

Cognitive Rehabilitation and TBI

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Overview

- What is Cognition?
- Treatment of Cognitive dysfunction
 - Learning and memory
- Can treatment be Effective?

“It is much more important to know what sort of a patient has a disease than what sort of a disease a patient has.”

William Osler
(1849- 1919)

What is Cognition?

Dictionary:

“the act or process of knowing”

What is Cognition?

- Receptive Functions
 - Sensory input, paying attention, rapid processing incoming information
- Learning and Memory
 - Acquiring, storing, retrieving
- Thinking
 - Mental organization and manipulation
- Execution and expressive functions
 - Acting upon and communicating intentions

Cognitive Deficits in TBI

- processing speed/understanding information
 - Slowness of thought
- Attention and Concentration
- Learning and memory of new Information
- Planning, organization, initiation of action
- Reasoning, problem solving, judgment
- Language and communication
- Spatial disorientation (problems with perception, direction)
- Difficulties recognizing own cognitive deficits/limits
- Inappropriate, embarrassing or impulsive behavior

Functional Outcomes from Inpatient Rehabilitation after Traumatic Brain Injury: How do Hispanics Fare?

Juan Carlos Arango-Lasprilla, Ph.D.

Mitchell Rosenthal, Ph.D.

John DeLuca, Ph.D.

David Cifu, M.D.

Robin Hanks, Ph.D.

Eugene Komaroff, Ph.D.

Archives of Physical Medicine and Rehabilitation,
2007, 88, 11-18

Functional Outcomes from Inpatient Rehabilitation after Traumatic Brain Injury: How do Hispanics Fare?

- Examine rehabilitation outcome in Hispanic vs Caucasian TBI survivors
- Longitudinal data of the TBI Model Systems database
- 3056 persons with TBI
 - 2745 Caucasian
 - 311 Hispanic
- Outcome from rehabilitation at
 - Admission
 - Discharge
 - 1-yr follow-up

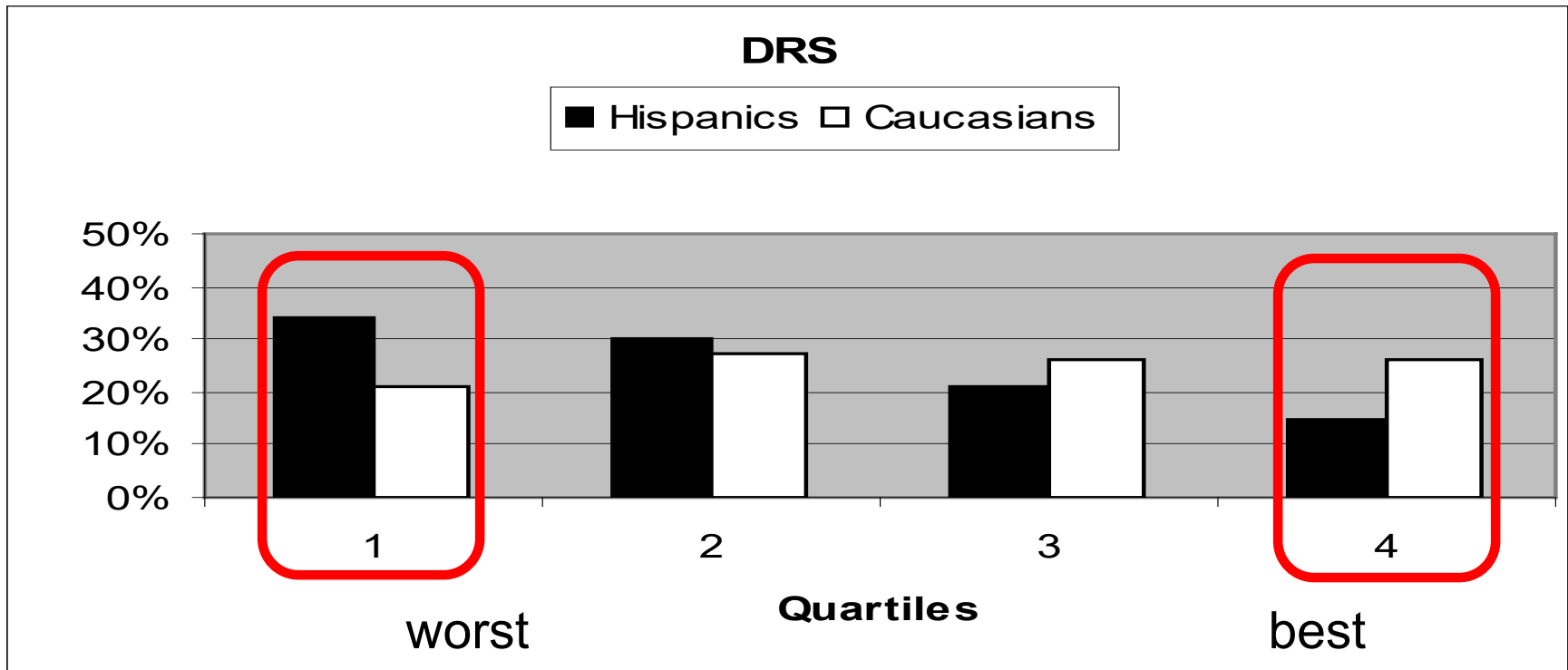
Functional Independence Measure (FIM)

	Hispanics	whites	p
Admission	54.0 \pm 24.8	54.5 \pm 26.3	ns
Discharge	95.1 \pm 22.5	96.2 \pm 23.4	ns
1-yr follow-up	113.2 \pm 17.1	116.4 \pm 18.5	< .001

Disability Rating Scale

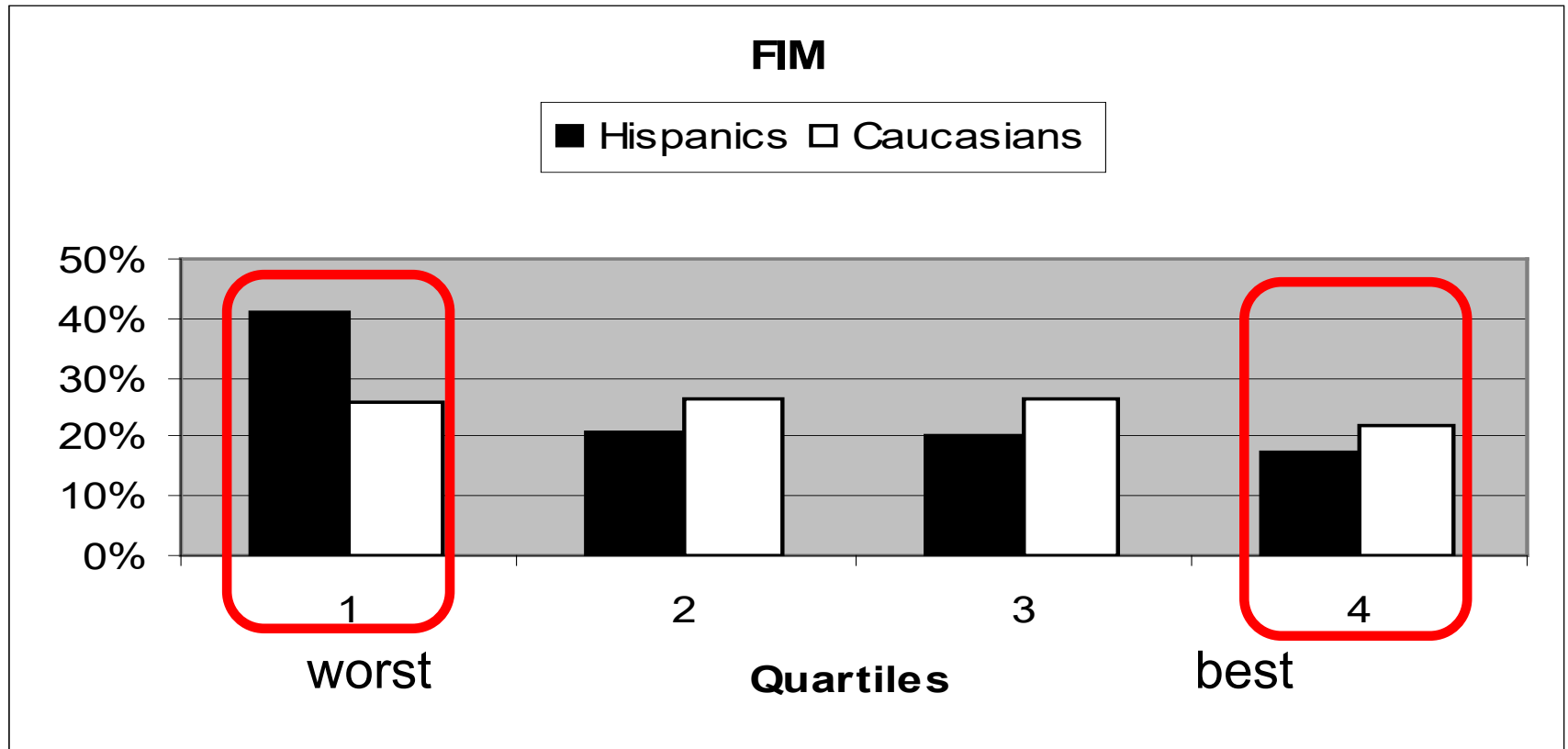
	Hispanics	whites	p
Admission	12.7 \pm 5.3	12.3 \pm 5.8	ns
Discharge	6.1 \pm 4.0	6.0 \pm 4.0	ns
1-yr follow-up	3.5 \pm 3.6	2.4 \pm 3.4	< .001

Disability Rating Scale (DRS) 1 year post Injury



Odds ratio = 2.79

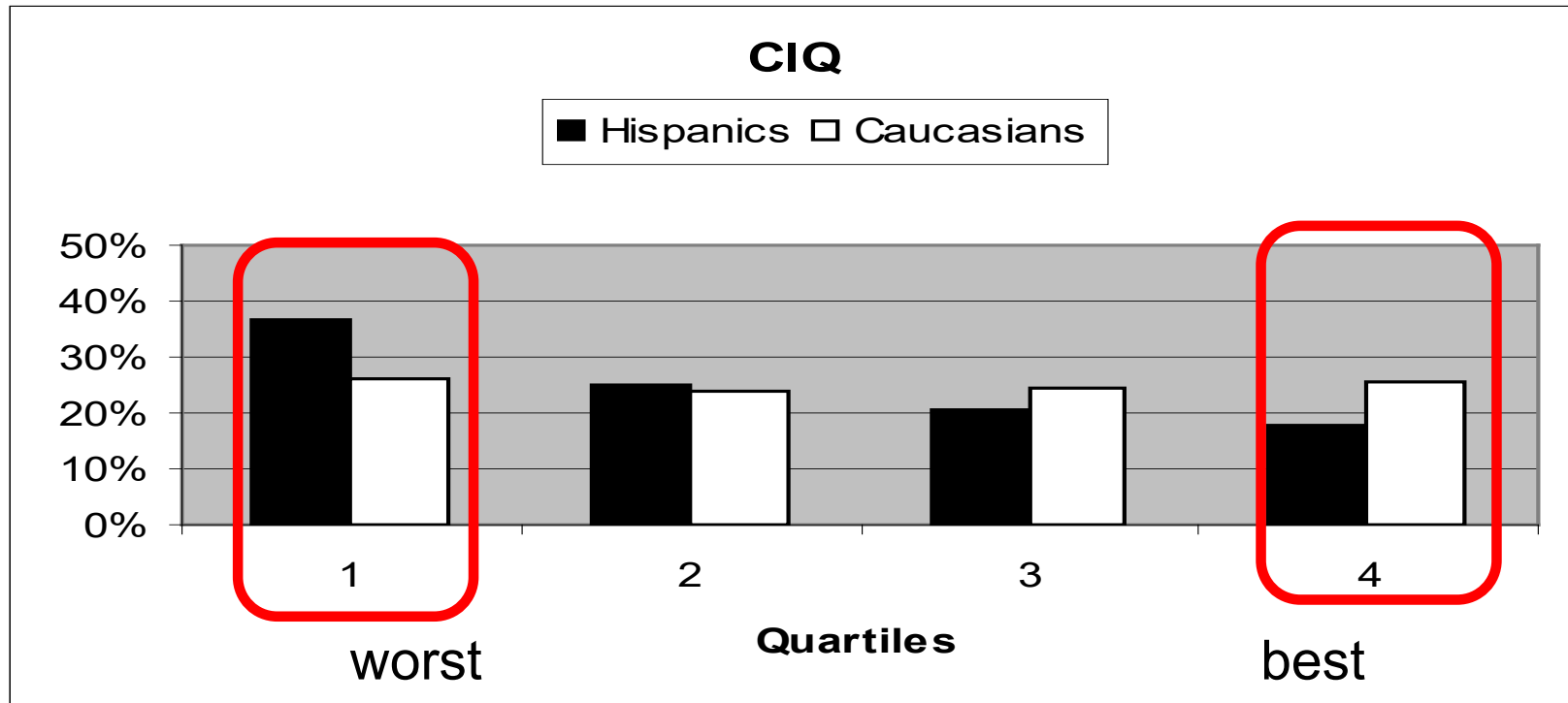
Functional Independence Measure (FIM) 1 year post Injury



Odds ratio = 2.98

Arango et al., 2007

Community Integration Questionnaire (CIQ) 1 year post Injury



Odds ratio = 2.92

Functional Outcomes from Inpatient Rehabilitation after Traumatic Brain Injury: How do Hispanics Fare?

