Cognitive benefits of learning to play chess and other strategy games
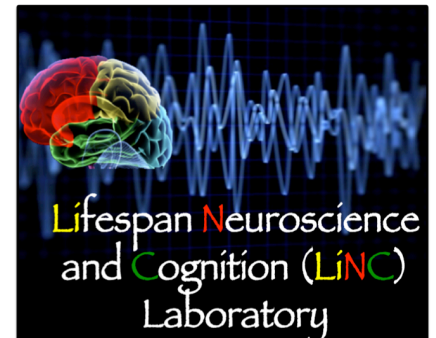
Dr. Chandramallika Basak

University of Texas at Dallas

The Center for Children and Families 2017 Spring Lecture Series on **"Expanding Opportunities for Children and Youth**
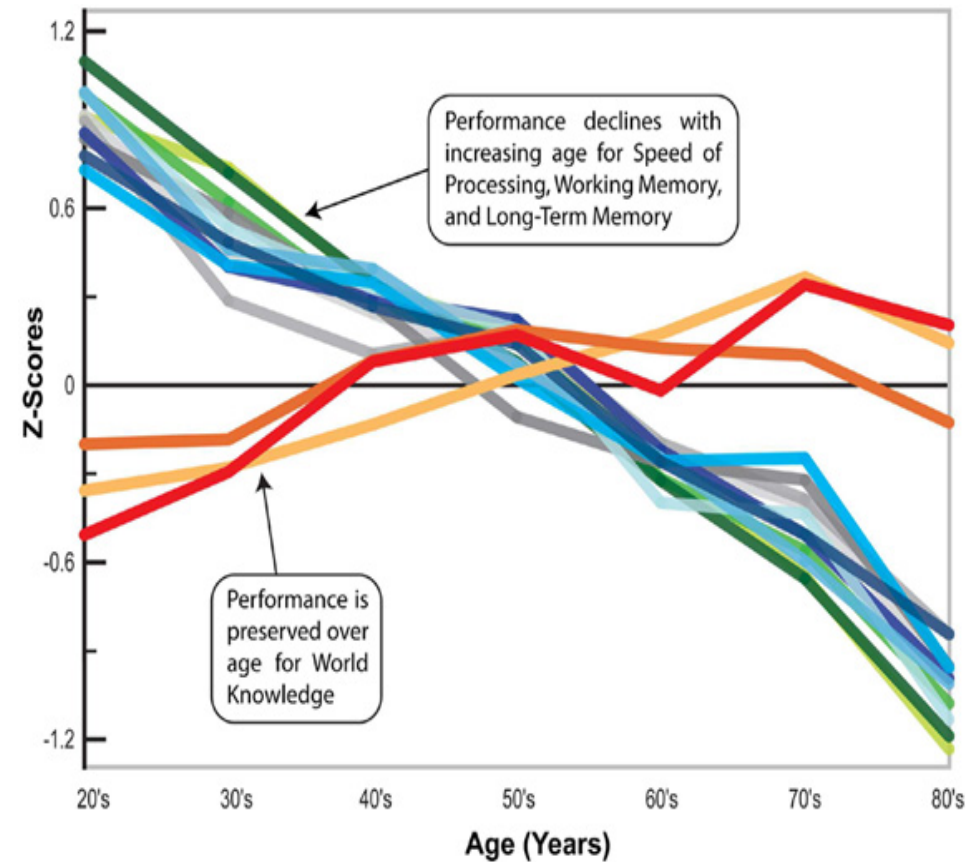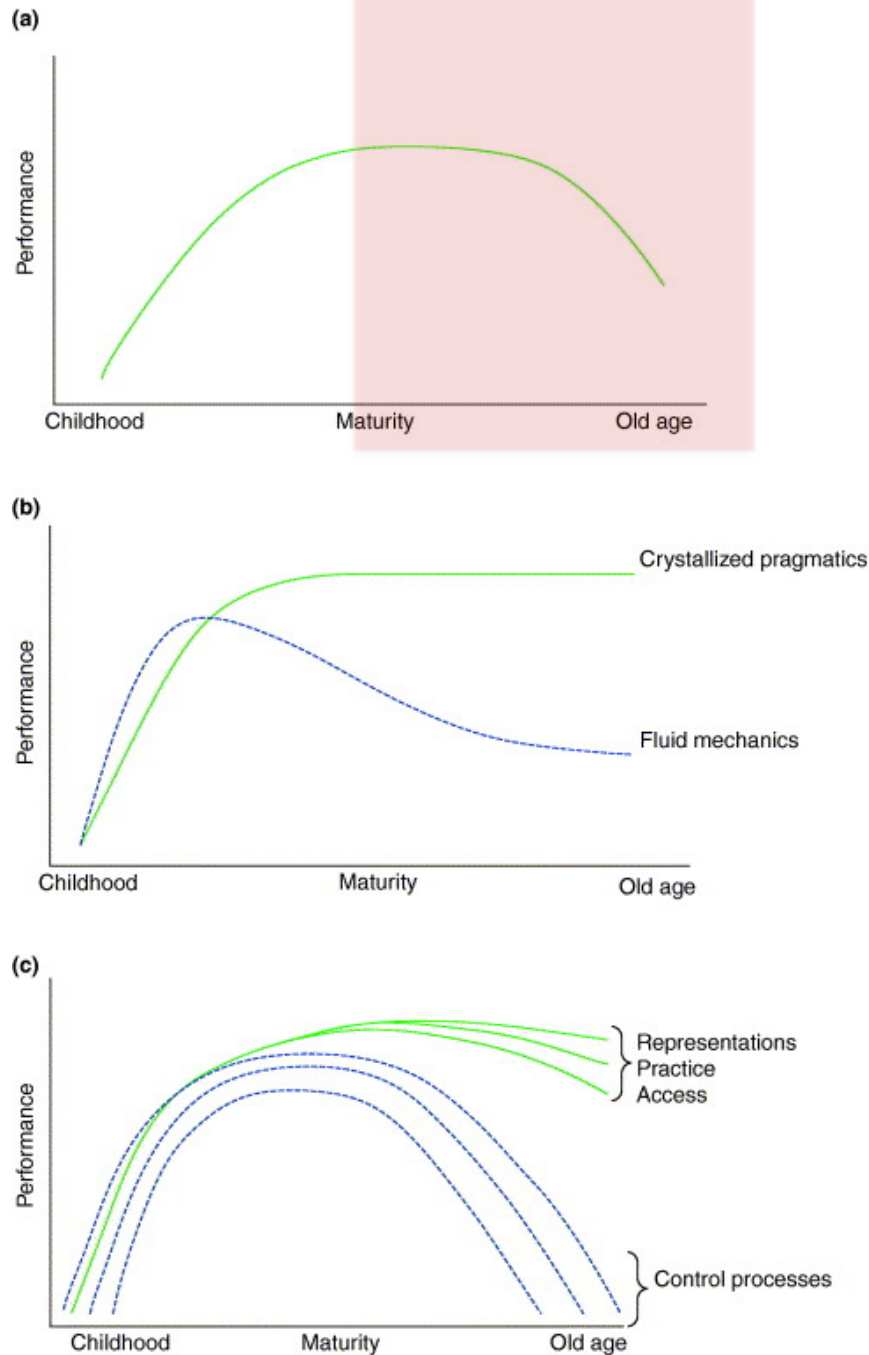
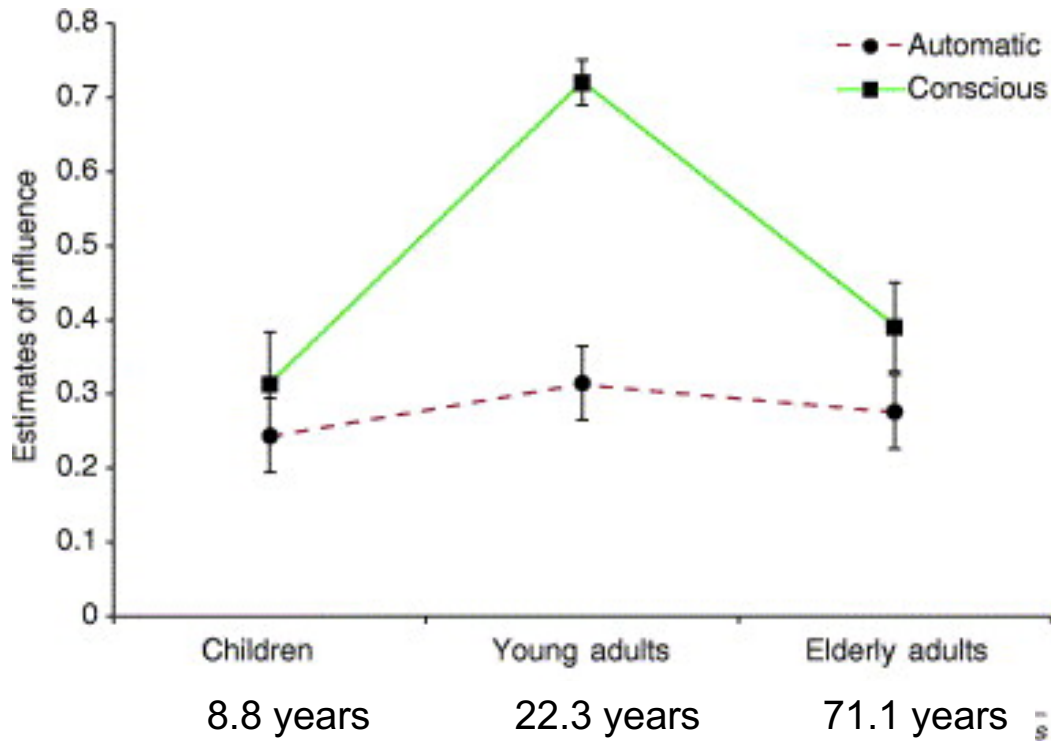March 3, 2017

