Virtual Iraq:
Virtual Reality Cognitive Performance Assessment Test

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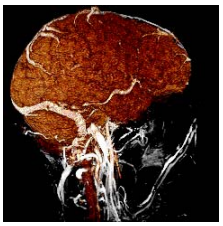
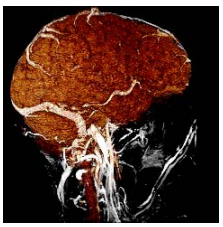
VRPSYCH Lab: Collaborators

- **Institute for Creative Technologies**
  - Rizzo, Pair, Gratch, Marsala, Hill, Swartout, Morie
- **Brain and Creativity Institute**
  - Antonio and Hanna Damasio
- **Child Psychiatry**
  - Pato, Pataki, Sugar
- **Integrated Media Systems Center**
  - Sawchuck, Yeh
- **Annenberg School for Communication/Journalism**
  - McLaughlin
- **School of Biokinesiology and Physical Therapy**
  - Winstein, Flynn
- **Department of Psychology**
  - Davison, Arbib
- **Children's Hospital Los Angeles**
  - Gold, Katz
- **School of Gerontology, Neurology**
  - Zilenski, Chui

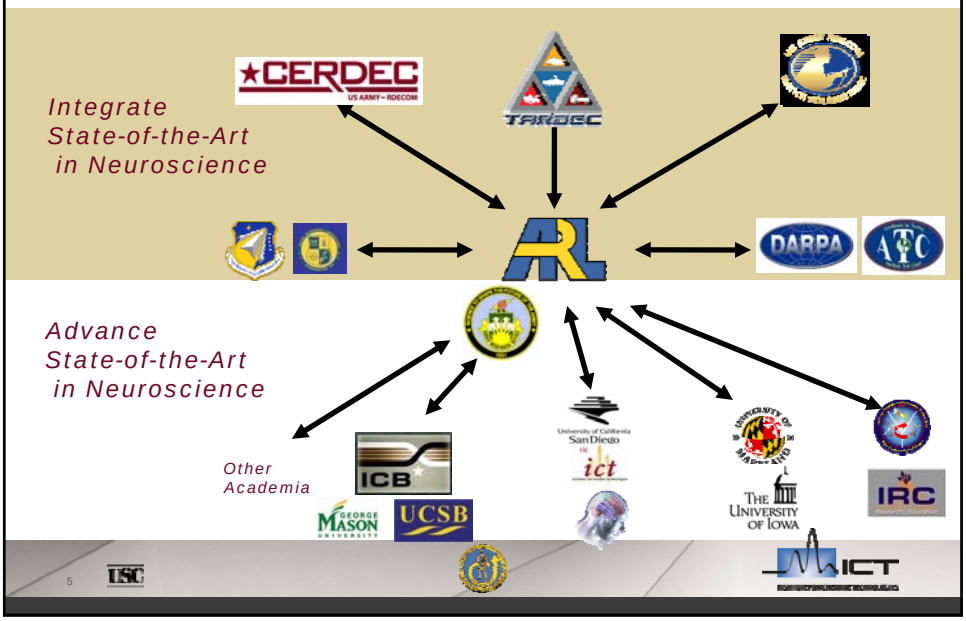


VRPSYCH Lab: Collaborators

- **Center for Study of Human Operator Performance**
- **University of Minnesota**
- **UCSF Dynamic Multimodal Imaging Lab**
- **UCSD & VR Medical Center**
- **Yale University**
- **Kessler Medical Rehab Center**
- **Virtually Better**
- **LA Children's Hospital**
- **St. John's University**
- **North Carolina A&T State University**
- **Utah Neurodevelopment Center**
- **Columbia University**
- **Emory University**



ARL Neuroscience STI



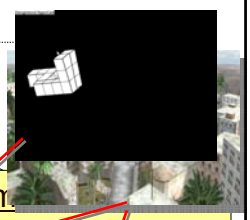
VRPSYCH Lab

Social Neuroscience:
Integrated Interdisciplinary

Emotion Modelling & Regulation
- Social psychological topics
- Attitude change
- Stereotyping

Neuroscience methods
- Neuropsychological Assessment
- Psychophysiological
- Neuroimaging

Social Neuroscience: VRPSYCH Lab Projects

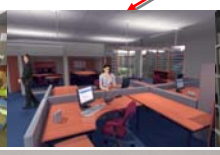


Emotion Models & Regulation

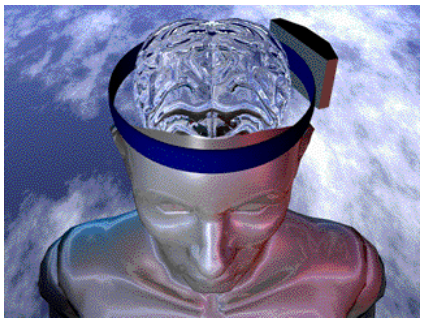
- Virtual Standardized Patients
  - Justin/Justina
  - Startle eye-blink and bias
- Panoramic (Anger Management)
- VR Exposure Therapy

Neuroscience m

- Visuospatial Processes
- VRClassroom/Office/Apartment
- VEGS
- VRCPAT (NP Assess)
  - Psychophys Correlates



VRPSYCH Lab



The Study of Brain/Behavior Relationships

Multisensory Simulations

Scent System

- Gunpowder
- Cordite
- Body Odor
- Garbage
- Burning Rubber
- Diesel Fuel
- Iraqi Spices

Bass Shaker Platform

Stimulus Delivery

Night Vision HMD Rig...

