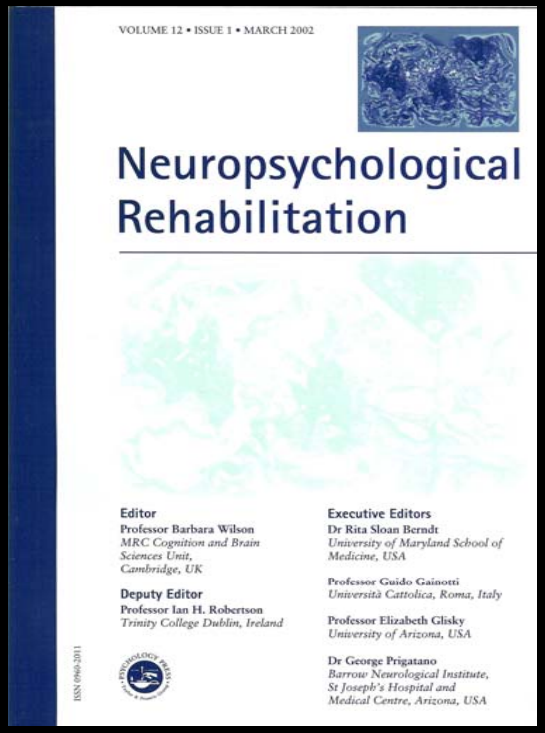
March 2005 Issue of:
Presence: Teleoperators and Virtual Environments



Special Issue with Papers from the International Workshop on Virtual Rehabilitation (IWVR) : March 2005

"Analysis of Assets for Virtual Reality Applications in Neuropsychology"

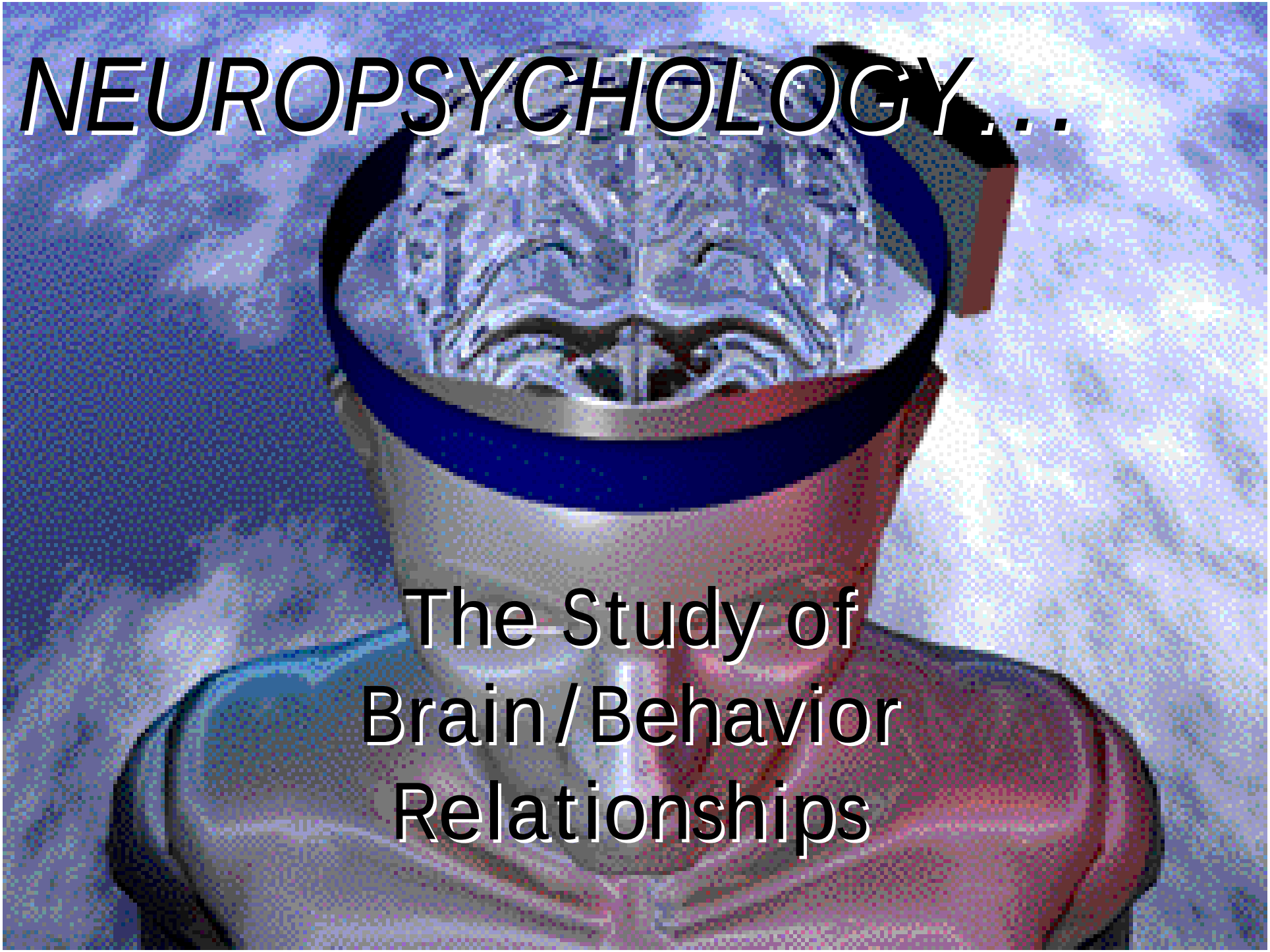
Albert A. Rizzo, Maria Schultheis, Kimberly A. Kerns, and Catherine Mateer



In: *Neuropsychological Rehabilitation*

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

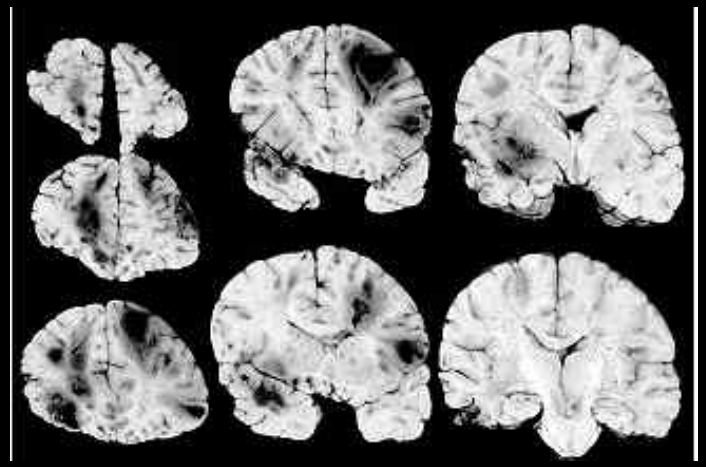
But First…


NEUROPSYCHOLOGY…
The Study of
Brain/Behavior
Relationships

Neuropsychological Purposes

- Neuropsychological Assessment

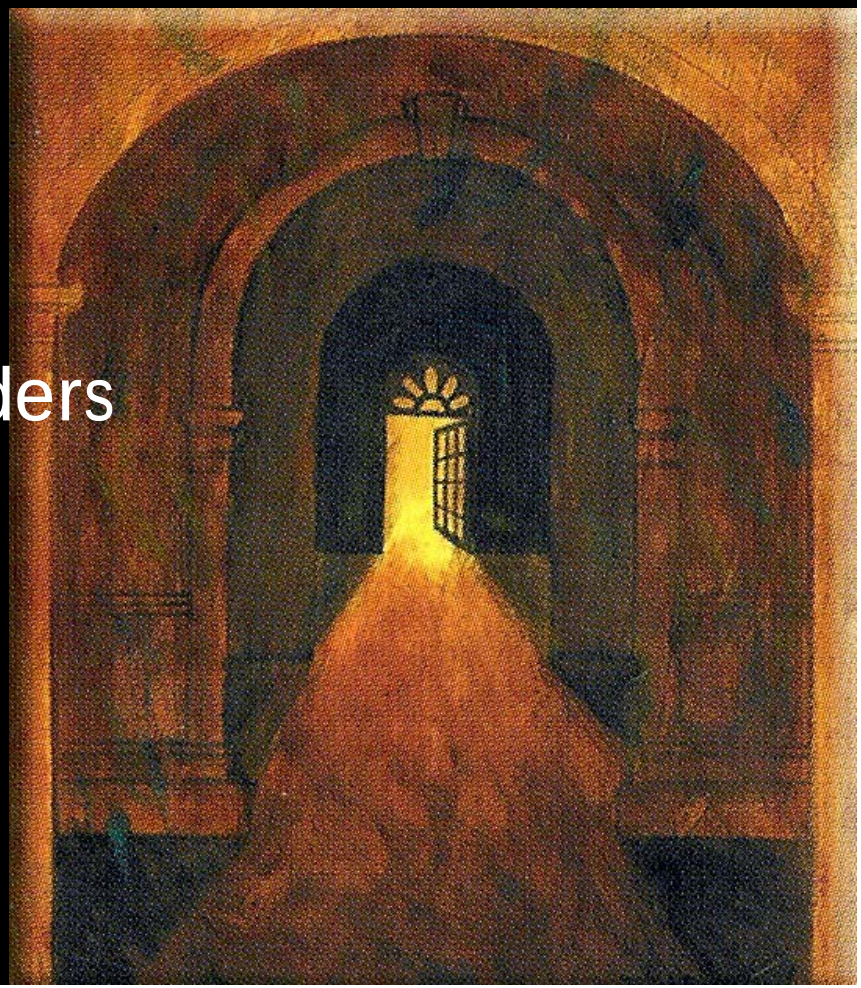
- Cognitive Rehabilitation



- Scientific study of cognitive & functional processes

Clinical Populations

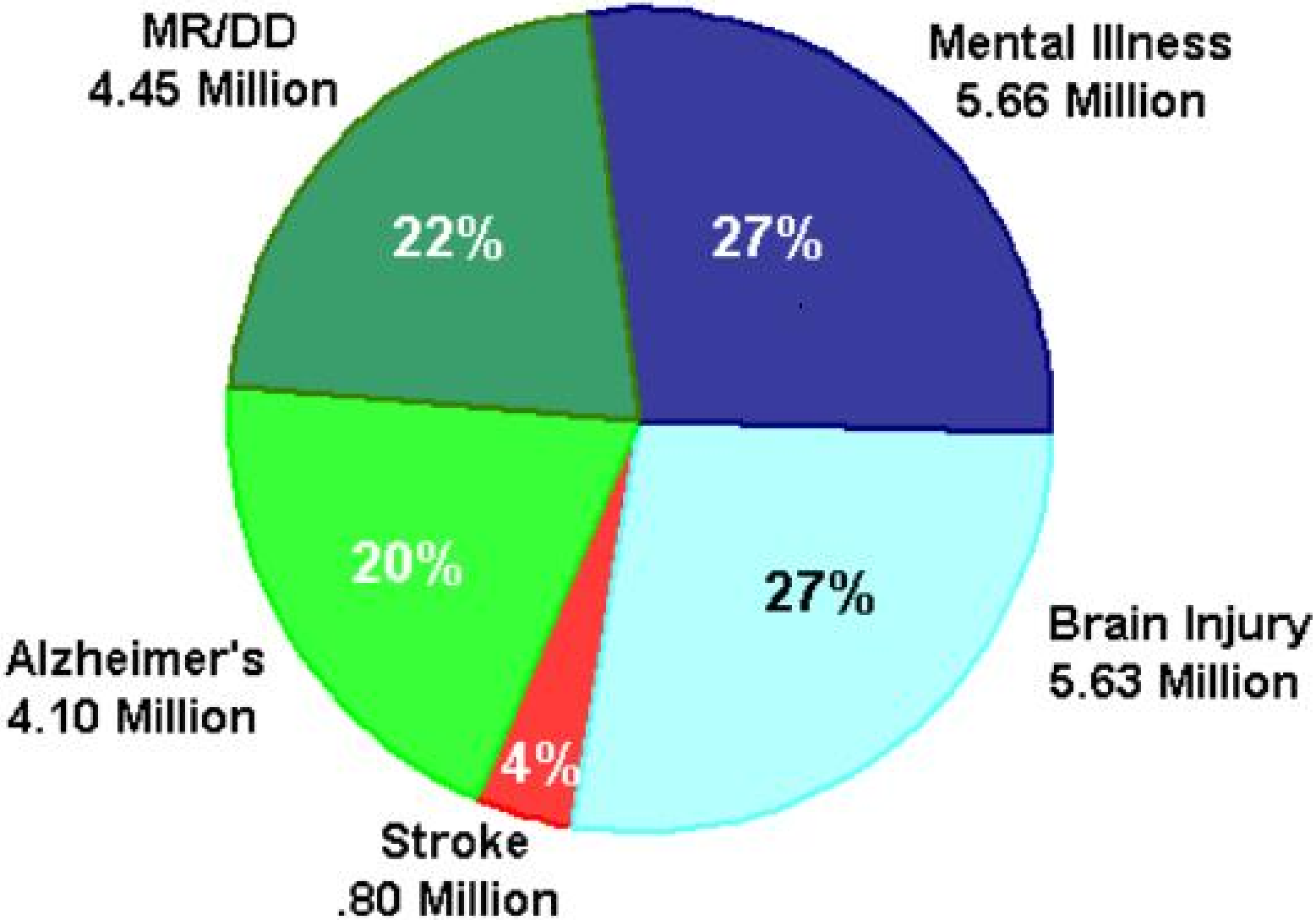
- Learning and Developmental Disabilities
- Traumatic Brain Injury
- Neurological Disorders
  - Alzheimer's disease
  - Stroke & Vascular Disorders
  - Brain Tumors
  - Multiple Sclerosis
  - Parkinson's
  - etc., etc., etc.



Clinical Populations

- Traumatic brain injury (TBI) - one every 15 seconds, 1 million new cases per year, many with lasting disabilities.
- Currently, as many as 4 million Americans have Alzheimer's disease. Many more as the "baby boomers" age!
- Attention deficit disorders - 5% of all USA children diagnosed.
- Developmental/learning disorders - 3% of population.

COGNITIVE DISABILITY IN THE UNITED STATES



Total: 20.64 Million Persons

Do we need to update our Neuropsychological tools?

Which item does not belong with the others?

- Black and white television
- Vinyl records
- Rotary-dial telephones
- The UNIVAC computer
- Currently used standardized intelligence and ability tests.

From: *Former APA President, Robert Sternberg, 1998*

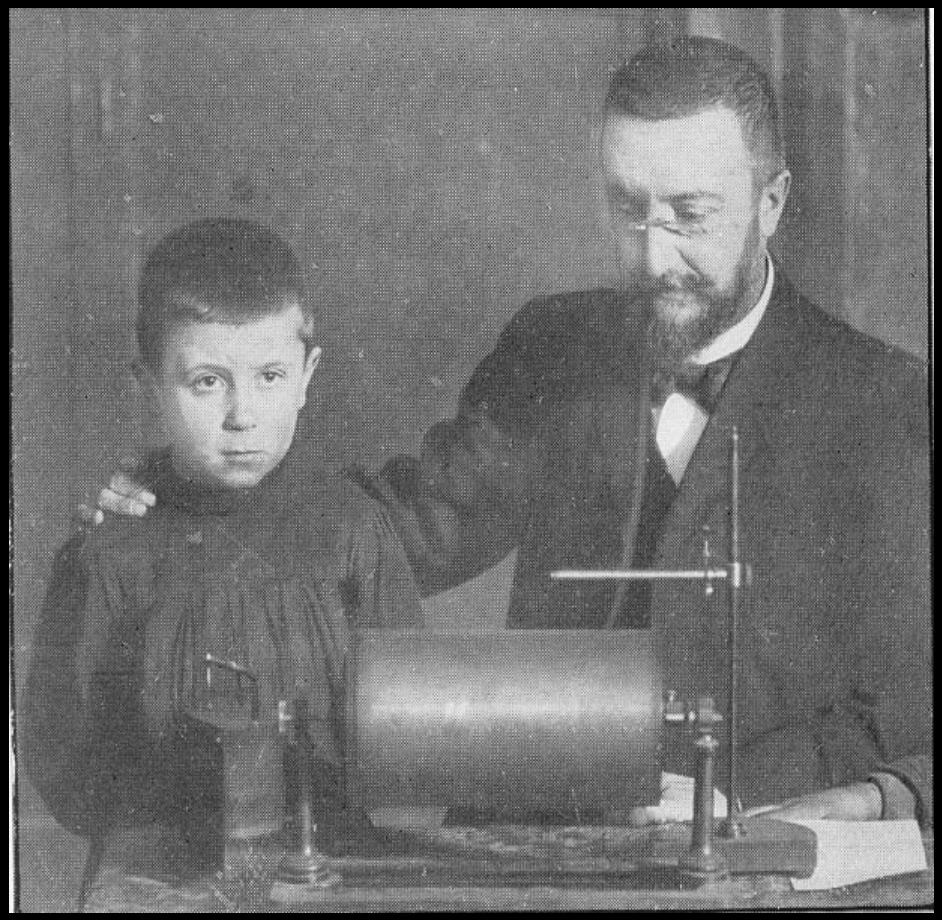
Which item does not belong with the others?

- Black and white television
- Vinyl records
- Rotary-dial telephones
- The UNIVAC computer
- Currently used standardized intelligence and ability tests.

From: *Former APA President, Robert Sternberg, 1998*

Traditional Tools for Neuropsychological Assessment

Alfred Binet



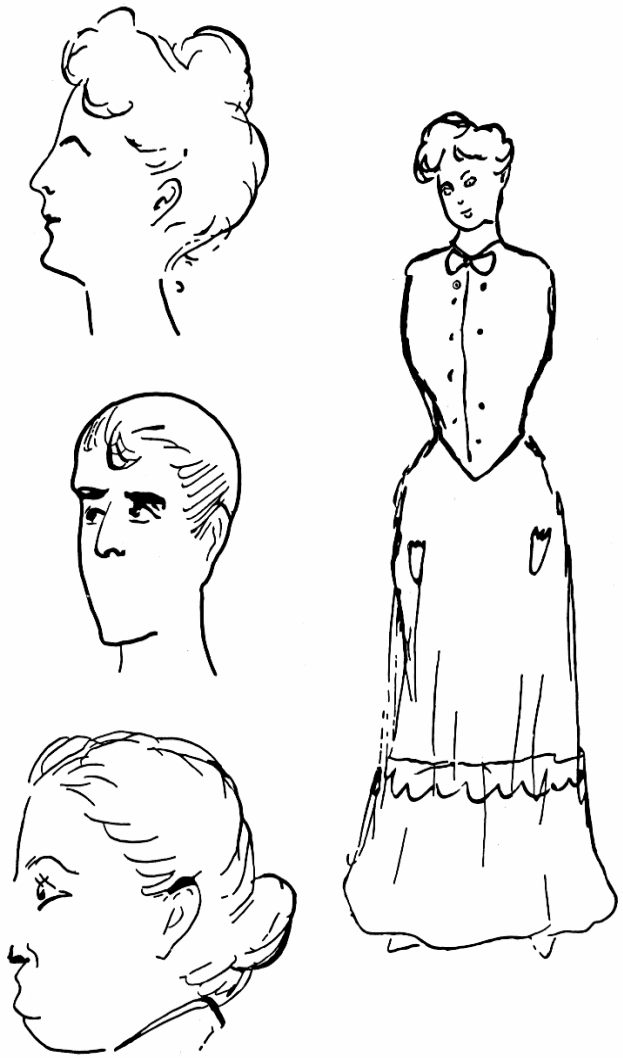
From: *L'Annèe Psychologique* **(1912).**

Reply to an abstract question (1905)

- “When one is sleepy, what must one do?”
- “When one has been struck by a playmate who did not mean to do it, what must one do?
- “Why must we judge a person by his acts, rather than his words?”

Now the “Comprehension” subtest of the Wechsler tests (WAIS, WISC, etc.)

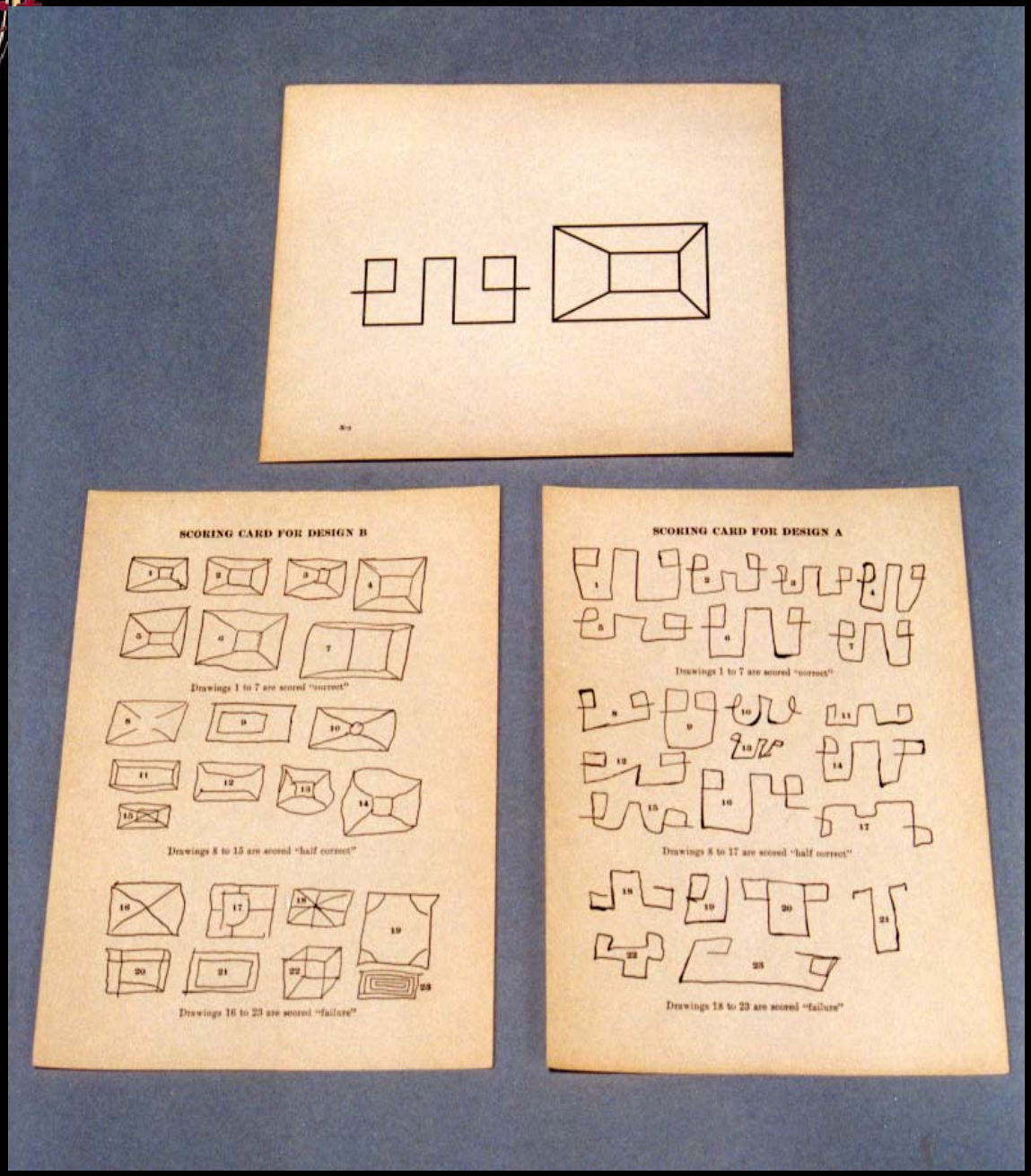
Unfinished Pictures



Now the "Picture Completion" Subtest on the WAIS, WISC, etc.

VI-2

From: Binet & Simon



Drawing a Design from Memory

"The subject is told that two designs will be shown to him, which he will be allowed to look at for ten seconds, and which he must then draw from memory."

Testing at Ellis Island

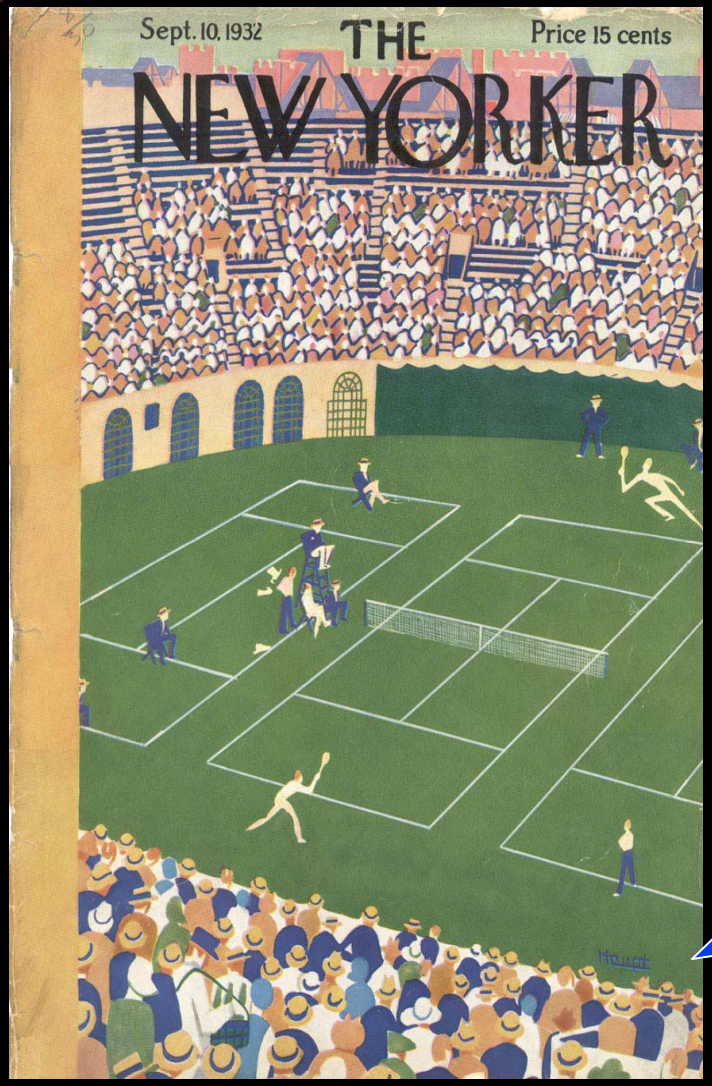
From: ***The U.S. National Archives***

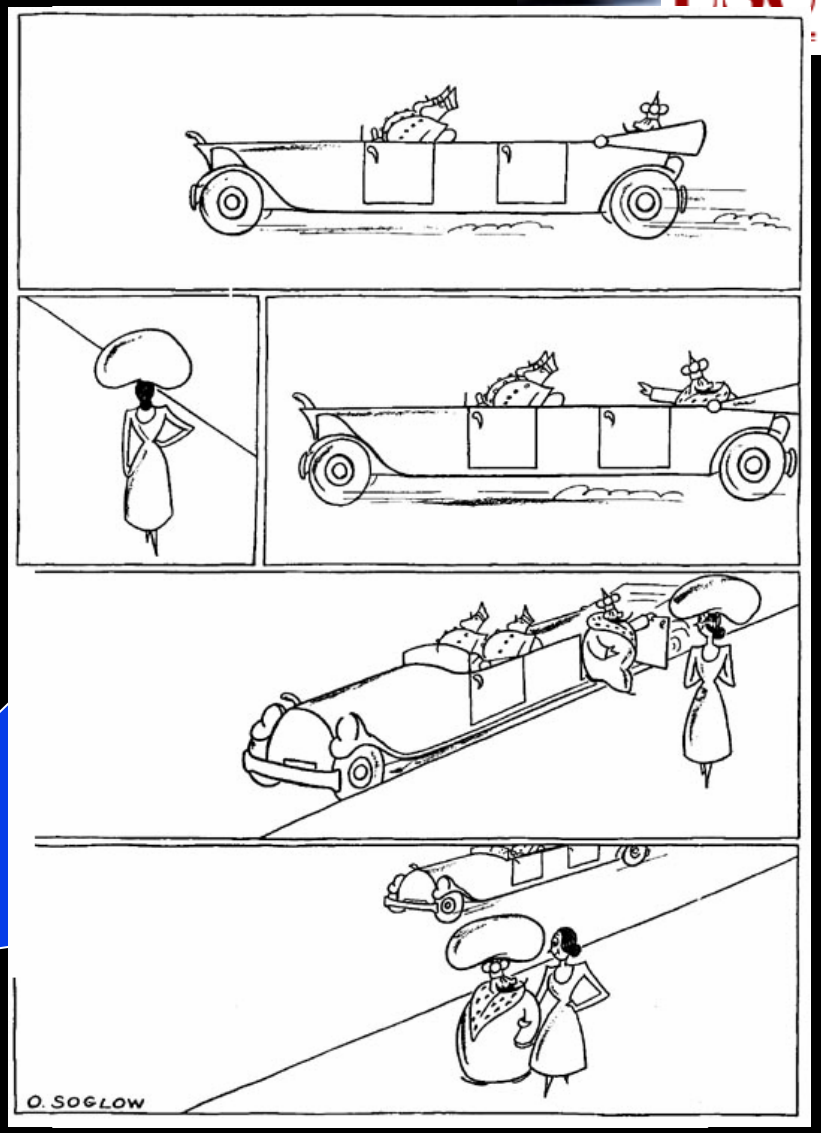
Profile Test

Army Performance Battery

The Manikin Test

Developed by Pitner-Patterson, 1917



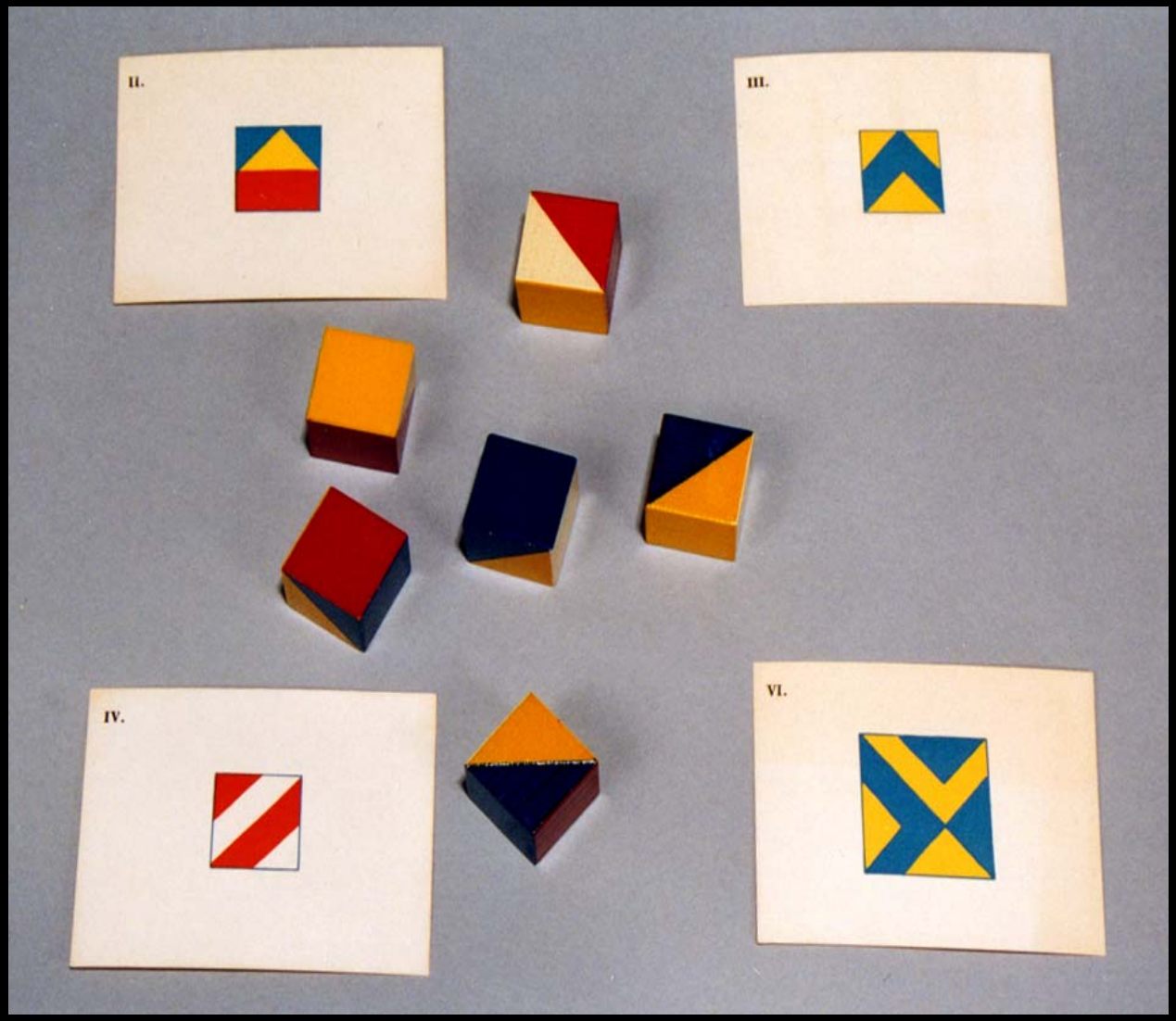


Now the "Picture Arrangement"
Subtest on the WAIS, WISC, etc.

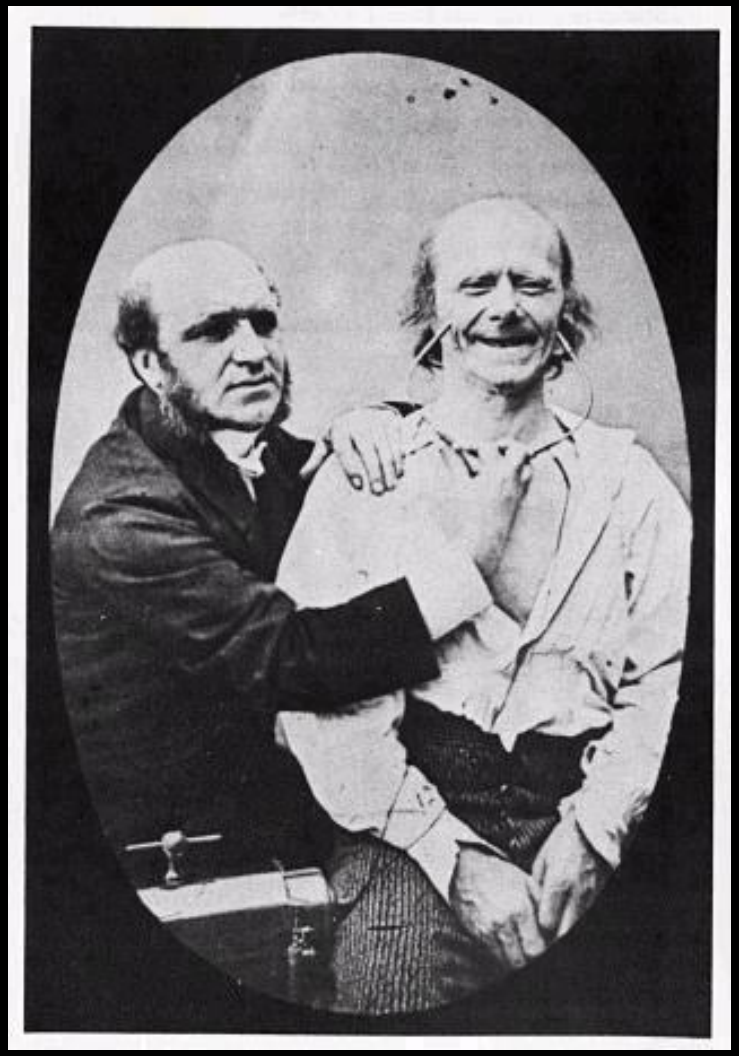
Copyright ©1932. The Cartoon Bank and The New Yorker Magazine. Used with Permission.

Color Cubes – Embossing Co.

Koh's Blocks



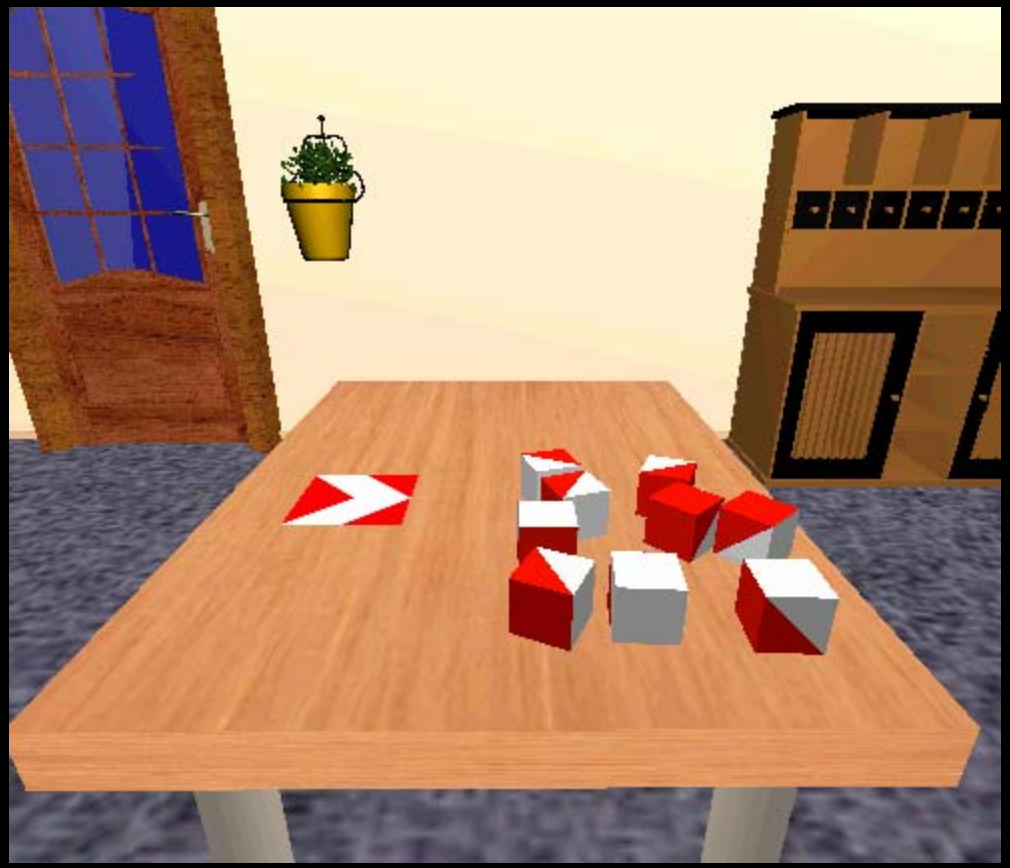
Are we still limited to using methods developed 80-100 years ago!



Is there a need for new tools? Can VR technology fill the need?

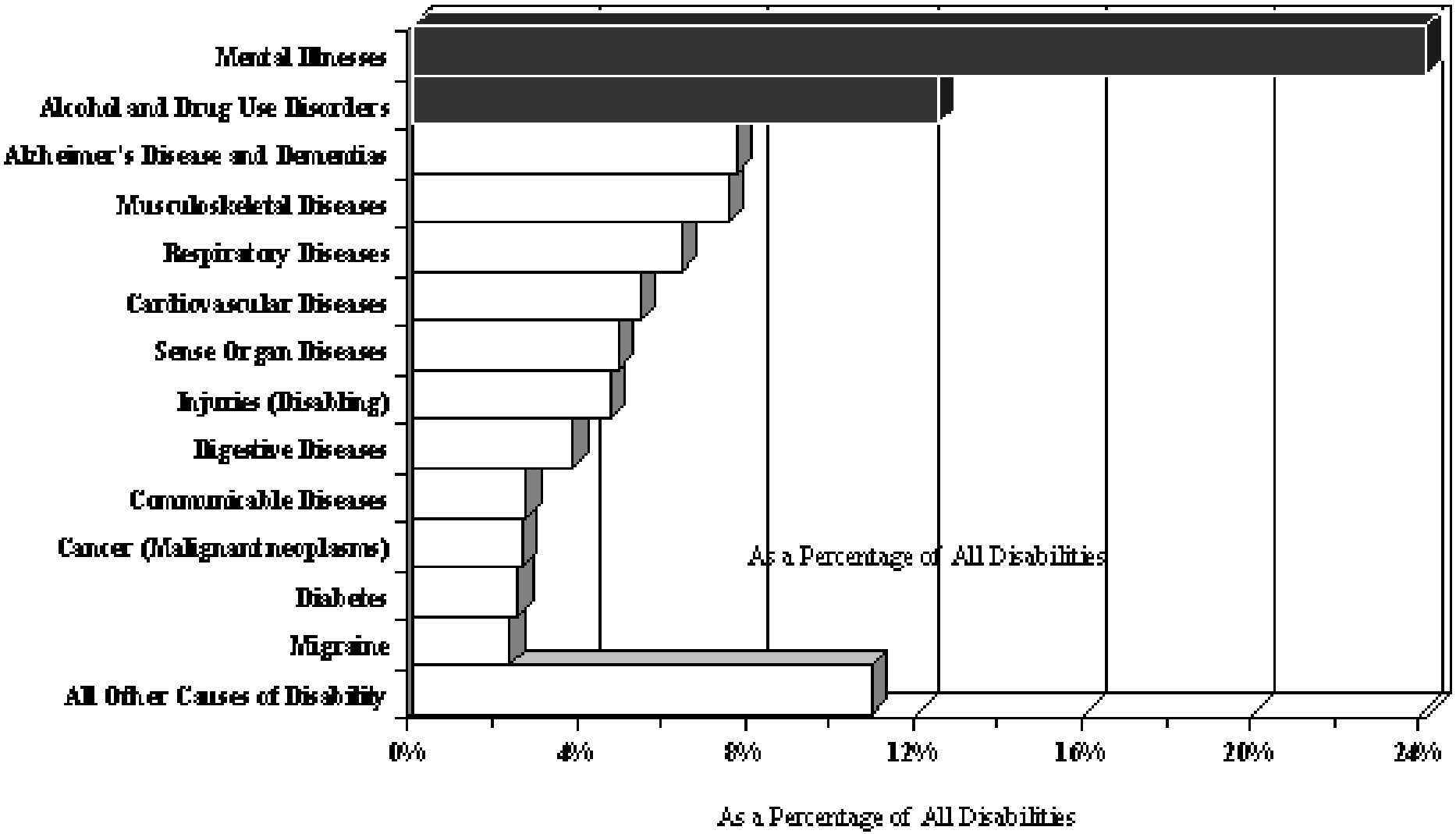
Or will we simply *"...automate the paradigms of the past."* *(Krueger)*

VR Block Design for use in fMRI (Zakzanis et al.)



Cause of Disability*

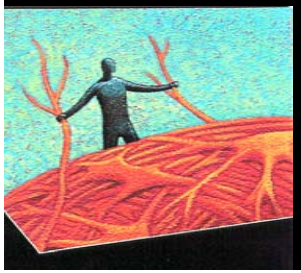
United States, Canada and Western Europe, 2000



* Causes of disability for all ages combined. Measures of disability are based on the number of years of "healthy" life lost with less than full health (i.e., YLD, years lost due to disability) for each incidence of disease, illness or condition. All data shown add up to 100%. SOURCE: World Health Organization (2001)

VR/Rehab Strengths

- Ecological validity
- Stimulus control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for “errorless learning”
- Real time performance feedback
- Self-guided exploration and independent practice
- Stimulus and response modification contingent on user’s impairments
- Complete naturalistic performance record
- 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



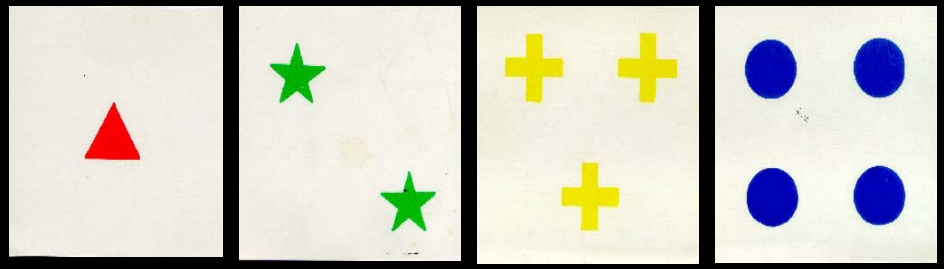
VR/Rehab Strengths

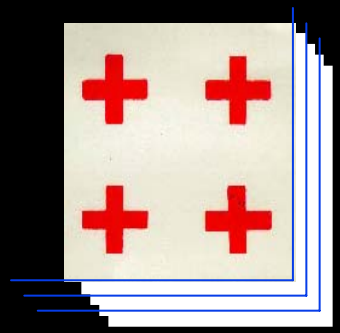
- Ecological validity

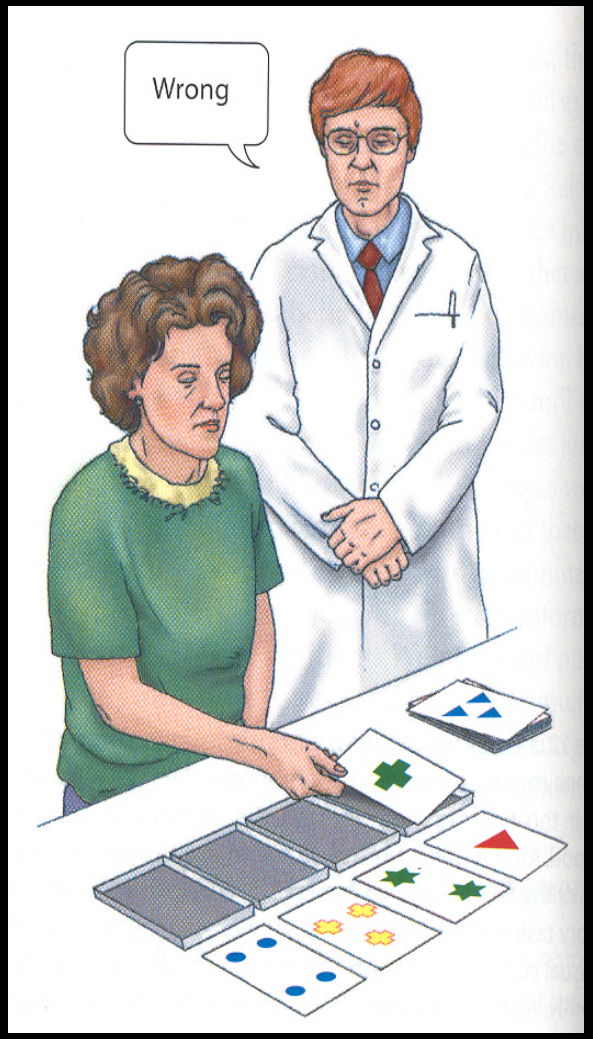
Traditional assessment and rehabilitation has been criticized as limited in the area of ecological validity, that is, the degree of relevance or similarity that a test or training system has relative to the "real" world (Neisser, 1978).

