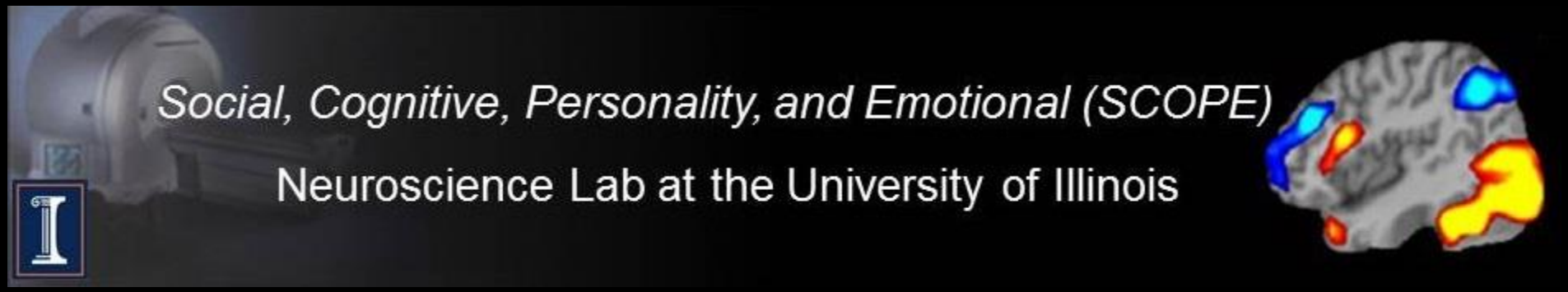

The Impact of Emotion on Memory for Context: Behavioral, Eye-Tracking, and Brain Imaging Evidence

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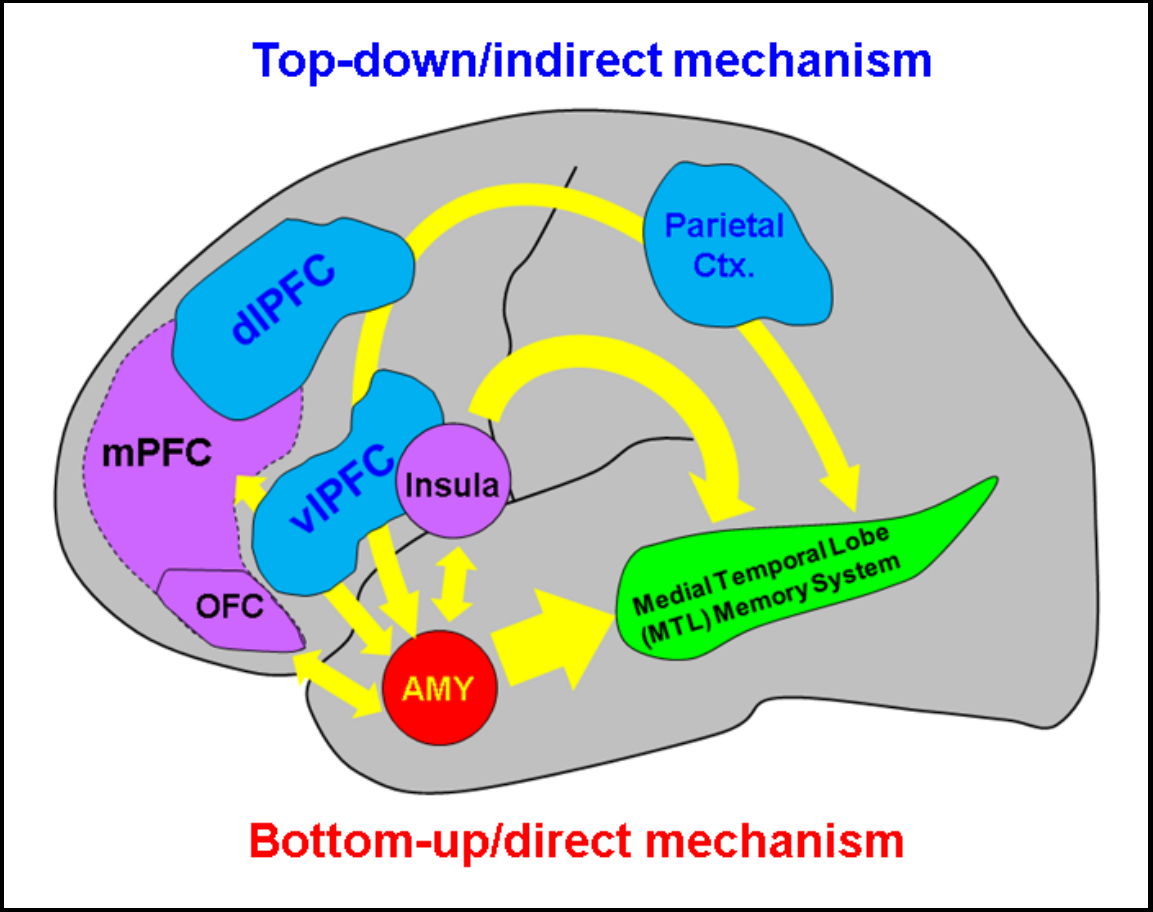
(*CEMSi* 2021, December 8th)

Why Do We Remember Better Emotional Events?

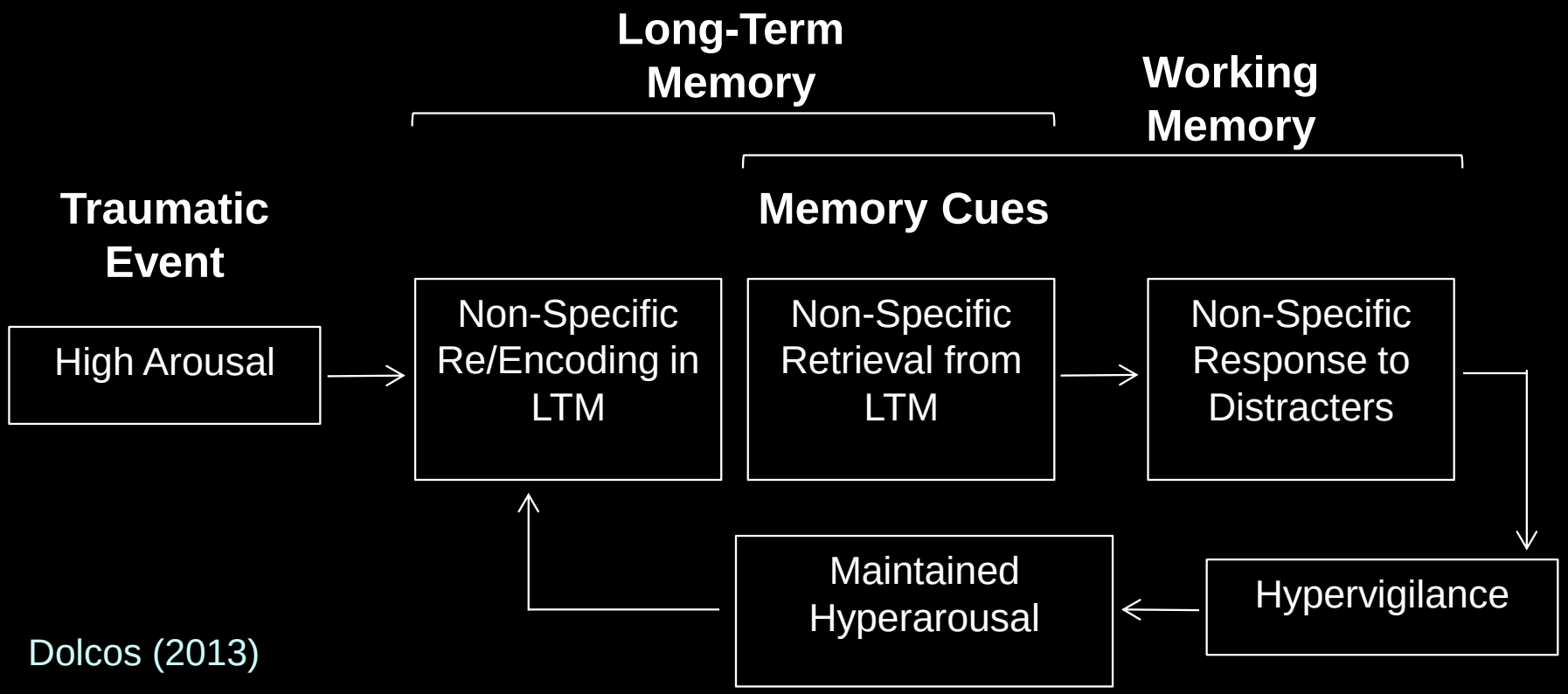
(Dolcos et al., 2004a/b, *Neuron/Neuroimage*; *PNAS*, 2005; Reviewed in Dolcos et al., 2006, 2008, 2011, 2012, 2014-2017)