Neuropsyc Assessment

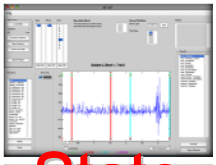
Standard Tests

Trait

VR Tests

Physiology Assessment

Biopac System



State

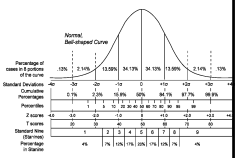
Neuropsychological Assessment

- Standardized tests used in a neuropsychological evaluation typically assess functioning in the following areas:
  - Attention
  - Executive functions
  - Language functions
  - Processing Speed
  - Learning and Memory
  - Visual-spatial functions
  - Sensory-Perceptual functions
  - Motor functions
- Academic skill development and emotional functioning are typically assessed as well.

Neuropsychological Assessment

- Advantages:
  - Cognitive functioning
    - Broad Spectrum of brain functioning

  - Standardized procedures
    - Psychometrically sound
    - Reliable scoring methods

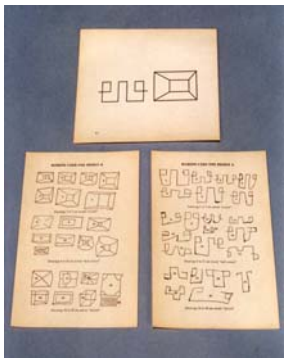


Neuropsychological Assessment

- Disadvantages:
  - Outmoded Tests
    - using methods developed 60-100 years ago!

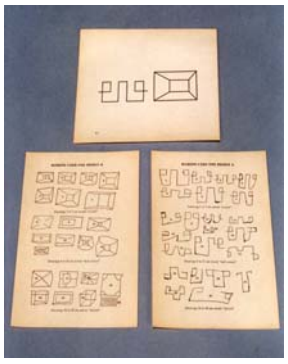
  - Ecological Validity
    - Relevance to real world functioning

Neuropsychological Tests (1905)



Binet (1905)
Drawing a Design from Memory

Neuropsychological Tests (Now)



Wechsler Memory Scale:
Visual Reproduction Subtest

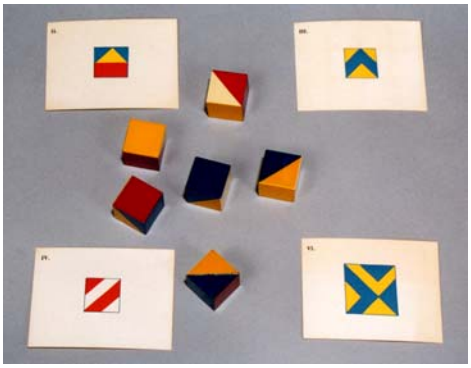
Neuropsychological Tests (1917)

The Manikin Test:
Developed by Pitner-Patterson, 1917

Neuropsychological Tests (Now)

Now the "Object Assembly" Subtest on the WAIS, WISC

Neuropsychological Tests (1915)



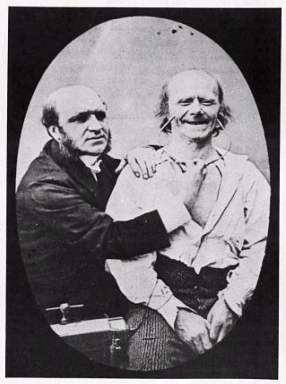
Kohs Blocks (1915)

Neuropsychological Tests (Now)

Now the “Block Design” Subtest on the WAIS, WISC, etc.

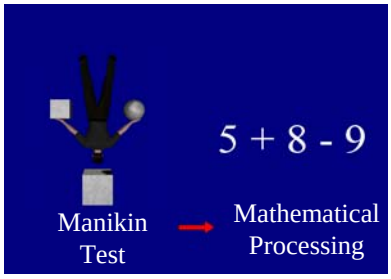
Neuropsychological Tests

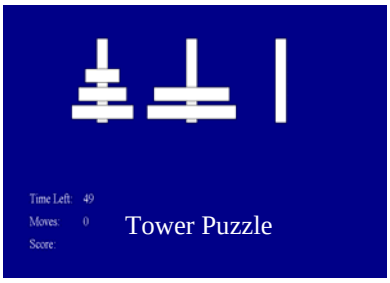
Are we still limited to using methods developed 60-100 years ago!



