Virtual Reality & Neuropsychology

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I. Neuropsychological Assessment

II. Cognitive Rehabilitation

I. Neuropsychological Assessment

II. Cognitive Rehabilitation

Neuropsychology

- Studies the structure and function of the brain as it relates to psychological processes and behaviors.
  - Lesion studies in humans and animals
  - Neuroimaging studies, EEG studies
  - Behavioral Studies

Neuropsychological Assessment

- Forms the core of Neuropsychology
- The means by which Neuropsychologists traditionally assess cognitive functioning
- Assessment methods
  - Paper and pencil tests
  - Computerized tests
  - Questionnaires

Neuropsychological Assessment

- Uses standardized neuropsychological tests
  - Designed so performance on the task can be linked to specific neurocognitive processes
  - Typically standardized
    - Administered to a specific group (or groups) of individuals before used in individual clinical cases.
    - Standardization yields normative data.
      - Used as the comparative standard against which individual performances can be compared
      - Measures an individual's strengths and weakness

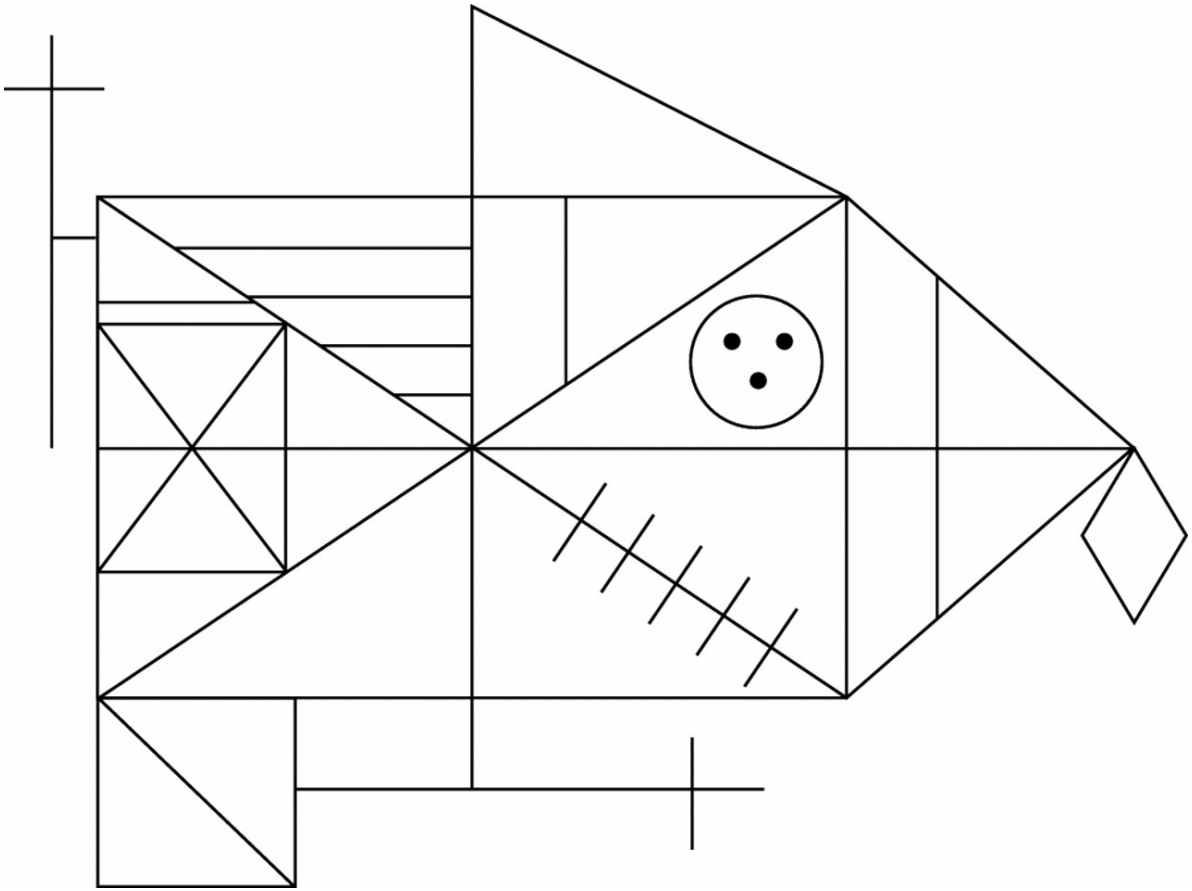
Neuropsychological Assessment Choosing Tools

- What is the question?
  - Are we concerned about daily life functioning, employment issues, classroom performance?
    - Usually yes
    - Generalization is important
- Assessing daily life functioning is important

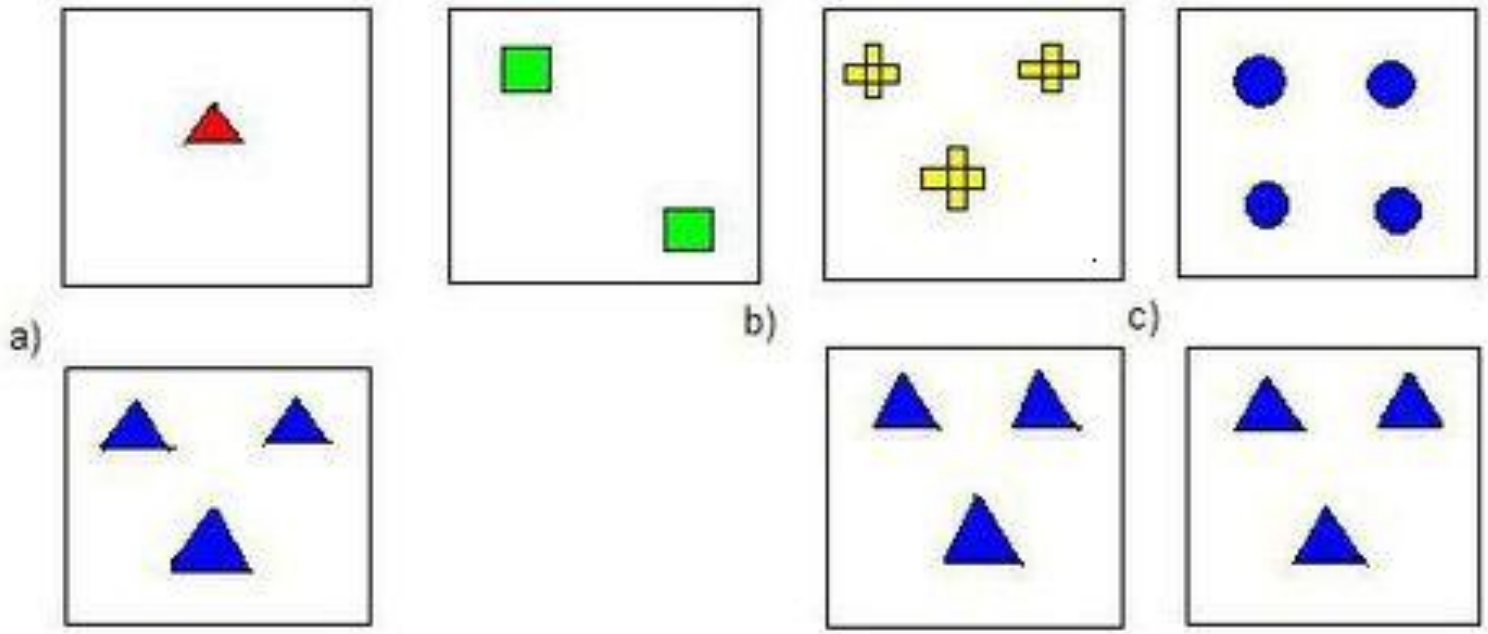
Domains Assessed

- Intelligence
  - framework within which one can interpret test results
- Attention/ Concentration
- Language Abilities
  - Comprehension, naming, etc
- Working Memory
  - Verbal and non-verbal
- Processing Speed
- Long-term Memory
  - Verbal and non-verbal
- Executive Functions
  - Planning, problem solving, mental flexibility, abstract reasoning

Neuropsychological Assessment
Rey Figure



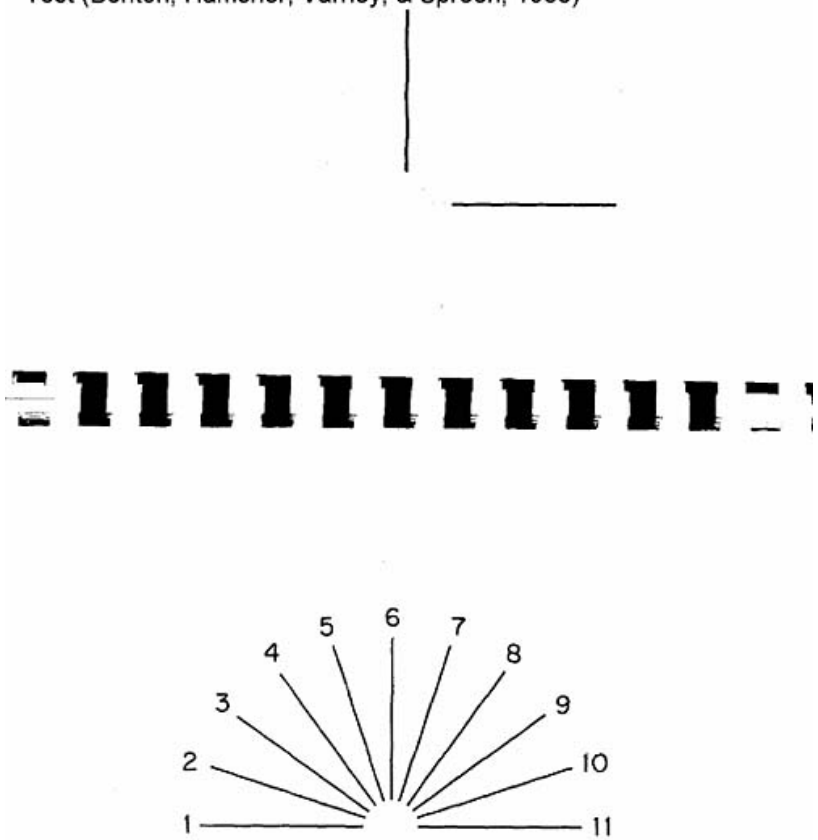
Neuropsychological Assessment
Executive Control



Neuropsychological Assessment Functions Assessed

- Visuospatial Functioning
  - Facial Processing
  - Line Orientation

An example of an item from the Judgement of Line Orientation Test (Benton, Hamsher, Varney, & Spreen, 1983)



Neuropsychological Assessment Functions Assessed

- Verbal New Learning and Memory
- California Verbal Learning Test
  - 16 words repeated over 5 trials
    - Words are from 4 semantic categories
    - Assess recall after every trial, after an interference list and after a 20 minute delay
    - Assess recognition
  - Evaluates learning slope, organization, short and long delay recall, recognition

Neuropsychological Assessment Functions Assessed

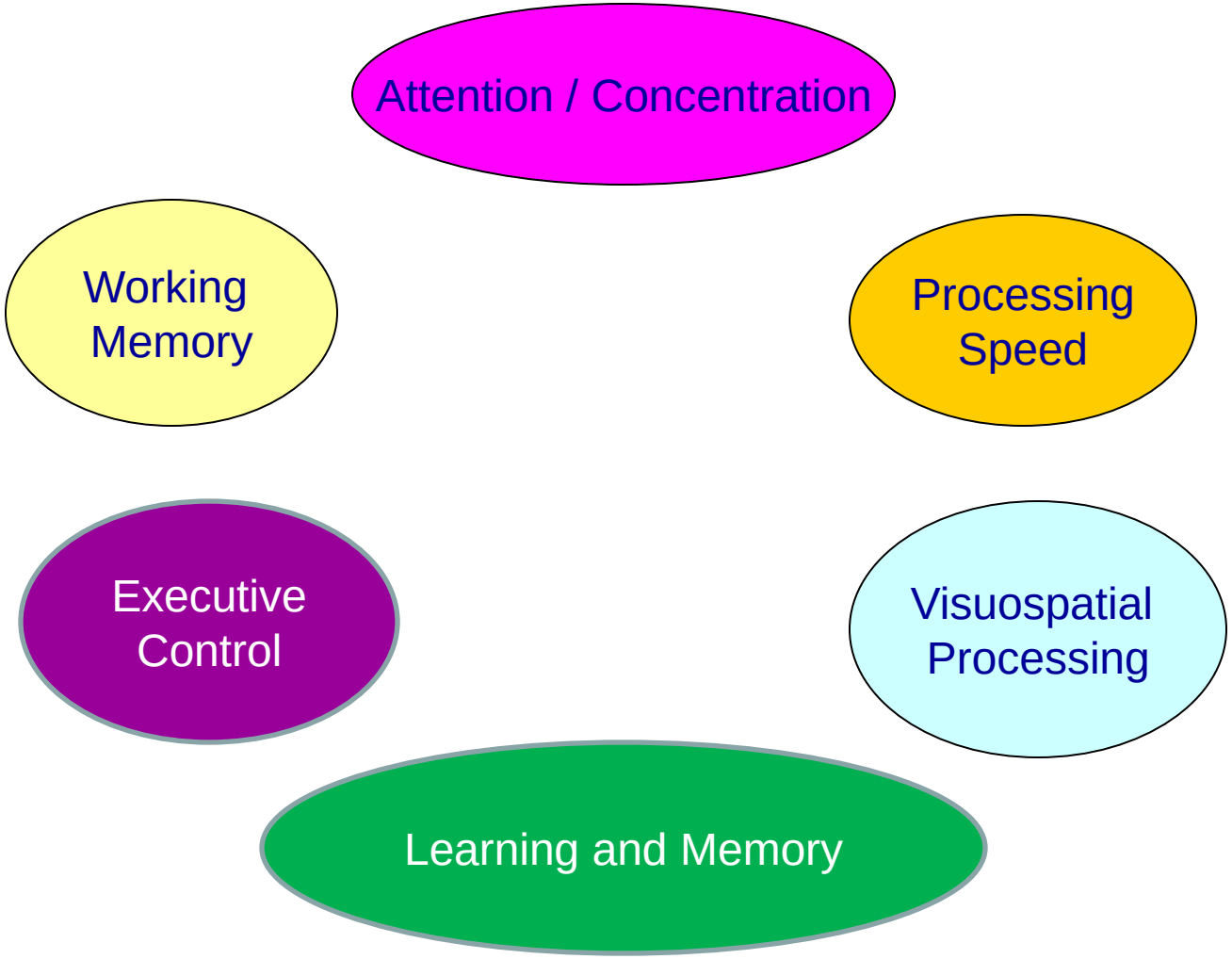
Technological Advances in NP

- Prior to VR
  - Neuropsychology's use of technology consisted of translating paper and pencil tools directly into computer delivered formats
    - Eased administration and scoring
- The application of VR has a different ***purpose***

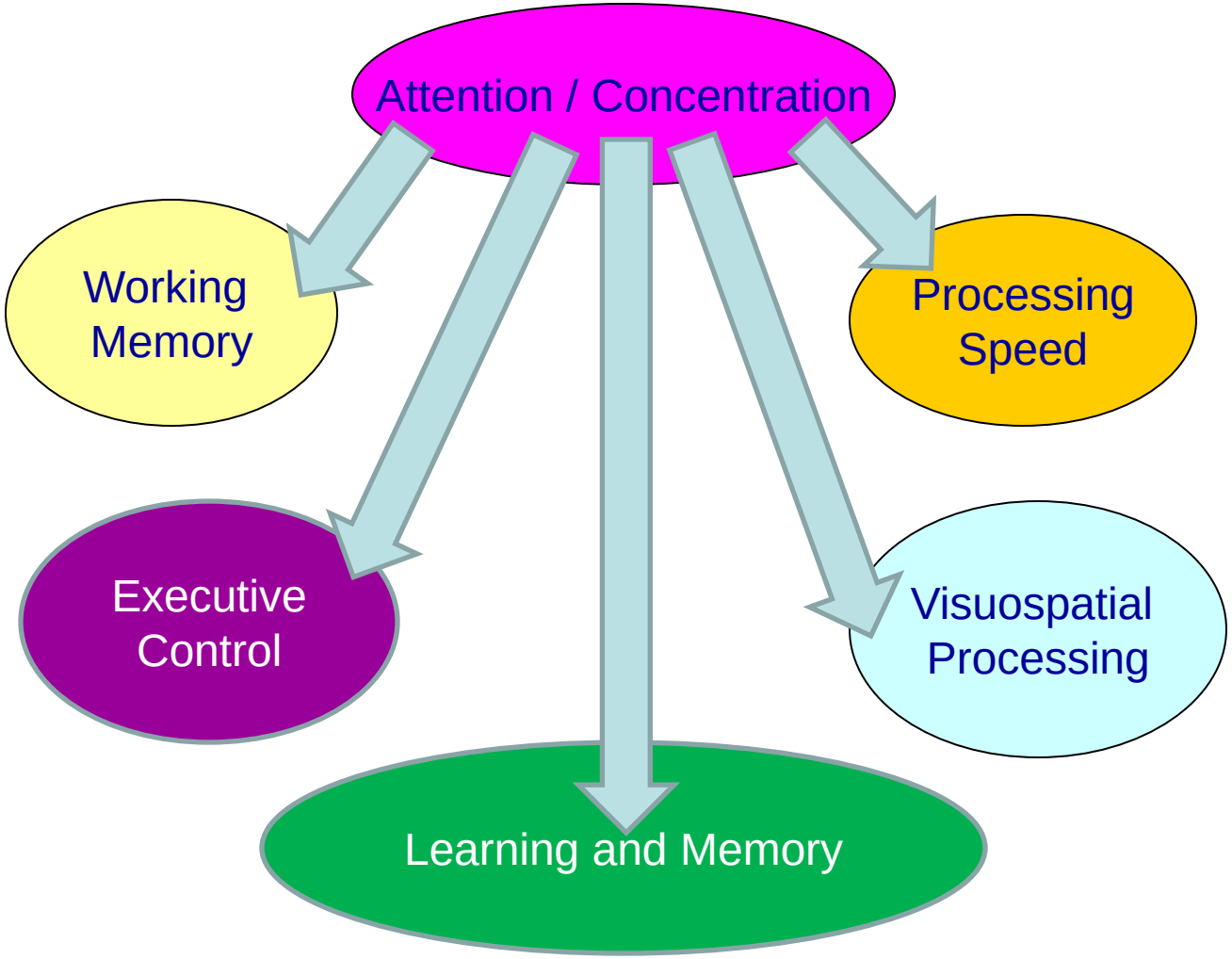
Different Uses of Technology

- Administering tests like the WCST via computer has many advantages
  - Less error in administration and scoring
  - Much faster and less cumbersome scoring
  - But, we are assessing the SAME thing
- VR assessing something different
  - Is VR positioned to replace traditional NP assessment ?
  - Supplement it and compliment NP