Dolcos et al., (2017)

- Unclear Issue: *Effect of Emotion on Relational Memory?*

Evidence from PTSD: Impaired Relational Memory is Central to Generating and Maintaining Symptoms



Dolcos (2013)

- Non-specific neutral cues can trigger recollection of distressing memories, due to hypervigilance and maintained hyperarousal
- This may be linked to non-specific/*de*contextualized initial encoding of traumatic memories, due to heightened arousal.

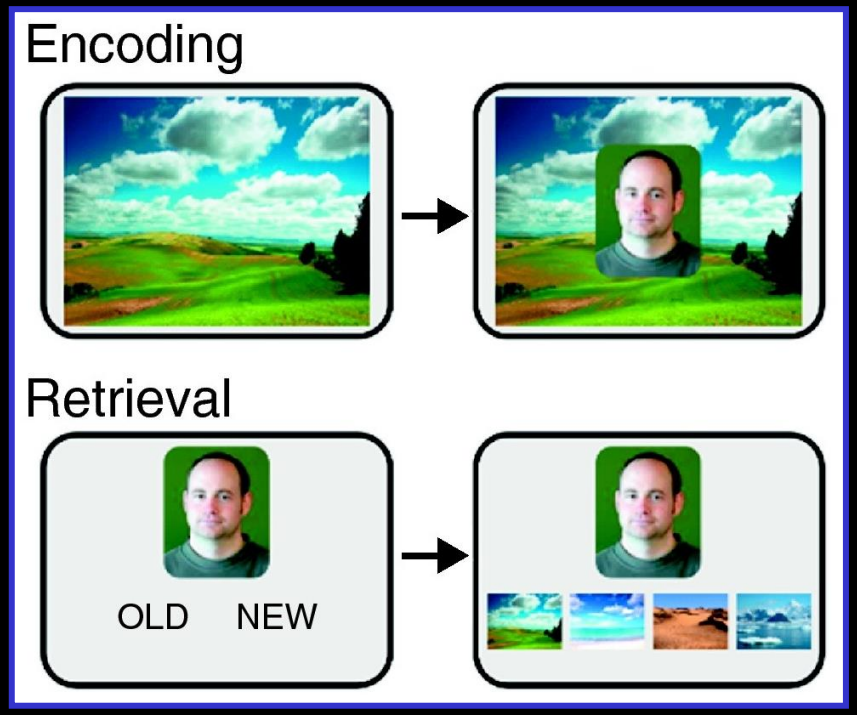
Open Questions

I. Does high emotional arousal *enhance* or *impair* relational memory in healthy functioning?

II. What can be done to promote memory *re*contextualization in clinical conditions and increase resilience and well-being?

Background Question I: Emotion & Memory

- Emotion enhances *item* memory, but the evidence regarding its impact on *relational* memory (RM) is mixed (reviewed in Dolcos et al., 2017)
- Several papers report impairments (reviewed in Bisby & Burgess, 2017)
- While others report enhancements (e.g., Ventura-Bort et al., 2020a, b; Madan et al., 2020; Dev et al., 2021)



Bisby & Burgess, 2017

➢ Important dissociation in relational memory:

Subjective vs. *Objective* RM

➢ Evidence points to enhanced emotional memory when testing subjective RM using Tulving's R/K/N task (e.g., Dolcos el al., 2005)

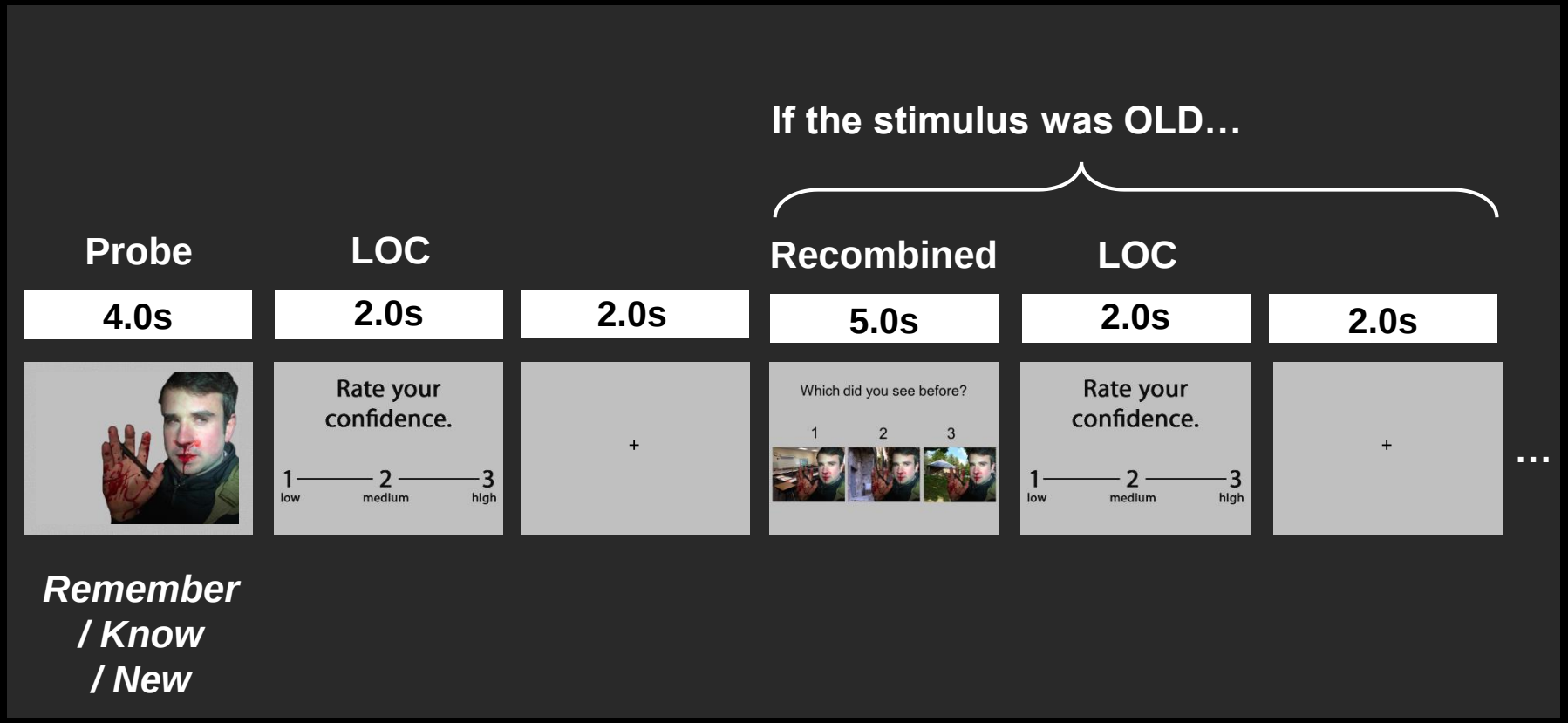
Study 1: Impact of Emotion on Subjective vs. Objective RM, Linked to Attentional Focus during Encoding

- Manipulation of Focused Attention (FA) was important to enhance/diminish emotion's effects.