Computerized Neuropsych Tests

ANAM





Computerized Neuropsych Tests

Slide on stimulus complexity

-SIMPLE = Numbers in middle of screen

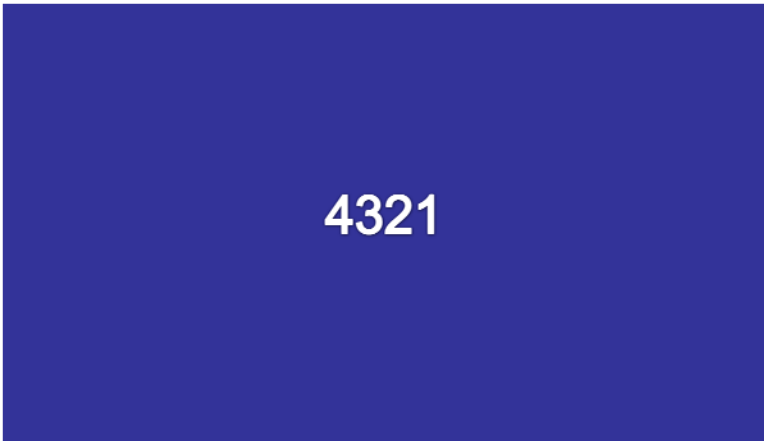
-COMPLEX = Numbers presented randomly throughout the screen

Computerized Neuropsych Tests

Attention: Simple Presentation

Computerized Neuropsych Tests

Attention: Simple Presentation



Computerized Neuropsych Tests

Attention: Simple Presentation

Computerized Neuropsych Tests

Attention: Complex Presentation

Computerized Neuropsych Tests

Attention: Complex Presentation

Computerized Neuropsych Tests

Attention: Complex Presentation

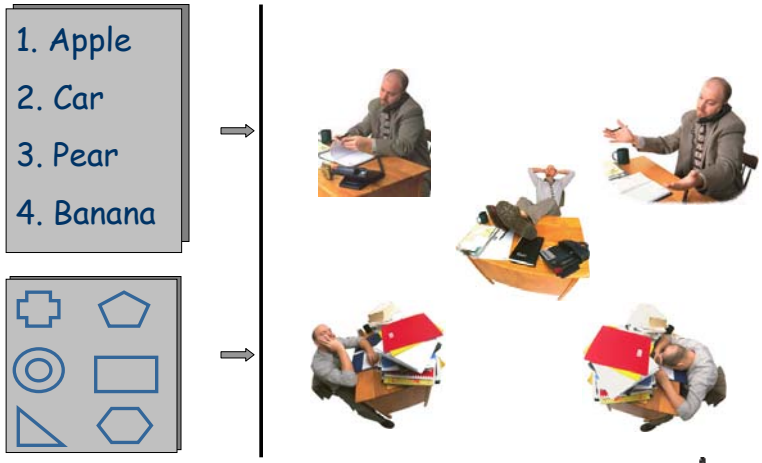
Neuropsychological Tests

Relevance to Real World Functioning

Neuropsychological Tests

Relevance to Real World Functioning

1. Apple
2. Car
3. Pear
4. Banana



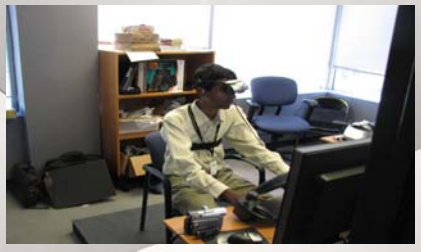
Virtual Iraq

Virtual Iraq: VRET & VRCPAT

The Vision…

- Recycle FSW
- Highly controllable
- Context relevant
- Psychometrically sound
  - Construct Valid
  - Ecologically Valid

Virtual Reality Cognitive Performance Assessment Test *(VRCPAT)*



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Military Relevance

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VRCPAT: Mixed Reality Scenario
(currently being developed)