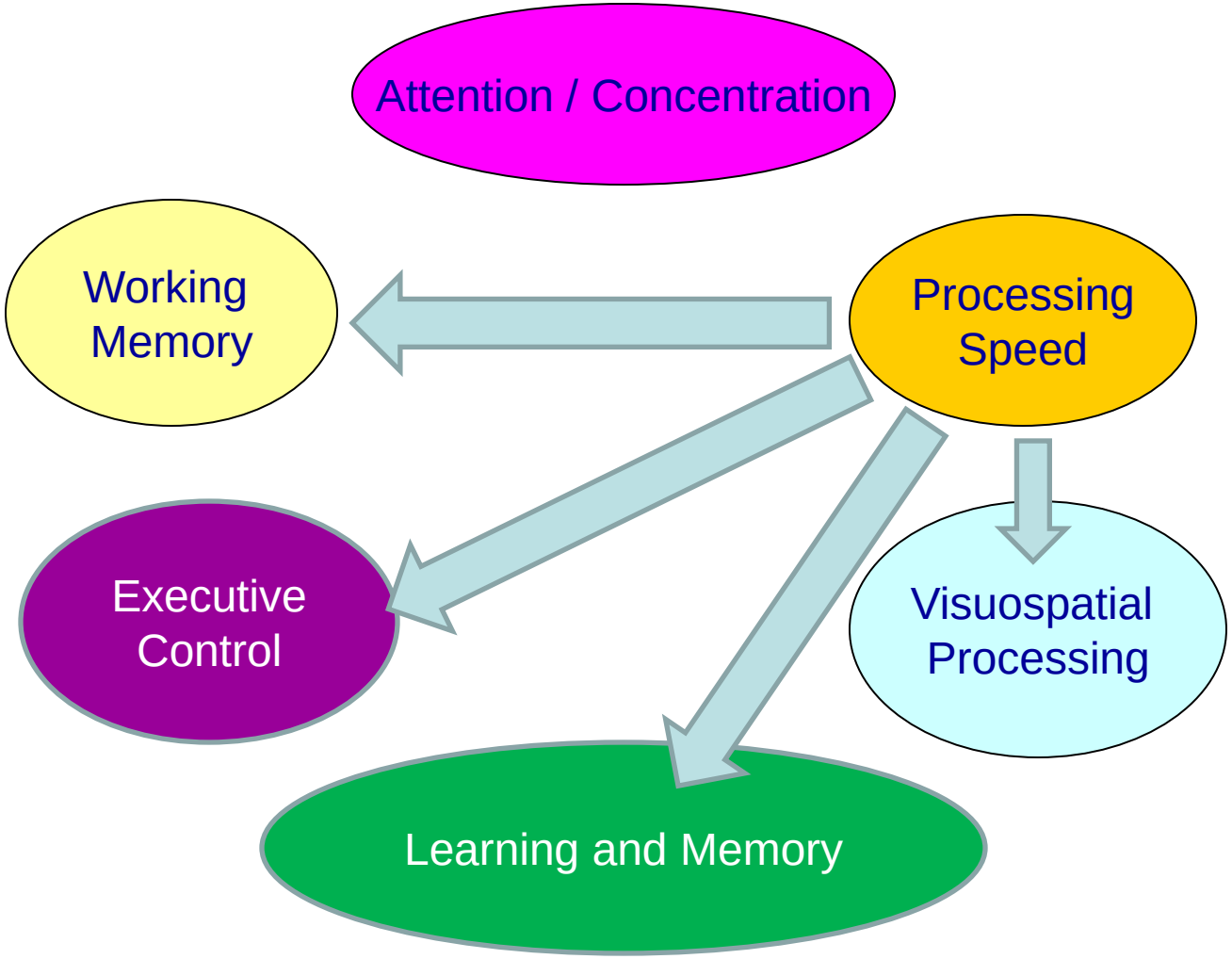
Understanding Cognition



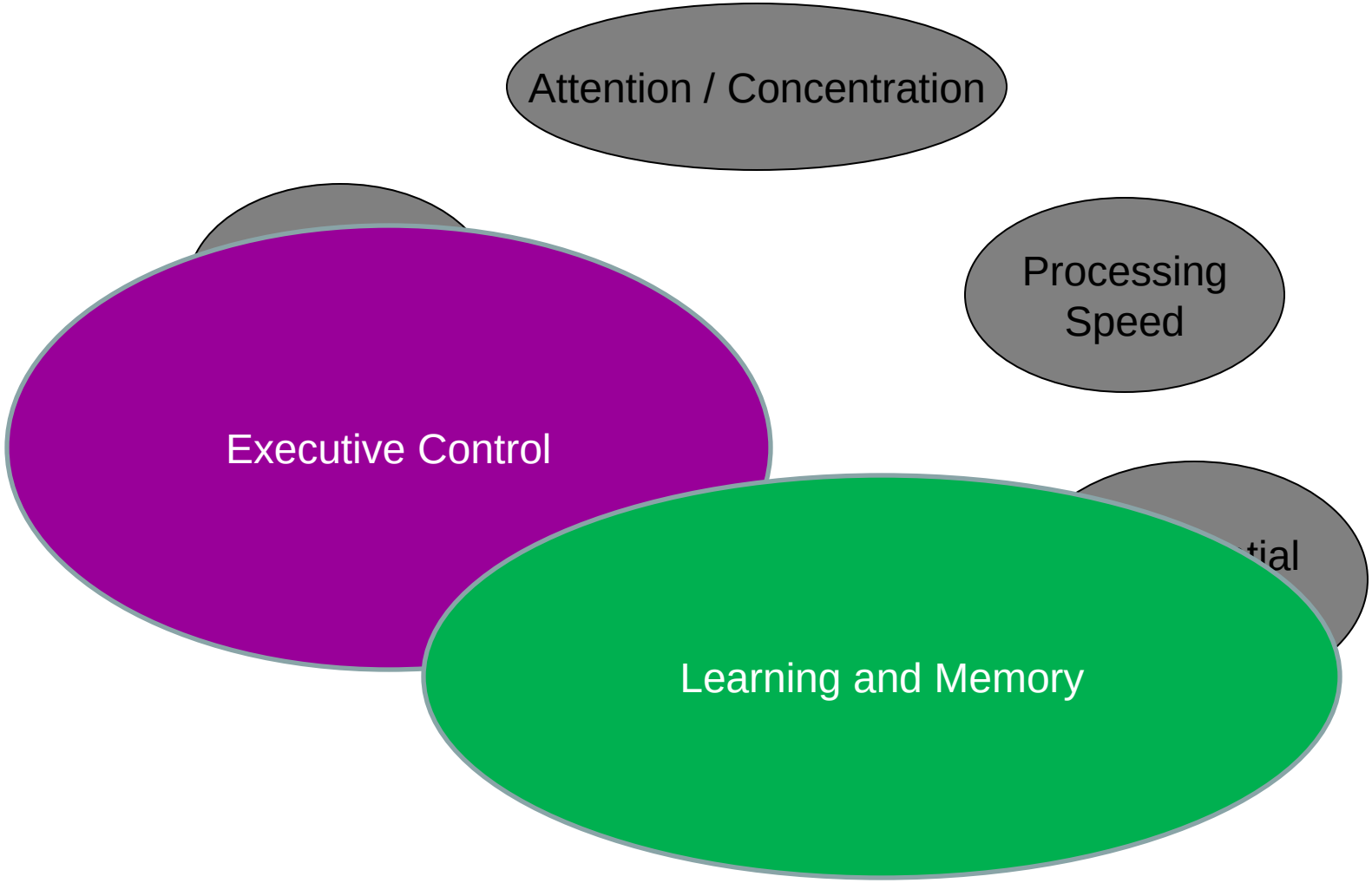
Understanding Cognition



Understanding Cognition



Understanding Cognition



Weaknesses of NP Assessment

- Paradigms not ecologically valid
- May perform normally on np tests, but be impaired in everyday life
  - Tests are short
  - Focus on a single domain
  - Tasks performed in front of an examiner who provides feedback

Neuropsychological Assessment

- Ecological validity
  - Psychology
    - Rivermead Behavioral Memory Test
  - Occupational Therapy
    - Timed Activities of Daily Living
    - Executive Functioning Performance Test
  - Actual Reality
    - Completion of a computer task (reserving airline tickets; purchasing items)

- Virtual Reality

Neuropsychological Assessment

- Application of Virtual Reality to NP
  - precise presentation and control of dynamic multi-sensory 3D stimulus environments
  - advanced methods for recording behavioral responses
  - simulate naturalistic environments
    - Allow presentation of more ecologically relevant stimuli imbedded in a meaningful and familiar context

Virtual Reality Applications in Psychology

- Virtual environments (VEs) have shown promise for addressing
  - Fear reduction with phobic clients
    - Rothbaum, Hodges & Kooper, 1997
  - Stress management in cancer patients
    - Schneider & Workman, 1999
  - Reduction of acute pain during wound care and physical therapy with burn patients
    - Hoffman, Doctor, Patterson, et.al., 2000; Reger et al., 2003
  - Body image disturbances in eating disorders
    - Riva, Bacchetta, Baruffi, et. al., 1999; 2005

Virtual Reality Applications in NP

- Attention processes
  - » Rizzo, Buckwalter, Bowerly, et.al., 2000; 2001;2005
- Executive cognitive functions
  - » Pugnetti et al., 1998; Marie, 2004
- Memory
  - » Brooks et al., 1999; Matheis et al., 2007
- Spatial skills
  - » McComas, et al., 1998; Rizzo et al., 2001a, 2005
- Functional skills
  - » Zhang et al., 2003; Brown & Stewart, 1996; Brown et al., 2002, 2004

Virtual Reality Applications in NP

- **Attention processes**
- Executive cognitive functions
- Memory
- Spatial skills
- Functional skills

Virtual Reality and Attention

- Attention:
  - Look at the effects of systematically increasing ecologically relevant attentional demands in a virtual environment (VE)
    - Classroom, office, or store
  - Timing and control over distractions, stimulus load and complexity
    - Alterations with patient responses

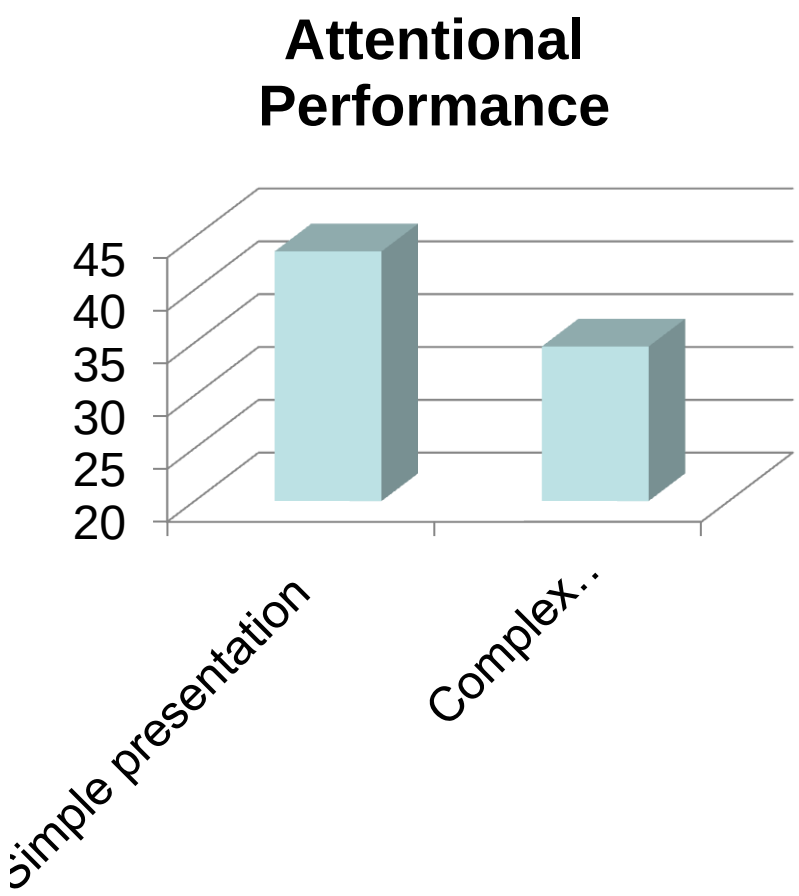
Virtual Reality Cognitive Performance Assessment Test battery (VRCPAT)

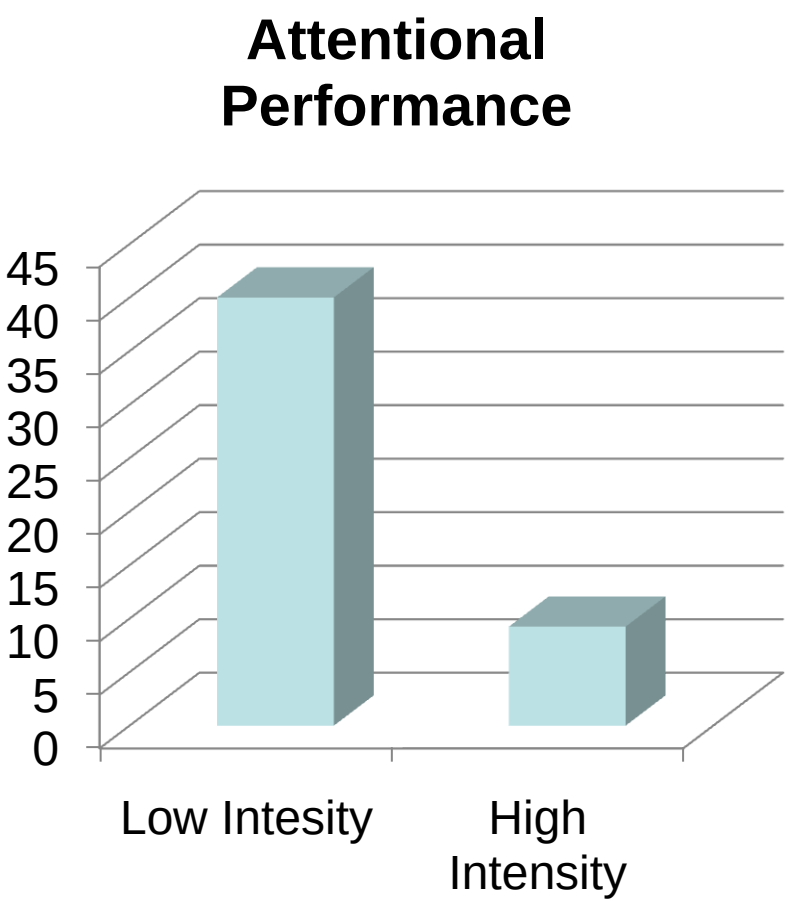
- USC – Institute for Creative Technologies
- Measure neurocognitive performance within ecologically valid domains
- Neurocognitive components
  - **Attention**
  - Memory
  - Executive functioning
  - Spatial ability
  - Language and reasoning tasks

VRCPAT Humvee Attention Task

- 4 digit number superimposed on a virtual windshield
  - Simple presentation
    - Fixed, central location on windshield
  - Complex presentation
    - Random placement on windshield
  - Low versus high intensity presentation
    - Safe vs ambush setting

VRCPAT Humvee Attention Task





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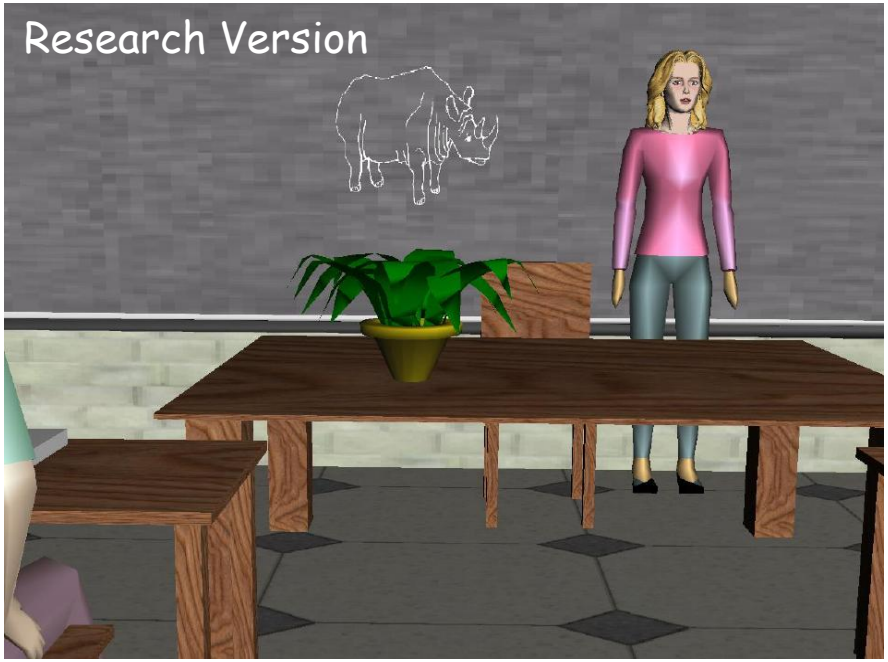
The Virtual Classroom



Slide thanks to Skip Rizzo, PhD

Rizzo et al., 1999

Slide thanks to Skip Rizzo, PhD

Rizzo, et al., 2003-2012

Slide thanks to Skip Rizzo, PhD

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Virtual Reality and Attention
Virtual Classroom (Rizzo et al., 1999)

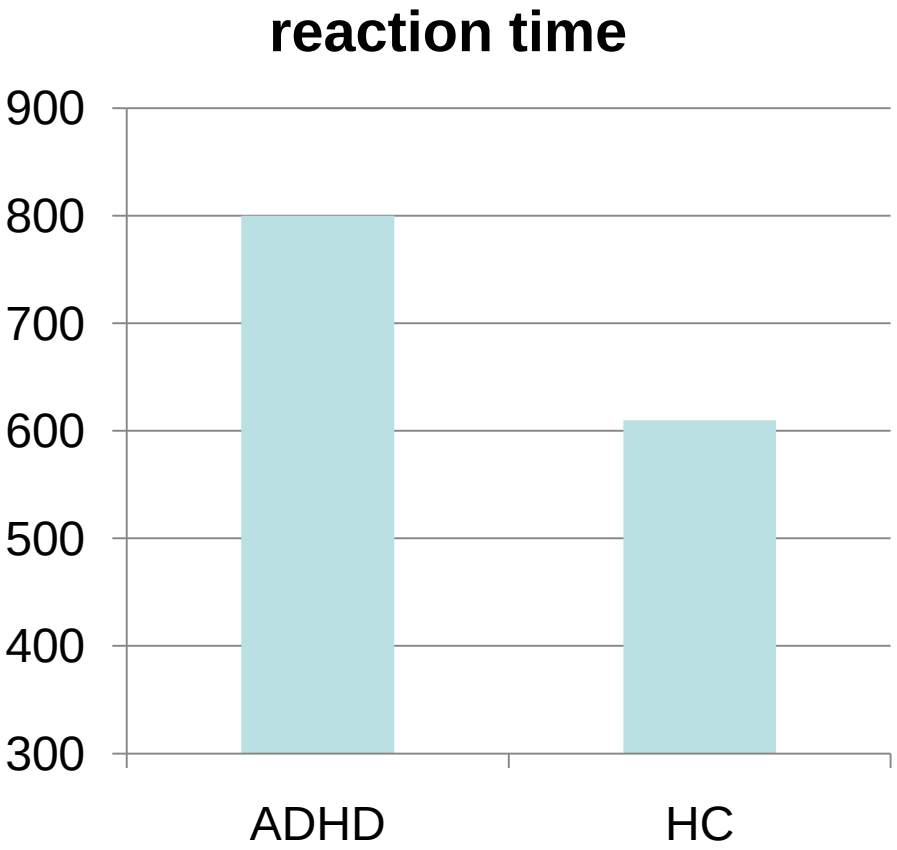
- Allows multiple manipulations assessing
  - Focused or selective attention
    - Press a “colored” section of the desk when the teacher says X
  - Sustained attention
    - Manipulating time demands of task
  - Alternating or divided attention
    - Touch the “colored” section of the desk only when the teacher says the color in relation to X
  - Allows other objective measures
    - Hyperactivity; Impulsive non-task behaviors; RT

Virtual Reality and Attention

Virtual Classroom (Rizzo et al., 1999)

ADHD children had *slower* correct hit reaction time in distraction condition

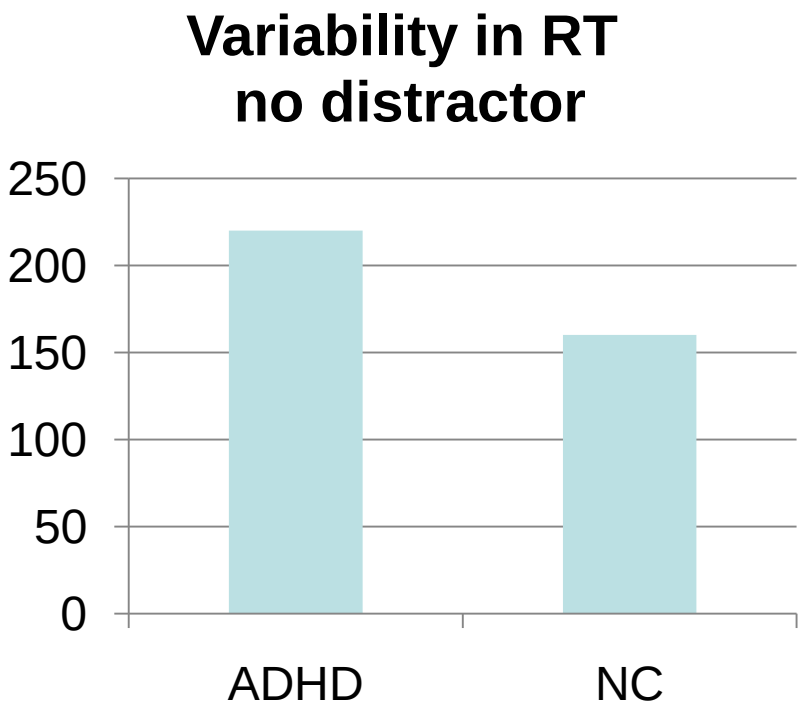
p <.03

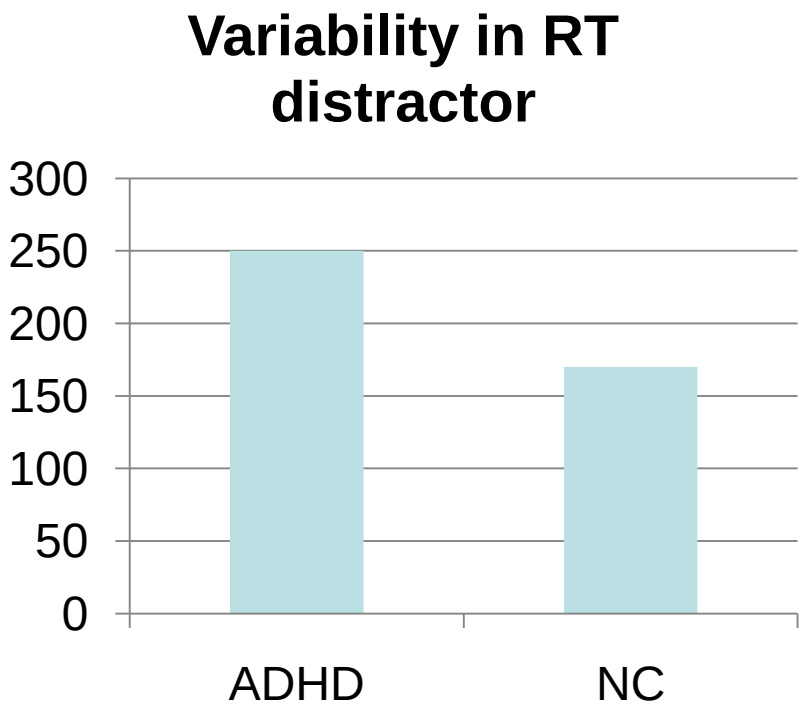


Virtual Reality and Attention

Virtual Classroom (Rizzo et al., 1999)

ADHD children had higher reaction time *variability* on correct hits compared with normal controls