- Largest multicenter longitudinal study on ethnicity and functional outcome in TBI
- No differences at admission and discharge to rehabilitation
- 1 year post discharge, Hispanics were roughly **2.5 times more likely** than Caucasians to have worse outcome across all outcome measures
- Understanding variables which lead to worse long –term outcome in Hispanics is needed

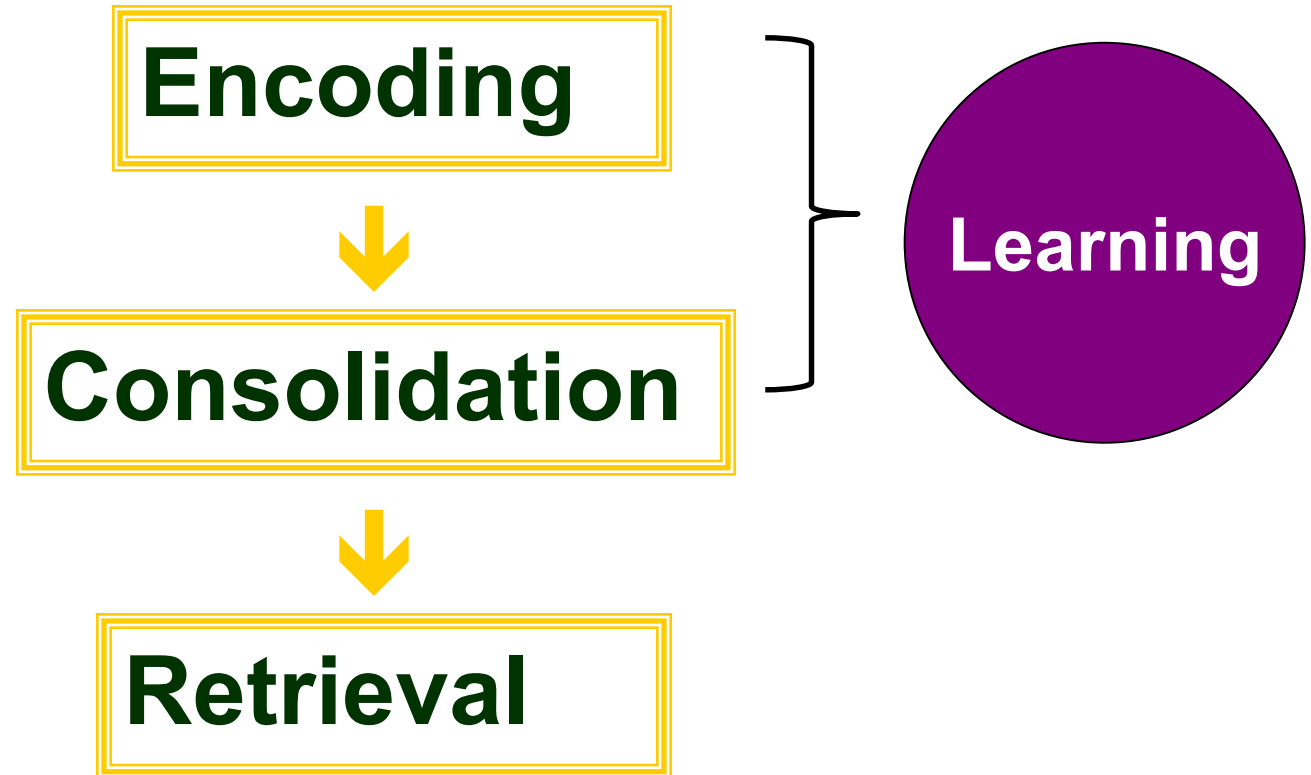
Overview

- What is Cognition?
- **Treatment of Cognitive dysfunction**
 - Learning and memory
- Can treatment be Effective?

Defining Learning

- Learning - “The *process* of acquiring new information”
- Memory - “The *persistence* of learning in a state that can be revealed at a later time”

Learning and Memory Process



Identifying the Cause

- Retrieval failure hypothesis ?
- Acquisition deficits?

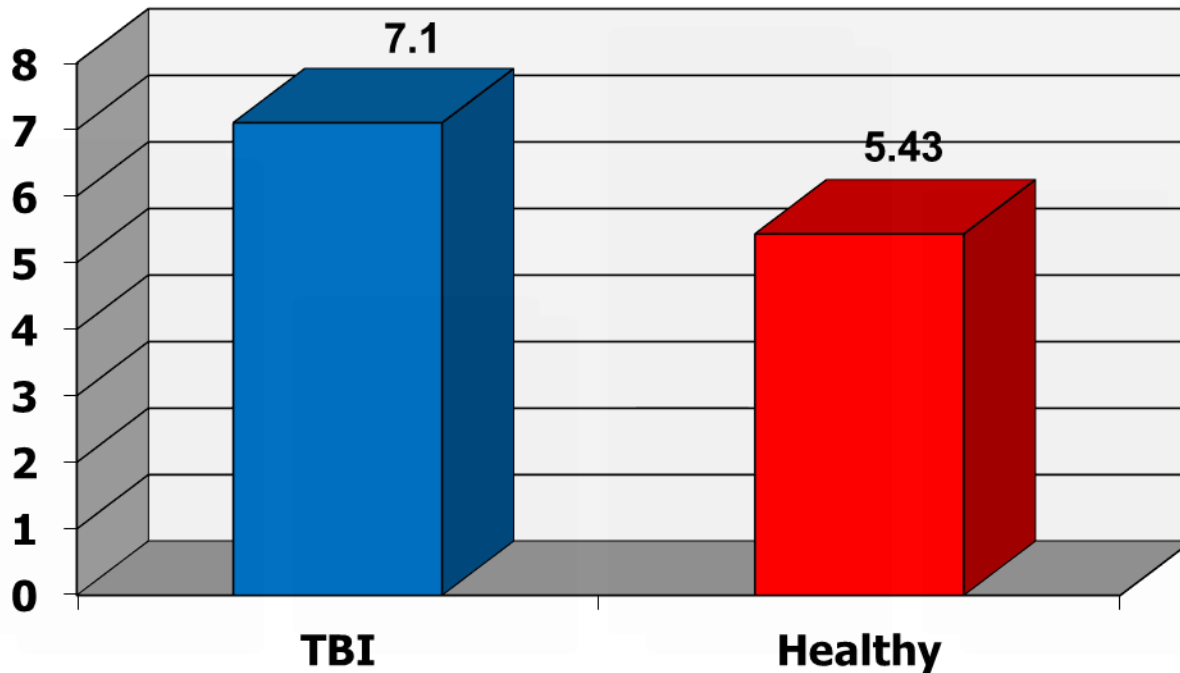
Acquisition Versus Retrieval Deficits in Traumatic Brain Injury: Implications for Memory Rehabilitation

John DeLuca, PhD, Maria T. Schultheis, PhD, Nancy K. Madigan, PhD, Christopher Christodoulou, PhD, Allison Averill, MD

- 10 words - Selective Reminding
- S's trained to learning criterion
 - all words recalled on 2 consecutive trials
- S's examined on
 - Trials to reach criterion
 - Recall
 - Recognition

Mean Trials to Criterion

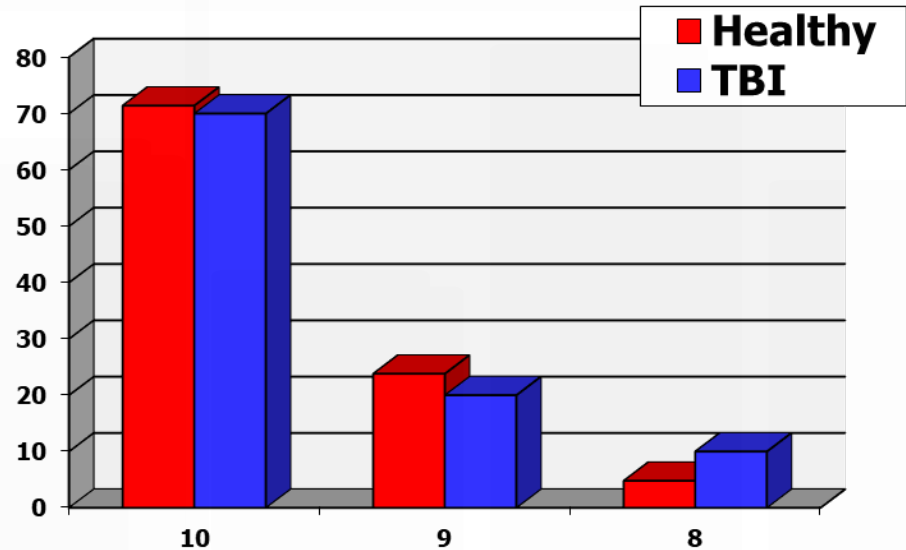
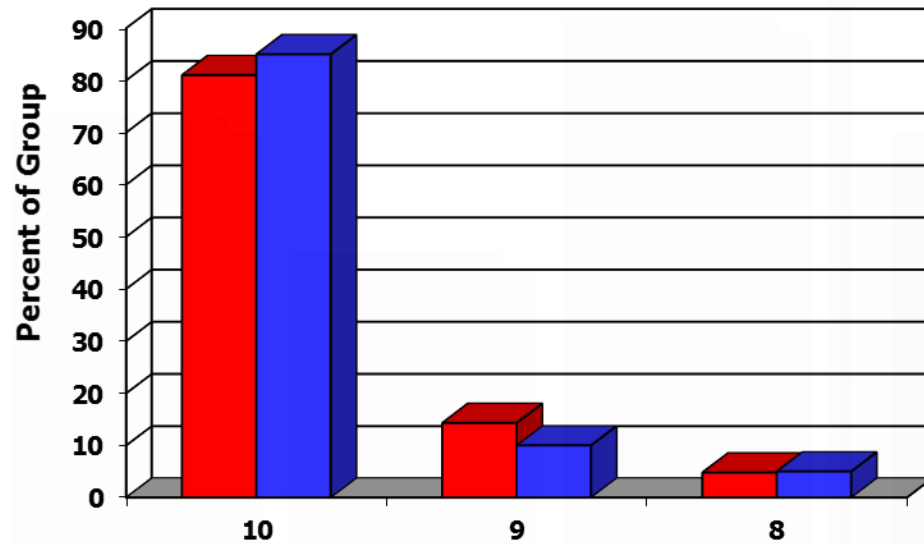
Open-Trial SRT