Wisconsin Card Sorting Task

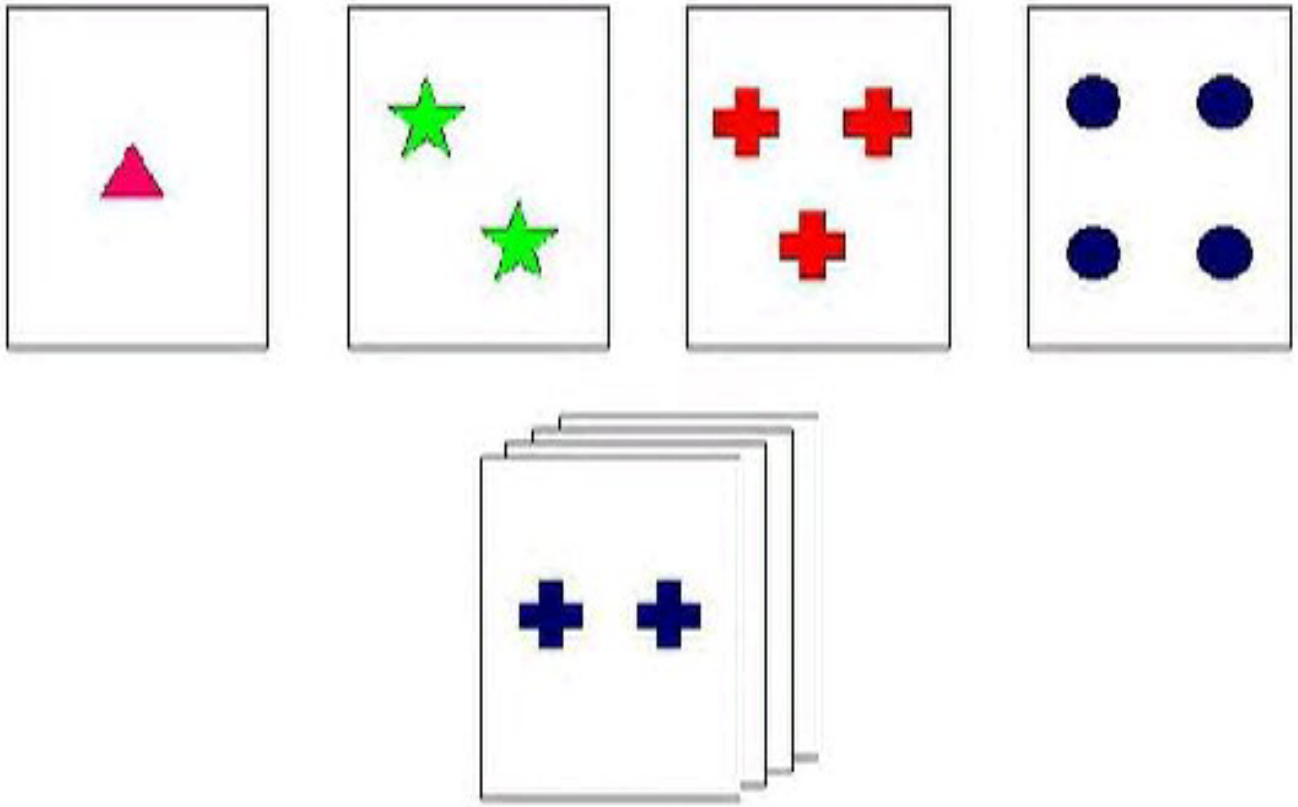
- Weinberger et al., 1986

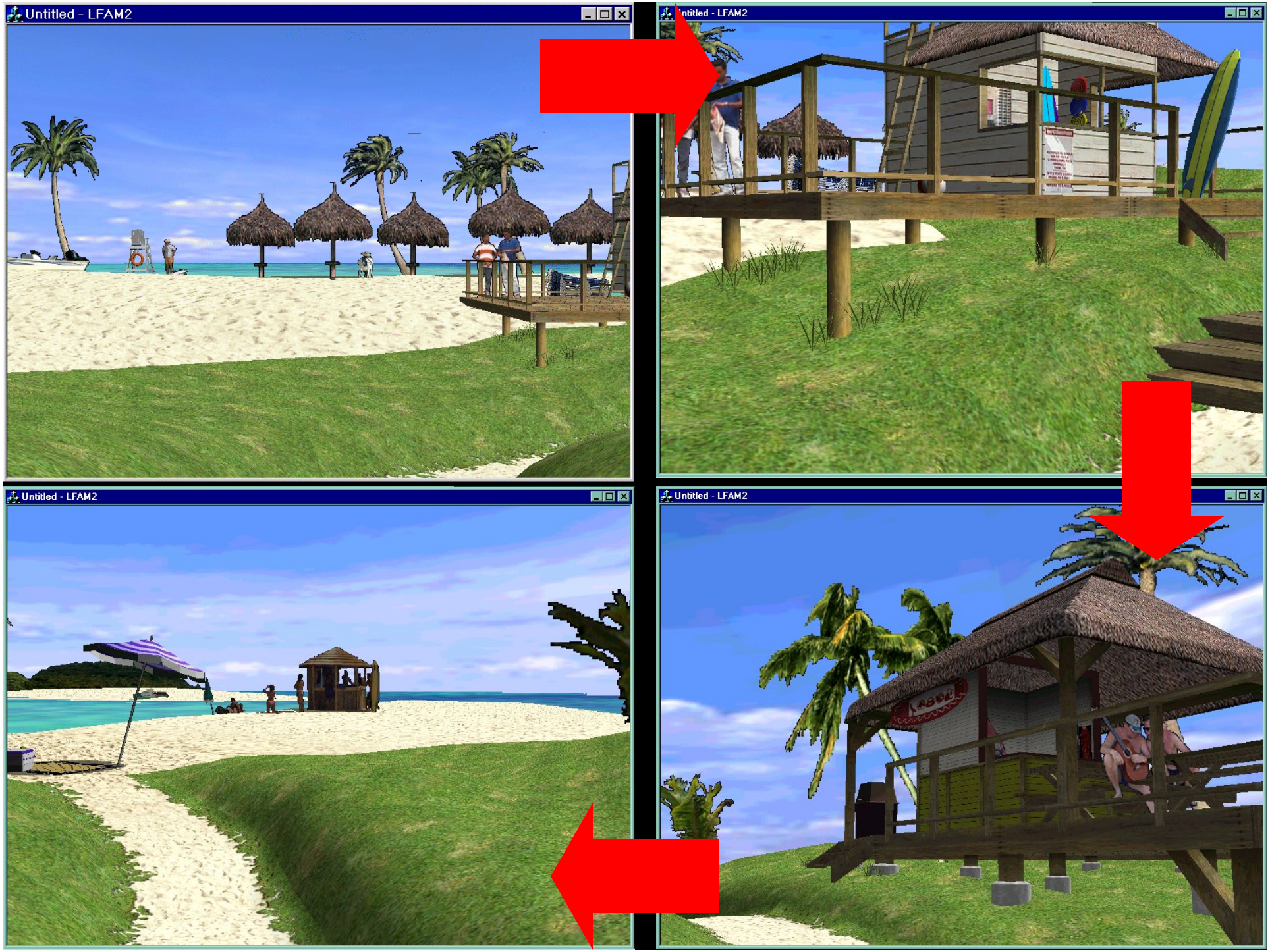


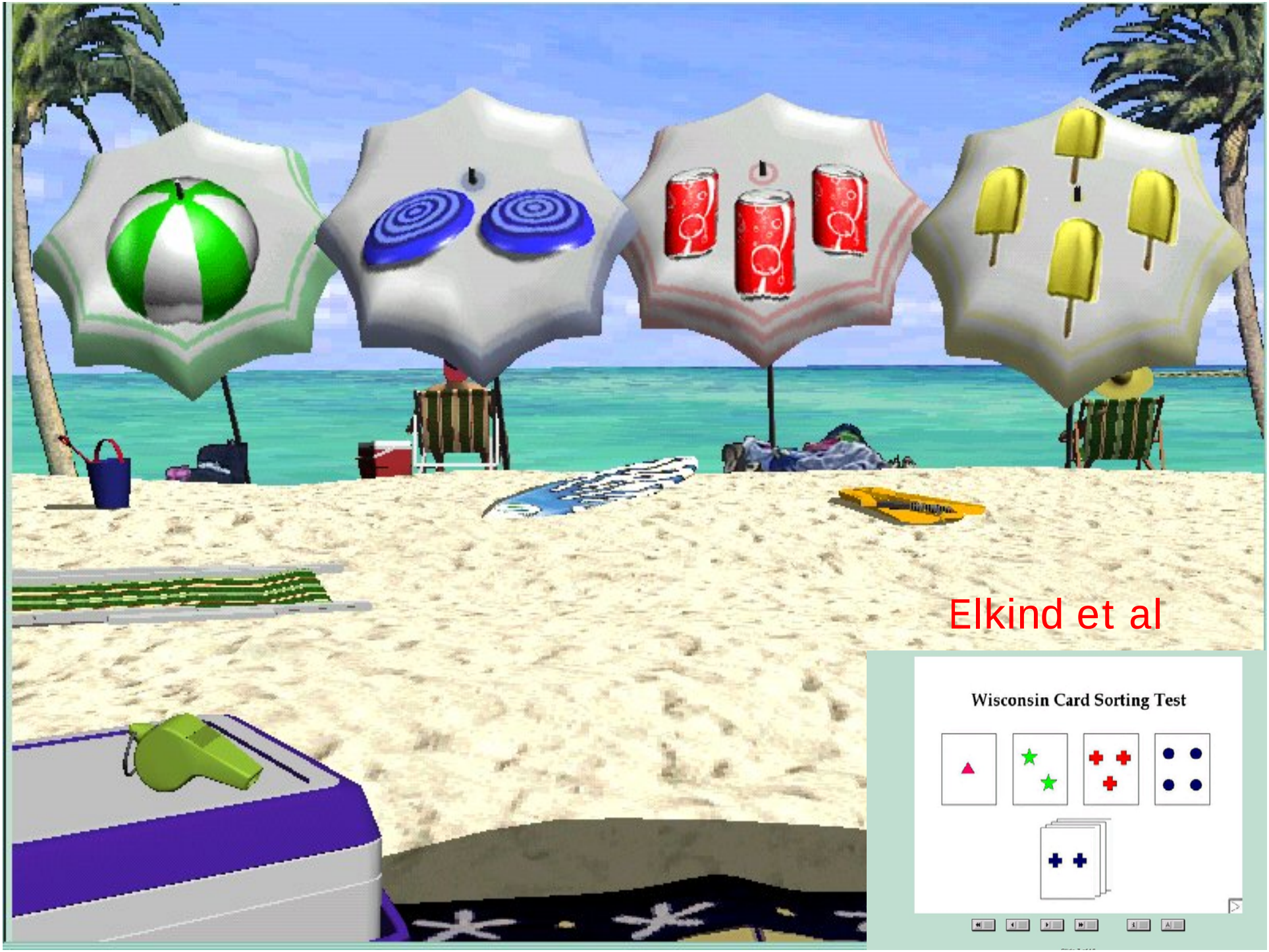




Wisconsin Card Sorting Test




Untitled - LFAM2
Untitled - LFAM2
Untitled - LFAM2
Untitled - LFAM2


Elkind et al
Wisconsin Card Sorting Test

Elkind et al

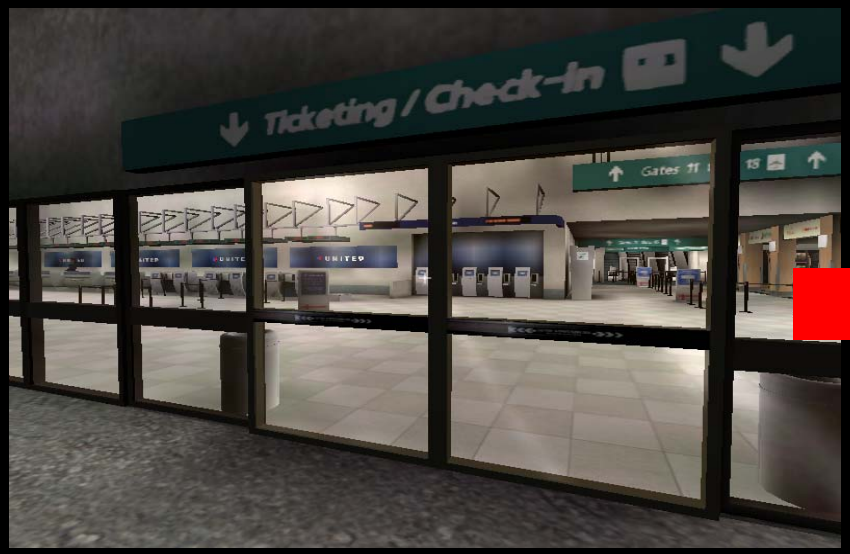
super3.VRT - Superscape VRT
File View Settings Editor Help
Shopping List
COMPLAIN
THANKYOU
Ready
5 100 8.0 800x544 12:30 PM
COFFEE
lothouse.vrt - Superscape Visualiser
File View Settings Help
Microsoft PowerPoint
Start
lothouse.vrt - Supers...
Microsoft Word - Document1
(Brown et al.)

(Schultheis et al.)

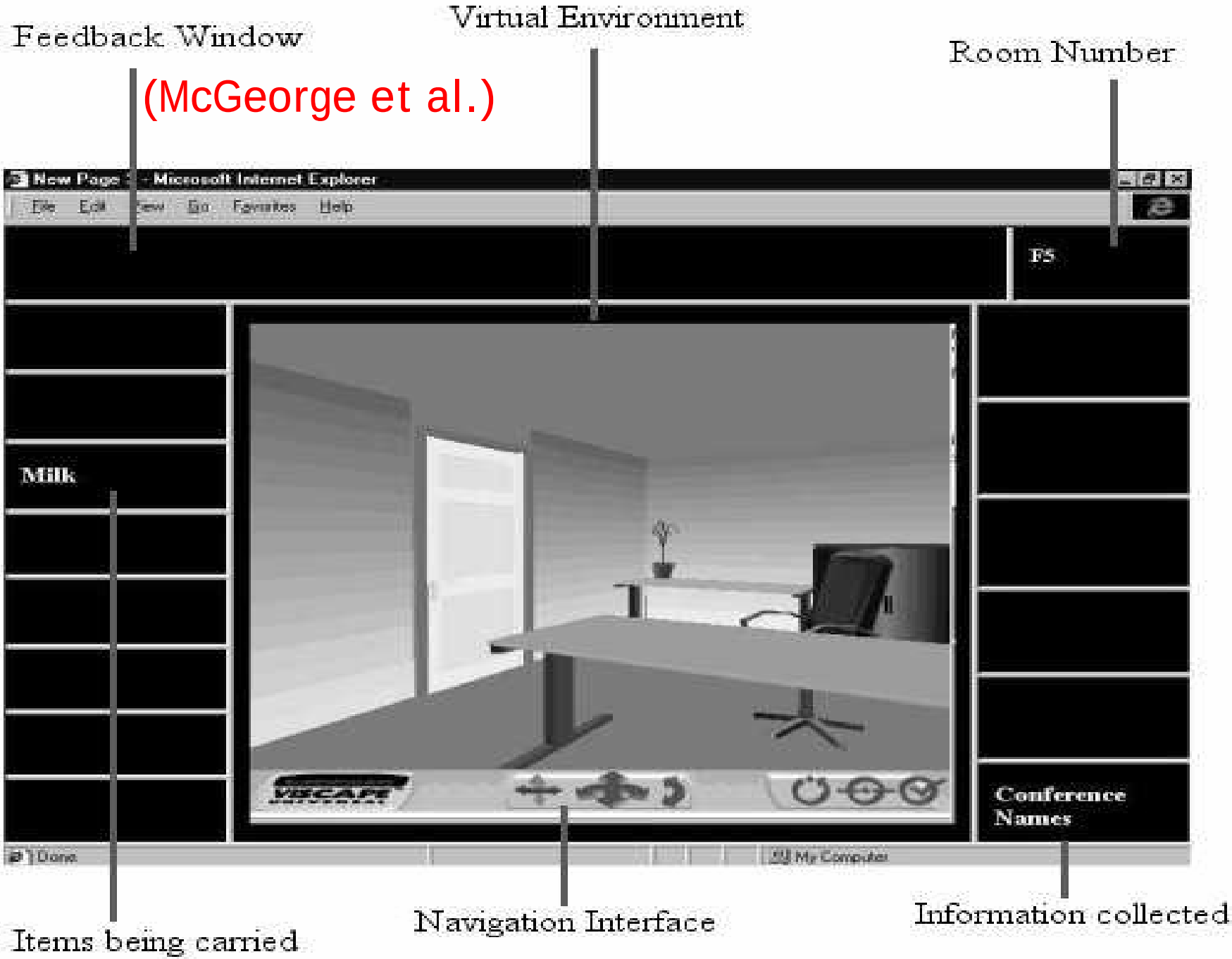
(Emmelkamp, Schuemie et al.)

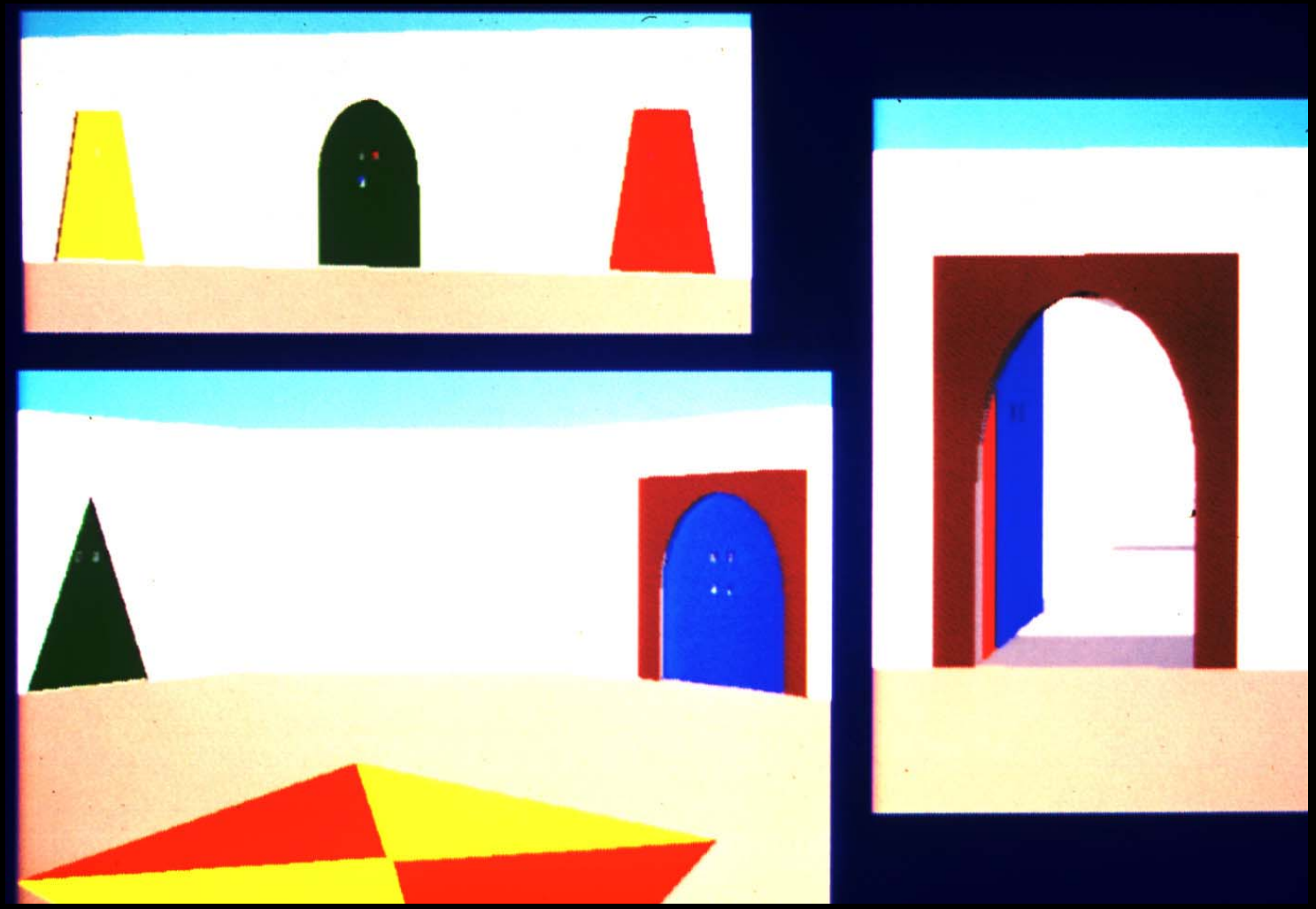
San Diego Airport Scenario

Using Unreal *Tournament Game Engine*

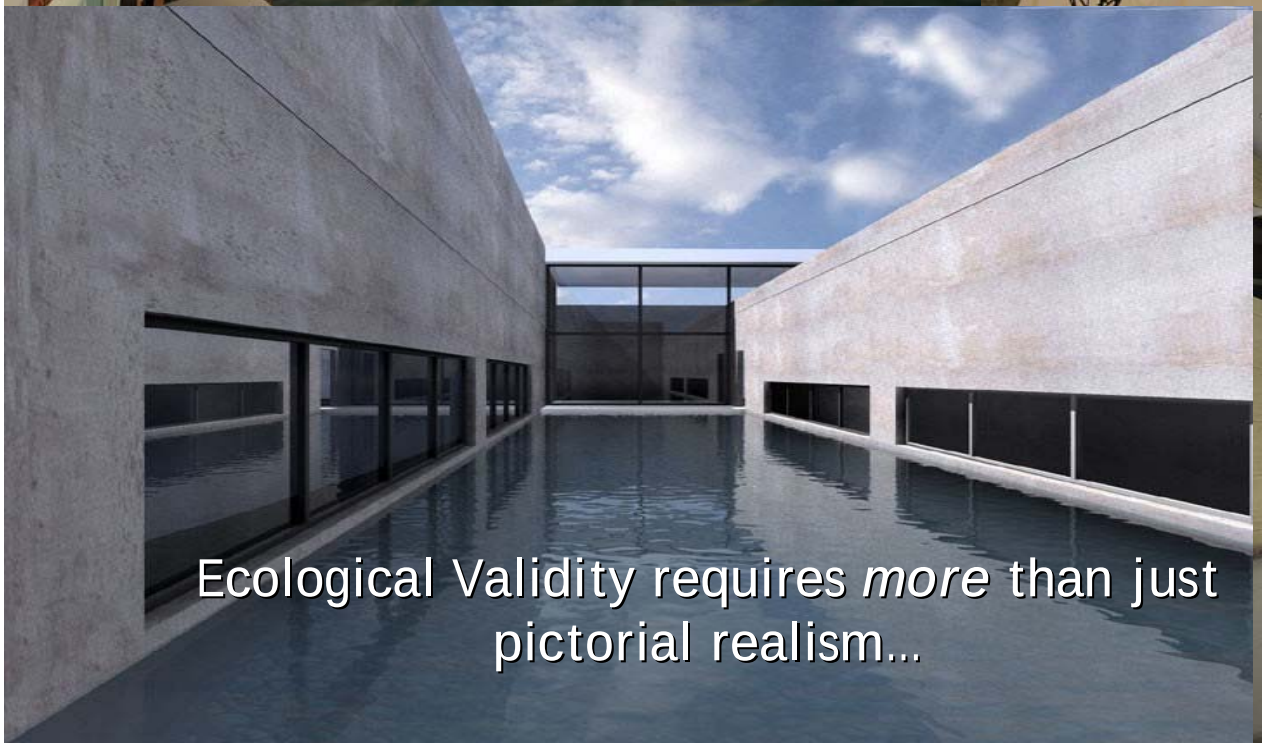


VRMC - Wiederhold et al.


Feedback Window
(McGeorge et al.)
Virtual Environment
Room Number
New Page - Microsoft Internet Explorer
File Edit View Go Favorites Help
F5
Milk
Conference Names
Done
My Computer
Items being carried
Navigation Interface
Information collected



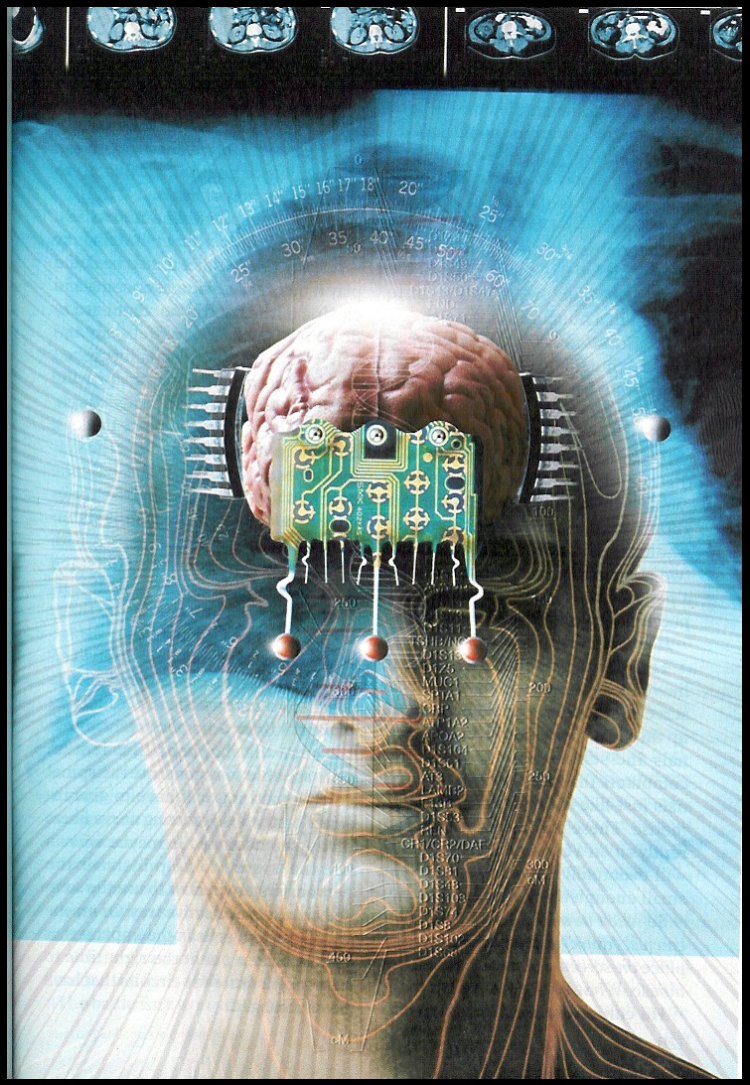
Executive Functions (Pugnetti et al.)



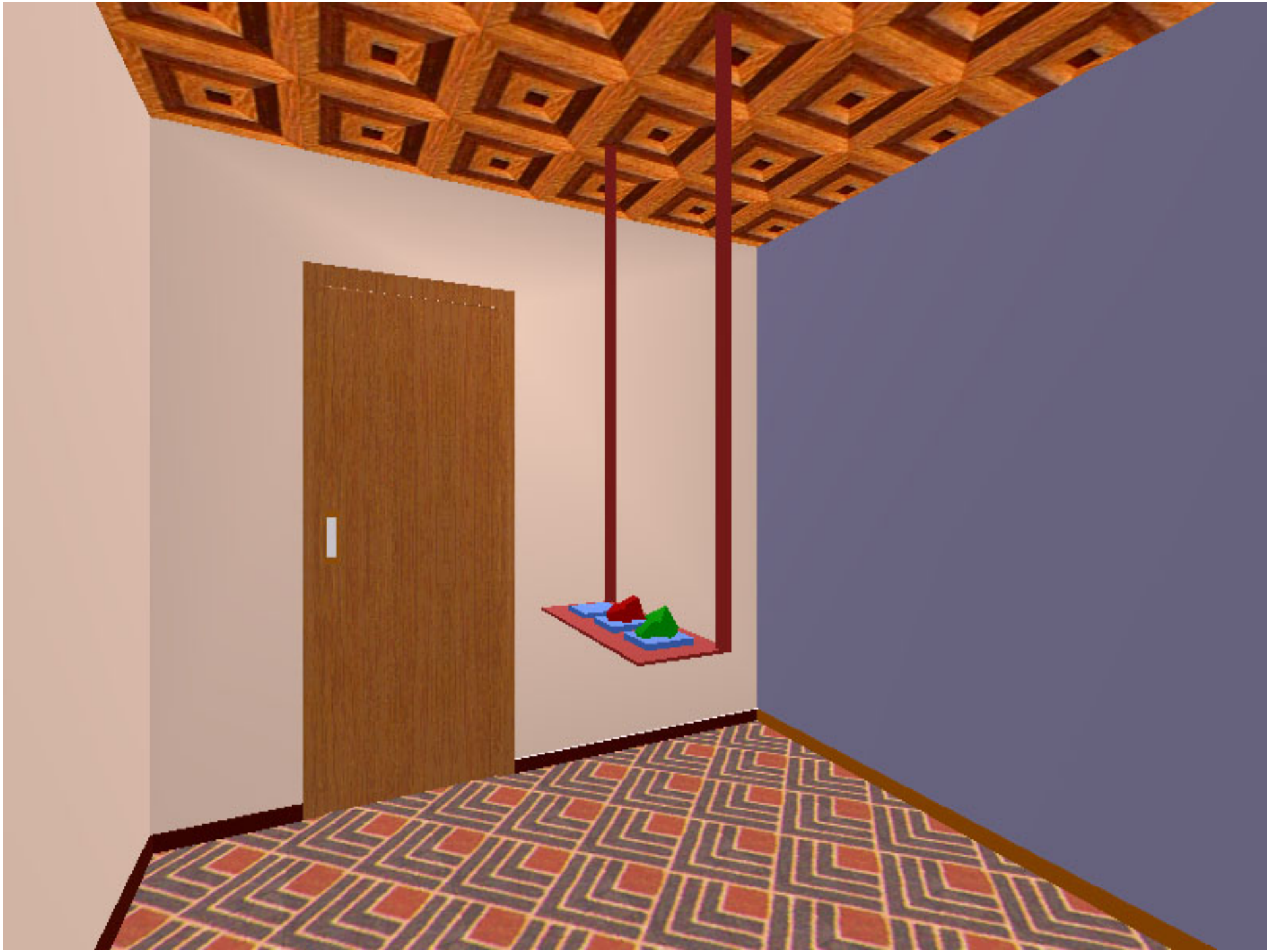
Ecological Validity requires *more* than just pictorial realism…

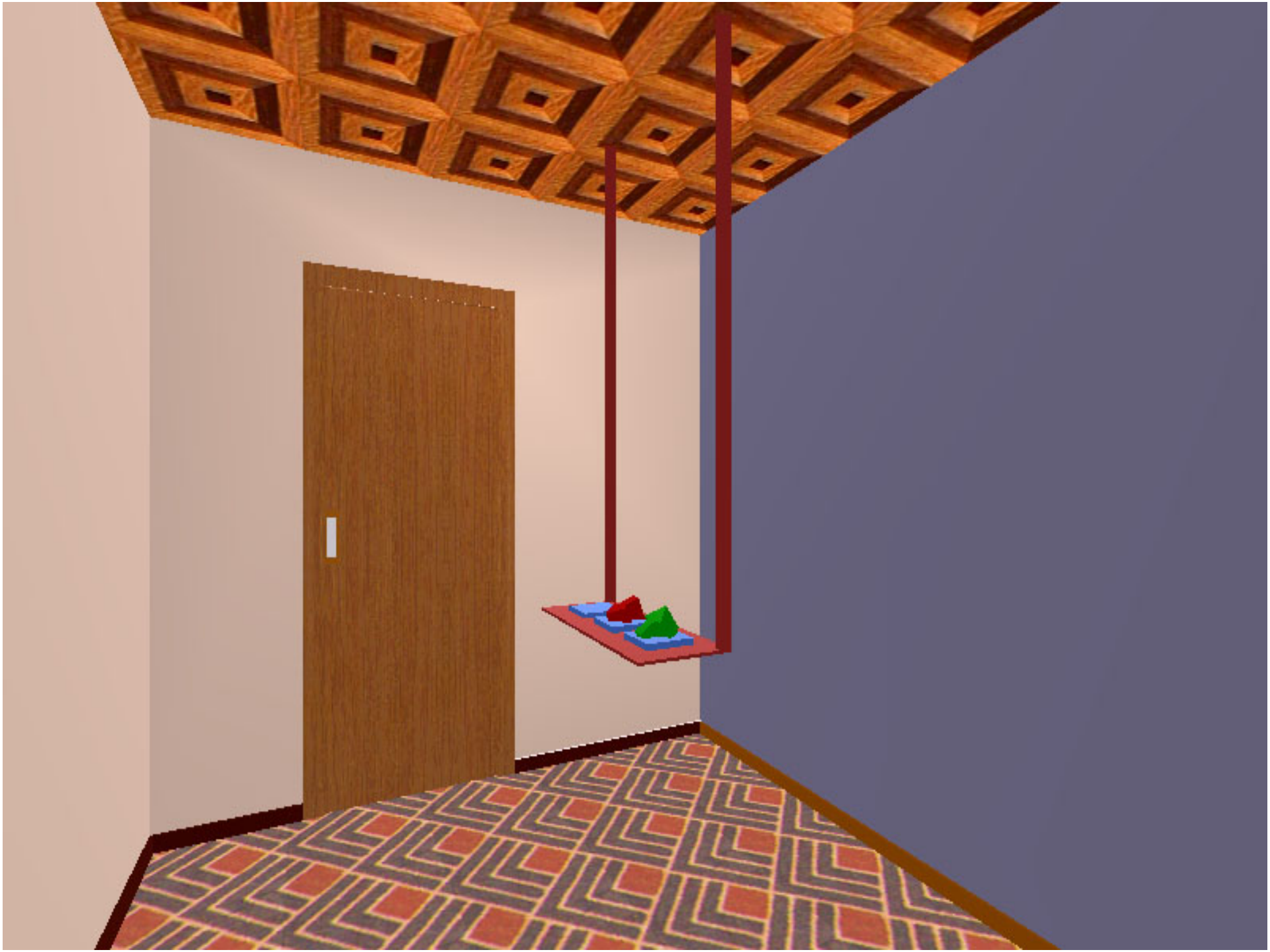
VR/Rehab Strengths

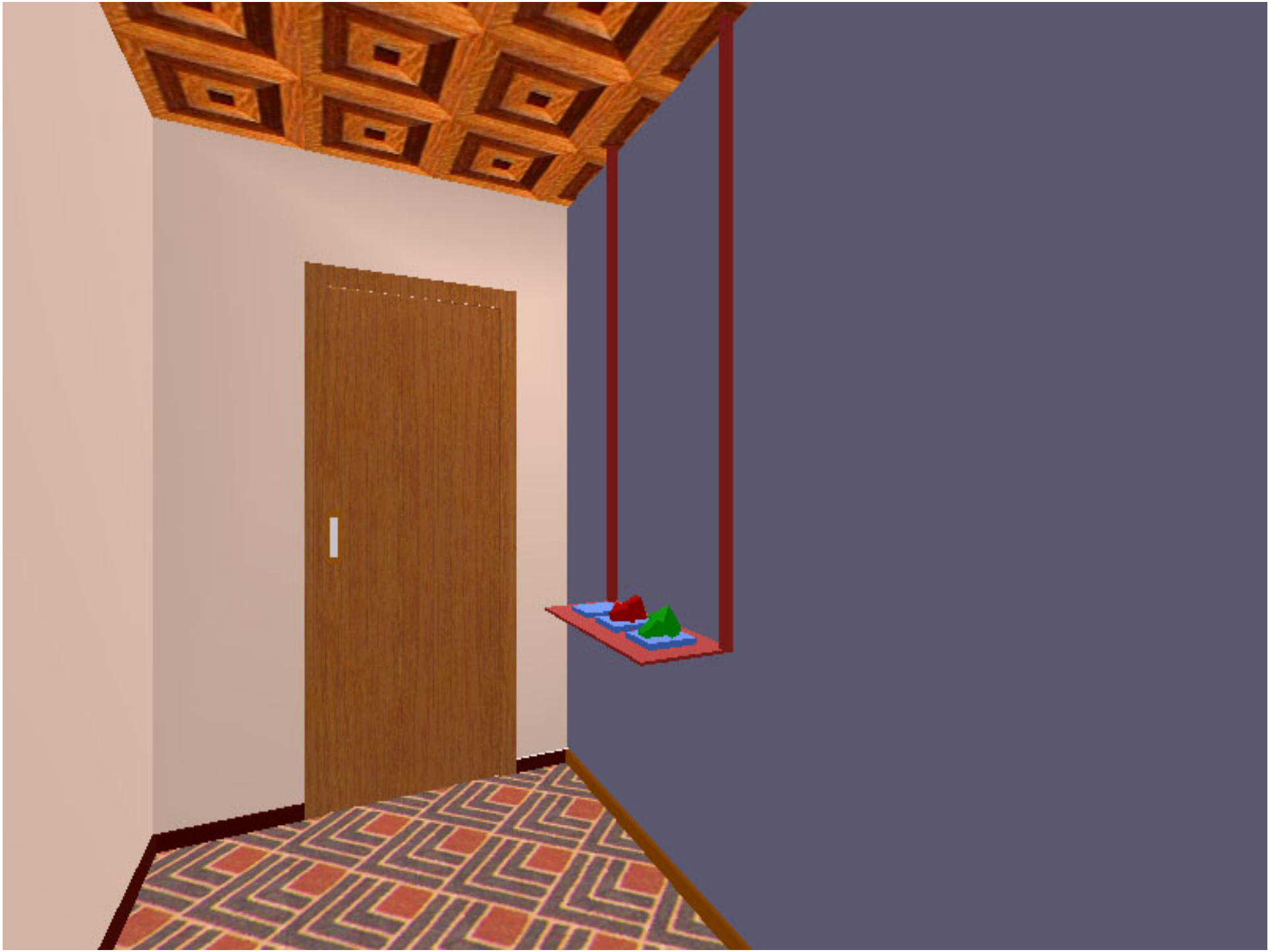
- Ecological validity
- Stimulus/Response control and consistency
- Repetitive and hierarchical stimulus delivery possible



VR Claustrophobia Application
(Botella et al)

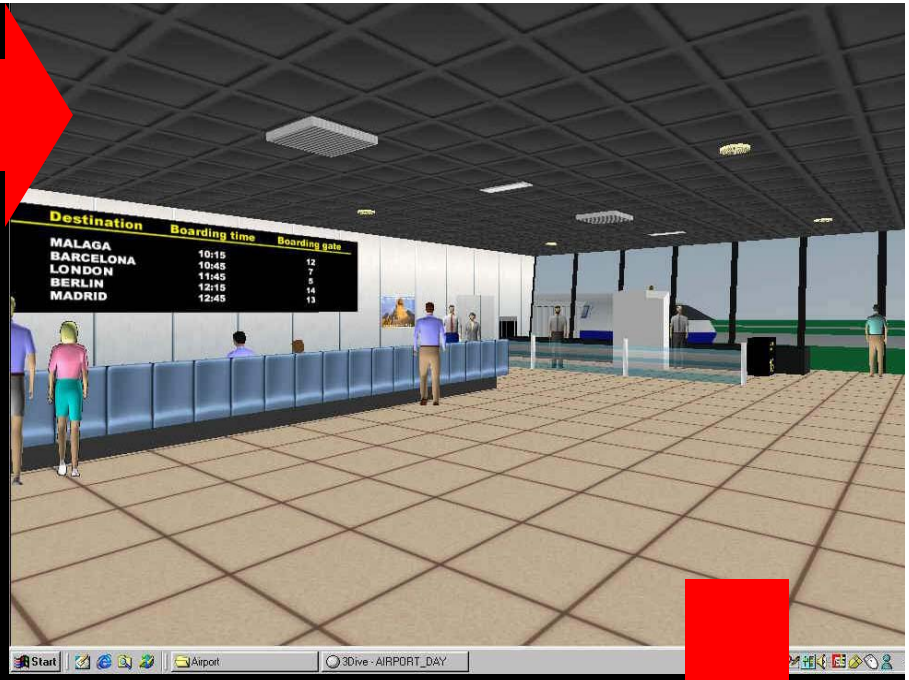


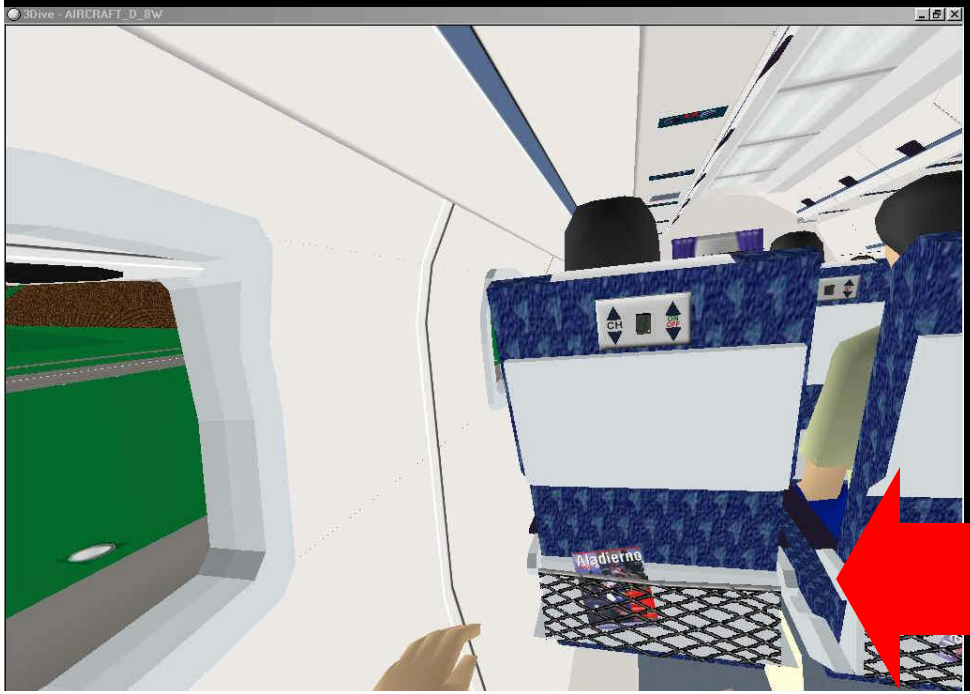




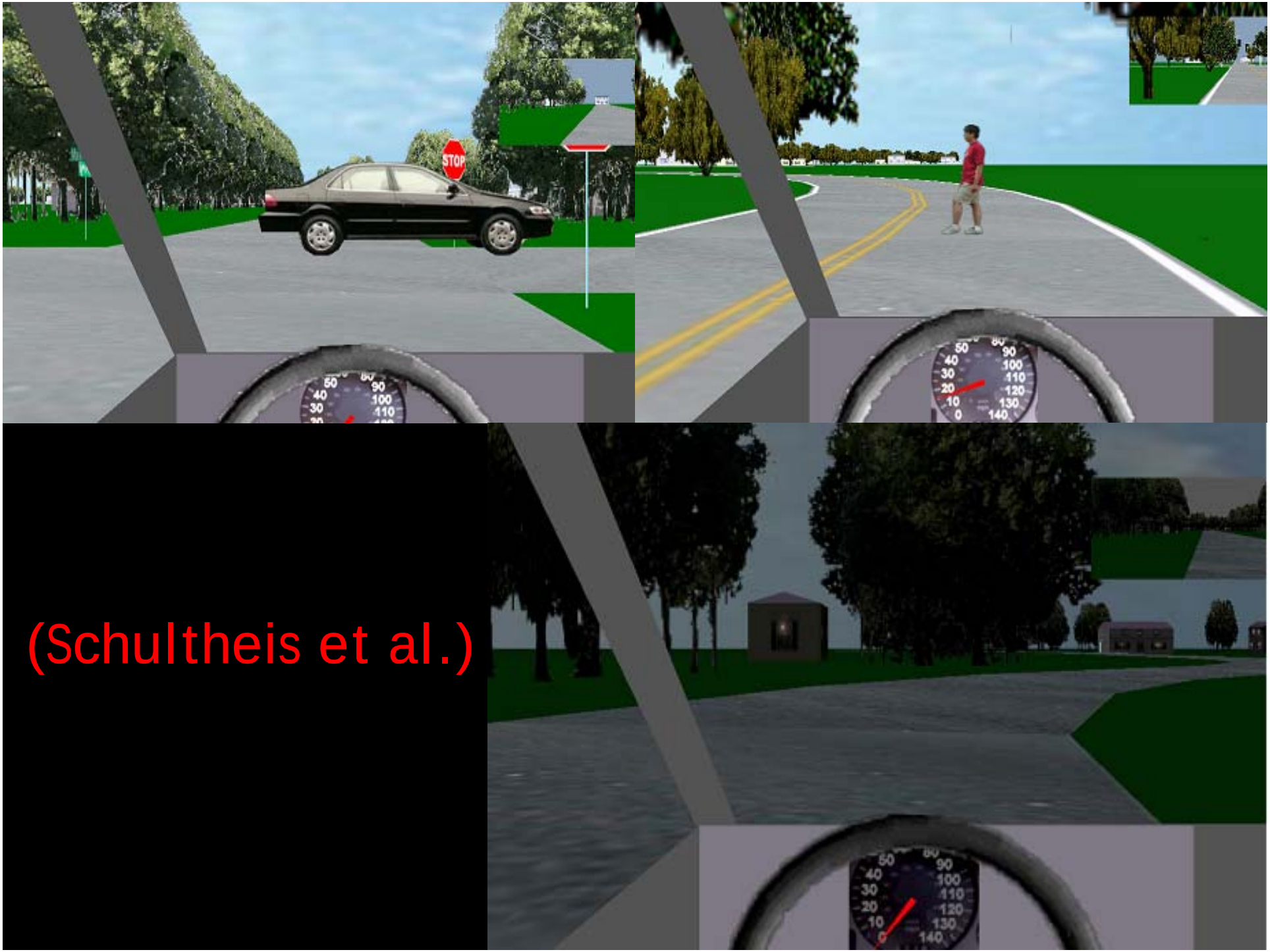
Previ Inc.

Room
3Dive - Room_day
4:45 PM


Destination
Boarding time
Boarding gate
MALAGA 10:15 12
BARCELONA 10:45 7
LONDON 11:45 5
BERLIN 12:15 14
MADRID 12:45 13
Start
Airport
3Dive - AIRPORT_DAY


3Dive - AIRCRAFT_D_BW
CH
VOL
Aladierno

3Dive - AIRPORT_DAY
Boarding
Gate
13

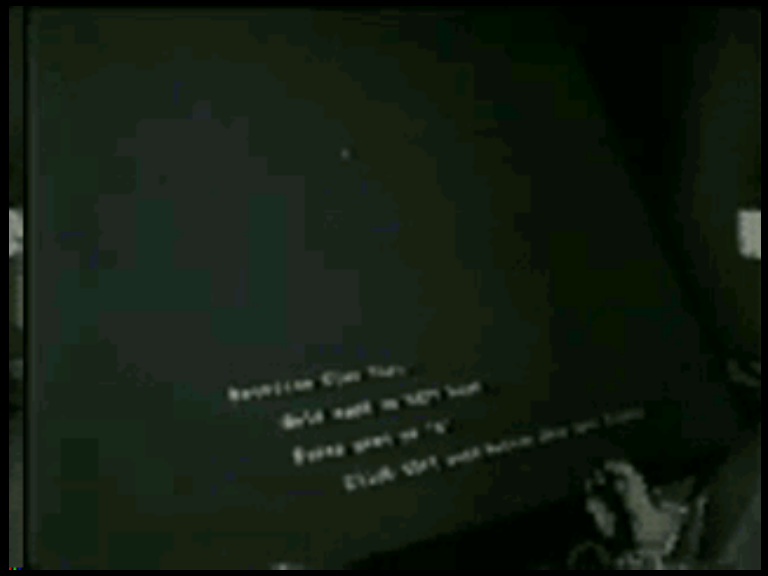


(Schultheis et al.)

Fakespace Mini-Workbench

Examples of two ImmersaDesk scenarios

Spatial Rotation



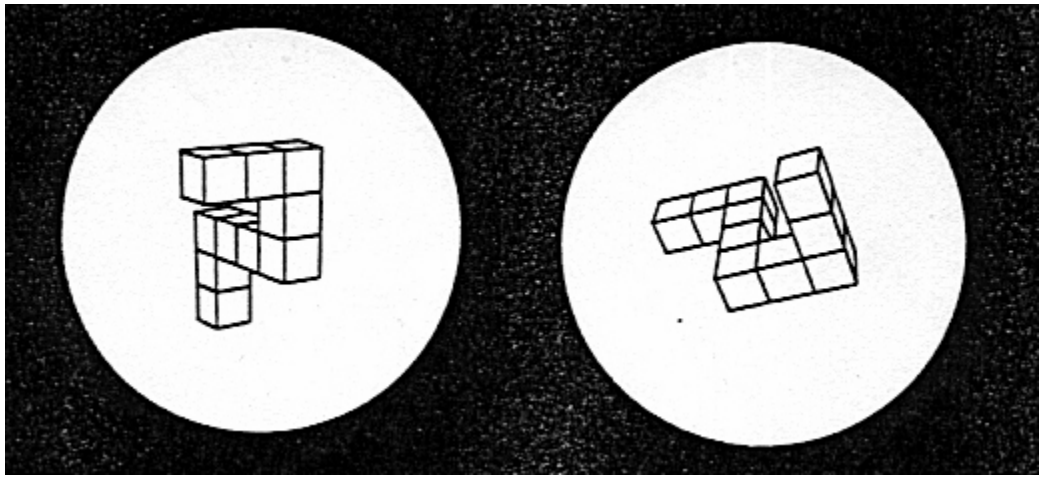
Basic Depth Perception Task

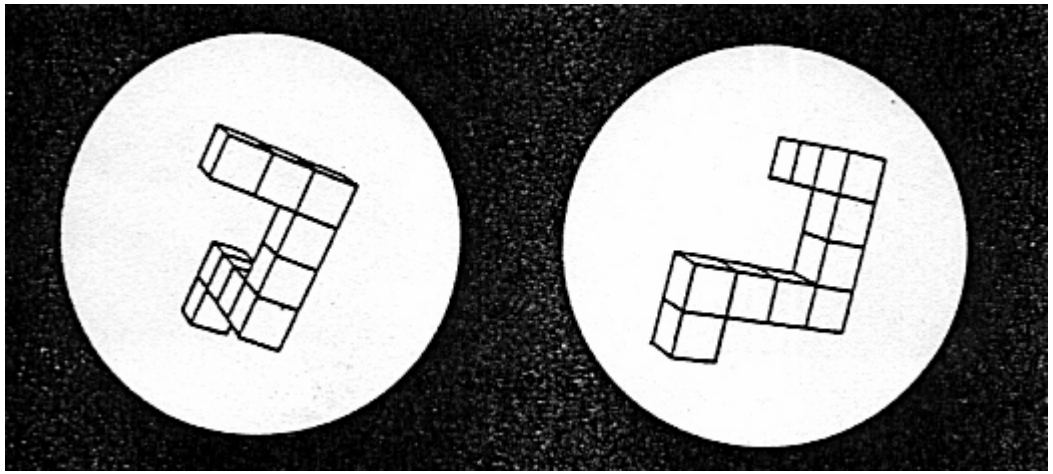
These applications have addressed performance across the lifespan, gender and disability issues regarding visuospatial processes, interface design, transfer of training, and immersidata analysis.

In: ***Presence: Teleoperators and Virtual Environments***

(Rizzo et al.)

Are these pairs of objects the same or different?