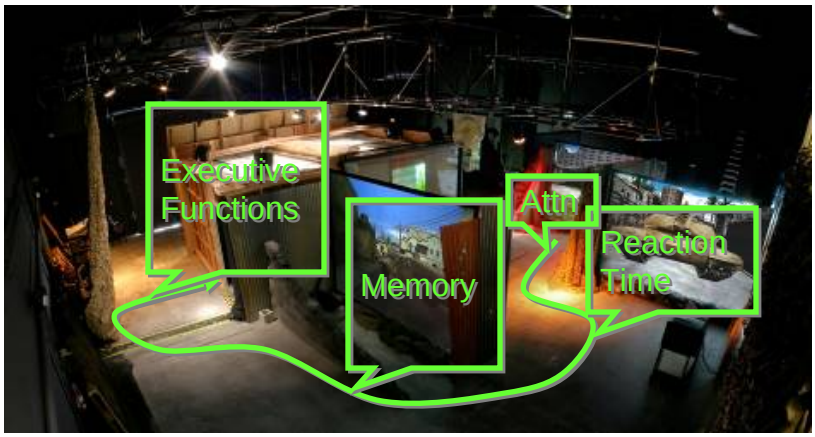
VRCPAT: Mixed Reality

VRCPAT: Mixed Reality

FlatWorld based Urban Terrain Module: Ft. Sill Oklahoma

VRCPAT: Mixed Reality

FlatWorld based VRCPAT



VRCPAT: Mixed Reality

FlatWorld based VRCPAT

VRCPAT: HMD Scenario

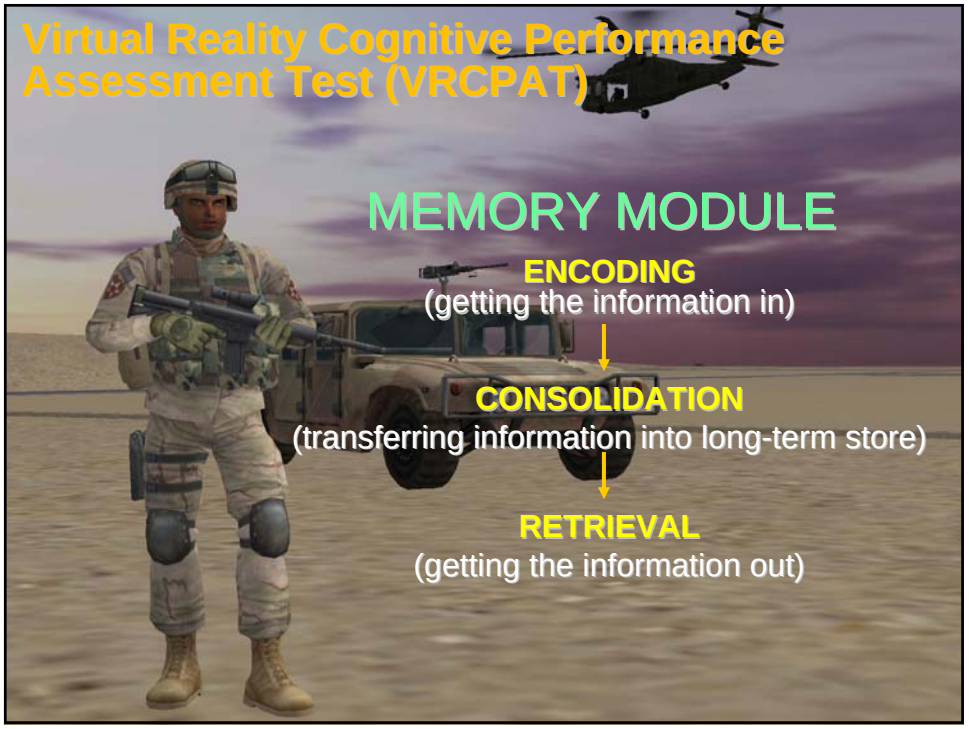
Neurocognitive Domains

Currently assessed:

- Attention
- Learning and Retrieval (Memory)
- Information processing speed

To be developed:

- Language/Verbal Skills
- Executive Function
- Visuospatial perception



Study 1: Memory Module

Parsons, T.D., and Rizzo, A.A. (2008). Initial Validation of a Virtual Environment for Assessment of Memory Functioning: Virtual Reality Cognitive Performance Assessment Test. *Cyberpsychology and Behavior, 11,* 17-25.

Initial Validation of a Virtual Environment for Assessment of Memory Functioning: Virtual Reality Cognitive Performance Assessment Test

ABSTRACT

Study 1: Memory Module

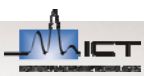
- **Neuropsychological battery**
  - Pencil/paper tests: including Self-reports and Demographics
- **Virtual Reality (VRCPAT)**
  - Learning Phase: Trials 1–3 (Similar to HVLT & BVMT-R)
  - VR Acclimation Phase
  - VRCPAT Immersion Phase
    - Capture images of 10 items (from Acquisition Phase: Trials 1-3)
    - 2 images at each of the 5 Zones
    - Time limit = 1 min. for each Zone
    - Actual immersion is around 15 min.

Study 1: Memory Module

- **Sample:**
  - 70 healthy subjects (50% female)
  - Recruited from undergraduate and graduate schools.
- **Comparable in age, education, ethnicity, sex, self-reported symptoms of depression**
- **Age Range:**
  - 21 to 36 (mean = 24.97, SD = 3.78)
- **Education Range:**
  - 13 to 20 years (mean = 16.13, SD = 1.69)
- **Inclusion/Exclusion Criteria:**
  - Excluded persons with significant psychiatric history
  - Excluded persons with significant neurologic history
- **USC's Institutional Review Board**

Study 1: Memory Module

Learning	***- HVLT Trials 1–3*** ***- BVMT-R Trials 1–3***
Memory	***- HVLT Retention and Recognition*** ***- BVMT-R Retention and Recognition***
Executive Functions	***- TMT B*** ***- Stroop Interference***
Attentional Processing	***- WAIS-III Digit Span Forward*** ***- WAIS-III Digit Span Backward***
Processing Speed	***- TMT A*** ***- Digit Coding***
Verbal Fluency	***- Category Fluency*** ***- Letter Fluency***