$p < .05$

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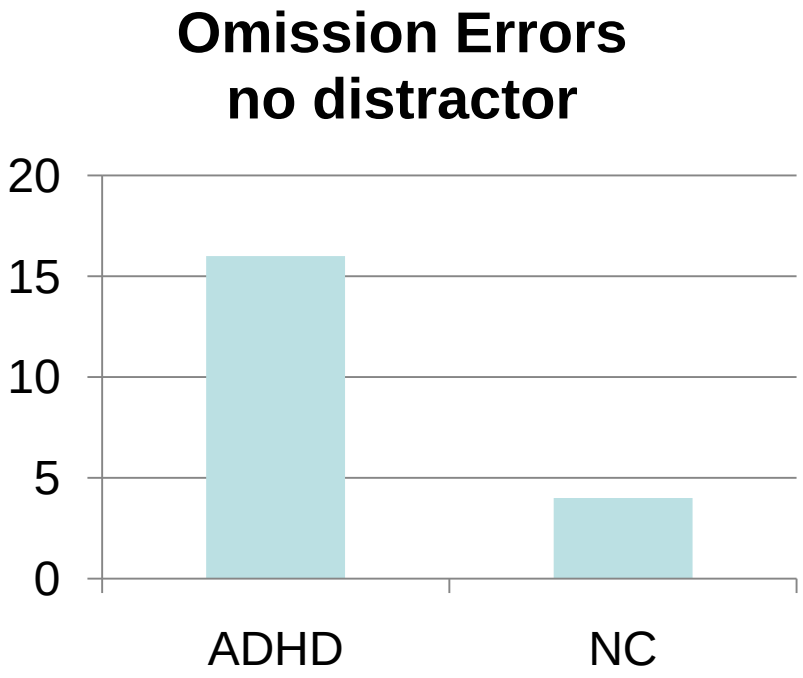
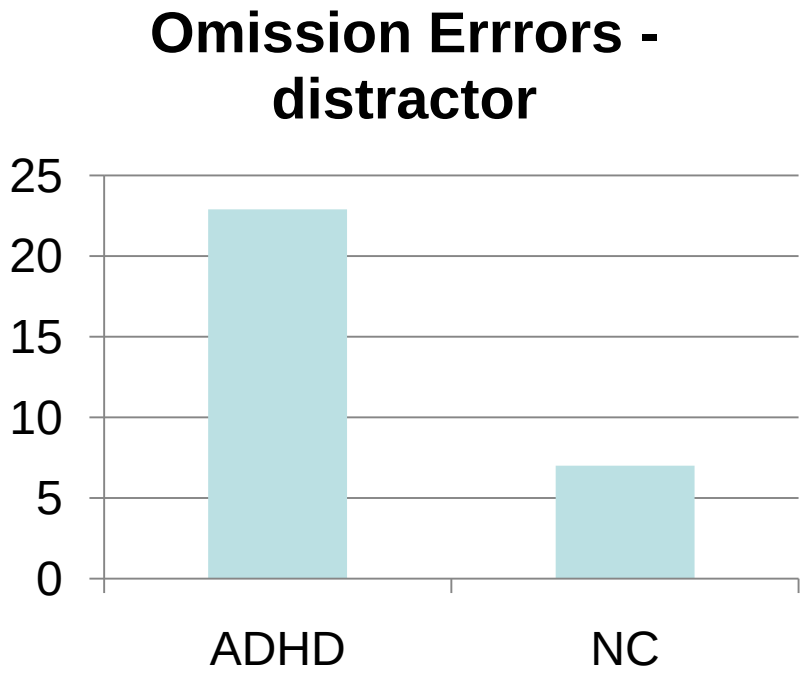
Virtual Reality and Attention

Virtual Classroom (Parsons et al., 2007)

ADHD children made more Omission errors (missed targets) compared with normal controls





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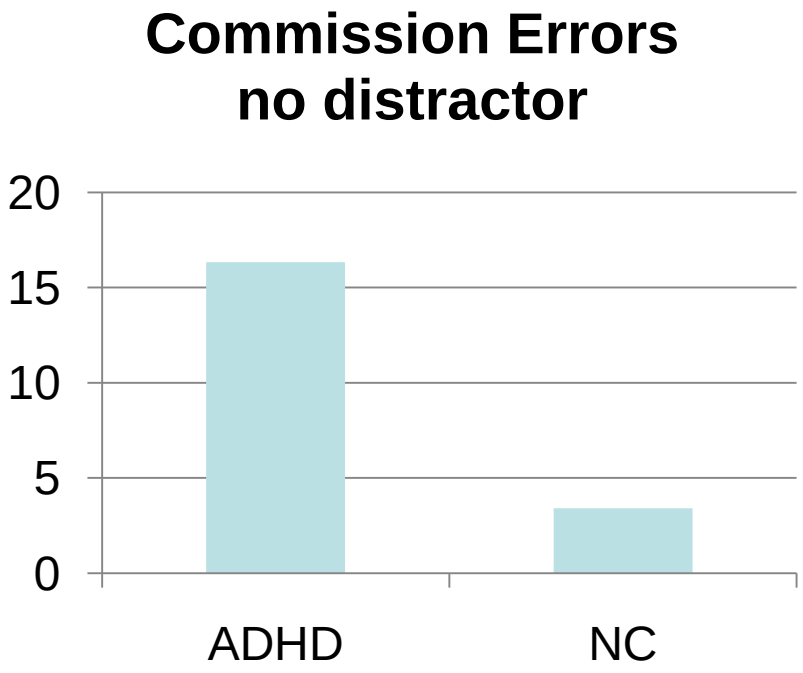
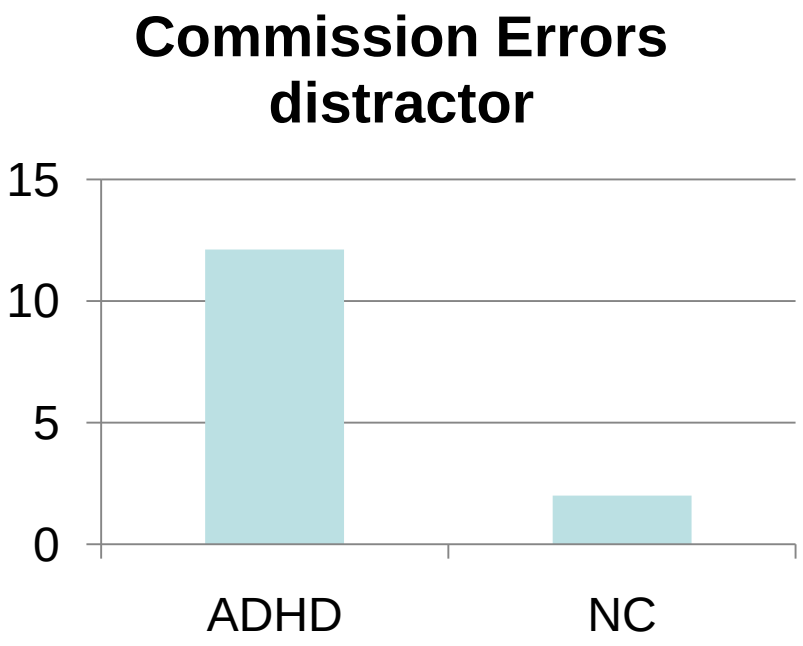
Virtual Reality and Attention

Virtual Classroom (Parsons et al., 2007)

ADHD children made more Commission errors (impulsive responding in the absence of a target)





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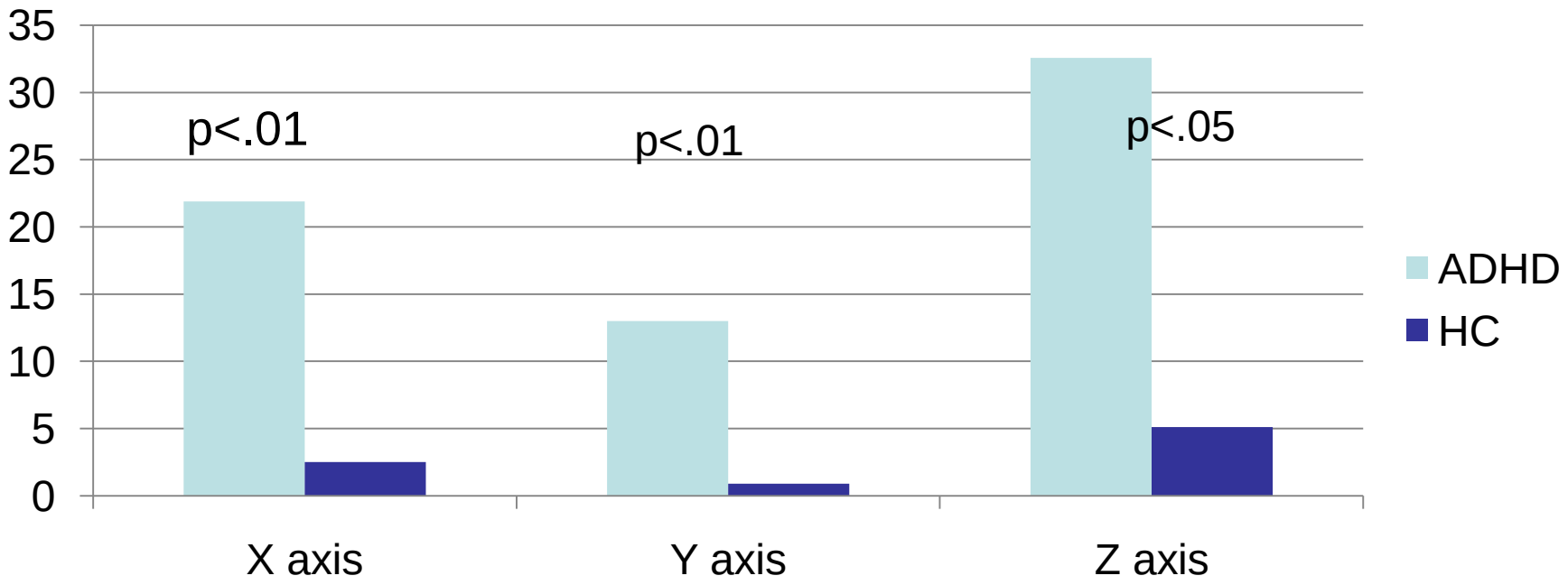
Virtual Reality and Attention
Virtual Classroom (Parsons et al., 2007)

Analysis of hyperactivity via body movement



Virtual Reality and Attention
Virtual Classroom (Parsons et al., 2007)

- Correlations with established measures
  - SWAN Behavior checklist
    - Omission errors: r=.51
    - Commission errors: r=.59
  - Connors' CPT
    - Commission errors r=.51
    - RT r=.75

New Attention Tasks being Developed

Stroop Task

Boston Naming Task

Letter Crowding Task

Slide thanks to Skip Rizzo, PhD

Recent Virtual Classroom Publications

- Rizzo, A.A., Bowerly, T., Buckwalter, J.G., Shahabi, C. & Sharifzadeh, M. (2004). Results and Future Developments from a Virtual Reality Classroom for Assessing Attention Processes in Children with ADHD. ***Biological Psychiatry***. 55:1S, 175.

- Rizzo, A.A., Klimchuk, D., Mitura, R., Bowerly, T., Shahabi, C. & Buckwalter, J.G. (2004). Diagnosing Attention Disorders in a Virtual Classroom. ***IEEE Computer***. 37 (5), 87-89.

- Rizzo, A.A. Klimchuk, D., Mitura, R., Bowerly, T., Buckwalter, J.G. & Parsons, T. (2006). A Virtual Reality Scenario for All Seasons: The Virtual Classroom. ***CNS Spectrums***.11(1), 35-44.

- Shahabi, C., Yang, K., Yoon, H., Rizzo, A.A., McLaughlin, M., Marsh, T. & Mun, M. (2007). Immersidata analysis: Four case studies. ***IEEE Computer***. (April 2007) 65-72.

- Parsons, T., Bowerly, T., Buckwalter, J.G. & Rizzo, A.A. (2007). A controlled clinical comparison of attention performance in children with ADHD in a virtual reality classroom compared to standard neuropsychological methods. ***Child Neuropsychology***.*13,* 363-381.

- Adams, R., Finn, P., Flannery, K., Moes, E. & Rizzo, A.A. (2009). The Virtual Reality Classroom: A Novel Approach to the Assessment of Attention Deficit/Hyperactivity Disorder. ***Child Neuropsychology***. *15* (2). 120-135.

- Adams, R., Finn, P., Flannery, K., Moes, E. & Rizzo, A.A. (in press). Attention Deficit Hyperactivity Disorder and Eye-Tracking in a Virtual Reality Classroom: A Pilot Study. ***Journal of Clinical and Experimental Neuropsychology.***

- Pollak, Y., Weiss, P.L., Rizzo, A.A., Weizer, M., Shriki, L., Shalev, R., Gross-Tsur, V. (in press). The utility of continuous performance test embedded in virtual reality in measuring ADHD-related deficits. ***Journal of Developmental and Behavioral Pediatrics*.**

- Bioulac, S., Lallemand, S., Rizzo, A., Philip, P., Fabrigoule, C. & Bouvard, M.P. (in press). Impact of time on task on ADHD patient's performances in a virtual classroom. ***European Journal of Paediatric Neurology***.

Slide thanks to Skip Rizzo, PhD

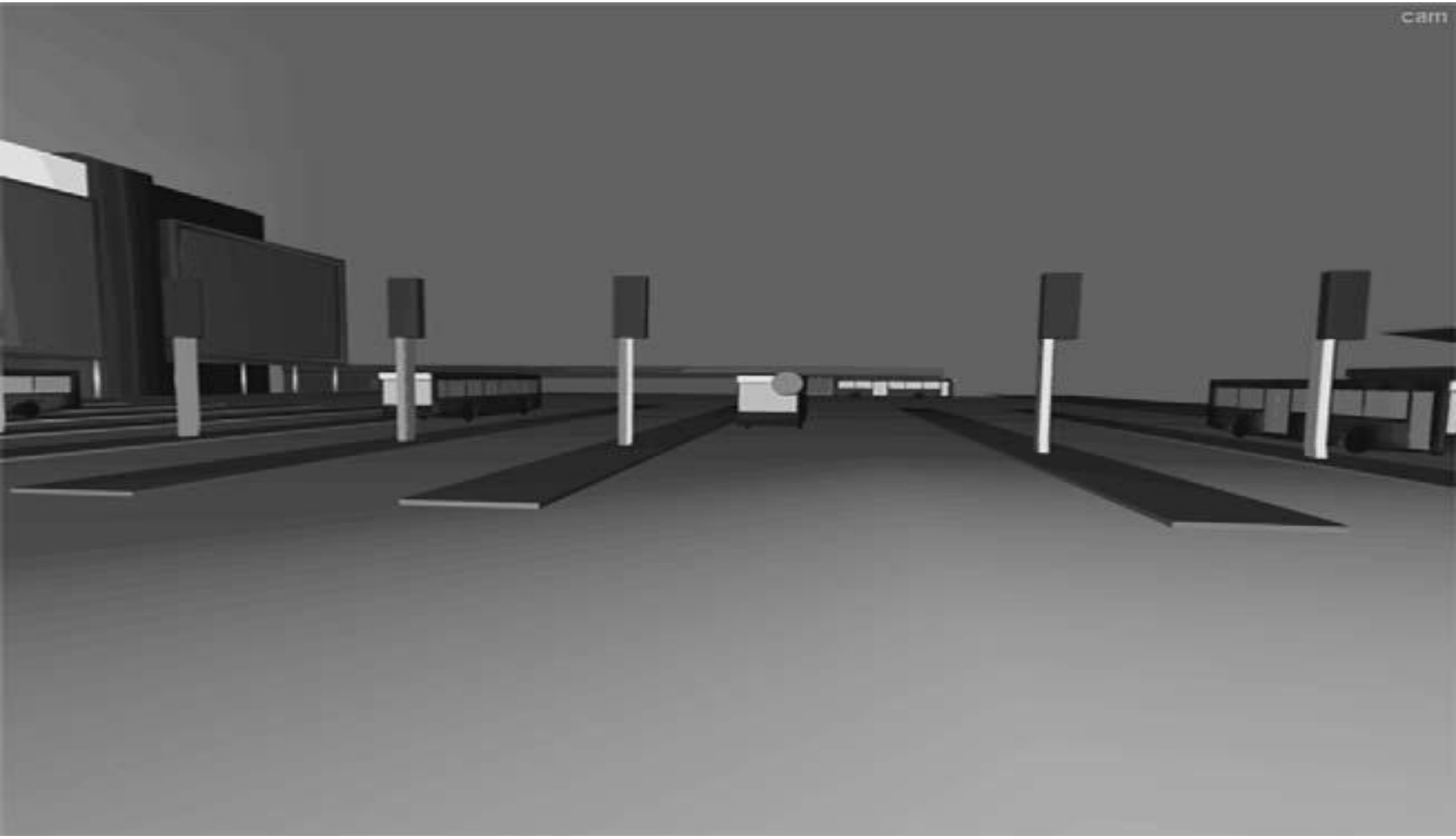
Virtual Reality and NP Assessment Other area classified as “attention”

- Neglect
  - Inattention to one visual field
  - Not a visual problem, an attention problem

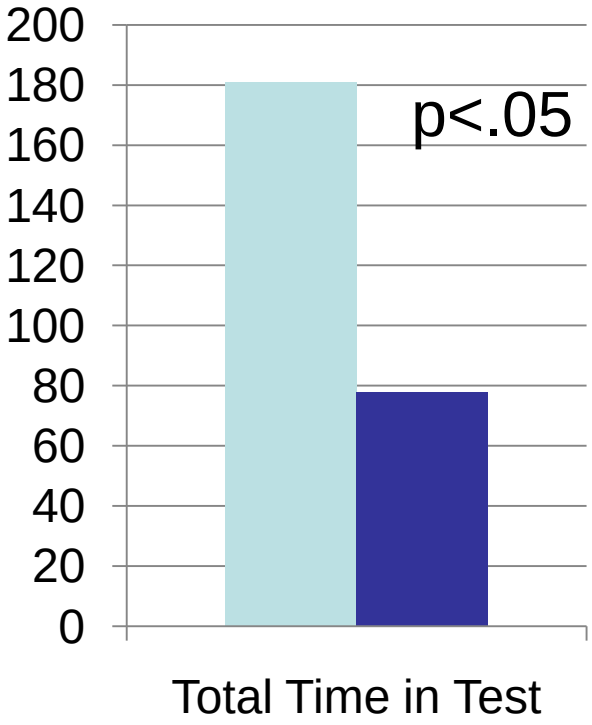
Assessing Neglect via VR Jannink et al., 2009

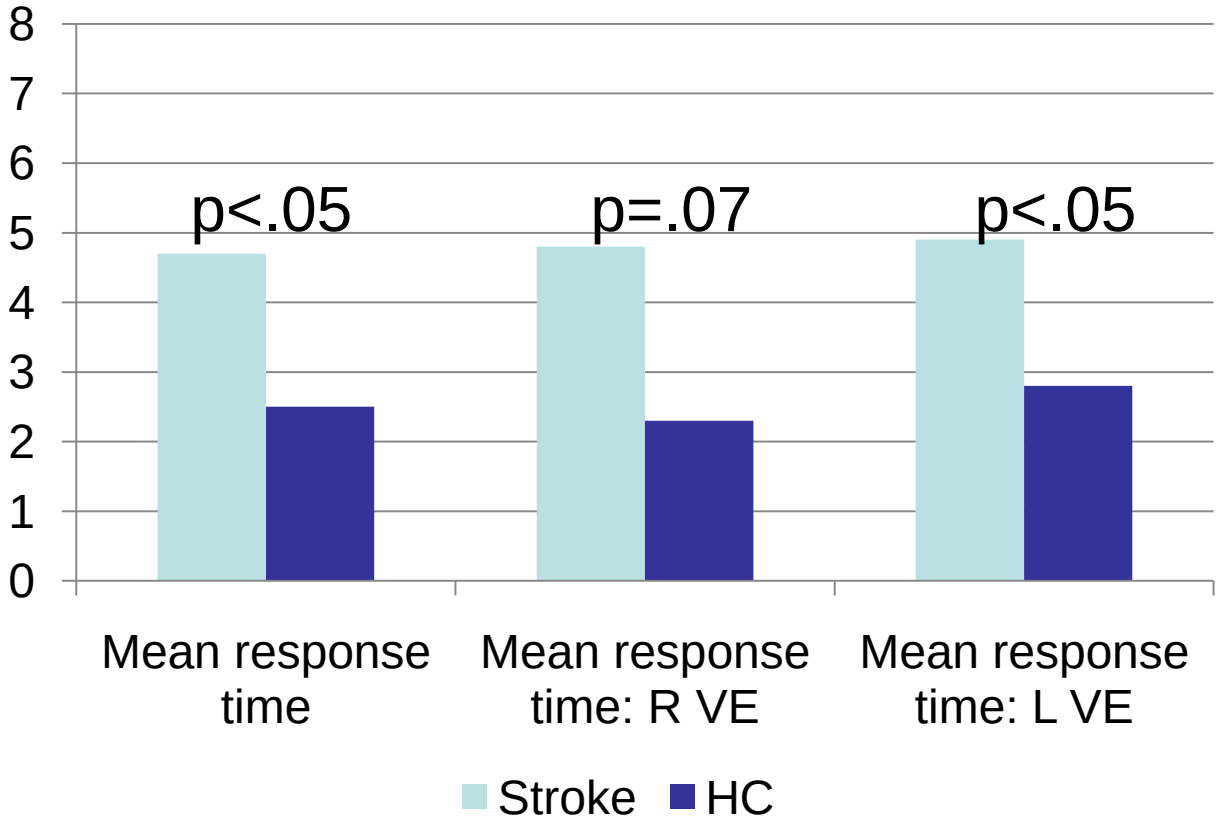
- Virtual Bus Station
  - Divided into right VE and left VE
  - Task: detect yellow colored balls coming toward them in different patterns
  - 3 levels of increasing difficulty