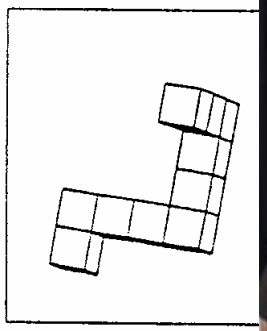
From: Shepard and Metzler, 1971

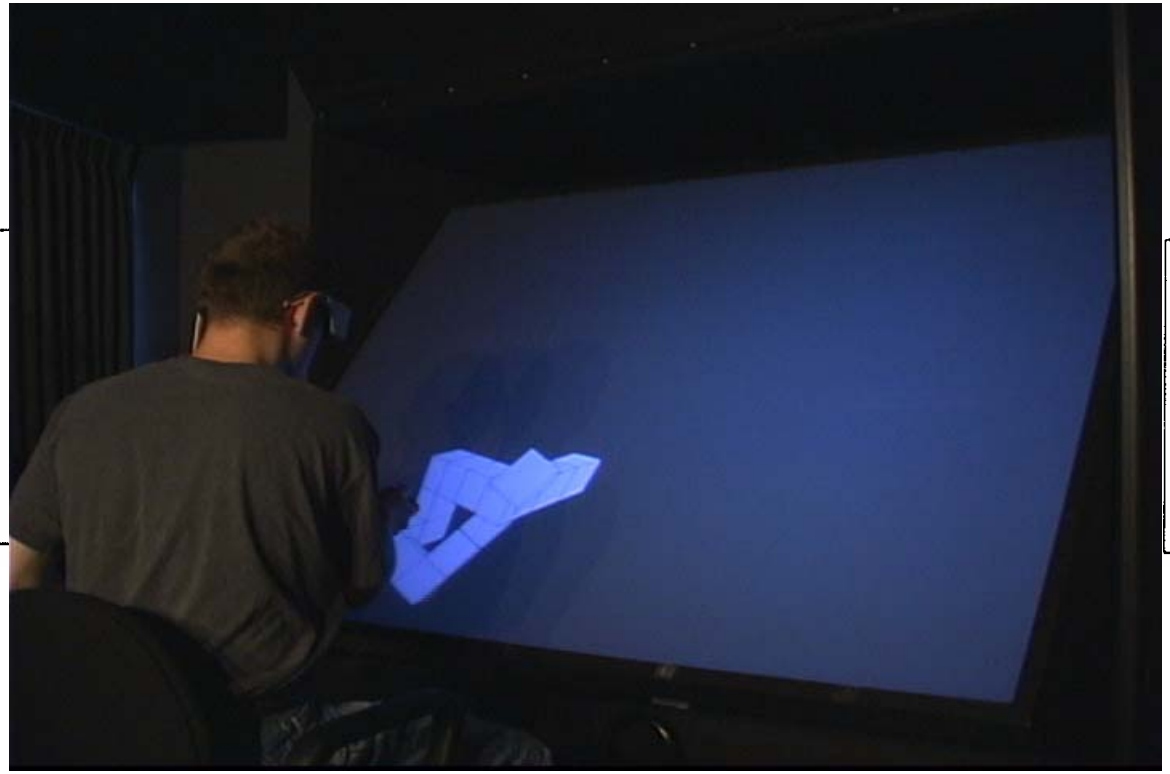
Mental Rotations Test (MRT)

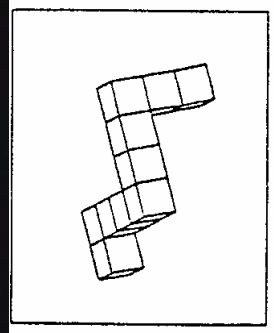
(Vandenberg and Kuse, 1978)

Now look at
this object:

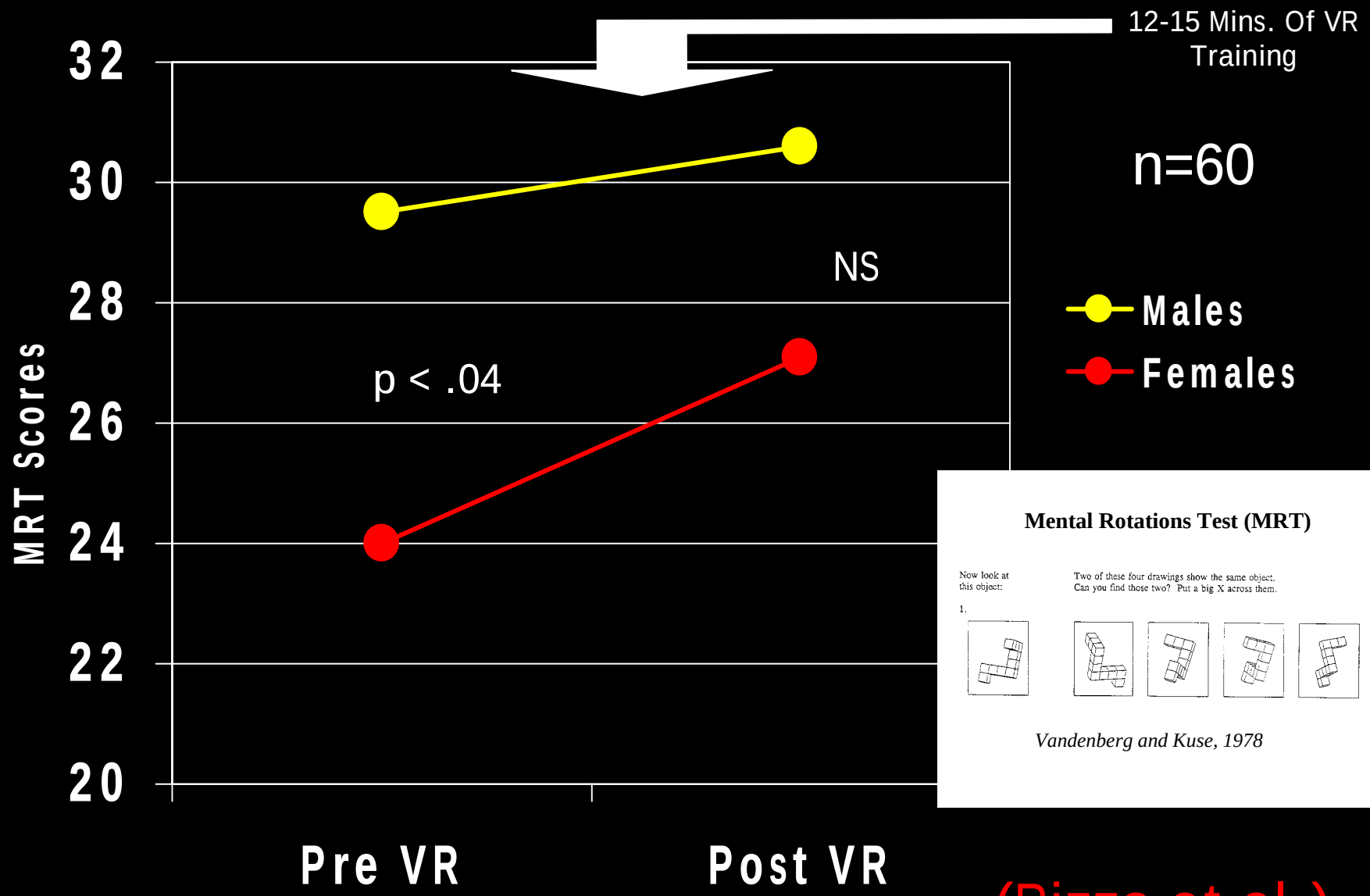
1.







Mental Rotation Scores - Pre/Post VR for *Males* vs. *Females*



Mental Rotations Test (MRT)

Now look at this object:

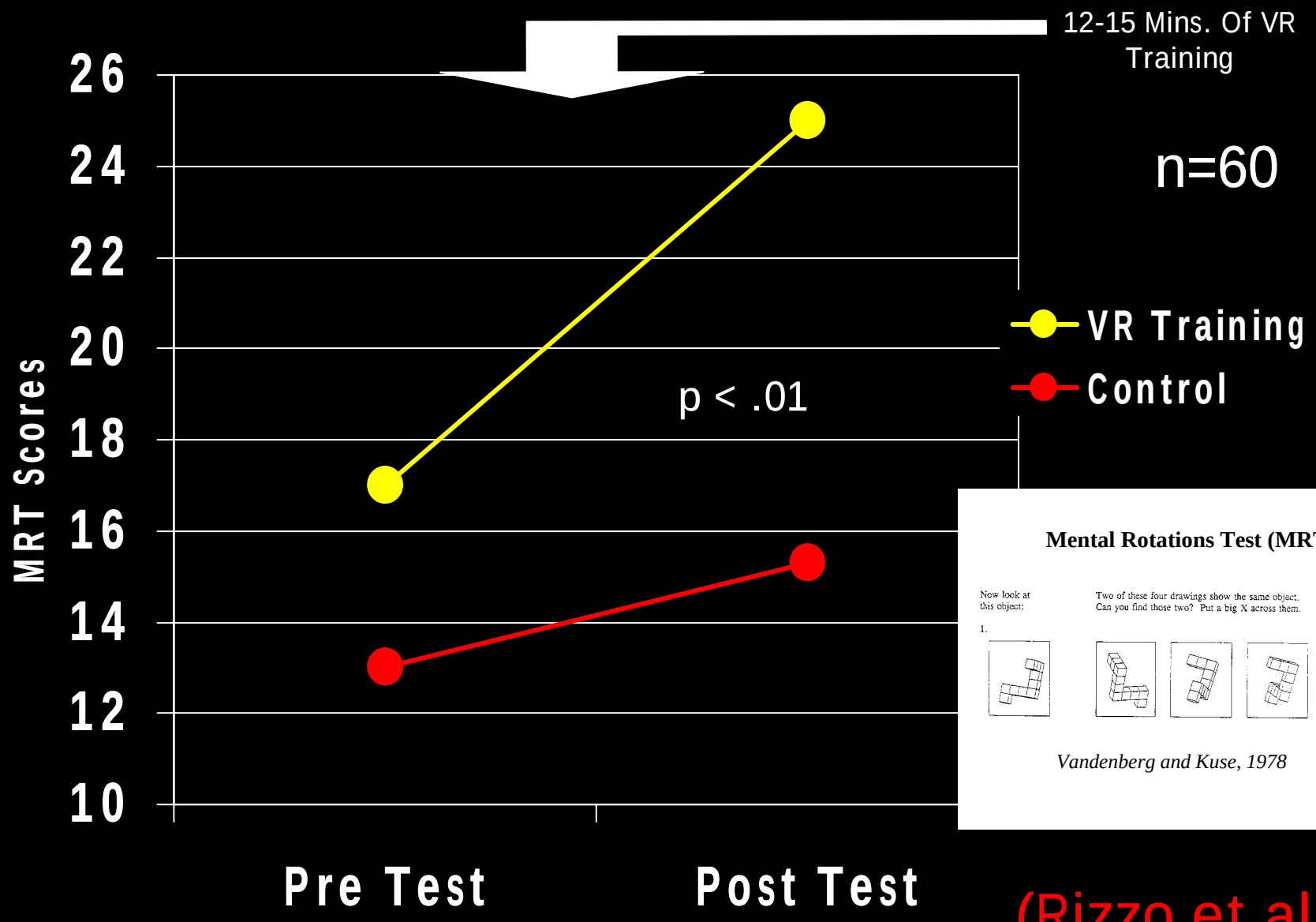
1.

Two of these four drawings show the same object. Can you find those two? Put a big X across them.

Vandenberg and Kuse, 1978

(Rizzo et al.)

Mental Rotation Scores – VR vs. Control group for *poor initial performers (male & females combined)*



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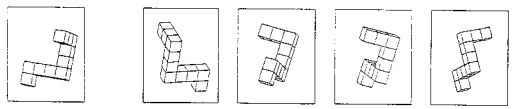
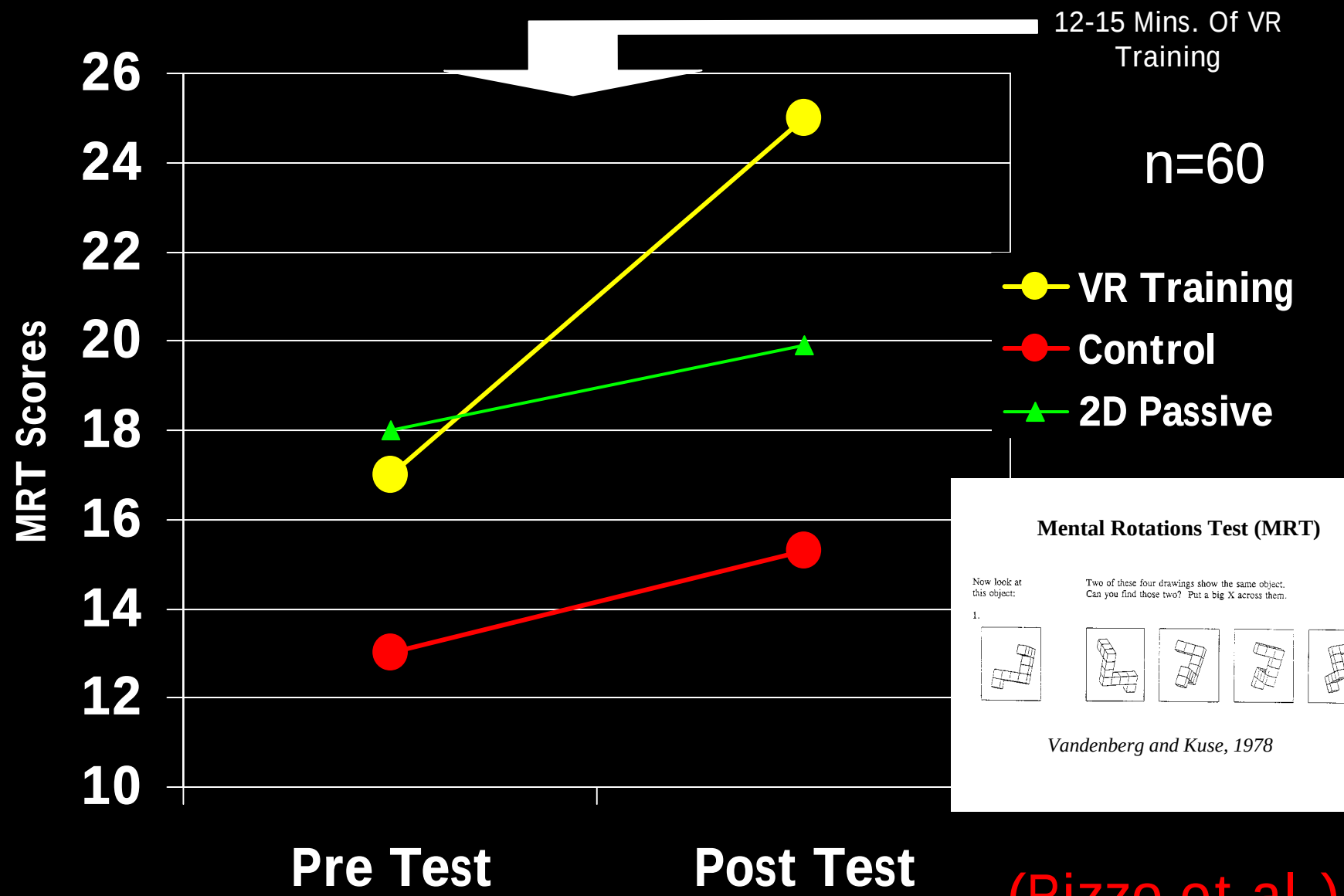
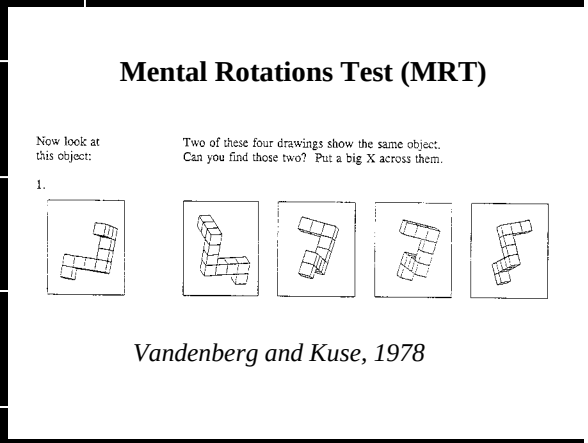


Vandenberg and Kuse, 1978

(Rizzo et al.)

Mental Rotation Scores – VR vs. Control group for *poor initial performers (male & females combined)*





Mental Rotations Test (MRT)

Now look at this object:

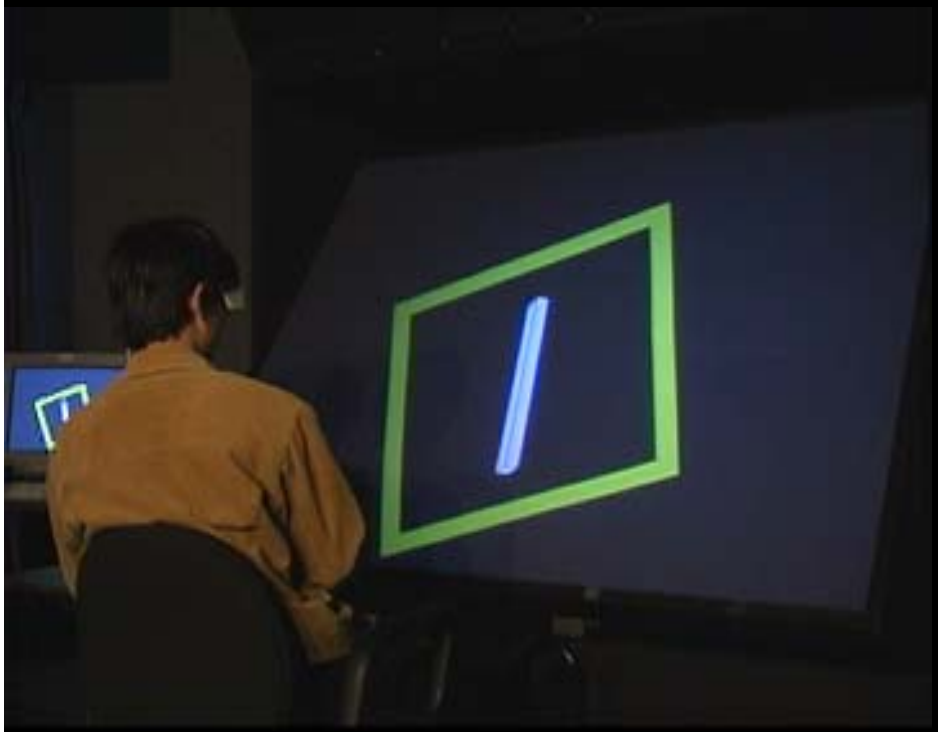
Two of these four drawings show the same object. Can you find those two? Put a big X across them.

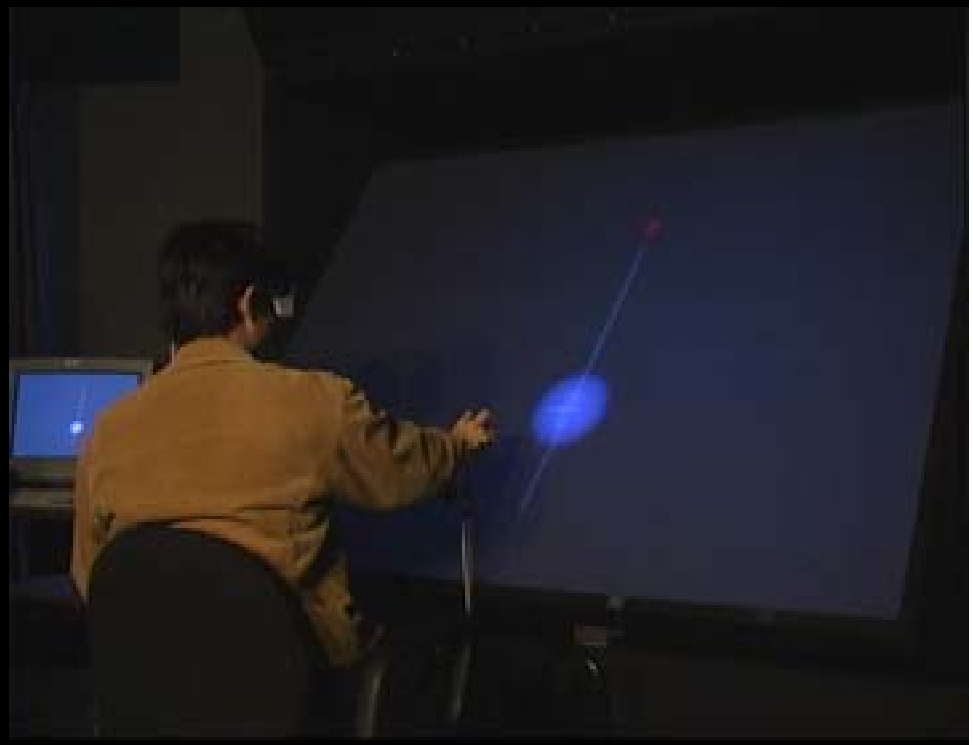
1.

Vandenberg and Kuse, 1978

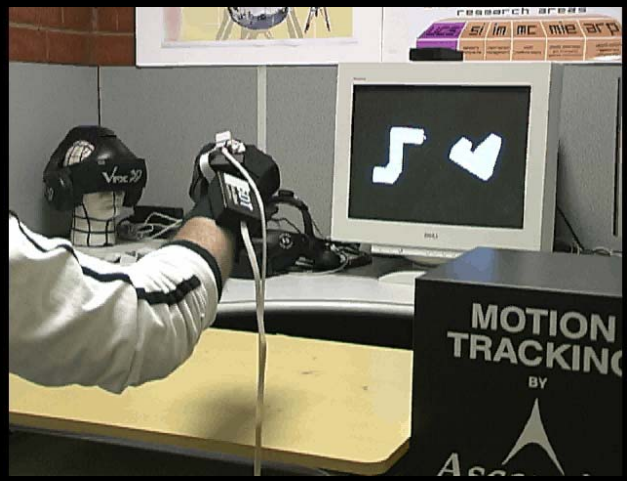
(Rizzo et al.)

Other Visuospatial Applications





PC-Delivered Visuospatial Applications



Vision:

System will allow users to select delivery by way of Stereo HMD, Crystal Eyes on PC monitor, ImmersaDesk and on Passive 3D Sharp Laptops and allows selection of MONO vs. STEREO and active vs. passive modes across a range of visuospatial tasks

The Virtual Classroom

(Rizzo et al.)

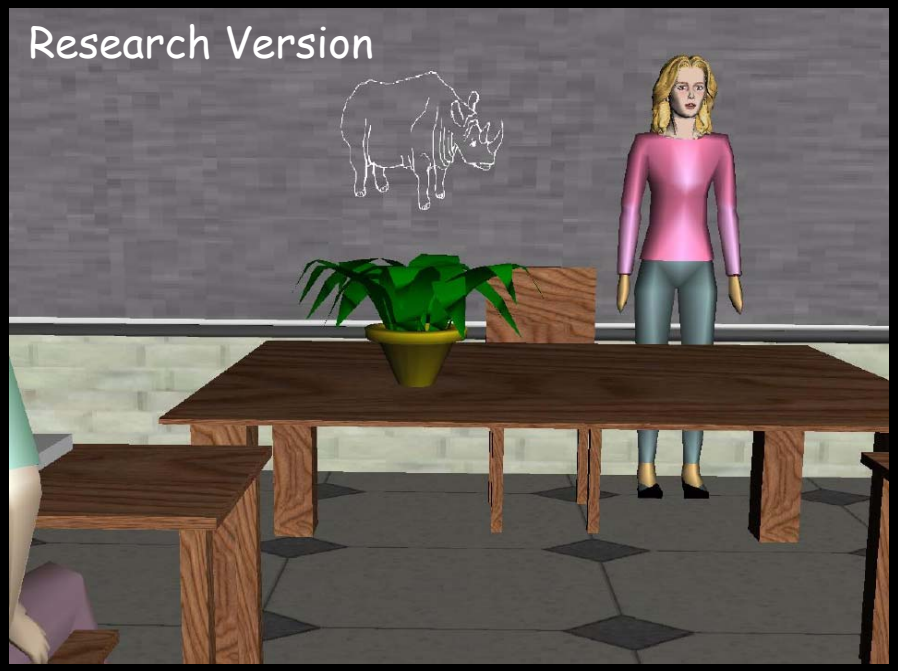


Table 2

Comparison of Means for Psychometric Measures Between ADHD Group and Normal Control Group

	ADHD (n = 8)		Normal (n = 10)		
Measures	M	SD	M	SD	t
SWAN[a]	.70	.94	-1.54	1.11	-4.55**
Conners CPT II[b]					
Omission	55.55	15.37	45.05	4.73	-2.06†
Commission	52.58	7.08	43.64	8.56	-2.37*
Hit RT	56.11	14.93	47.00	4.77	-1.83†

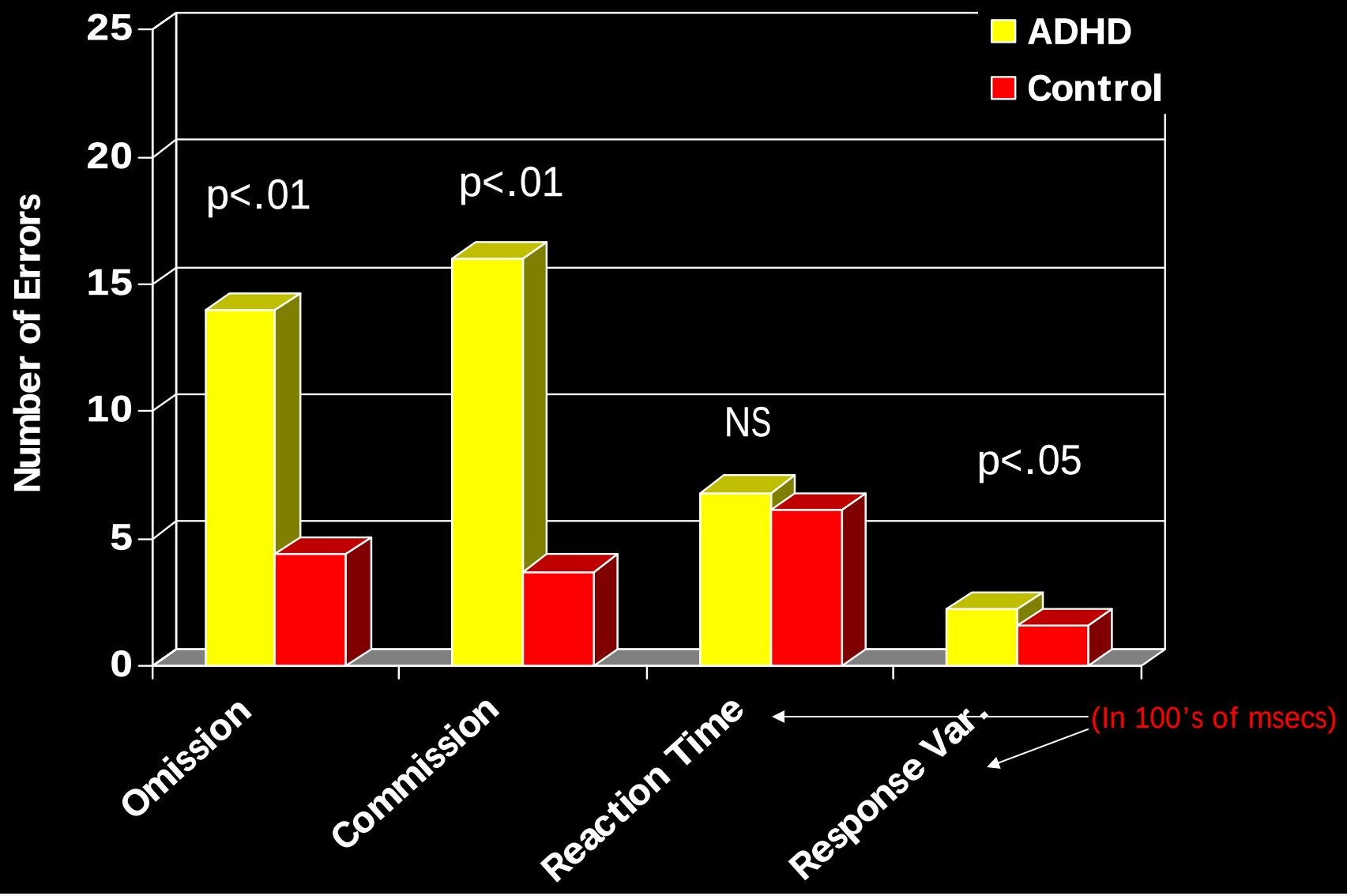
Not Significant…

Note: ADHD = Attention-Deficit/Hyperactivity Disorder. [a]SWAN Behavior Checklist raw scores. [b]Age- and gender-corrected T-scores based on Conners CPT II General Population Norms were used for comparison.

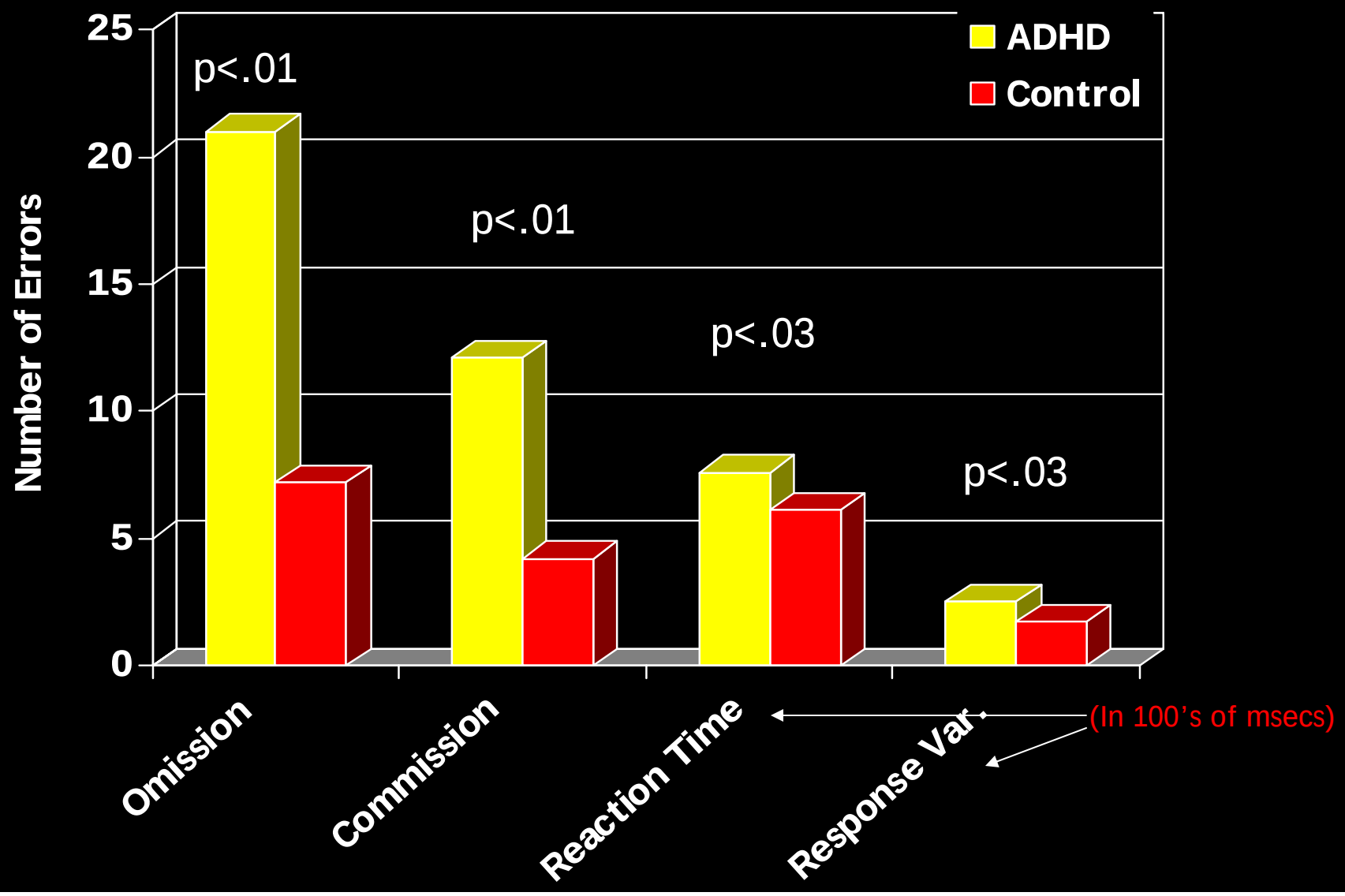
**$p < .01$, *$p < .05$, † $p < .10$

Standard Psychometrics produced mixed results…

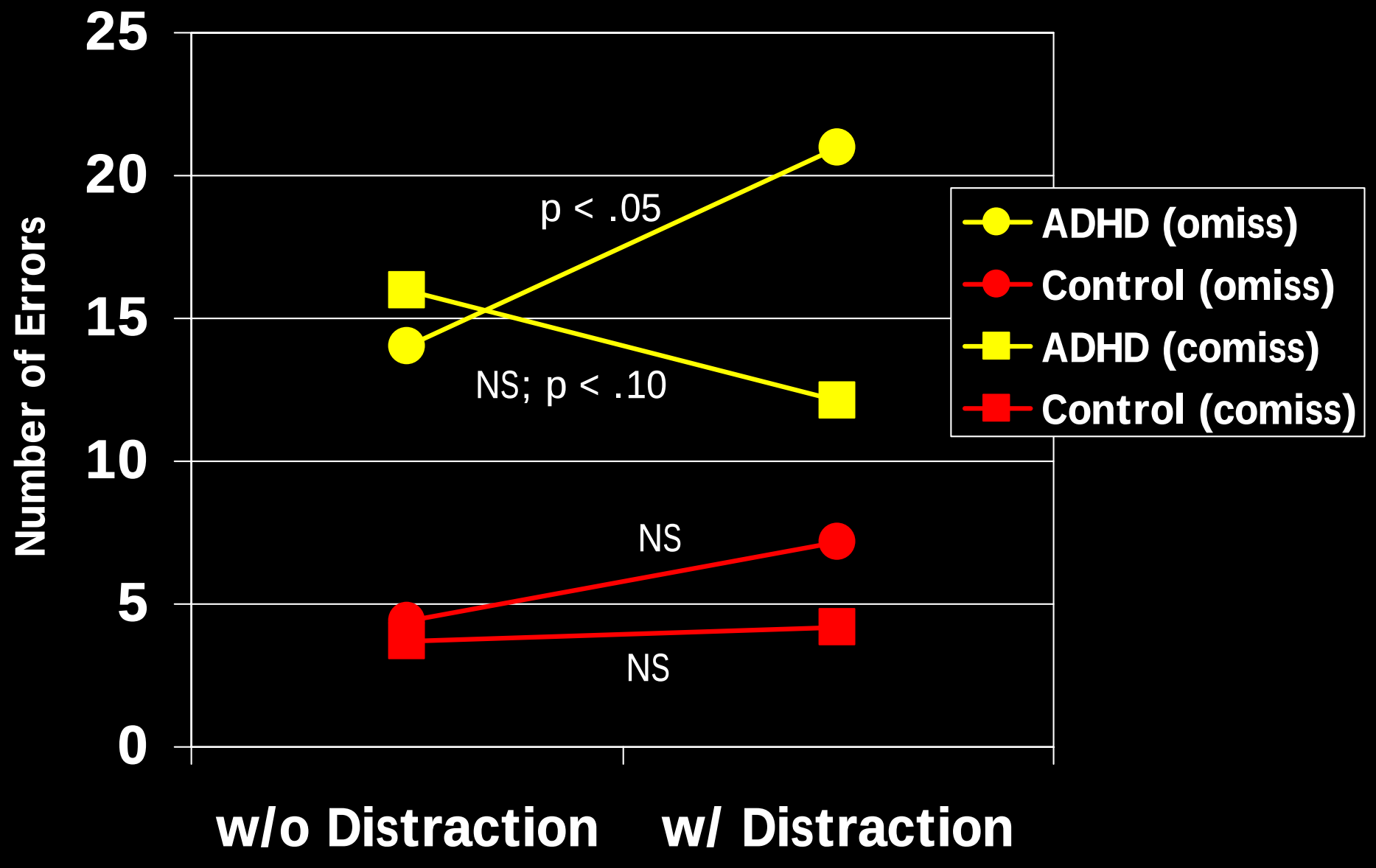
"AX" Attention Task Performance *without* Distraction



"AX" Attention Task Performance *with* Distraction

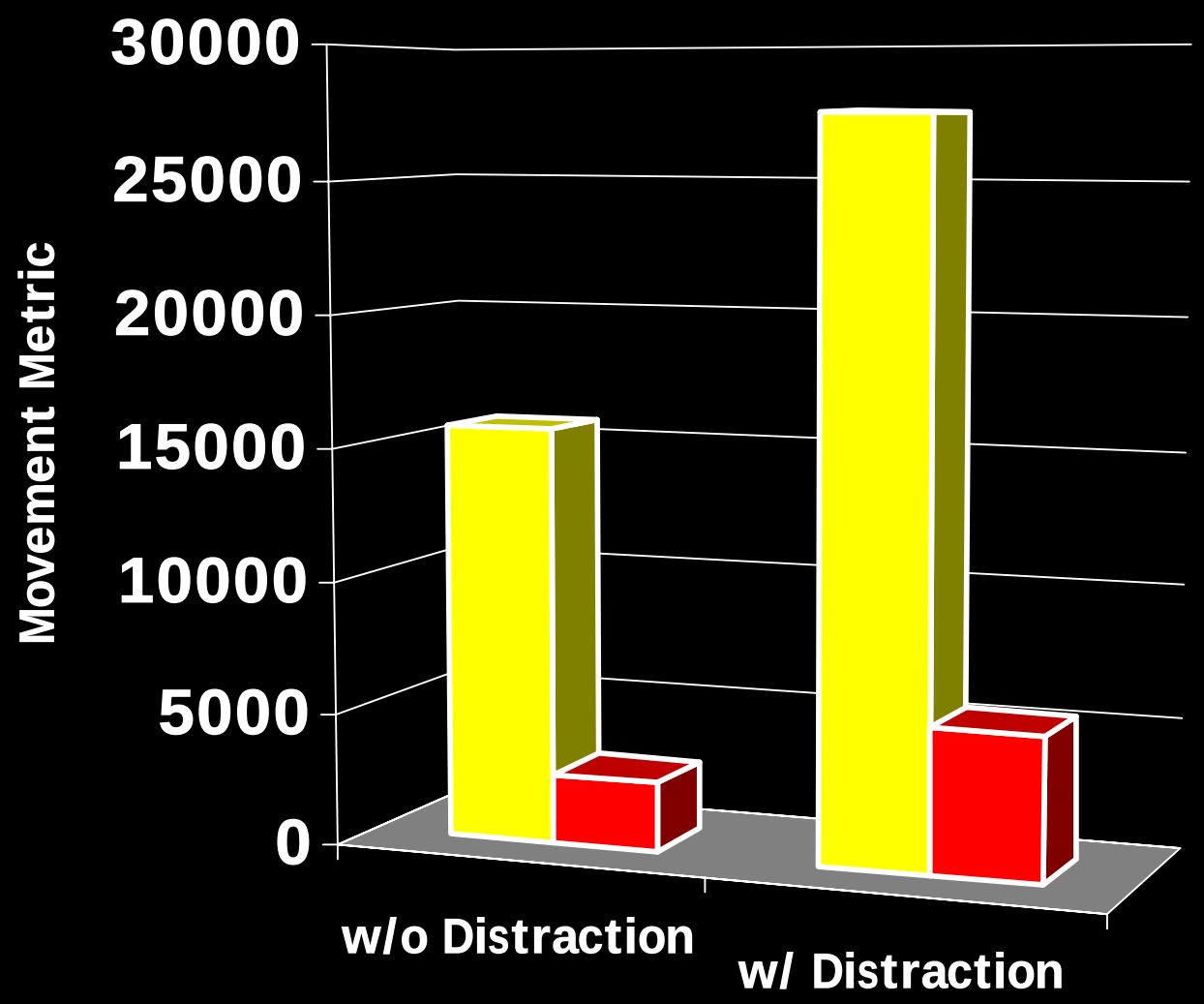


"AX" Attention Task Performance Summary



Sample Movement Measures

Collaboration with Cyrus Shahabi



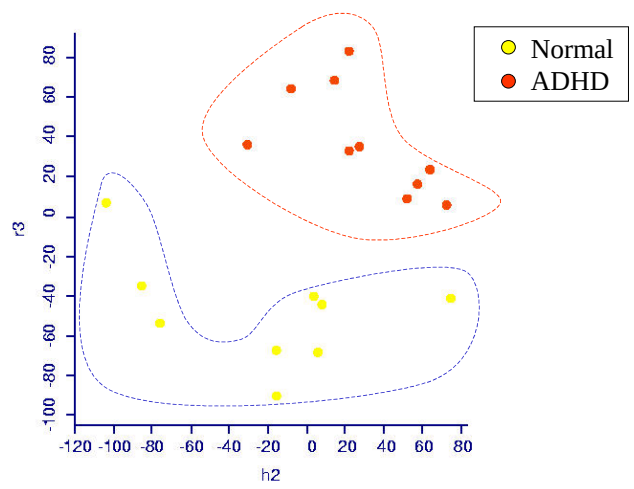
All 18 component movement metrics produced significant diffs. between groups and across distraction conditions!

All tracked movement metrics from Head, Arm & Leg:

Collaboration with Cyrus Shahabi

- Significantly different between groups
- Significantly different within ADHD group across distraction/no distraction conditions
- No differences in Control group across distraction conditions

Neural Net Approach (Support Vector Machine analysis) – after training system on first five subjects per group, 100% discrimination on groups for stereotypic rotation movement of the leg was uncovered.



VR/Rehab Strengths

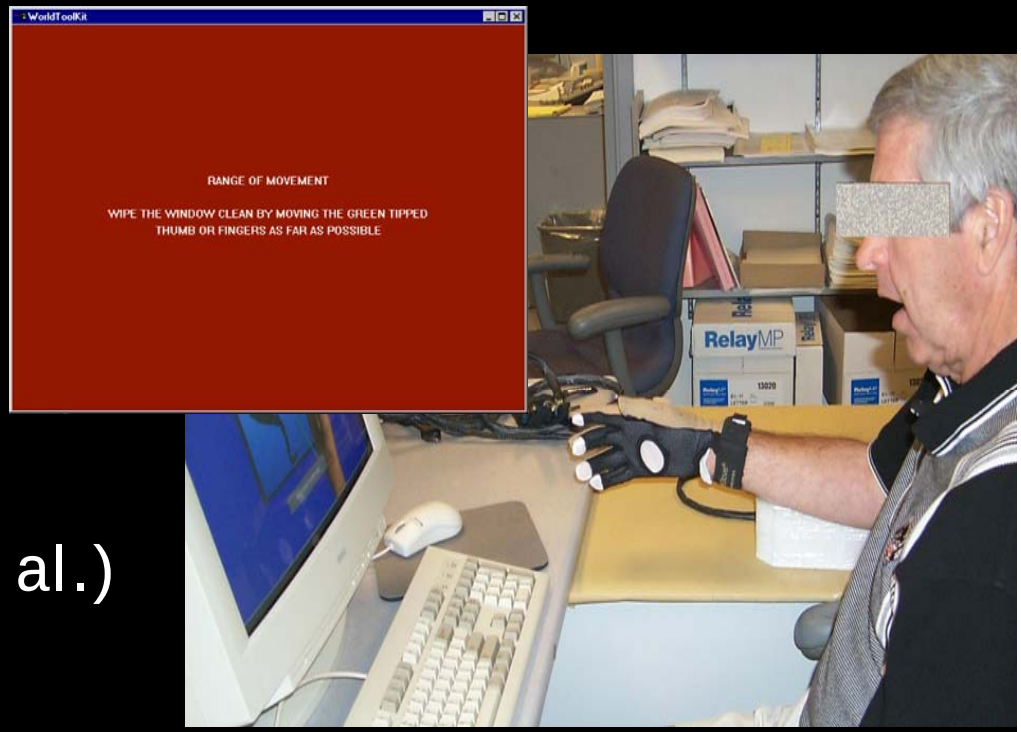
- Ecological validity
- Stimulus/Response control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for "errorless learning"

(Strickland et al.)

Figure 1
Yellow Visual Floor Cues in Virtual House

VR/Rehab Strengths

- Ecological validity
- Stimulus/Response control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for "errorless learning"
- Real time performance feedback



(Burdea et al.)

VR/Rehab Strengths

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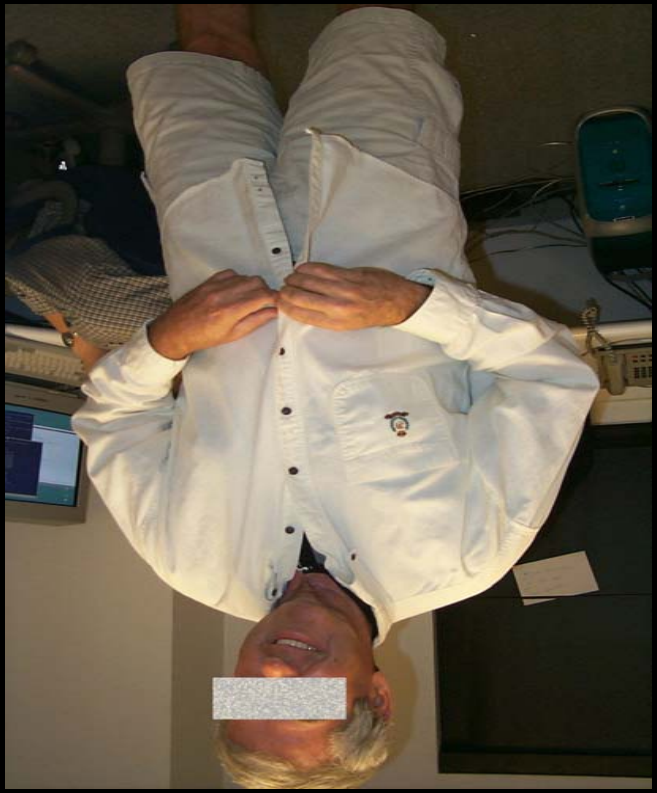
(Burdea et al.)

- Real time performance feedback



VR/Rehab Strengths

- Ecological validity
- Stimulus/Response control and consistency
- Repetitive and hierarchical stimulus delivery possible
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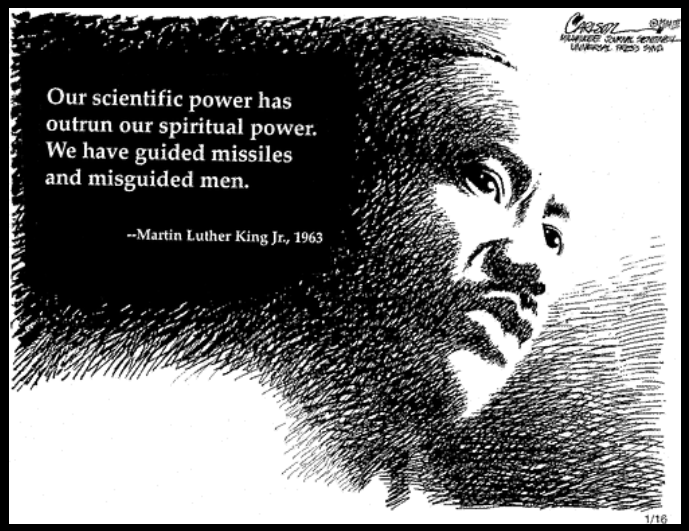
- Real time performance feedback
- Self-guided exploration and independent practice



Challenges

We need guard against the perception that VR Tools are designed to eliminate the need for the Clinician.

VR/Rehab Strengths

- Ecological validity
- Stimulus/Response control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for "errorless learning"
- Real time performance feedback
- Self-guided exploration and independent practice

VR/Rehab Strengths

- Ecological validity
- Stimulus/Response control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for "errorless learning"
- Real time performance feedback
- Self-guided exploration and independent practice
- Stimulus and response modification contingent on user's impairments

Topographical Disorientation

(Brooks et al., 2000)

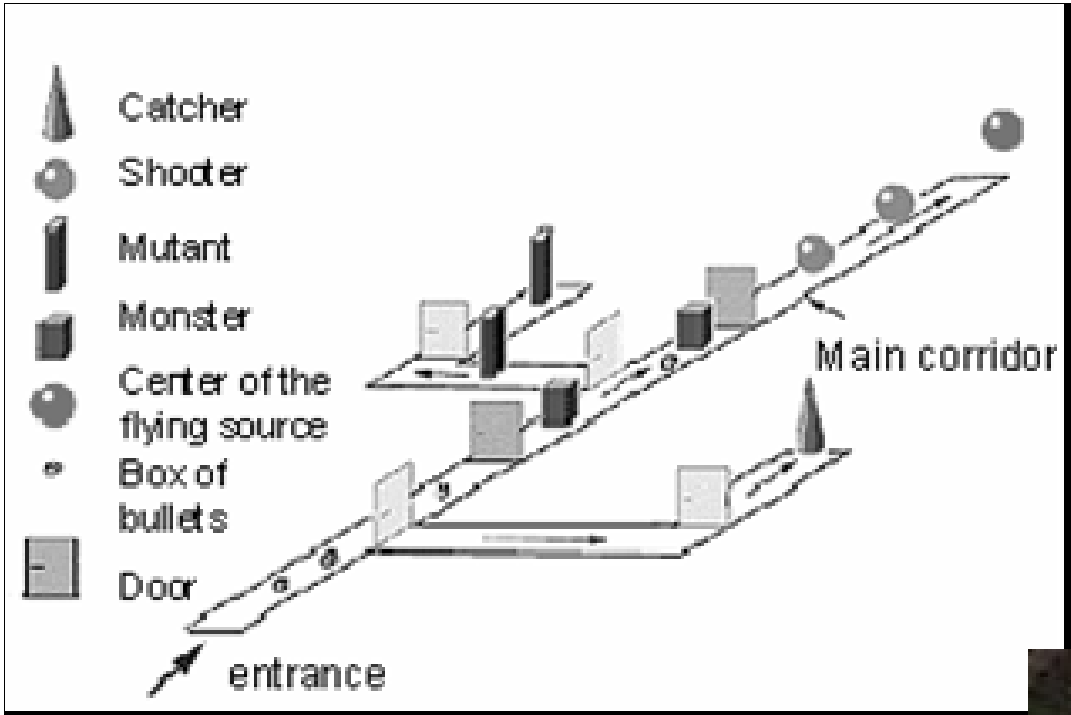
Joystick navigation allowed for more trials than would be possible with the patient's ambulatory skills

Immersive Audio

"AudioDoom"

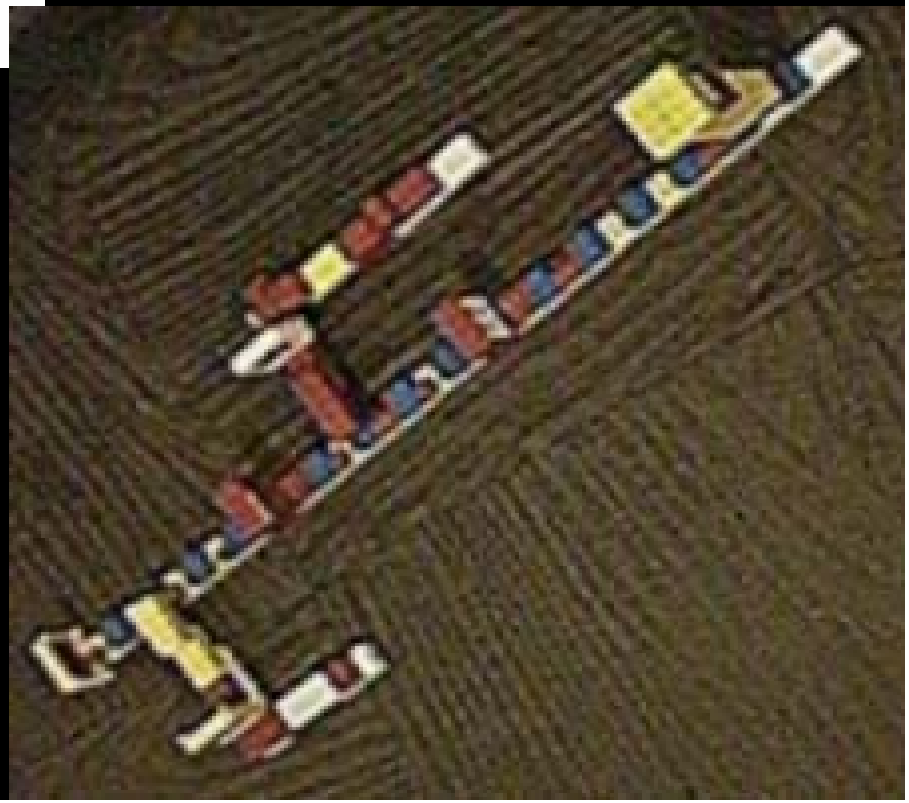
(Lumbreas & Sanchez, 1998)

AudioDoom Lego Construction Task



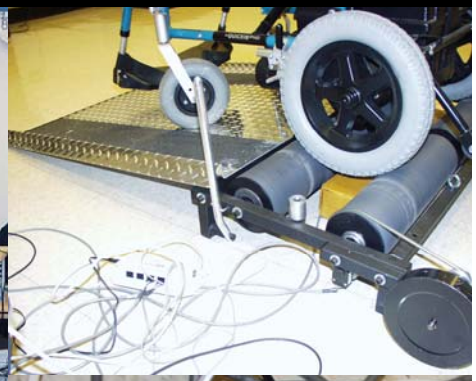
AudioDoom Layout

Lego Reproduction



Wheelchair Interface for Neglect Project

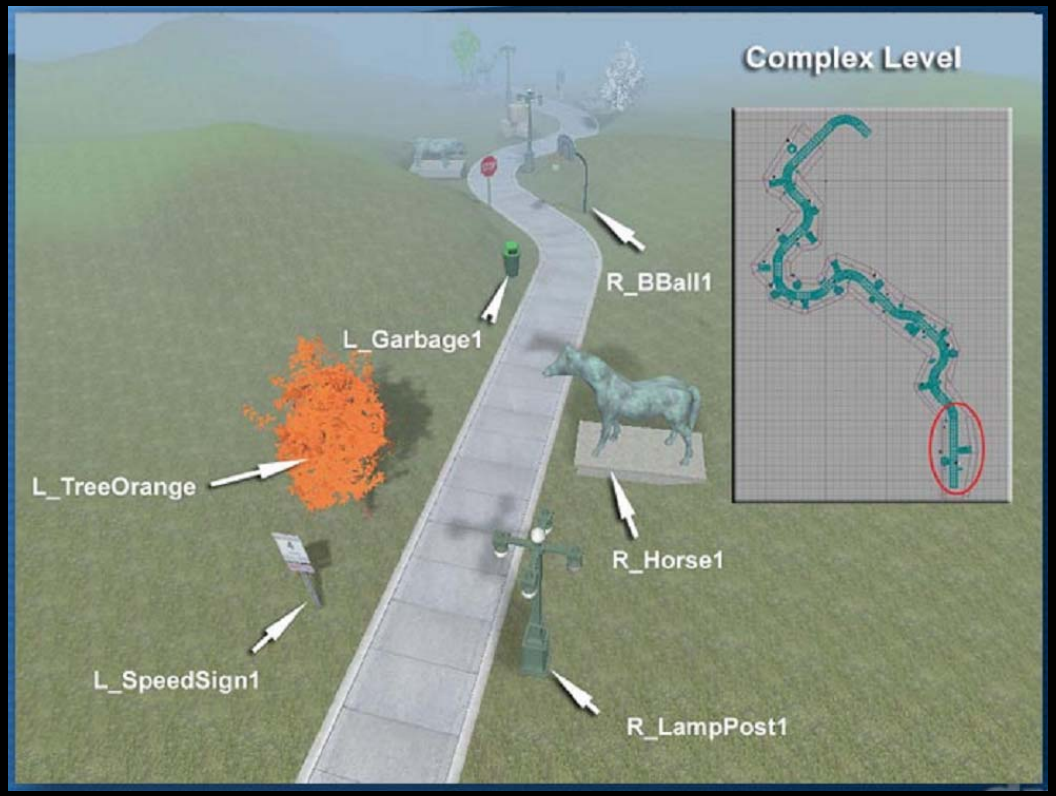
(Buxbaum et al.)



