

Meditation, motor learning and aging

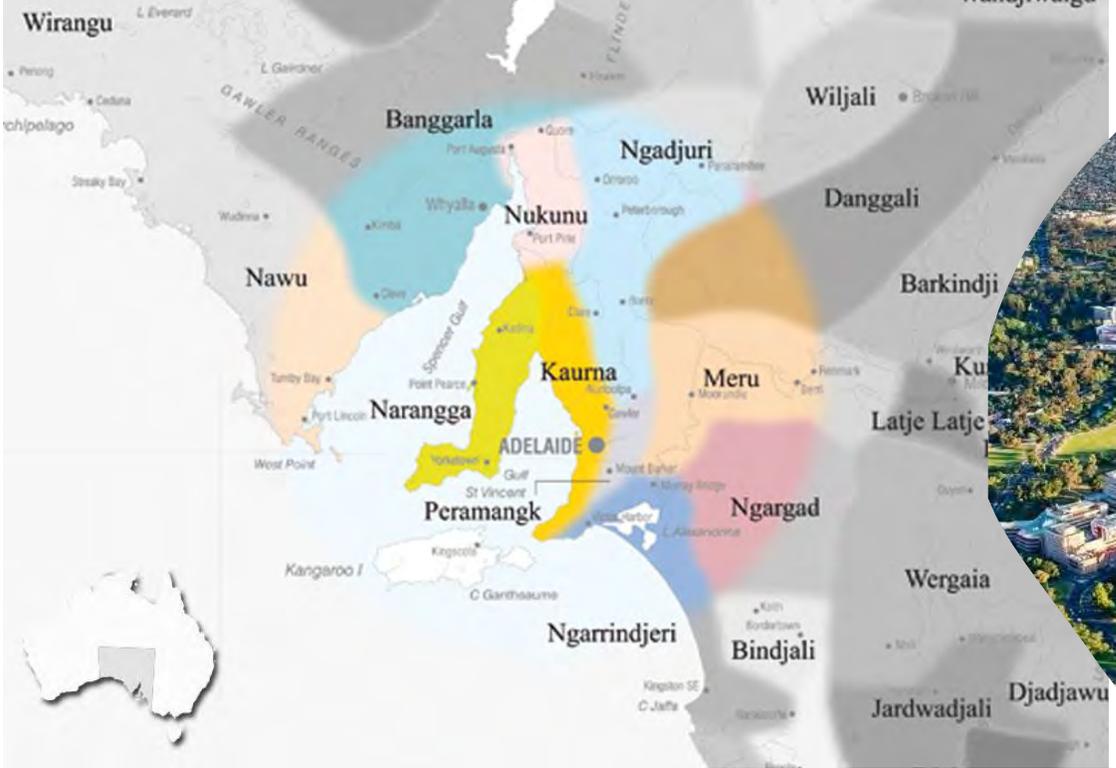
From context preservation to contextual integration

Maarten A Immink & Russell Chan



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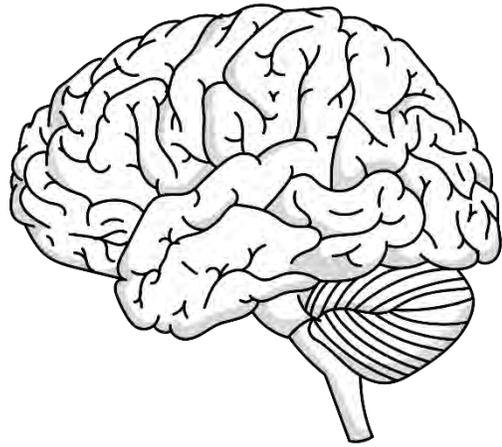
Kaurna Country

Tandanya

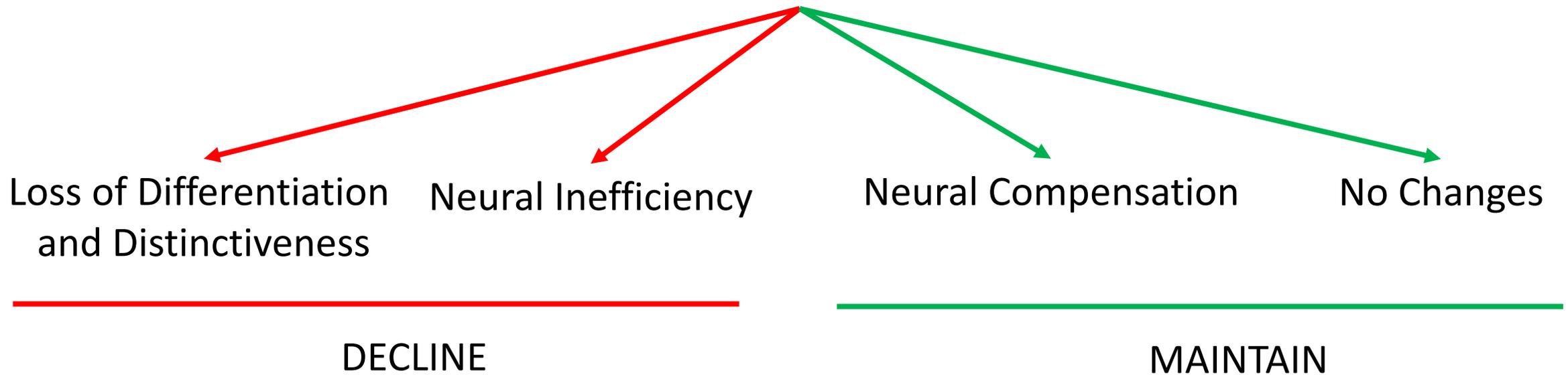
"Red Kangaroo Place"



Compared to my early adulthood, I now have reduced processing speed, working memory and inhibitory control.



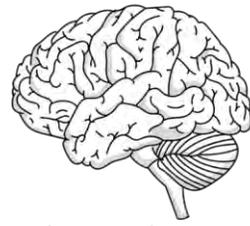
Aging Brain Patterns



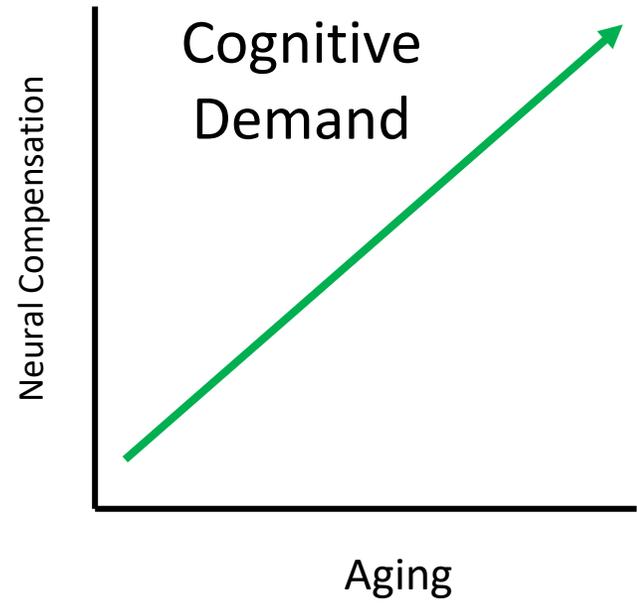
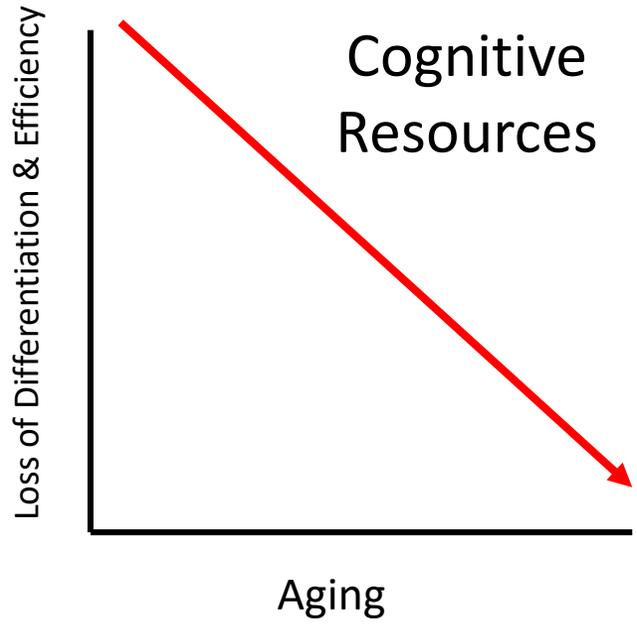
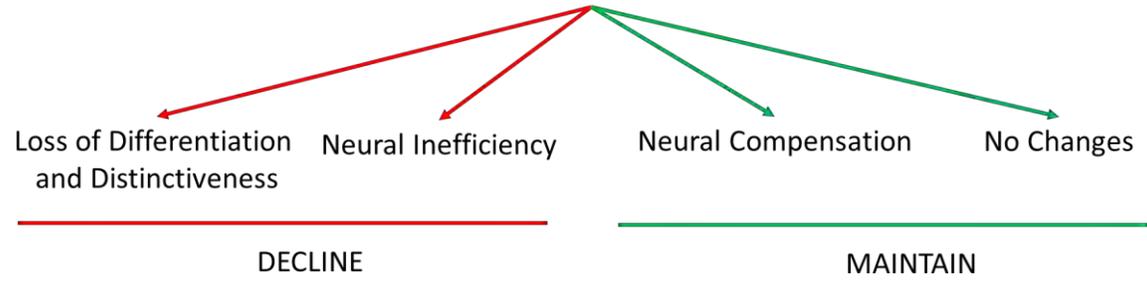


I also have reduced movement function, including slower walking , poorer eye-hand coordination, and decreased motor learning capacity.