Recall Performance in TBI

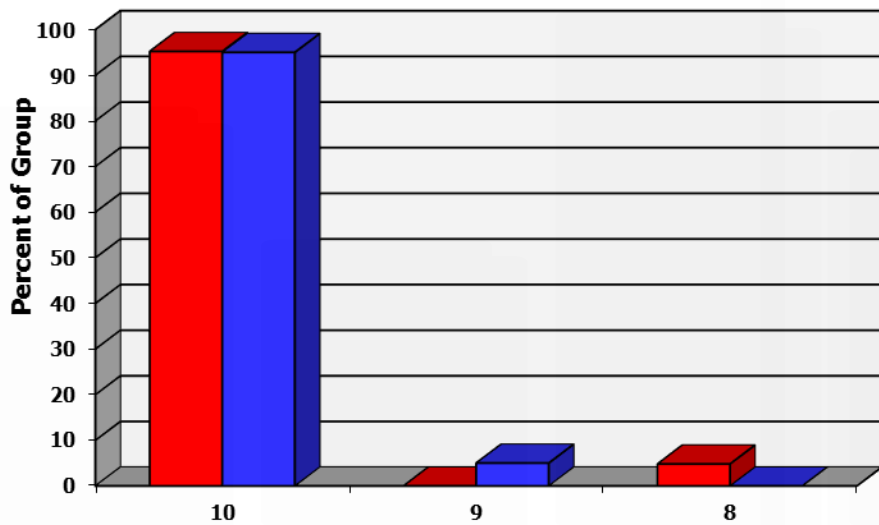
30' recall

90' recall

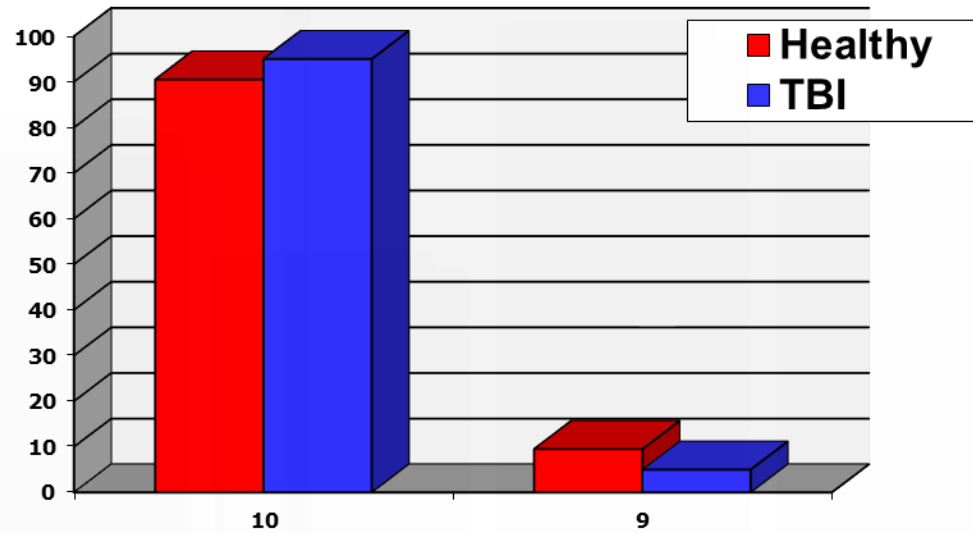


Recognition Performance in TBI

30' recall

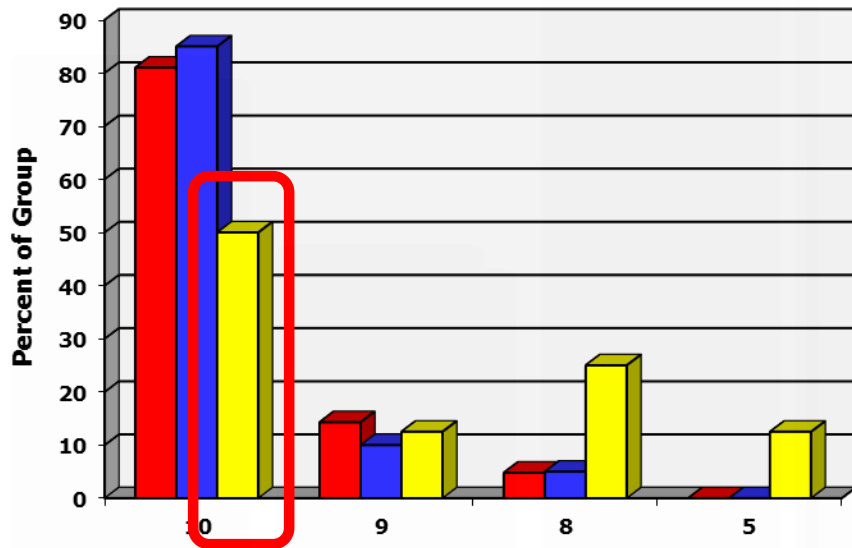


90' recall

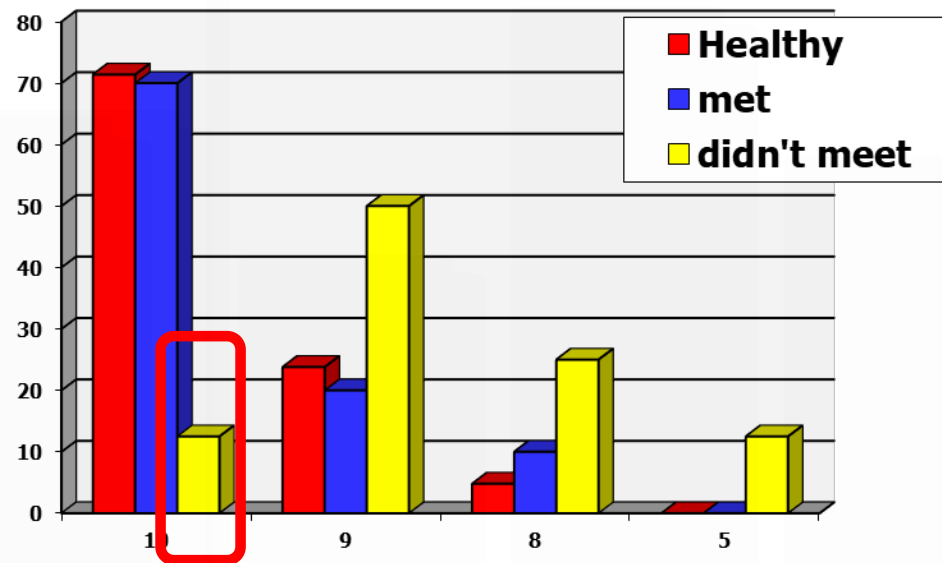


Recall in TBI who met and didn't meet criterion

30' recall



90' recall



Cognitive Performance in TBI Learners and non-Learners

	Learner	Non-learner	p-value	Cohen's d
PS composite	7.1 (3.3)	4.5 (2.3)	.01	.79
WM composite	9.7 (2.3)	7.7 (1.8)	.01	.97
EF composite	8.5 (2.9)	5.8 (3.0)	.01	.92
Verbal comp	10.0 (2.5)	7.8 (2.9)	.01	.81
Percep comp	9.6 (3.0)	8.5 (3.1)	ns	.36

No group differences in Anxiety or depression

Mean Standard score + SD

Overview

- What is Cognition?
- Treatment of Cognitive dysfunction
 - Learning and memory
- Can treatment be Effective?

Evidence-Based Cognitive Rehabilitation: Updated Review of the Literature From 2003 Through 2008

Keith D. Cicerone, PhD, Donna M. Langenbahn, PhD, Cynthia Braden, MA, CCC-SLP, James F. Malec, PhD, Kathleen Kalmar, PhD, Michael Fraas, PhD, Thomas Felicetti, PhD, Linda Laatsch, PhD, J. Preston Harley, PhD, Thomas Bergquist, PhD, Joanne Azulay, PhD, Joshua Cantor, PhD, Teresa Ashman, PhD

Substantial evidence to support interventions for:

- Attention
- Memory
- Social communication skills
- Executive functions
- Comprehensive-holistic neuropsychological rehabilitation program

“There is now sufficient information to support evidence-based protocols and implement empirically-supported treatments for cognitive disability after TBI and stroke”

Cognitive Rehabilitation

Sample RCT results

An RCT to Treat Learning Impairment in Traumatic Brain Injury: The TBI-MEM Trial

Neurorehabilitation and
Neural Repair
2016, Vol. 30(6) 539–550
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DOI: 10.1177/1545968315604395
nrr.sagepub.com



Nancy D. Chiaravalloti, PhD^{1,2}, Joshua Sandry, PhD^{1,2},
Nancy B. Moore, MA¹, and John DeLuca, PhD^{1,2}

69 Mod-severe TBI randomized to Tx vs Placebo

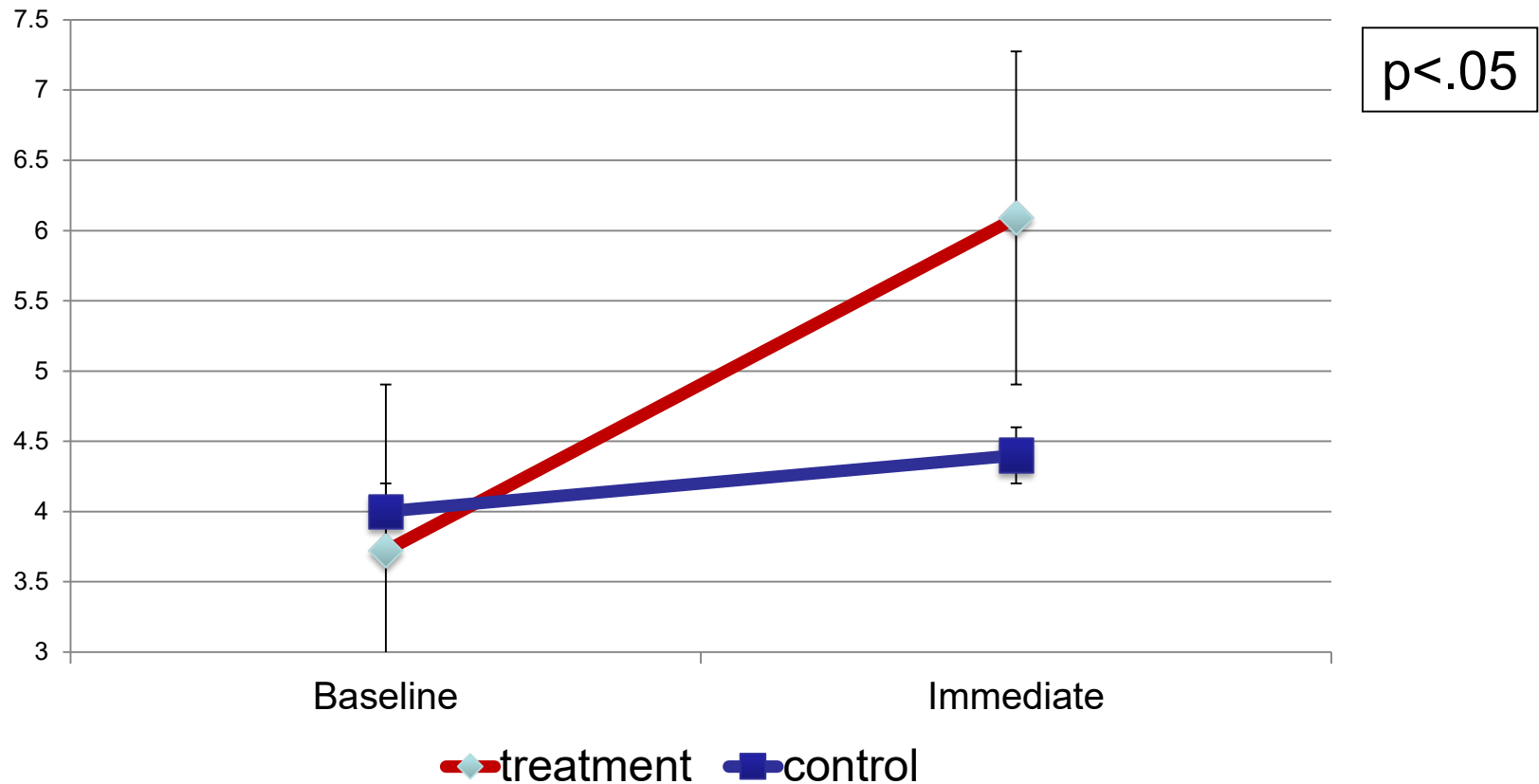
Context and imagery

Classification of Evidence: This study provides **Class I evidence** that the modified Story Memory Technique© behavioral intervention improves both objective memory and everyday memory in persons with TBI over 5 weeks

Modified Story Memory Technique

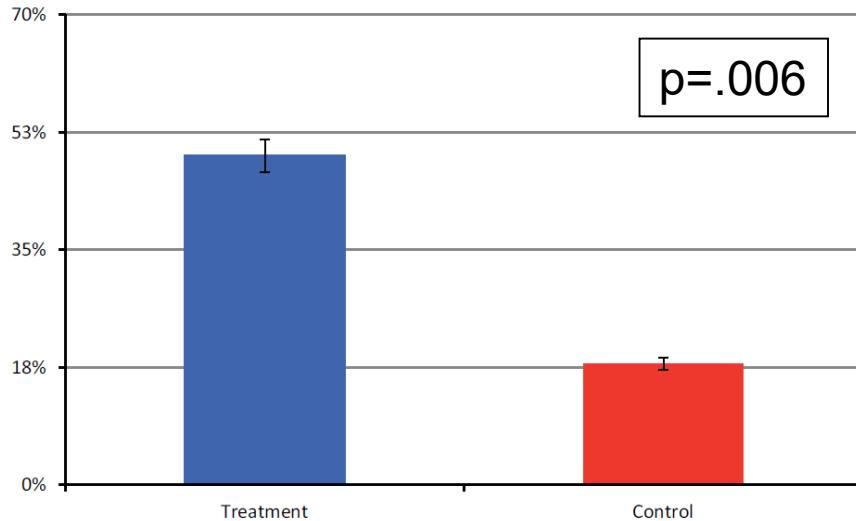
- Double-blind, placebo-controlled RCT
- 10 sessions
 - 2x per week for 5 weeks
 - 45-60 minutes in duration
- Two skills taught
 - Imagery (sessions 1-4)
 - Context (sessions 5-8)
- Generalization
 - How you use skills in daily life (sessions 9 and 10)