What is cognition?

How does it change across human lifespan?.

Three speculative models of cognitive change across the lifespan.
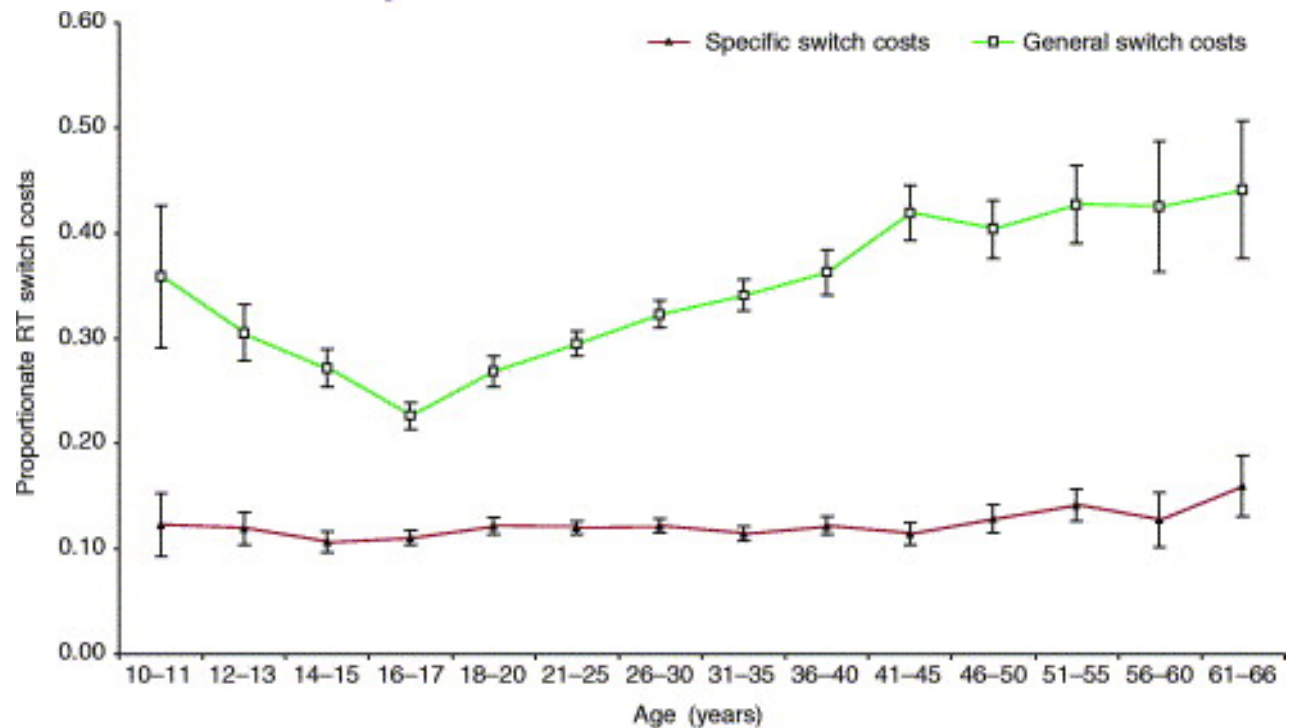