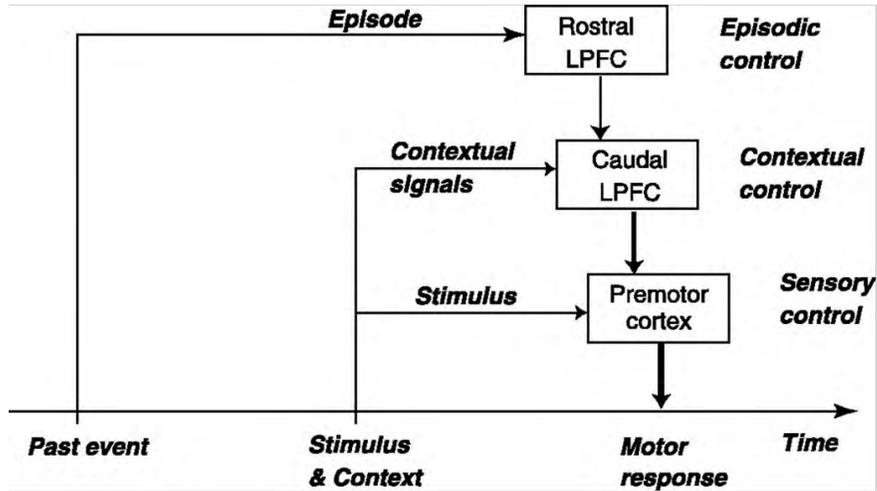
Yan, 1999; 2000; Yan et al., 2009; Studenski et al., 2011



Aging Brain Patterns



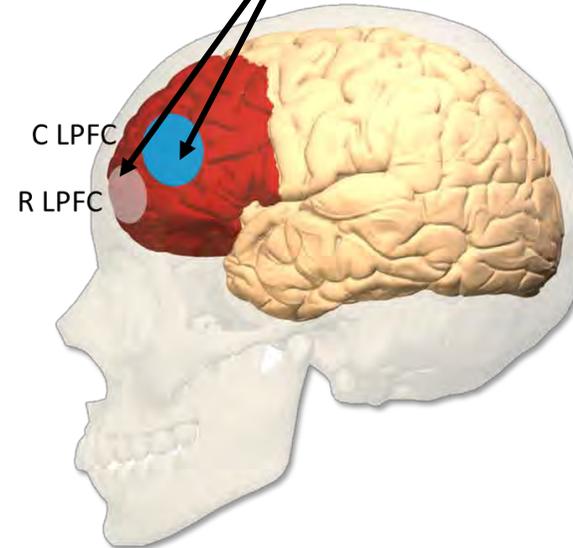
Cascade Model of Cognitive Control



Koechlin & Summerfield, 2007; Koechlin et al., 2003; 1999

Aging-related decline in LPFC

Cabeza, 2002; Prakash et al., 2014; Raz et al., 2005; Ziegler et al., 2012



↓ Working Memory

Deficit

Salthouse & Pink, 2008; Unsworth & Spillers, 2010

↑ Cognitive Control

Overactivation CCN: dlPFC, IPC, SMA

Reuter-Lorenz et al., 2000; Cabeza, 2002; Cabeza et al., 2004; Isingrini et al., 2015

↓ Motor Sequencing

Consequence

Bo, Borza & Seidler, 2015; Verwey, 2010; Verwey, Abrahamse & Ruitenberg, 2011



To counteract or slow my aging-related declines, I complete a daily mindfulness meditation practice. I wonder if this can help me learn motor skills.

Meditation Training in Aging



Behavioral

Executive Function

Cognitive Flexibility

Processing Speed

Working Memory

Visuospatial Processing

Prakash et al., 2014; Tang et al., 2007; Chan & Wollacot, 2007; Jha et al, 2007

Neural

Cognitive Control Network

Inferior and Superior Parietal Cortex (IPC, SPC)

Dorsolateral Prefrontal Cortex (dlPFC)

Anterior Cingulate Cortex (ACC)

Brefczynski-Lewi et al., 2007; Hasenkamp et al., 2012; Prakash et al., 2014

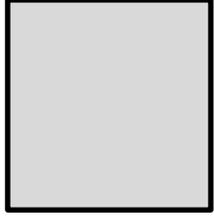
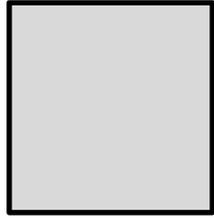
Default Mode Network

Inferior Parietal Lobule (IPL)

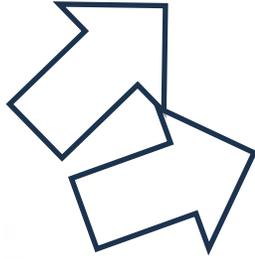
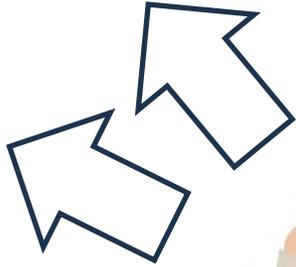
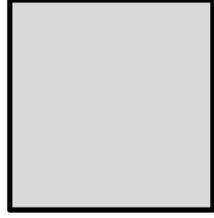
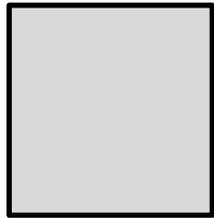
Posterior Cingulate Cortex (PCC)

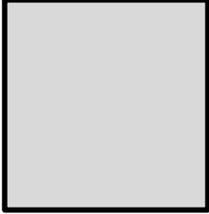
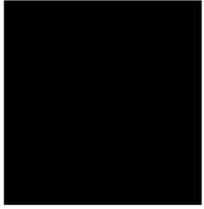
Ventromedial Prefrontal Cortex (vmPFC)

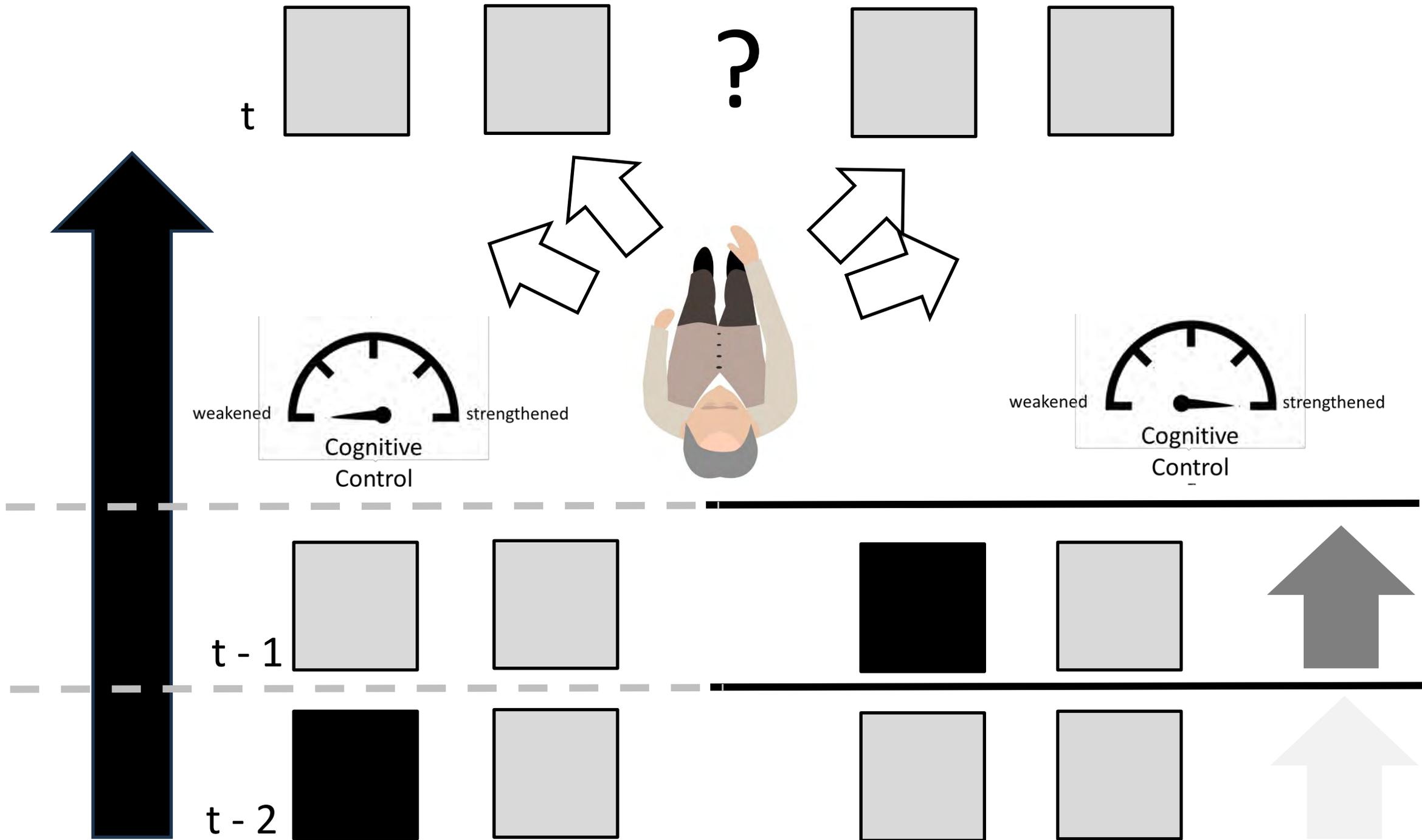
Brewer et al., 2011; Hasenkamp et al., 2011; Prakash et al., 2014; Taylor et al., 2011



?

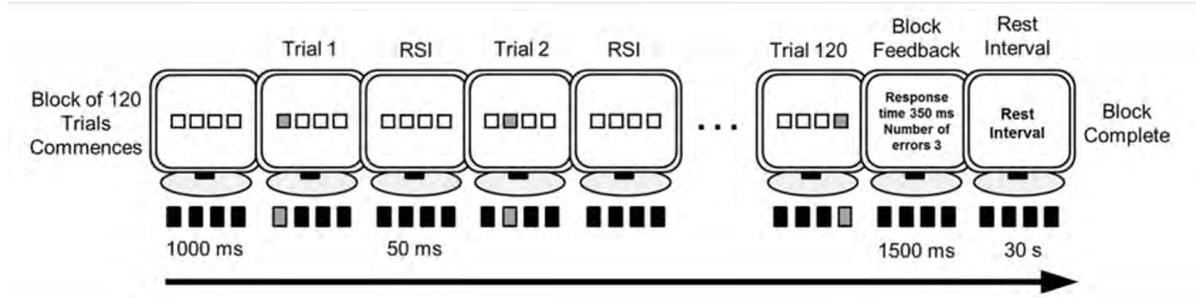
A large, bold, black question mark is centered between the second and fourth squares in the row.