MAS Prose Memory Delayed Recall: pre to post treatment

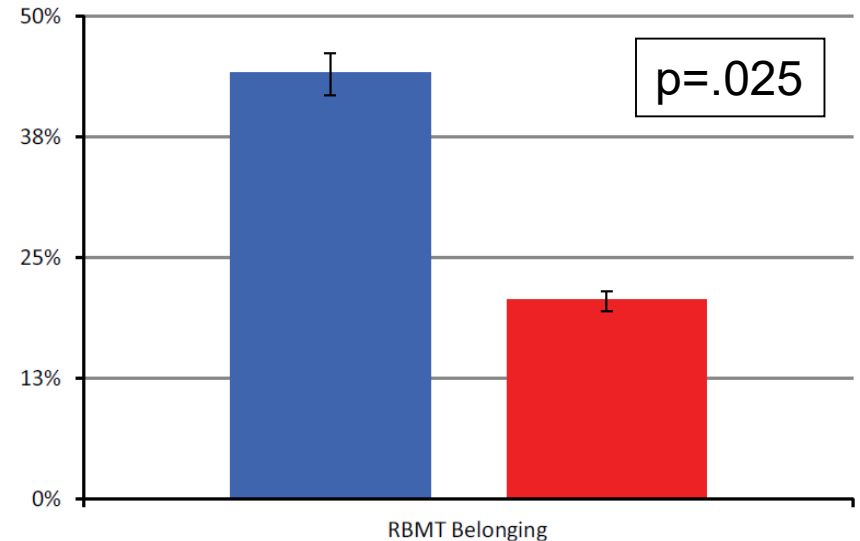


Improvement on mSMT in TBI

% pre-post improvement in Prose Recall



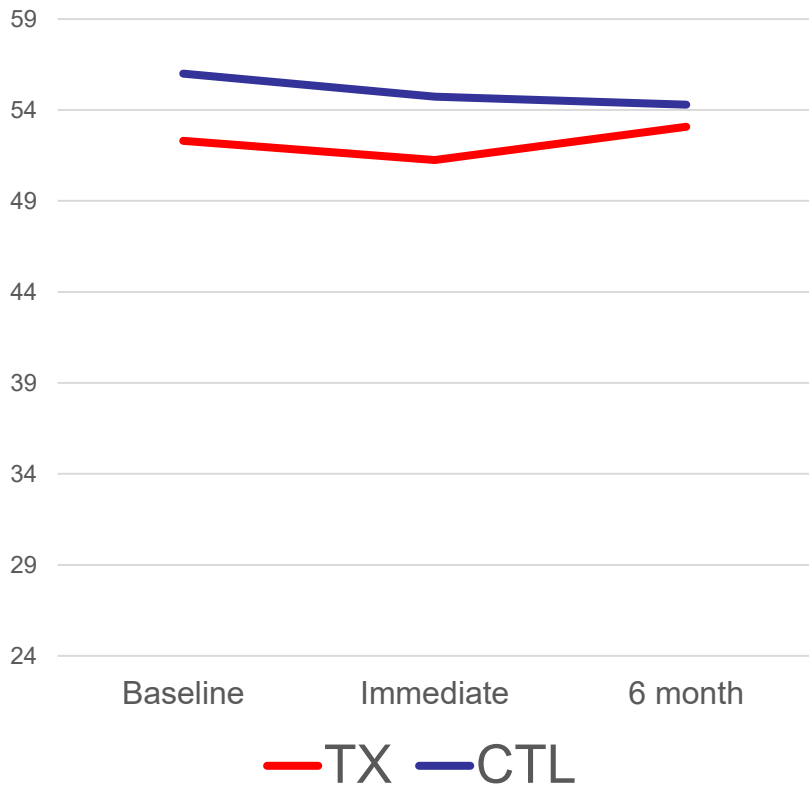
% improving on RBMT – post tx



■ TREATMENT
■ CONTROL

Depression and Anxiety

CMDI: T-score



STAI: T-score

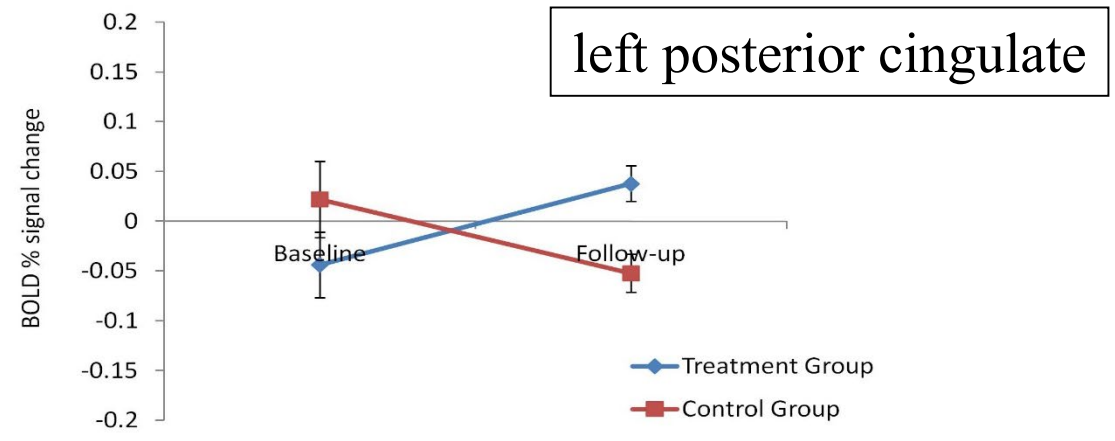
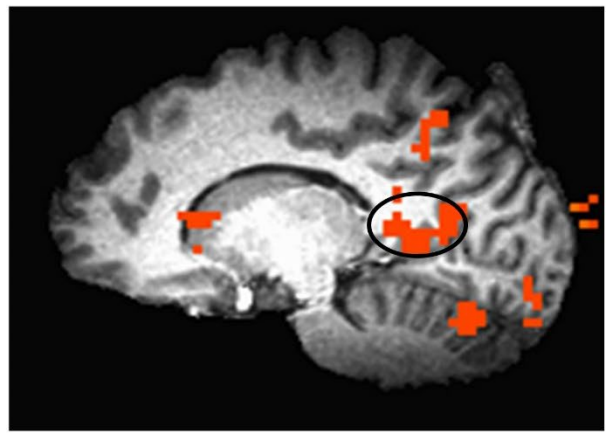


Examining the Efficacy of the Modified Story Memory Technique (mSMT) in Persons With TBI Using Functional Magnetic Resonance Imaging (fMRI): The TBI-MEM Trial

*Nancy D. Chiaravalloti, PhD; Ekaterina Dobryakova, PhD; Glenn R. Wylie, DPhil;
John DeLuca, PhD, ABPP*

Figure 1. BOLD % signal change
Posterior insula and cerebellum also showed increased activation in TX vs placebo

A.



B.

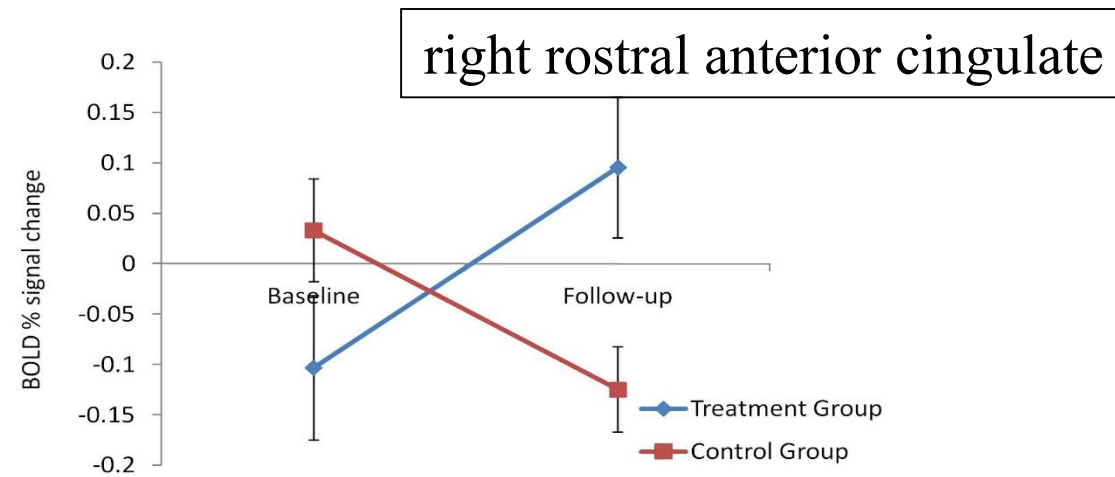
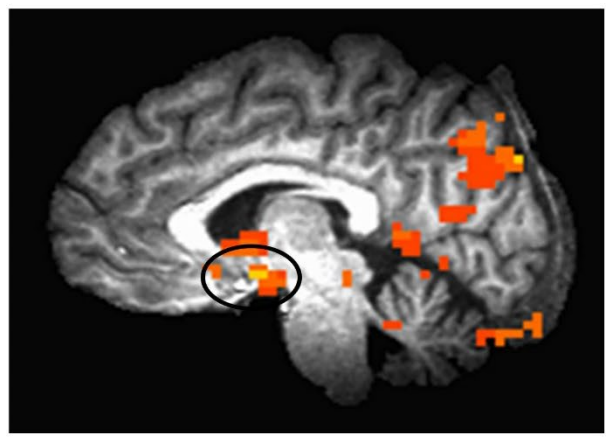
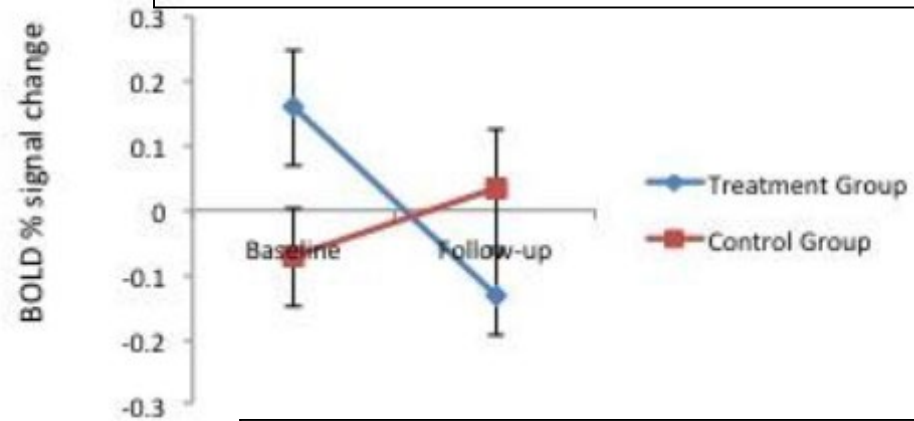
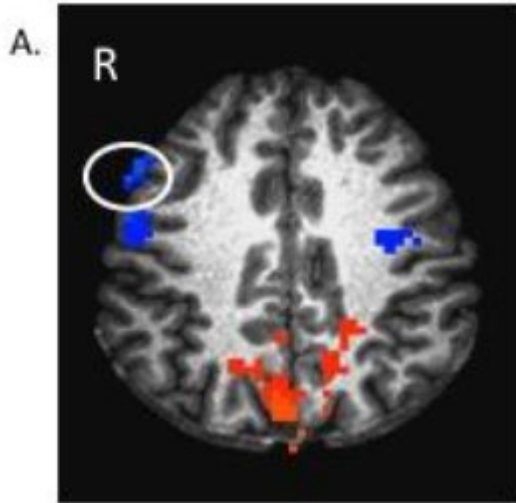
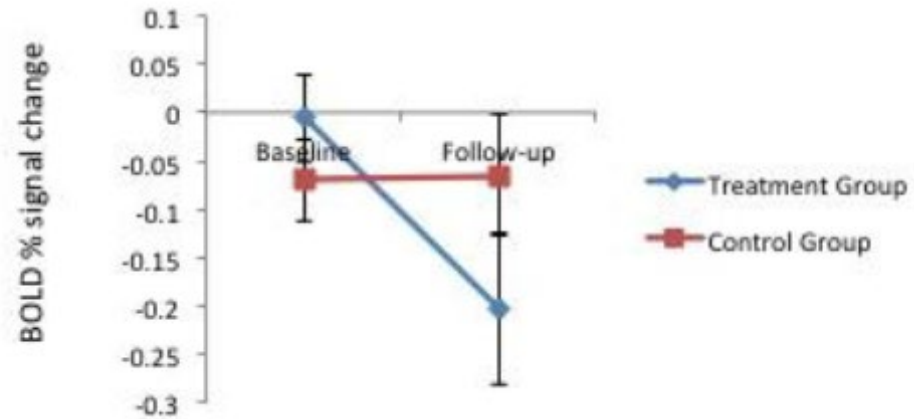
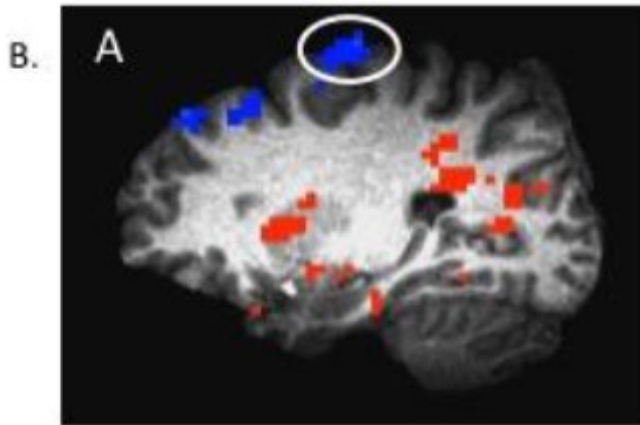