Park & Bischoff (2010)

Craik & Bialystok, 2006

Automatic and consciously controlled influences in a word-stem completion task

Over 5000 participants whose ages ranged from 10 to 66 years performed a multi-tasking experiment on the internet.

Performance declines with increasing age for Speed of Processing, Working Memory, and Long-Term Memory

Performance is preserved over age for World Knowledge
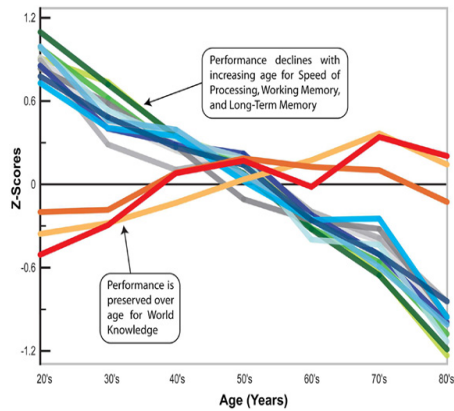
Working Memory

It is those mechanisms or process that are involved in the control, regulation, and active maintenance of task relevant information in service of complex cognition. It is capacity limited.

In many cognitive tasks, WM must be continuously updated => Requires Attention Control

Brain and Cognition

Functional connectivity in Attentional Control Networks

Fronto-Executive

Fronto-Parietal

Single Task

*ns

Dual Task

Memory Updating

O'Connell & Basak, submitted

p (corrected)