Study 1: Memory Module

1. intact wooden barrel with US Army stencil
2. man with blue shirt (white stripes)
3. tanned Caucasian American soldier with moustache
4. camel with an M brand on rear left side
5. large red shipping container numbered 7668
6. sealed wooden crate with Iraqi flag on side corner
7. injured brown and white dog on its side
8. blue car with bullet holes in the windshield
9. sign above door with English words “Internet Homeland”
10. Robed man holding cell phone by graffiti image of Saddam on wall

Study 1: Memory Module

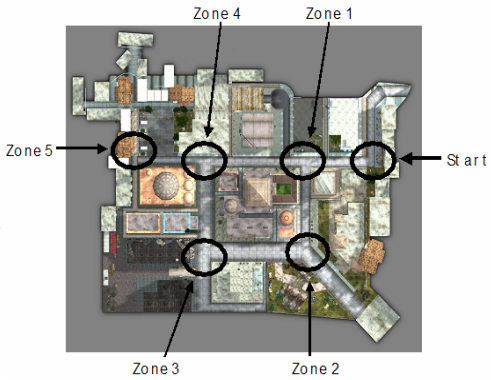
Study 1: Memory Module

- **Demonstrate:**
  - HMD, earphones, and controller
  - Adjust for proper fit
- **Acclimatation:**
  - Participant navigates the Virtual Environment

Once instructions are clear, participant begins scenario

Study 1: Memory Module

- **Capture images of 10 items**
  - from Acquisition Phase
  - Trials 1-3
- **2 targets at each of 5 Zones**



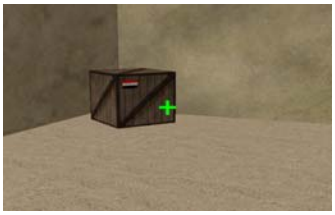
Study 1: Memory Module

Study 1: Memory Module

Zone Targets

Injured brown and white dog on its side

Sealed wooden crate w/ Iraqi flag on side corner



Zone Distractors

Blue car *WITHOUT* bullet holes in the windshield

Man with *RED* (instead of blue) shirt

Convergent Validity

Theory

Neuropsychogical tests (HVLT; BVMT) reflect a memory construct

Memory construct

Verbal Learning | Verbal Memory | Visual Learning | Visual Memory

Observation

VRCPAT & NP Test Correlations	
Learning	
HVLT Trials 1–3	0.58
BVMT-R Trials 1–3	0.75
Memory	
HVLT Retention	0.50
BVMT-R Retention	0.40

the correlations provide evidence that the items all *converge* on the same construct

Discriminant Validity

Theory

Memory Construct

theorize that we have two *distinguishable* constructs

Other Domains

HVLT | BVMT | Exec | Attn | PS | VF

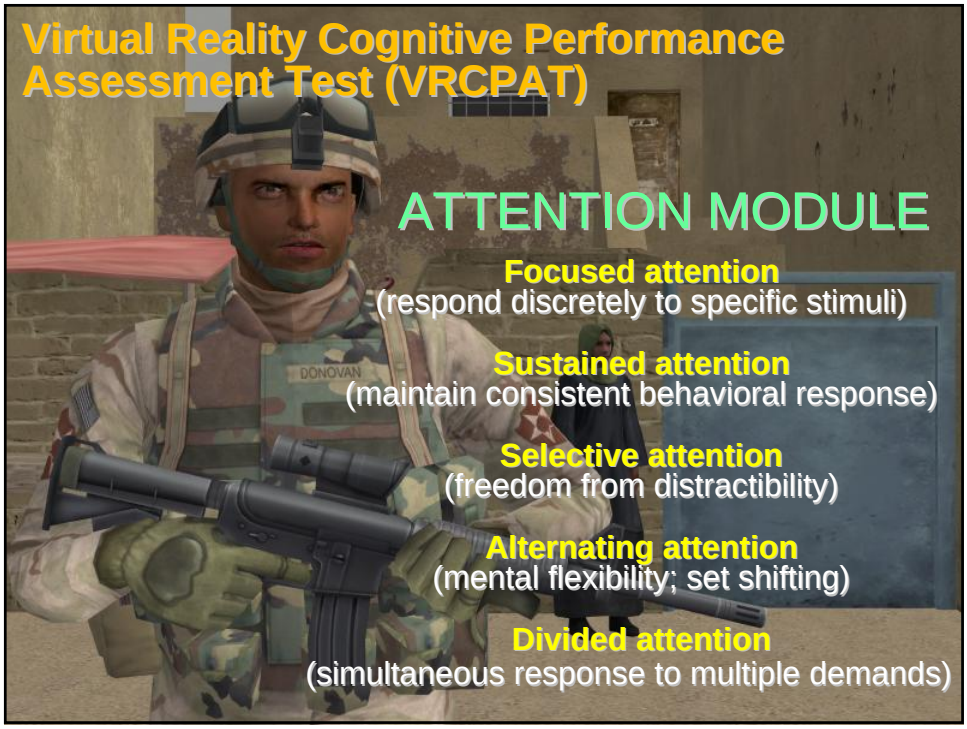
Learning	
HVLT Trials 1–3	0.58
BVMT-R Trials 1–3	0.75
Memory	
HVLT Retention	0.50
BVMT-R Retention	0.40