Figure 1. Areas of **decreased** BOLD % signal change

right dorsolateral prefrontal cortex



supplementary motor area



Overview

- What is Cognition?
- Treatment of Cognitive dysfunction
 - Learning and memory
- **Can treatment be Effective?**
 - Techniques to improve learning

Pilot Study to Examine the Use of Self-Generation to Improve Learning and Memory in People With Traumatic Brain Injury

Yael Goverover, Nancy Chiaravalloti, John DeLuca

- The generation effect is:
 - items generated by subjects are remembered better than items presented
- Robust effect in Healthy subjects
- Little work in Clinical samples

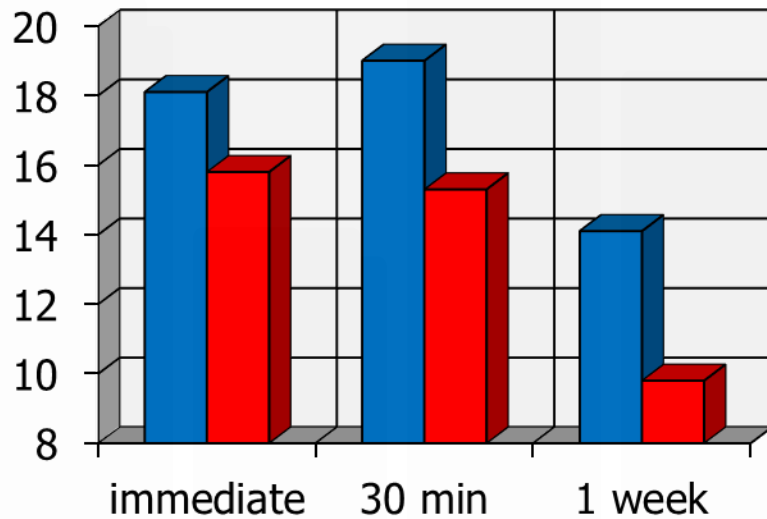
Everyday Life Tasks

- Participants were asked to complete two tasks:
- **Food Preparation**
- **Financial management**
- **Within-group design**

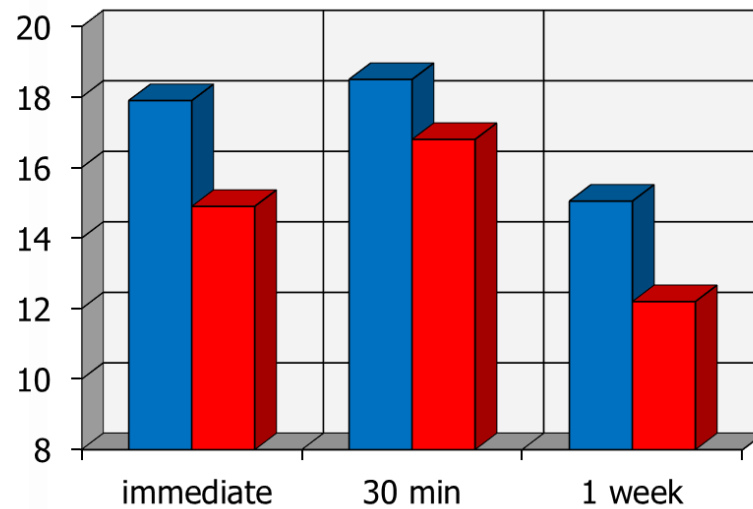


Self-Generation and Everyday Life Activities in TBI

Food Preparation



Managing Finances



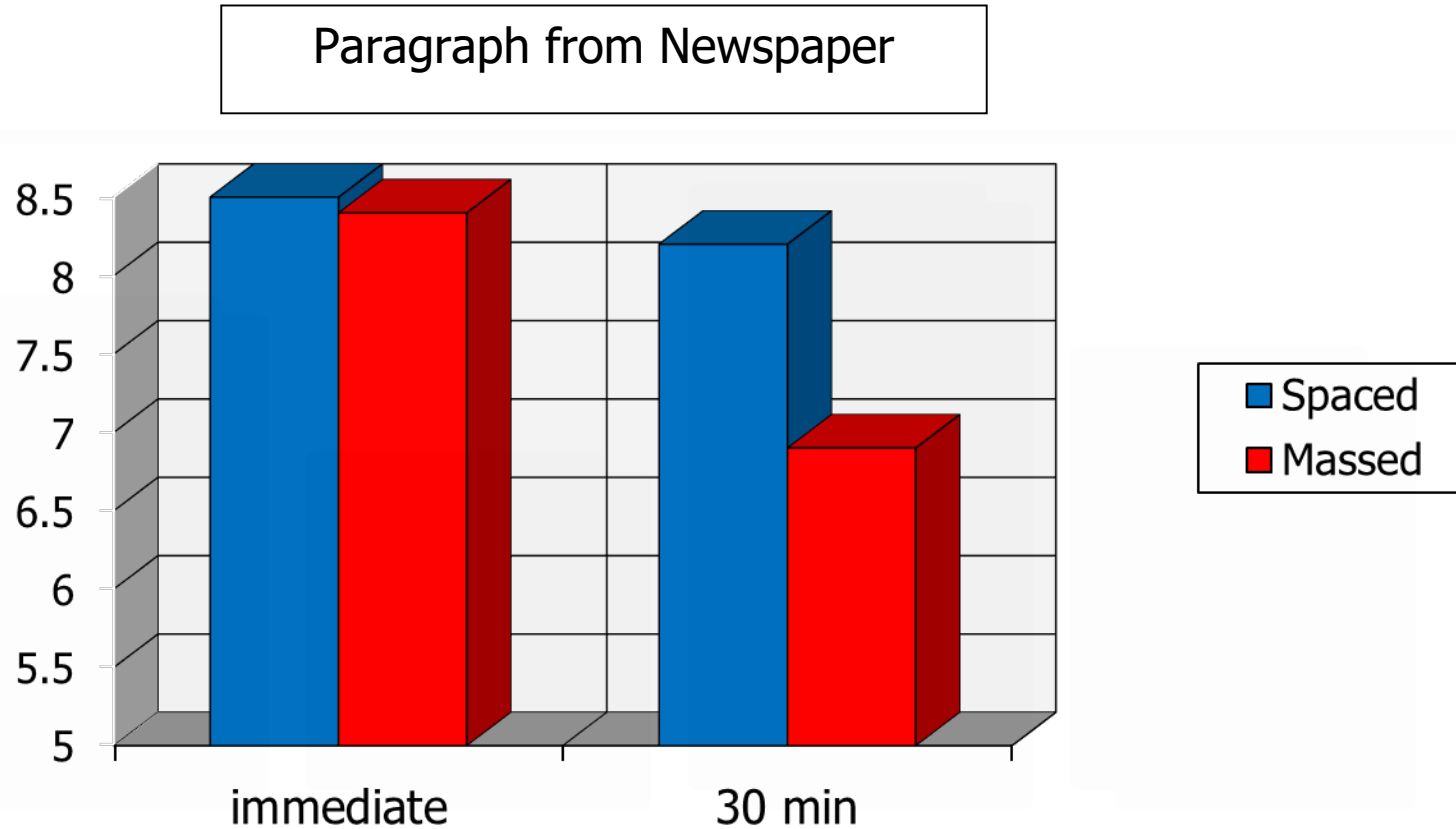
■ Generated
■ Provided

Spaced Learning or “Spacing Effect”

- Is learning better if trials are **spaced** vs massed?
- Instructions on how to perform tasks were presented three times in two conditions:
 - Massed condition 1/2/3
 - Spaced condition 1_____2_____3
 - Within-group design

Application of the Spacing Effect to Improve Learning and Memory for Functional Tasks in Traumatic Brain Injury: A Pilot Study

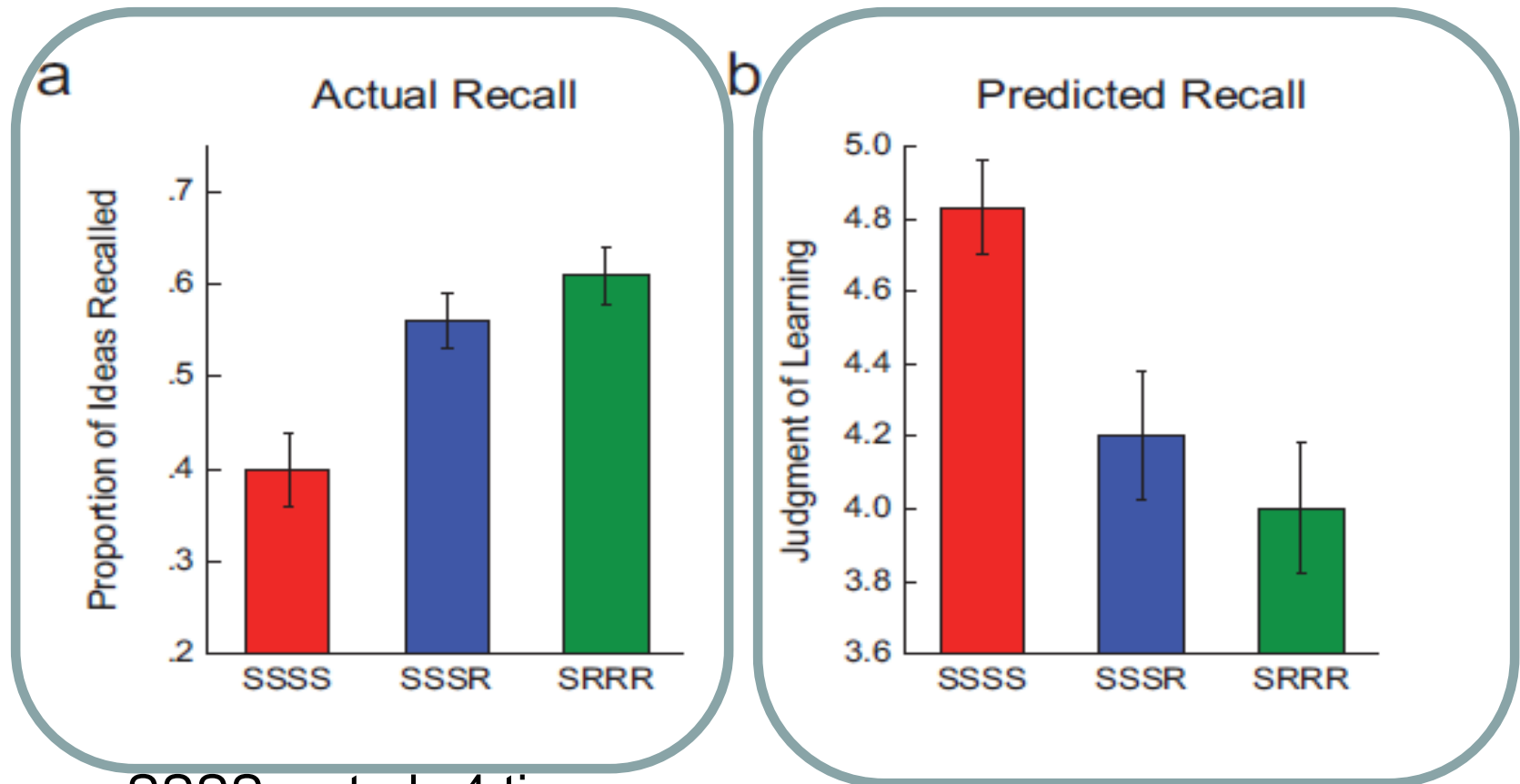
Yael Goverover, Juan Carlos Arango-Lasprilla, Frank G. Hillary,
Nancy Chiaravalloti, John DeLuca