Designed by: Klimchuk, Mitura & Rizzo

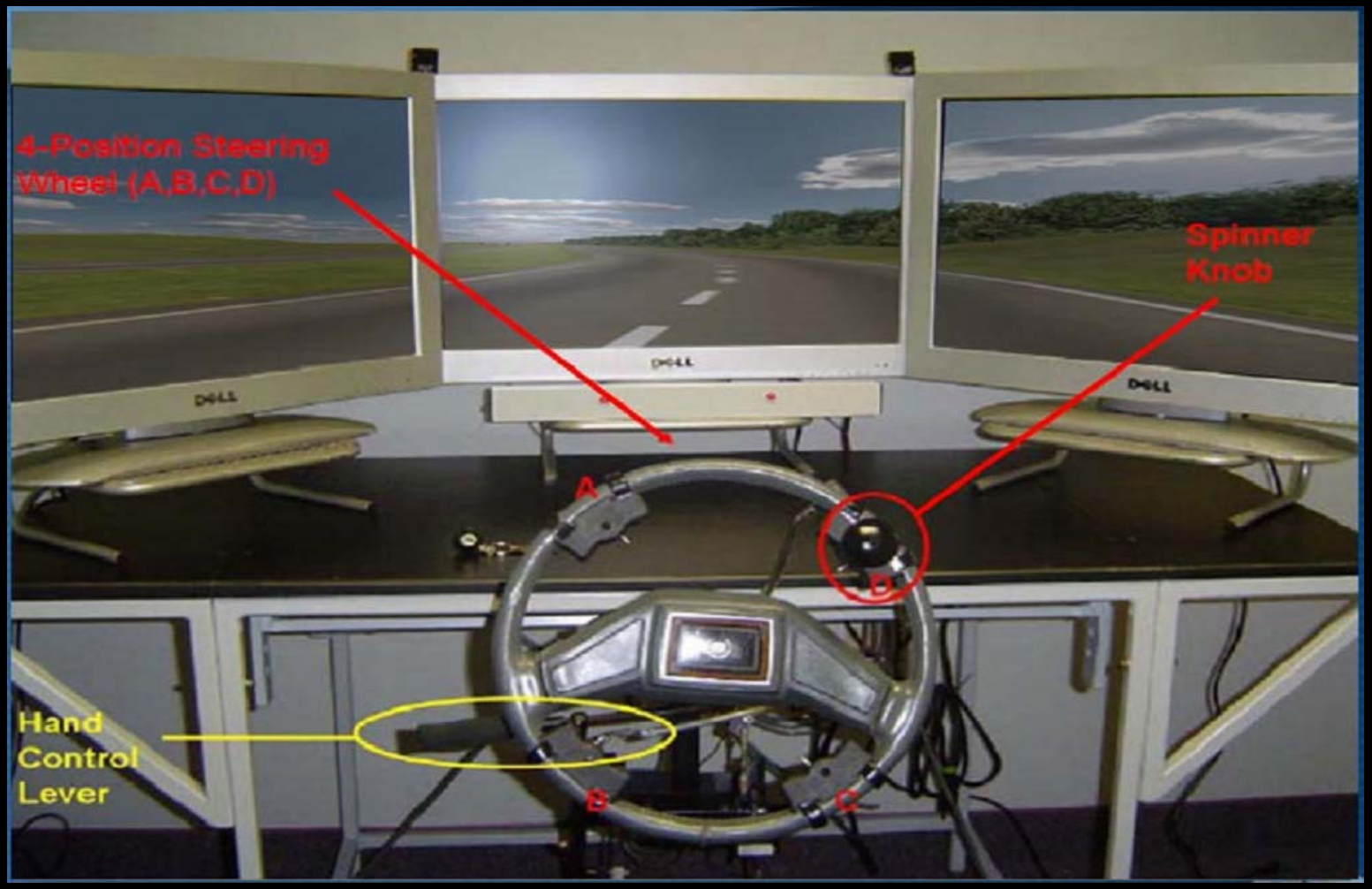
Wheelchair Interface for Neglect Project

(Buxbaum et al.)



Designed by: Klimchuk, Mitura & Rizzo

Interface for Retraining Driving Skills following Spinal Cord Injury (Schultheis et al.)



Designed by: Klimchuk, Mitura & Rizzo

Retraining Driving Skills following Spinal Cord Injury (Schultheis et al.)

Retraining Driving Skills following Spinal Cord Injury (Schultheis et al.)

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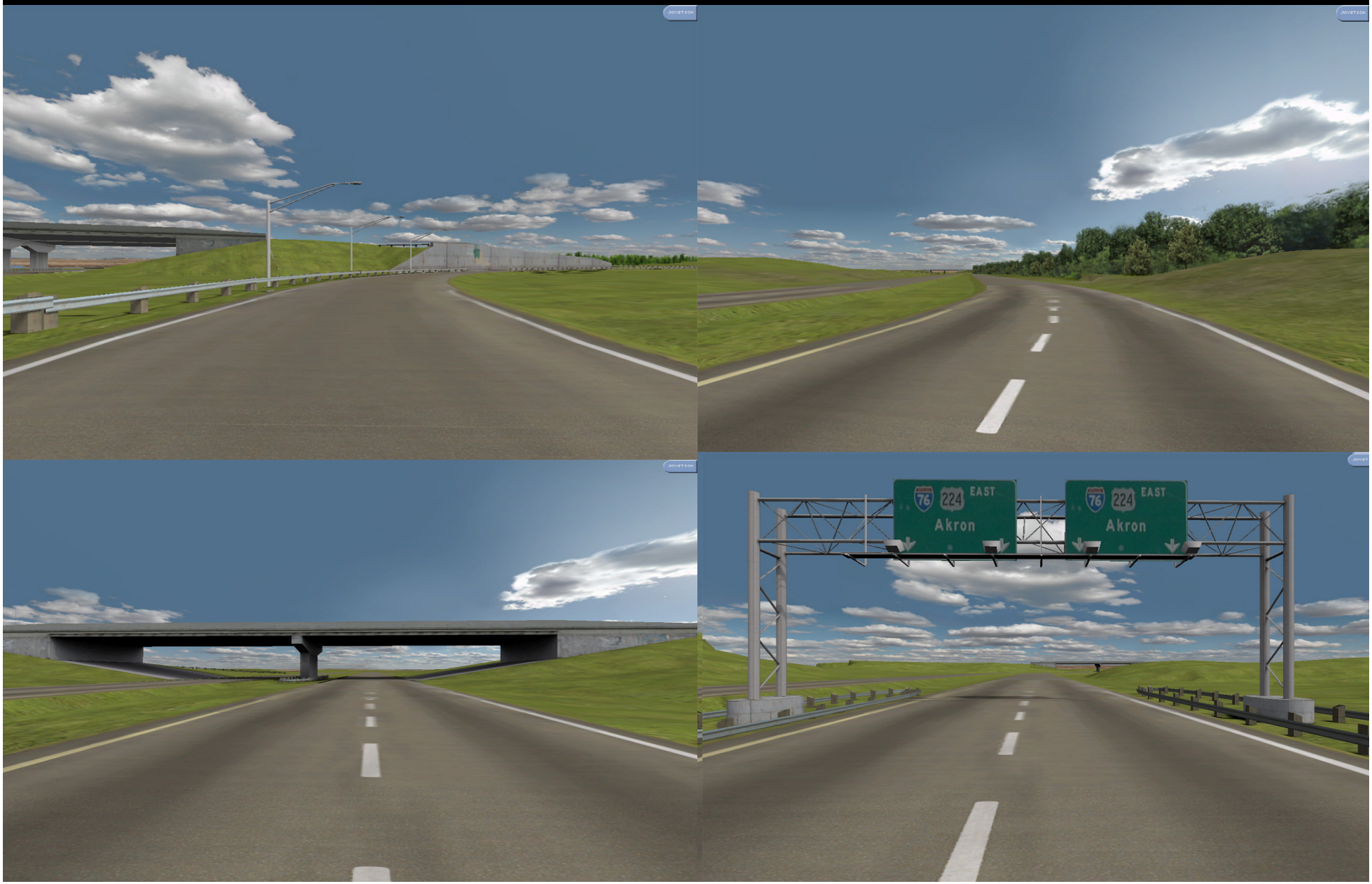
Retraining Driving Skills following Spinal Cord Injury (Schultheis et al.)

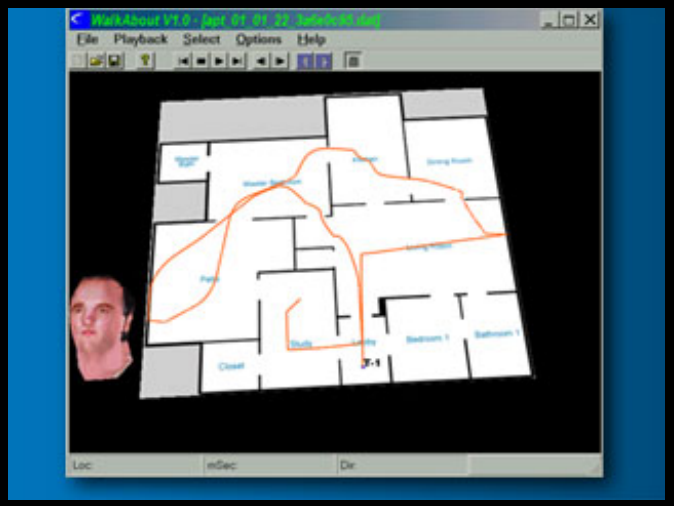


VR/Rehab Strengths

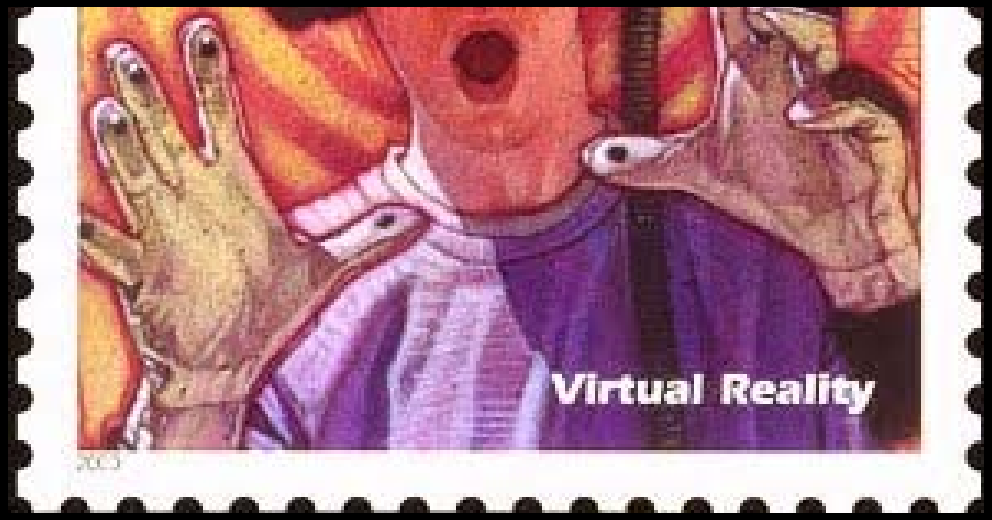
- Complete naturalistic performance record

VR/Rehab Strengths

- Complete naturalistic performance record



VR Classroom Head Tracking Demo



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

VR/Rehab Strengths

- Complete naturalistic performance record

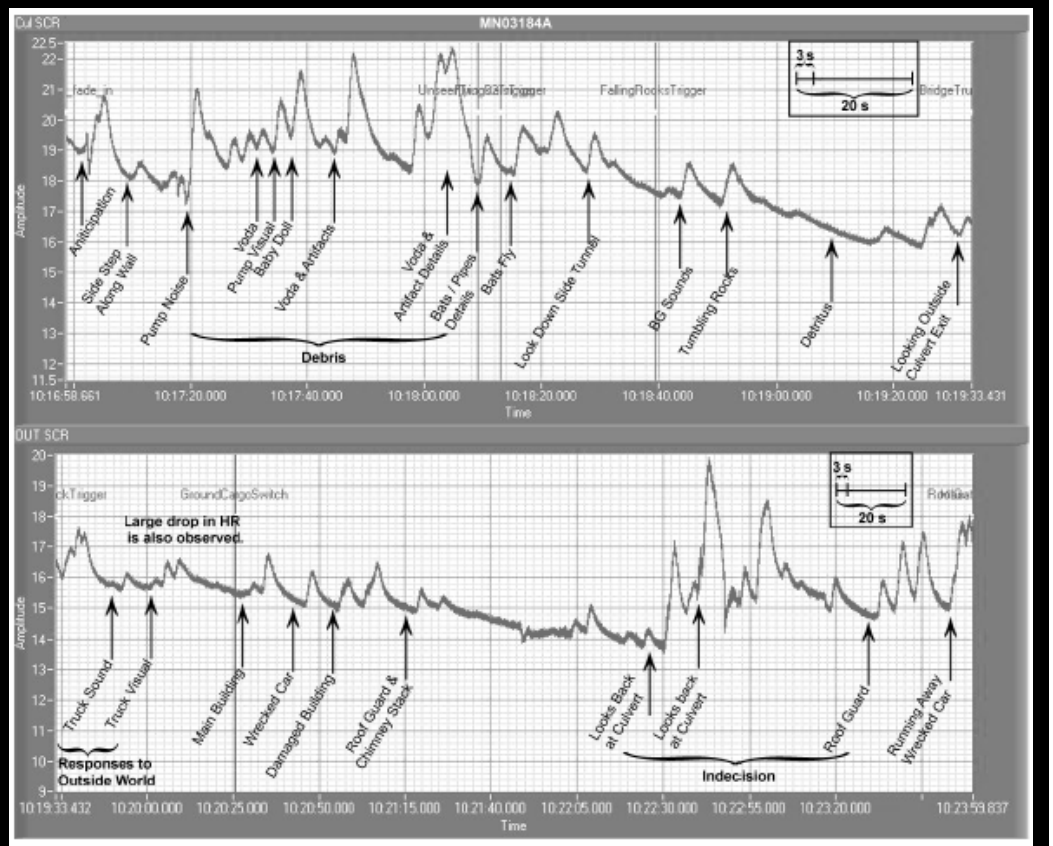


Figure 3. Annotated Skin Conductance results from one DarkCon subject obtained via a replaying of the experience with Phloem

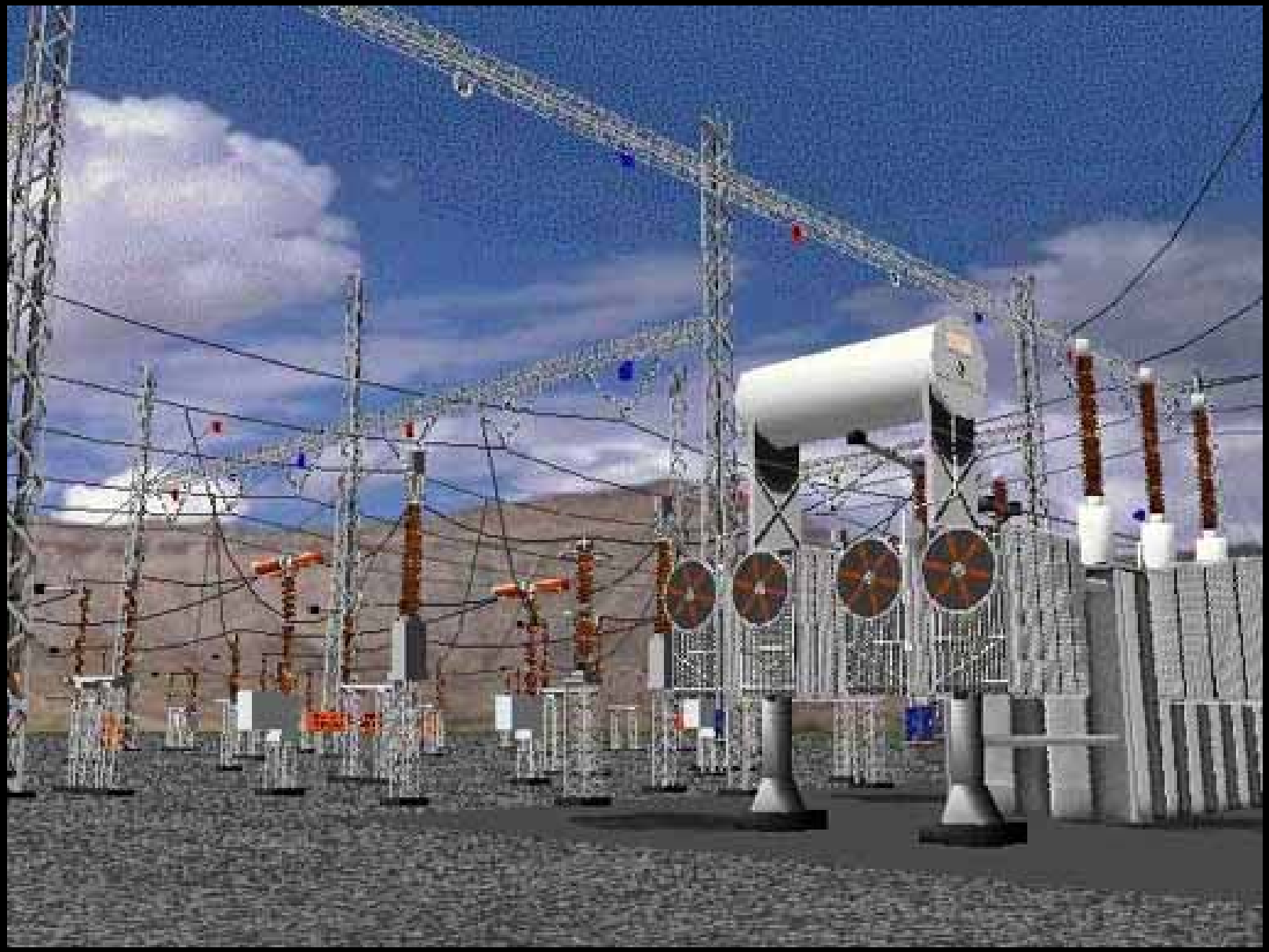
New Project at the USC Institute for Creative Technologies!

Applied Psychophysiology and Biofeedback

Morie, J.F., Iyer, K., Luigi, D.P., Williams, J., Dozois, A. & Rizzo, A.A. (in press). Development of a Data Management Tool for Investigating Multivariate Space and Free Will Experiences in Virtual Reality. *Applied Psychophysiology and Biofeedback*. 30 (3).

VR/Rehab Strengths

- Complete naturalistic performance record
- Safe testing and training environment which minimizes risks due to errors



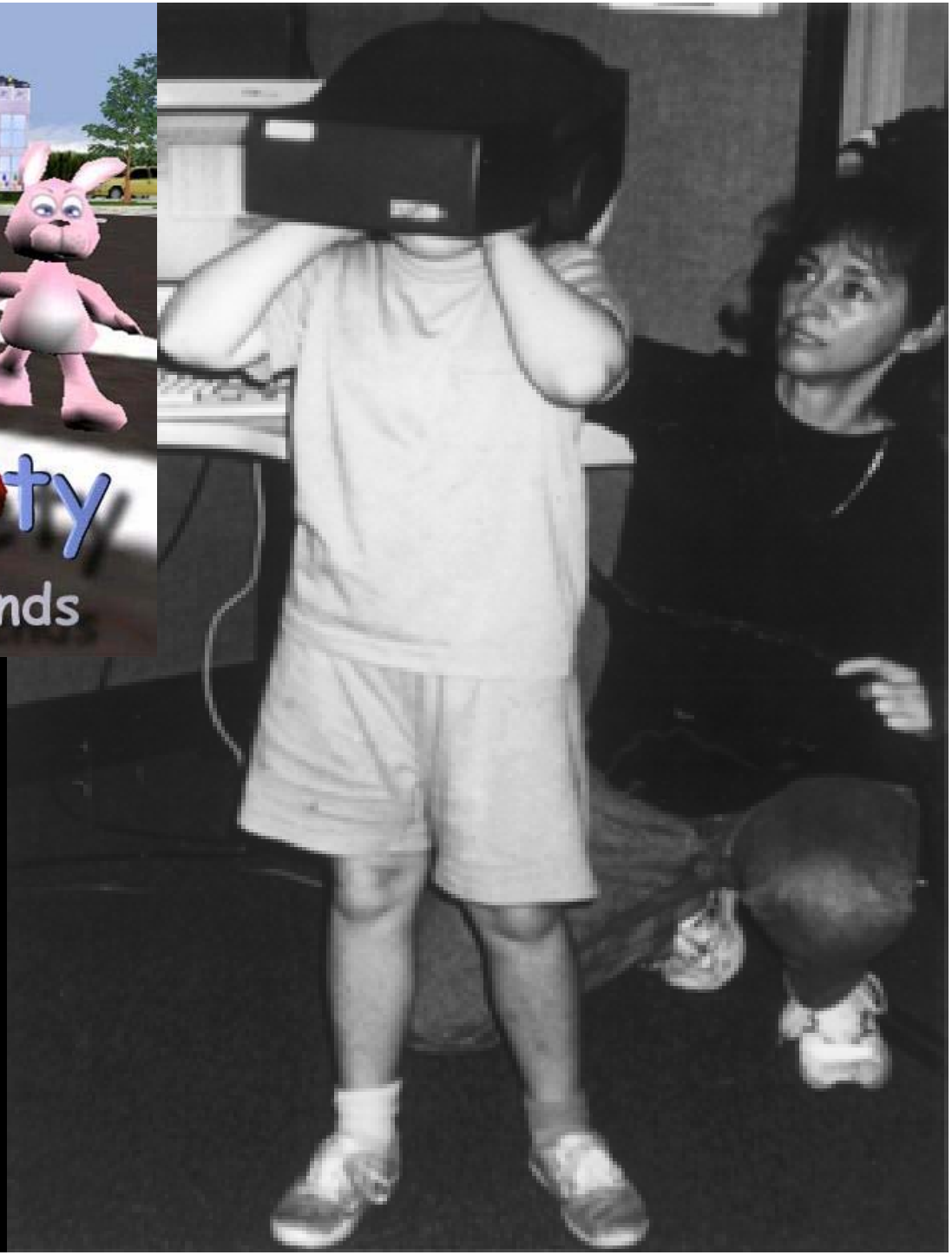
High Voltage Training (5DT)

Kitchen Safety (Brown et al.)

Street Crossing & Neglect (Nevah, Katz & Weiss)

(McComas et al.)

(Strickland et al.)



Asperger's Syndrome Video
Strickland (2002)

Motorized Wheelchair Training Video (Inman et al.)

VR/Rehab Strengths

- Complete naturalistic performance record
- Safe testing and training environment which minimizes risks due to errors

VR/Rehab Strengths

- Complete naturalistic performance record
- Safe testing and training environment which minimizes risks due to errors
- Graduated, systematic exposure

Hodges/Rothbaum

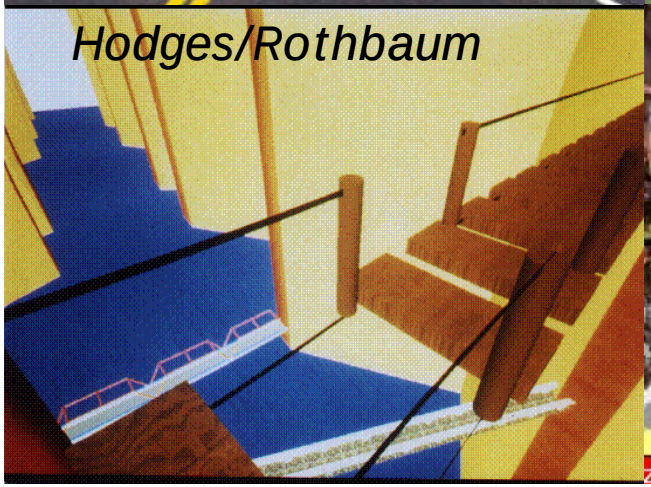
North

Previ
Boarding
Gate
13

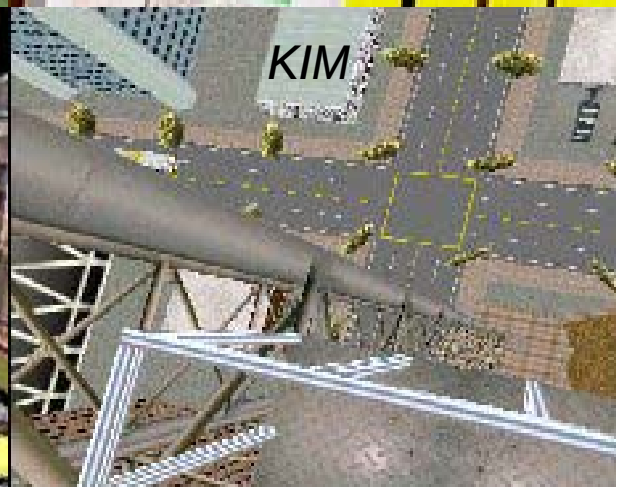
Midtown Madness

Riva

Hoffman


Hodges/Rothbaum

Emmelkamp
zoom


KIM

Fear of Heights

Fear of Heights…Research Studies

- Lamson (1995)
  - 9 participants
- Hodges, Rothbaum, & North (1995)
  - 17 undergraduate students
- Bullinger (1997)
  - VR vs. In vivo
- Huang (1998)
  - VR vs. In vivo
- Emmelkamp, Krijin, Schuemie (1999)
  - VR vs. In vivo
- Kim, Jang, & Choi (1999)
- Wiederhold (2000)
- Scheumie (2002)

North 1000.com

Fear of Heights…Success Stories!

- Lamson (1995)
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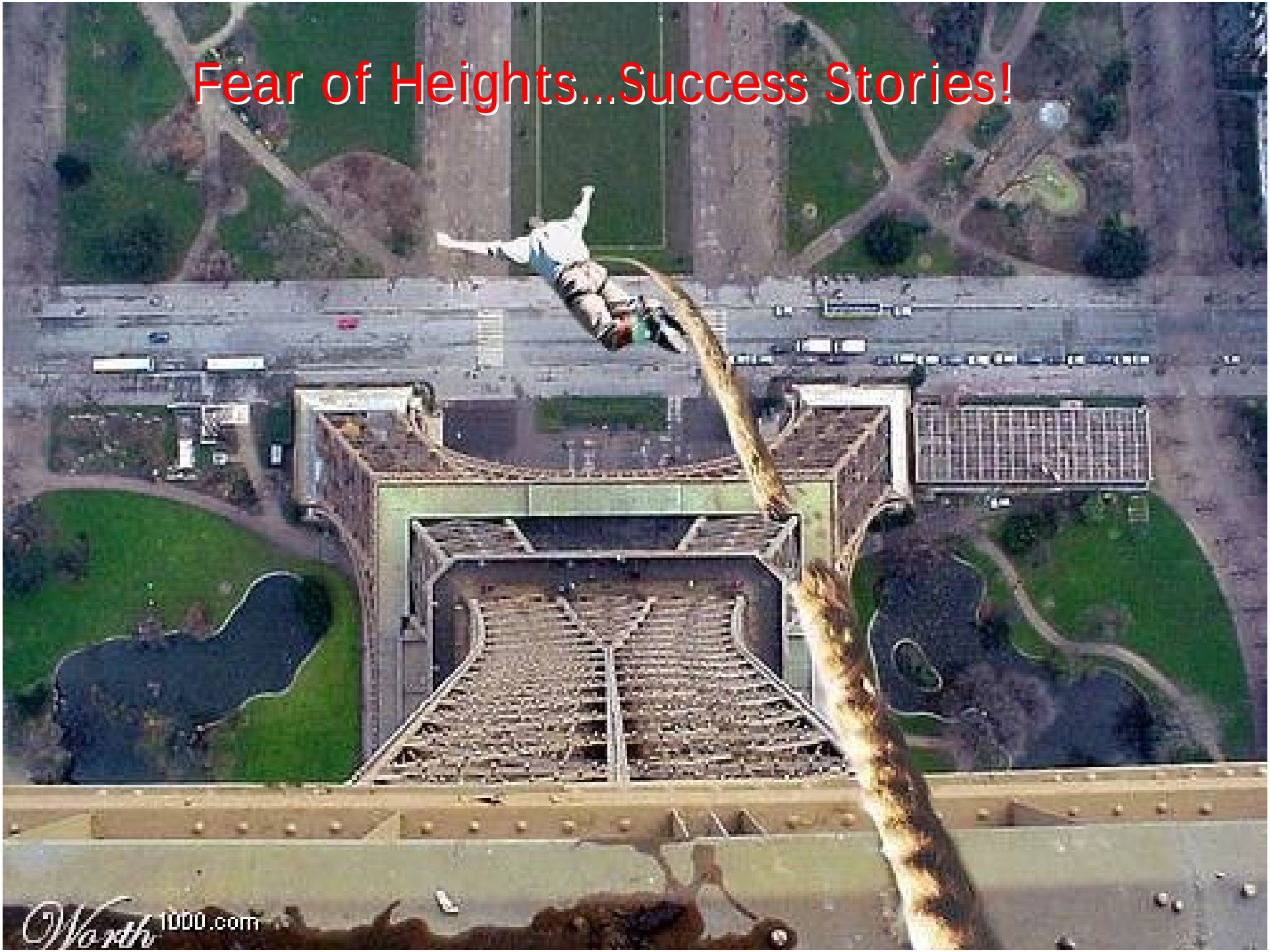
North 1000.com

Fear of Heights…Success Stories!



Fear of Heights Exposure Therapy

Using Unreal *Tournament Game Engine*

(Bouchard et al., 2003)

Arachnophobia

Using Unreal *Tournament Game Engine*

Virtual Vietnam

Hodges, Rothbaum et al.

This occurred over 20 years following the end of the Vietnam War.

Virtual Reality Exposure Therapy for Treatment of Acute World Trade Center PTSD: A case study

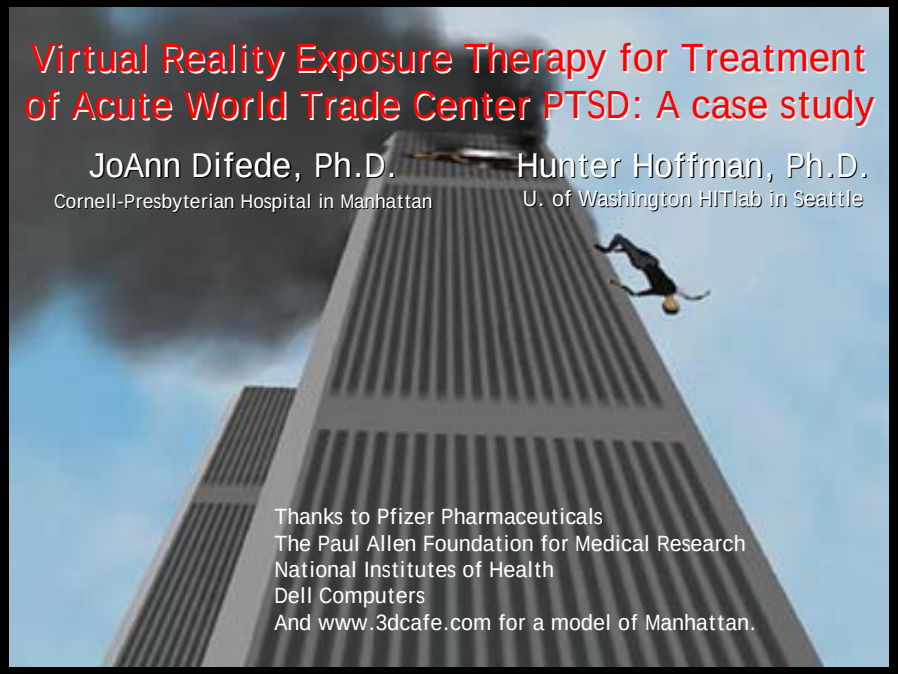
JoAnn Difede, Ph.D.
Cornell-Presbyterian Hospital in Manhattan

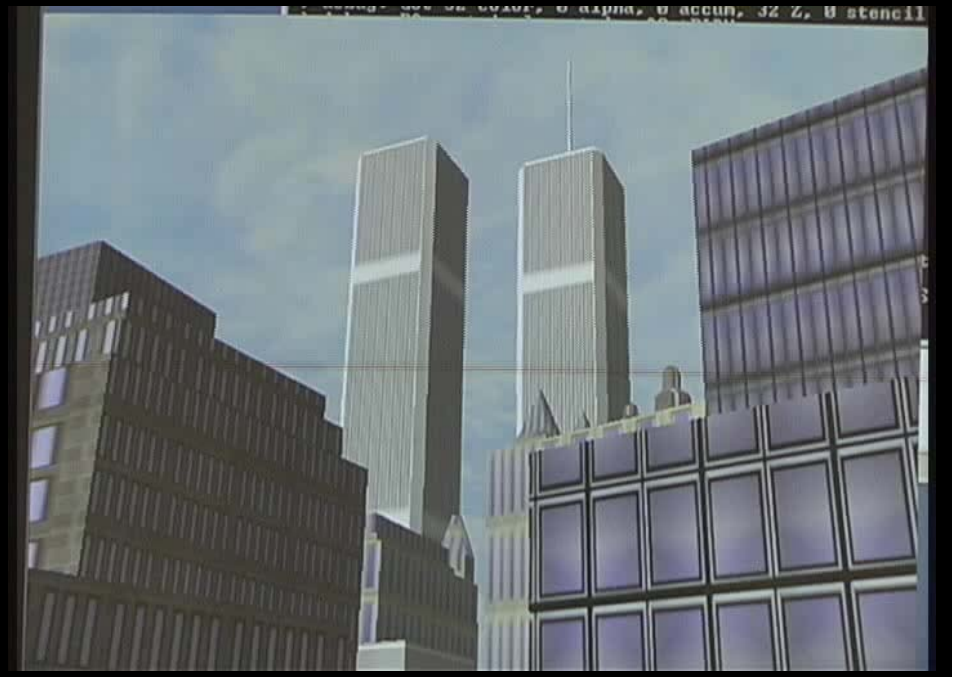
Hunter Hoffman, Ph.D.
U. of Washington HITlab in Seattle

Thanks to Pfizer Pharmaceuticals
The Paul Allen Foundation for Medical Research
National Institutes of Health
Dell Computers
And www.3dcafe.com for a model of Manhattan.

World Trade Center PTSD

Univ. of Washington HIT Lab/Cornell-Presbyterian NYC (Hoffman & Difede)





Shortcut to 911PTSDTherapy_Fina_144[1].mov.lnk

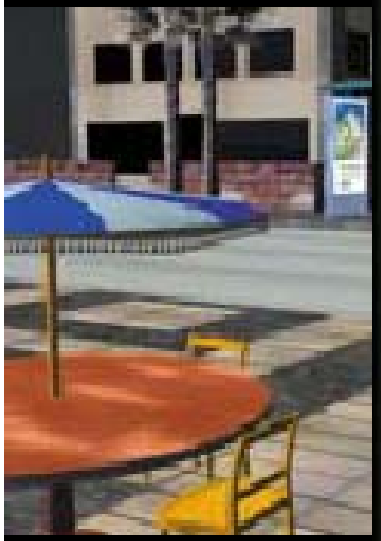
Table 1 Self-Report Scores of PTSD and Depression

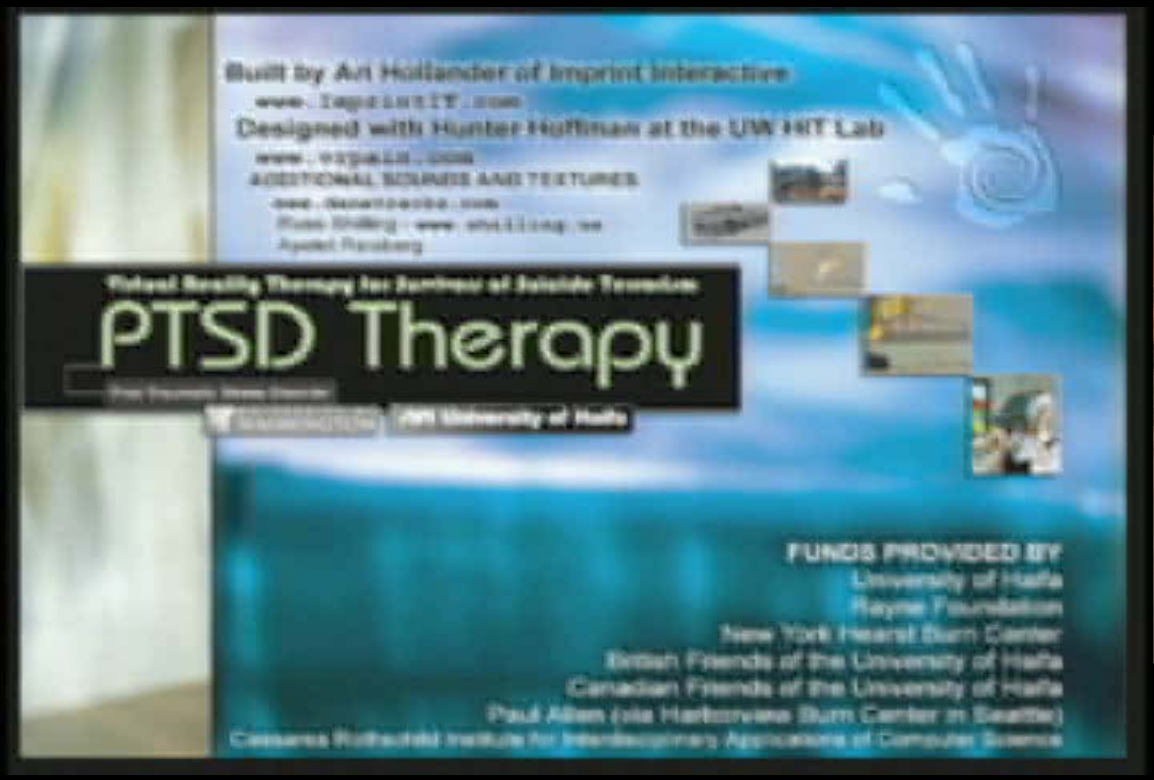
	Depression (BDI)	PTSD (PDS) Total Score	Reexperience Symptoms	Avoidance Symptoms	Arousal Symptoms
Baseline	37.00	37.00	9.00	16.00	12.00
VR Session 1 (week 5)	30.00	40.00	13.00	14.00	13.00
Completion of Treatment (week 14)	5.00	4.00	1.00	0.00	3.00

Note that Re-experiencing Symptoms + Avoidance Symtoms + Arousal Symptoms = PTSD Total Score.

Terrorist Bus Bombing

U of Wash. HIT Lab/U. of Haifa





USC-ICT Full Spectrum VR Application for Iraq War PTSD

More on this later in the tutorial

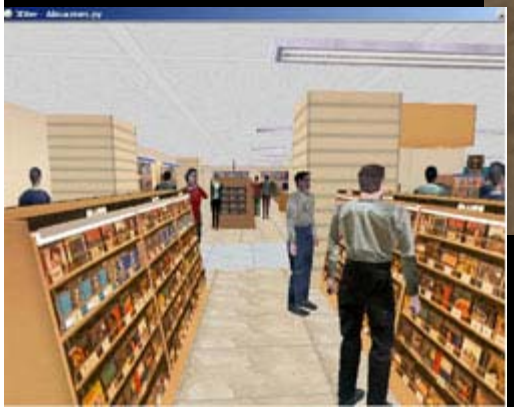
Rizzo et al

Riva

Social Phobia/Cue Exposure

Slater

Previ



Hodges, Rothbaum et al.

VR Cue Rooms

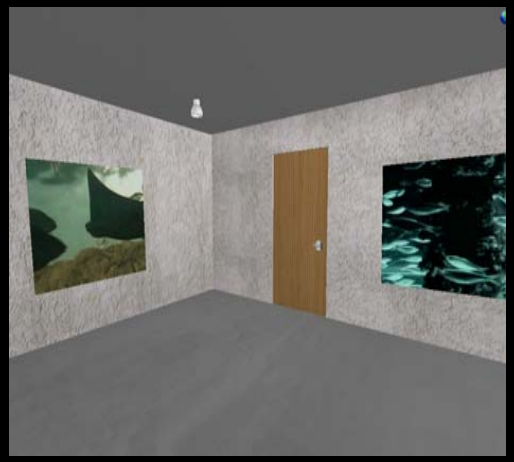
(Bordnick et al.)

Figure 4. VR smoking social interaction party environment.

Social interaction

Smoking materials

Figure 10. VR party on a deck at night with pine and cigarette smoke scents using the Scent Palette™ system



Neutral Room

VR Cue Rooms

(Bordnick et al.)

Figure 2. Traditional cue. Still photo of alcohol beverages

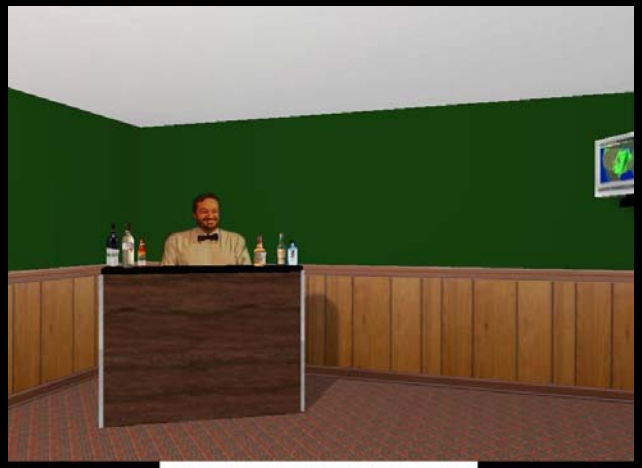
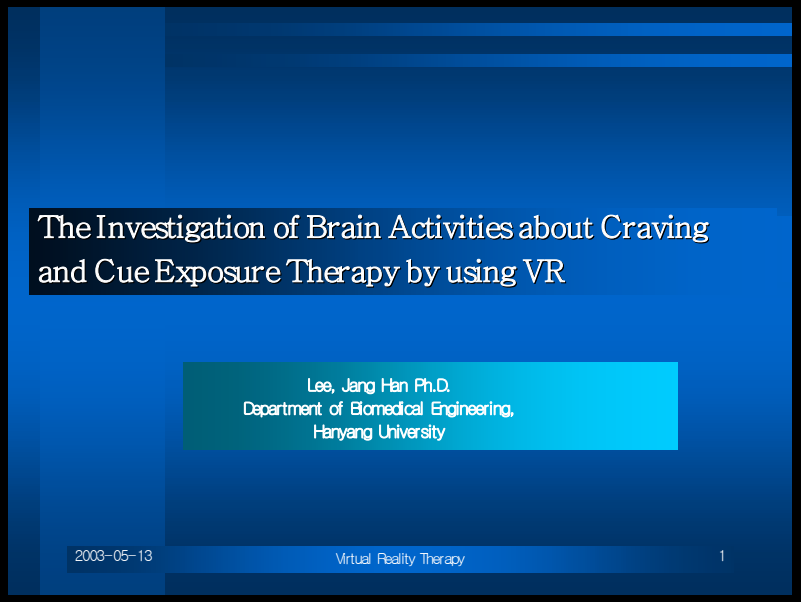


Figure 7. VR alcohol bar environment.

Social interaction

Virtual "Crack House"



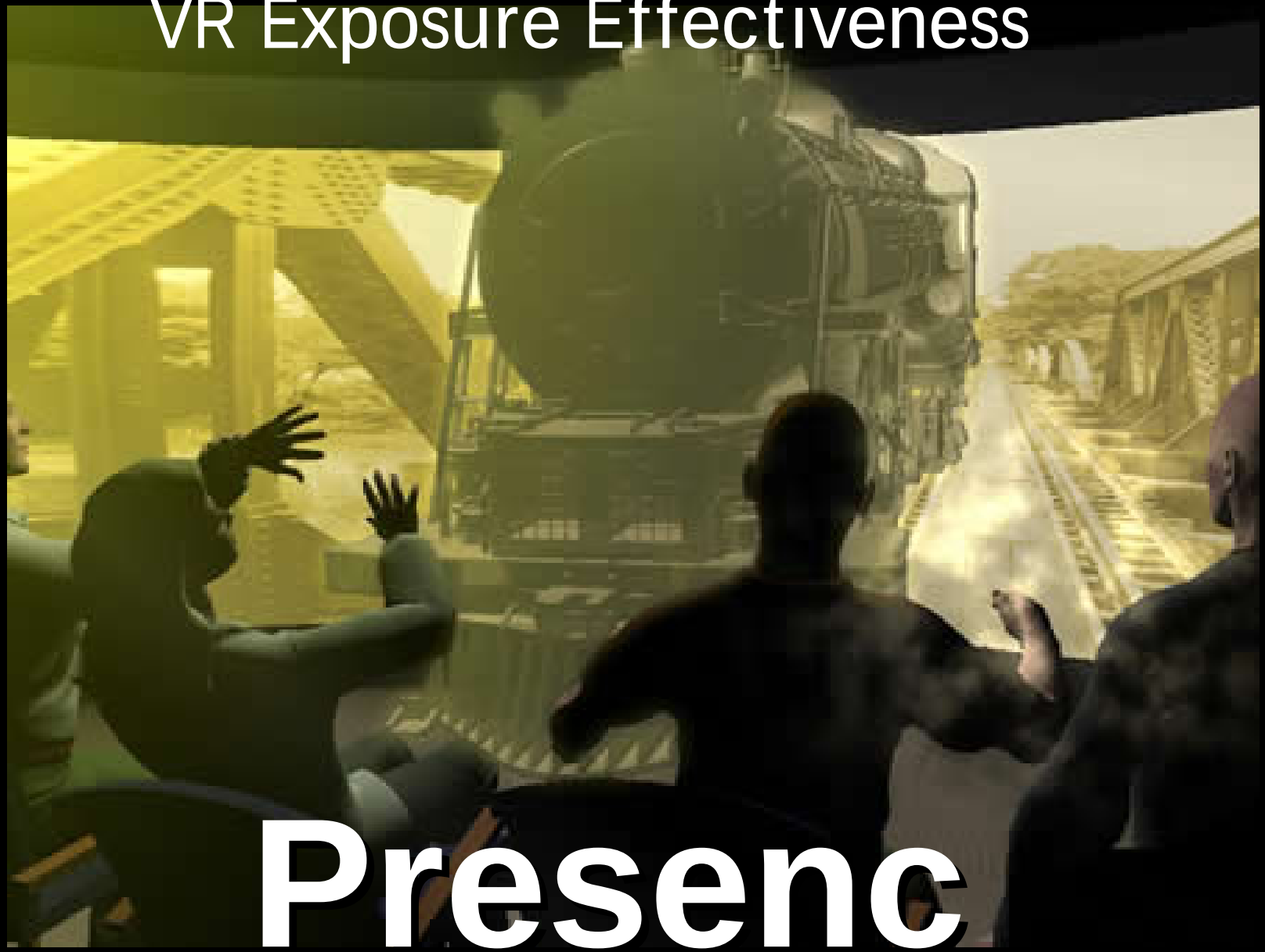
Hanyang University, Korea

Lee & Kim, 2003

Virtual Environment

Number of smoking avatars are 2. One avatar is standing, and the other avatar is sitting on a chair. Five craving objects are shown, i.e., an alcoholic drink, a pack of cigarettes, a lighter, an ashtray, and a glass of beer).