10^{-5}

.05
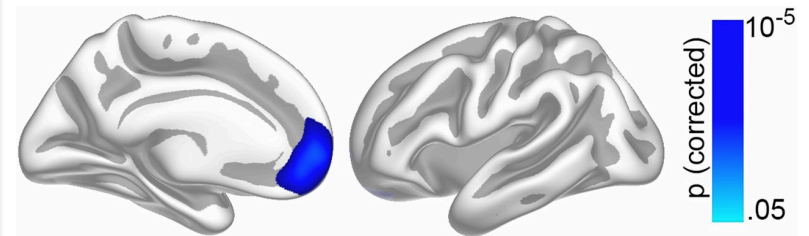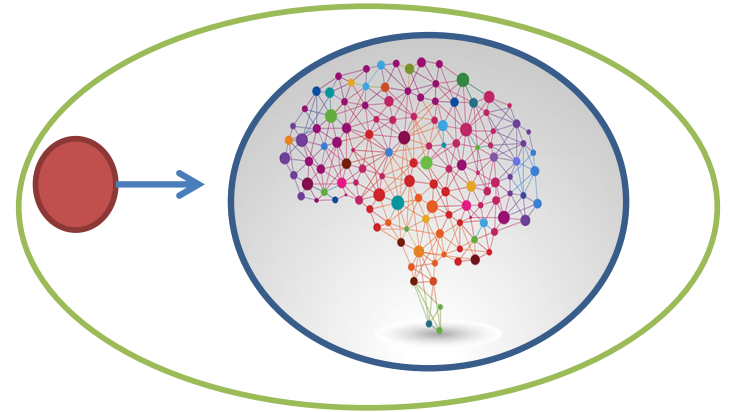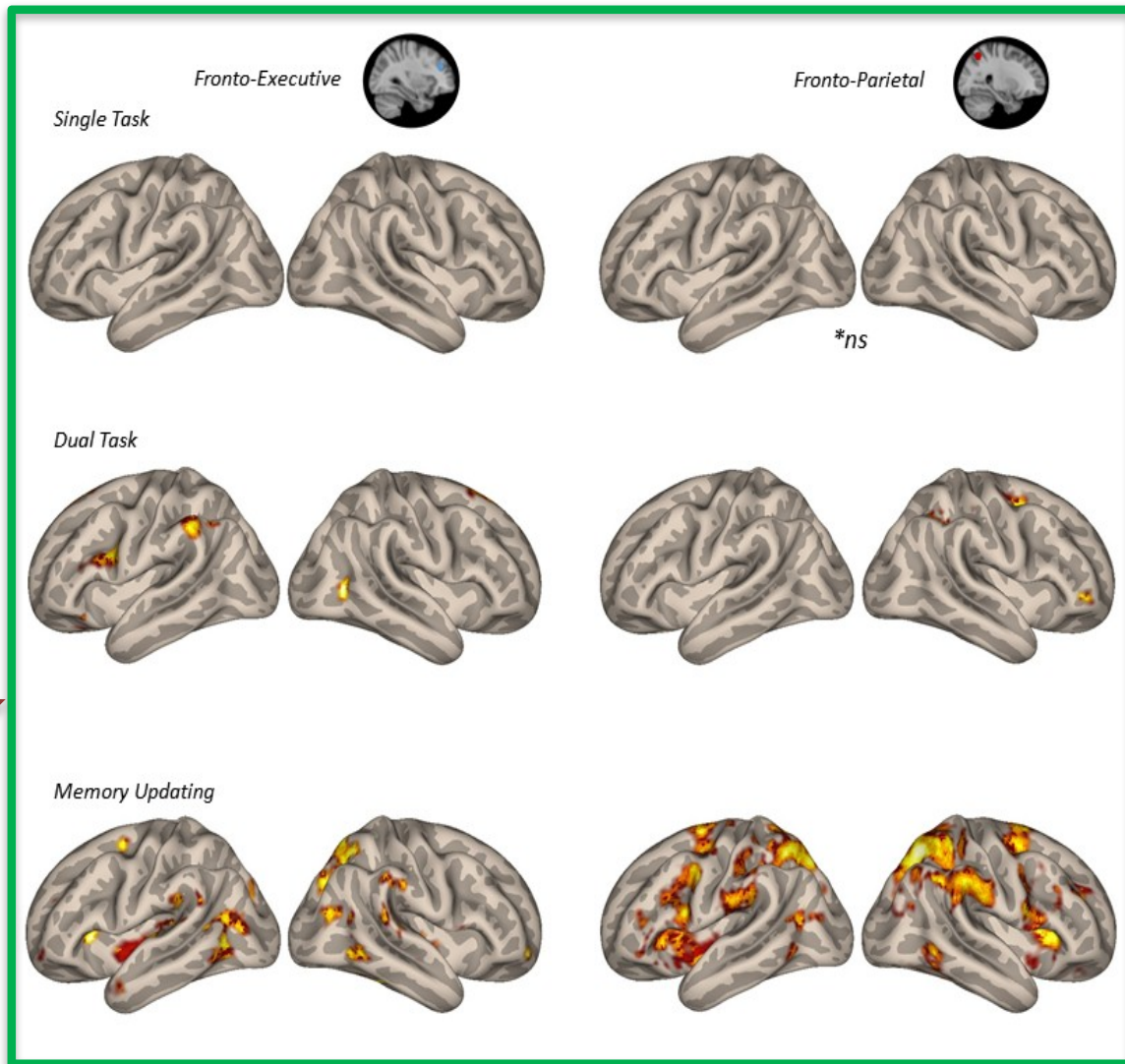
Correlation between cortical thickness and Cognition in 449 children below 12 years of age.