Cue	Image	EmoRate	
0.5s	4.0s	2.0s	9.5s
Foreground Focus/ Background Focus		Rate Emotion 1 ----- 2 ----- 3 ----- 4 ----- 5 (not at all negative) (very negative)	+

Dolcos et al., 2020 (*Neuropsychologia)*

Retrieval Task



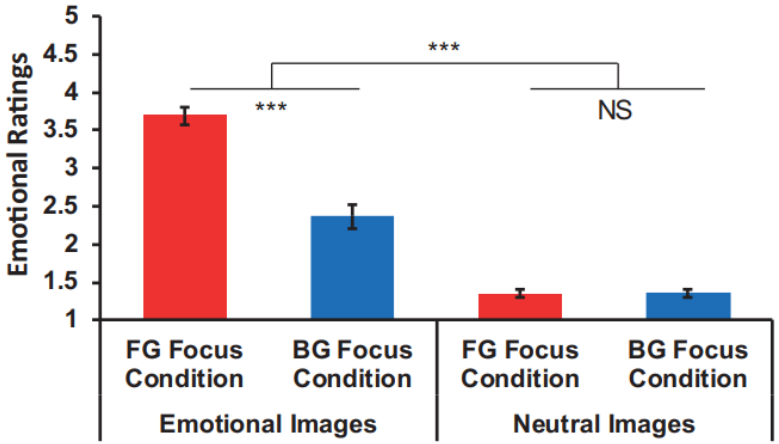
Subjective RM:
Accurate *R*-based Responses

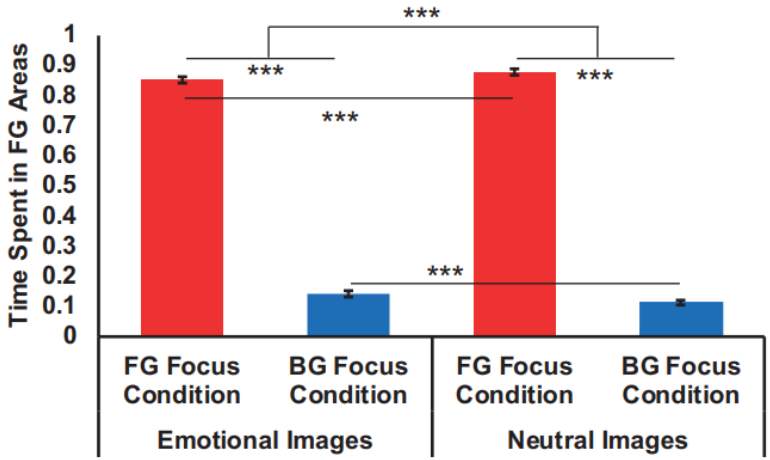
Objective RM:
Accurate Identification of Matches

Dolcos et al., 2020 (*Neuropsychologia)*

Manipulation Checks:
Behavioral and Eye-Tracking Evidence

- Reduced Emotional Ratings following FA
- Gaze Behavior Linked to the FA Manipulation

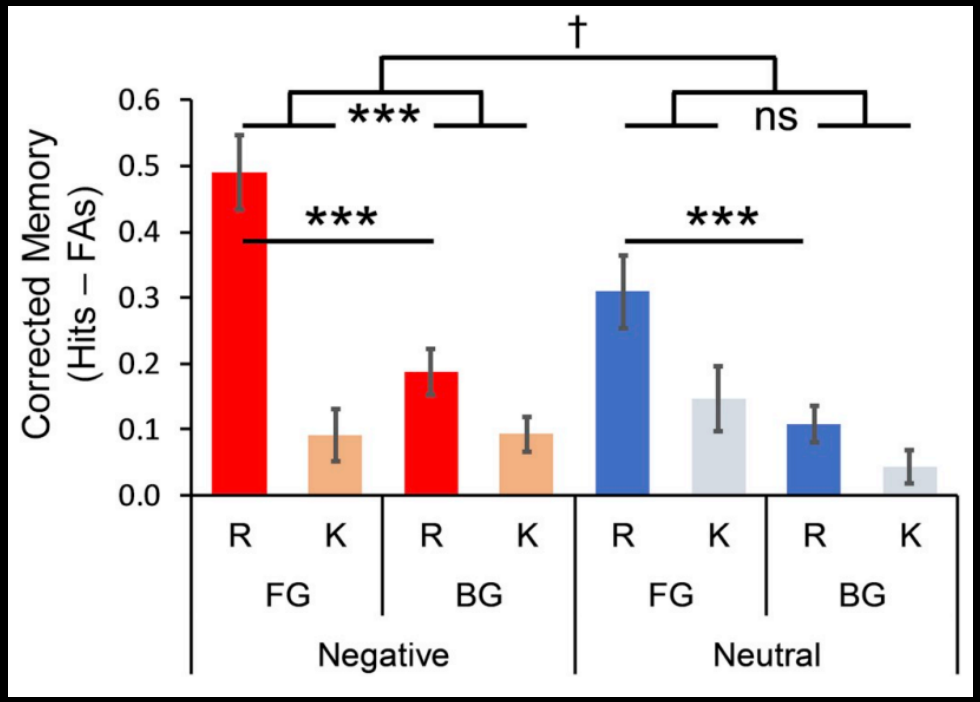




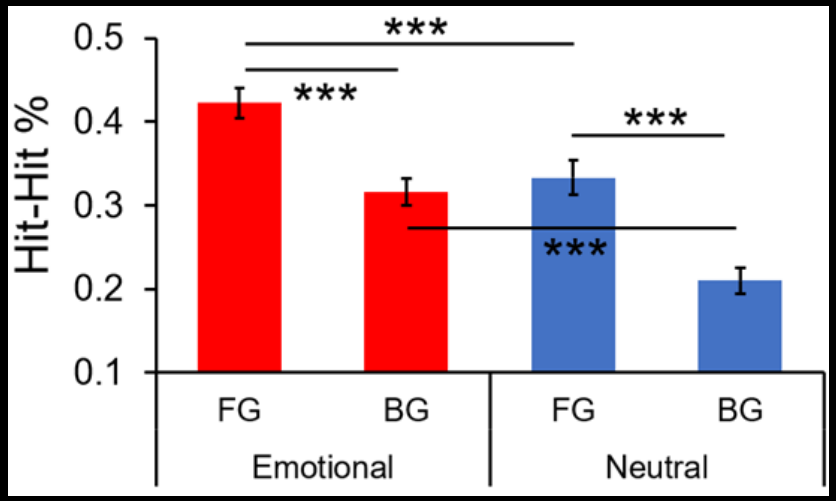
Dolcos et al., 2020 (*Emotion, CABN, Neuropsychologia)*

Results 1: Evidence for Enhanced RM by Emotion

- Memory enhancement effect of emotion driven by recollection-based responses (subjective RM)
- Effect maximized when focusing on emotional aspects (Foreground Focus, FG)