Retrieval practice or “Testing Effect”

- **Which do you prefer for new learning**
 - 4 opportunities to learn something
 - 1 opportunity then tested 3 times

Active Retrieval during Learning enhances deep and conceptual encoding



SSSS – study 4 times

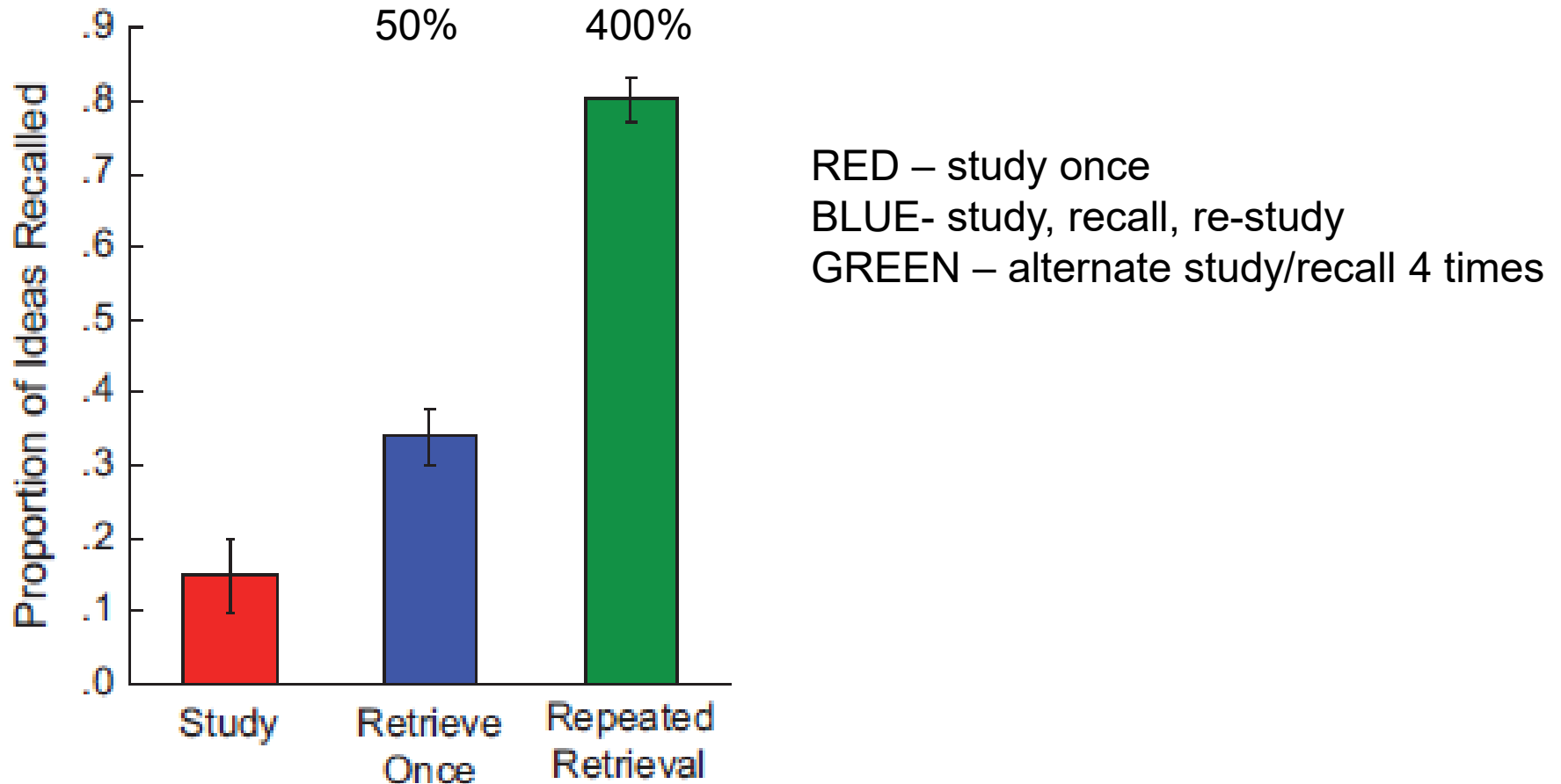
SSSR – study 3 times then recall once

SRRR – study 1 time then recall 3 times

Reading educational texts

Active Retrieval during Learning enhances deep and conceptual encoding

One week recall



Journal of the International Neuropsychological Society (2010), **16**, 1147–1150.
Copyright © INS. Published by Cambridge University Press, 2010.
doi:10.1017/S1355617710001128

BRIEF COMMUNICATION

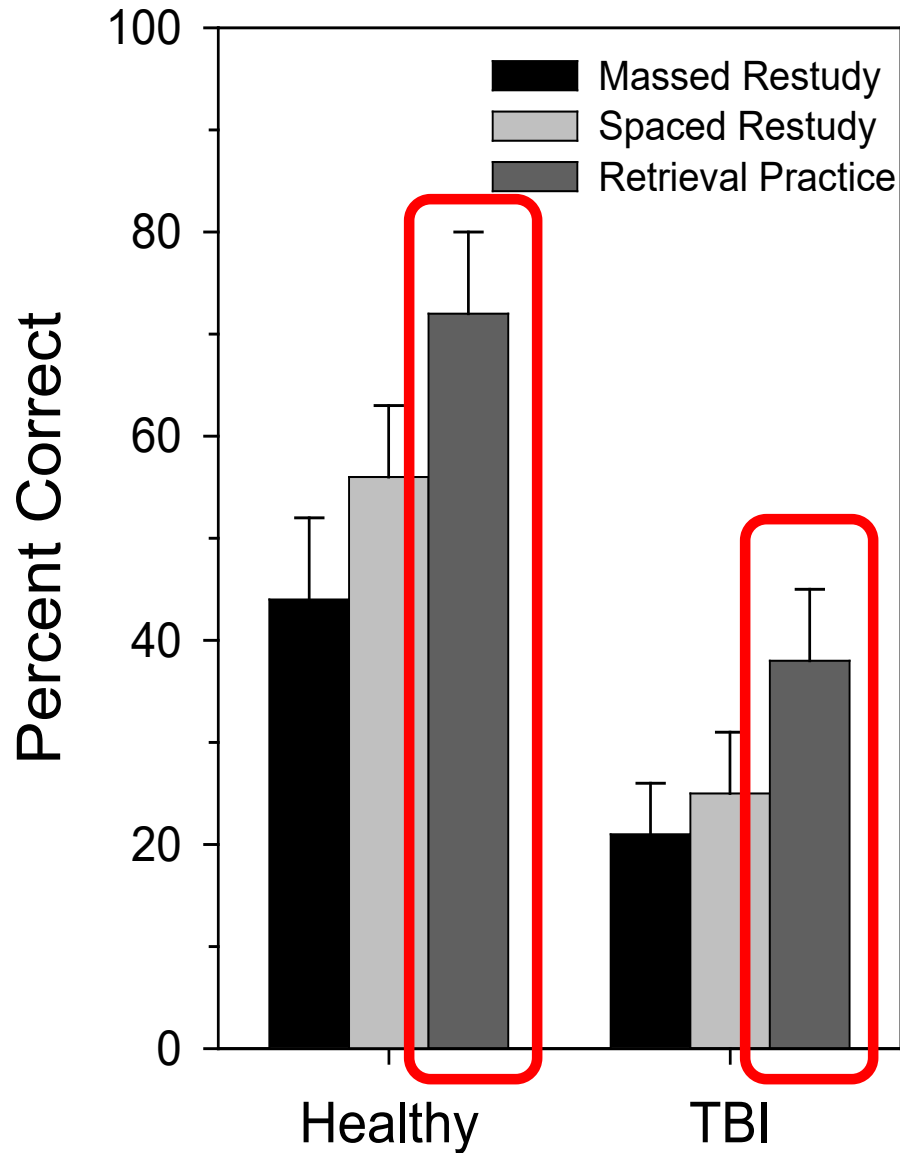
**Retrieval practice: A simple strategy for improving memory
after traumatic brain injury**

JAMES F. SUMOWSKI,^{1,2} HALI G. WOOD,¹ NANCY CHIARAVALLI,^{1,2} GLENN R. WYLIE,^{1,2}
JEANNIE LENGENFELDER,^{1,2} AND JOHN DELUCA^{1,2,3}

Testing Effect Demographics

	TBI	HC
	14	14
Age	38.4 \pm 12.6	44.9 \pm 12.1
Mdn age at TBI	26.4	
Mdn duration coma (days)	45.5	
Mdn verbal memory (CVLT)	1 st %ile	50 th %ile

Testing Effect in TBI



Large effect size of Retrieval practice

Retrieval practice was best learning strategy
In 93% of TBI S's



Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95:397-400



BRIEF REPORT

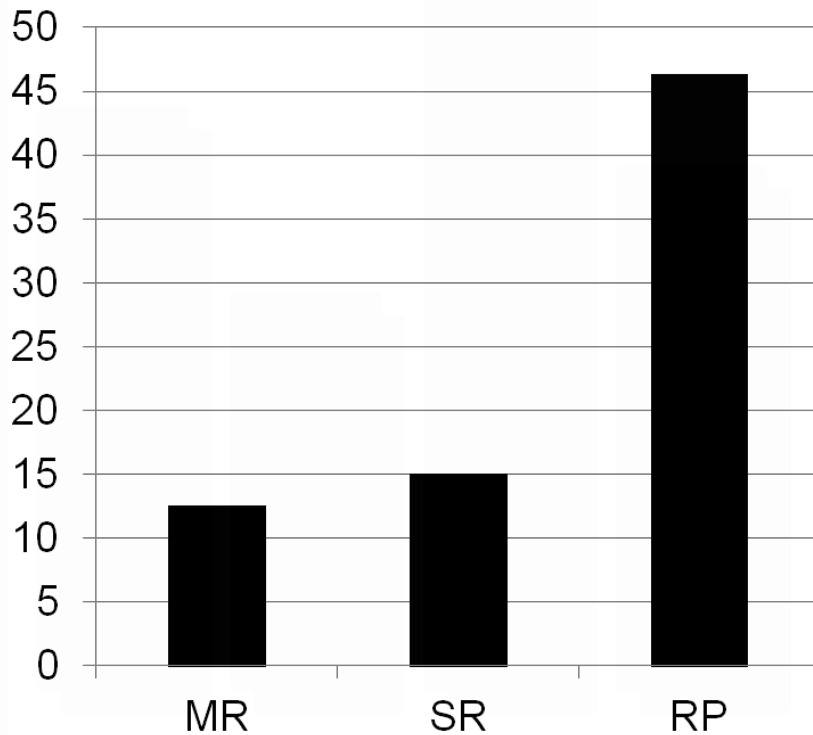
Retrieval Practice Improves Memory in Survivors of Severe Traumatic Brain Injury