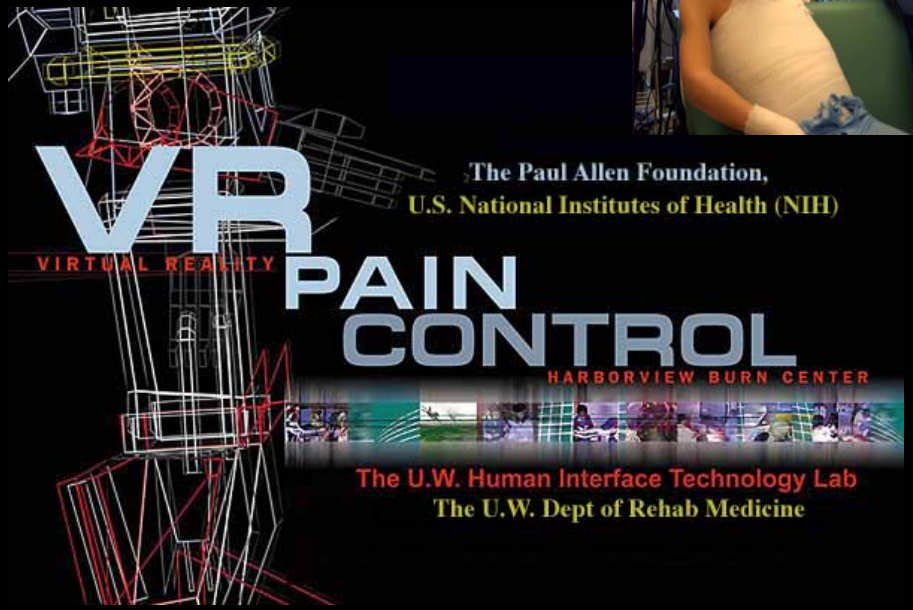
Key Research Issue for Enhancing VR Exposure Effectiveness



VR/Rehab Strengths

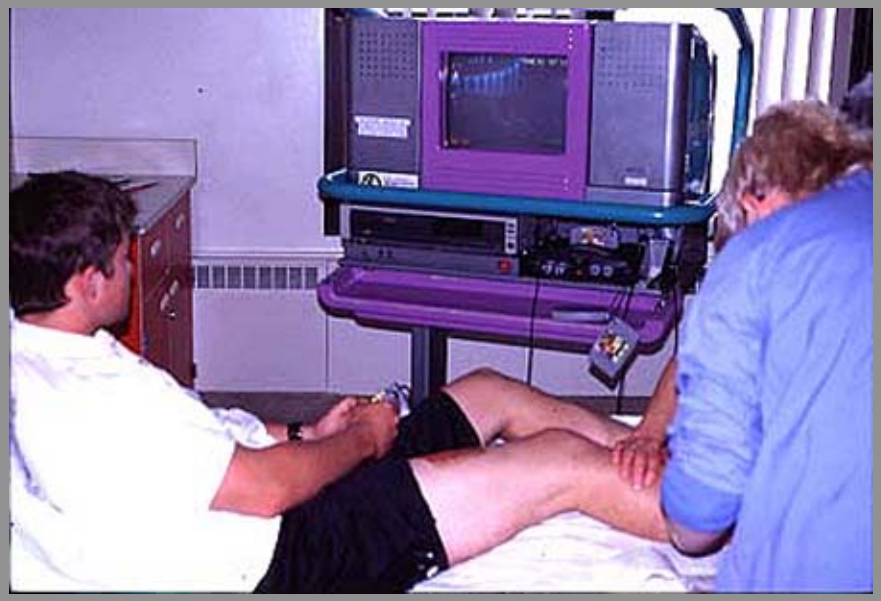
- Complete naturalistic performance record
- Safe testing and training environment which minimizes risks due to errors
- Graduated, systematic exposure

- Distraction



Burn Wound Care & Physical Therapy (Hoffman et al.)

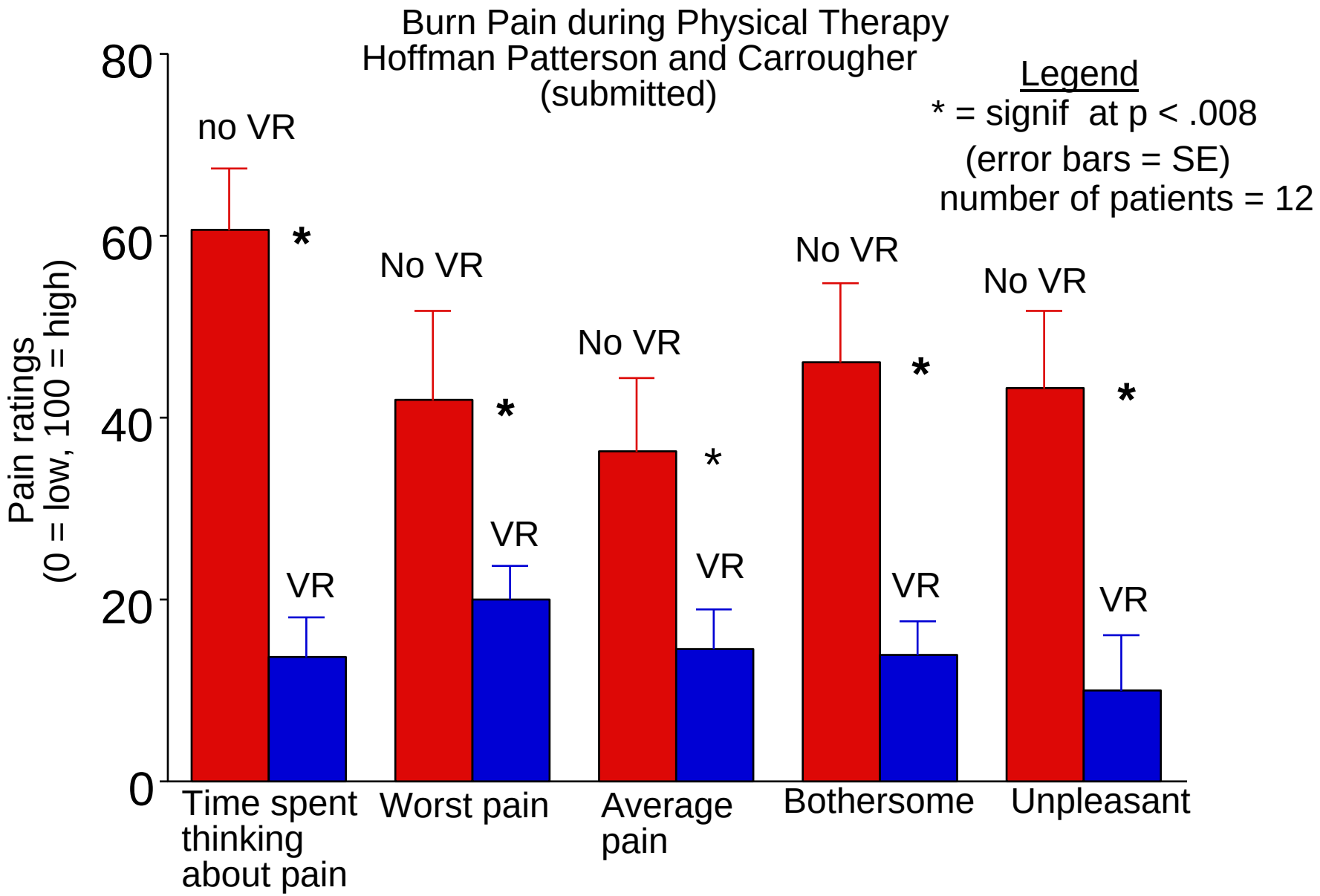
Comparison Between Ninetendo and VR



Video game during wound care

In VR during wound care

Hoffman, Doctor, Patterson, Carrougher & Furness, T.A. III (2000). Use of virtual reality for adjunctive treatment of adolescent burn pain during wound care: A case report. Pain.


Burn Pain during Physical Therapy
Hoffman Patterson and Carrougher
(submitted)
Legend
* = signif at p < .008
(error bars = SE)
number of patients = 12
Pain ratings
(0 = low, 100 = high)
80
60
40
20
0
no VR
VR
No VR
VR
No VR
VR
No VR
VR
No VR
VR
*
*
*
*
*
Time spent thinking about pain
Worst pain
Average pain
Bothersome
Unpleasant

Virtual Game World's Used for Pain Distraction

Hodges et al. - ZooAtlanta
"Gorilla World"

and "WaterWorld"

VRMC - Wiederhold et al.

Using Unreal *Tournament Game Engine*

Rationale for VR/Games Pain Distraction

Limited-Capacity of Attention

(e.g., Broadbent, 1958; Shiffrin & Schneider, 1977)

Attention and Pain

- Pain perception requires attending to noxious stimuli
- Pain can be reduced by distributing attention elsewhere
- Effectiveness related to intensity, novelty, & unpredictability of distracting stimuli (McCaul & Malott, 1984).
- VR/Games draws heavily upon attentional resources
- HMD prevents visual perception of environment

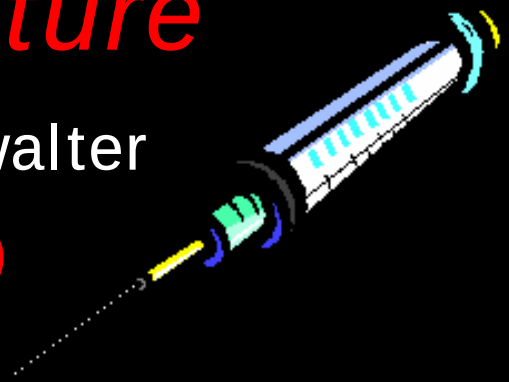
ChildrensHospitalLosAngeles
International Leader in Pediatrics

VR Games Pain Distraction Project (Rizzo, Gold, Reger & Katz)

VR Pain Distraction for Children Undergoing Venipuncture

Reger, Rizzo, Gold, Allen & Buckwalter

(In Progress – Target N = 120)



Between group comparison of 4 conditions:

- Standard Care + Visual Occlusion; n=18
- VR HMD w/Force Feedback Joystick; n=13
- VR Flatscreen w/Force Feedback Joystick; n=12
- Cartoon; n=14

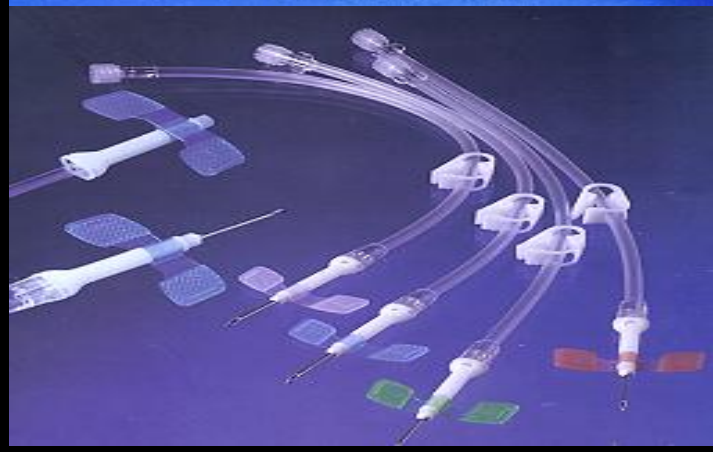
Other Variables: Presence; Anxiety; Parental/Phlebotomist ratings; etc.

VR Games Pain Distraction Project

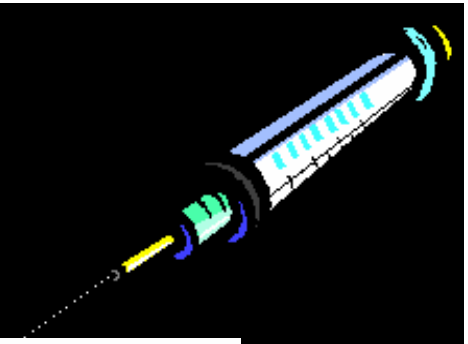
(Rizzo, Gold & Katz)

Initial Scenario used:

For Venapuncture



Childhood Pain Measures Used:



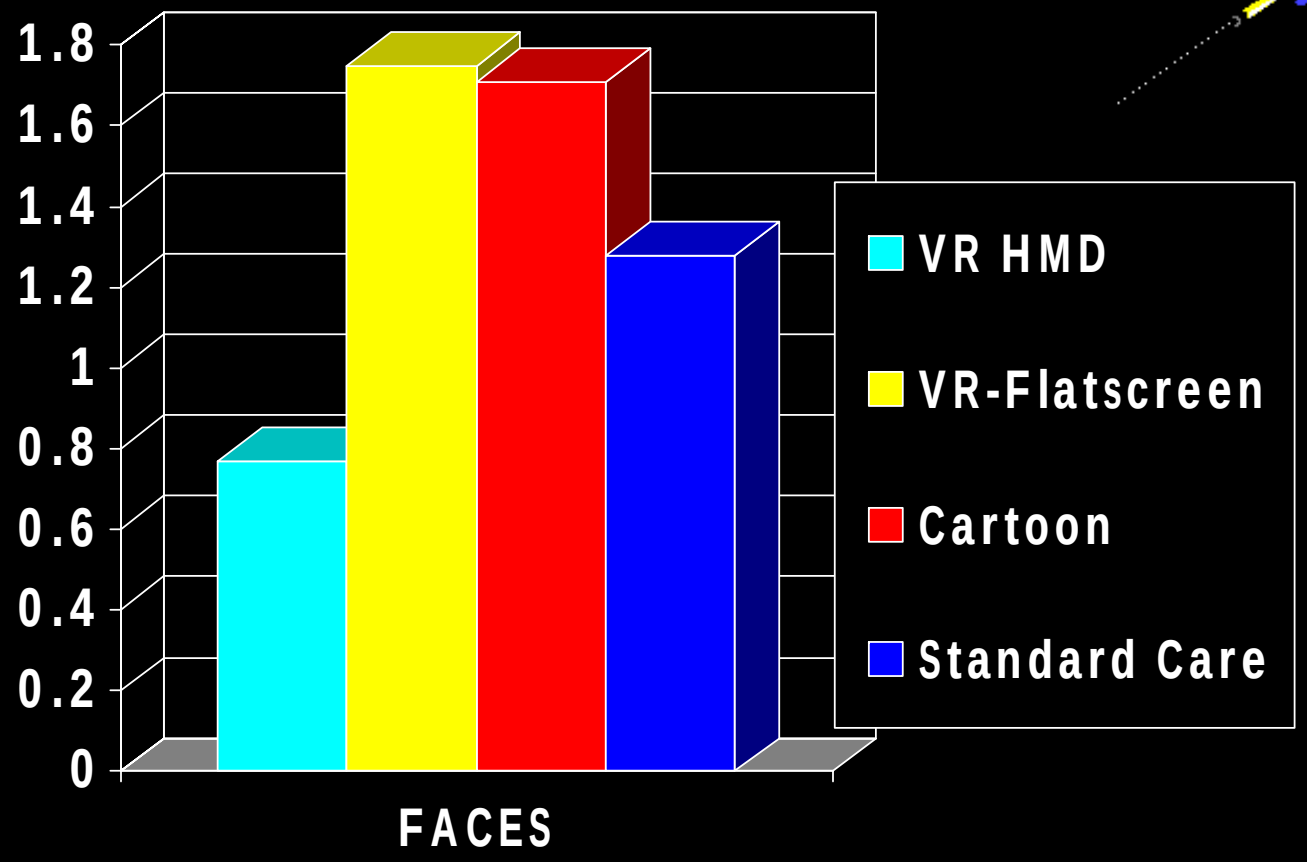
The Wong-Baker Faces scale (1988):

Visual Analog Scale:

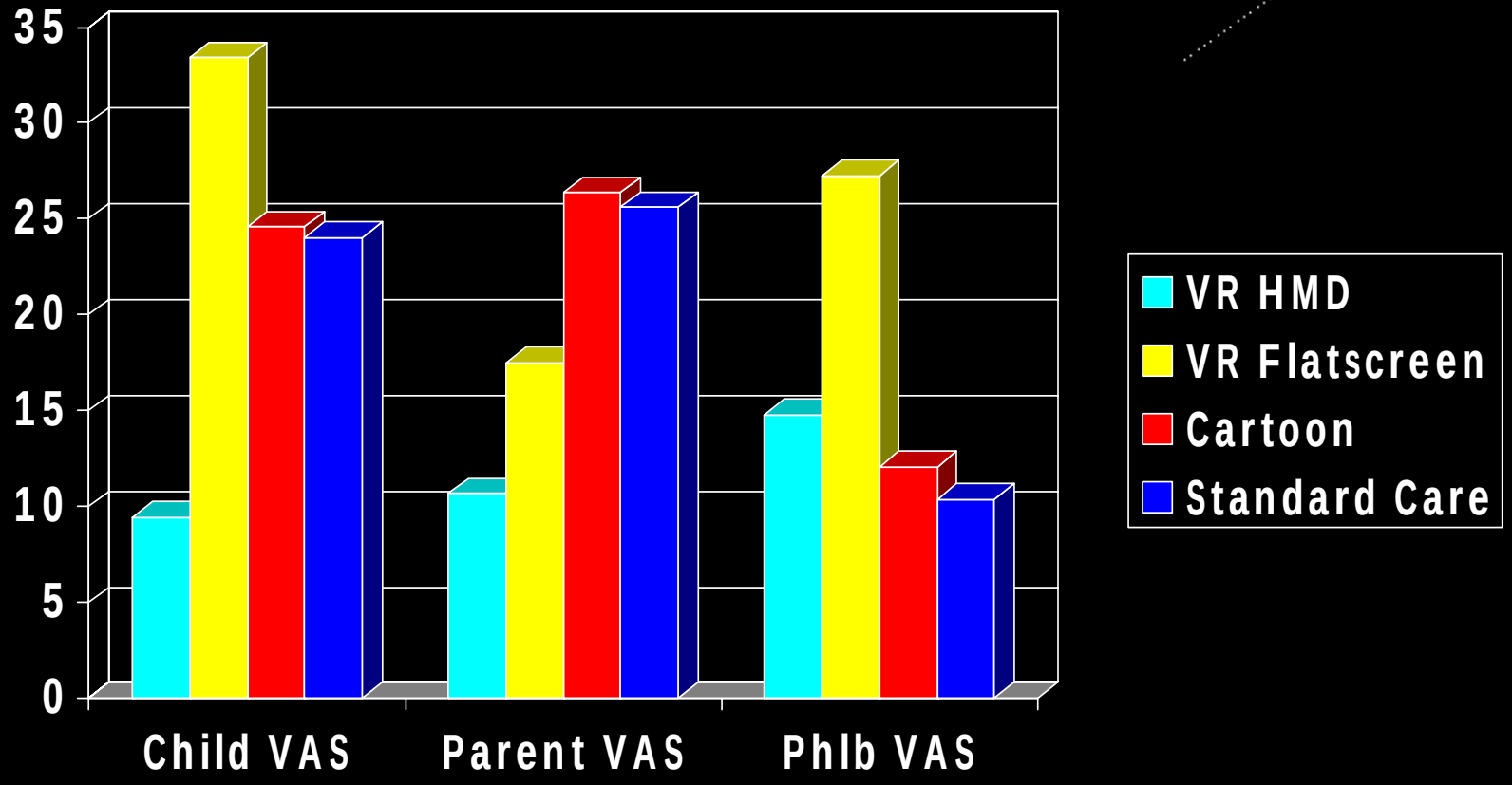
This line is kind of like a thermometer. Only it is a thermometer for pain. With a real thermometer, when the line gets longer it means the temperature is getting hotter and hotter. Here, the longer the line is, the more pain your child is feeling. Show where this line should end. If you end the line end immediately, your child is currently in no pain. The more you move to the right, the more pain your child is in. If you end the line all the way to the right, your child is in the worst pain possible. Show how much pain your child is in now, by drawing a line to show where this line should end. Remember, the longer you let the line be the more pain your child is in.

No Pain _____ Worst Possible Pain

Child Affective Needle Pain Ratings



VAS Ratings of Needle Pain



No Pain ——————————————————— Worst Possible Pain

ChildrensHospitalLosAngeles
International Leader in Pediatrics

VR Games Pain Distraction Project

(Rizzo, Gold & Katz)

New Scenarios to be used for IV Drips and Chemotherapy:

Jelly Men – Ages 4-6:

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Fifth Dimension Technologies
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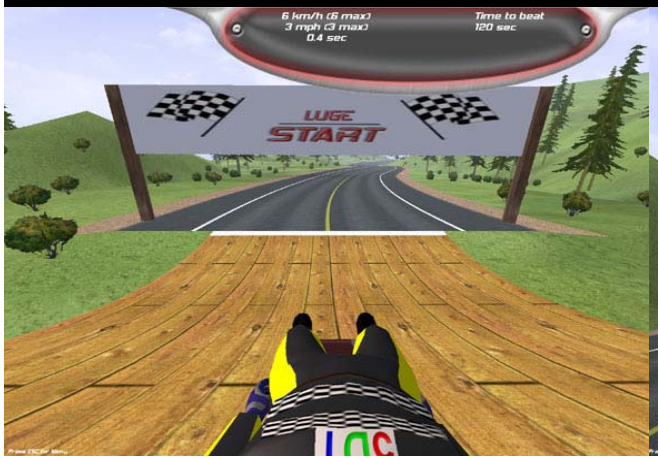
Street Luge – Ages 6-



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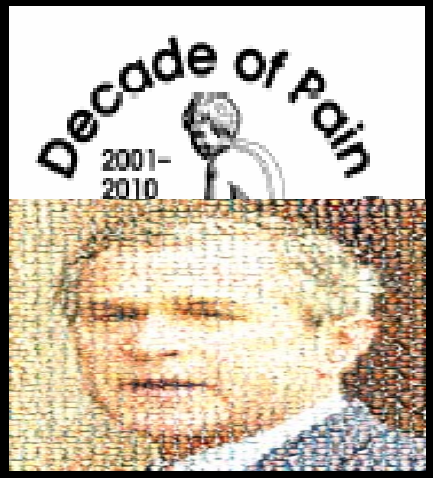
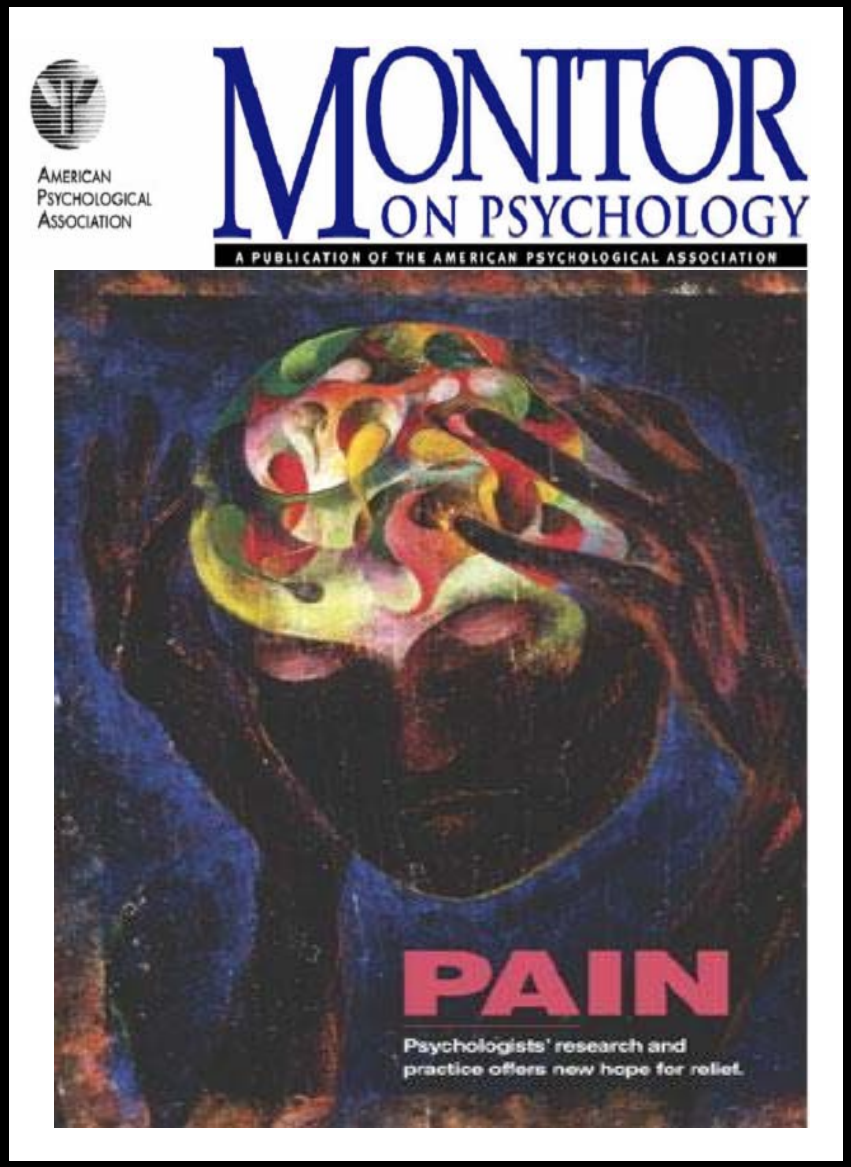


October 31, 2000 – The 106th U.S. Congress passed into law Title VI, Sec. 1603, which provides for the *"Decade of Pain Control and Research,"* to begin January 1, 2001.

This is only the second Congressionally declared medical decade, the first being the Decade of the Brain in the 1990s.

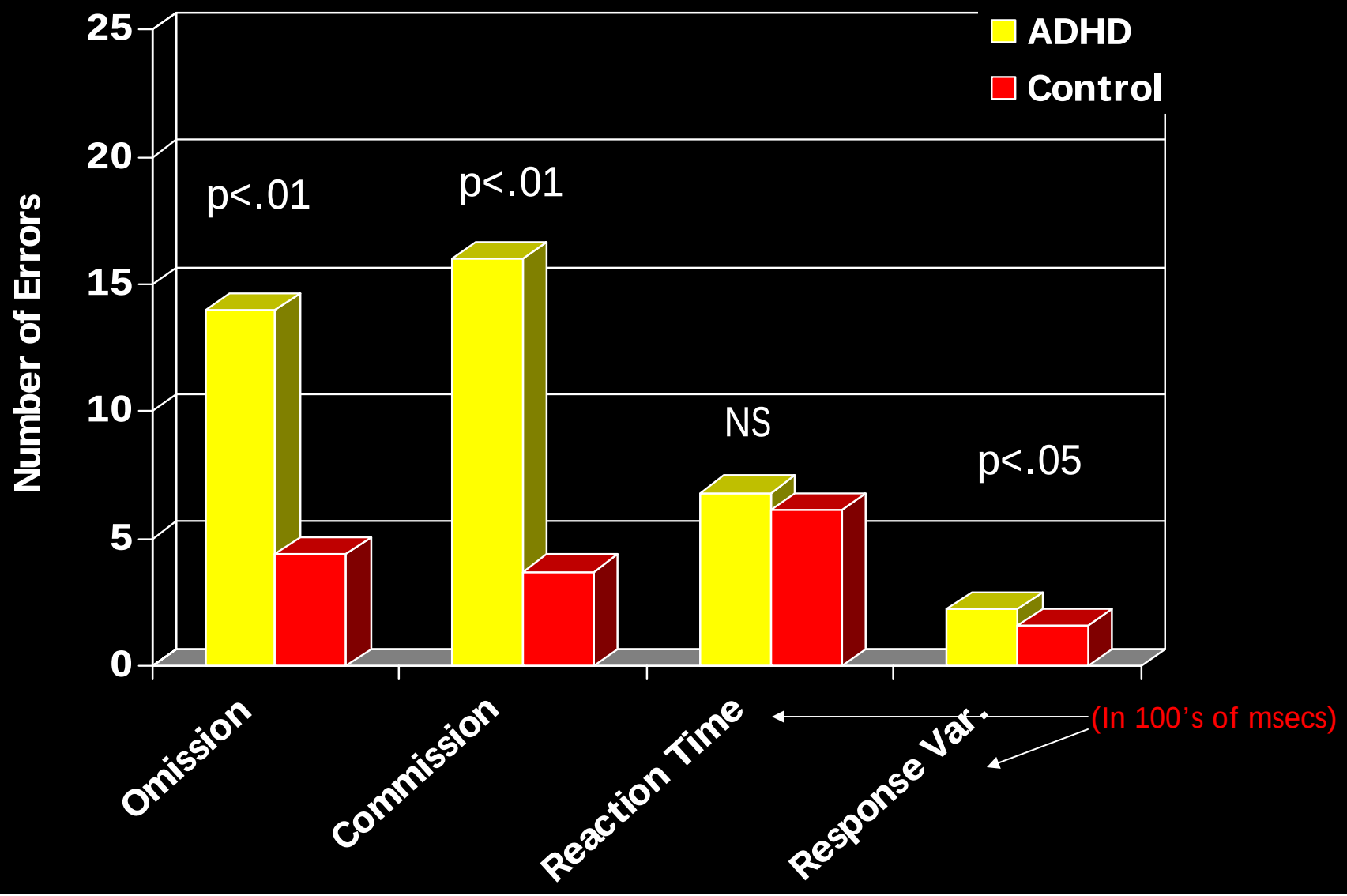


April 2002 Issue

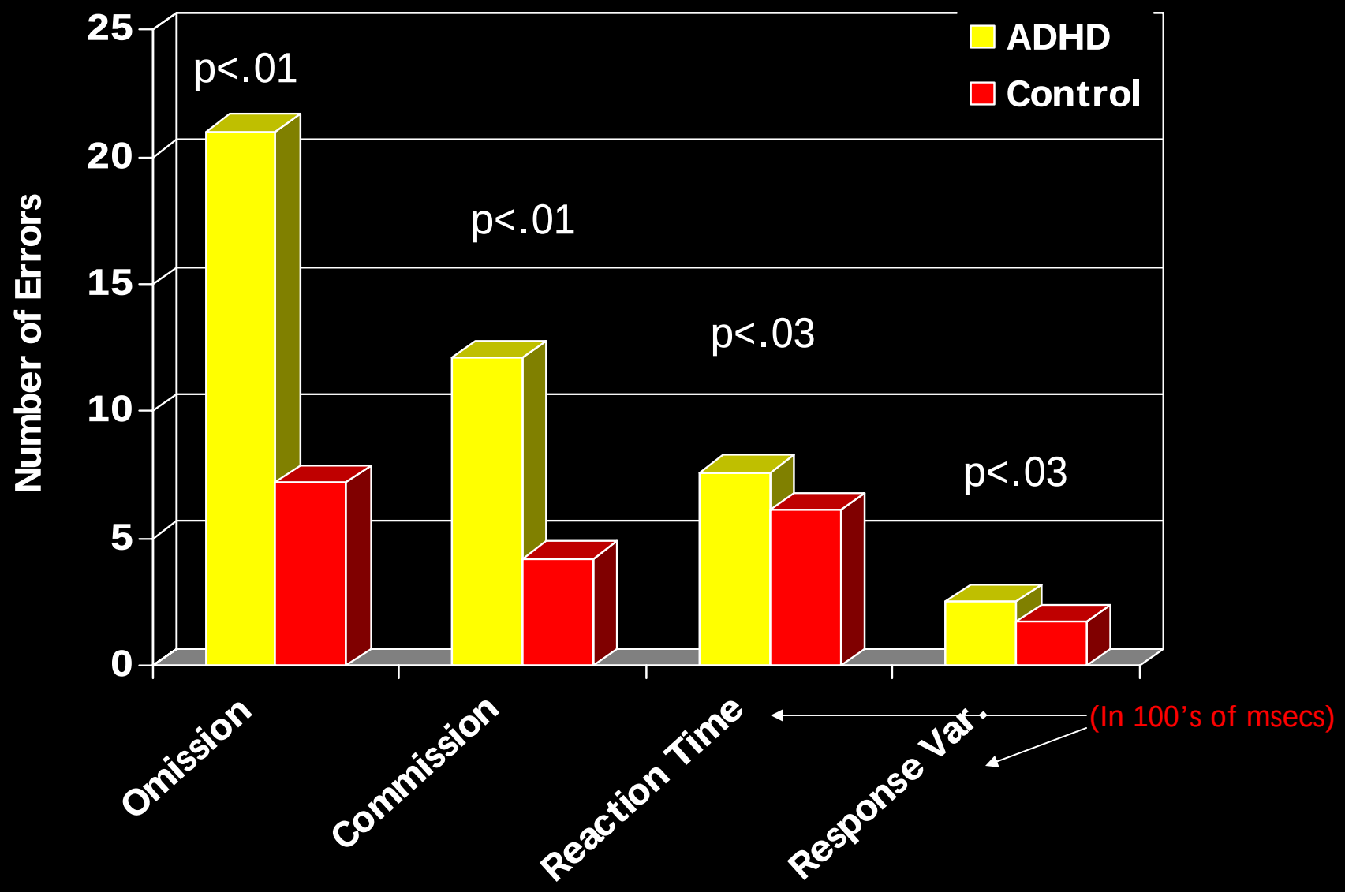
The Virtual Classroom

A recent Consensus Report by the National Institute of Health on ADHD (1998) suggests a variety of areas where better assessment tools would be of value. The report specifically cites the need for better definition of the nature of this disorder and an emphasis on measuring the effectiveness of intervention strategies.

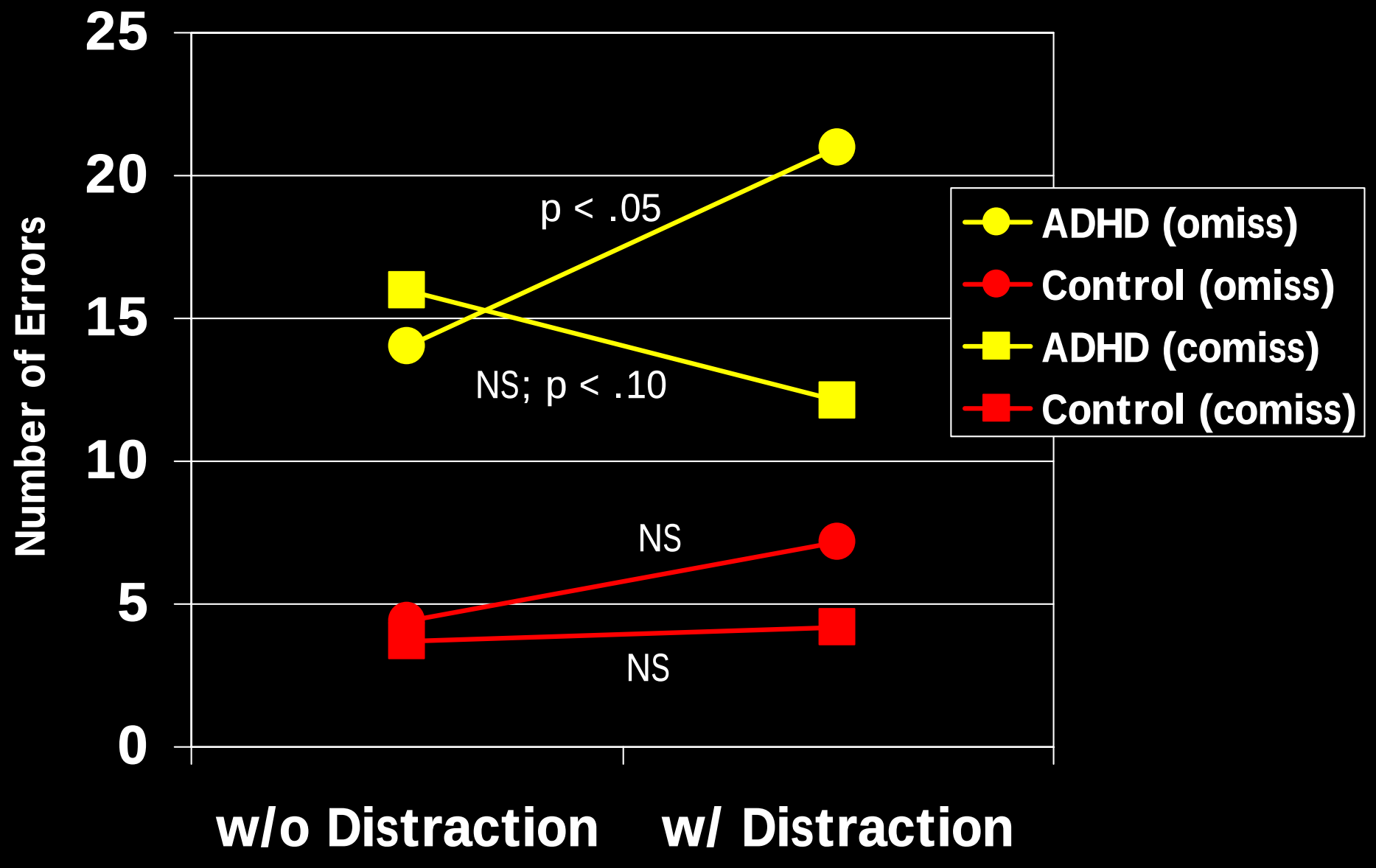
"AX" Attention Task Performance *without* Distraction



"AX" Attention Task Performance *with* Distraction

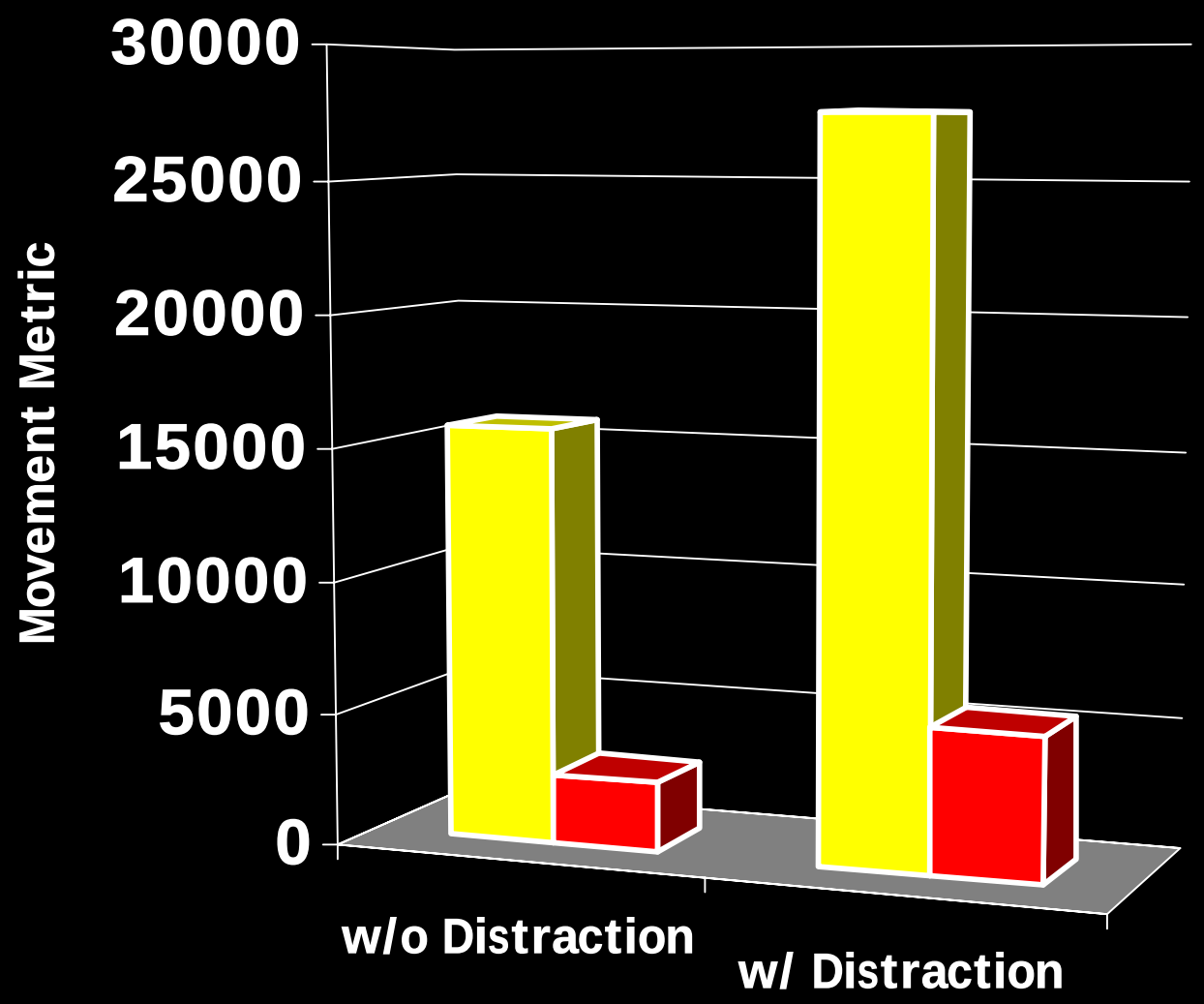


"AX" Attention Task Performance Summary



Sample Movement Measures

Collaboration with Cyrus Shahabi



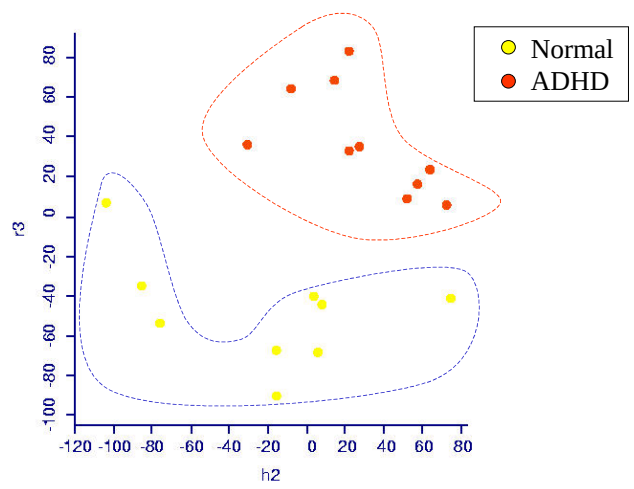
All 18 component movement metrics produced significant diffs. between groups and across distraction conditions!

All tracked movement metrics from Head, Arm & Leg:

Collaboration with Cyrus Shahabi

- Significantly different between groups
- Significantly different within ADHD group across distraction/no distraction conditions
- No differences in Control group across distraction conditions

Neural Net Approach (Support Vector Machine analysis) – after training system on first five subjects per group, 100% discrimination on groups for stereotypic rotation movement of the leg was uncovered.

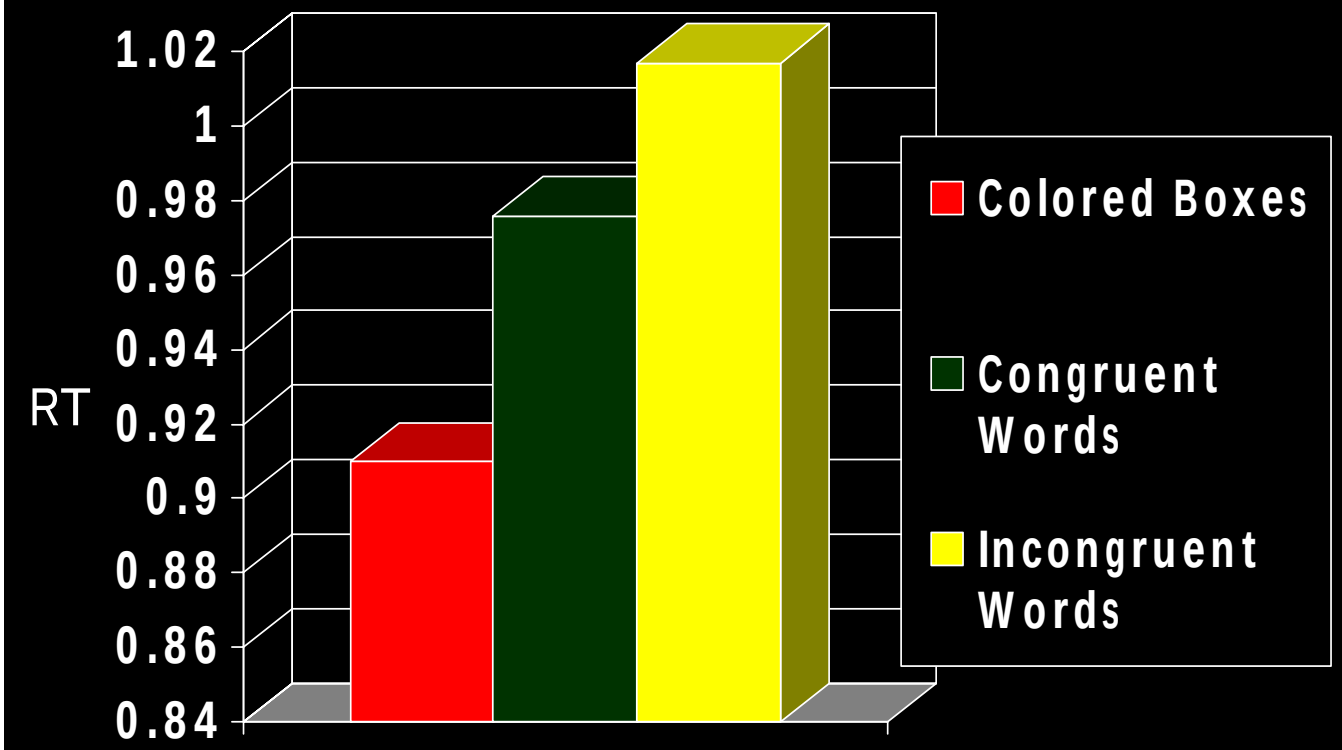


VR Classroom Stroop Test

Research Version

Krandall, Kerns, Mateer & Rizzo

VR Classroom Stroop Test



Stimuli on board	Spoken
	Red
Red	Red
Green	Red
Red	Red

N= 97 $F(1,36)= 3591.8$, $p > .0001$

**No Difference when using traditional error counts!*

VR Classroom Stroop Test

But, what does VR add over a flatscreen Stroop???

- Controlled stimulus environment
- Test to serve as a foundation for an ecologically "enhanced" battery of "Stroop-Like" everyday interference performance tasks
- To become part of a larger comprehensive battery of VR performance tests being developed for the *VR Classroom*

D
D
TEST
MONDAY!

New Attention Tasks being Developed

Boston Naming Task

Stroop Task

Letter Crowding Task

360 Degree Panoramic Video Camera: A New Method to Create Virtual Environments

USC
Los Angeles Times
USC: BUILDING ON EXCELLENCE

360 Tech Details and Concept

Panoramic Camera

5 Panasonic CCD cameras, each looking off an individual planar mirror, controller allows communication via serial port.

Recording System

5 Sony DVCam (DRS-70) recorders, Grassvalley VPE 351 (SuperEdit), VideoTek STG-6000.

Workstation

Dell Precision 220 Workstation (Pentium III 866 MHz, 128 MB RAM), 5 Imagenation PXC 200 frame grabbers, Matrox G400 graphics card.

HMD

Sony PLM-S700 (Glasstron), Intersense IS300 tracker.

User Directed News

An approach to journalism based on panoramic video technology

A joint research project of the USC *Integrated Media Systems Center* and the USC *Annenberg Online Journalism and Communication Program*

User Directed News

Emerging technology may allow the consumer of news to change from being a passive observer of "fixed" content to being an active participant in the news acquisition process.

"A new way" to experience news through an immersive environment.

Funeral of two boys in Rafah, Gaza, 25/5/01 (photograph courtesy of Gary Knight)

This constitutes a new paradigm for how News is covered and consumed.

User Directed News

Skid Row- Single

User Directed News

Skid Row - Panoramic

User Directed News

Research Comparing three viewing conditions:

- **Single Frame Viewing**
- Panoramic Viewing on Flatscreen
- Panoramic Viewing in HMD

On multiple measures of Memory for the story, Scanning behavior (Flatscreen vs. HMD), Sense of Presence and Empathy

On multiple measures of Memory for the story

Story B–1st Recall

2. Logical Memory I (continued)

At 6:00 on Monday evening, Joe Garcia of San Francisco was watching television as he dressed to go out. A weather bulletin interrupted the program to warn that thunderstorms would move into the area within the next two to three hours and remain until morning. The announcer said the storm could bring hail and up to four inches of rain and cause the temperature to drop by fifteen degrees. Joe decided to stay home. He took off his coat and sat down to watch old movies.

	Score 0 or 1		
Story B — 1st Recall	Story Unit	Thematic Unit	Scoring Criteria
At 6:00			*6:00* is required
on Monday			*Monday* is required
evening,			*evening* (in any context)
Joe			*Joe* or variant of the name
Garcia			*Garcia* is required
of San Francisco			*San Francisco* is required
			indication of a main character who is male
was watching television			indication that he was watching/listening to the television
as he dressed			indication that he was getting dressed
to go out.			indication that he was going out
			indication that the character was preparing to leave
A weather bulletin			indication that there was an announcement about weather
interrupted the program			indication of a break in the regularly scheduled program
			indication of a weather announcement
to warn that thunderstorms			indication that there was a warning about a storm
would move into the area			indication that the storm was coming
			indication of a storm moving into the area
within the next 2 to 3 hours			a phrase meaning about 2 or 3 hours
and remain until morning.			indication that the storm would stay until morning
			indication of storm duration
The announcer said			indication that someone was repeating about a storm
the storm could bring hail			indication that hail was possible
and up to 4 inches			*4 inches* is required
of rain			*rain* is required
and cause the temperature to drop			indication that the temperature would drop or decrease
by 15 degrees.			a relative decrease of 15 degrees is required
			indication of storm's activity
Joe decided to stay home.			indication that he decided to stay home
			indication that the character decided to stay in
He took off his coat			indication that he took off outer clothing
and sat down			indication that he was sitting down
to watch old movies.			indication of viewing movies is required
			indication that the character decided to watch a movie or TV

Story B — 1st Recall Unit Score Range = 0 to 25 [ ] [ ]

Story B — 1st Recall Thematic Unit Score Range = 0 to 8

1st Recall Total Score Calculation

[ ] + [ ] = [ ]

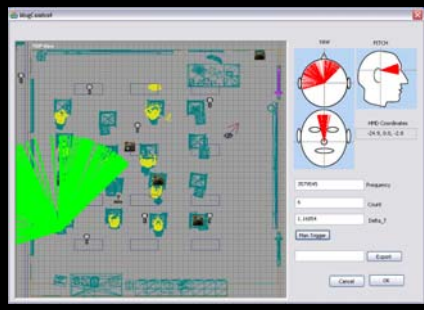
Story A Recall Unit Score Range = 0 to 25 | Story B—1st Recall Unit Score Range = 0 to 25 | 1st Recall Total Score Range = 0 to 50

- Free Recall
- Cued Recall
- Recognition
- Immediate & 1-Week Delay

Key Hypothesis: HMD Immersive Condition will enhance Delayed Memory for content of the story due to the episodic retrieval cues created by "Being There"!