Assessing Neglect via VR
Jannink et al., 2009



Assessing Neglect via VR
Jannink et al., 2009





Assessing Neglect via VR
Buxbaam et al., 2008

- VR wheelchair navigation task
  - Navigate the wheelchair via a joystick along a path with outdoor objects
    - Objects on left and right of path
    - Name objects seen as precisely as possible
    - Avoid bumping into objects
    - Complete the course as quickly as possible

Assessing Neglect via VR
Buxbaam et al., 2008

– 2 levels of complexity
  - Simple: 10 objects on each side of path
  - Complex: 20 items on each side of path; more variety

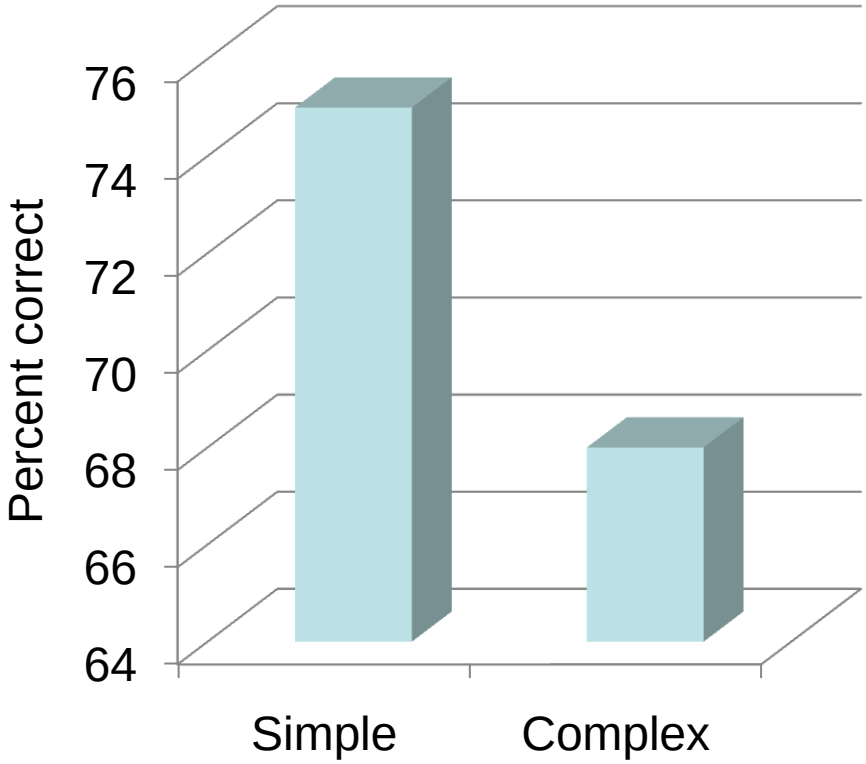
– 2 levels of activity
  - Examiner navigated
  - Participant navigated

– 4 conditions total

Results

9 RH Post-Acute Stroke Patients

Complexity p<.01



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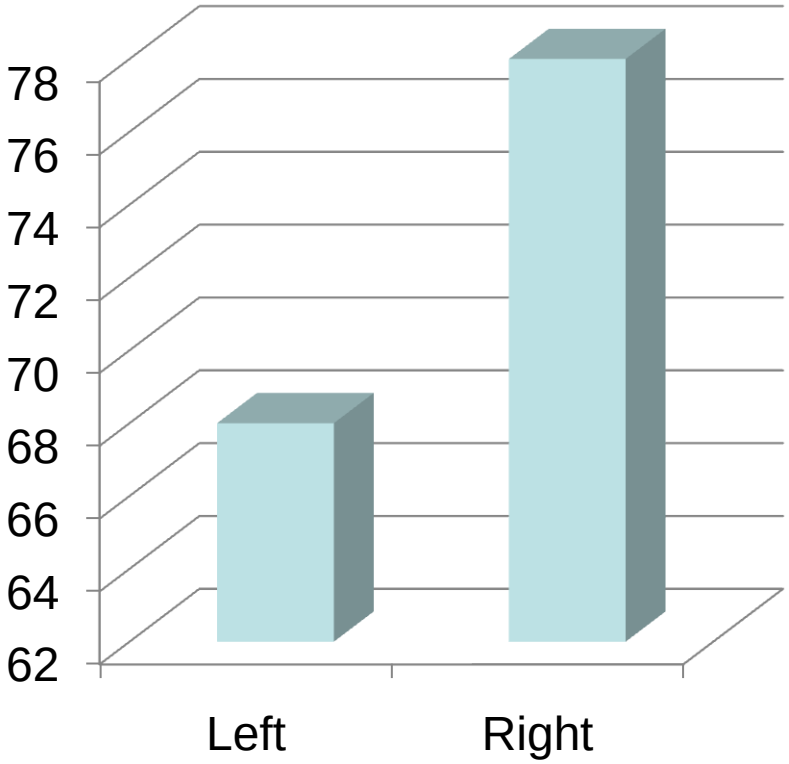

Virtual Reality Applications in NP

- Attention processes
- **Executive functions**
- Memory
- Spatial skills
- Functional skills

Virtual Reality and NP Assessment Executive Functioning

- A set of behavioral competencies that include planning, sequencing, the ability to sustain attention, resistance to interference, utilization of feedback, the ability to coordinate simultaneous activity, cognitive flexibility and the ability to deal with novelty
  - Crawford, 1998

Virtual Reality and Executive Functioning

- VEs targeting executive functioning are especially valuable when patients perform well on tests of specific cognitive abilities (attention, memory), but report difficulties with everyday activities
  - Require planning, initiating, multi-tasking, self-awareness

Virtual Reality and Executive Functioning

- ARCANA (Pugnetti et al., 1995)
  - Likely the first VE applied to np assessment
  - Virtual building
  - Rooms connected with corridors of varying length
  - Task based on WCST

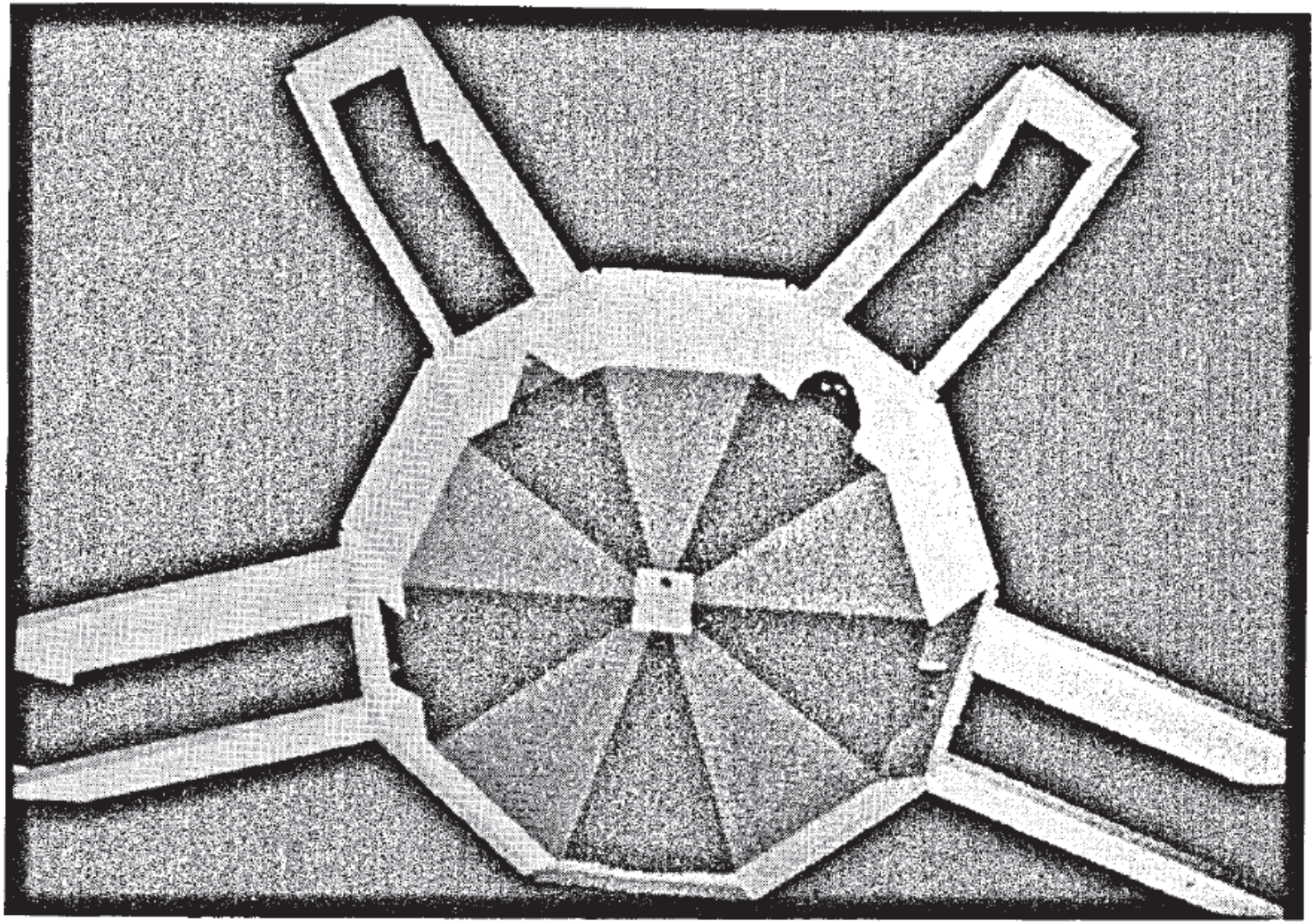

Fig. 2. Top-down view of a virtual room of ARCANA 1. The entrance door is marked with a

Virtual Reality and Executive Control

- Task: exit the building as fast as possible
  - Room can only be left by selecting the correct door
- Utilize environmental clues in the selection of appropriate choices (doorways) to navigate from room to room
  - Doors vary according to shape, color & form
- Criteria changes and the person has to shift cognitive set

VR and Executive Functioning Ku et al., 2003

- VE consisting of rooms similar to an Egyptian pyramid and linked by corridors
- Every door has 3 features
  - Shape, color, sound
- Subject must choose one door in every room
- Subject has to figure out the rule
- Rules can be changed during the task

VR and Executive Functioning Ku et al., 2003

		WCST Perseveration	WCST Rule Finding	WCST Total
VR Index No distractors	perseveration	-.585**	-.108	.157
	Rule Finding	-.505*	-.327	-.453*
	Total Index	-.636**	-.151	-.373
VR Index Distracters	Perseveration	.585**	.034	.264
	Rule Finding	-.438*	-.653**	-.672**
	Total Index	-.607**	-.396	-.547

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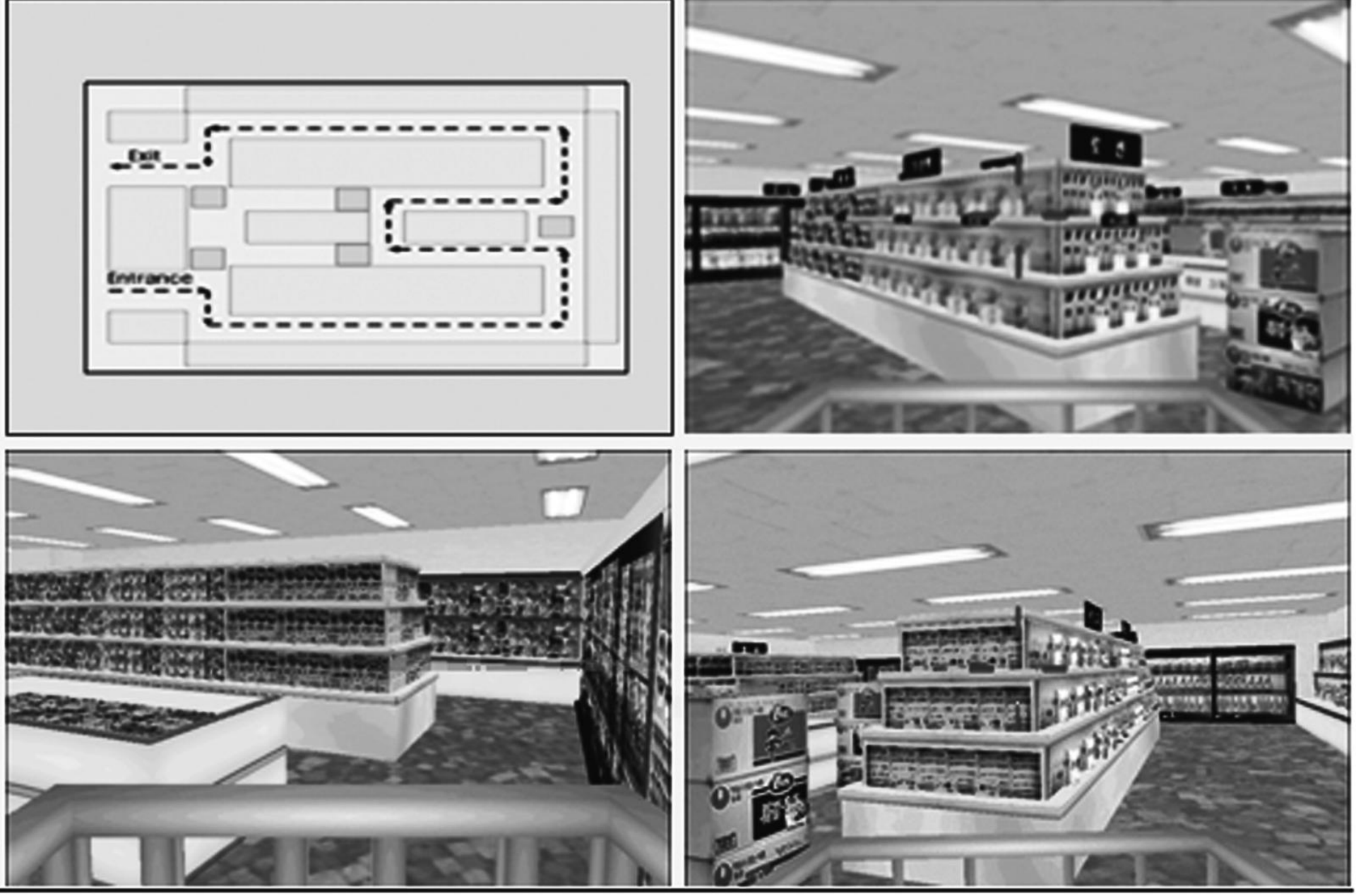
* p<.05 **p<.01

VR and Executive Functioning Kang et al., 2008

- VR Shopping Simulation
  - Stage 1: Find 3 items in supermarket
  - Stage 2: Select and place items in cart; respond to unexpected events (dropping an item); selecting all items within a category
  - Stage 3: select shopping item on own in accordance with a request and meet the designate price
    - Executive task



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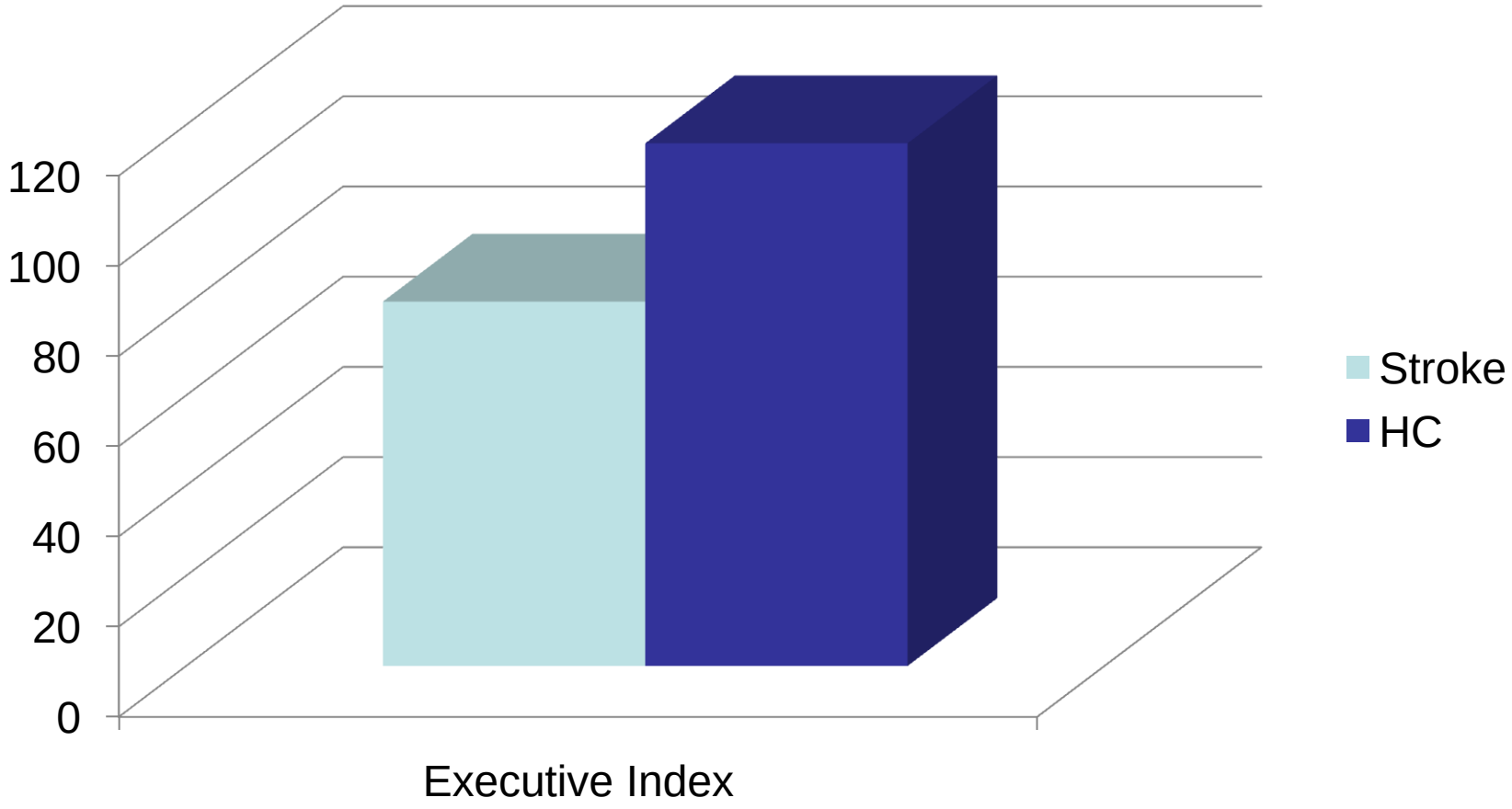
Kang et al., 2008

VR and Executive Functioning Kang et al., 2008



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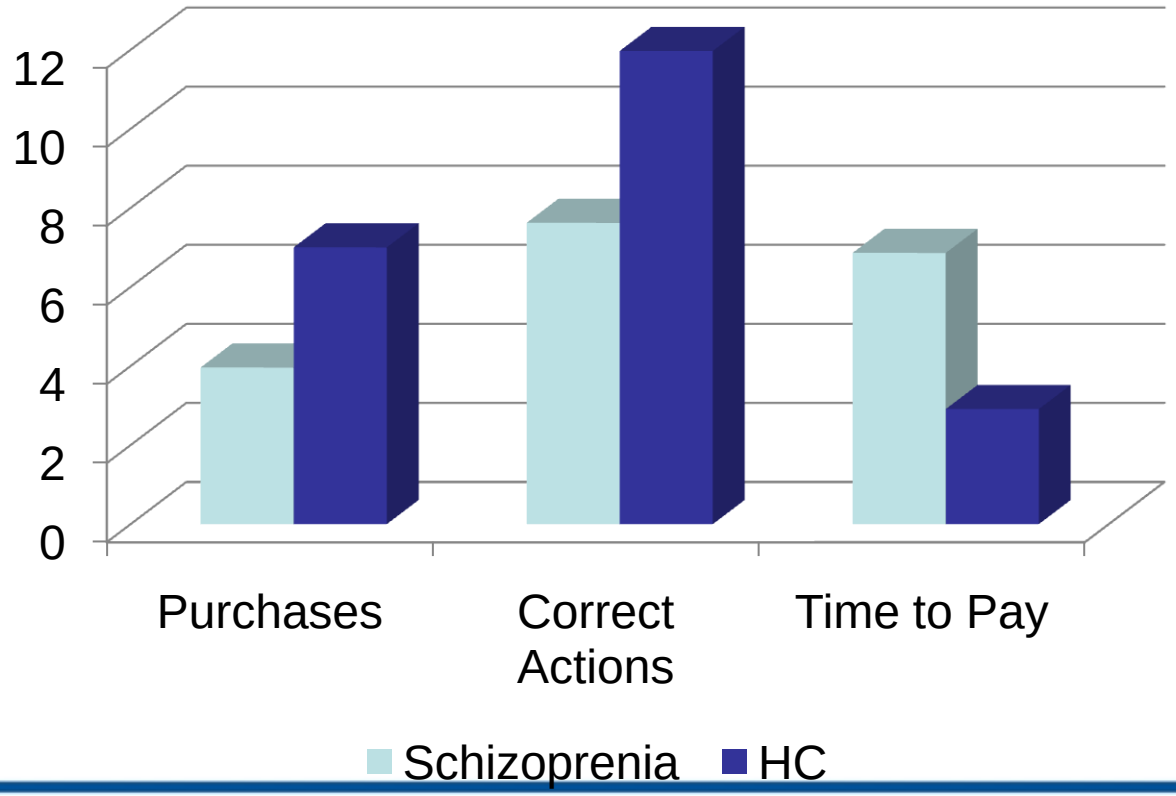
VR and Executive Functioning Josman et al., 2009