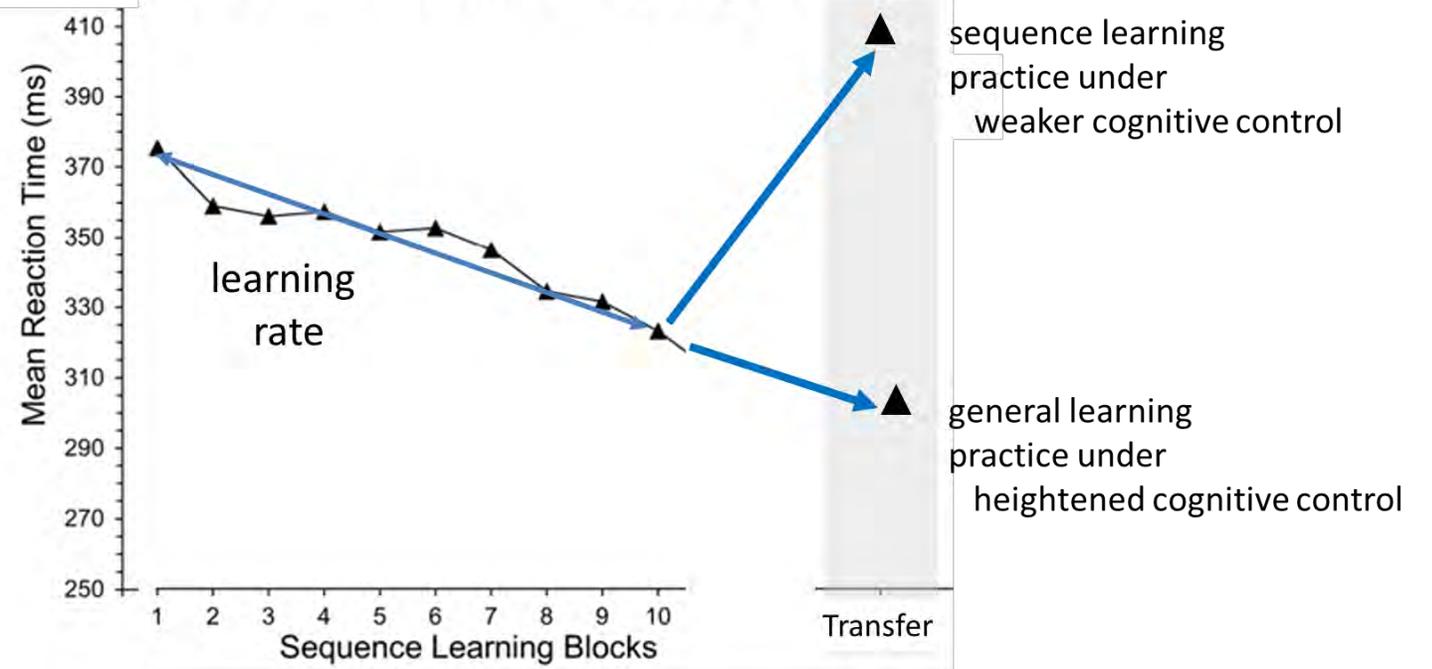
Serial Reaction Time (SRT) Task

Nissen & Bullemer, 1987

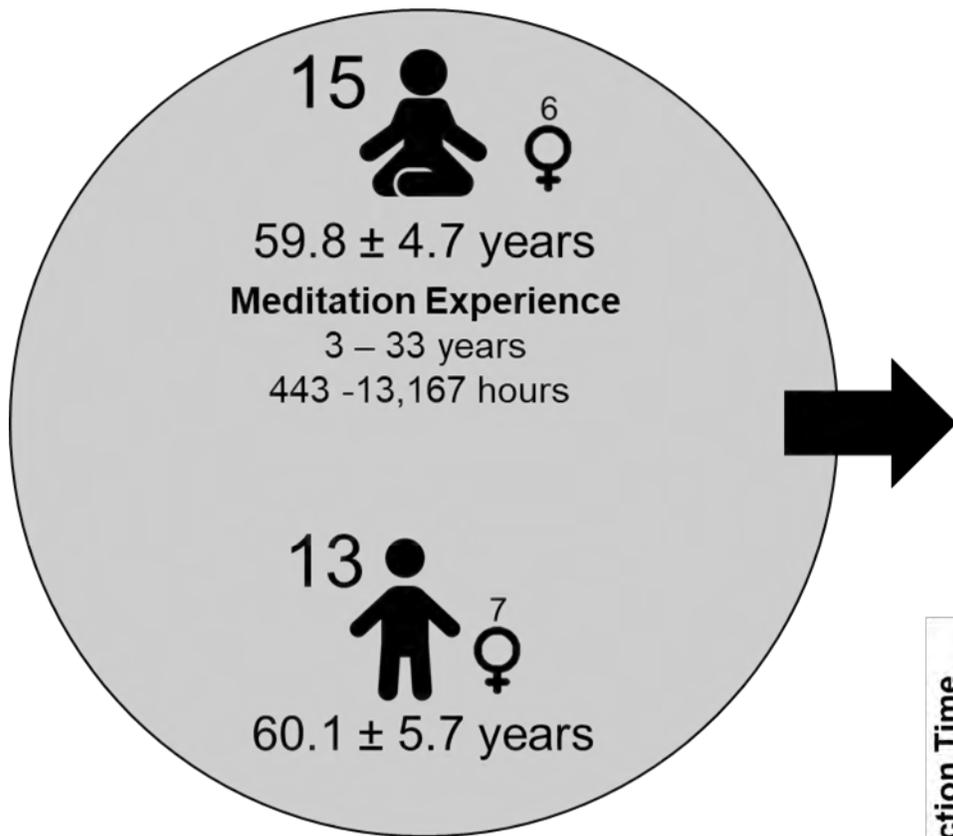


second-order conditional sequence:
121342314324

Serial Reaction Time (SRT) Task

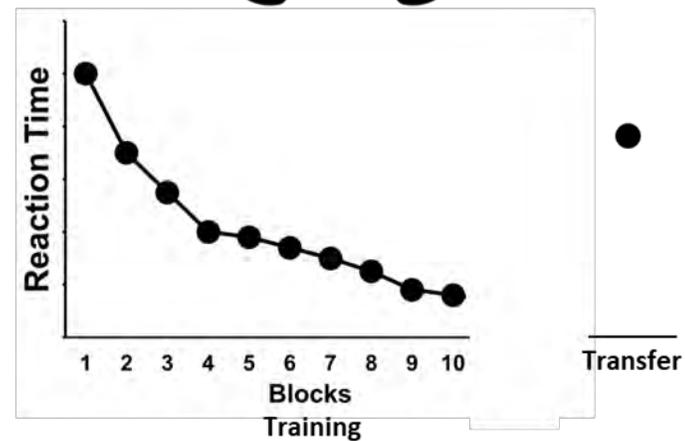
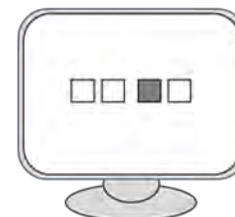


Cross-Section



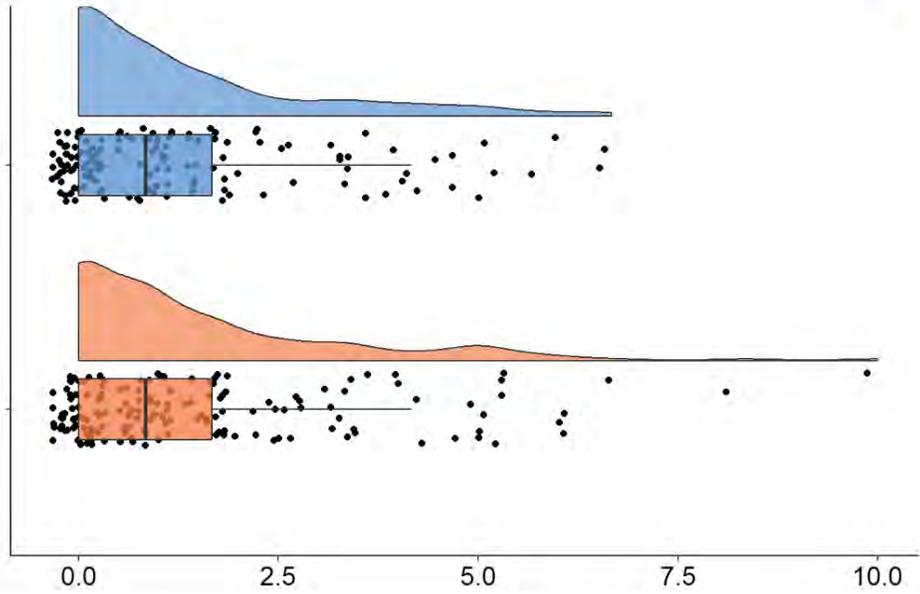
Sequence Learning

serial reaction time task
Robertson (2007)