VRCPAT & NP Test Correlations

Executive Functions	
Trail Making Test: Part B	ns
Stroop Interference	ns
Attention	
Digit Span Forward	ns
Digit Span Backward	ns
Processing Speed	
Trail Making Test: Part A	ns
Digit Symbol Coding	ns
Verbal Fluency	
Animals	ns
Letter Fluency	ns

correlations provide evidence that items *discriminate*

Observation



Attention Module

- **Fixed position in the virtual city test**
  - Requires user to man checkpoint

- **Exploratory Path**
  - well marked to minimize navigational cognitive load

- **Humvee scenario**
  - User will be either driving or riding as a passenger in a simulated Humvee

Fixed Position: Checkpoint

Humvee: Simple (Low Intensity)

Humvee: Simple (High Intensity)

Humvee: Complex (Low Intensity)

Humvee: Complex (High Intensity)

Study 2: Attention Module

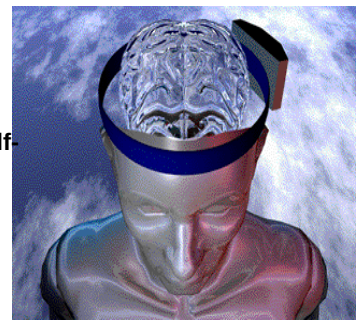
- ***VRCPAT and Traditional NP Tests***

- **Sample:**
  - 16 healthy subjects (50% female)
  - Recruited from undergraduate and graduate schools

- **Comparable in age, education, ethnicity, sex, self-reported symptoms of depression**
  - Age Range: mean = 26.71, SD = 4.49
  - Education Range: mean = 15.50, SD = 2.54

- **Inclusion/Exclusion Criteria:**
  - Excluded persons with significant psychiatric history
  - Excluded persons with significant neurologic history

- **USC's Institutional Review Board**

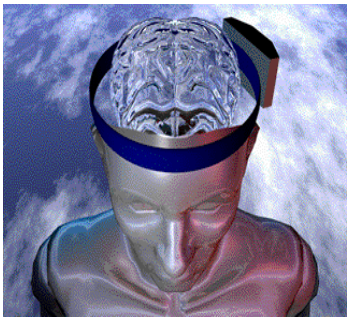


Study 2: Attention Module

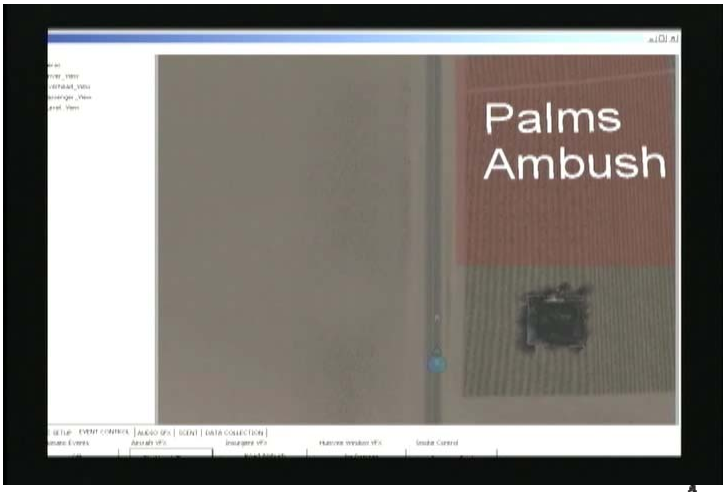
- **Neuropsychological battery**
  - Pencil/paper tests:
  - including Self-reports and Demographics

- **Virtual Reality (VRCPAT)**
  - Attention Modules

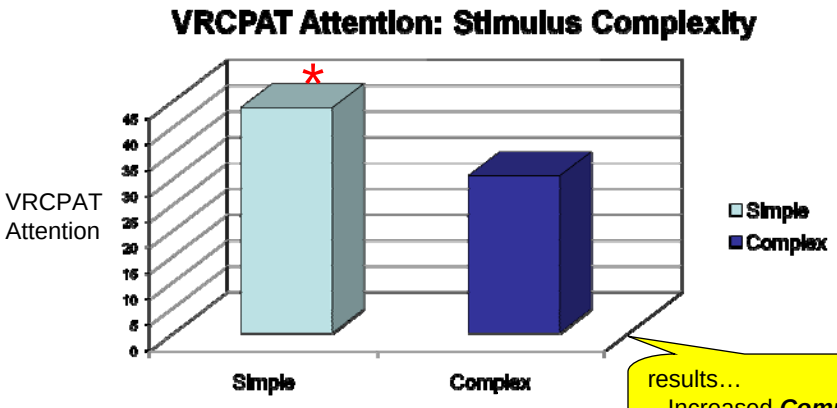
- **Psychophysiological Metrics**
  - EEG, EMG, ECG, respiration, HR, GSR, etc.)