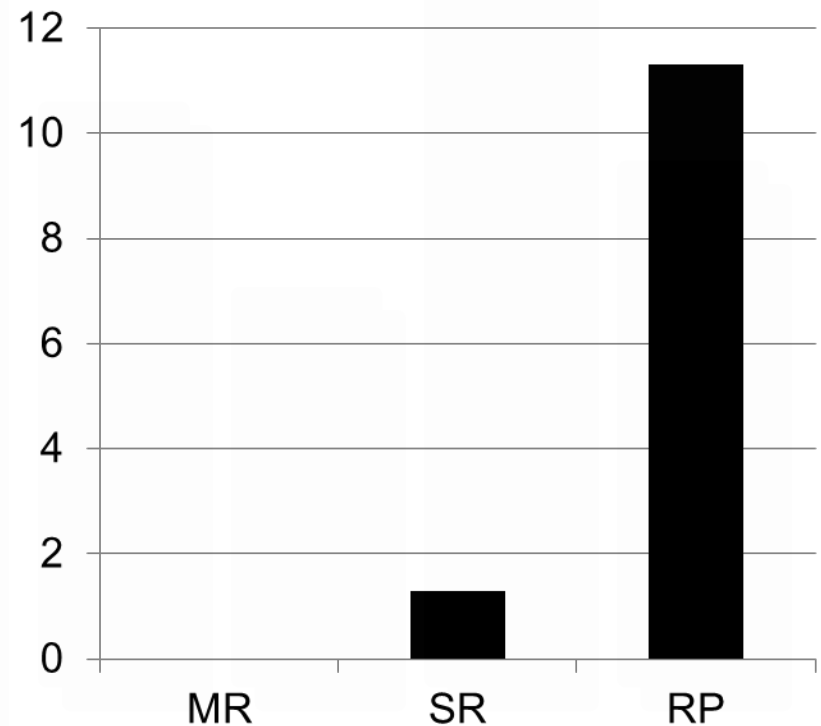
James F. Sumowski, PhD,^{a,b} Julia Coyne, PhD,^{a,c} Amanda Cohen, BA,^a
John DeLuca, PhD^{a,b}

Testing Effect in Severe TBI

Short delay



Long Delay (1 week)



Overview

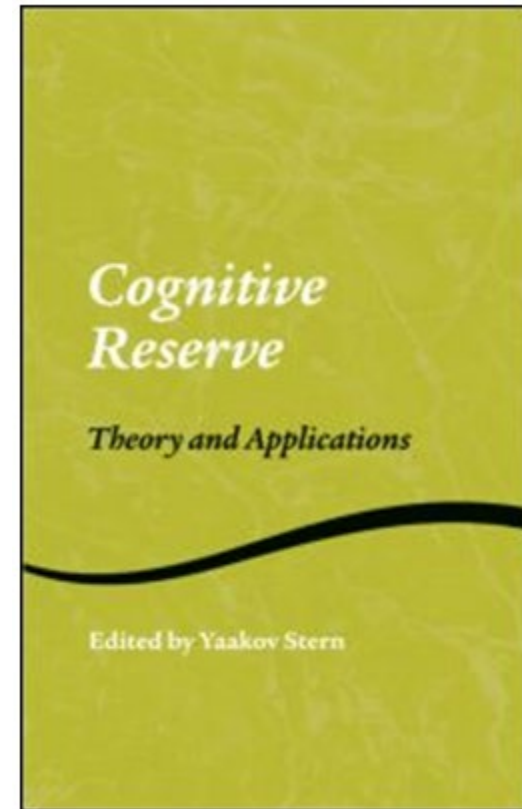
- What is Cognition?
- Treatment of Cognitive dysfunction
 - Learning and memory
- Can treatment be Effective?
 - Techniques to improve learning
- What else can be done?
 - Cognitive Reserve

Cognitive Reserve Hypothesis

Persons with higher lifetime intellectual enrichment can better withstand disease-related neuropathology without suffering cognitive impairment or dementia, likely due to more efficient neurocognitive processing.

Stern et al., *JINS* 2002;8:448-460.

Stern et al., *Cereb Cortex* 2005;15:394-402.





Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2013;94:2562-4



BRIEF REPORT

Education Attenuates the Negative Impact of Traumatic Brain Injury on Cognitive Status



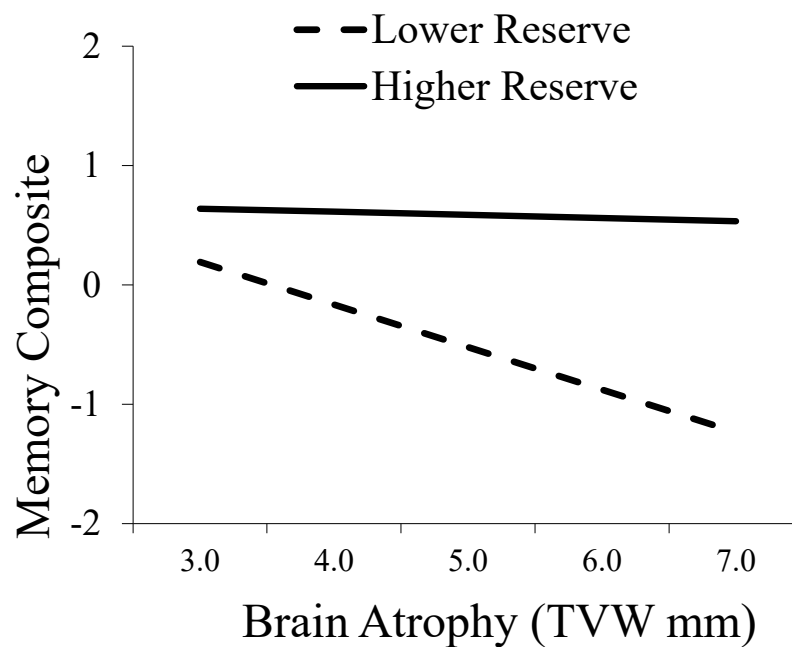
James F. Sumowski, PhD,^{a,b} Nancy Chiaravalloti, PhD,^{a,b,c} Denise Krch, PhD,^{b,c}
Jessica Paxton, PhD,^{a,b} John DeLuca, PhD^{a,b,d}

Cognitive Reserve Moderates the Effect of TBI Brain Pathology on Memory

14 TBIs (42.6 ± 9.9 years; 7 females)

Block	Term	R ² change (p)
1	TVW	30% (< .05)**
2	CR	39% (< .05)**
3	TVW x CR	13 % (< .05)*

*moderate effect size; ** large effect size

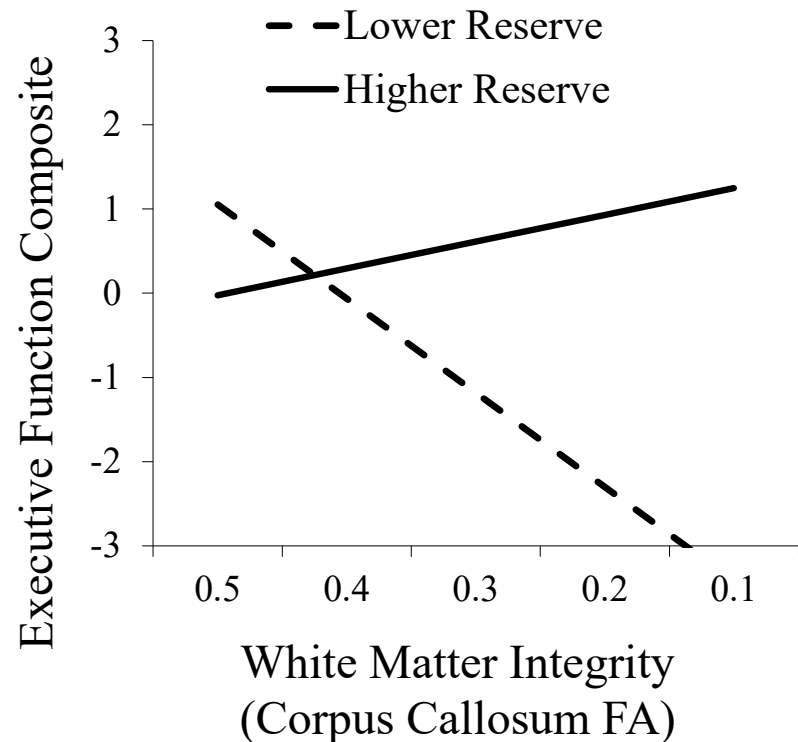


Cognitive Reserve Moderates the Effect of TBI Brain Pathology on Executive Function

14 TBIs (42.6 ± 9.9 years; 7 females)

Block	Term	R ² change (p)
1	CC FA	35% (.026)**
2	CR	16% (.085)*
3	CC FA x CR	9% (.178)*

*moderate effect size; **large effect size



Cognitive Reserve and Rehabilitation

- Higher cognitive reserve protects TBI subjects from TBI-related cognitive decline
- Can we identify “at risk” patients for cognitive impairment?
- Can one build up a “cognitive reserve”?
 - “neuroprotective” against developing cognitive impairment?

What is the Potential Impact of Cognitive Rehabilitation?

ACTIVE study

Effects of Cognitive Training Interventions With Older Adults:

A Randomized Controlled Trial

Karlene Ball, PhD, Daniel B. Berch, PhD, Karin F. Helmers, PhD, Jared B. Jobe, PhD, Mary D. Leveck, PhD, Michael Marsiske, PhD, John N. Morris, PhD, George W. Rebok, PhD, David M. Smith, MD, Sharon L. Tennstedt, PhD, Frederick W. Unverzagt, PhD, and Sherry L. Willis, PhD for the ACTIVE Study Group

2832 Participants 65-94 yo

Randomized into 1 of 4 groups (10 sessions of group training)

verbal episodic memory (n=711)

reasoning (n=705)

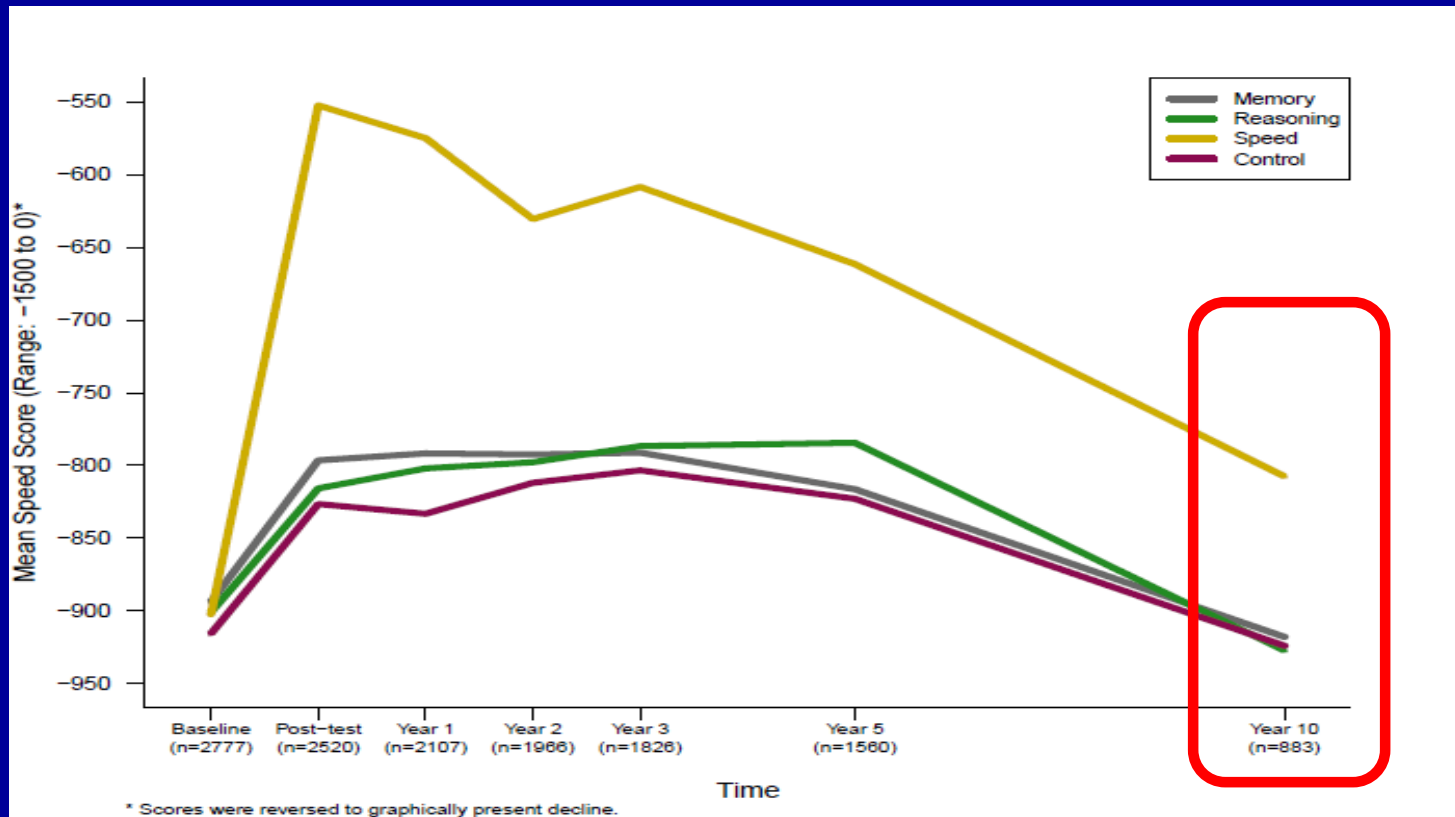
Processing speed (n=712)

no contact control (n=704)