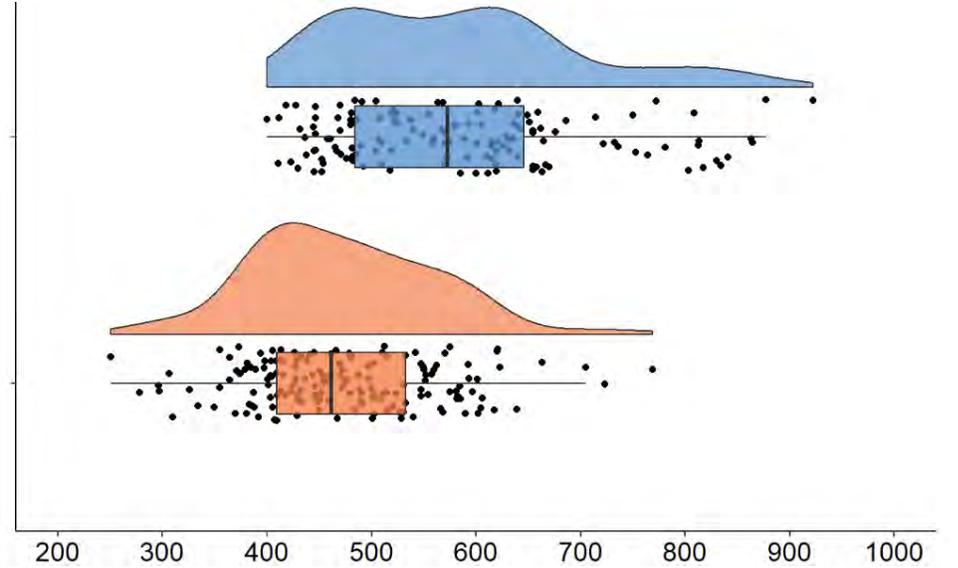


Percent Error

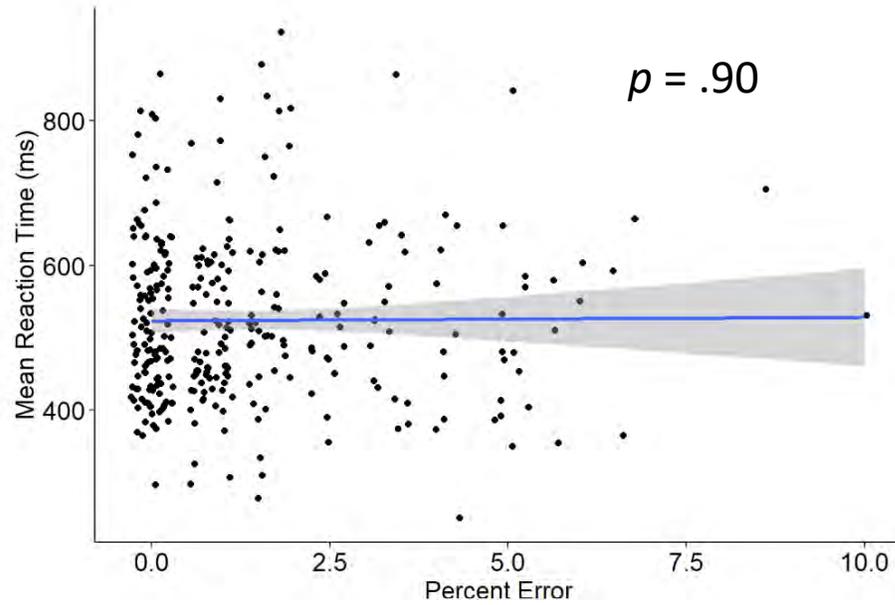
○ Meditator ○ Non Meditator



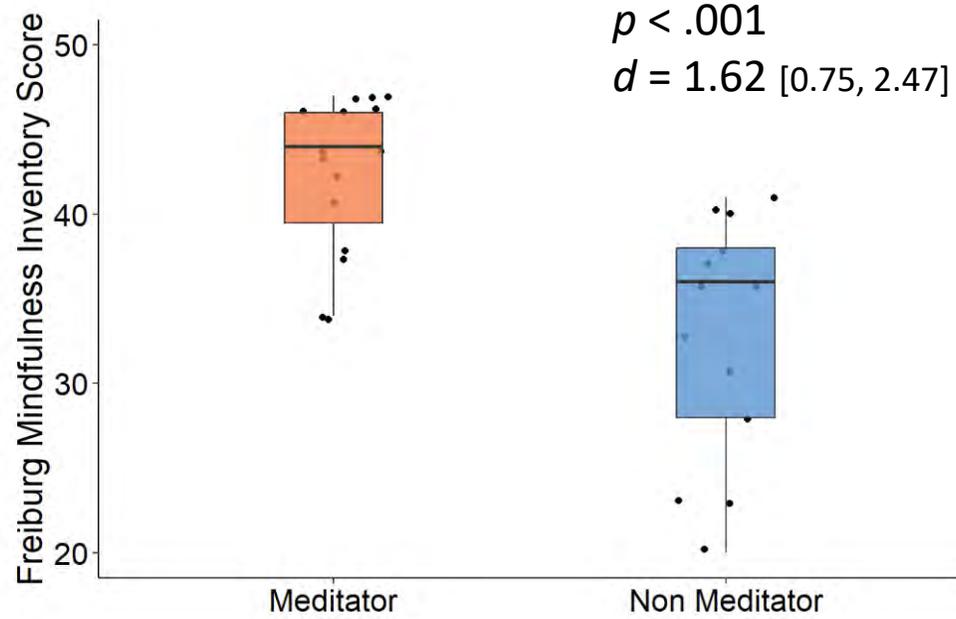
Reaction Time



Reaction Time x Percent Error



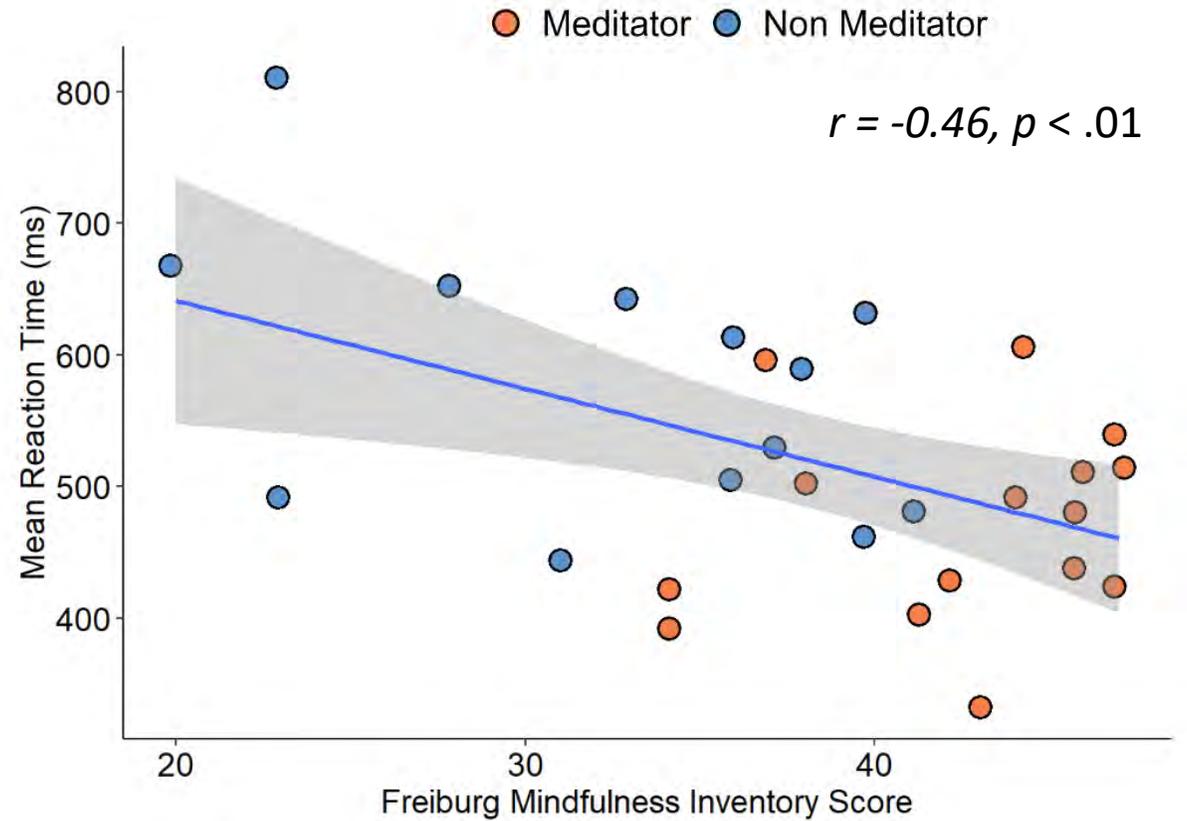
Mindfulness Disposition



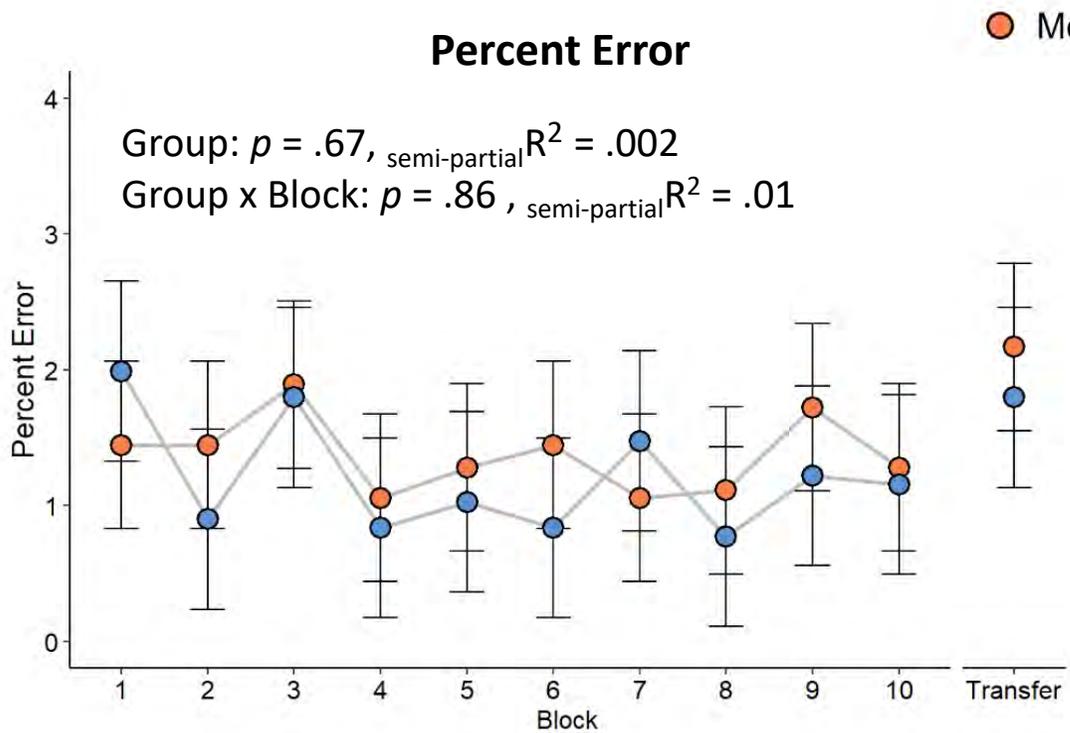
Lehto et al., 2015

	Mean (SD)	Mean (SD)
Overall	37.9 (7.6)	35.9 (7.0)
Meditator	42.4 (4.6)	37.04 (6.7)
Non Meditator	32.8 (7.2)	35.0 (7.1)