Walhovd et al., 2016

Brain, Cognition and Lifespan

A Cognitively relevant brain networks

Default Mode | Executive/Fronto-Insular | Fronto-parietal

RALPFC, RIPS, PCC

B Younger > Older Adults

LMFG, LOC, MTG, PCC, LPHG, FMC, RPHG, LPFC, LIFG, LINS, RPFC, RALPFC, RINS, RIFG, RIPS, RSMG, RLOC, VVIS, RFOI
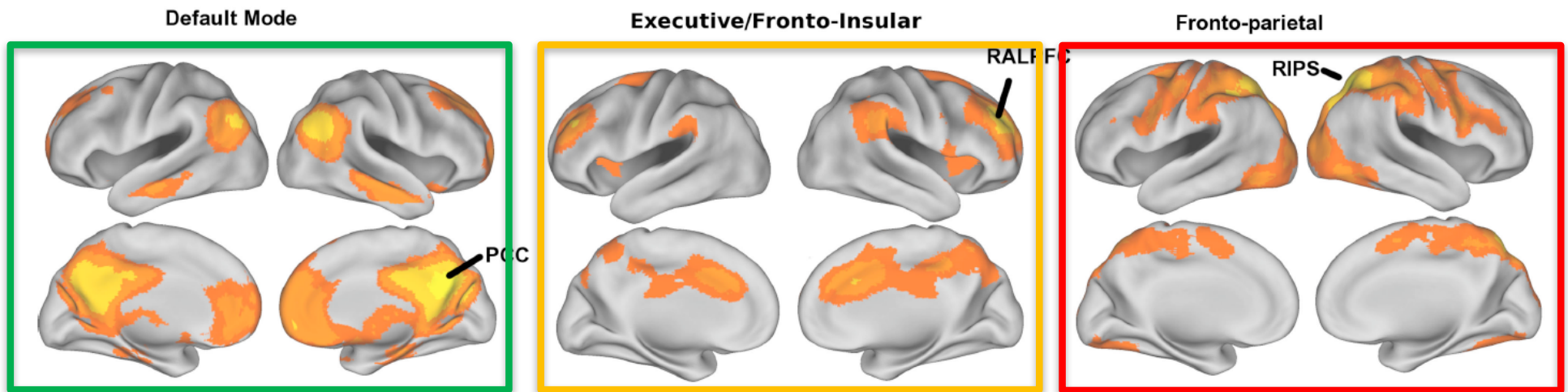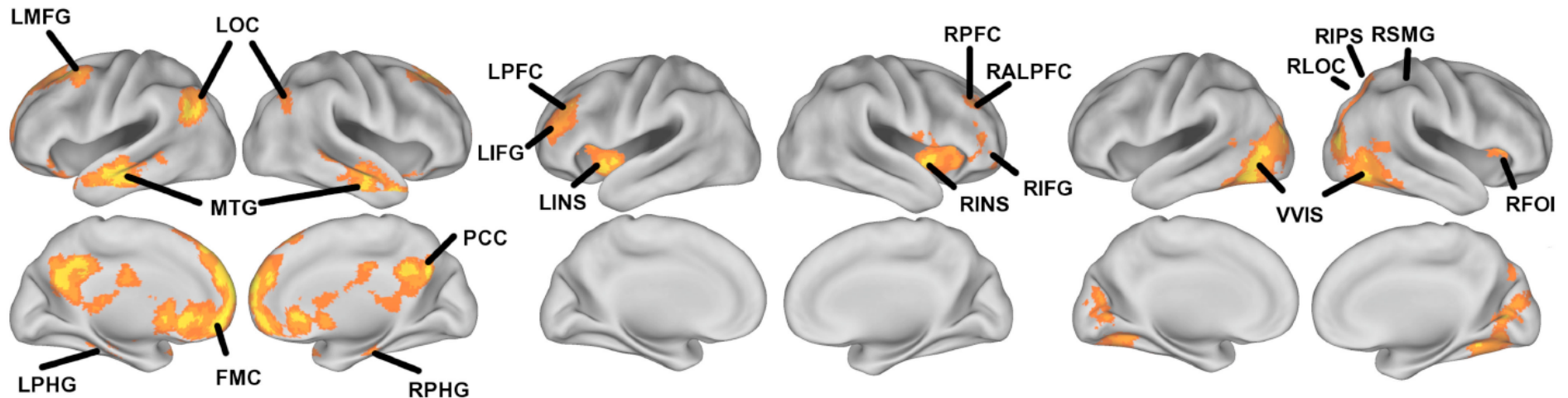
Functional connectivity in Attention Control Networks: Older Adults <Younger Adults
Voss et al., 2010; 2012.