Outcome: immediate, 1yr, 2yr, 3 yr, 5 yr 10yr post training

ACTIVE Results at 10 years

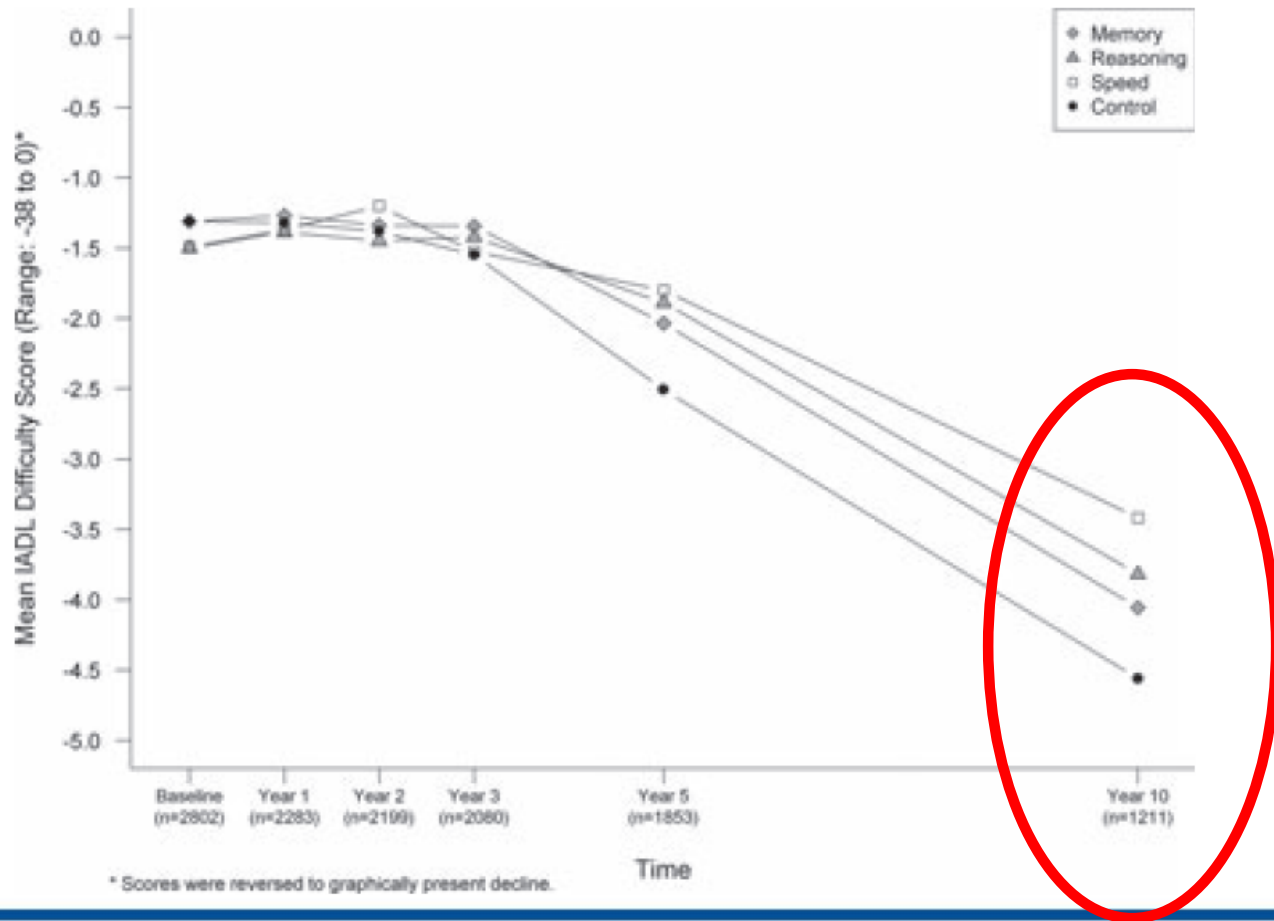
Mean PS Score



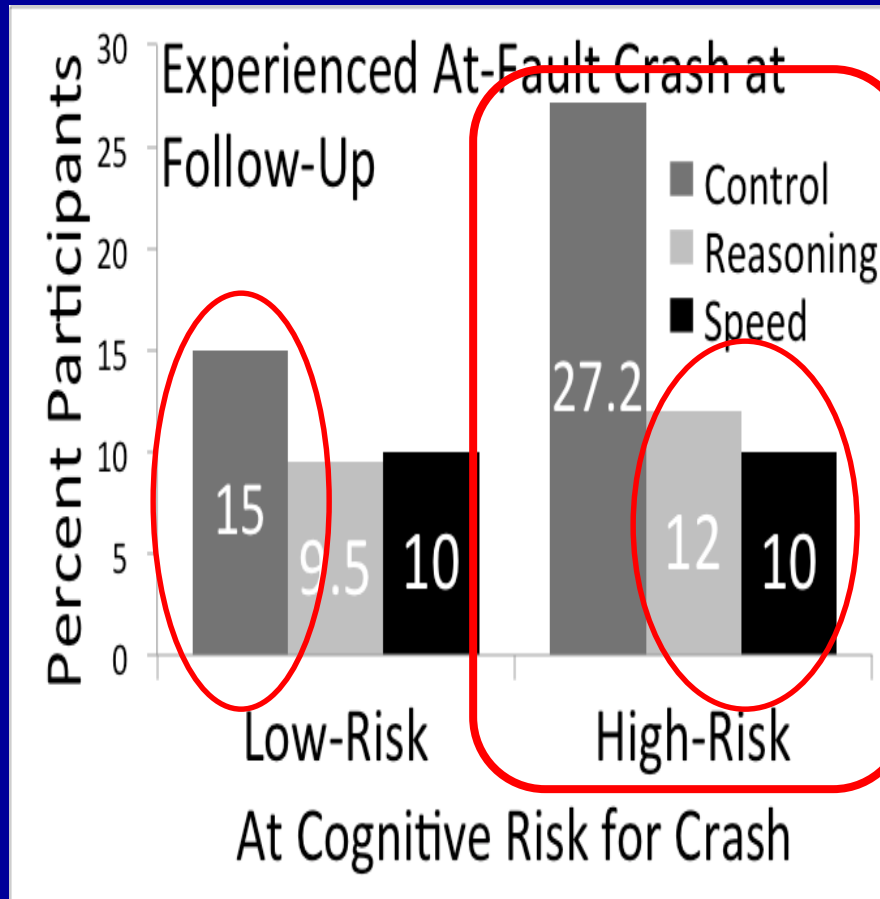
(JAGS 2014)

ACTIVE Results at 10 years

Mean IADL



Reduction in auto crashes: Comparison of speed & reasoning training & control group: 5- and 10-yr findings



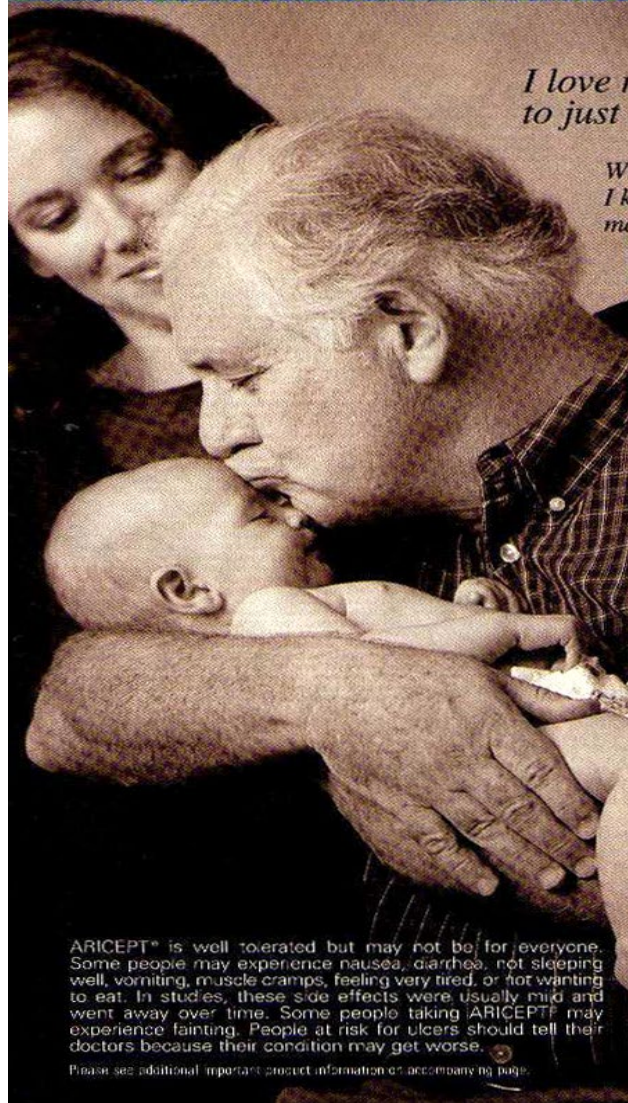
- Reduced Crashes for participants in Speed & Reasoning Training at high risk for crash
- For training groups, % high risk participants who crashed was reduced to level of low risk participants

What is the Potential Impact of Cognitive Rehabilitation?

- ACTIVE trial in healthy aging:
- Cog Rehab and Dementia Risk:
 - 78.8% relative risk reduction of dementia 10 years later
 - magnitude of this effect is greater than:
 - the of 20-40% relative risk reduction antihypertensive medications provide over 3-5 years against *:
 - stroke
 - coronary heart disease
 - heart failure

* Lancet 2003;362:1527–35

Fighting Back with Aricept®



*I love my life way too much
to just hand it over to Alzheimer's.*

*When my memory started failing,
I knew I had to see my doctor. He put
me on ARICEPT®. Now I'm doing better.**

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There is no cure for Alzheimer's. But a prescription drug called ARICEPT® has been used by millions of people to help their symptoms.

In studies, ARICEPT® has been proven to work for mild to moderate Alzheimer's. It has helped people improve their memory over time. It has also helped them to keep doing everyday things on their own, longer.

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Please see additional important product information on accompanying page.

*Individual responses to ARICEPT® can be different – people may get better, stay the same or not get better.

Time
Magazine
1/20/2003

“When my
memory
started
Failing, I
knew
I had to see
my
Doctor. He
put me
On ARICEPT.
Now I'm
doing
better”

Video Games and Cognitive Rehabilitation

- Can I tell my client to use “brain games” or “video games” for cognitive rehabilitation?

A Consensus on the Brain Training Industry from the Scientific Community

Max-Planck-Institut für Bildungsforschung
Max Planck Institute for Human Development

October 20, 2014



75 Leading Cognitive Psychologists & Cognitive Neuroscientists Representing 48 Universities

"We object to the claim that brain games offer consumers a scientifically grounded avenue to reduce or reverse cognitive decline when there is no compelling scientific evidence to date that they do."

Lumosity to Pay \$2 Million to Settle FTC Deceptive Advertising Charges for Its “Brain Training” Program

- “Lumosity preyed on consumers’ fears about age-related cognitive decline, suggesting their games could stave off memory loss, dementia, and even Alzheimer’s disease, But Lumosity simply did not have the science to back up its ads.”
- Lumosity claimed that training would:
 - 1) improve performance on everyday tasks, in school, at work, and in athletics
 - 2) delay age-related cognitive decline and protect against mild cognitive impairment, dementia, and Alzheimer’s disease
 - 3) reduce cognitive impairment associated with health conditions, including stroke, traumatic brain injury, PTSD, ADHD, the side effects of chemotherapy, and Turner syndrome, and that scientific studies proved these benefits.

<https://www.ftc.gov/news-events/press-releases/2016/01/lumosity-pay-2-million-settle-ftc-deceptive-advertising-charges>

Conclusions

- Cognitive rehabilitation works in TBI
- Treatment is available and effective
- Cognitive rehabilitation works through neuroplasticity in the brain
- Can we build a “cognitive reserve” after TBI?
- Future research needed to look at factors which predict response to treatment

Acknowledgments

Nancy Chiaravalloti, Ph.D.

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Kathy Chiou, Ph.D.

Denise Krch, Ph.D.

Joshua Sandry, Ph.D.



Thank You