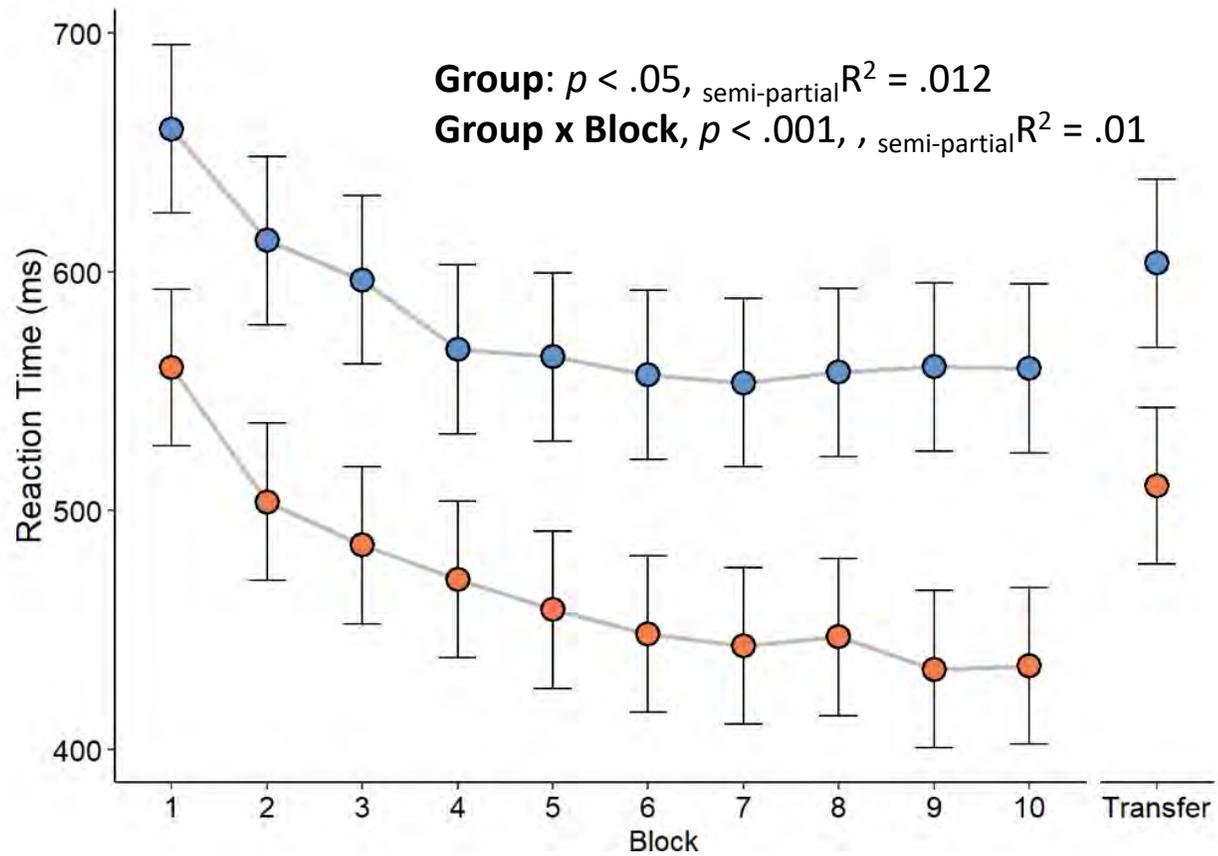
Reaction Time x Mindfulness Disposition



Percent Error

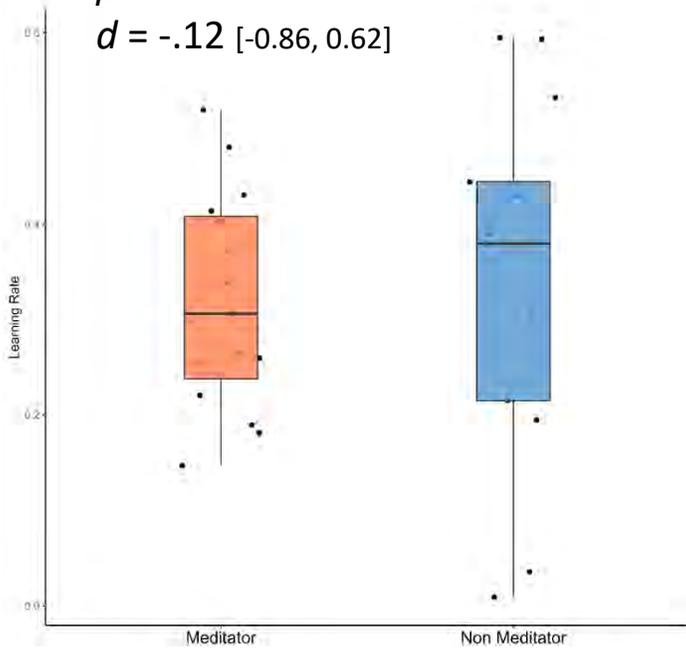


Reaction Time



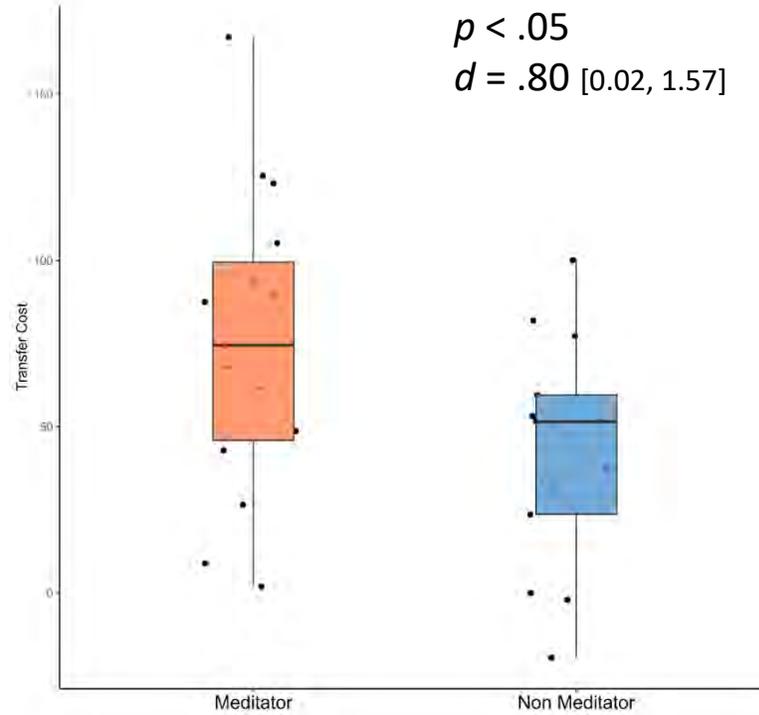
Learning Rate

$p = .75$
 $d = -.12 [-0.86, 0.62]$



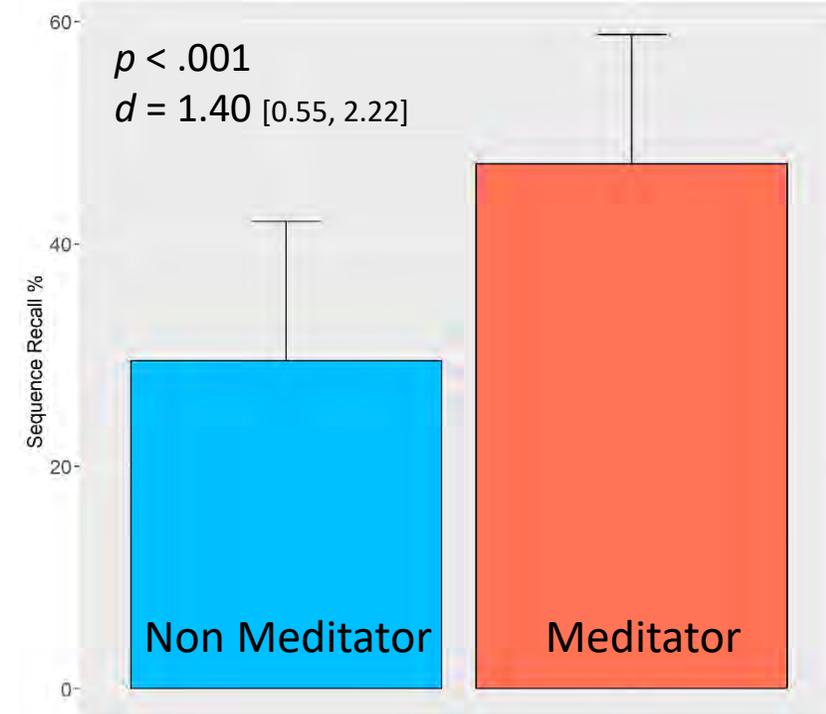
Transfer Cost

$p < .05$
 $d = .80 [0.02, 1.57]$



Sequence Recall

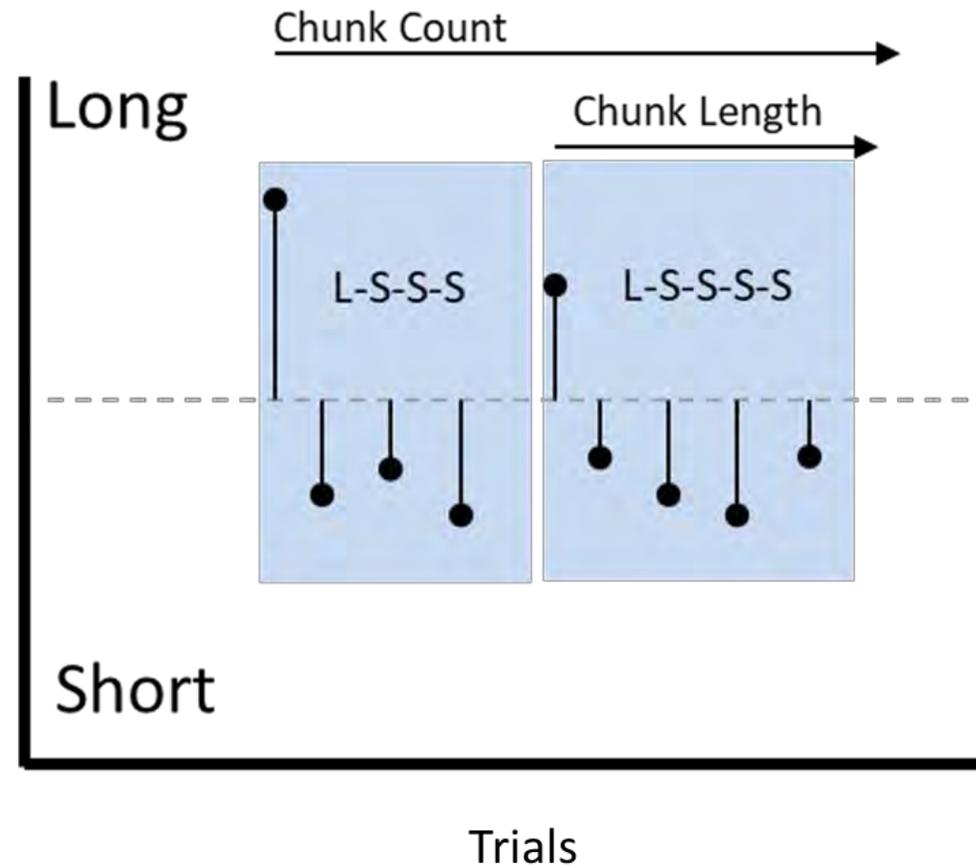
$p < .001$
 $d = 1.40 [0.55, 2.22]$



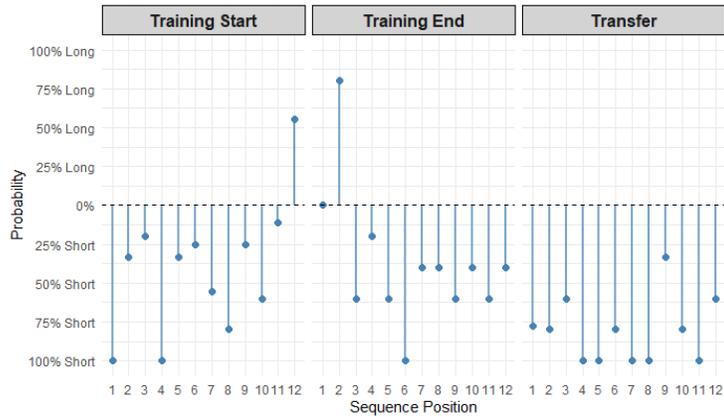
Sequence Awareness

Meditators demonstrated greater sequence awareness (12/15) than Non Meditators (5/13): $p < .01$, $\phi=0.53$