Schizophrenia and Virtual Supermarket



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Virtual Reality Cognitive Performance Assessment Test battery (VRCPAT)

- USC – Institute for Creative Technologies
- Measure neurocognitive performance within ecologically valid domains
- Neurocognitive components
  - Attention
  - Memory
  - **Executive functioning**
  - Spatial ability
  - Language and reasoning tasks

VRCPAT Humvee Stroop Task

- Stimuli superimposed on a virtual windshield in a fixed central location while the humvee automatically drives down a desert road in Iraq
- 4 conditions
  - Word reading
  - Color naming
  - Interference
  - Complex Interference

VRCPAT Humvee Stroop Task

	VRST (RT) Word Reading	VRST (RT) Color Naming	VRST (RT) Interference	VRST (RT) Complex Interference
ANAM Stroop RT – Word Reading	**.75***	**.66***	**.61***	**.63***
ANAM Stroop RT – Color Naming	**.77***	**.64***	**.61***	**.73***
ANAM Stroop RT – Interference	**.63***	**.55***	**.64***	**.67***
ANAM Simple Reaction Time	.26	.19	.11	.15
ANAM Simple Reaction Time 2	.14	.16	.20	.20

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*p<.01

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VRCPAT

- Virtual city
- HMD
- Navigate via game pad device
- Memory Module
  - 15 minutes
  - Travel to 5 zones in a virtual city
  - Attempt to identify 10 targets (2 in each zone)
  - Learning score from acquisition phase
  - Memory score from retrieval phase

VRCPAT Memory Module
Parsons & Rizzo, 2008

	VRCPAT Learning n=30	VRCPAT Memory n=30
Learning	.69*	.73*
Memory	.67*	.65*
Executive functions	.21	.13
Attention	.25	.12
Processing Speed	.12	.15
Verbal fluency	.27	.25

*p<.01

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VR and NP Assessment Memory (Matthias et al, 2007)

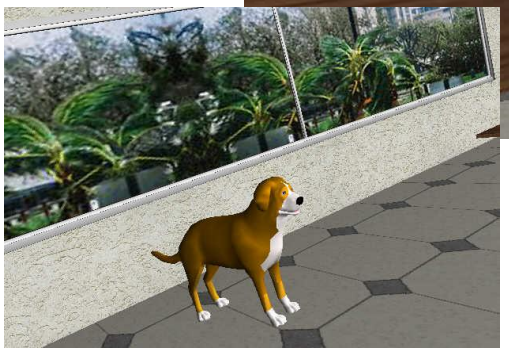
- Virtual Office
  - Containing 16 target items
    - 8 common office items (e.g. phone)
    - 8 uncommon office items (e.g. blender)
    - Among numerous distractors
  - Task: learn the 16 target items
    - Max of 3 sec per item
    - Guided by experimenter
  - Measured acquisition (trials to criterion), 30 min recall, 24 hour recall

Slide thanks to Skip Rizzo, PhD

Initial 16 Item Memory Test

Slide thanks to Skip Rizzo, PhD

8 Uncommon Items…



8 Common Items…

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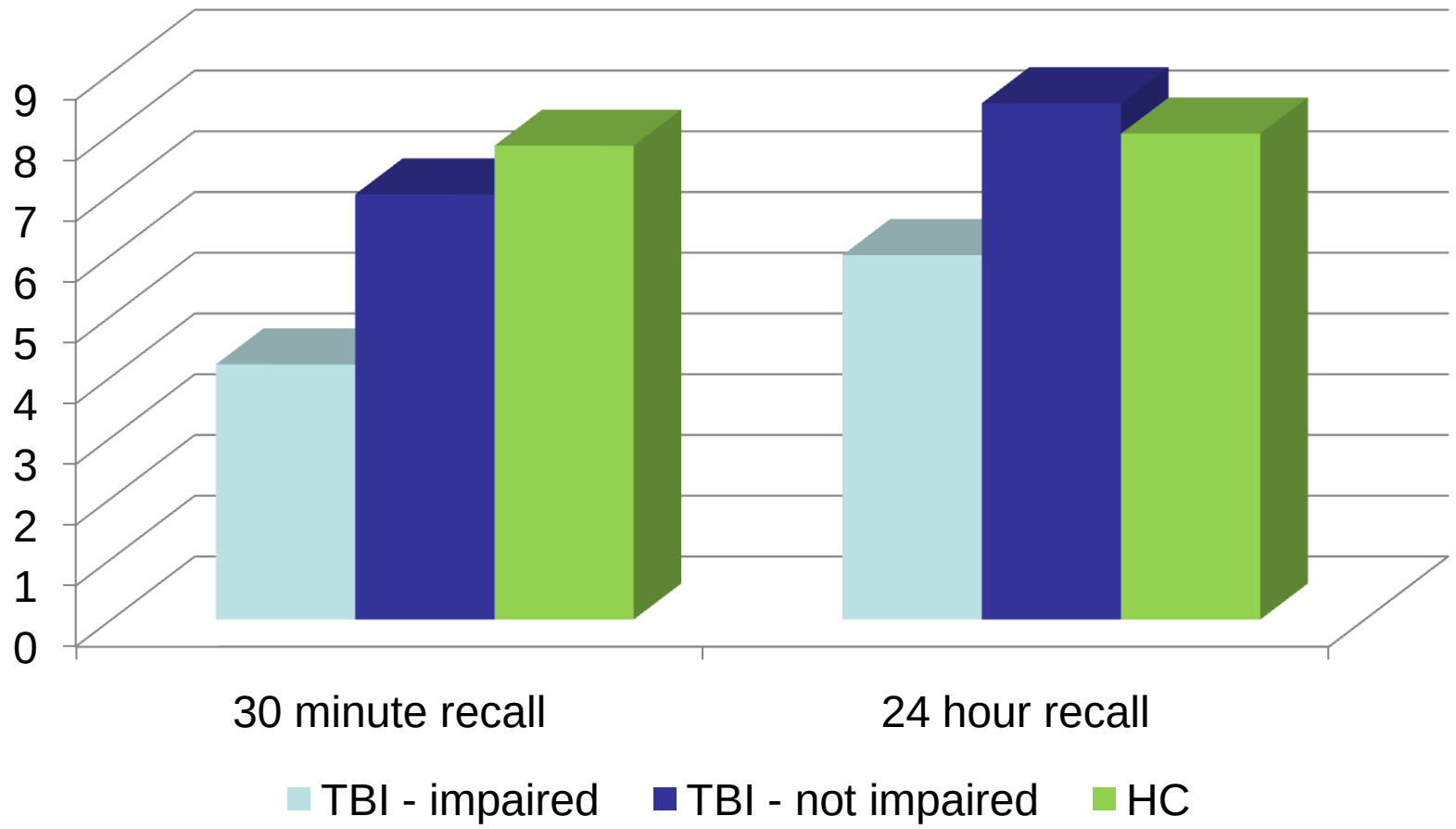
Slide thanks to Skip Rizzo, PhD

VR Recall by Group

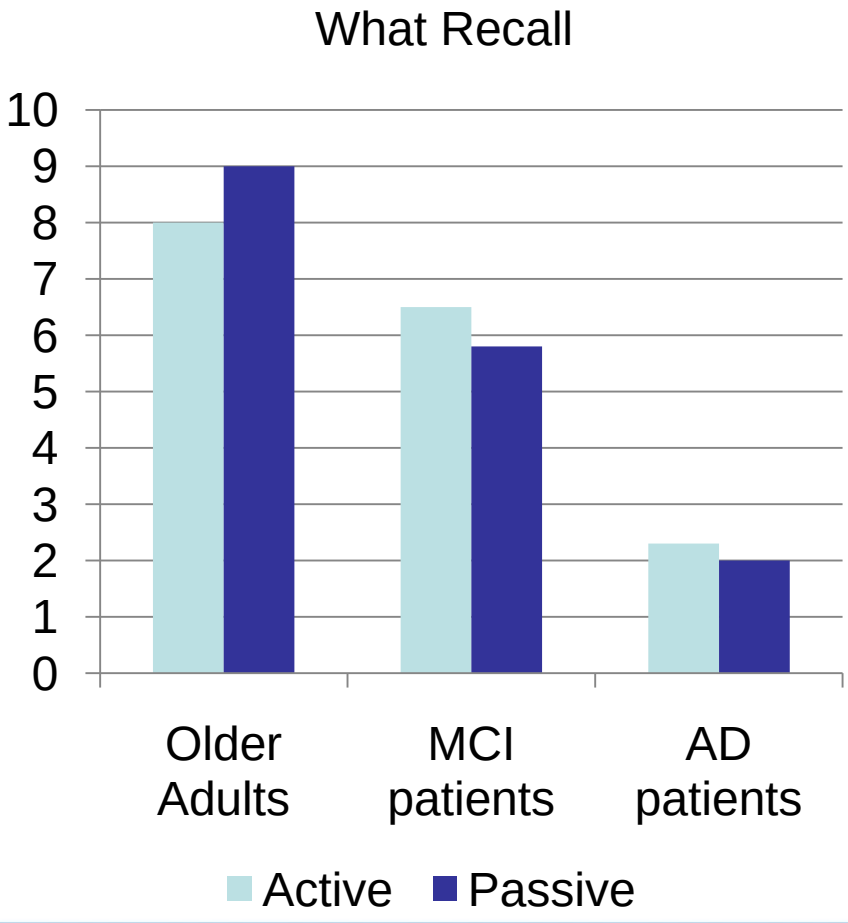


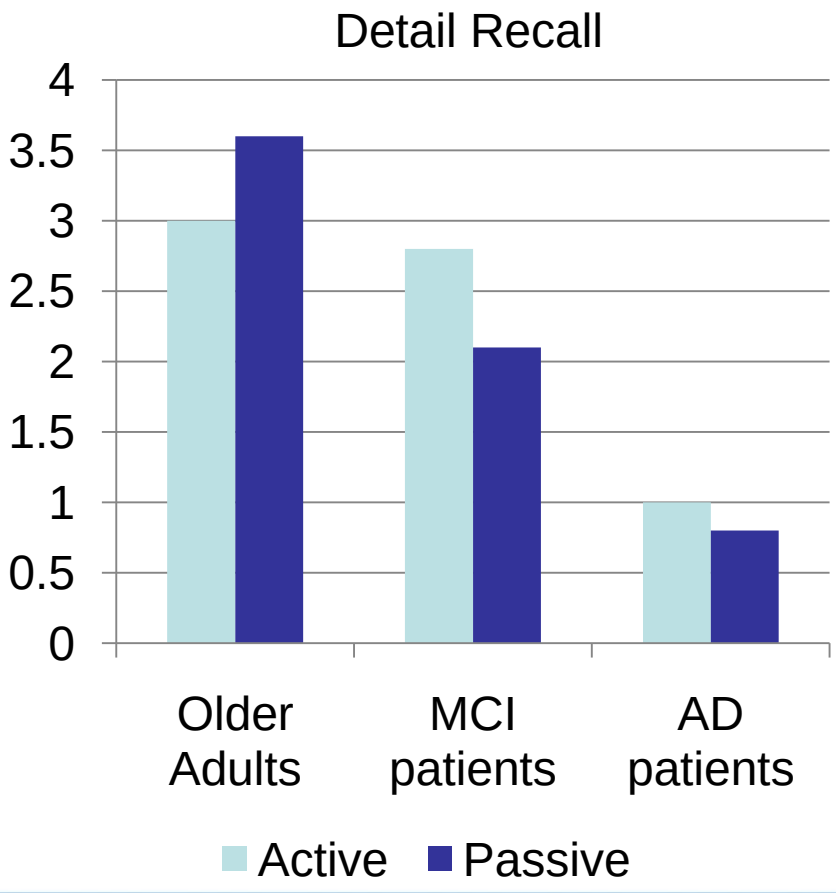
ME Group p<.01

VR and Episodic Memory
Plancher et al., 2012

- Urban environmental replica of Paris
  - One route connected 9 scenes
  - Each scene: 1 central element (e.g. news stand) and 2-3 secondary elements (man, bench)
  - Could be active or passive
    - Active → participant was driving
  - Task: drive into town, do not stop, and memorize all elements of the scene they encounter

VR and Episodic Memory
Plancher et al., 2012



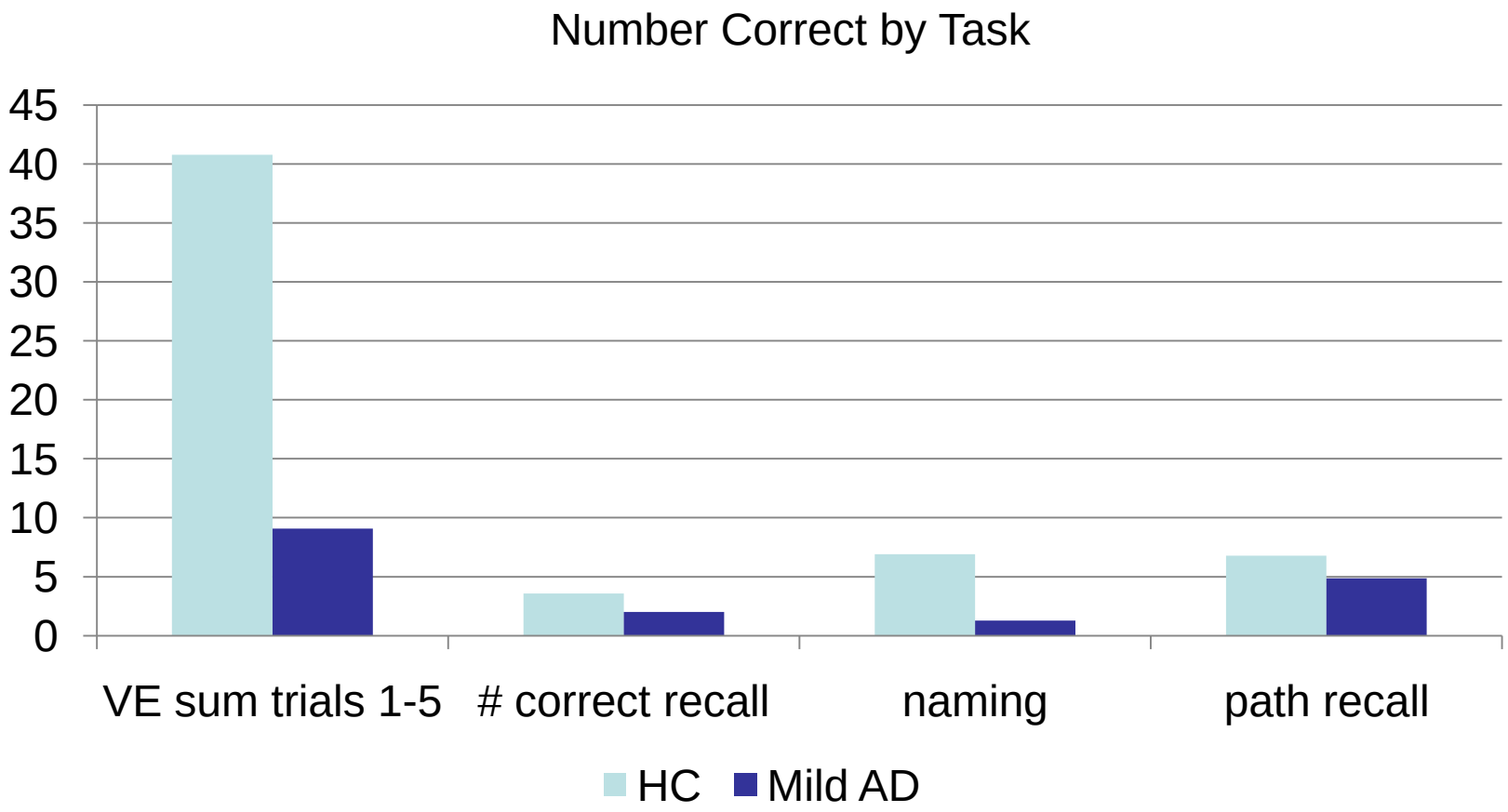


Both comparisons, main effect of group p<.001

VR and Everyday Memory
Wildmann et al., 2012

- VE of Philadelphia
- Task: You are going on a shopping trip through the jewelry district of a large city
  - Read names of stores out loud and try to remember them
  - Try to remember the path you took; you will be asked about it later

VR and Everyday Memory
Wildmann et al., 2012



All comparisons significant at p<.01

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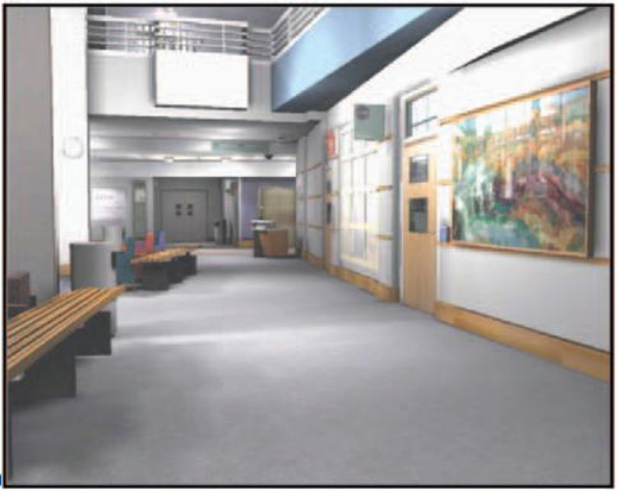
AD and Spatial/Route Memory (Cushman et al., 2008)

- Real world versus VR environment
  - Hospital lobby
- Subtests
  - **Route learning**
  - **Free recall**
  - Self-orientation
  - Route drawing
  - Landmark recall
  - Photograph recognition & location

B Scenes from real-world environment

C Scenes from virtual environment



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AD and Navigational Ability (Cushman et al., 2008)

- Strong correlation between real world and VR
  - R=.73
- No interaction of group by environment
- VR – safer and more practical way of documenting spatial, navigational deficits

Virtual Reality and NP Assessment Memory

- Other studies with similar findings
  - Stanton et al., 1998 – children with disabilities
  - Skeleton et al., 1999 - TBI

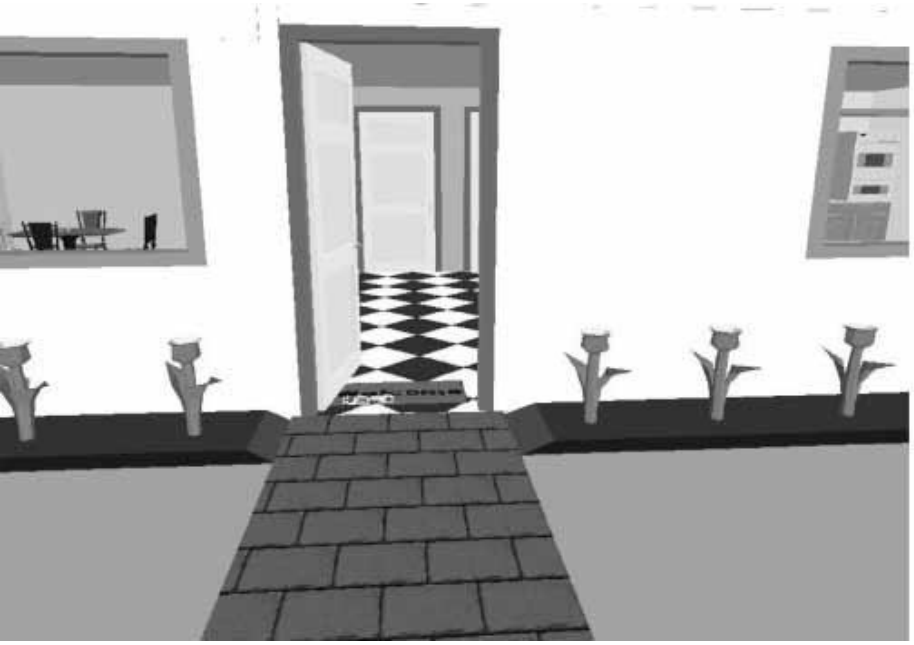
Virtual Reality Applications in NP

- Attention processes
- Executive functions
- Memory
- Spatial skills
- Functional skills