Humvee Scenario



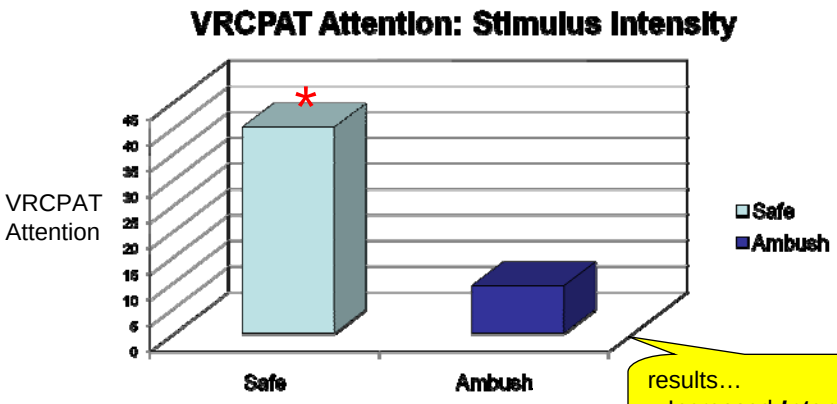
Study 2: Preliminary Results



results…
Increased ***Complexity***
Decreased Attention

* Significant, p<.05.

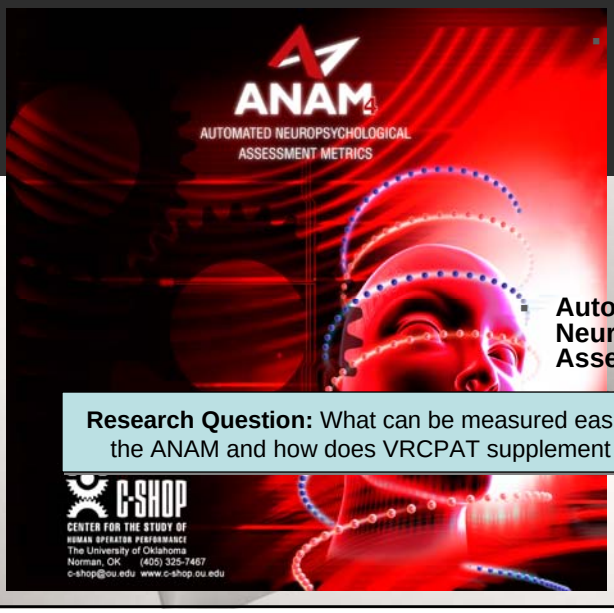
Study 2: Preliminary Results



results…
Increased ***Intensity***
Decreased Attention

* Significant, p<.05.

Collaboration with. . .



University of Oklahoma Center for the Study of Human Operator Performance (C SHOP)

Robert E. Schlegel

Kirby Gilliland

Automated Neuropsychological Assessment Metrics (ANAM)

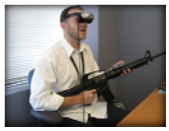
Research Question: What can be measured easily and effectively with the ANAM and how does VRCPAT supplement this measurement?

Multisensory

Neuropsychophysiology

Envirodine Scent System

- **Gunpowder**
- **Cordite**
- **Body Odor**
- **Garbage**
- **Burning Rubber**
- **Diesel Fuel**
- **Iraqi Spices**

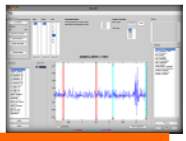


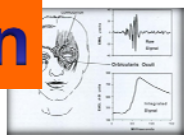
Bass Shaker Platform

Immersion

And Night Vision HMD Rig…

Biopac System





Study 3: Immersion

Do High Immersion experiences impact people more than Low Immersion experiences

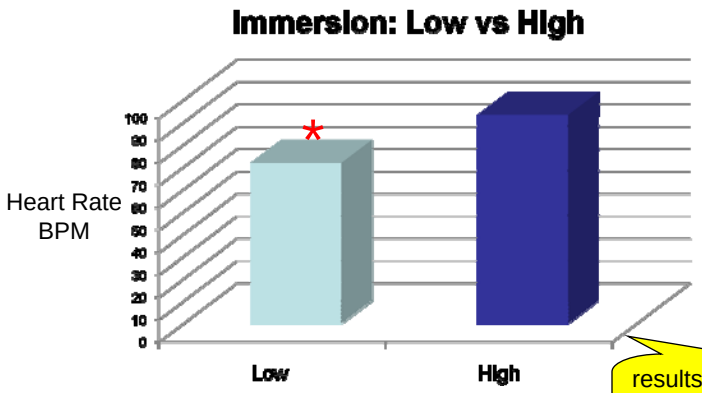
- **Startle Eye-Blink**
  - Measures: Negativity Emotional State
- **Heart Rate**
  - Measures: Intensity of Emotional State
- **High Immersion, to justify its costs, should impact Emotional State**
  - ↑ **Startle Eye-Blink**
  - ↑ **Heart Rate**

Study 3: Preliminary Results

results…
Higher Immersion,
More Negative Response

* Significant, p<.05.