Motor Chunks



Subject: 1008 | Group: meditator

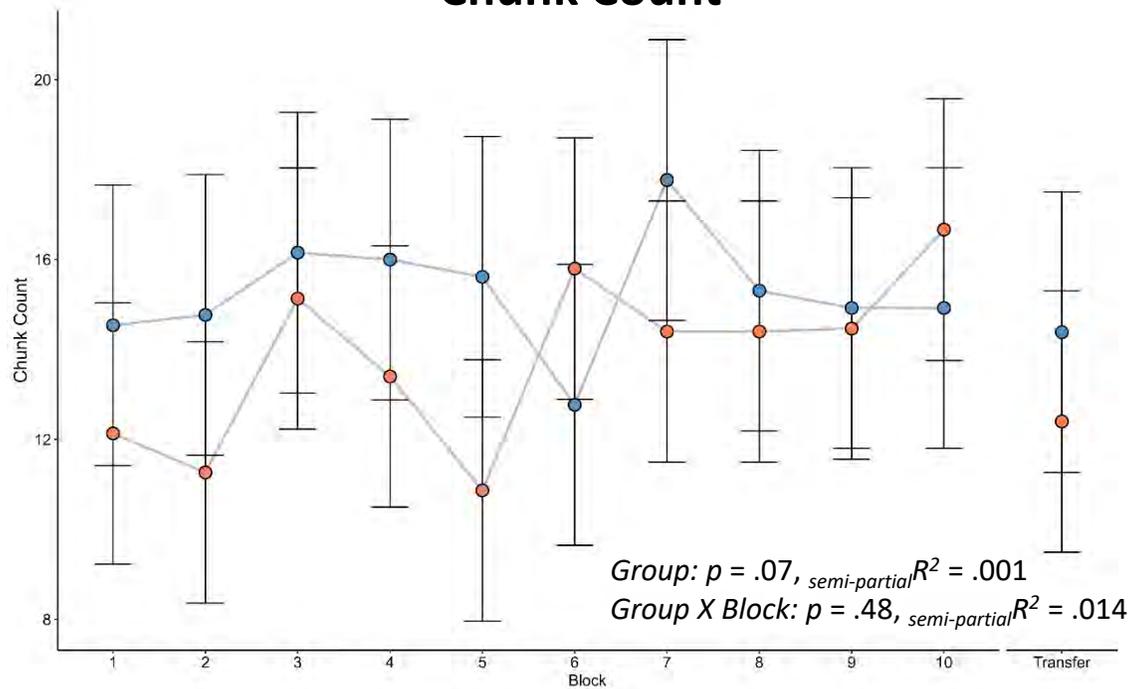


Subject: 1579 | Group: nonmeditator

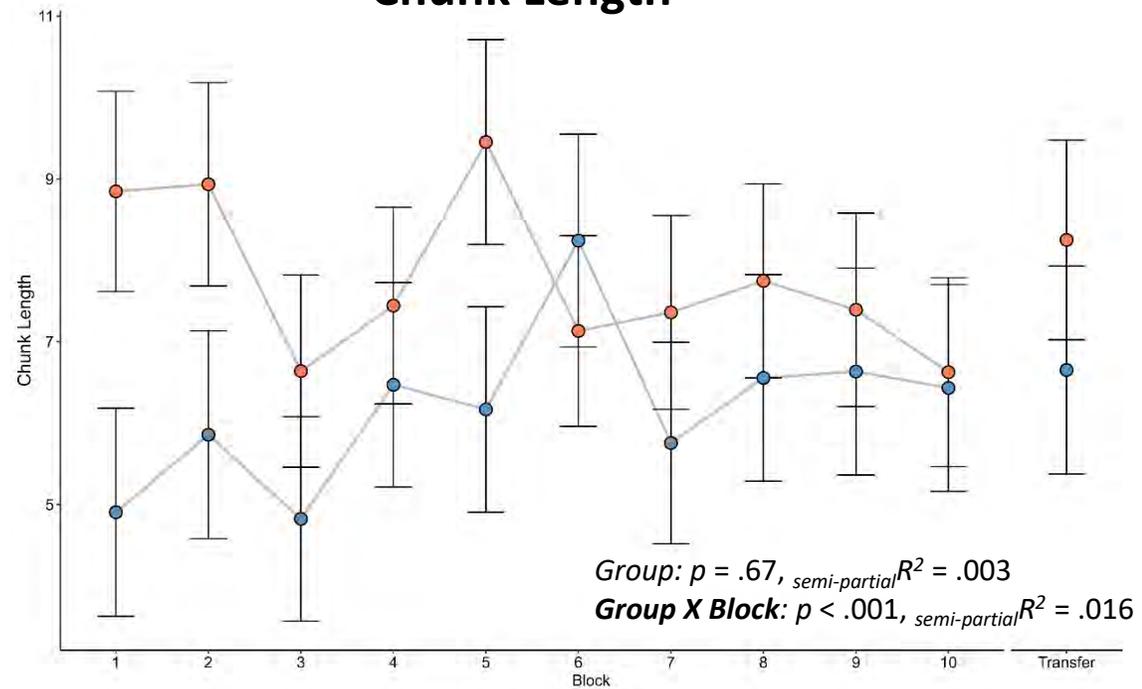


● Meditator ● Non Meditator

Chunk Count

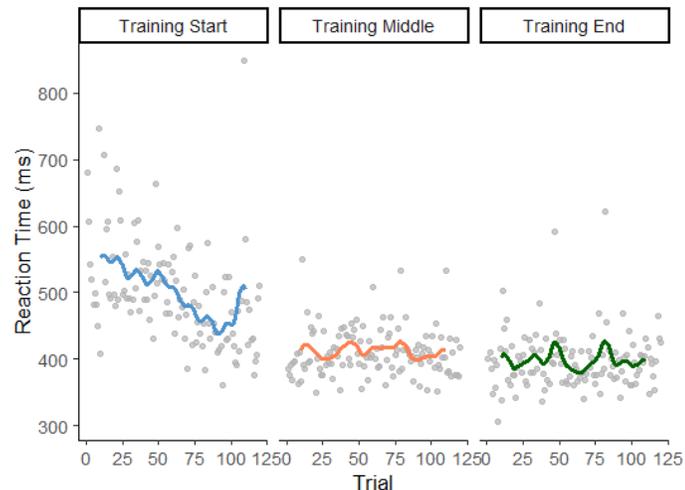


Chunk Length

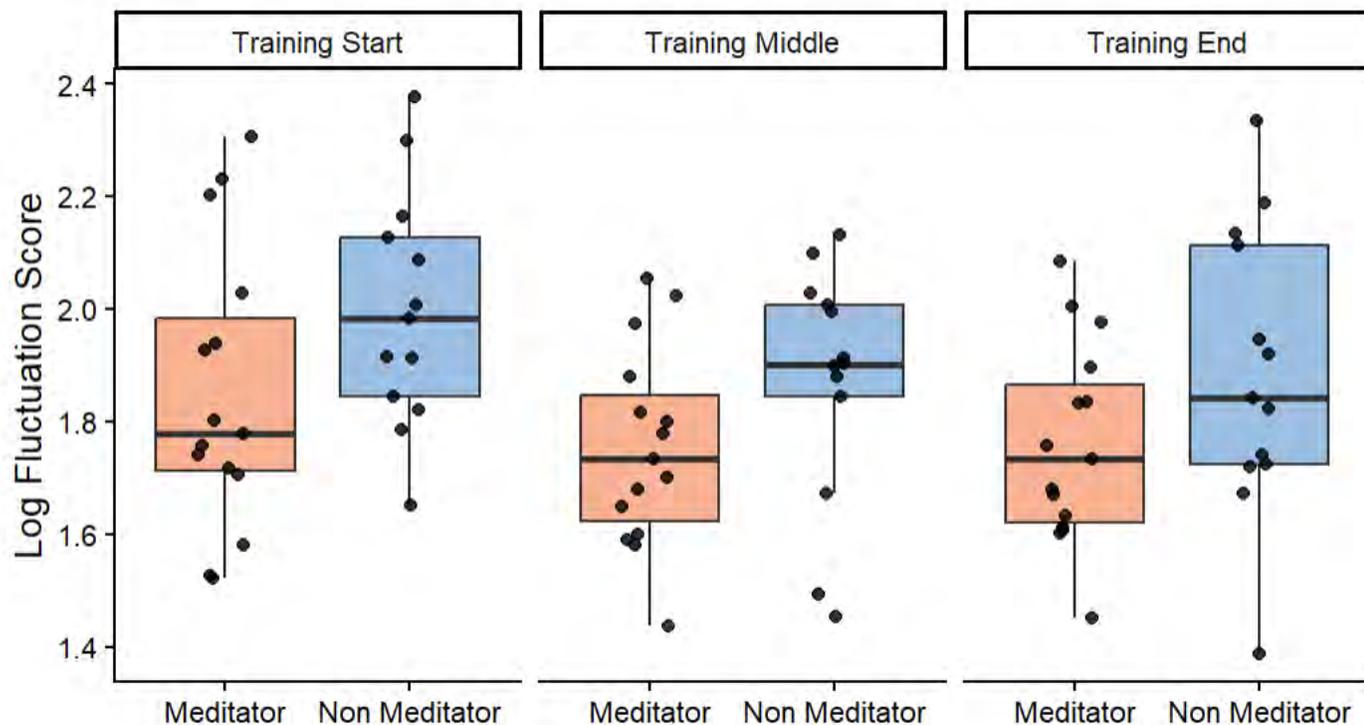