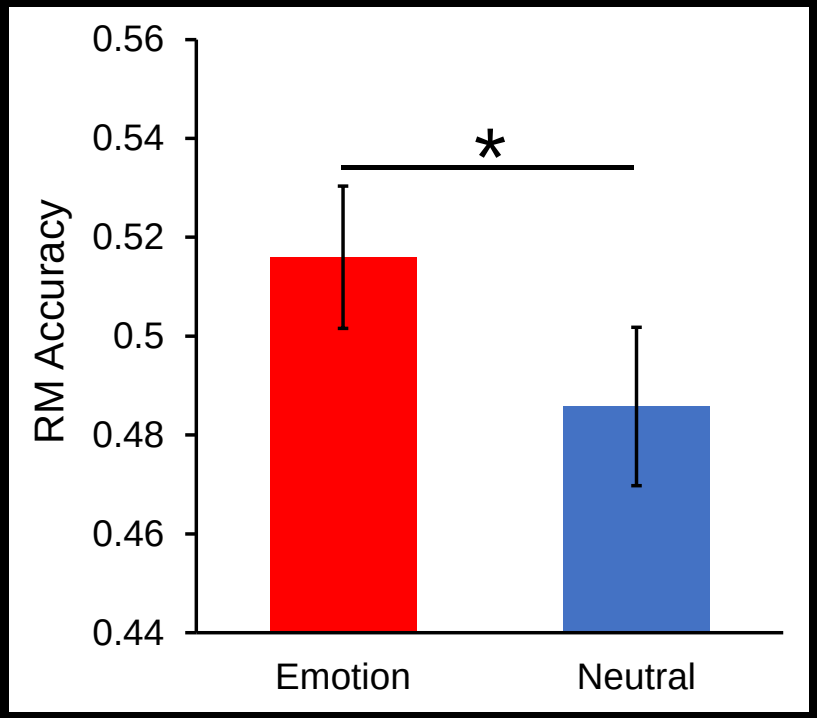
- Recollection and FG Focus enhance RM when Objective accuracy confirms Subjective accuracy

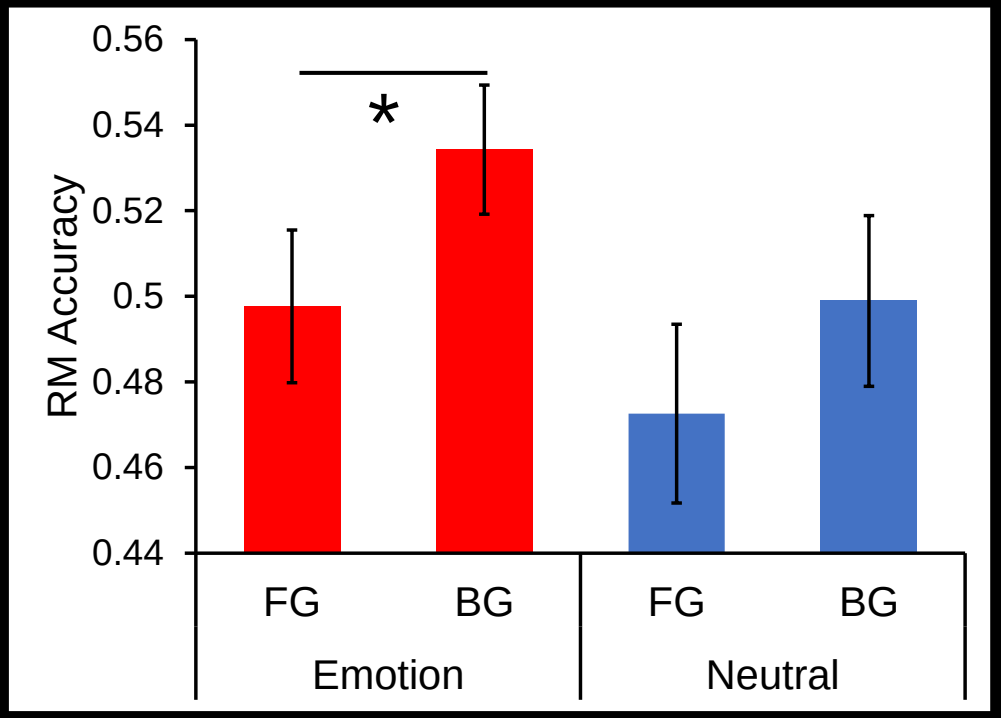


Dolcos et al., 2020 (*Neuropsychologia*)

Results 2: Evidence for Impaired RM by Emotion

- Emotion also enhances Objective RM, which is driven by a focus on non-emotional aspects (Background Focus, BG)
- Consistent with a detrimental effect of emotion on RM, when emotion processing is maximized (FG Focus)





Interim Summary

- Present evidence reconciles mixed findings from literature
  - ⇒ Emotion *enhances* Subjective RM, separately and when confirmed by accurate Objective RM (effect is driven by Recollection and Emotion/FG Focus)
  - ⇒ Emotion *impairs* Objective RM, when tested without accounting for Subjective RM (effect also driven by Emotion/FG Focus)

- Focusing on contextual aspects of emotional events (BG Focus) enhances objective RM, possibly by diminishing memory *de*contextualization
  - ⇒ Relevant for using FA training to promote memory *re*contextualization?

Open Questions

I. Does high emotional arousal *enhance* or *impair* relational memory in healthy functioning?

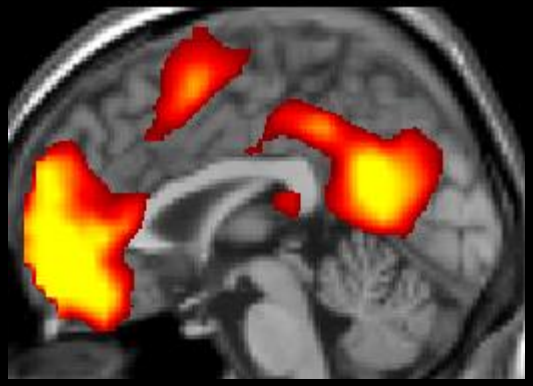
II. What can be done to promote memory *re*contextualization in clinical conditions and increase resilience and well-being?

Background Question II: What Predicts Resilience?

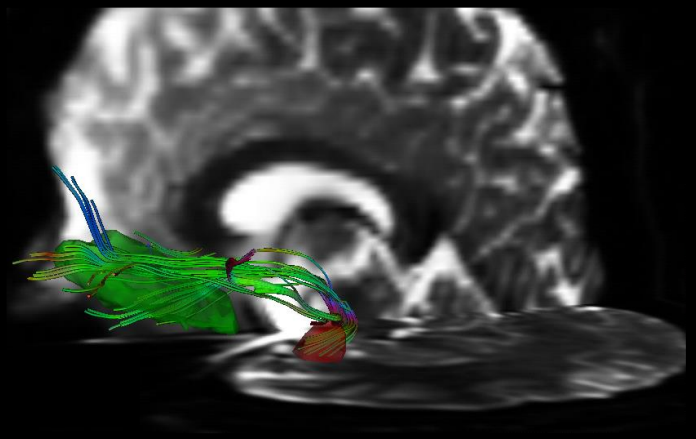
- **Training/Intervention Studies to:**
  - *Enhance the Brain*
  - *Change Behavior/Personality*

- **Capitalize on Brain's Plasticity**

Functional Changes



Structural Changes



(Dolcos S. et al., 2016; Hu & Dolcos S., 2017; Moore et al., 2018; Dolcos S. et al., 2021)

A Brain-Personality-Symptom Approach

(e.g., Dolcos S. et al., 2016; Hu & Dolcos S., 2017; Moore et al., 2018)

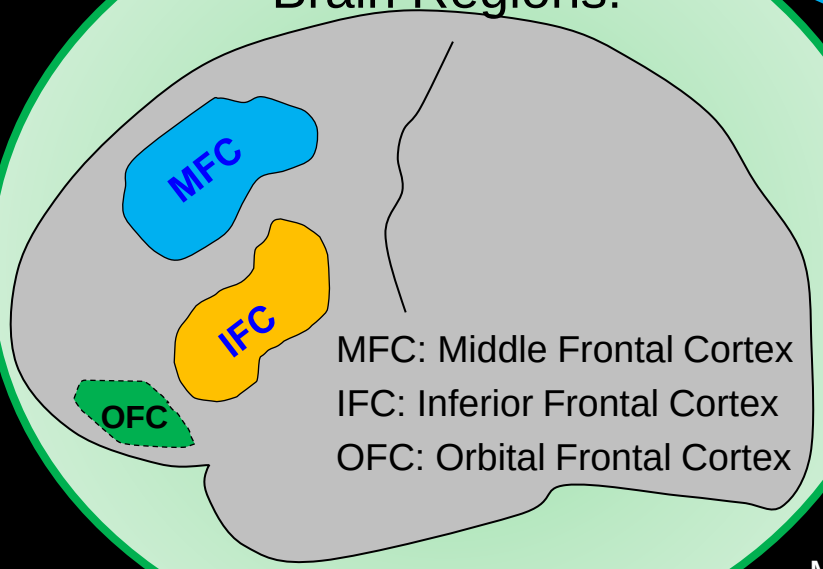
"Resilience"