Myths and facts about "cerebral" games

We think Chess instruction makes you smarter, especially in mathematics.

- Achievement in mathematics => STEM
- One Solution: Teach chess at school
- Chess is an optional subject in several countries.
- Spanish parliament has approved of chess instruction during school hours.
- Large project: Chess curriculum in 175 UK schools

Fact: Chess players are more intelligent than general population

But this does not prove that teaching chess to any child will improve their IQ/mathematics skill

How to establish causal link?

- Randomized Controlled Trial (RCT)
  - clinicaltrials.gov
- Randomize children into chess training vs. a different type of training
- Assess their change in cognition after training

Pre-training

59 Individuals Recruited for Participation
Wave 1: 43 Individuals Recruited
Wave 2: 16 Individuals Recruited
　　3.5 h baseline cognitive battery

VGT　　　SKT

Wave 1: 20 randomly assigned to VGT
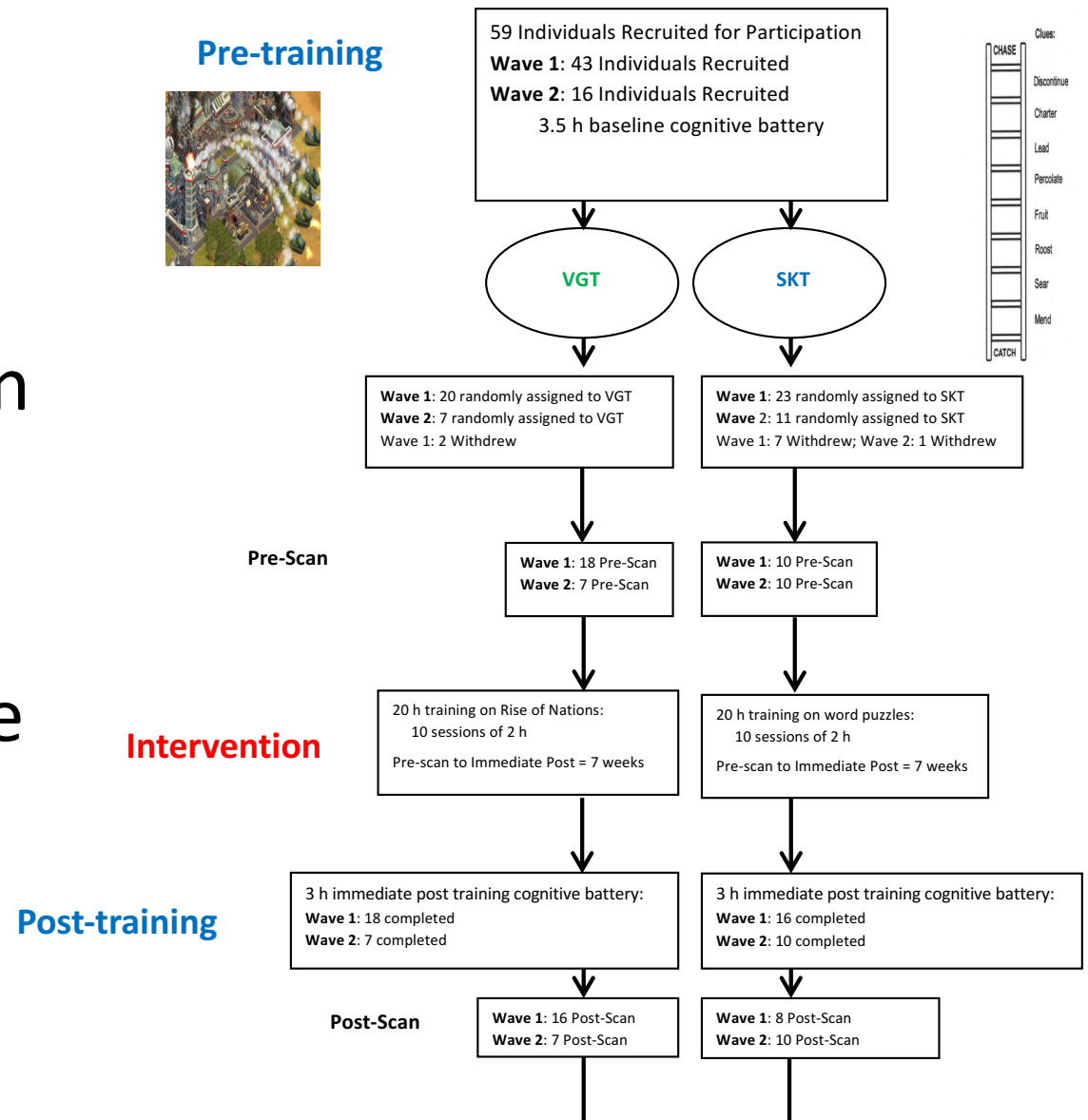**Wave 2**: 7 randomly assigned to VGT
Wave 1: 2 Withdrew

Wave 1: 23 randomly assigned to SKT