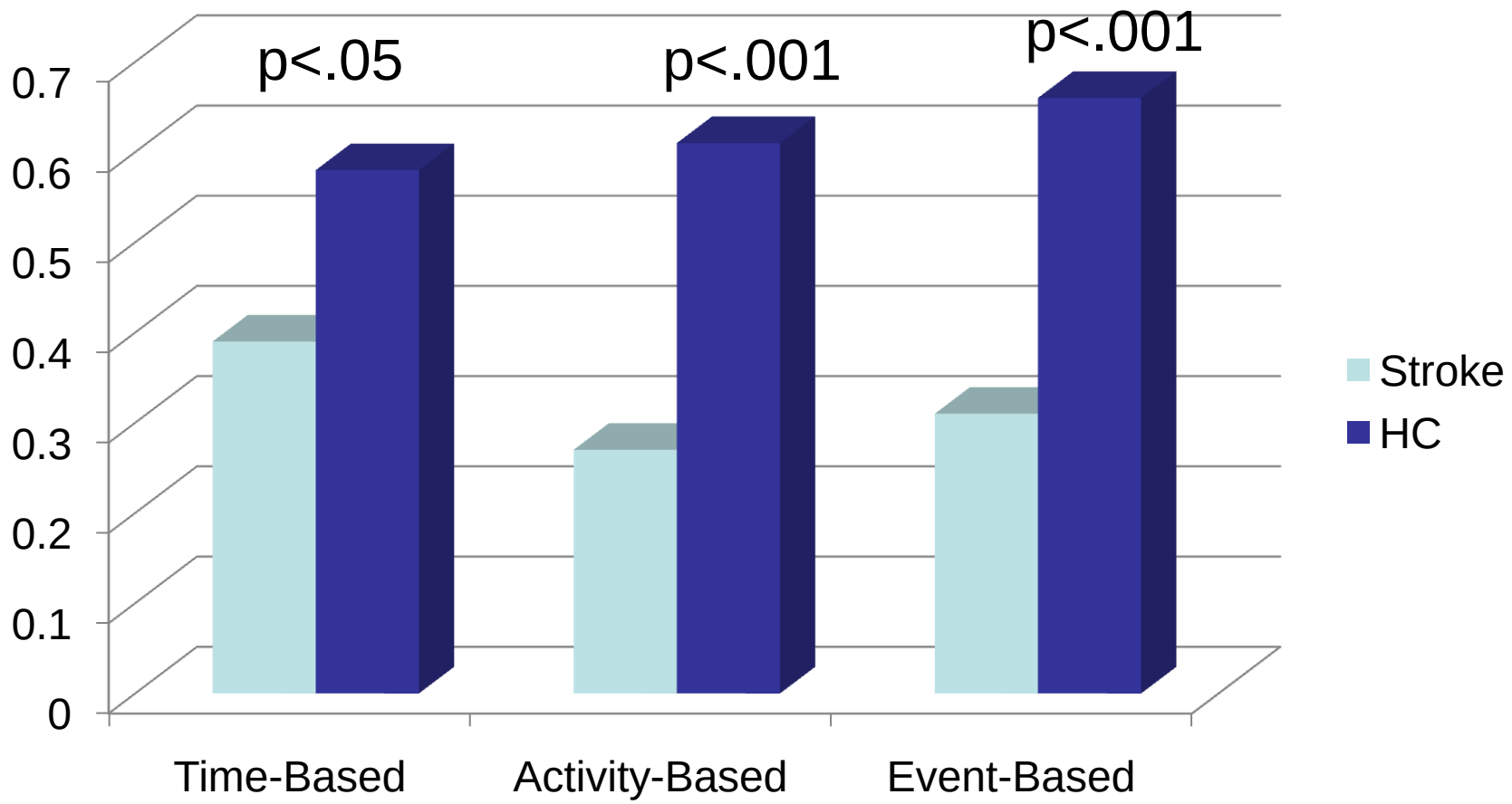
Virtual Reality and Spatial Ability Brooks et al., 2004

- Four interconnected rooms
  - Bedroom, music room, lounge, kitchen
  - 25 household objects throughout
  - Task: the owner of the virtual bungalow is moving
    - Ask exp to put “fragile” notices on item with glass
    - Allow the movers to access the bungalow by clicking on the red button at 5 min intervals
    - As the experimenter to close the kitchen door whenever you leave to keep the cat in

Virtual Reality and Spatial Ability
Brooks et al., 2004



Probability of Correct Performance in VE by Group



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AD and Navigational Ability (Cushman et al., 2008)

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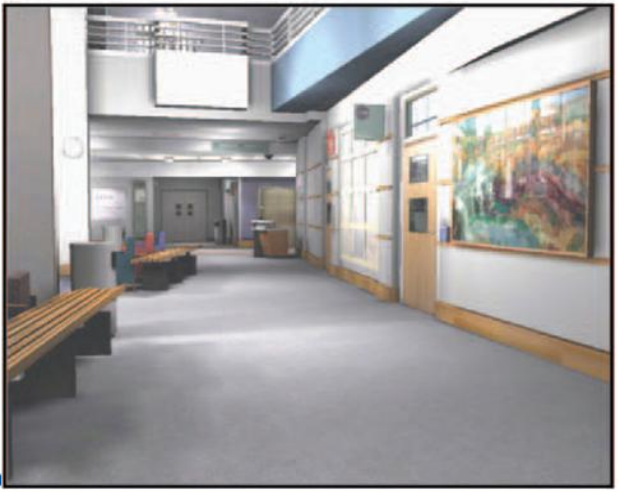

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AD and Navigational Ability (Cushman et al., 2008)

- Strong correlation between real world and VR
  - R=.73
- No interaction of group by environment
- VR – safer and more practical way of documenting spatial, navigational deficits

Allocentric vs Egocentric Spatial Ability

- Virtual Park
  - 9 points of 2-way intersection
  - 11 cul-de-sacs
  - Landmarks spread throughout allowing route leaning based on landmarks
- Task
  - Find the shortest way to the pot with money

Allocentric vs Egocentric Spatial Ability

- Virtual Maze
  - 6 points of 2-way intersection
  - 7 cul-de-sacs
  - Brick walls, colored floor, blue sky
  - Intersections were identical
  - No landmarks → **Egocentric processing**
- Task
  - Find the shortest way to the pot with money

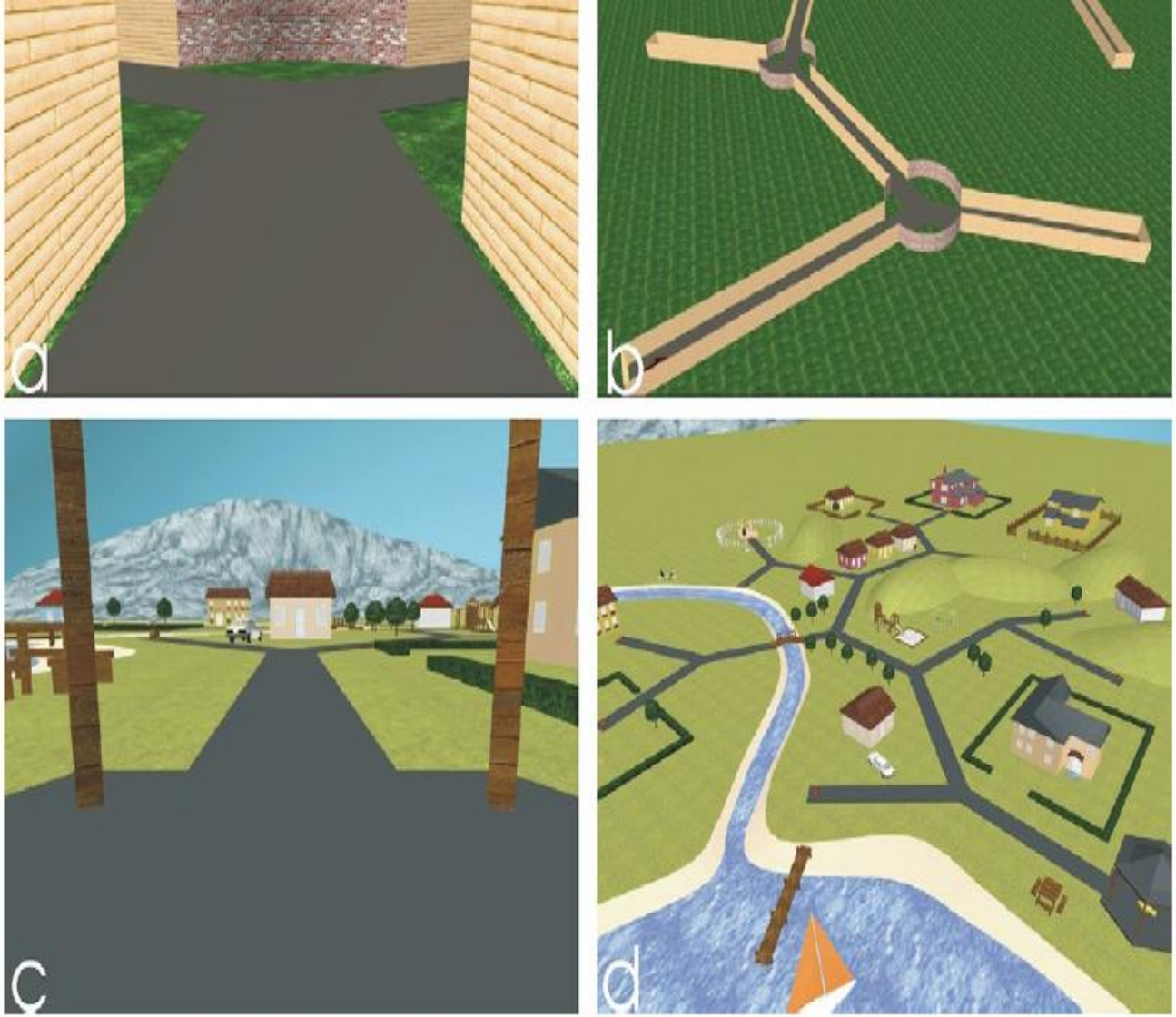


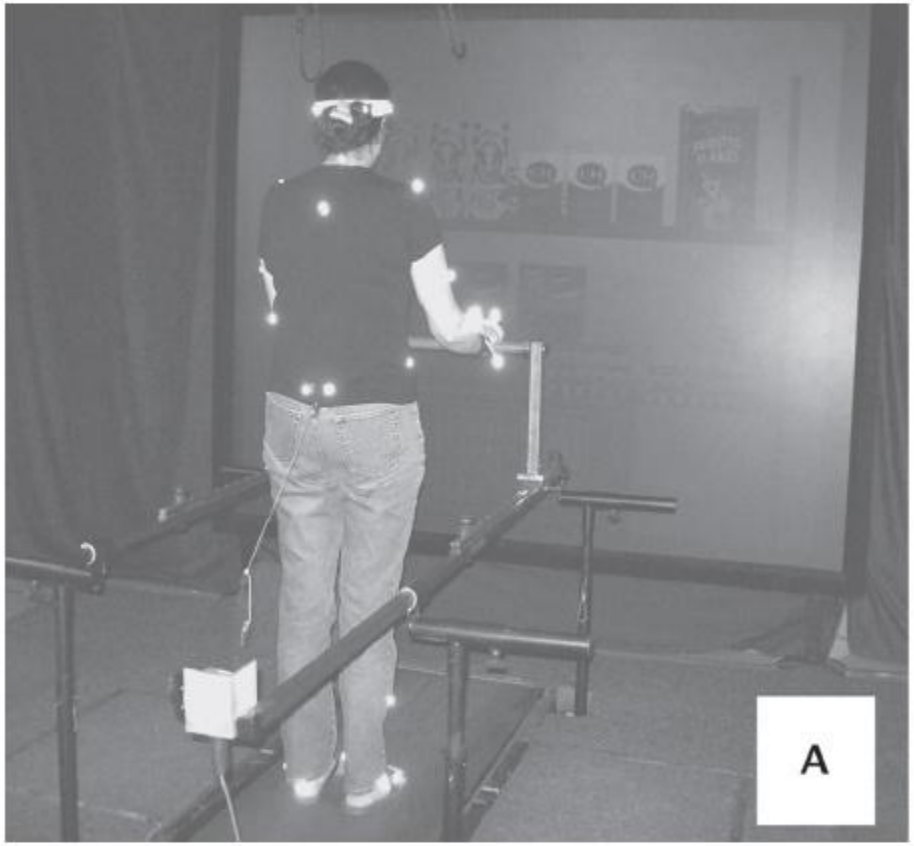
Fig. 2. Grey scale rendering of subject view (a and c) and aerial view (b and d) of the virtual maze (a and b) and the virtual park (c and d). Actual stimuli were in full colour. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of the article.)

Allocentric vs Egocentric

- Schizophrenia (Weniger et al., 2008)
  - Virtual Park: ME of Group (p=.007)
  - Virtual Maze: No group effect
  - **Allocentric** spatial processing impaired
- Stroke: Unilateral Parietal Lesions (Weniger et al, 2009)
  - Virtual Park: No group effect
  - Virtual Maze: ME of Group (p=.001)
  - **Egocentric** spatial processing impaired

Dual Task Paradigm

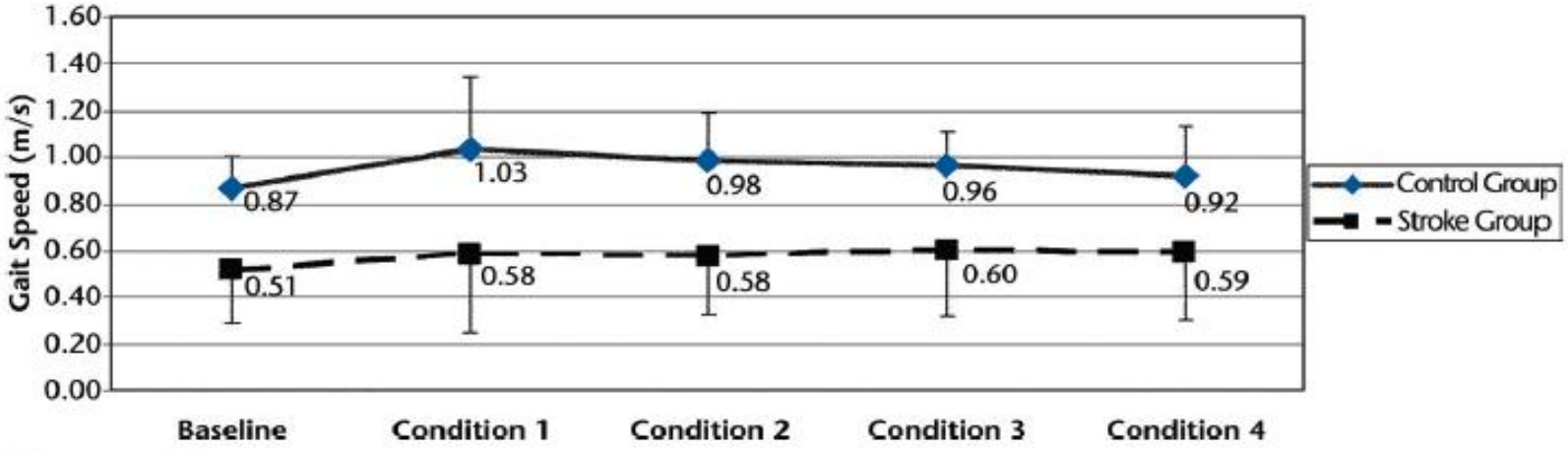
Kizony et al., 2010



Dual Task Paradigm

Kizony et al., 2010

- Either single or dual task
  1. Walk through the aisle
  2. Walk through the aisle and select items



Virtual Reality Applications in NP

- Attention processes
- Executive functions
- Memory
- Spatial skills
- **Functional skills**

VR & Functional Skills
Zhang et al., 2004

- Virtual Kitchen
- Task: stovetop prep of a can of soup and a sandwich
  - 81 steps and substeps
- Also performed actual kitchen task
- 54 patients with TBI

VR & Functional Skills Zhang et al., 2004

- Correlation between VR and actual task
  - .59-.63 (p<.01)

	1st VR Kitchen	2nd VR Kitchen
Meal Prep (OE)	.30*	.29*
Cognitive subskills (OE)	.37**	.40**
Full Scale IQ (NP	.56**	.44**
Performace IQ	.56**	.35*
Verbal IQ	.38**	.40**

*p<.05; **p<.01

Virtual Reality and NP Assessment Functional Skills / IADLs

- Target Specific Functional Skills
  - Street crossing (Strickland 1996)
  - Wheelchair navigation (Inman et l., 1997)
  - Meal preparation (Christiansen et al., 1998; Daves et al., 1998)
  - Use of public transportation
  - Driving
  - Obstacle avoidance (reduce falling risk; Jaffe, 1998)

I. Neuropsychological Assessment

II. Cognitive Rehabilitation

Virtual Reality and Cognitive Rehabilitation (CR)

- Cognitive rehabilitation
  - The therapeutic process of increasing or improving an individuals capacity to process and use incoming information so as to allow increased functioning in everyday life
    - Sohlberg and Mateer (1989, 2001)
  - Targets:
    - Specific component cognitive processes
    - Functional behaviors or Instrumental Activities of Daily Living (IADLs).

Virtual Reality and Cognitive Rehabilitation

- Larger conceptualization of cognitive rehab includes focus on vocational, self-awareness and social interaction concerns (Prigatano, 1997)

Virtual Reality and Cognitive Rehabilitation

- Traditional breakdown
  - *Restorative* approaches
    - Systematic retraining of component cognitive processes (i.e., attention, memory, etc.)
    - Teaches how to think
  - *Functional* approaches
    - Stepwise training of observable behaviors, skills, and IADLs
    - Teach individuals how to *do*.

Virtual Reality and Cognitive Rehabilitation

- Weaknesses of both approaches
  - Restorative methods
    - Reliance on test materials or tasks that are artificial and have little relevance to real-world functional cognitive challenges.
    - Memorizing increasingly difficult lists of words or activities within a therapy environment does not support *generalization*

Virtual Reality and CR

- Weaknesses of both approaches
  - Functional methods
    - Learning standard stereotyped behaviors to accomplish IADLs
      - Assumes a static world where life demands do not change
      - Person's underlying cognitive processes are not specifically addressed

Virtual Reality and CR

- VR can limit the major weaknesses of both the restorative and functional approaches,
  - Systematic restorative training
  - Functionally relevant, ecologically valid simulated environments
  - Optimize the degree of transfer of training or generalization of learning to the person's real world environment

Virtual Reality and CR

- Benefit of VR interventions over traditional CR
  - Systematically deliver and control dynamic, interactive stimuli within a complex environment
  - More ecologically valid rehabilitation scenarios
  - Deliver immediate performance feedback
  - Provide “cueing” stimuli or visualization tactics designed to help guide successful performance
  - Availability for a more natural/intuitive performance record

Virtual Reality and CR

- Benefit of VR interventions over traditional CR
  - Pause treatment and training for discussion and/or integration of other methods
  - Provide a safe training environment that minimizes risks due to errors
  - Enhance motivation through the integration of game mechanics and tasks

Virtual Reality and CR

- Vital factor → generalization
  - One of the primary expected benefits of VR
- 3 types of VE-produced transfer
  - Transfer of gains on the same material at different times
  - Improvement on similar, but not identical tasks
  - Transfer from training to the day to day environment

Virtual Reality and CR Evidence of Generalization

- Positive learning transfer from non-HMD virtual training settings to the real world navigation training tasks
  - Cromby et al., 1996; Stanto et al., 1998; Brooks et al., 1999
- Reports of impaired performance on self report of everyday life with intact NP, but impaired performance on VE
  - Mendozzi et al., 1998

Virtual Reality and CR

- Data on VR-based training in
  - Spatial Skills
  - Memory
  - Daily Life Skills / Multi-tasking

- Other VEs
  - Virtual Home
  - Virtual Office

Virtual Reality and CR

- Data on VR-based training in
  - Spatial Skills
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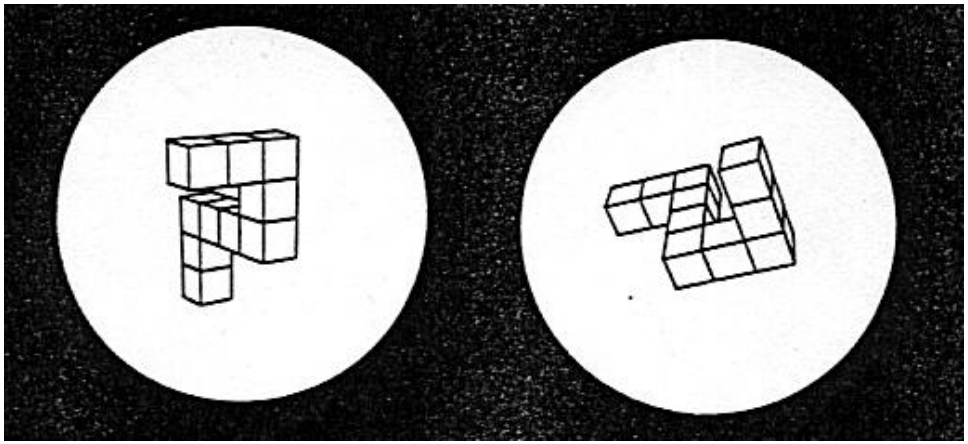
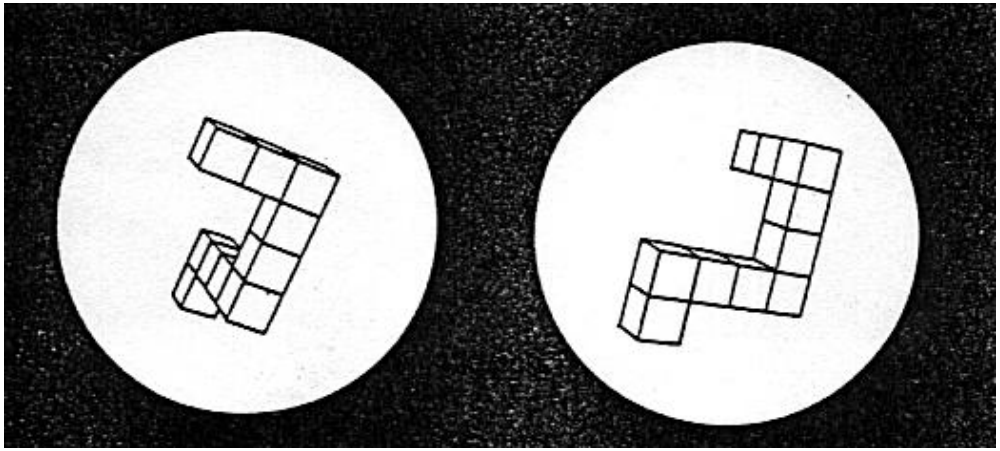
Are these pairs of objects the same or different?