Personality Factors:

- Emotion Regulation
- Positive Affect
- Optimism

"Control"

Brain Regions:



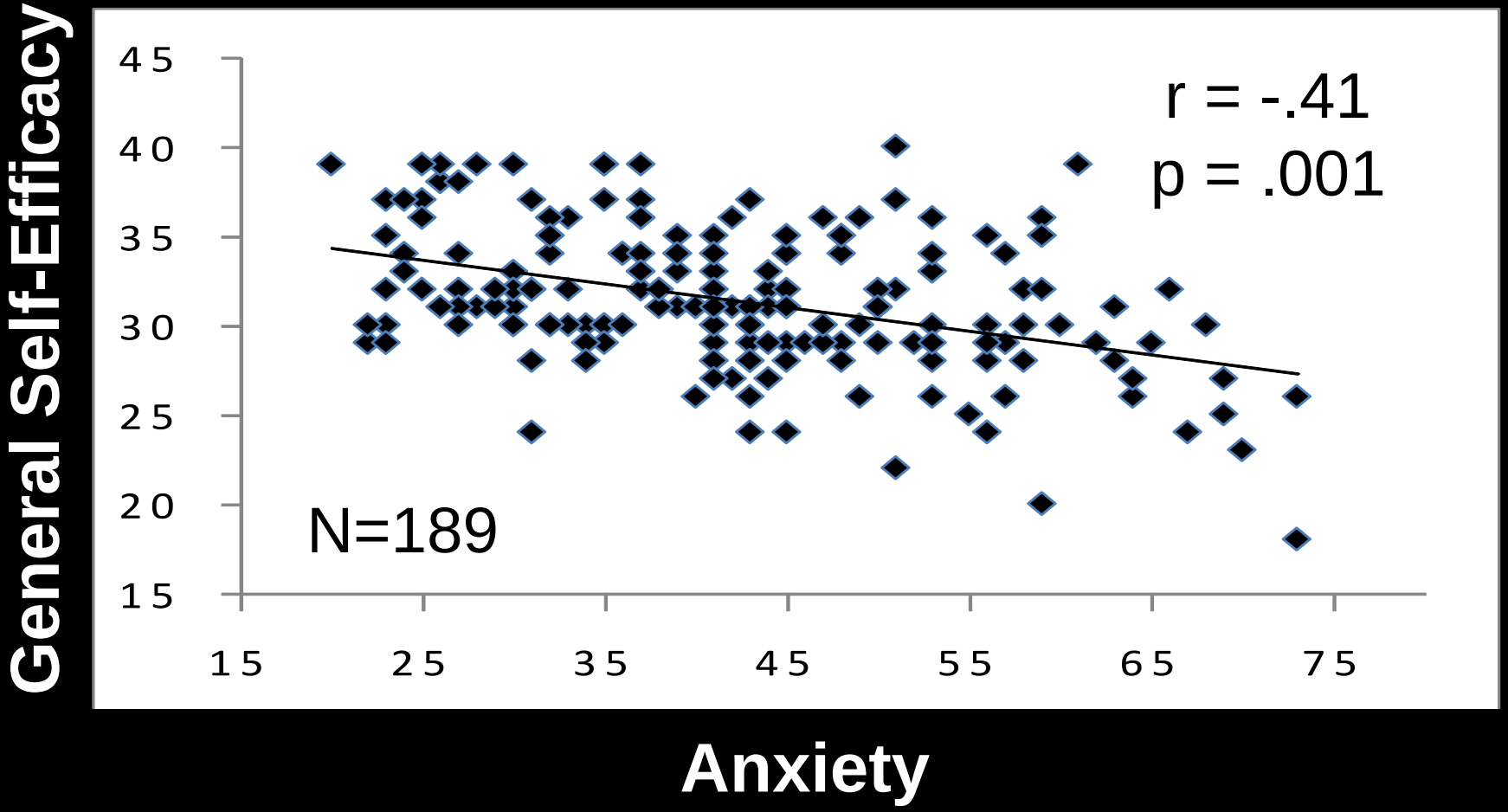
"Distress Symptoms":

- Anxiety
- Depression

Moore et al. (2018),
Personality Neuroscience

Other Protective Factors?

Self-Efficacy: Possibly Essential Mechanism in Reducing Distress



Dolcos S. et al. (*in prep)*

Study 2: Emotion Control Training in Student Veterans

(**STRIVE: S**ocio-Cognitive **T**raining and **R**esources **I**n **V**eterans in **H**igher **E**ducation)

Challenges Faced by Student Veterans:

- Fitting-in (feeling older/more mature/perceptions of an anti-military environment)
- Having a break from their education – feeling rusty
- Learning to manage their disability
- Unclear career goals since leaving the military

STRIVE Pilot Study:

- 19 veterans (32.21 years old, SD = 7.12; all males)
- With a deployment assignment to Iraq and/or Afghanistan in the preceding 5 years.
- Randomly assigned to one of two alternative training programs over 5-8 weeks:
  - **Emotion Regulation (ER)** training: Dolcos lab
  - Broad Socio-Emotional skills: Berenbaum lab

Basic Experimental Design

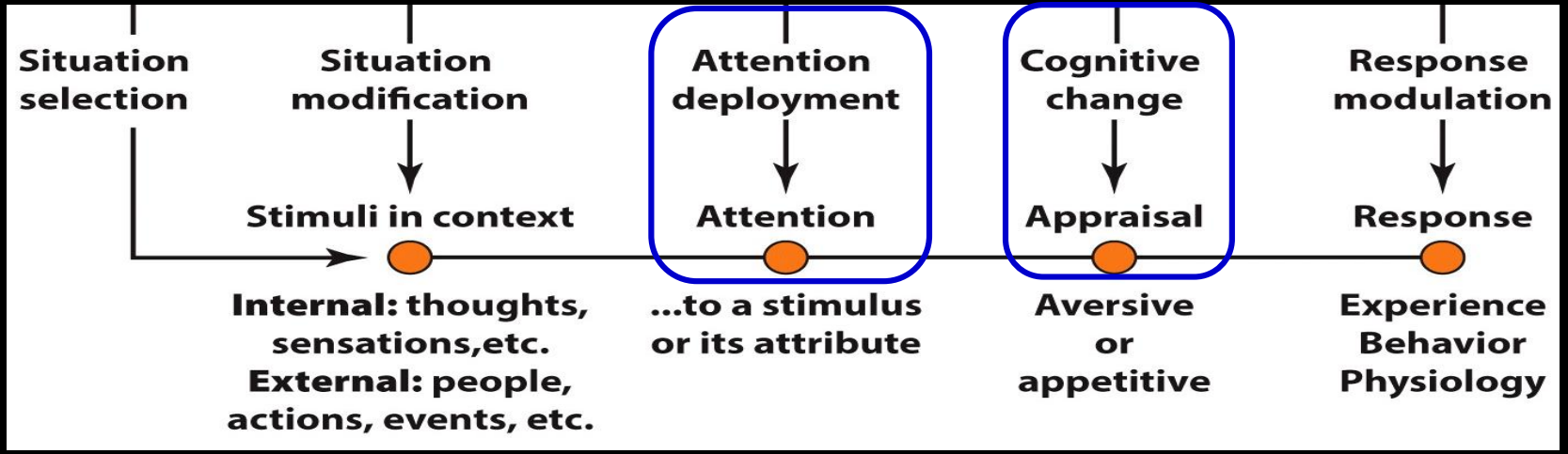
Pre-Training Assessments (Brain Imaging, Neuropsychological, Clinical, etc.)