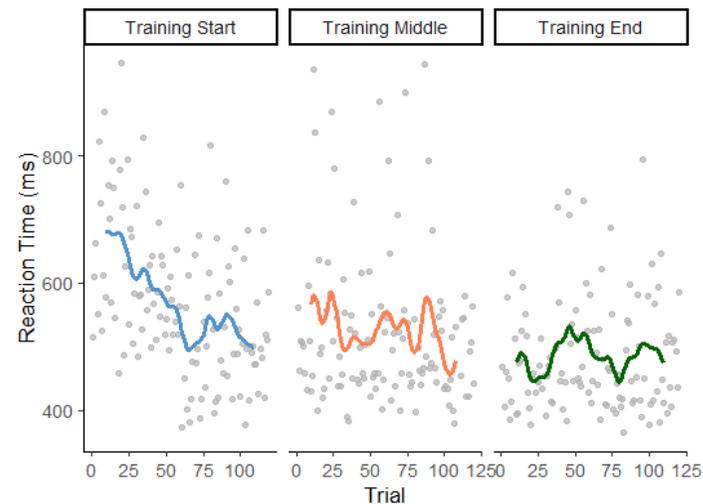


RT Fluctuation

RT Curve for Subject 1038 (Meditator)



RT Curve for Subject 1649 (Non Meditator)

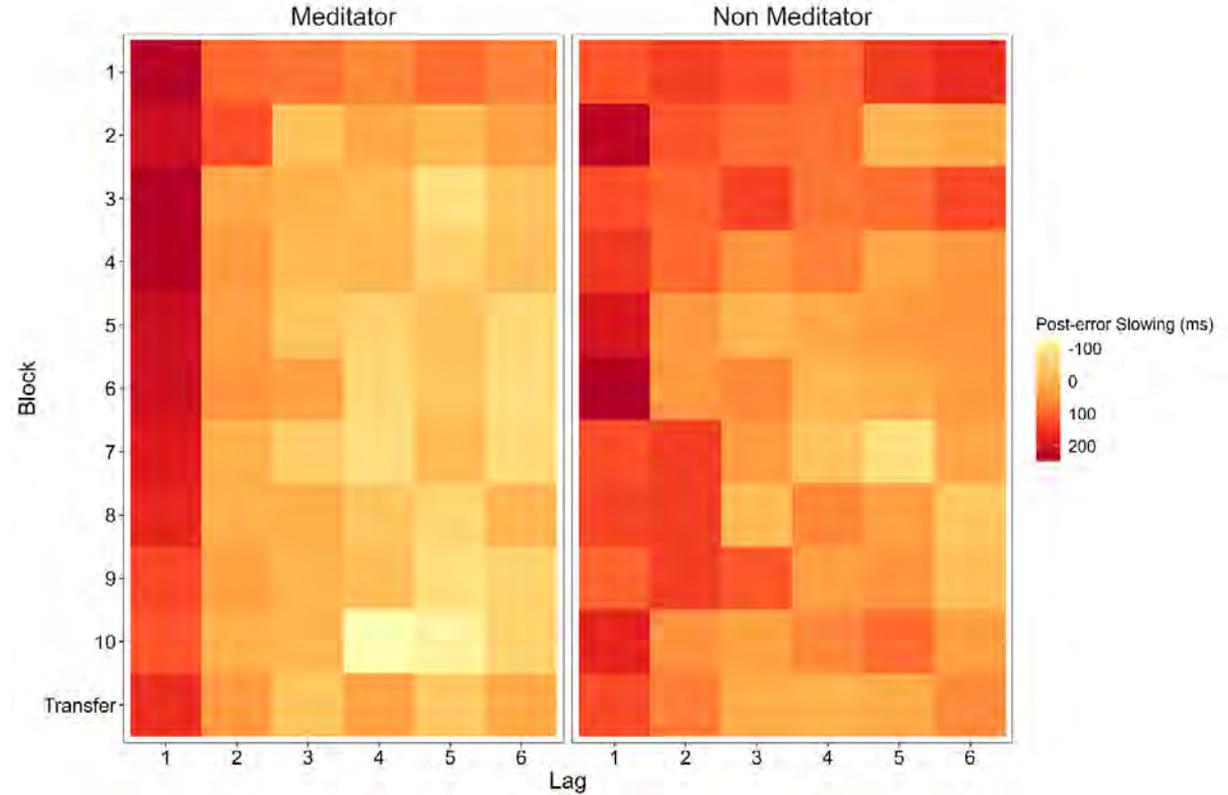
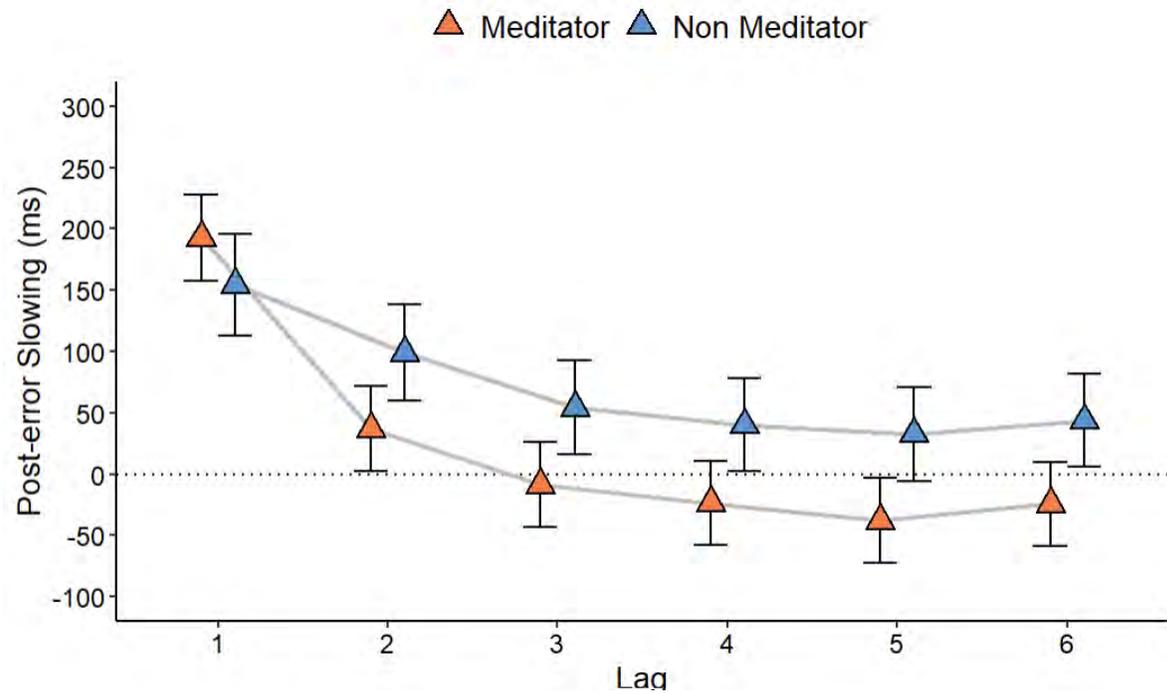


Group: $p = .09$, $semi\text{-}partial R^2 = .038$
 Group X Block: $p = .85$, $semi\text{-}partial R^2 = .001$