Multiple Measures of Scanning Behavior:

- Total scanning activity
- Percent time on Reporter
- Across Segments of Story

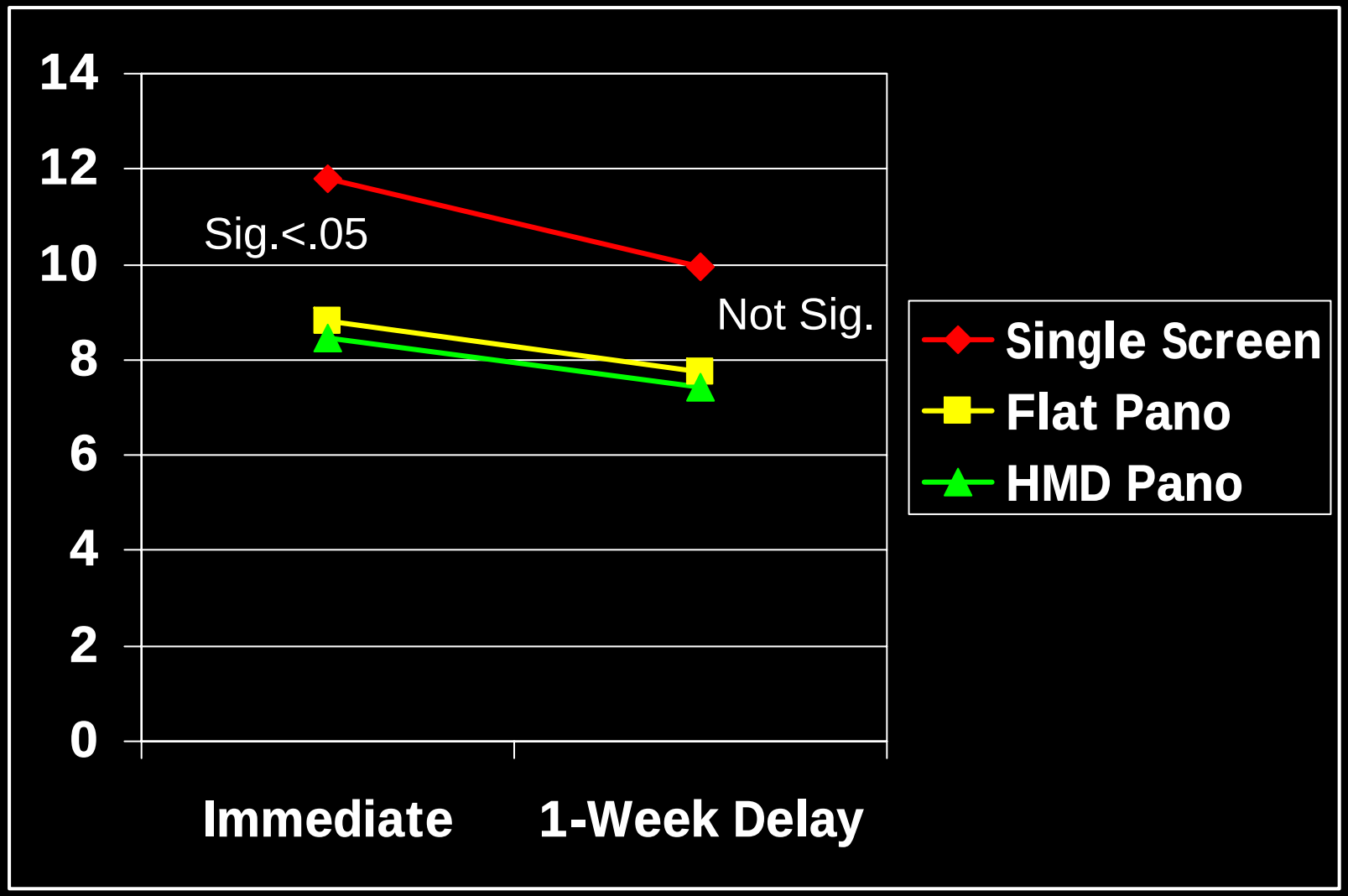


- And how this relates to Memory, Immersive Tendencies and Sense of Presence

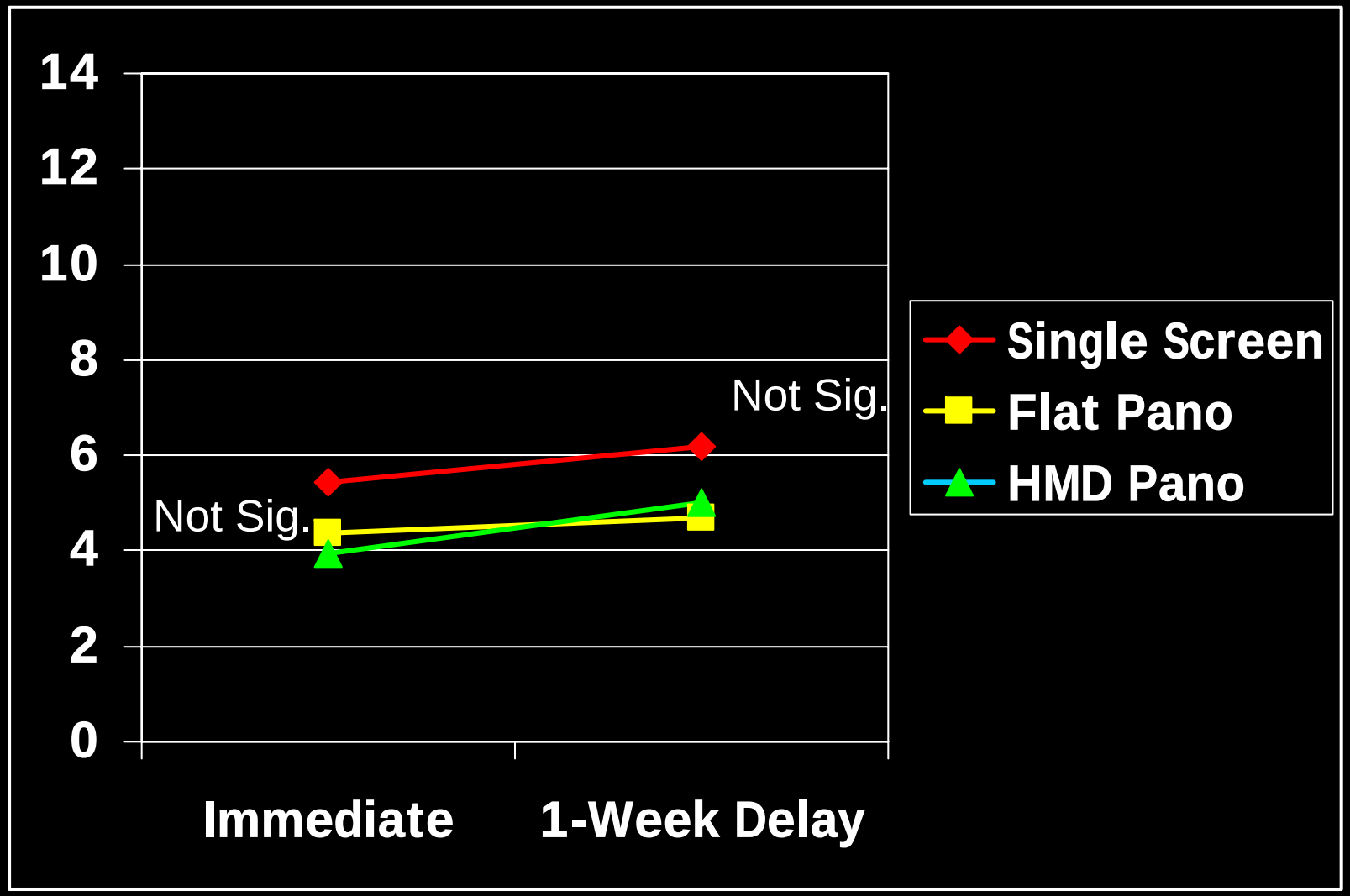
Status of Initial Project

- 48 Participants Tested (40 females/8 males)
- Target n =90
- Avg. Age = 20, Ed level = 13
- No sig diffs between groups or gender on basic demographics
- But, sig diffs between males and females on:
  - Immersive Tendencies (Females higher, $p < .006$)
  - Presence Q after 360 Pano conditions (males higher)
    - Total Presence (94.4 vs. 82.2, $p < .006$)
    - Involvement subscale (59.9 vs. 48.9, $p < .01$)

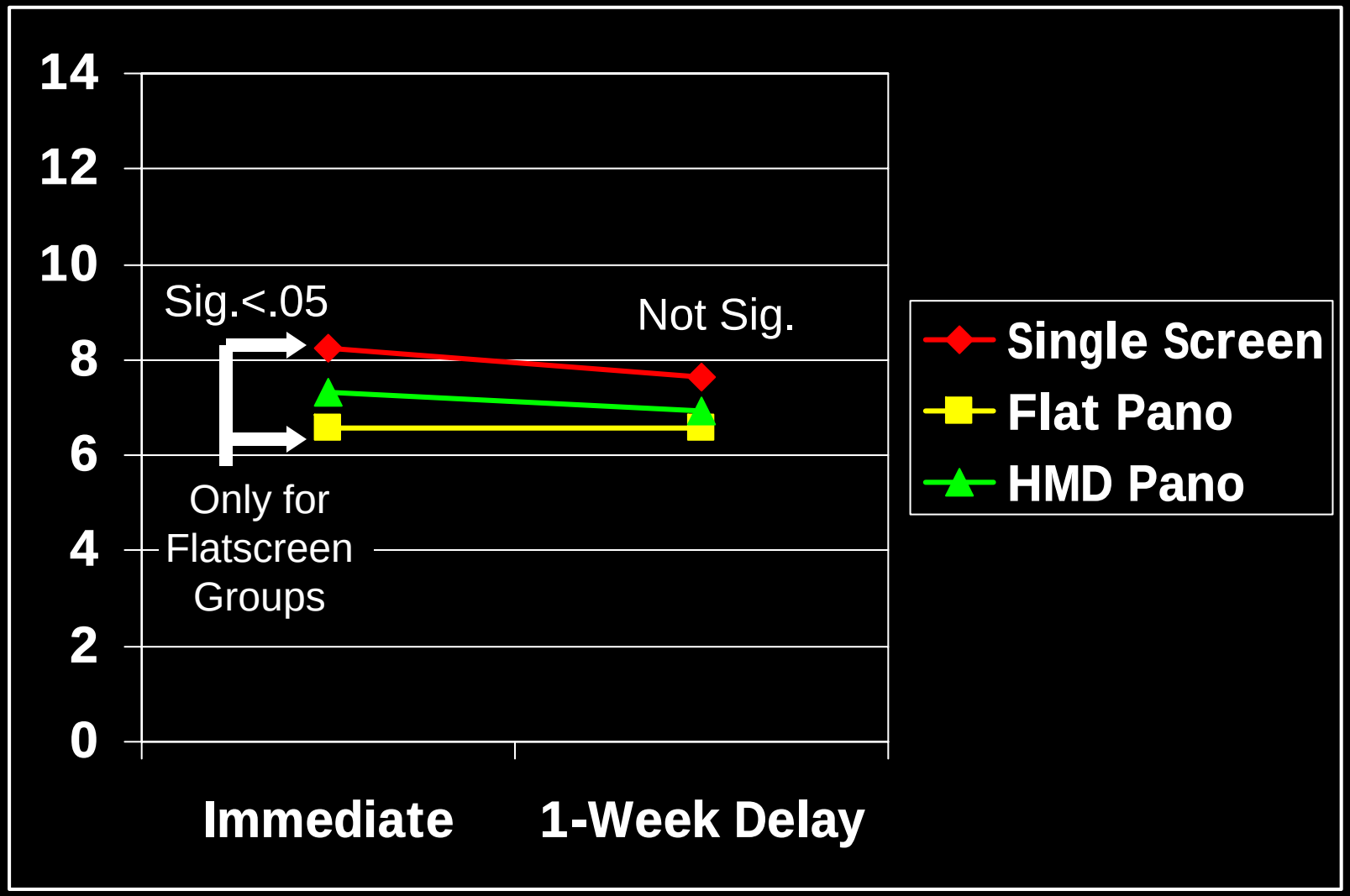
Pure Recall


14
12
10
8
6
4
2
0
Sig.<.05
Not Sig.
Immediate
1-Week Delay
Single Screen
Flat Pano
HMD Pano

Cued Recall


14
12
10
8
6
4
2
0
Not Sig.
Not Sig.
Immediate
1-Week Delay
Single Screen
Flat Pano
HMD Pano

Recognition (Multiple Choice)



Early Observations and Limitations

- Panoramic conditions have higher cognitive demands, but produce equal verbal memory performance at 1-week follow-up with this unimpaired sample
- Higher Presence Ratings in Panoramic conditions for all subjects.
  - Total presence (p. <.005)
  - Involvement subscale (p. <.001)
- No relationship to memory performance
- “Difficult” recruitment limit conclusions at this time.

User Directed News

World's Largest Yoga Class
NEW TIME AND ADDED FEATURE!
--Over 2,000 people will become part of history when they join a special class taught by Bikram Choudhury, which is aiming for the Guinness Book of Records. Who knows what happens when the energy and focus of that many people doing yoga at the same time fills a room. Free with general admission to Yoga Expo;
Saturday, B Hall
3pm lecture, 4:30pm class

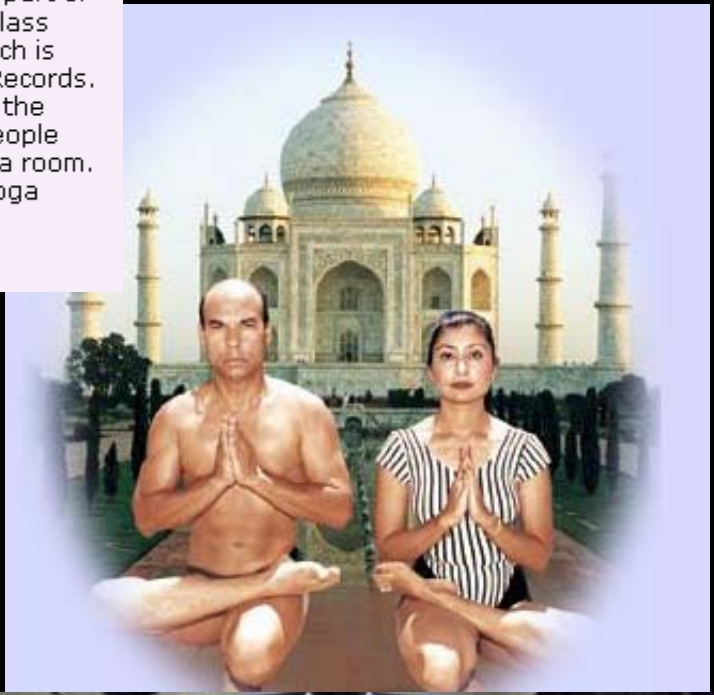
YOGA EXPO™

Executive Producer **Bikram Choudhury**

September 25-28, 2003
Los Angeles Convention Center, USA

In the 5,000 year history of Yoga...
there has never been an event like this... until now.

Yoga Expo will celebrate the extraordinary growth of yoga in the Western World, with information, demonstrations, seminars, workshops and exhibits. The Expo will provide a vivid experience of the profound changes this ancient, yet very modern health and fitness program can produce in every aspect of life.
$10 admission includes up to 300 free workshops!



VR/Rehab Strengths

- Complete naturalistic performance record
- Safe testing and training environment which minimizes risks due to errors
- Graduated, systematic exposure

- Distraction
- Gaming factors to enhance motivation

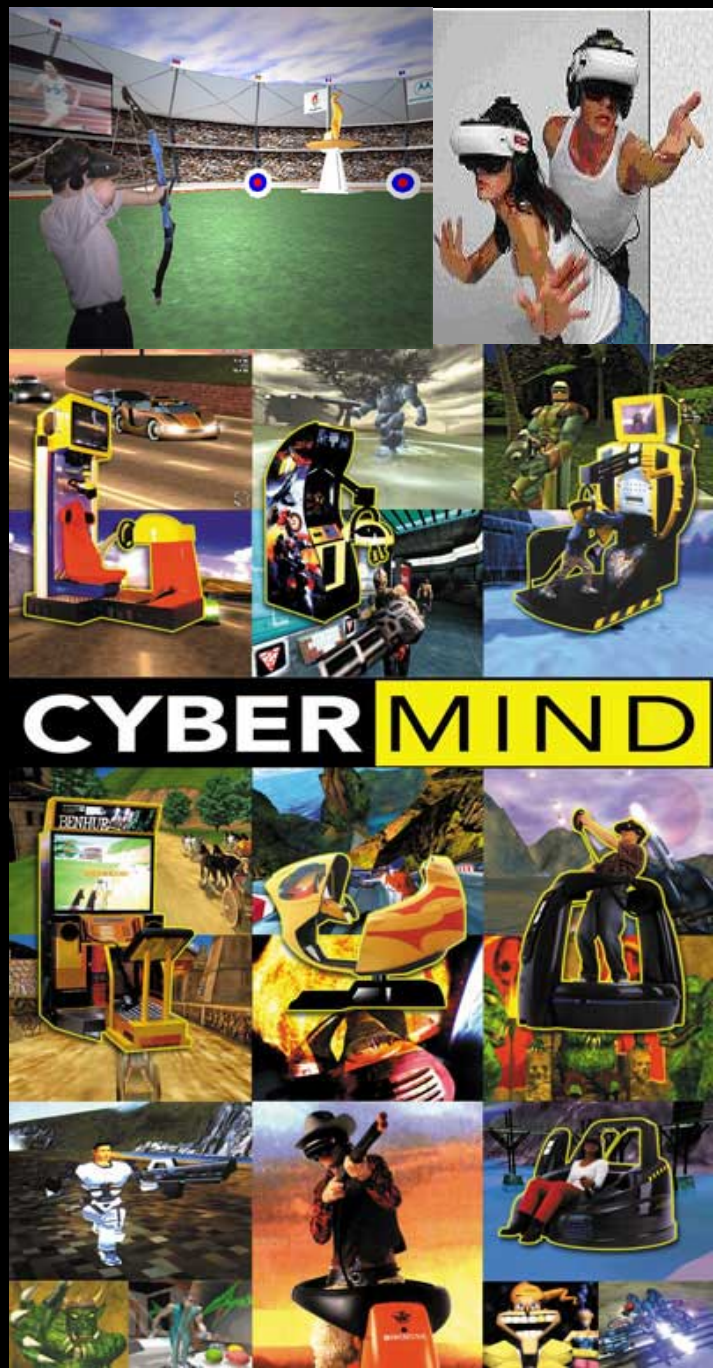
From Gameboys to Virtual Reality!

VR/Rehab Strengths

"You can discover more about a person in an hour of play than in a year of conversation." *Plato*

"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



How can Games Advance VR Applications in Mental Health and Rehabilitation???

- Use of games to distract and motivate
- Use of game software/technology for VR scenario development

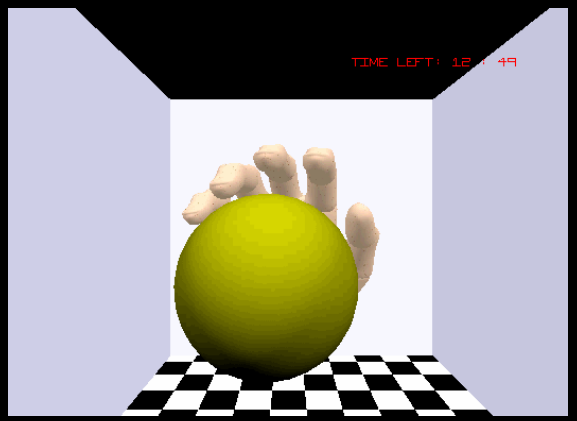
How can Games Advance VR Applications in Mental Health and Rehabilitation???

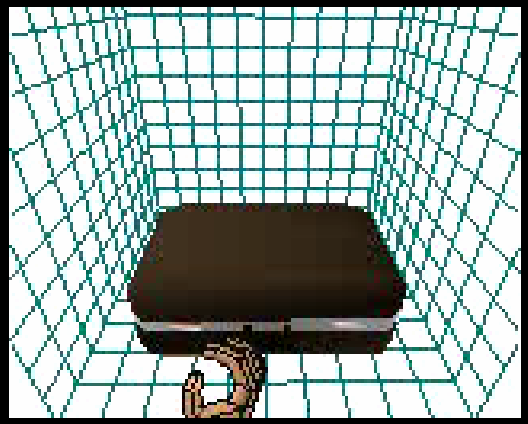
- Use of games to distract and motivate
- Use of game software/technology for VR scenario development

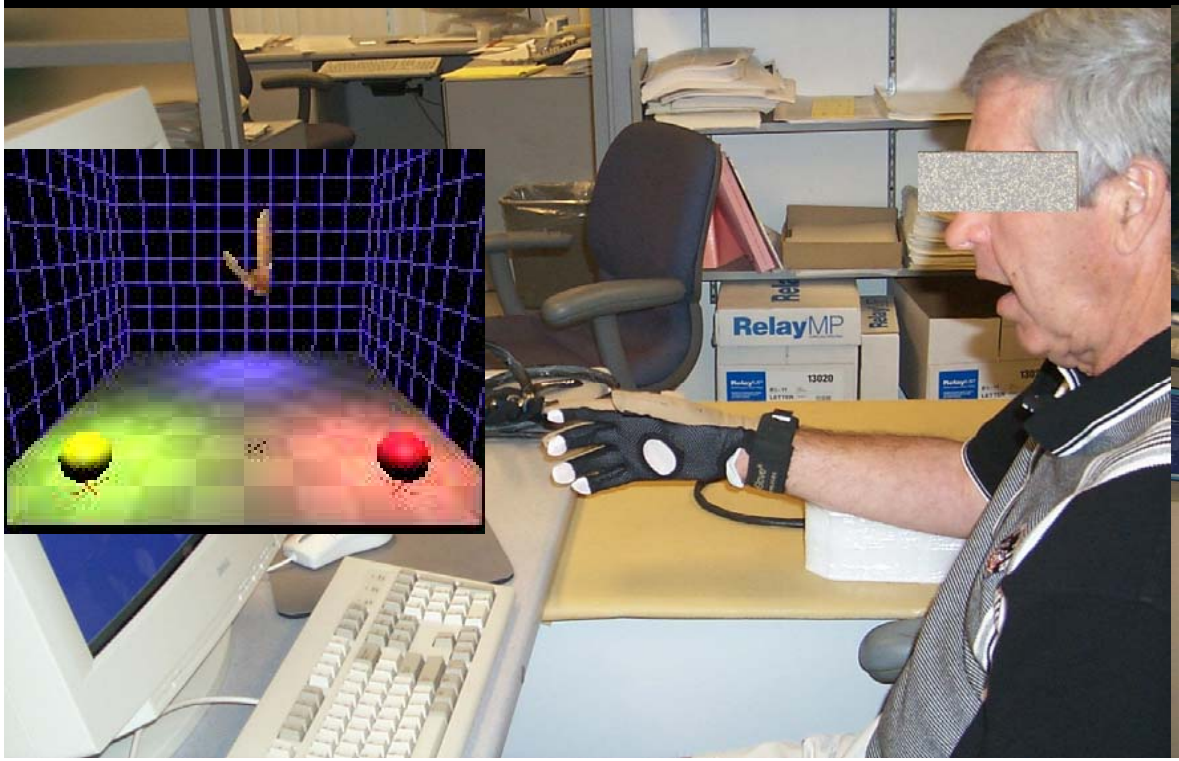
CHECKPOINT
Checkpoint time: 0.0.10:33
Checkpoints: 2/15
Pulse: 0
0.0.17:52

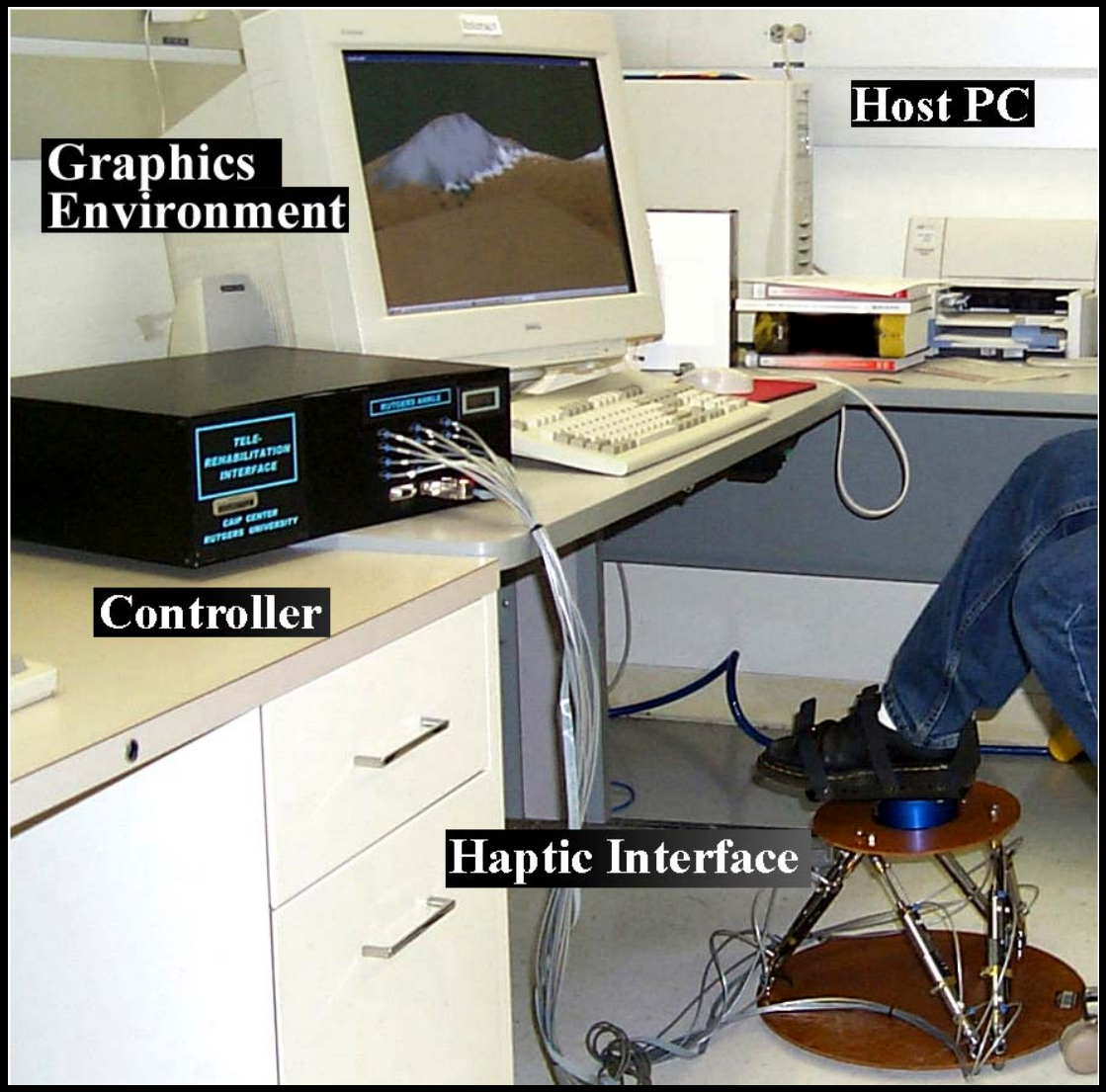
Rutgers Research Group

(Burdea,Deutsch, Merins et al.)









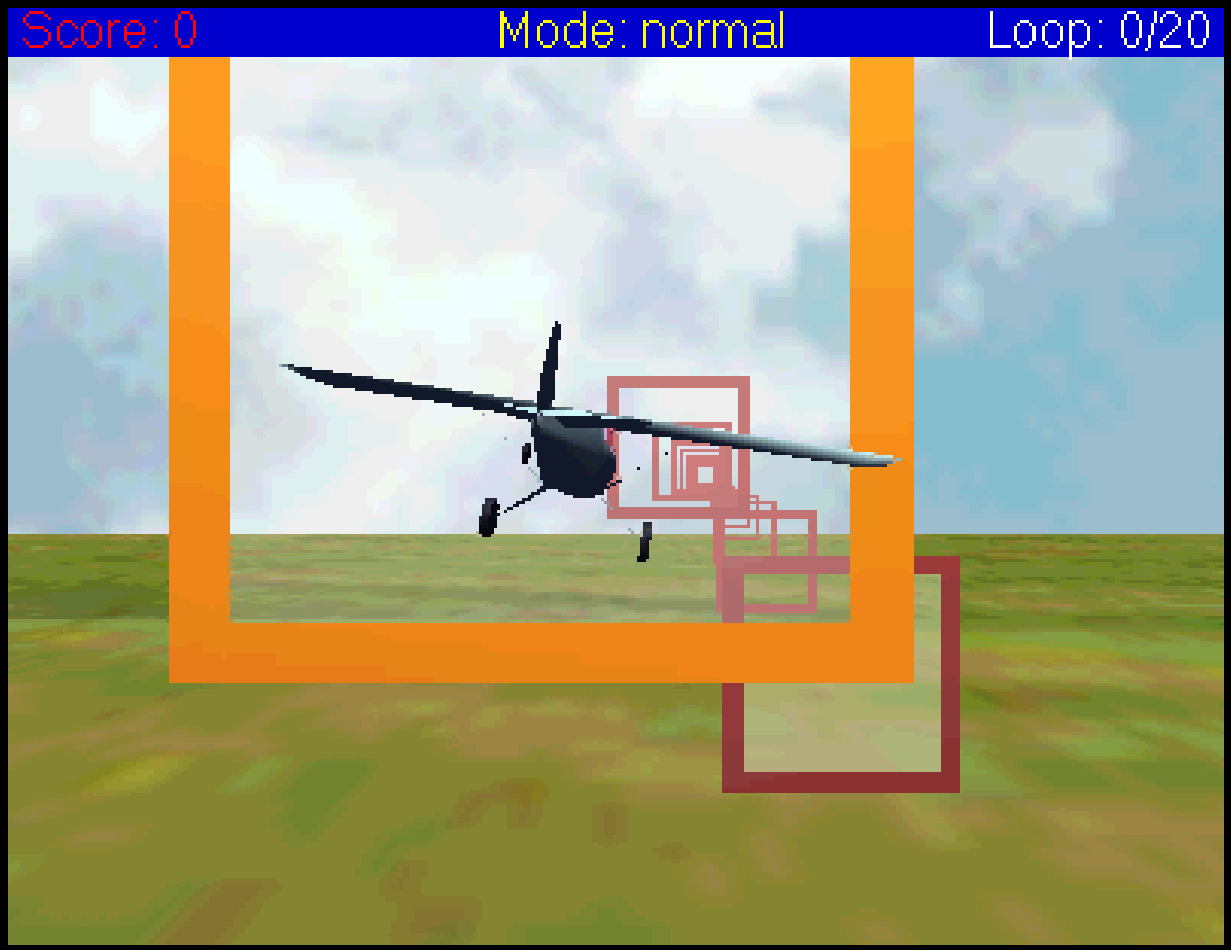
The Rutgers Ankle Interface integrated with the PC workstation – NSF Funded

Burdea et al.

Figure 5. Stroke patient exercising on the Rutgers Ankle system

Figure 4. Exercise screen showing the airplane piloted by the patient's ankle

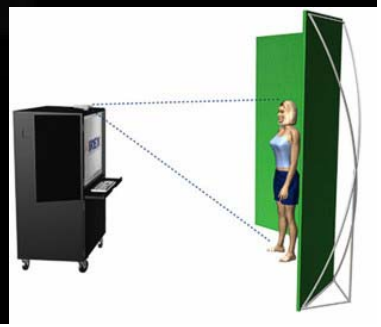
(Burdea et al.)



VR ankle rehabilitation exercise

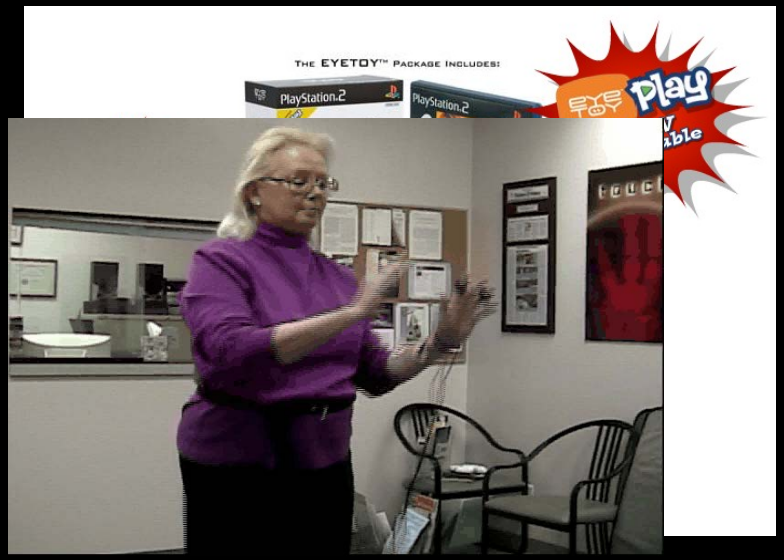
Burdea et al.

Vivid IREX System for OT/PT after Stroke/TBI/SCI (Weiss, Rizzo et al.)

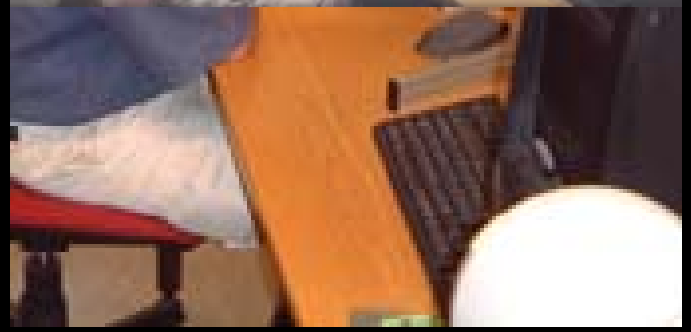


Vivid IREX System for OT/PT after Stroke/TBI/SCI (Weiss, Rizzo et al.)

SONY Playstation **Eye Toy** for OT/PT after Stroke/TBI/SCI (Weiss, Rizzo et al.)

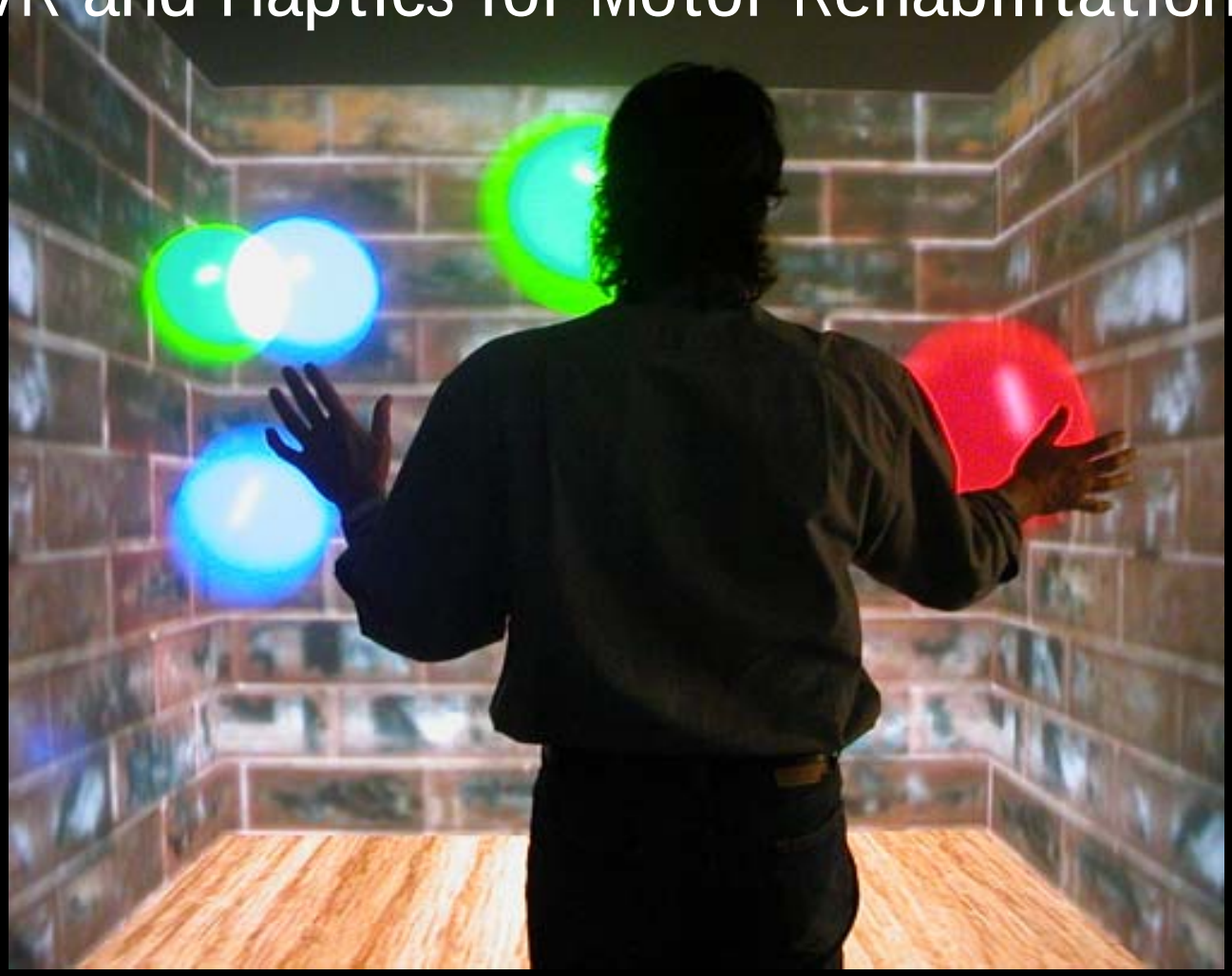


Reach-in Game-Like Rehab



Broeron et al.

VR and Haptics for Motor Rehabilitation



Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Recently Funded NIH Exploratory Center at USC that will support interdisciplinary development of VR/Gaming/Haptics apps to foster neuroplasticity and rehabilitation in stroke patients

- -- Thomas H. McNeill, USC Dept of Cell and Neurobiology, Keck School of Medicine

  -- Carolee Winstein, USC Dept of Biokinesiology and Physical Therapy

  -- Helena Chui, USC Dept of Neurology, Keck School of Medicine

  -- Michael Arbib, USC Dept of Computer Science, Viterbi School of Engineering

  -- Nicolas Schweighofer, USC Dept of Biokinesiology and Physical Therapy

- -- Albert "Skip" Rizzo, ICT/IMSC, Viterbi School of Engineering

  -- Margaret McLaughlin, IMSC & Annenberg School for Communication

  -- Stan Azen, Dept of Preventive Medicine, Keck School of Medicine

  -- Theresa Jones, Dept of Psychology, University of Texas, Austin

  -- Tim Schallert, Dept of Psychology, University of Texas, Austin

Cellular Computational Behavioral VR/Haptics Clinical

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VR/Haptics Aims

- Create novel 3D VR Haptic interaction scenarios that:
  - Motivate rehabilitation via gaming features
  - Mimic real life scenarios that may enhance the ecological validity of rehabilitation and foster generalization to real world functional performance
- Design "Clinical Interfaces" that allow therapists without computer expertise to flexibly control stimulus delivery based on realtime client performance
- Eventually build AI component to aid therapist in delivery (long term)
- Develop Data Mining tools that capture and analyze complex performances needed to evaluate effectiveness of our approach

Rehabilitation Tasks must:

- focus on a specific target and involve data-based and directed treatment
- be adjustable in terms of difficulty level from something simple for the patient to accomplish, to a level representing normal or criterion performance
- be quantifiable in order to assess progress
- be administered repetitively and hierarchically
- provide the client with immediate feedback as to the outcome of performance
- have some relevance to real world function

Limitations of current Rehabilitation approaches…

- RESTORATIVE……uncertainty of how interventions apply to the “real world”!
- FUNCTIONAL……limited experimental control and therefore difficult to establish validity & reliability data needed for good science!

RESOLUTION!!!

Virtual Environments that provide systematic restorative training within the context of functionally relevant, ecological valid, simulated environments!!

Developing single Phantom Haptic integration to provide fine motor haptic feedback during basic game-based rehab

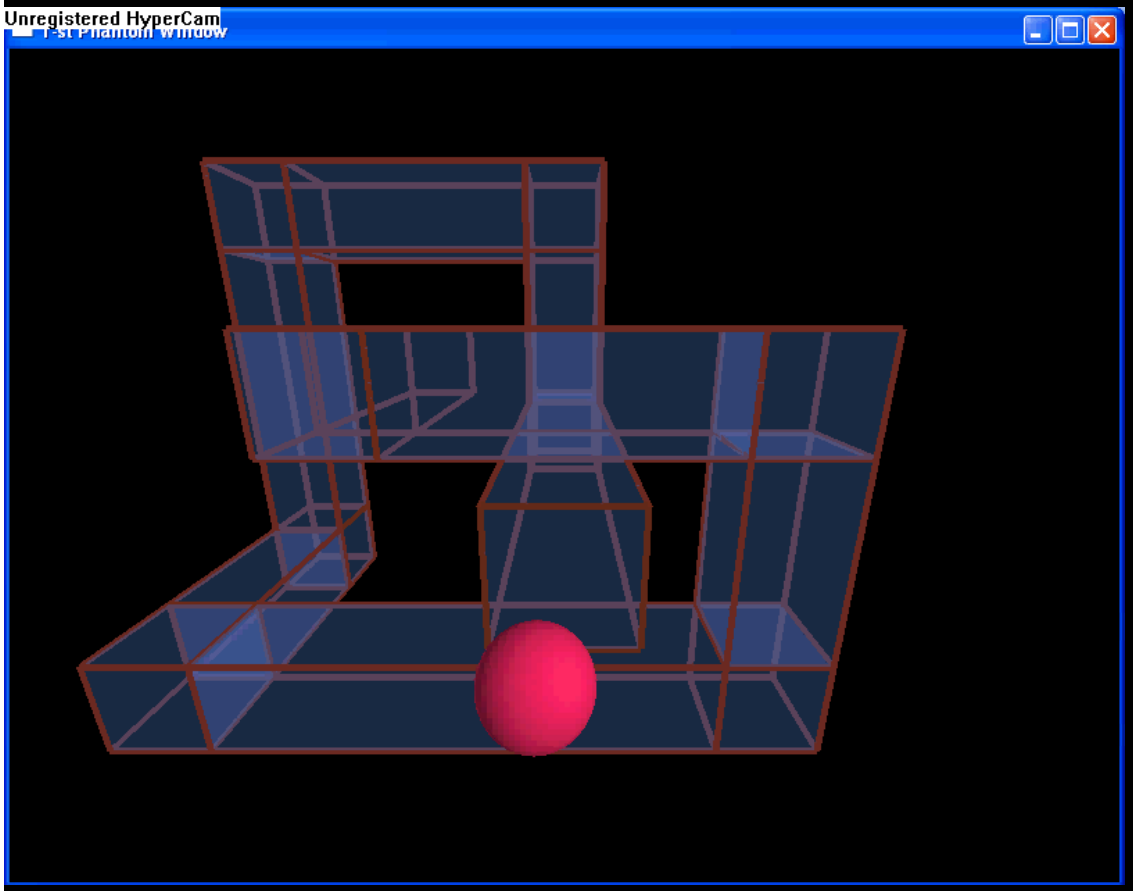
Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Recently Developed Scenarios



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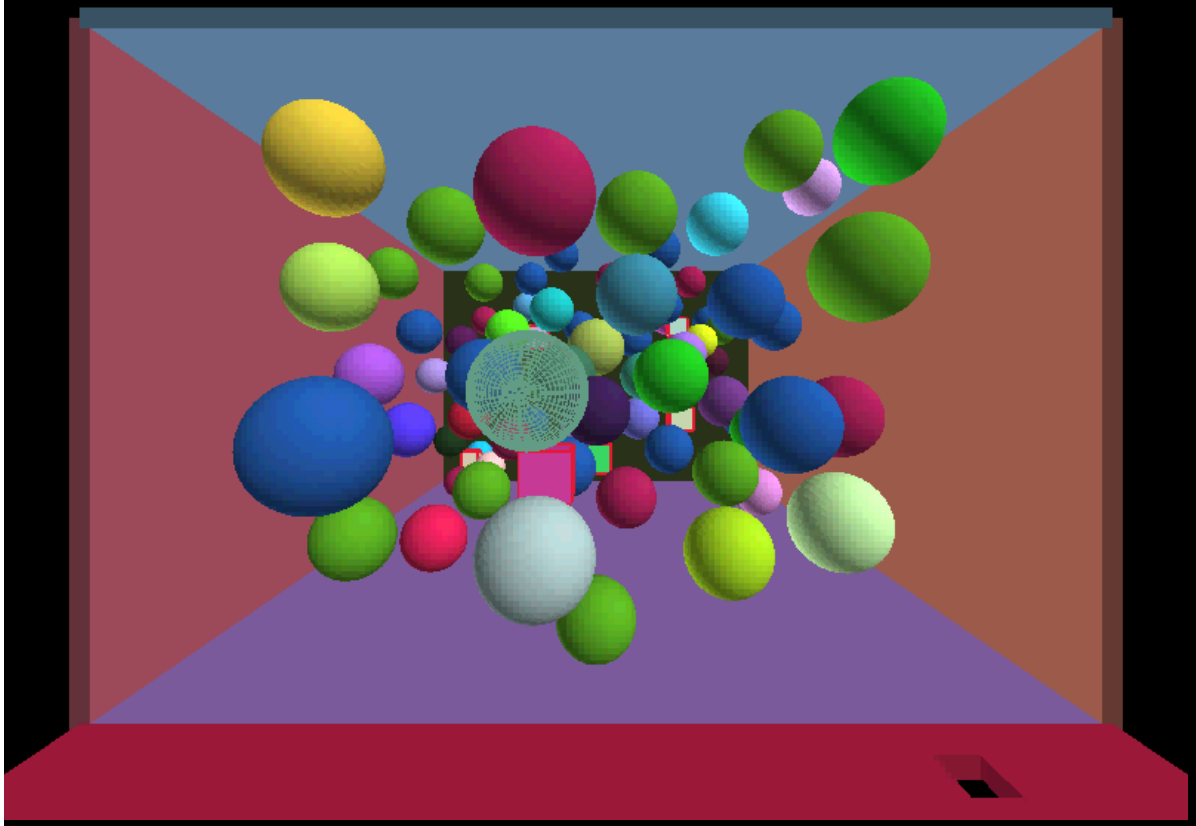
Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Recently Developed Scenarios

Unregistered HyperCam



Cellular Computational Behavioral VR/Haptics Clinical

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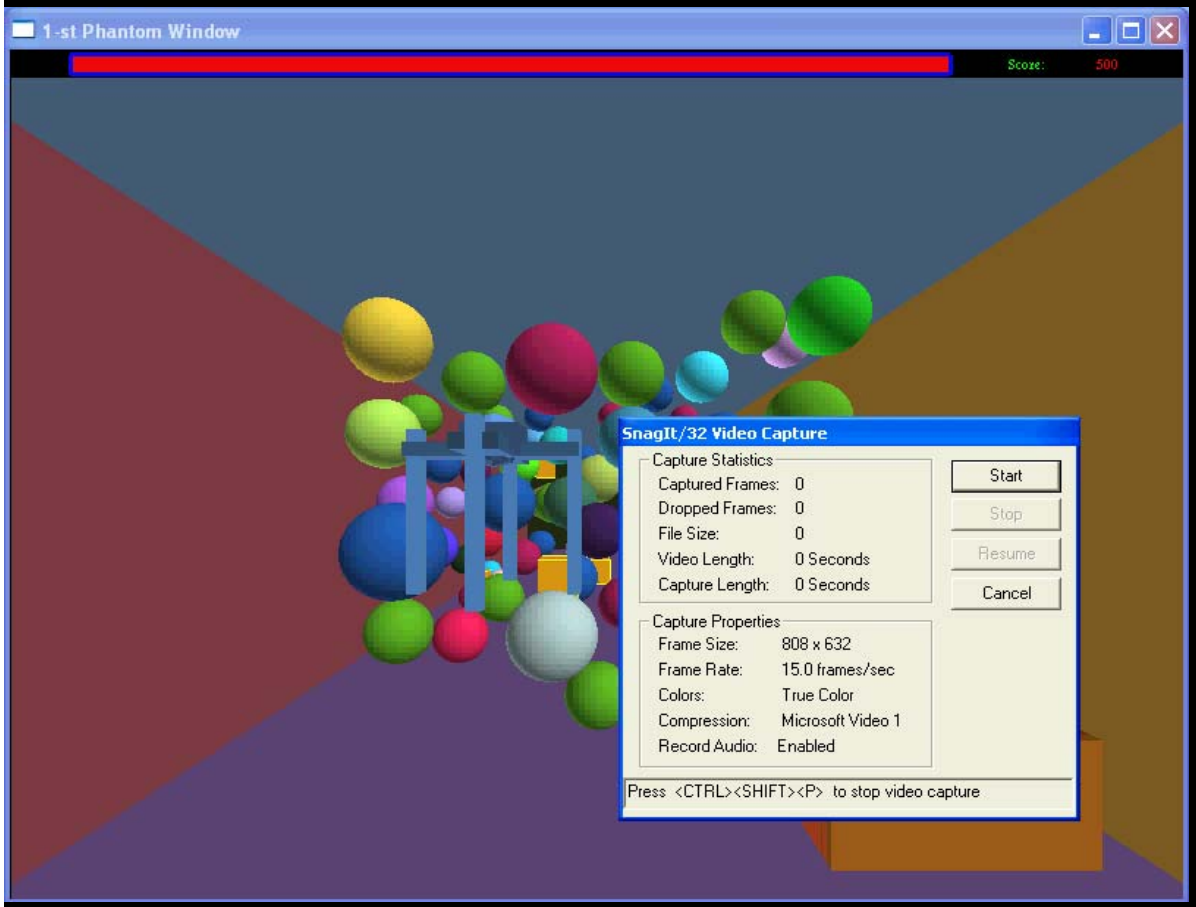
Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Iteratively Evolved Scenarios



Based on User-Centered Patient Trials!