Training

Post-Training Assessments (Brain Imaging, Neuropsychological, Clinical, etc.)

Basic Training Implementation – Two Main ER Strategies:
Focused Attention (FA) and Cognitive Reappraisal (CR)

Faster Responses vs. *Slower* Reframing



Gross, 2008

Focused Attention as Emotion Regulation Strategy

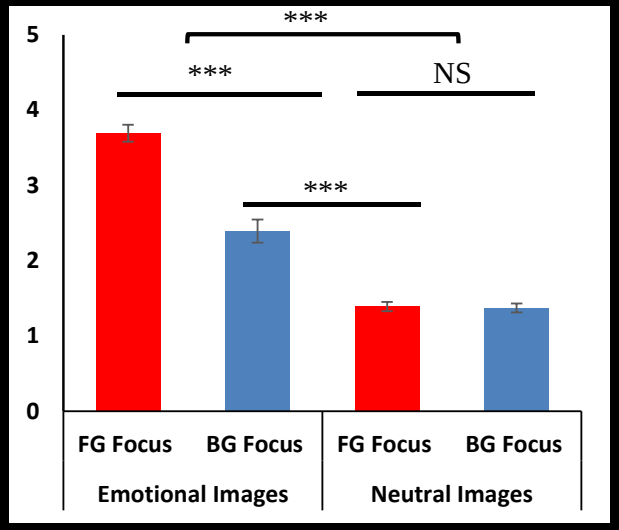
***Focused Attention*:** shift in attention on or away from emotional aspects of emotion eliciting stimuli/events (*External* or *Internal*).

- **Effectiveness & Mechanisms?**

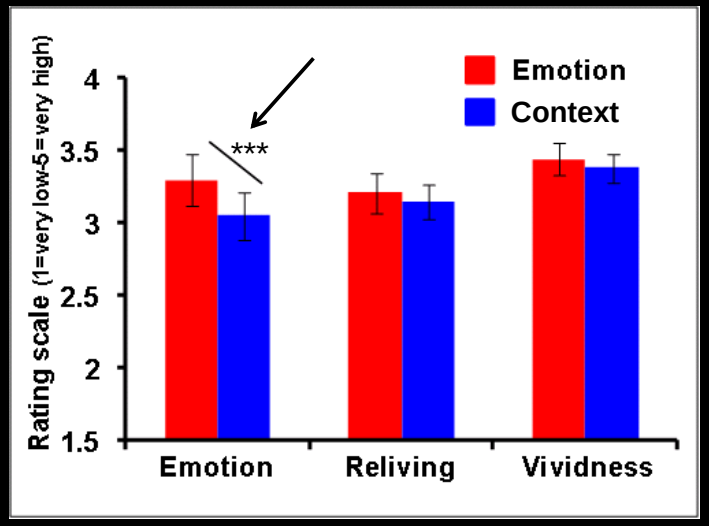
Evidence for the Effectiveness of FA - Behavioral Results:

Decreased Subjective (Re)Experiencing of Emotion when Focusing on Non-Emotional Contextual Aspects

Emotion/Foreground Focus > Context/Background Focus



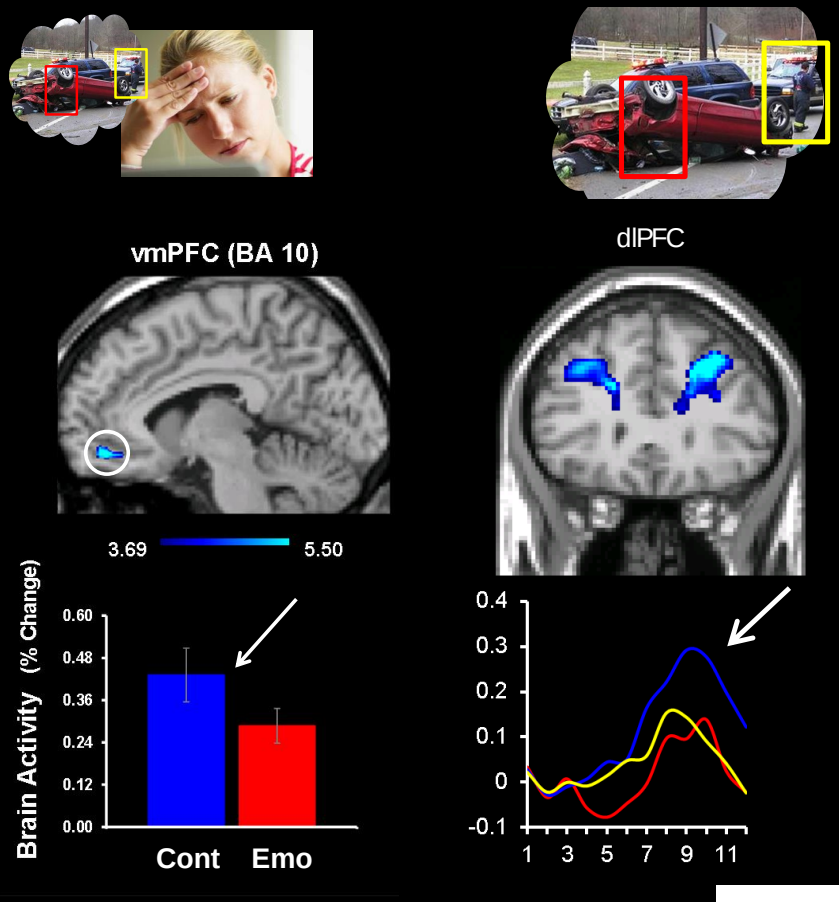
Dolcos et al.(2020), *CABN*



Denkova et al. (2015), *SCAN;*
Iordan et al. (2019), *Cerebral Cortex*

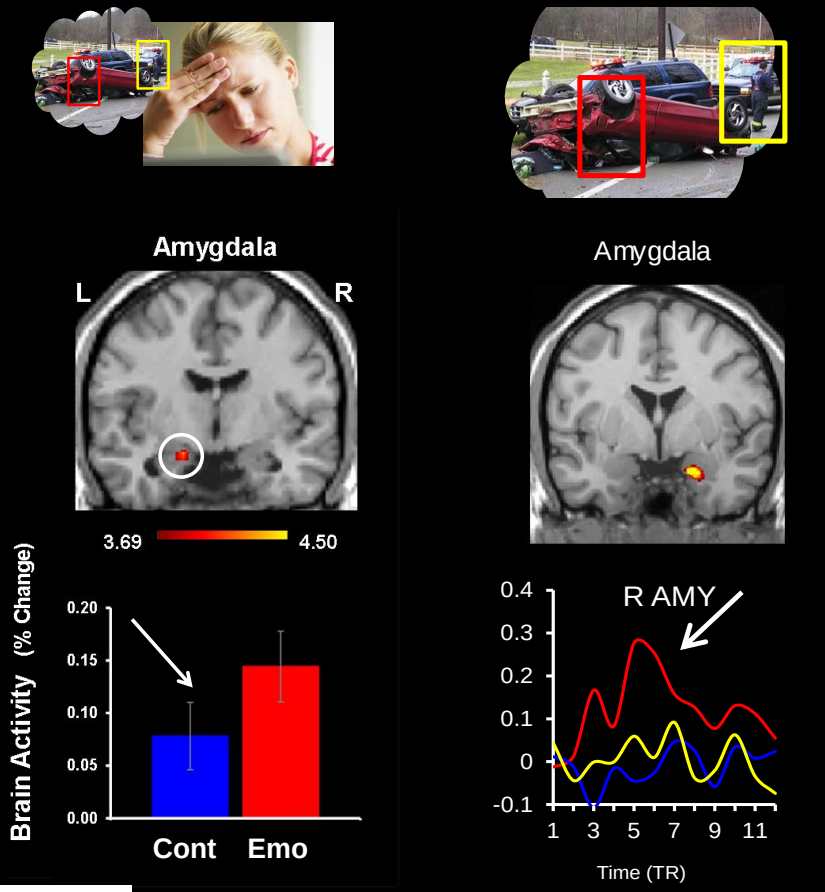
Evidence for the Effectiveness of FA - fMRI Results:
Opposing Patterns of Response in PFC and AMY