Study 3: Preliminary Results



results…
Higher Immersion,
Stronger Emotional State

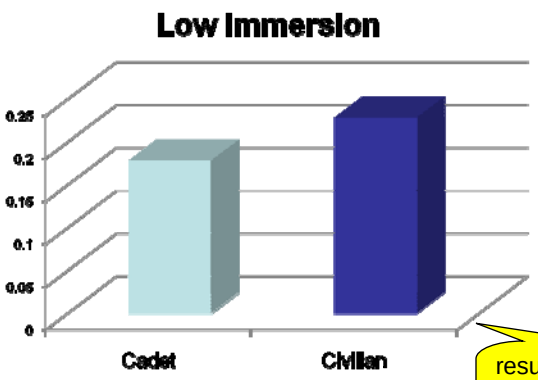
* Significant, p<.05.

Study 4: Immersion: Cadets

Vs.

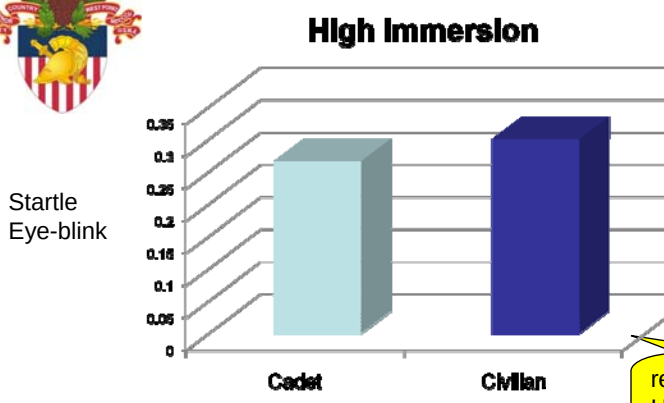
Study 4: Preliminary Results

Startle
Eye-blink



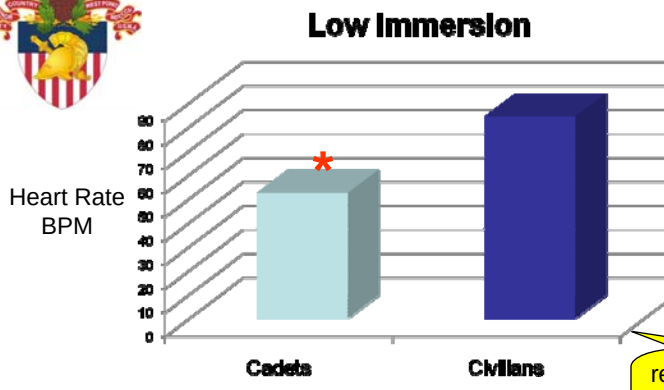
results…
Low Immersion
Cadet less negative (ns)

Study 4: Preliminary Results



results…
High Immersion
Cadets same as civilians

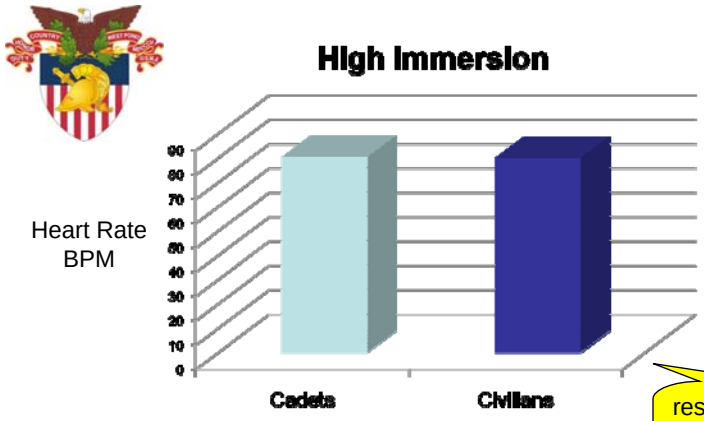
Study 4: Preliminary Results



results…
Low Immersion
Cadets less intense

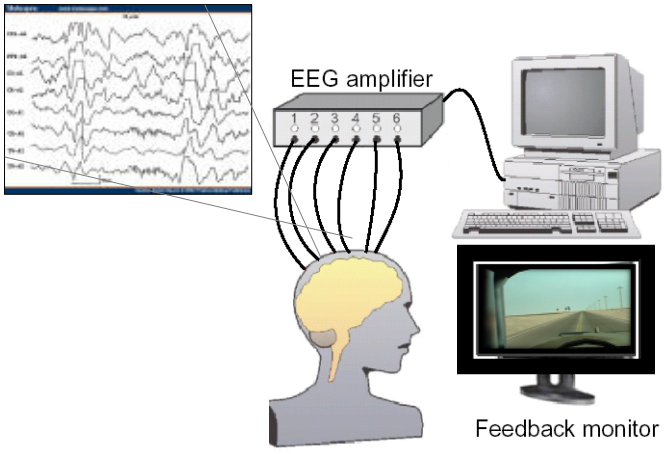
* Significant, p<.05.

Study 4: Preliminary Results



results…
High Immersion
Cadets same as civilians

Future Work: Intelligent Feedback System



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