Cellular Computational Behavioral VR/Haptics Clinical

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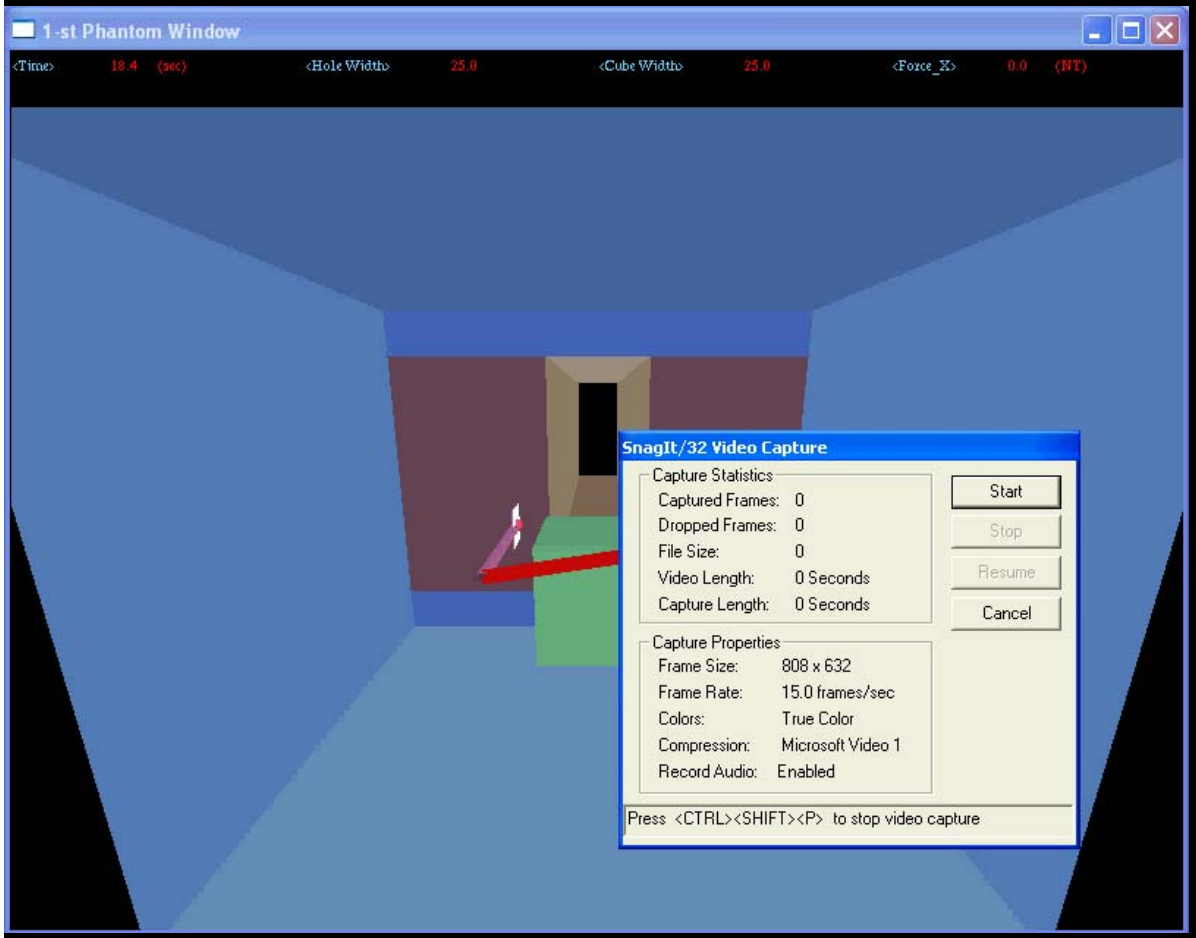
Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Recently Developed Scenarios



Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Developing multiple Phantom Haptic integration to provide fine motor haptic feedback during basic game-based rehab

Video from Harwin, 2004

Developing Full Hand VR Haptic Tasks

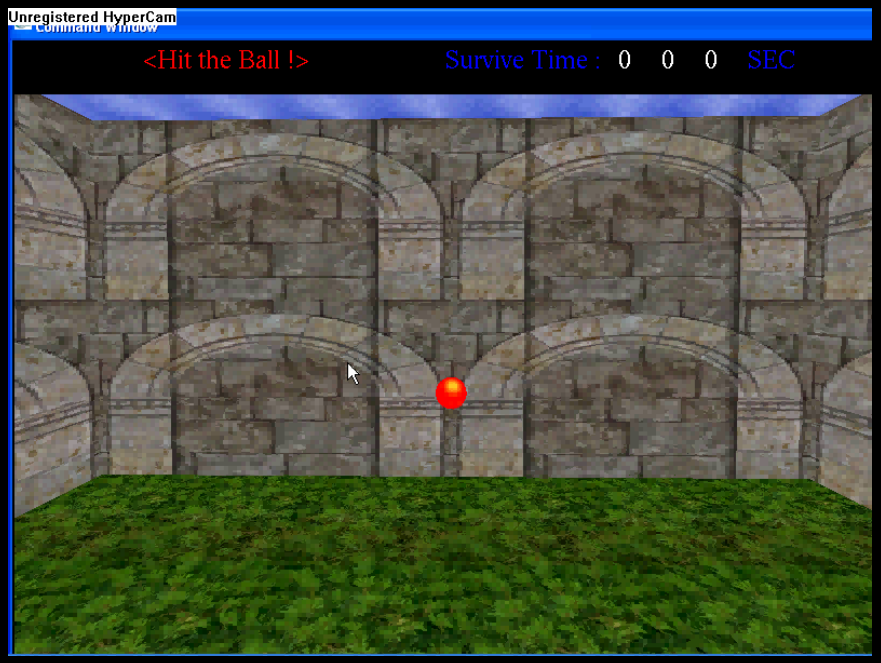
Cellular Computational Behavioral VR/Haptics Clinical

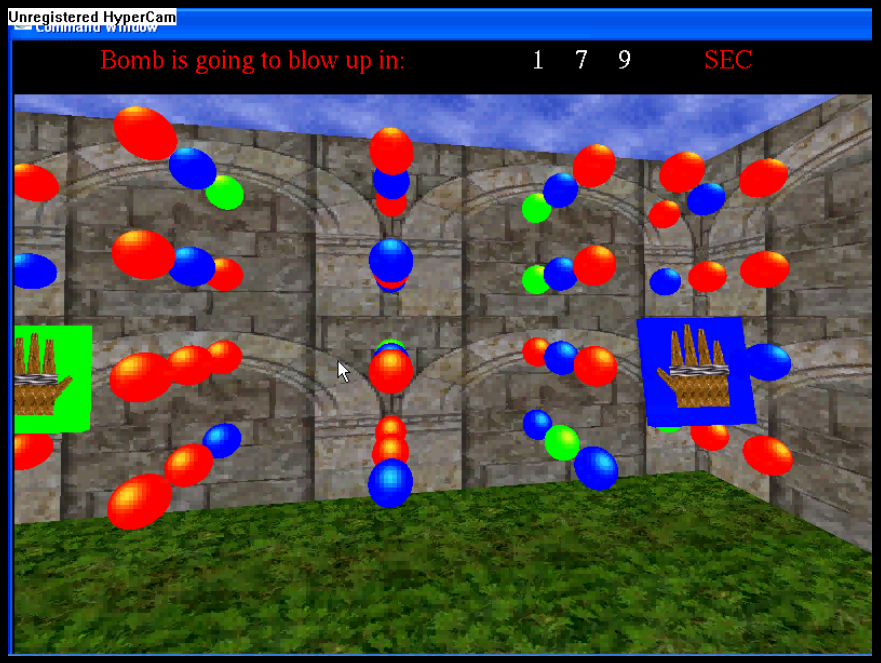
ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

USC VR Lab "Proof of Concept"
3D First Person System





USC VR Lab "Proof of Concept" Upper Body 3D First Person System

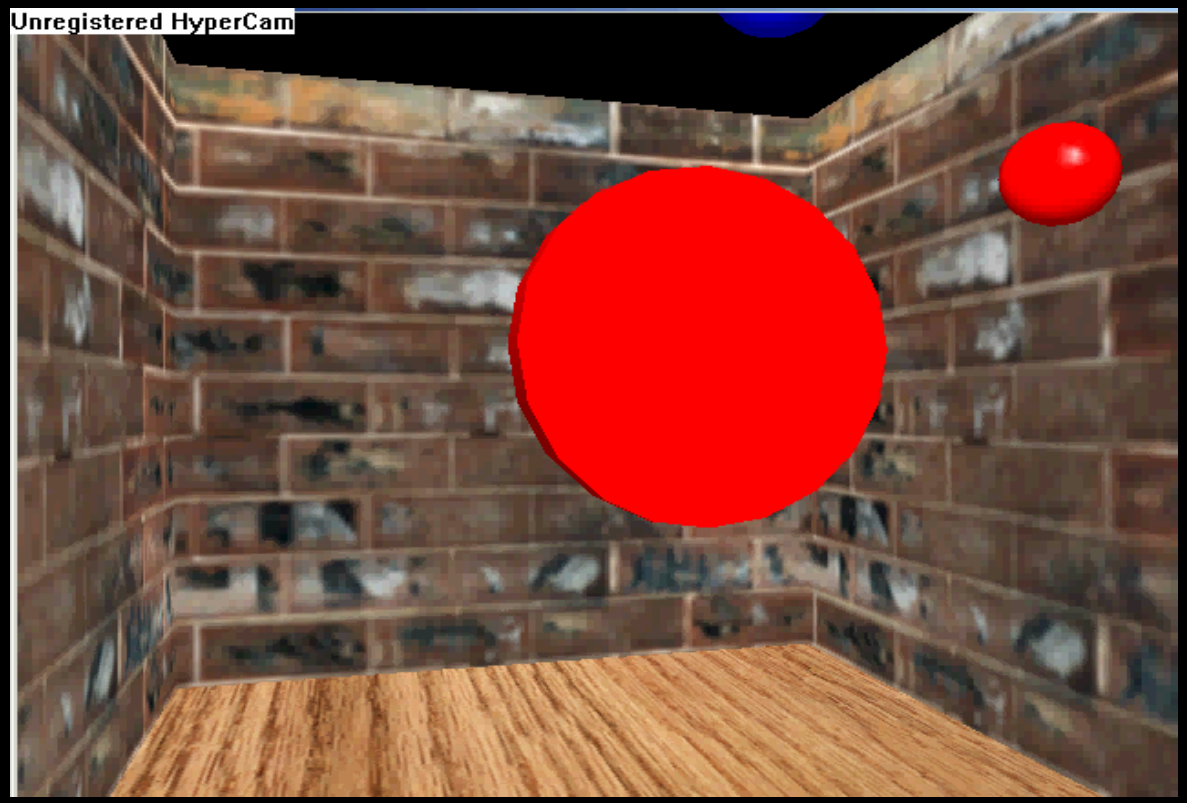
Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

USC VR Lab "Proof of Concept" Upper Body 3D First Person System



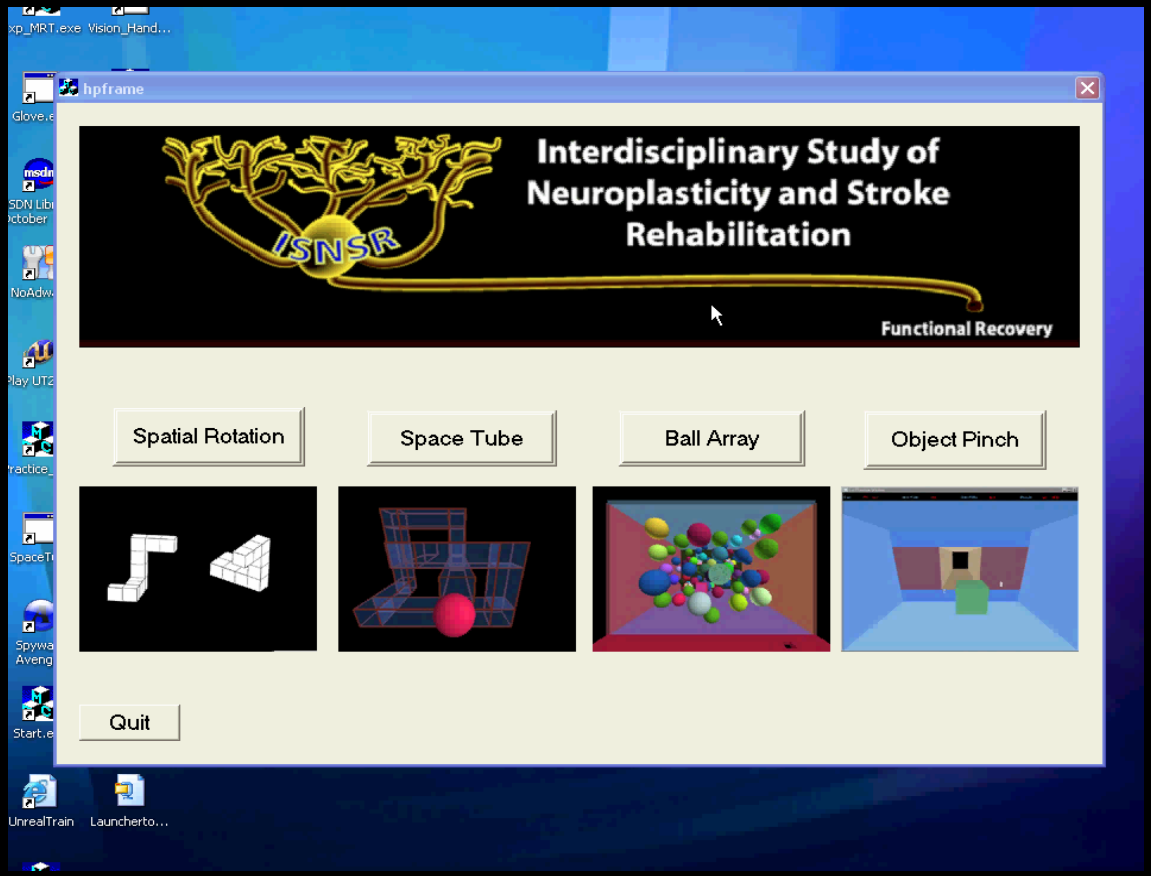
Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Clinical Interface Design



Cellular Computational Behavioral VR/Haptics Clinical

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

ISNSR

Functional Recovery

Clinical Interface Design

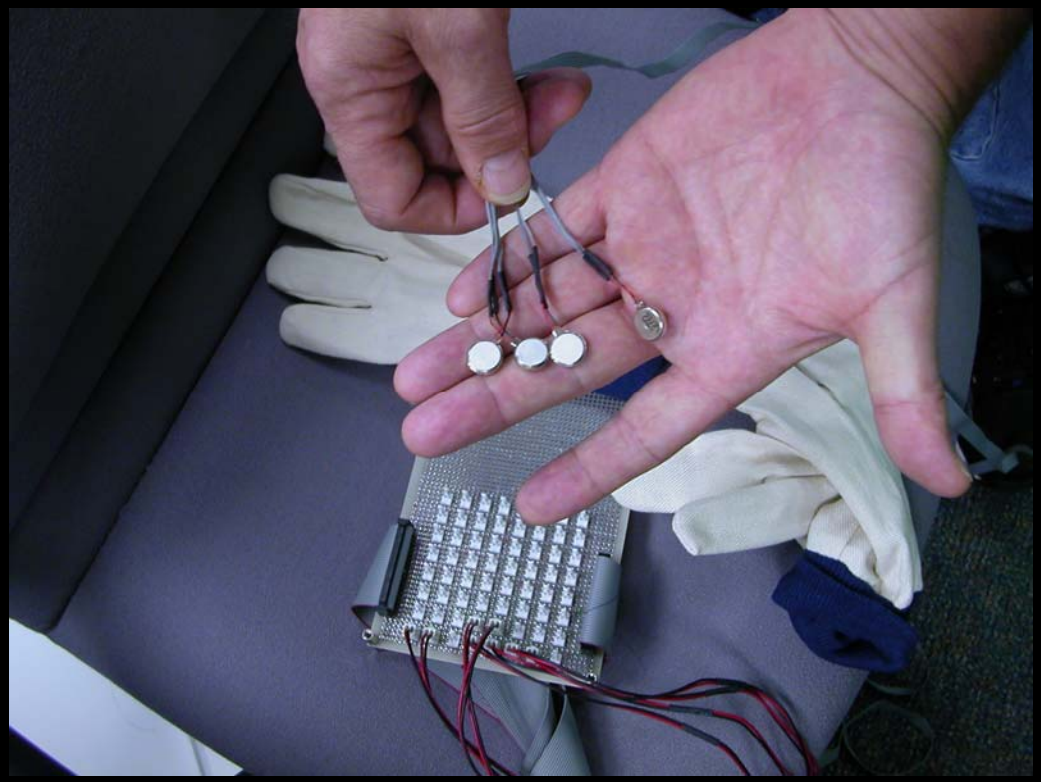
Cellular Computational Behavioral VR/Haptics Clinical

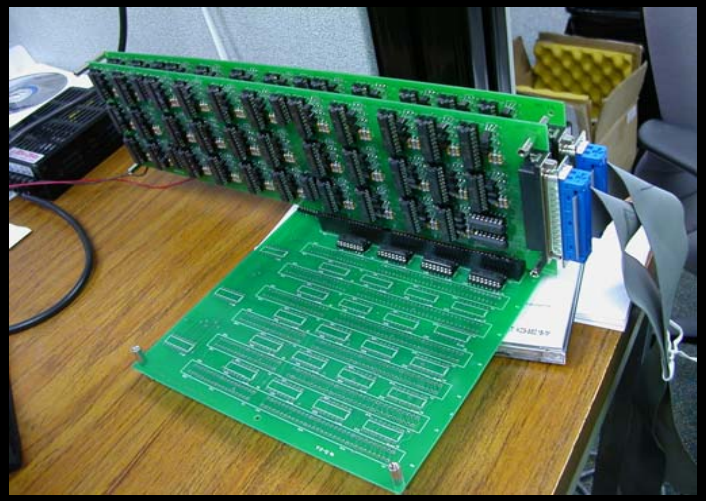
ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Experimenting with $7.00 cellphone vibrators embedded in user gloves to provide haptic feedback of collision detection

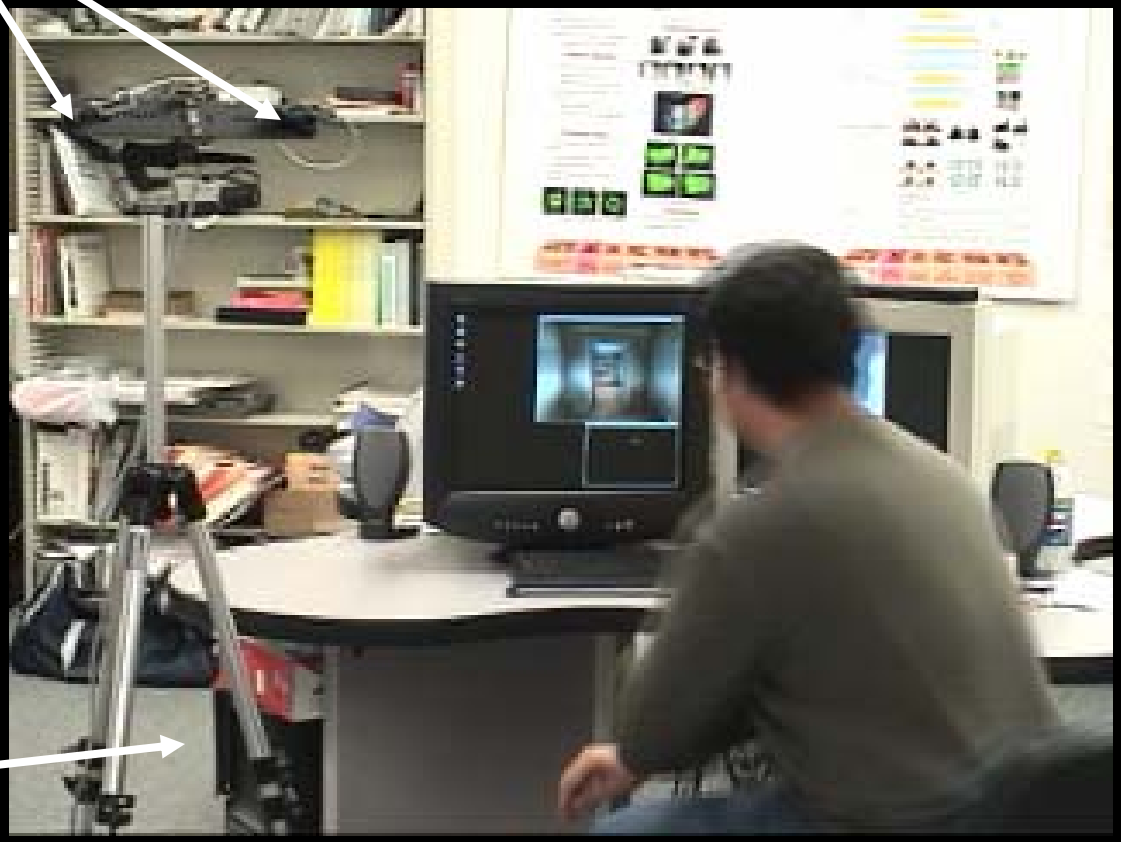




3D Computer Vision-Based Applications

Two inexpensive Point Grey cameras

Cohen, Lee & Rizzo, 2003



Natural "unencumbered" hand gesture control

5 Camera Full Body System in progress…

Opportunities

Gaming and Entertainment Industry Drivers

How can Games Advance VR Applications in Mental Health and Rehabilitation???

- Use of games to distract and motivate
- Use of game software/technology for VR scenario development

Digital Gaming using Virtual Environments has also thrived!

"The computer gaming industry has now surpassed the "Hollywood" film industry in total entertainment market share, and in the USA--sales of computer games *now outnumber the sale of books*."

Doug Lowenstein, IDGA, 2002

Display Technology - New Head Mounted Displays…

Download PDF BROCHURE

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V920 Display

VIDEO EYEWEAR AT PLAY In 1982 Sony introduced the first flat screen TV, an event many credit as the beginning of the home theater market. More than two decades later, screens still continue to grow in size, with LCDs winning the image quality battle. Now, Icuiti Corporation has made the home theater experience both personal and portable. Icuiti's Video Eyewear is creating a new paradigm in video entertainment—high resolution, LCD quality, in an eyewear format that can be used anywhere, anytime.

HOW WILL YOU USE YOUR ICUITI VIDEO EYEWEAR?

Enjoy movies • Watch music videos • Play games on your cell phone and PC • Watch streamed video from your cell phone • Check email in complete privacy • View confidential material in privacy • Watch TV • View 3D images and video • Play games on Nintendo®, PlayStation®, and Xbox®

Only $499

QUANTITIES ARE LIMITED, ORDER NOW!

Display Technology - New Head Mounted Displays…

Unveiled at the Consumer Electronics Show in Las Vegas, Jan. 2005

Driving (Astur et al.)

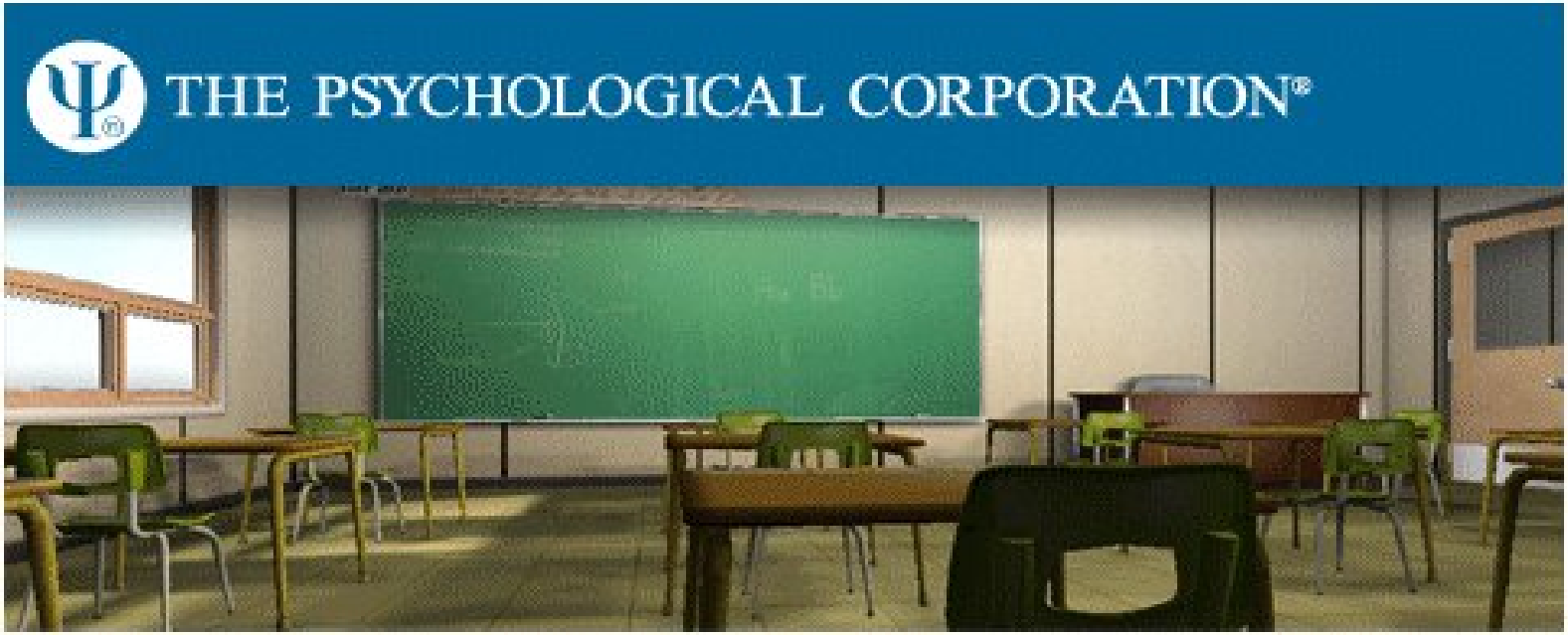
Morris Water Maze (Astur et al.)

THE PSYCHOLOGICAL CORPORATION®

2003

Psychological Assessment

The Virtual Classroom



VR Classroom 1.0

Copyright (c) 2001-2003 The Psychological Corporation

digital mediaworks

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TACHED CLIE

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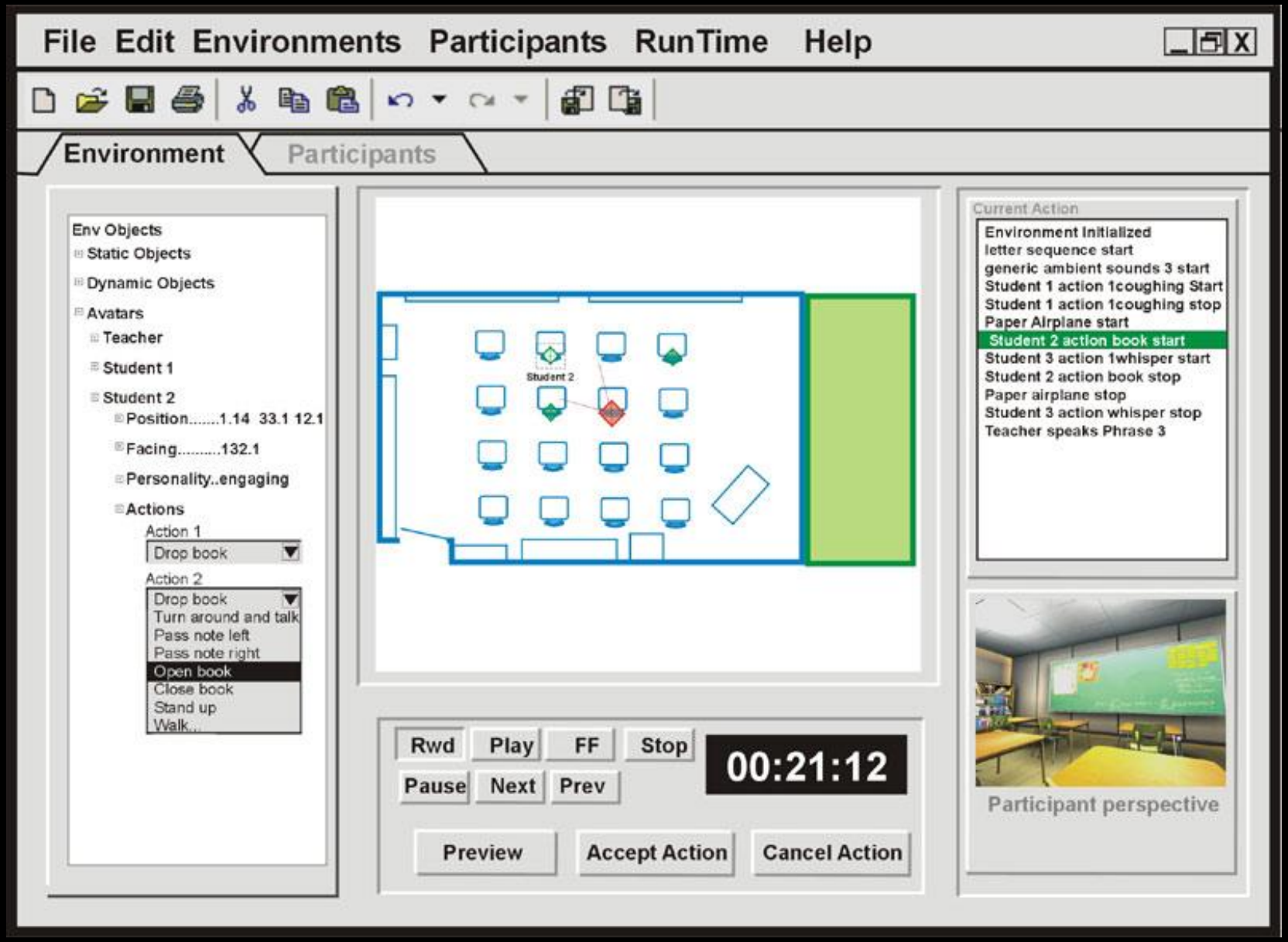
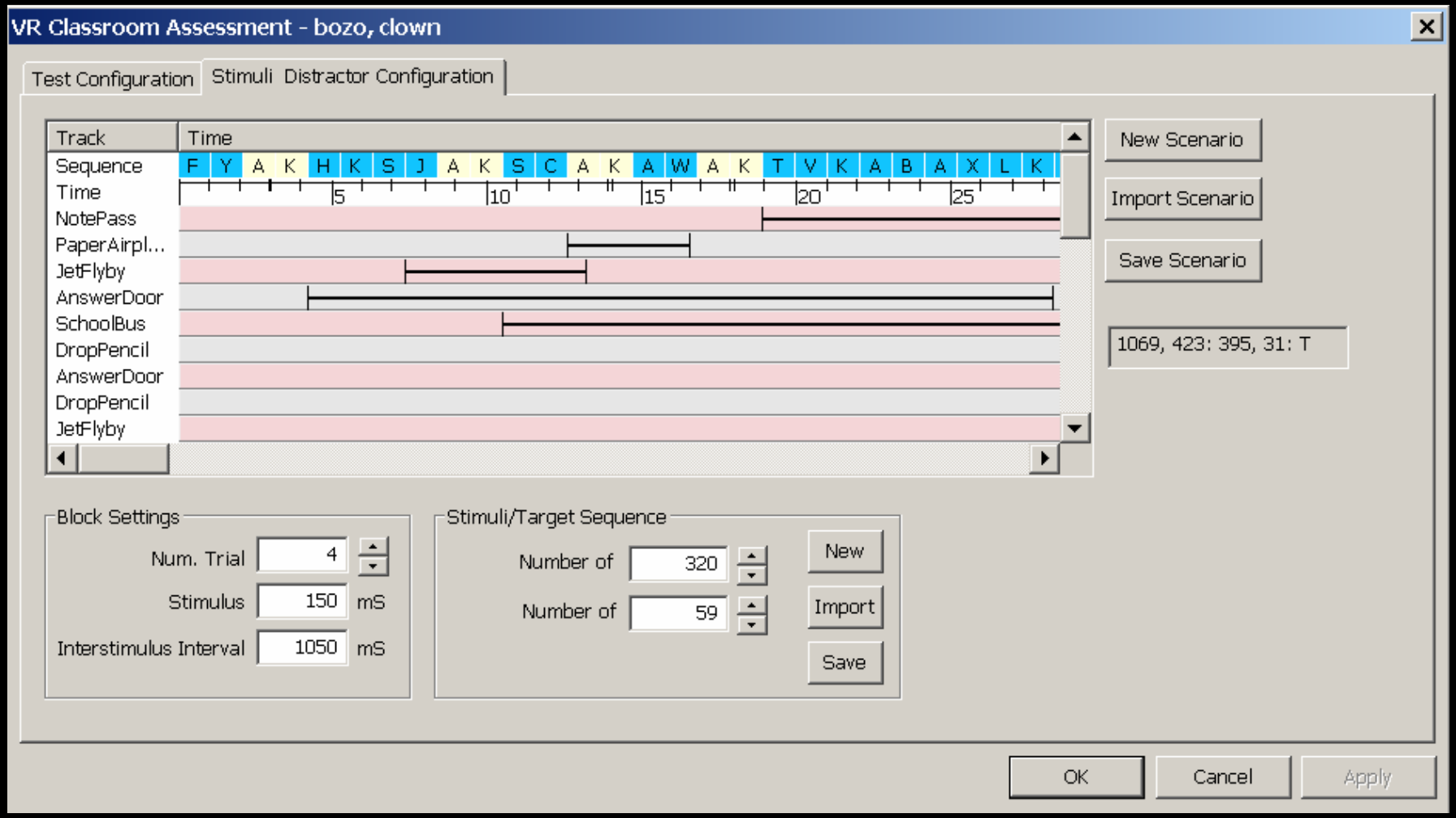
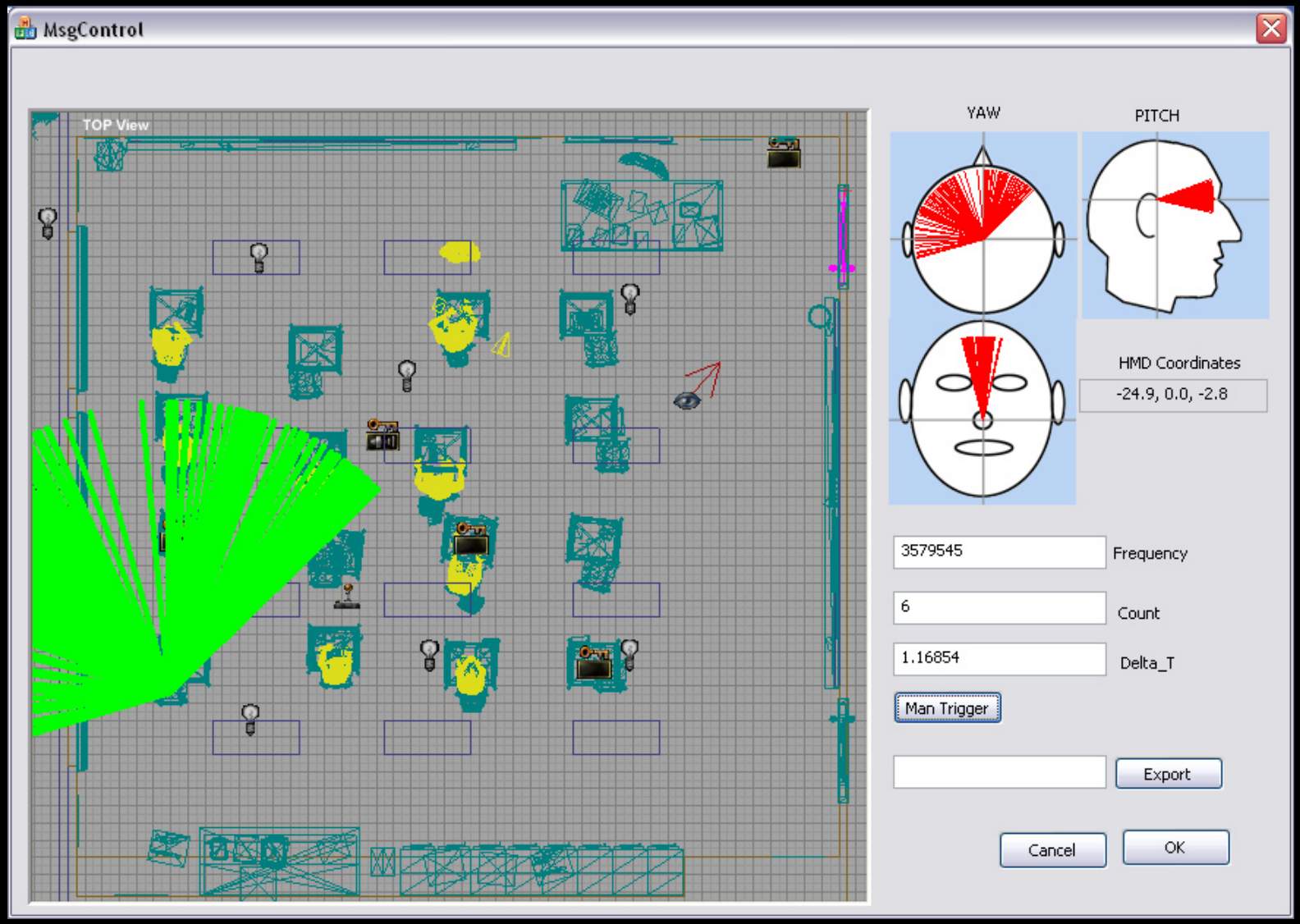
D
TEST
MONDAY!



Front End Interface

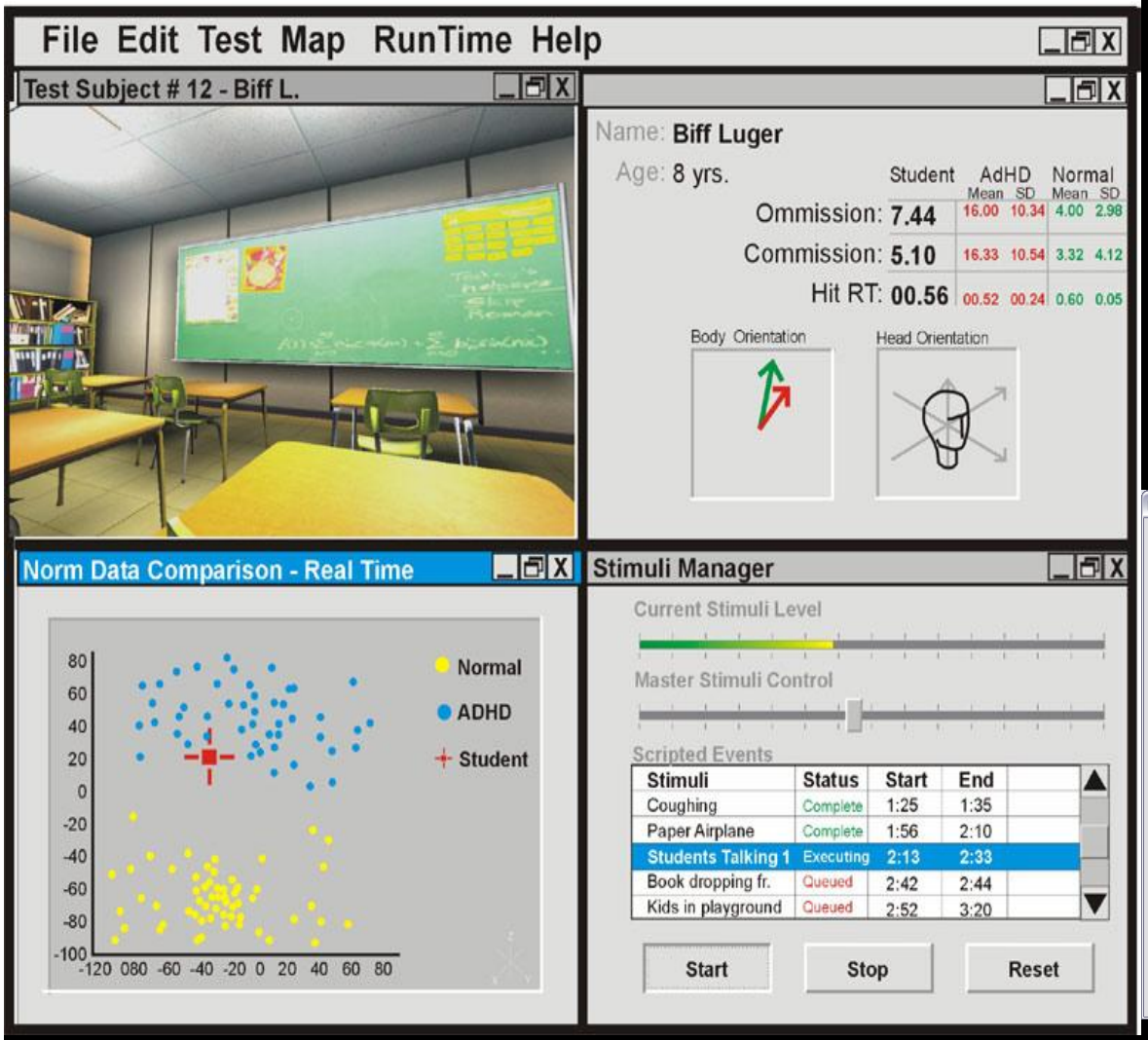


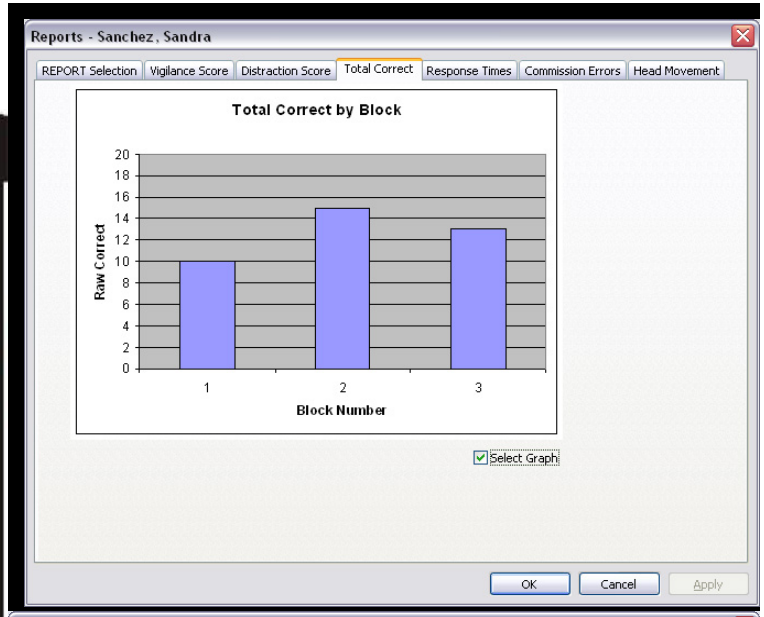
Front End Flexibility

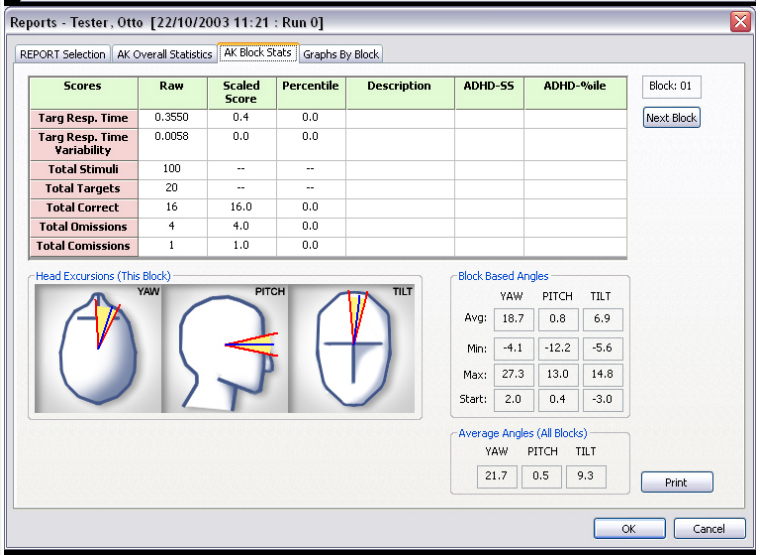


Data Monitoring Tool

Sample Run Time Interface - Assessor's Station







Data Extraction Tools

Three Center Trial

(has now replicated initial findings!)

- University of Victoria
- TPC Internal
- Norfolk Children's Clinic

PsychCorp

dmw digital mediaworks

VR/Rehab Strengths

- Complete naturalistic performance record
- 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

VR/Rehab Strengths

- Low cost functional environments that can be duplicated and distributed

Cognitive Planning assessed by Virtual Reality

Marié RM, Klinger E , Chemin I.

Equipe Universitaire :
Processus Exécutifs et Attentionnels :
Neuroanatomie Fonctionnelle, Physiopathologie et Réadaptation.
Responsable : Dr RM Marié

Ergonomic assessment of VR input devices for defining their usability

A preliminary study for further investigation in the Neuropsychology field

Teddy Louisy [1], Paul Richard [1], Damien Morin [1], Didier Le Gall [2], Philippe Allain [2]

[1] Laboratoire CPNI

Institut des Sciences et Techniques de l'Ingénieur d'Angers

62 avenue Notre Dame du Lac, F- 49000 Angers, France

Paul.Richard@istia.univ-angers.fr

[2] Unité de Neuropsychologie

CHU d'Angers

11 Boulevard Lavoisier, 49045 Angers, France

Teddy.Louisy@istia.univ-angers.fr

The sequential completion of a virtual coffee cup

1-Trigger the opening of the water container (on top of the coffee machine)

2-Reach and pick-up the bottle of water

3-Put the water in the coffee-maker

4-Reach and pitch up the coffee bag

5-Put the coffee in the filter

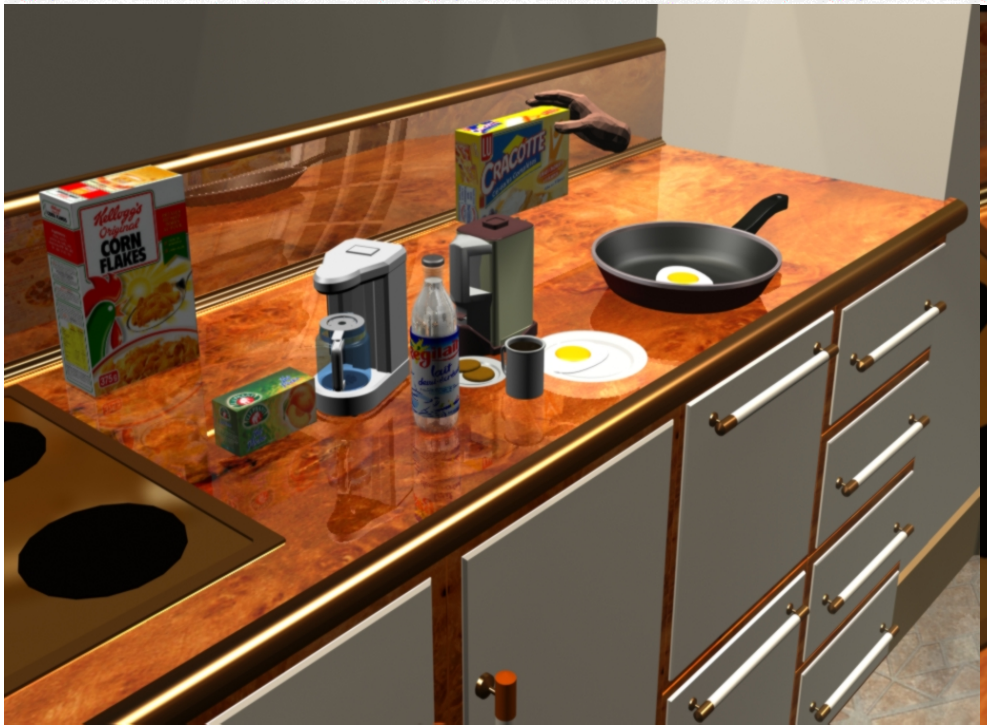
6-Put the filter on the top of the coffee pot

7-Put the coffee pot on the coffee-maker

8-Turn on the coffee-maker

9-Remove the filter from the coffee-maker

10-Grasp the coffee pot and pour it in the cup.



imsc
No Smoking

The Virtual Office!

Rizzo, Schultheis et al.