Context > Emotion



Denkova et al. (2015), *SCAN;*
Iordan et al. (2019), *Cerebral Cortex*

Emotion > Context



Dolcos et al. (2020), *CABN*

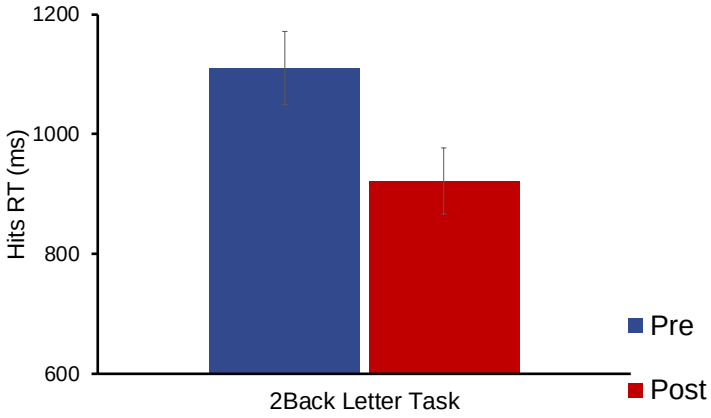
Negative (FG Focus)
Negative (BG Focus)
Neutral

Basic Training Implementation:
FA & Reappraisal of *Internal* and *External* Events

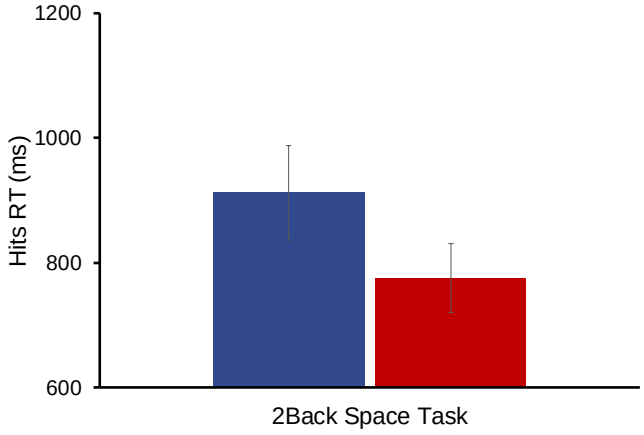
	Focused Attention		Reappraisal	
Internal Events (Writing about Memories).	Focusing on non-emotional contextual aspects of **Memories**.	"The crash happened close to a farm, a fireman wearing blue uniform was present at the scene…"	Writing about reappraisals of memory events.	"At least it's good that the situation had been reported and seemed to be under control."
External Events (Picture Viewing)	Focusing on non-emotional contextual details of **Pictures**.		Generating reappraisals of the depicted scenes.	"Fortunately the casualty seems to be low, and it wasn't one of those chain crashes."

Dolcos S. et al. (2021)

Behavioral Results 1: Improved Executive Function Following Emotion Control Training