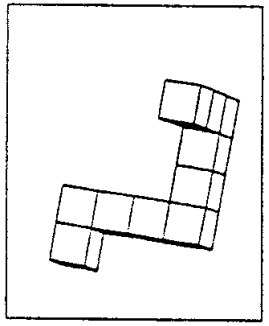
From: Shepard and Metzler, 1971

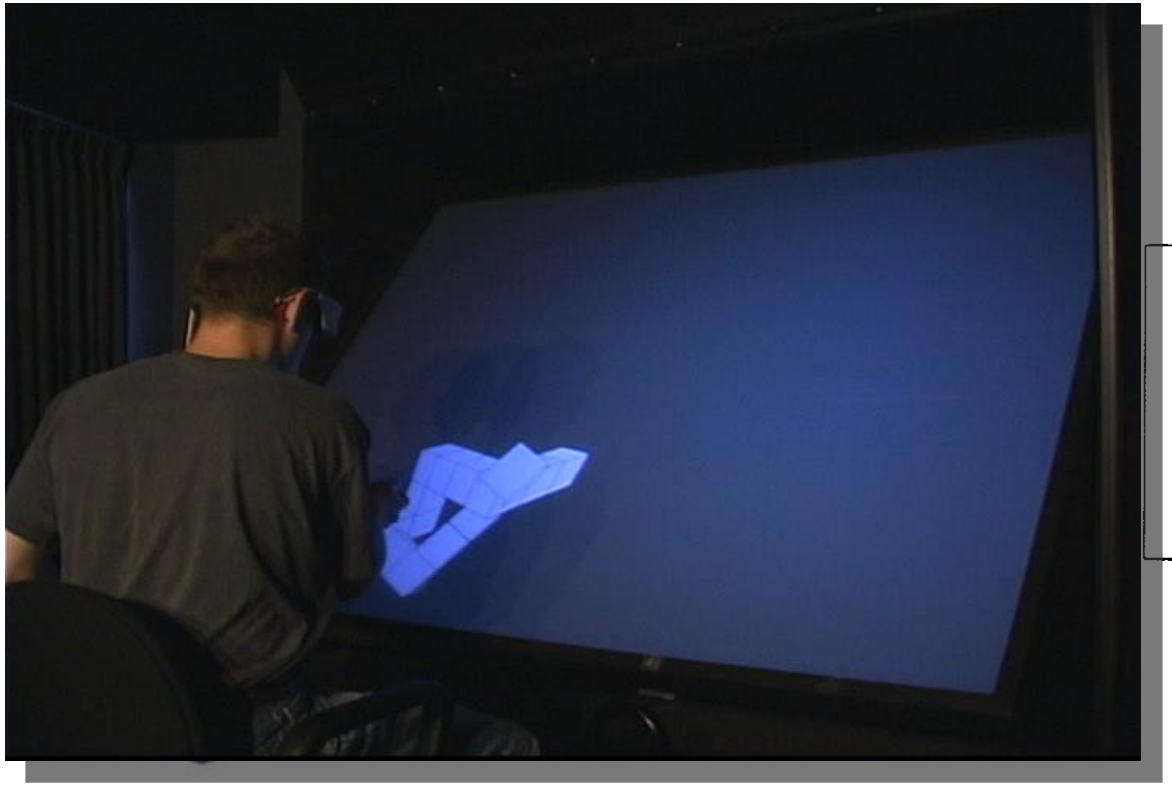
Mental Rotations Test (MRT)

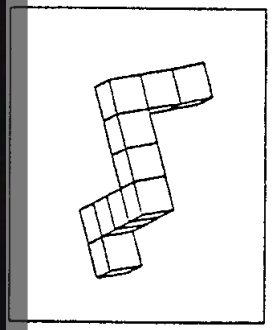
(Vandenberg and Kuse, 1978)

Now look at
this object:

1.







1996

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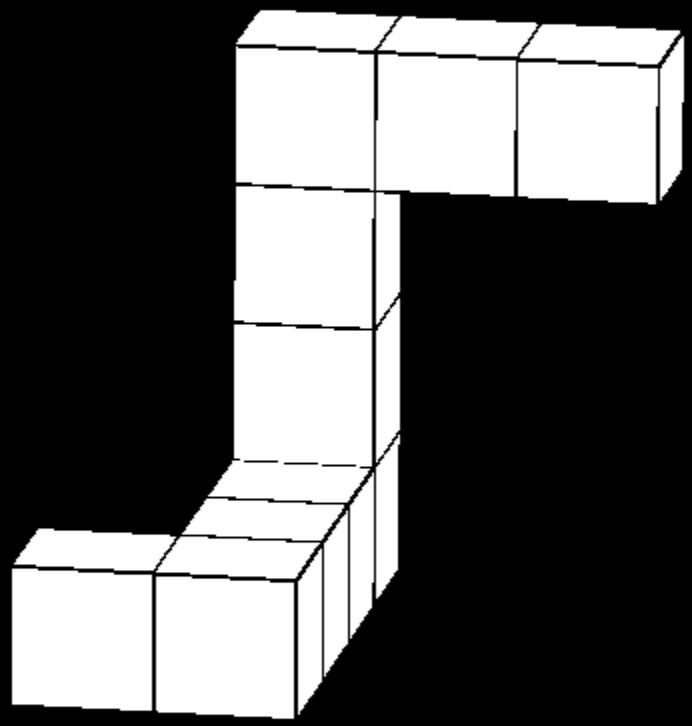
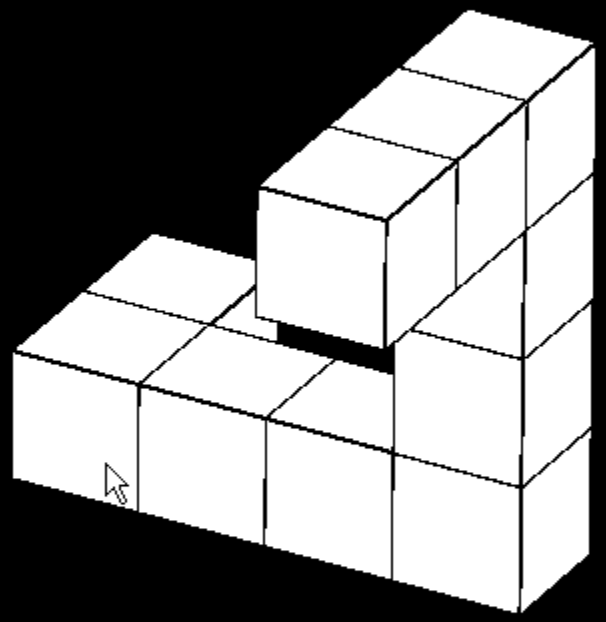
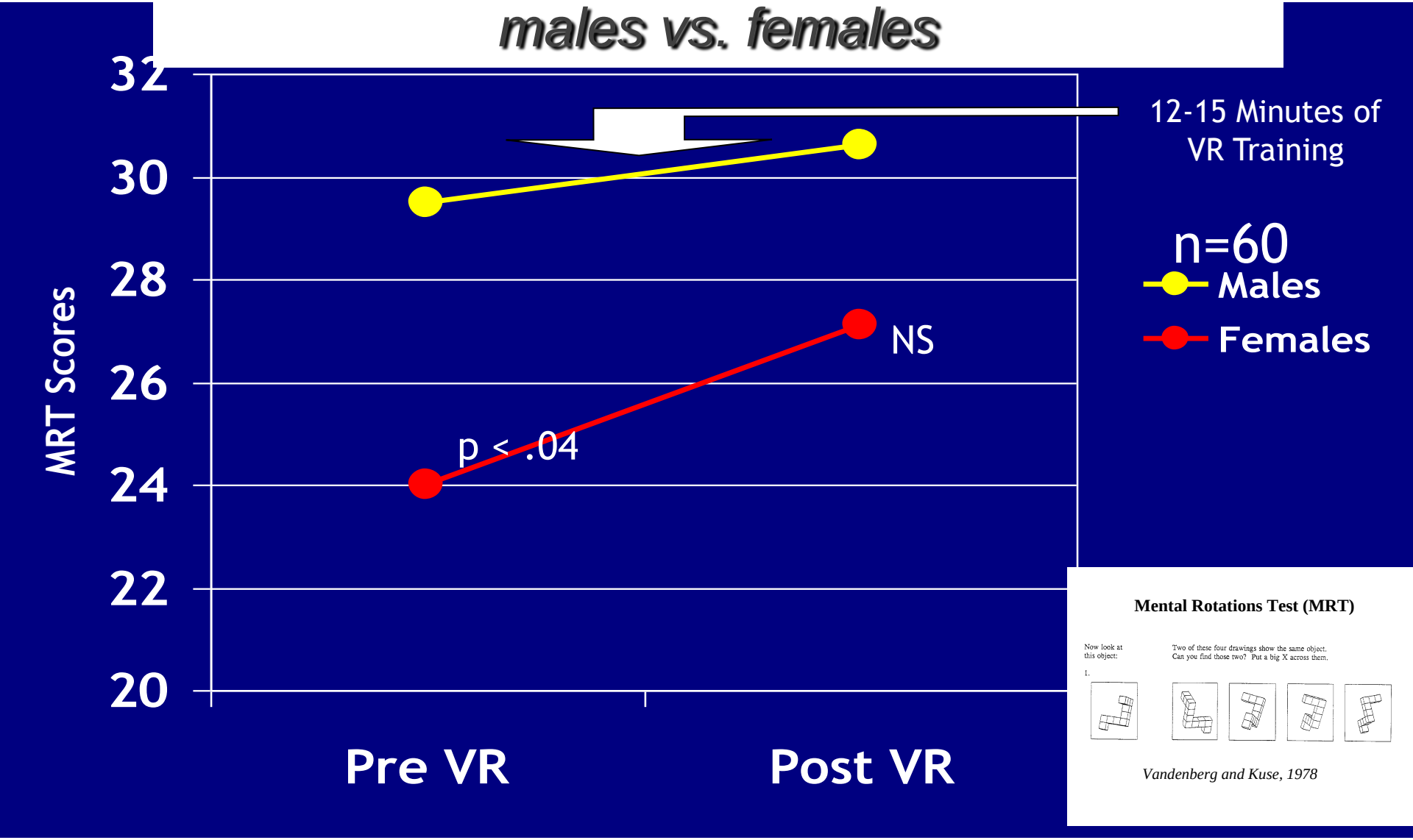




Mental Rotation Scores – Pre/Post VR for *males vs. females*



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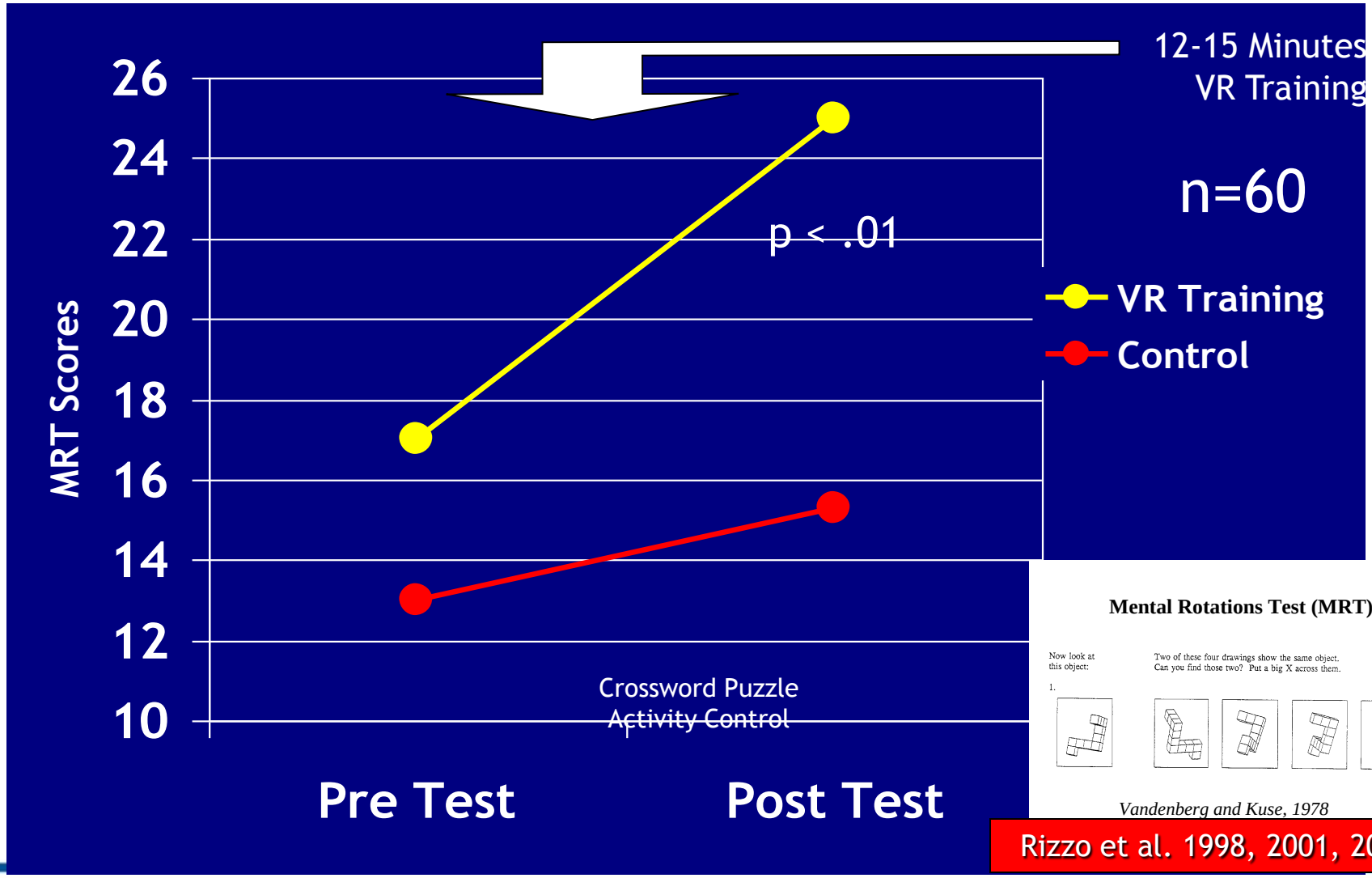
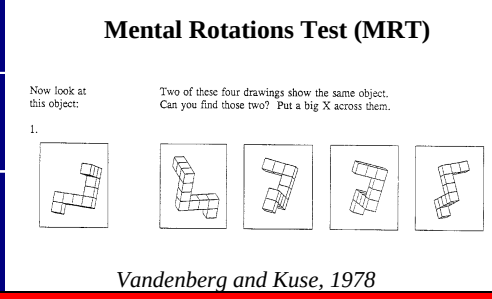
Mental Rotation Scores – VR vs. Control group for ***poor initial performers (male & females combined)***





Rizzo et al. 1998, 2001, 2005

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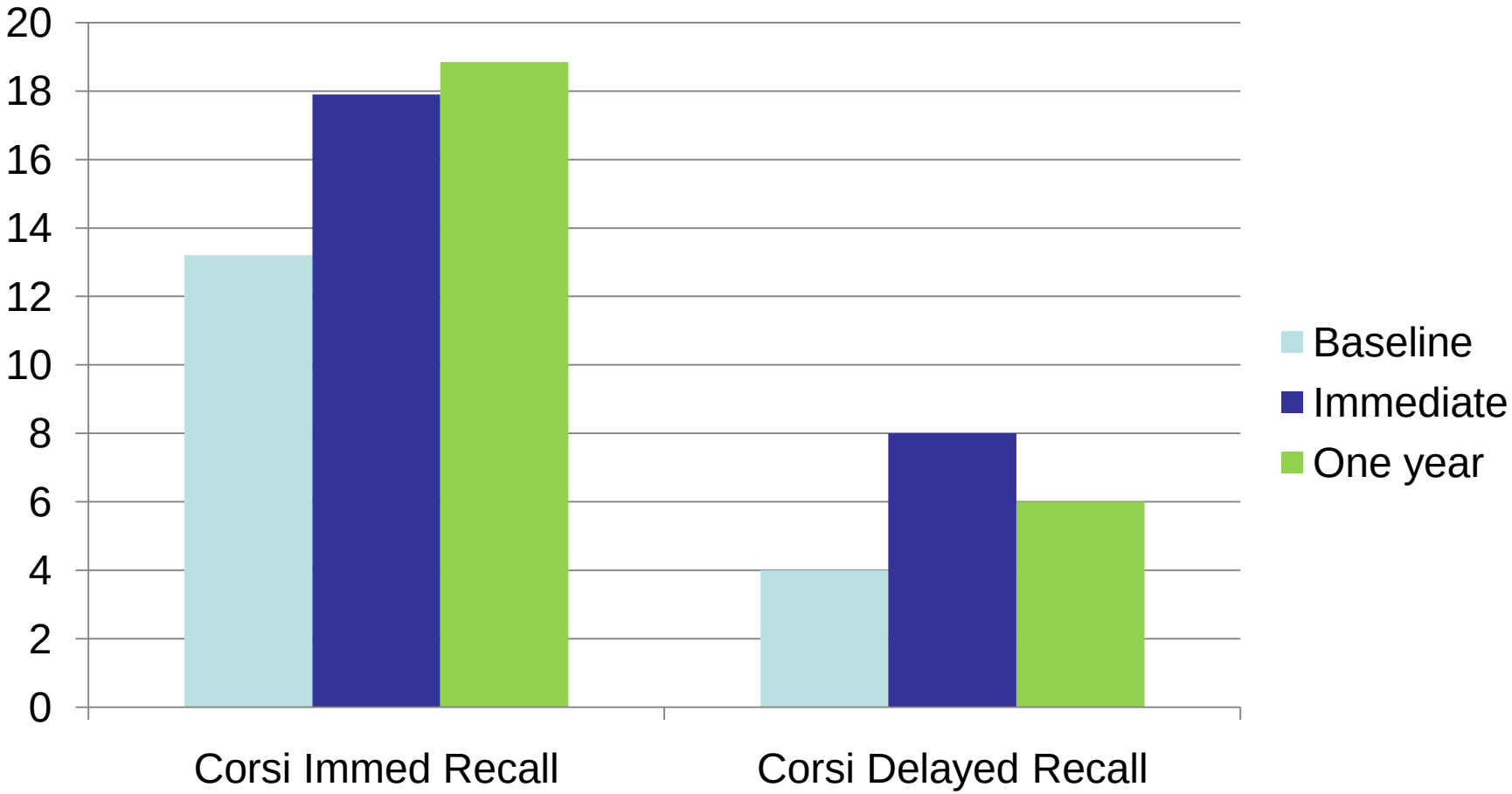
Slide thanks to Skip Rizzo, PhD

VR based Training in Spatial Navigation (Caglio et al., 2012)

- Case Study: 24 y/o/ man with TBI
- Rehab: navigational task of a virtual town (London) from a ground level perspective
- "You must cut down poles and trees you see along the way"
  - Encourage extensive exploration of the VE
- 90 minute sessions, 3x/week for 5 weeks
- Assessments at baseline, immediately post training and 1 year follow-up

VR based Training in Spatial Navigation (Caglio et al., 2012)



All comparisons Mann-Whitney U, p<.05

Virtual Reality and CR

- Data on VR-based training in
  - Spatial Skills
  - Memory
  - Daily Life Skills / Multi-tasking

- Other VEs
  - Virtual Home
  - Virtual Office

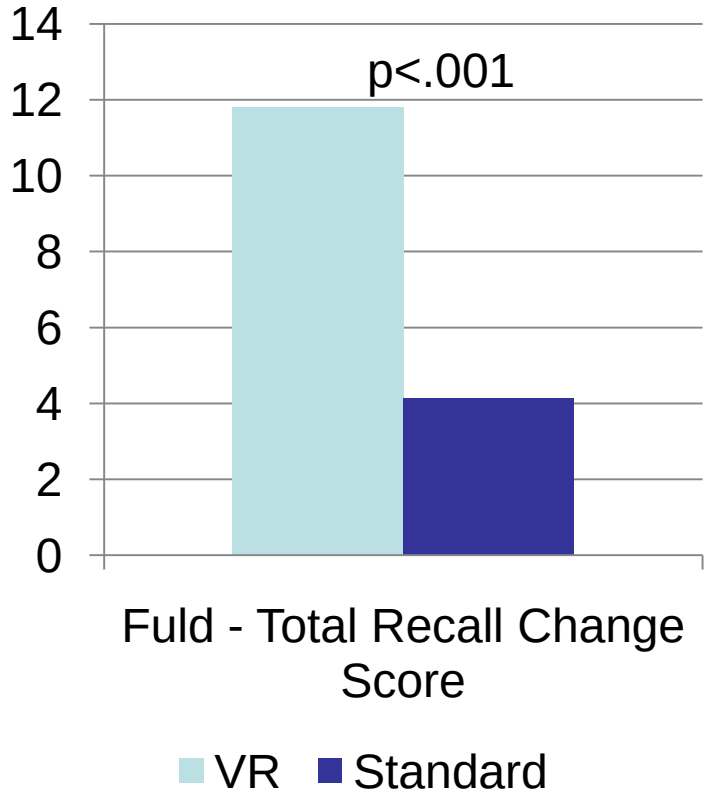
VR-based Memory Retraining
Man et al., 2012