The Virtual Office Object Memory Test

Initial 16 Item Memory Test

8 Uncommon Items…

8 Common Items…

Measures from the VR Office

Trials to Criterion - total number of trials required to learn all targets

30-minute recall - total number of items recalled after 30 minute delay

24-hour recall - total number of items recalled after 24 hour delay

Study Design

20

TBI

Matched

20

HC

Traditional Neuropsychological Battery

VR Office Task

General Questionnaires

Participants

Variable*	**TBI** (n=20)	**HC** (n=20)
Age (*M*)	38.0	31.6
Gender	45% female	55% female
Education (*M*)	13.4	15.2

** No significant differences between groups*

TBI Participants

Variable	TBI (n=20)
Years Post-Injury (*M*)	7.3
Days Loss Consciousness (*M*)	16.0
Glasgow Coma Scale (*M*)	3.5
Injury Type	60% MVA 30% Fall

TBI Group Equivalence

Type of injury

- MVA (60%)
- Fall (30%)

Time post-injury

- 1 - 22 yr.s
- *M* = 7.3 yr.s (SD = 5.1)

Time loss consciousness

- 1 - 60 days
- *M* = 16.0 days (17.3)

Hypothesis I

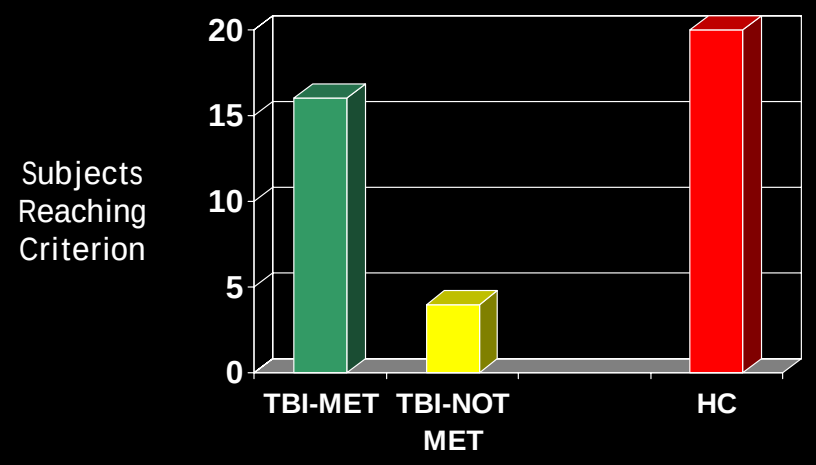
I. Two TBI groups will emerge:

TBI-MET & **TBI-NOT MET**

Results: Trials to Criterion

I. Two TBI groups emerged:

TBI-MET & **TBI-NOT MET**



TBI-MET (80%, n=16): Met Learning Criterion

TBI-NOT MET (20%, n=4): Did not Meet Criterion

Statistically Equivalent in Age, Gender, Education, Time post injury, Time LOC

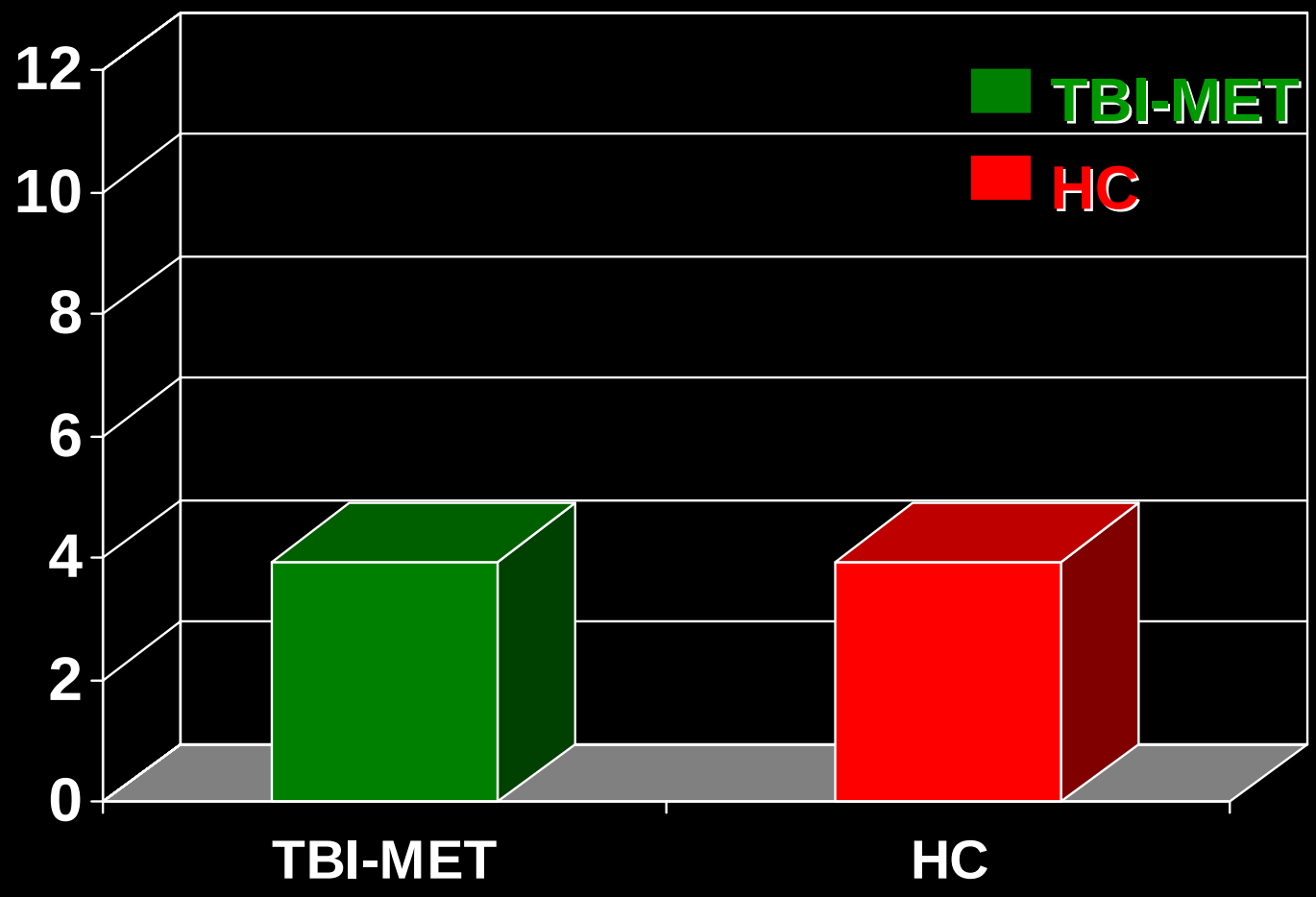
HC: Met Learning Criterion

Hypothesis II

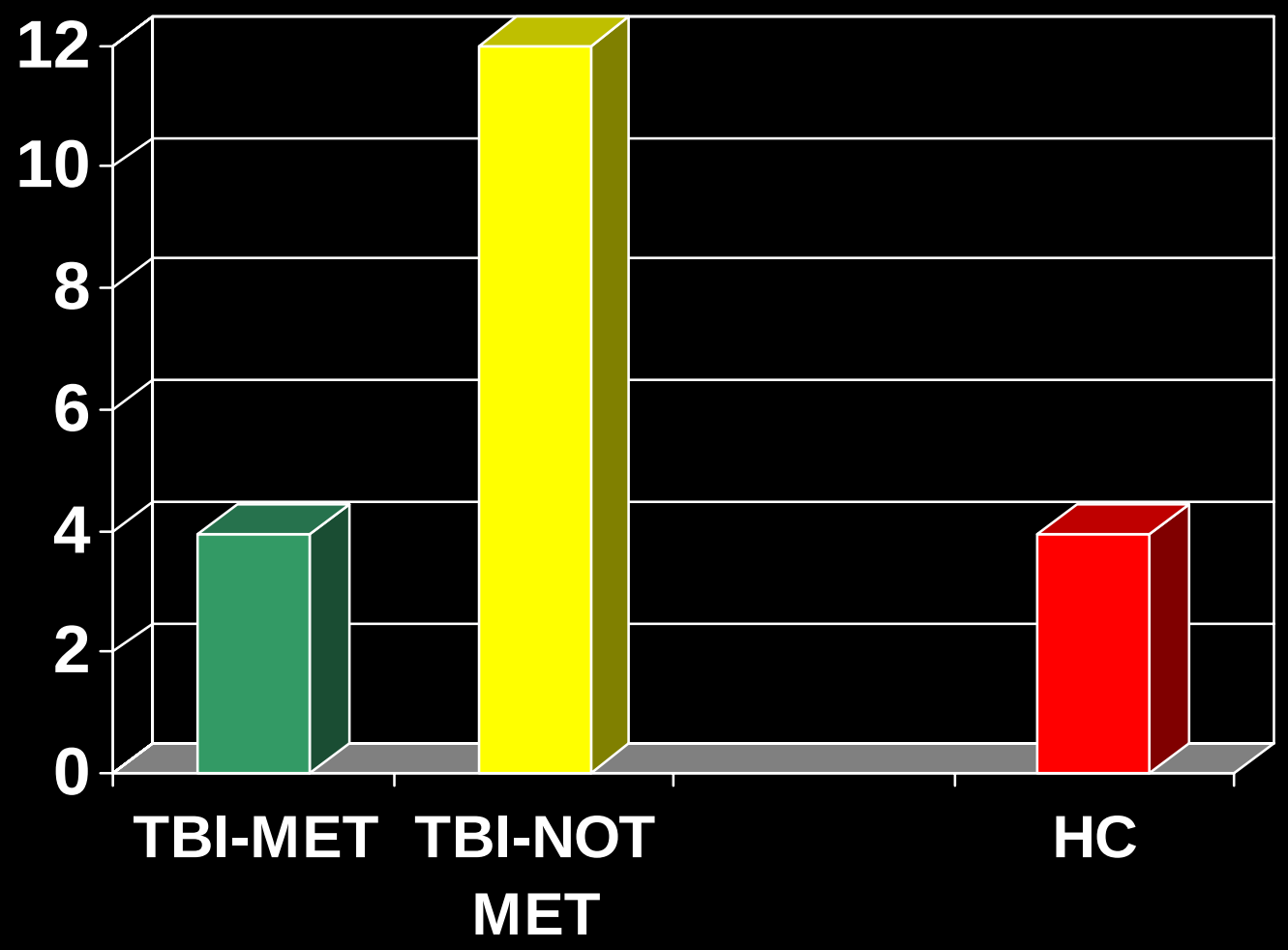
II. TBI-MET Group will require a greater number of trials to learn office items than HC group

Results: Trials to criterion

No Difference!



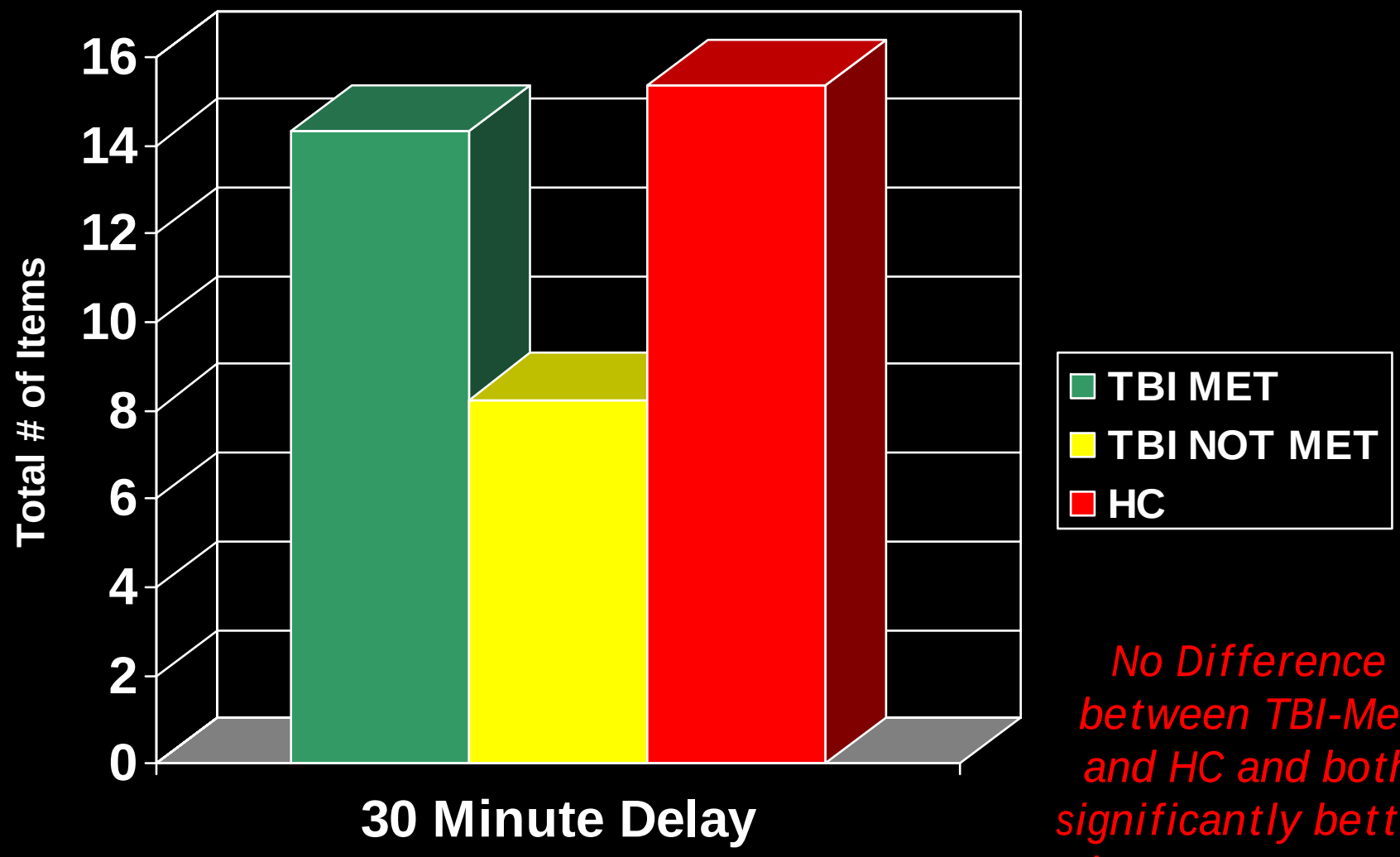
Results: Trials to criterion



Hypothesis III

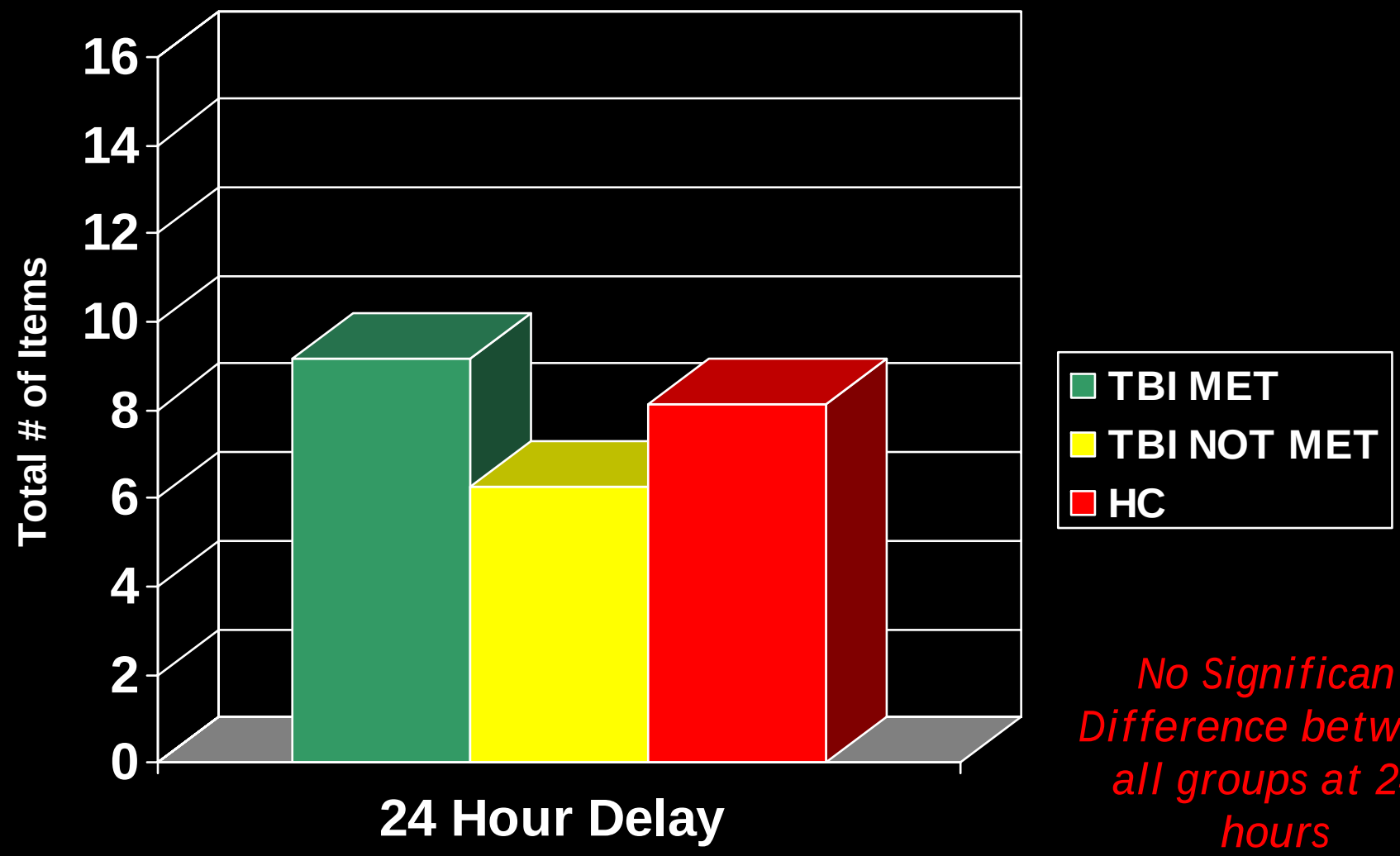
III. TBI-MET group equivalent to HC group at 30-minute and at 24-hour delay

Results: 30-Minute Recall



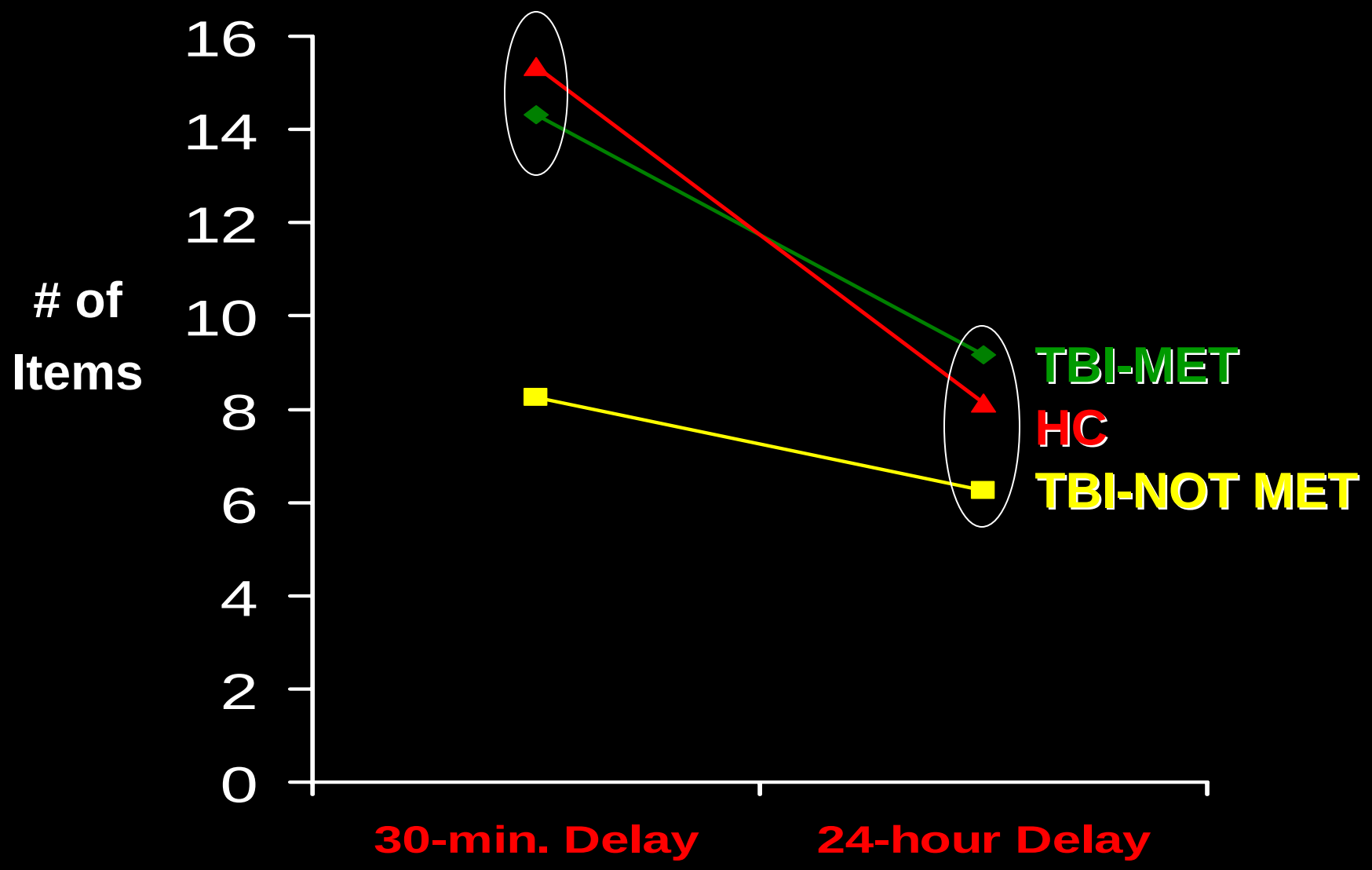
No Difference between TBI-Met and HC and both significantly better than TBI Not-Met!

Results: 24-Hour Recall



No Significant Difference between all groups at 24-hours

Results: Hypothesis III

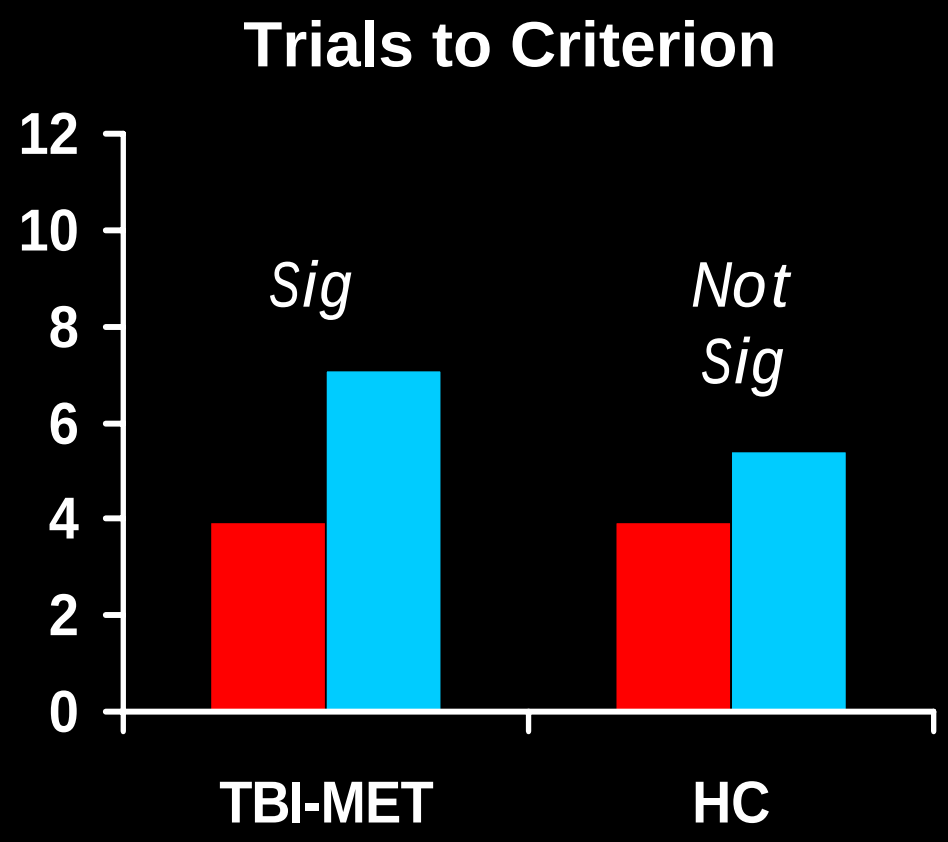


Hypothesis IV

IV. Object Memory Performance better among participants tested in VR compared to a auditory Verbal Learning measure of memory

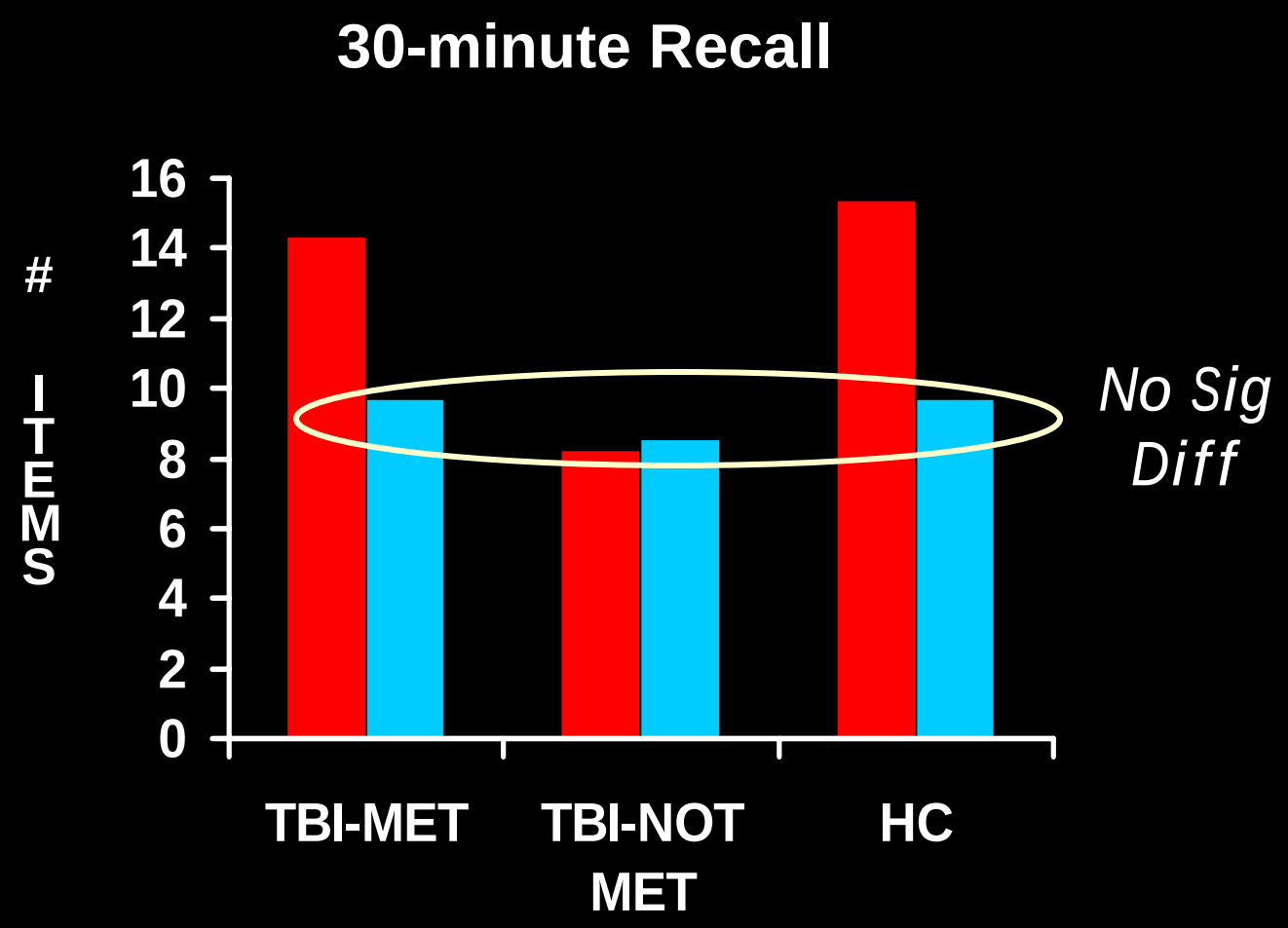
Results: Hypothesis IV

VR Office
Selective Reminding Task



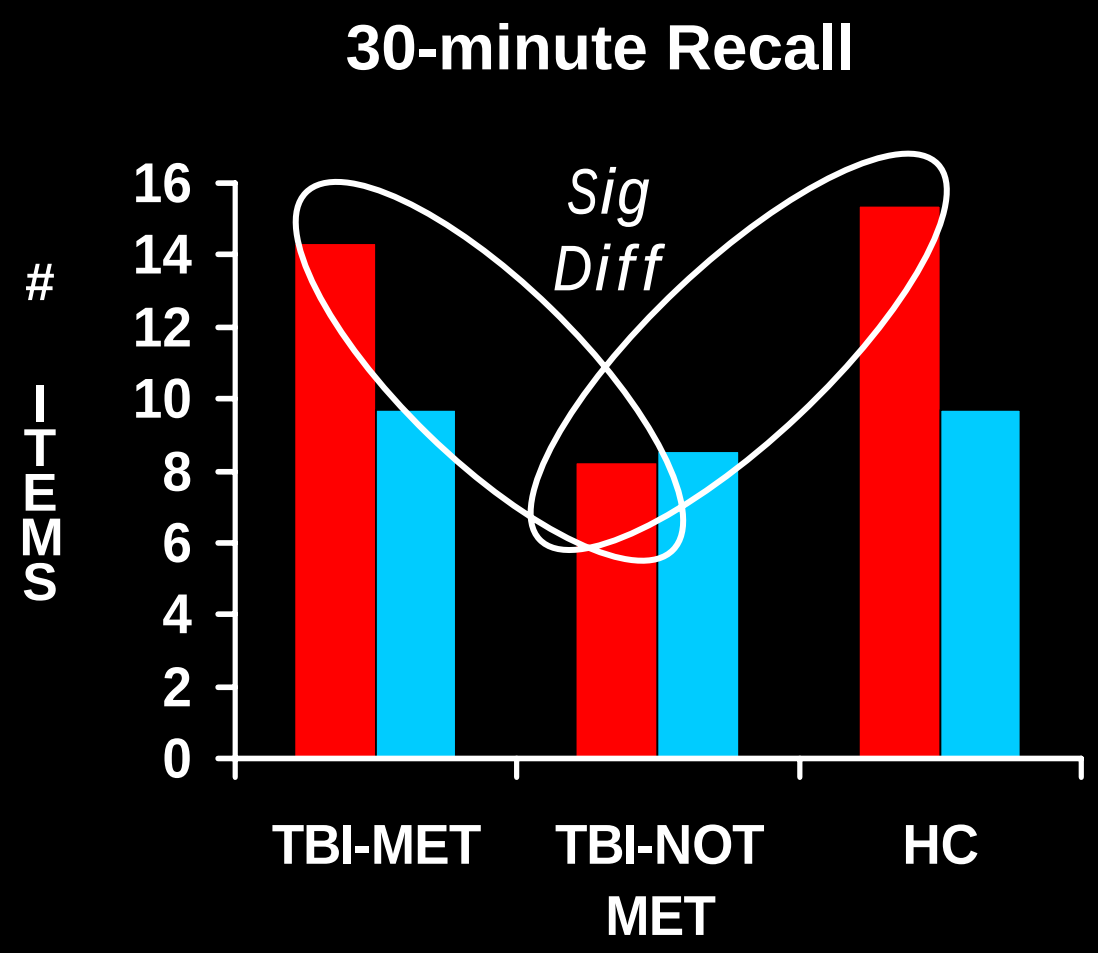
Results: Hypothesis IV

VR Office
Selective Reminding Task



Results: Hypothesis IV

VR Office
Selective Reminding Task



Discussion

Lack of Learning and Intermediate Recall Impairment in TBI-MET group?

Nature of Task

Highly Contextualized Target Stimuli

1. truck
2. spinach
3. squirrel
4. cabbage
5. bookcase
6. motorcycle

Auditory Based Target Stimuli

Key Findings

- Good usablity & low incidence of side effects
- Trials to criterion method revealed “layers” of learning impairment within TBI group
- TBI-MET group equivalent to HC group on acquisition and at 30-minute/24-hour delay
- Differential results compared to auditory list learning tests typically employed in traditional neuropsychological assessment.

Key Findings

- Such results can be interpreted to indicate:

This method is weak at discriminating TBI from HC

or

This method reveals preserved memory abilities in some TBI subjects that would be lost to traditional assessment and could in fact inform development of everyday memory rehabilitation?

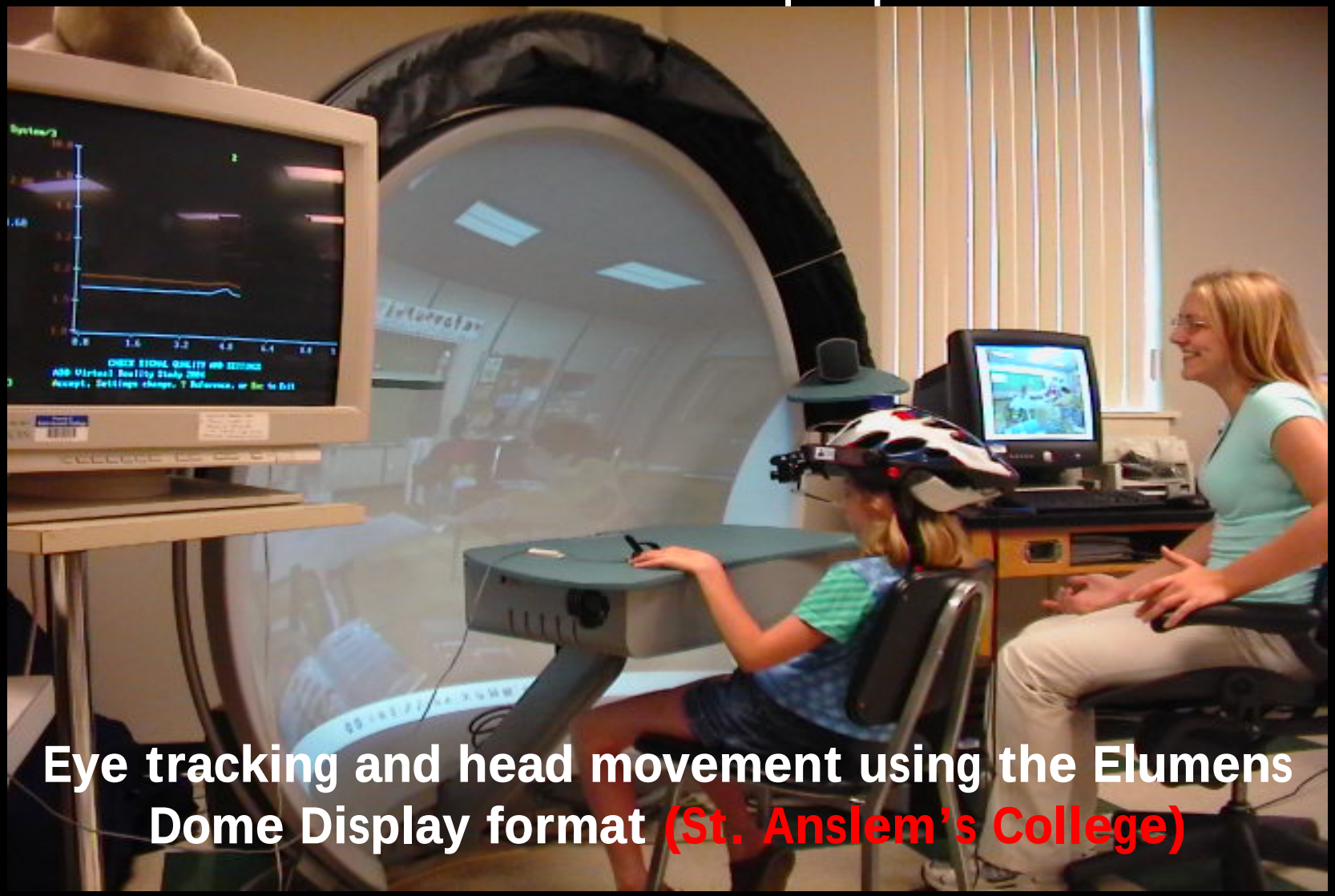
Next Generation VR Office

Rizzo, Klimchuk & Mitura

Next Generation VR Office

Rizzo, Klimchuk & Mitura

Flexible reconfiguration of this “Archetypic” scenario for other purposes:



Eye tracking and head movement using the Elumens Dome Display format (St. Anslem’s College)

New Attention Tasks being Developed

Boston Naming Task

Stroop Task

Letter Crowding Task

Flexible reconfiguration of this "Archetypic" scenario for other purposes:

Public speaking with children who have Social Phobia
(Virginia Tech)

Flexible reconfiguration of this “Archetypic” scenario for other purposes:

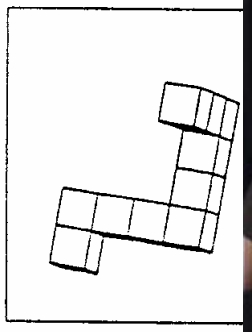
Virtual Earthquake safety training tool for children with developmental and learning disabilities. (Aristotle University of Thessalonica, Greece)

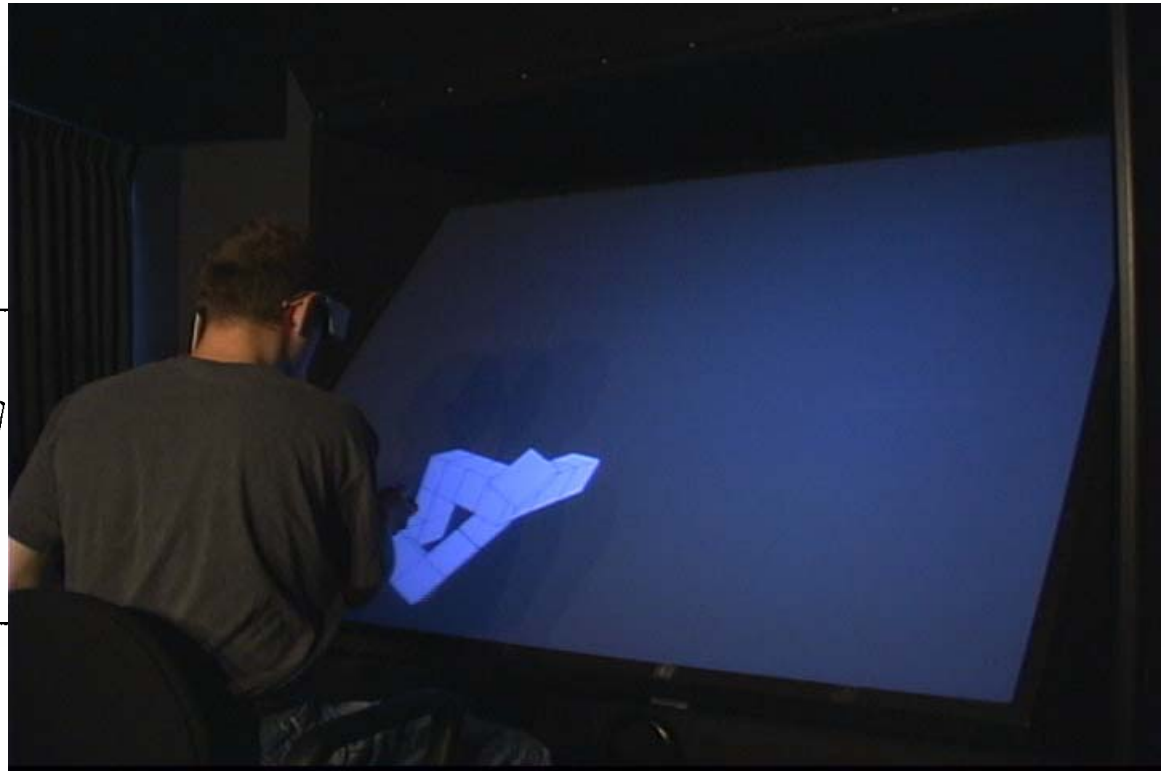
PATHNODES
1596.95,295.87,-2306.00
1386.32,229.29,-2297.15
0.00,0.00,0.00
65119,3193,0
ANG:17.54,176.56
PATHNODES
1596.95,295.87,-2306.00
1386.32,229.29,-2297.15
0.00,0.00,0.00
65119,3193,0
ANG:17.54,-82.27
PATHNODES
1596.95,295.87,-2306.00
1456.81,305.20,-2294.19
0.00,0.00,0.00
64681,64843,0
ANG:-3.81,-6.31

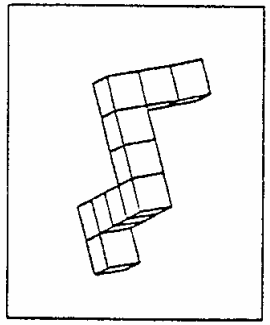
Flexible reconfiguration of this "Archetypic" scenario for other purposes

Now look at this object:

1.







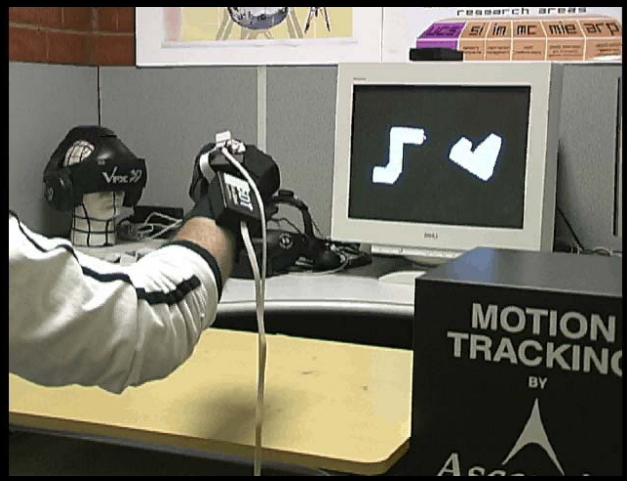
Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Manual Suppination and Pronation Block Task



System allows delivery by way of Stereo HMD, Crystal Eyes on PC monitor, ImmersaDesk and on Passive 3D Sharp Laptops

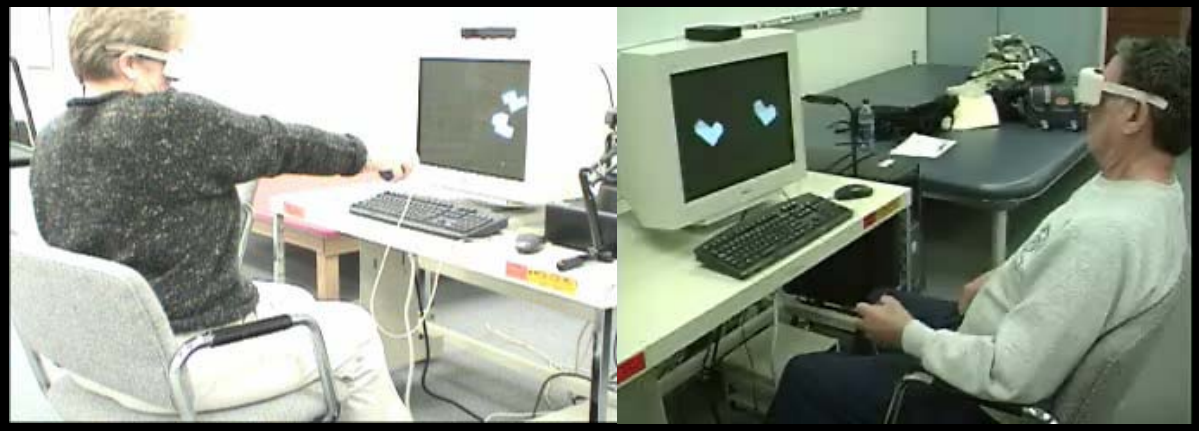
Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

Translation of Spatial Rotation Stimuli into a Supination Rehabilitation Task Following Stroke!



Initial User-Centered Trials have commenced…

Cellular Computational Behavioral VR/Haptics Clinical

ISNSR

Interdisciplinary Study of Neuroplasticity and Stroke Rehabilitation

Functional Recovery

VR/Rehab Strengths

- Ecological validity
- Stimulus control and consistency
- Repetitive and hierarchical stimulus delivery possible
- Cueing stimuli for “errorless learning”
- Real time performance feedback
- Self-guided exploration and independent practice
- Stimulus and response modification contingent on user’s impairments
- Complete naturalistic performance record
- 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

A Psychologist's DREAM!?

The capacity to design a functional environment, precisely administer stimuli, and measure, treat and train performance within the environment.

VFX 3D
HMD Demo

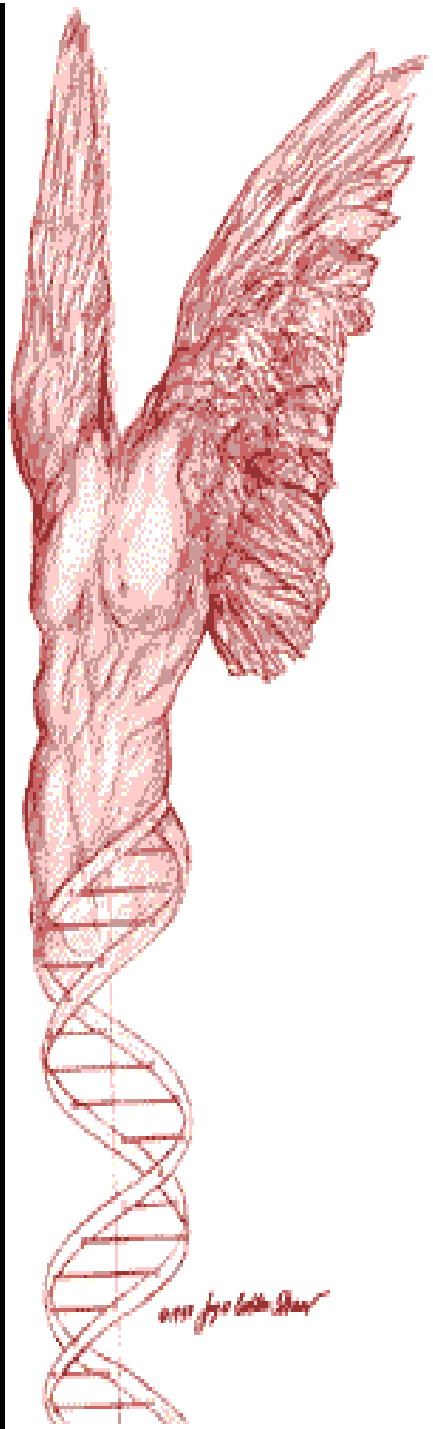
VR and Mental Health Listserver

"VRPSYCH"

- *Clinicians and Researchers worldwide sharing information on mental health applications using Virtual Environments!*
- *As of 09/2003, 450 professionals in 22 countries!*
- *Email* arizzo@usc.edu *to sign-up!*

Medicine Meets Virtual Reality
2005
2-day Mental Health Symposium
January 14-17, 2005
Newport Beach, California
http://www.amainc.com

Full papers will be published as a special issue of
CyberPsychology & Behavior Journal
http://www.liebertpub.com



3rd Annual Virtual Reality & Rehabilitation: Algorithms, Avatars & Applications

Two-day Symposium

March 8-10 2005

University of Haifa, Israel

3rd Annual Virtual Reality & Rehabilitation: Algorithms, Avatars & Applications

Two-day Symposium

March 8-10 2005

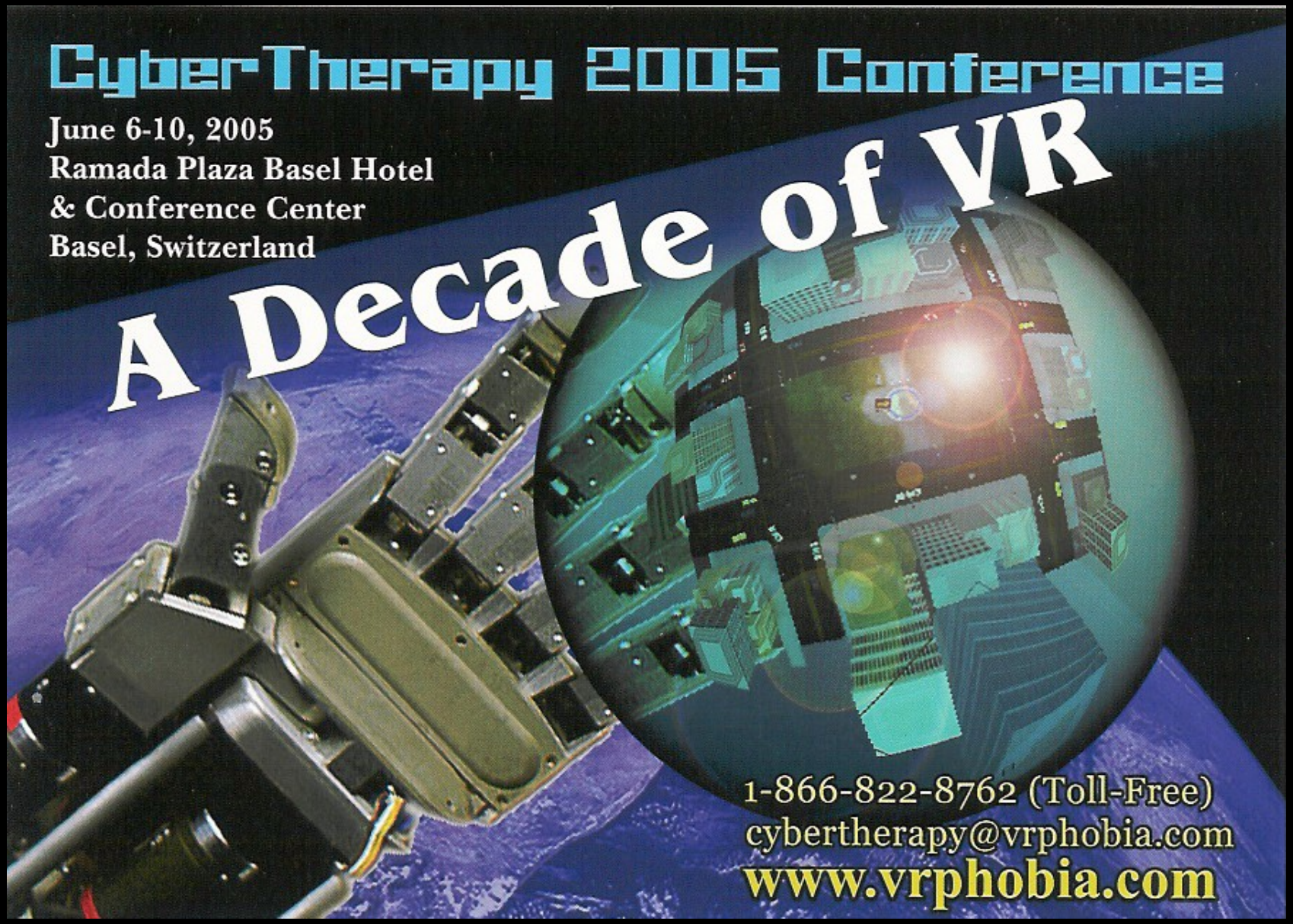
University of Haifa, Israel

VR 2004

March 27-31, Chicago, IL USA – www.vr2004.org

IEEE VR2005 – Bonn, Germany

March 2005



Basel Switzerland - June 2005

Call for Participation

HCI International 2005

11th International Conference on Human-Computer Interaction

jointly with

Symposium on Human Interface (Japan) 2005
5th International Conference on Engineering Psychology & Cognitive Ergonomics
3rd International Conference on Universal Access in Human-Computer Interaction
1st International Conference on Virtual Reality
1st International Conference on Usability and Internationalization

22-27 July 2005

Caesars Palace • Las Vegas, Nevada USA

Under the auspices of 7 distinguished international boards of 171 members from 25 countries

Coming to LA in 2005!!!
4th International Workshop on Virtual Rehabilitation IWVR 2005
Catalina Island, California, USA
September 19-21, 2005

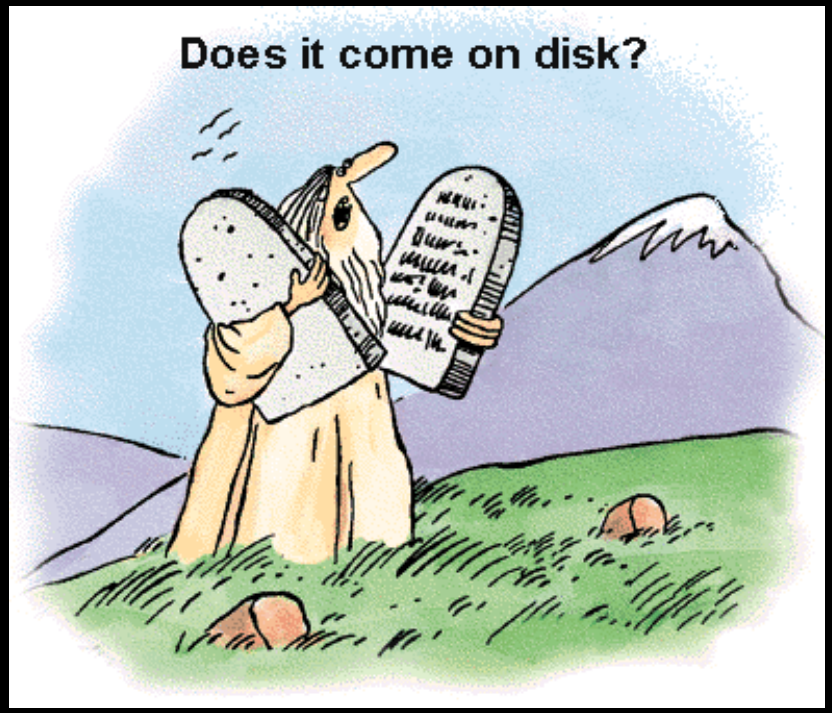
N234AH

International Conference on Disability, Virtual Reality, and Associated Technology
ICDVRAT 2006

Denmark

September, 2006

A Copy of this talk will be available for the attendees. Please cite the source if you use any of the materials from this talk.



Contact Information:

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Institute for Creative Technologies
and the School of Gerontology
Los Angeles, California
arizzo@usc.edu
213-740-9819

The End (for now)

"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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