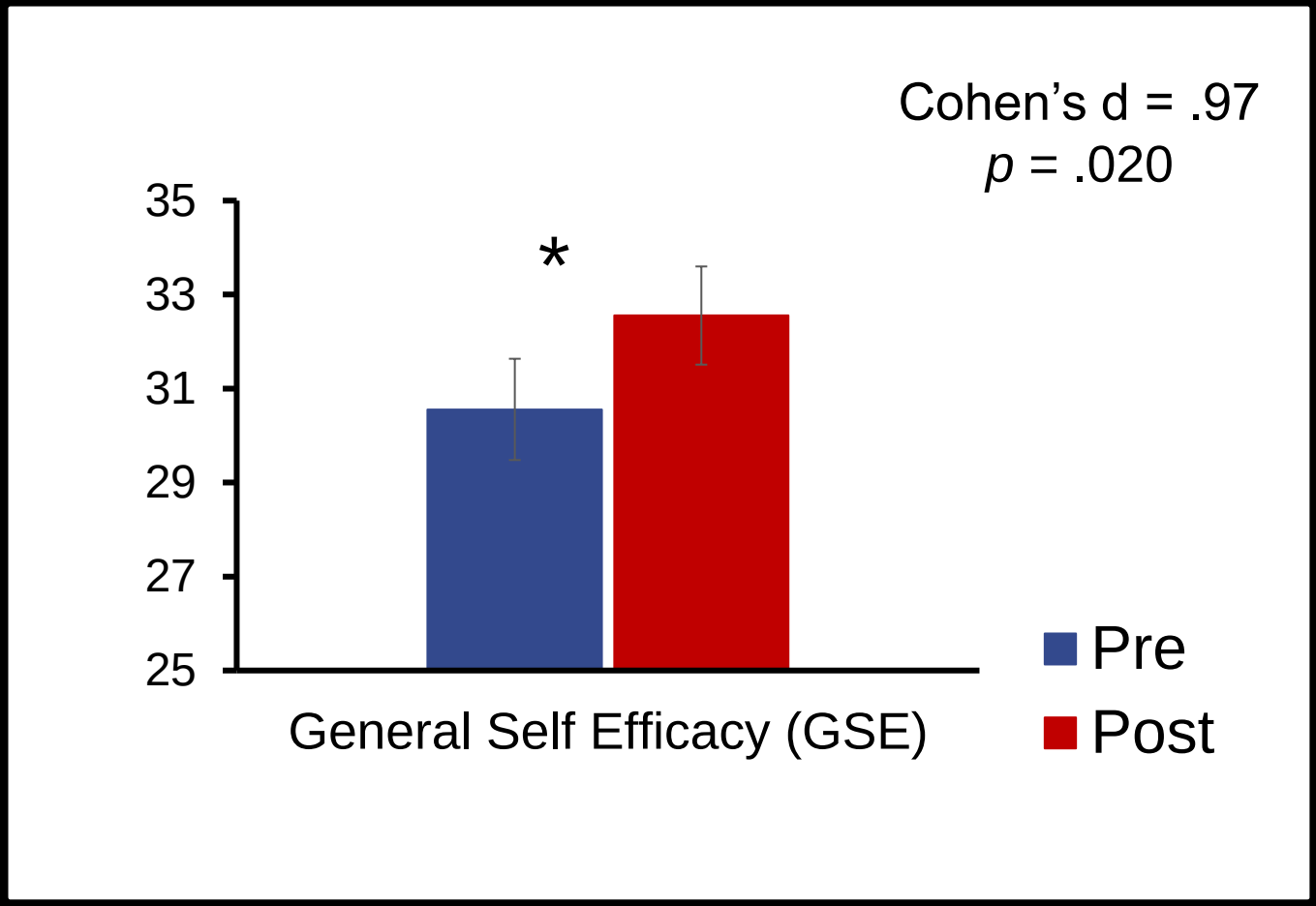
Cohen's d = -1.06
p = .013



Cohen's d = -.85
p = .035

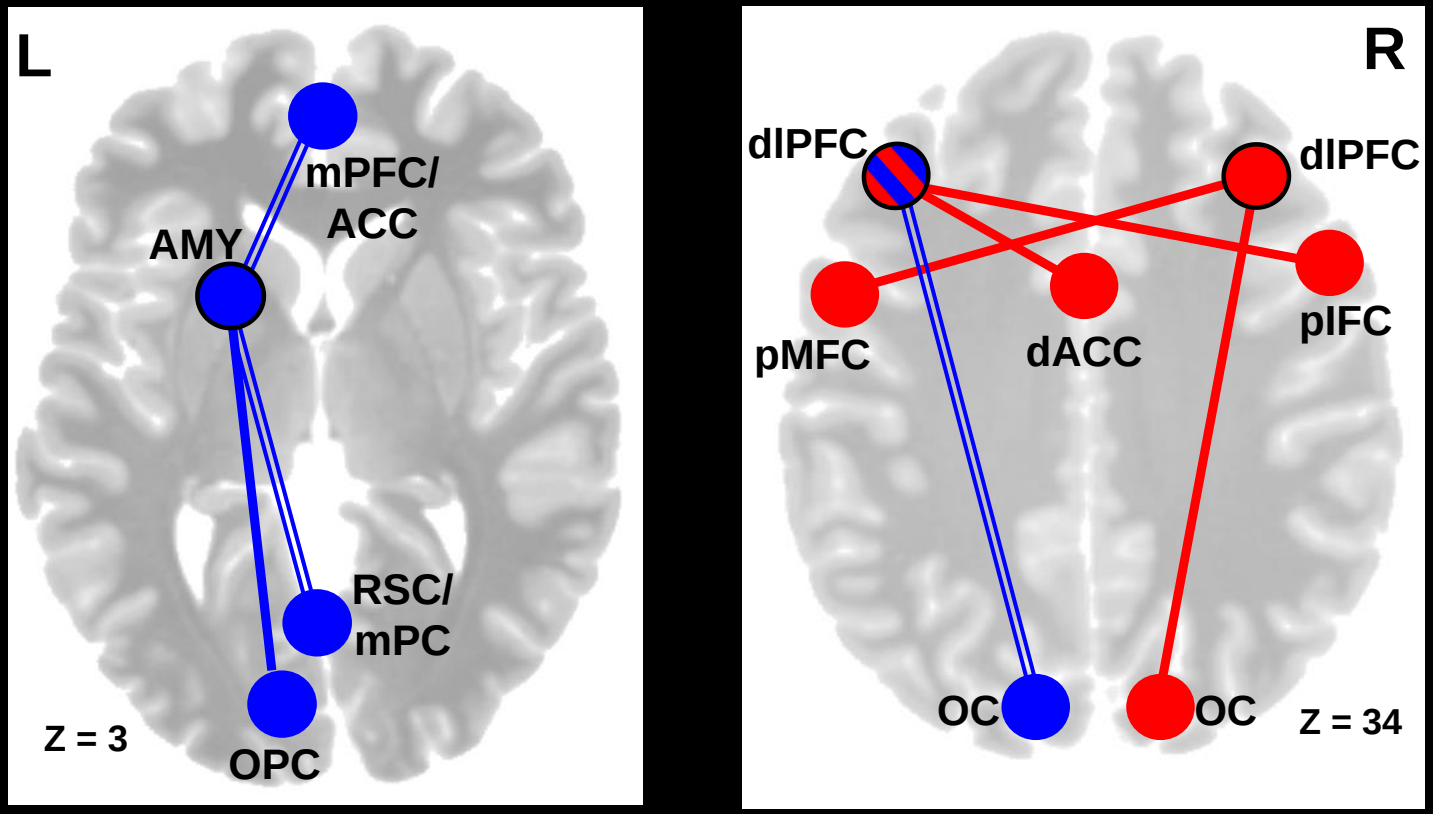
Dolcos S. et al. (2021)

Behavioral Results 2: Increased General Self-Efficacy Following Emotion Control Training



Dolcos S. et al.(2021)

fMRI Results: Changes in the Resting-State Functional Connectivity Following Training



Dolcos S. et al. (2021)

- Consistent with reduced bottom-up influences from emotion processing and perceptual areas, coupled with increased cross-talk among cognitive control brain regions, after ER training.

General Summary & Future Directions

- Impact of Emotion on Memory – provides reconciling evidence regarding the effect on RM => points to FA as potentially effective in memory *re*contextualization.

- ER Training – promising in providing tools that allow adaptive changes of both behavior and brain.

- Changes affect both specific (*executive control*) and general aspects of processing (*self-efficacy*).

- Future research will explore possible differential effects of ER strategies (FA vs. CR), as well as extend training effectiveness in other groups.

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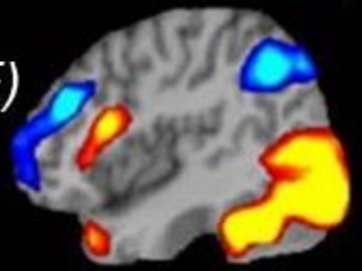
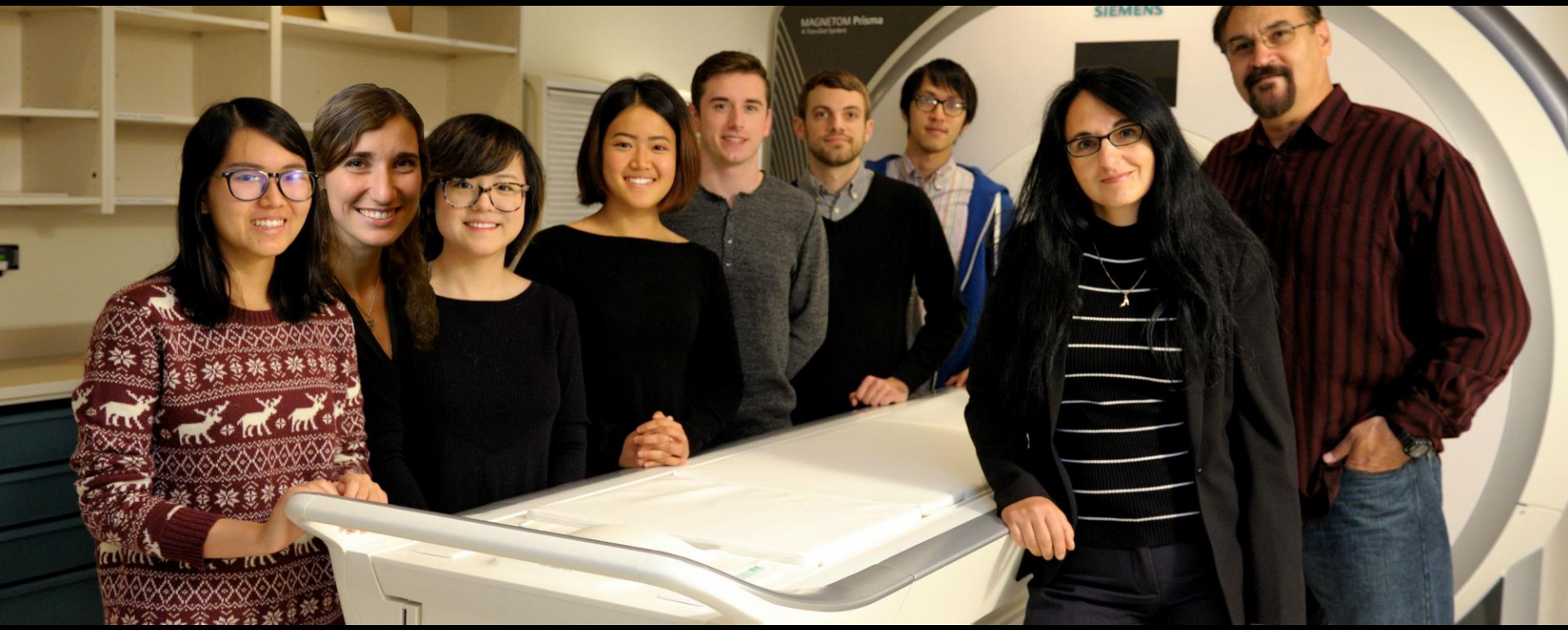
Neuroscience Lab at the University of Illinois

http://dolcoslab.beckman.illinois.edu/



Dolcos Lab (a.k.a., *D*Lab)