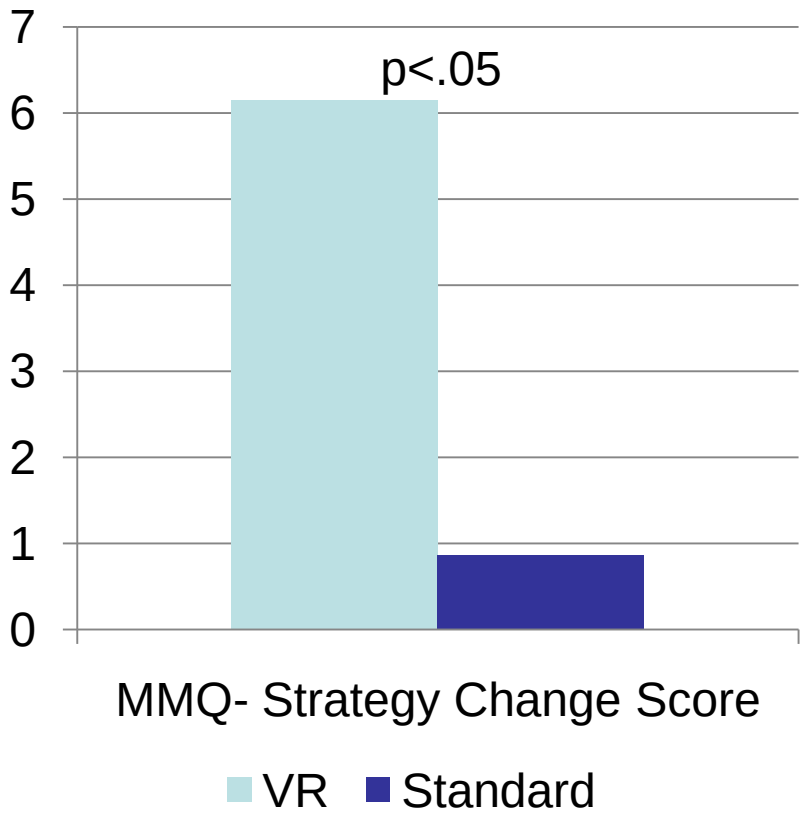
2 settings: a home setting and a convenience shop

VR-based Memory Retraining Man et al., 2012

- Tasks moved from simple to complex
- Therapist guided
  - 3 min task: moving around, reading & memorizing items on a memo pad
  - Distractor
  - Take memorized items out of refrigerator
  - Similar in 2 scenes
- Non-VR group did same task via color-print images

VR-based Memory Retraining
Man et al., 2012





VR-Based Memory Retraining
Optale et al., 2010

- Single Blind Clinical Trial
- Both groups
  - 3 sessions/ week for 3 months
  - Boosters: 2 sessions / week for 2 months
  - 30 minutes in duration

VR-Based Memory Retraining

Optale et al., 2010

- Experimental Group
  - VR based
  - Moves in a garden environment
  - Tests paths taken and orientation
  - Paths are individualized with color or form
  - Musical background
- Control group
  - Music therapy
  - Same frequency and duration

VR-Based Memory Retraining
Optale et al., 2010

- Significant effects of group on
  - Mini-Mental Status Examination
  - Digit Span
  - Story Recall
  - Dual Task Performance
  - Cognitive Estimation Test

Virtual Reality and CR

- Data on VR-based training in
  - Spatial Skills
  - Memory
  - Daily Life Skills / Multi-tasking

- Other VEs
  - Virtual Home
  - Virtual Office

Virtual Reality and CR IADLs and the Virtual City

- Brown, Kerr, & Bayon, 1998
- Addresses multiple challenges
  - Public transport
  - Road safety
  - Home safety
  - Use of public facilities in a café
  - Shopping skills
- House, supermarket, café and transport system

Virtual Reality and CR IADLs and the Virtual City

- Initial study: 20 sj with mental retardation
  - Cobb, Neale, Reynolds, 1998
- Usability (high)
- Enjoyment (high)
- Skill learning evident
- Clear transfer of skills to daily life (evaluated via self-report and behavioral observation)

Virtual City & Acquired Brain Injury

- 4 subjects
- 10 sessions of Community living skills training
- Results
  - 4/4 higher scores on behavioral checklist
  - 4/4 greater distances traveled in less time
  - 3/4 improved performance in attending to danger signs
  - 4/4 better community living reported

VR and CR: Supermarket VE Cromby et al., 1996

- Study Procedure
  - Baseline
  - 11 weeks of VR training (2x/wk)
  - Follow-up
- Experimental group was better able to navigate within a real supermarket post training and successfully obtain items ($p<.05$)

Time	First Visit	Second Visit
Experimental Group	11.97	11.59
Control Group	11.21	16.92

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Virtual Reality and CR

- Data on VR-based training in
  - Spatial Skills
  - Memory
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- Other VEs
  - Virtual Home
  - Virtual Office

Virtual Home

Rizzo, Klimchuk & Mitura 2003

Slide thanks to Skip Rizzo, PhD

Slide thanks to Skip Rizzo, PhD

Slide thanks to Skip Rizzo, PhD

Slide thanks to Skip Rizzo, PhD

Virtual Reality and Cognitive Rehabilitation
Virtual Office

- VE consisting of an office setting in which patients navigate the setting with a mouse
- Developed by the Institute of Creative Technologies at the University of Southern California in collaboration with Kessler Foundation

Koenig ST, Krch D, Chiaravalloti N, Lengenfelder J, Nikelshpur O, Lange BS, DeLuca J, Rizzo AA, User-centered development of a virtual reality cognitive assessment. Proceedings of the 2012 International Conference on Disability, Virtual Reality and Associated Technologies, September 10-13, 2012, Laval, France.

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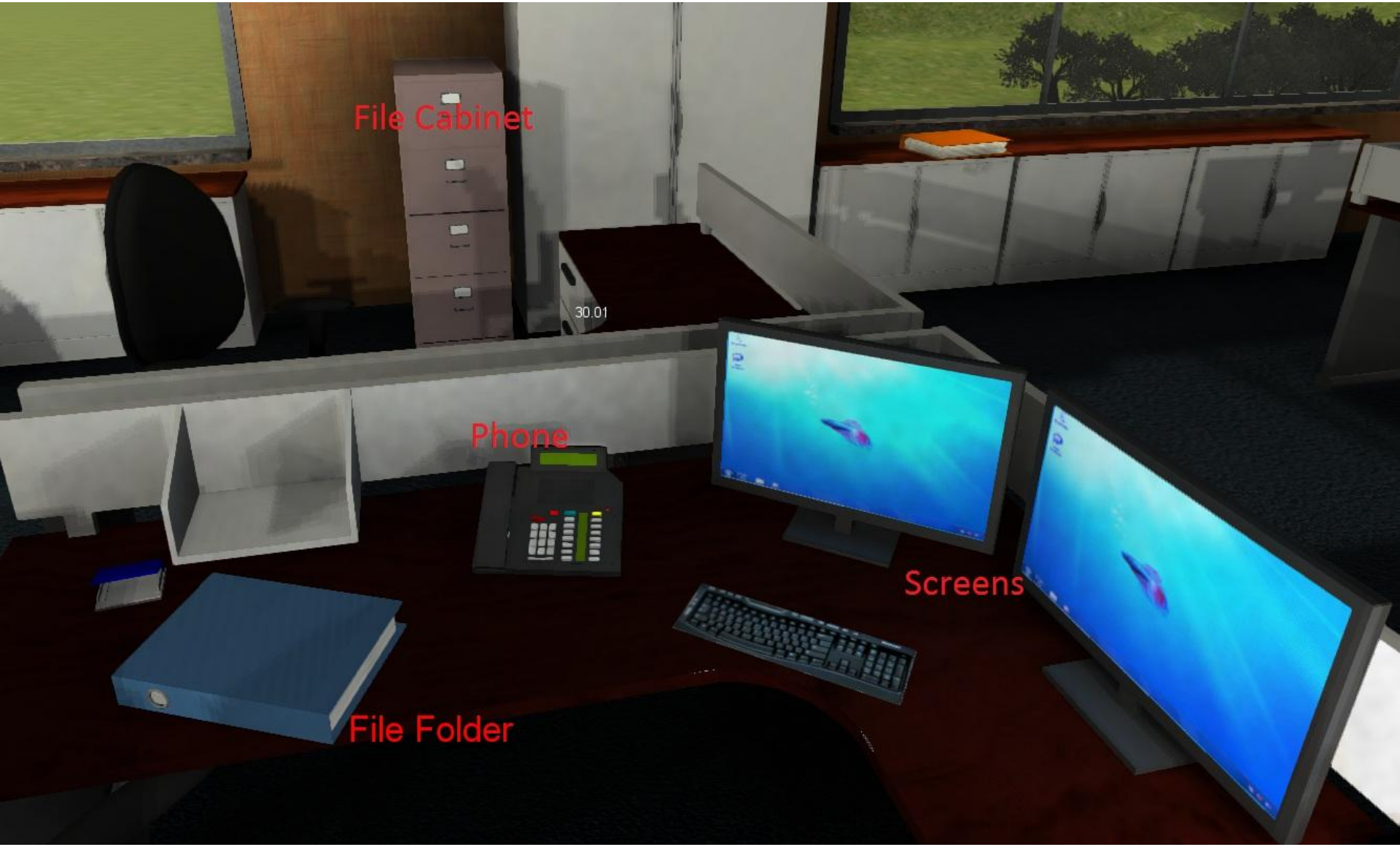
File Cabinet
30.01
Phone
Screens
File Folder

Virtual Office

- Tasks within the environment
  - Patient is given a set of criteria (e.g., # of bedrooms, cost, budget, etc) which they are to use to judge real estate offers that appear on their computer monitor.
    - Must decide based on the criteria whether to accept or decline each real estate offer.
    - They receive a total of 16 real-estate offers.
  - 6 times during the course of the program, the projector turns off and the person has to click the remote to make the projector come back on.

Virtual Office

- Distractors
  - Phones ringing in various locations
  - Boss speaking
  - Patients can freely navigate the environment
    - Shred
    - File
    - Leave

VR Office

- Small sample (n=6) of individuals with TBI
- Qualitative analysis
  - Understood task instructions
  - Navigated through the VR environment and maneuvered around obstacles using a mouse,
  - Could complete the required tasks (e.g., respond to emails, follow commands).
- Qualitative feedback from participants
  - Distractors (e.g., phones made completing the tasks much more challenging

Virtual Office

	# correct on decision task	# of times instructions were viewed	# of offers incorrectly accepted
Token Test	.564 P=.09		
PASAT T3		-.668 .049	-.819 .007
PASAT T4			-.715 .012
Symbol Search		-.572 .084	

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Total n=8 (TBI and MS)

Virtual Office

	# of ads Clicked	# of offers declined incorrectly
IADL Phonebook time in sec	.780 .008	.659 .038

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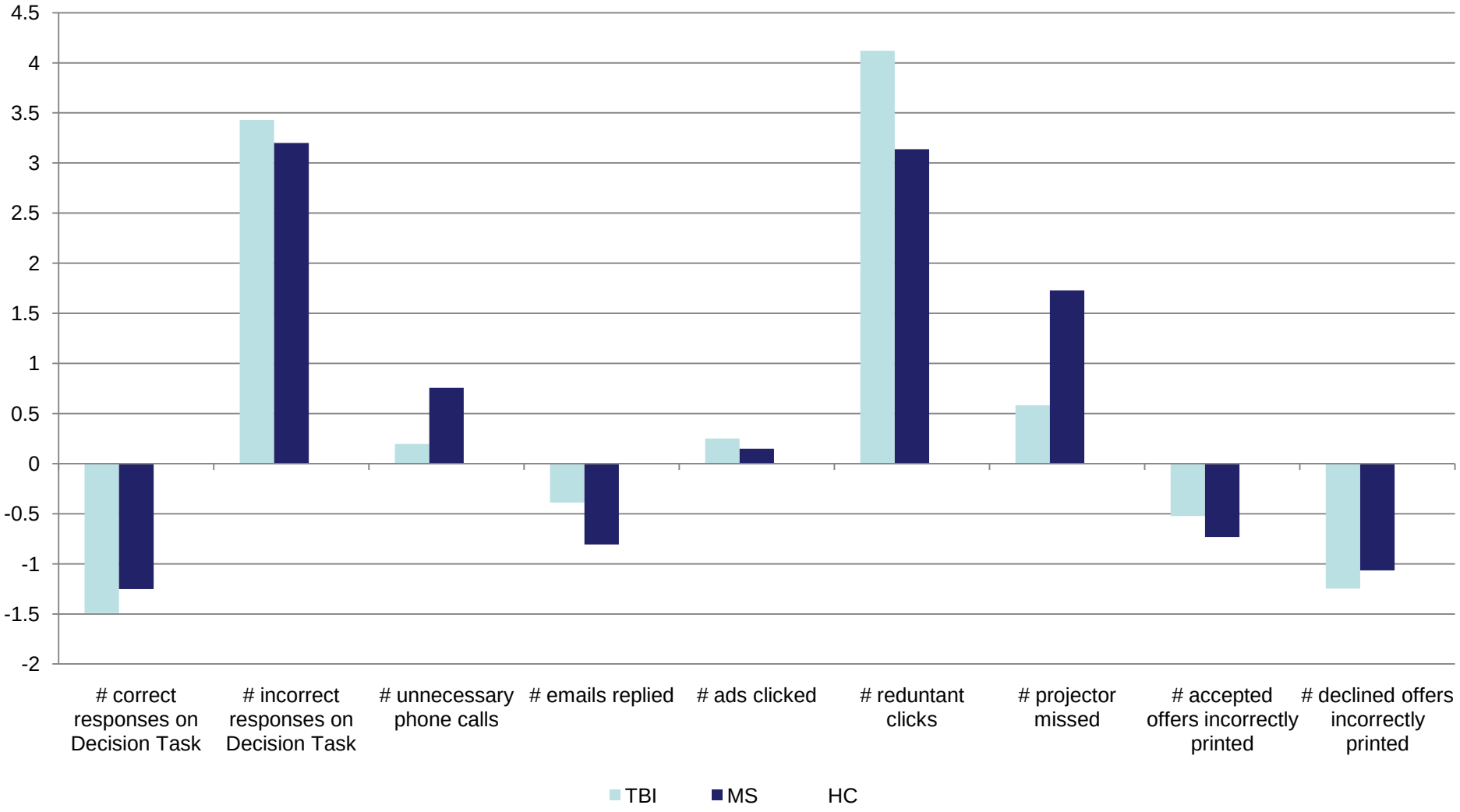
Total n=8 (TBI and MS)

VR Office z-scores



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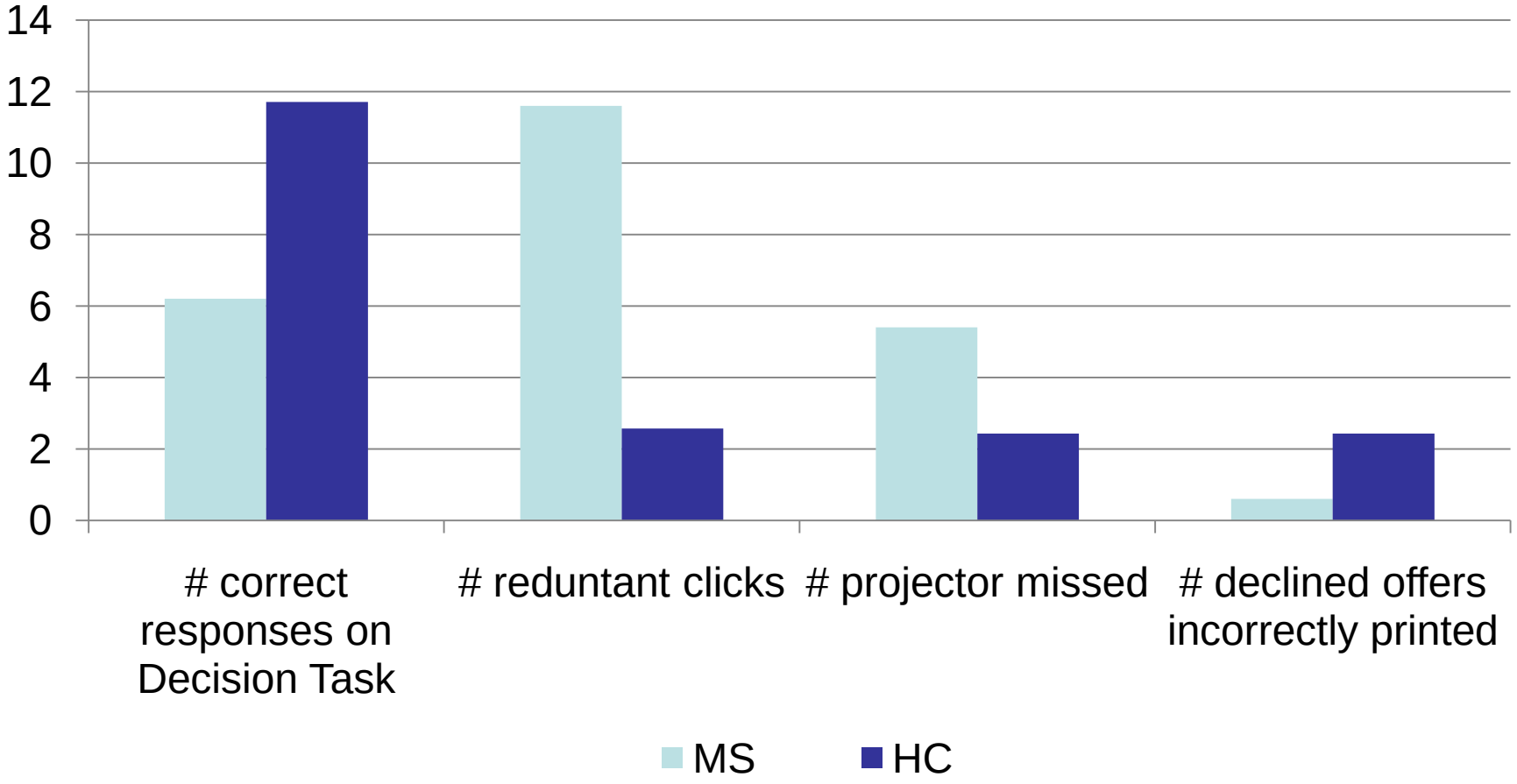
MS vs HC on VR Office



All comparisons, $p<.05$

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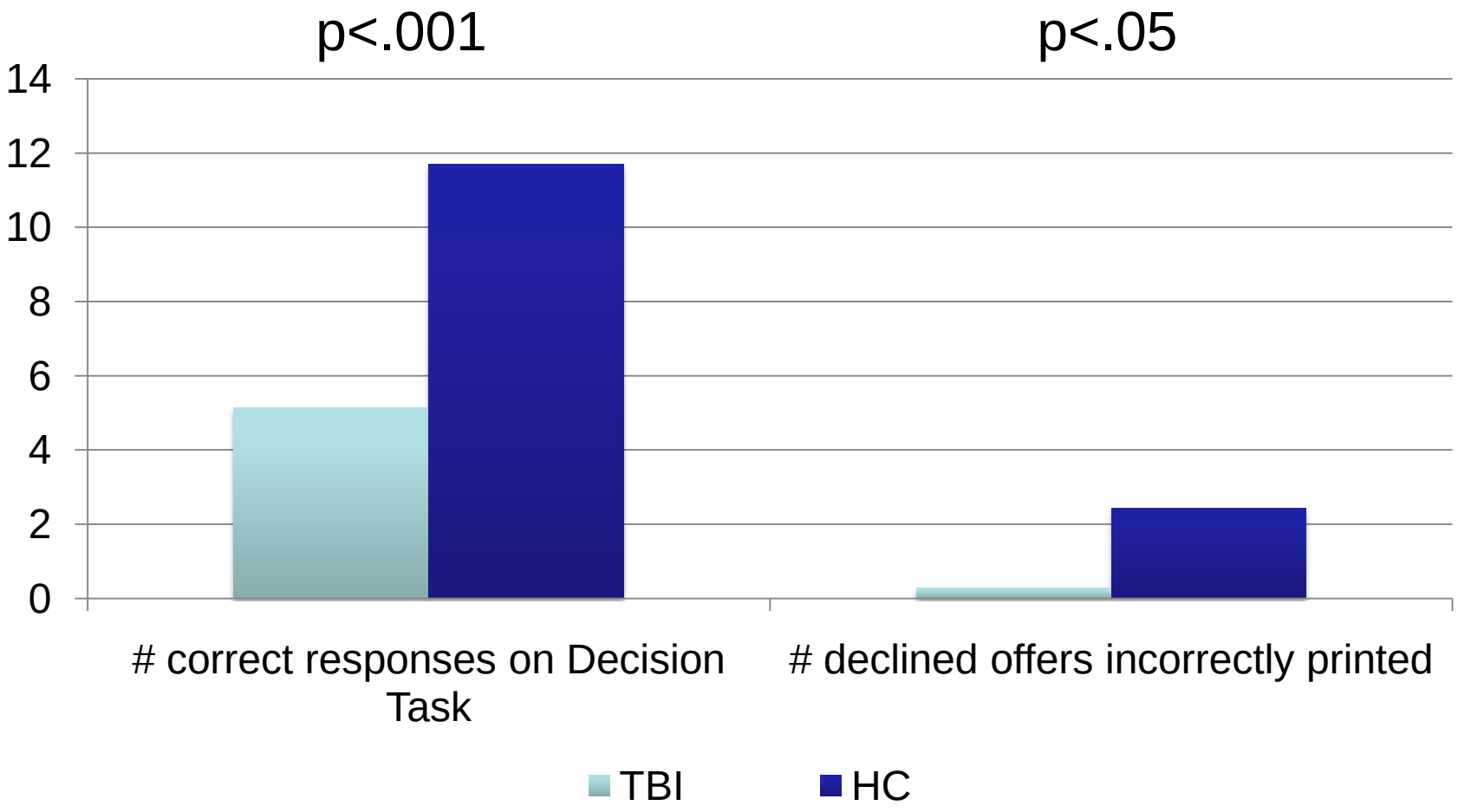
TBI vs HC on VR Office Measures



Thank You…

- Denise Krch, PhD
- Jean Lengenfelder, PhD
- Olga Nikelshpur, PhD
- John DeLuca, PhD
- Skip Rizzo, PhD
- Sebastian Koenig, PhD

Questions / Comments…