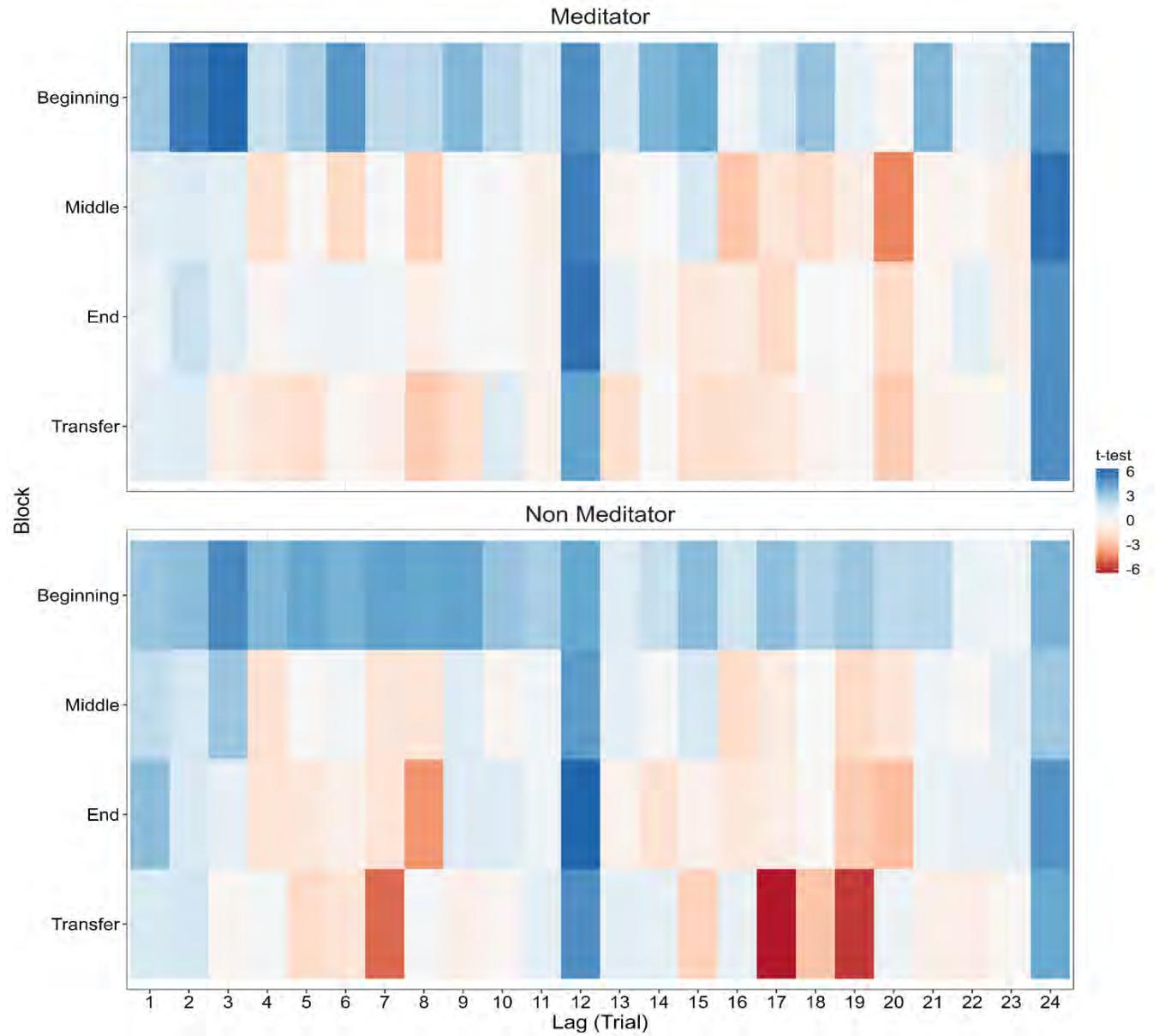
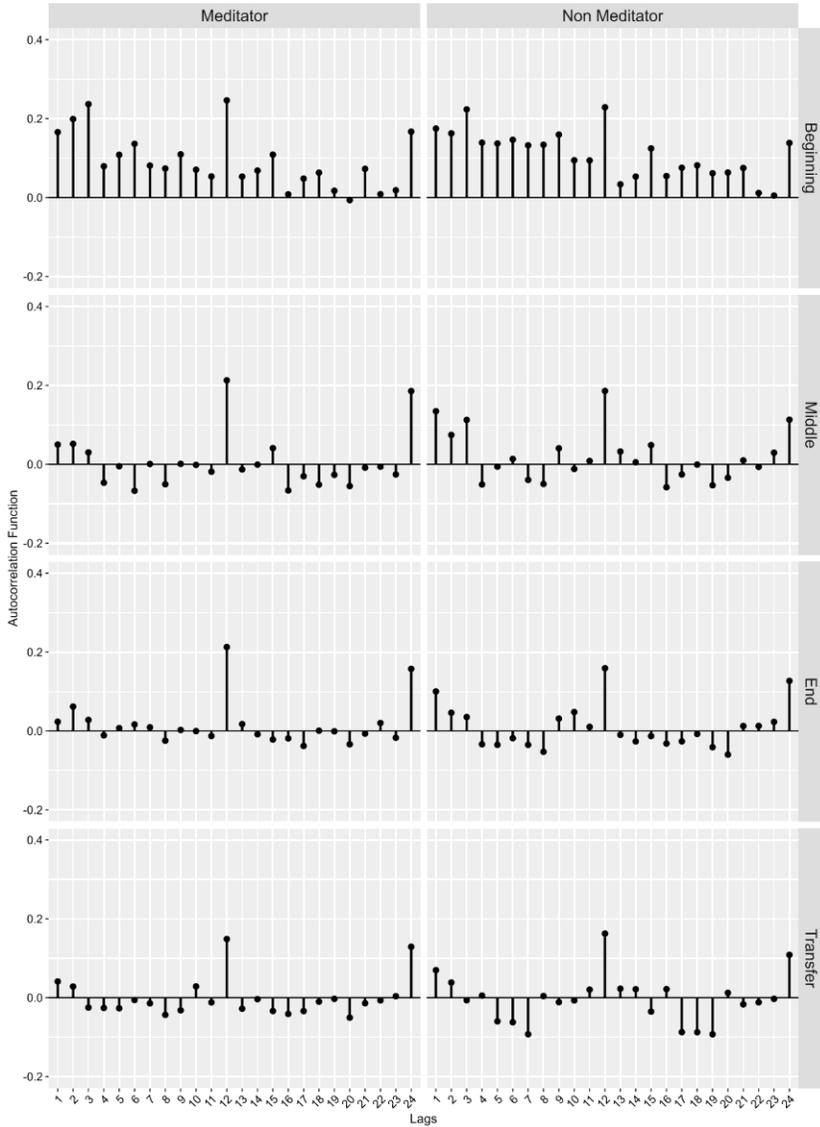
Dykiert et al., 2012
 Tremblay et al., 2009

Post-Error Slowing

Group: $p = .14$, $\text{semi-partial}R^2 = .002$
Group X Lag: $p < .001$, $\text{semi-partial}R^2 = .004$
Group X Block: $p = .19$, $\text{semi-partial}R^2 = .005$
Group X Block X Lag: $p = .51$, $\text{semi-partial}R^2 = .029$



Autocorrelation



Performance & Learning



Meditators



Non-Meditators

Accuracy



Reaction Time



RT Variability



Learning Rate



Motor Sequence Development



Meditators



Non-Meditators

Transfer Cost



Sequence Awareness



Sequence Recall



Chunking



Fluctuation



Post-Error Slowing

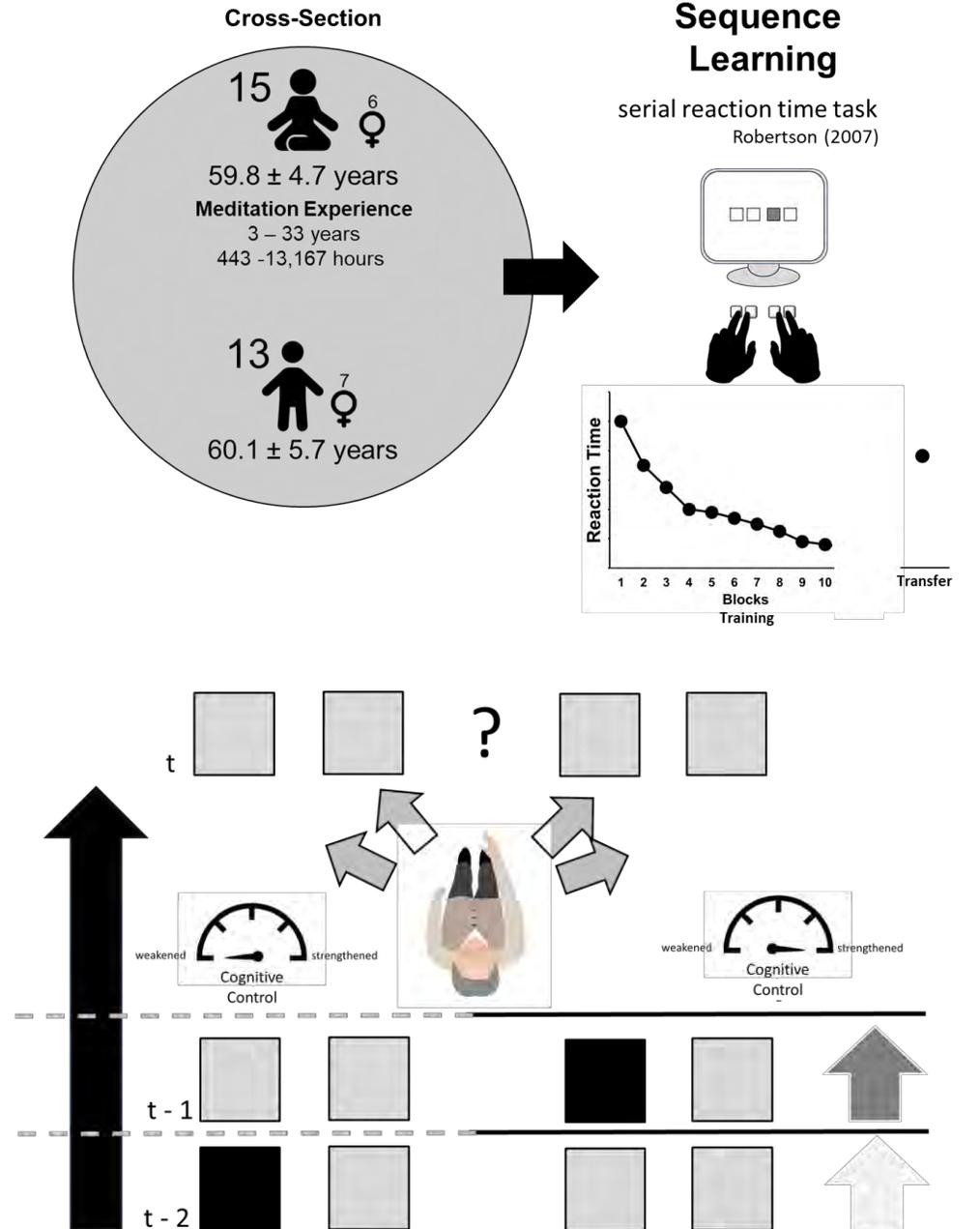


Autocorrelation



Cross-Section Design
Small Sample
Distinct Levels of Trait Mindfulness
Meditation Experience

Cognitive Control
Behavioral & Neural Indices



Meditation, motor learning and aging

From context preservation to contextual integration

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