Wave 2: 11 randomly assigned to SKT
Wave 1: 7 Withdrew; Wave 2: 1 Withdrew

Pre-Scan

Wave 1: 18 Pre-Scan
Wave 2: 7 Pre-Scan

Wave 1: 10 Pre-Scan
Wave 2: 10 Pre-Scan

Intervention

20 h training on Rise of Nations:
　　10 sessions of 2 h

Pre-scan to Immediate Post = 7 weeks

20 h training on word puzzles:
　　10 sessions of 2 h

Pre-scan to Immediate Post = 7 weeks

Post-training

3 h immediate post training cognitive battery:
Wave 1: 18 completed
Wave 2: 7 completed

3 h immediate post training cognitive battery:
Wave 1: 16 completed
Wave 2: 10 completed

Post-Scan

Wave 1: 16 Post-Scan
Wave 2: 7 Post-Scan

Wave 1: 8 Post-Scan
Wave 2: 10 Post-Scan

Clues:
Discontinue
Charter
Lead
Percolate
Fruit
Roost
Sear
Mend
CHASE
CATCH

Review

Do the benefits of chess instruction transfer to academic and cognitive skills? A meta-analysis ☆

Giovanni Sala ▲ , ✉ , Fernand Gobet

- Reviewed 24 studies on primary or secondary grade children
- Outcomes considered: mathematics, reading or cognitive skills
- Results show a modest overall effect size ($g = 0.338$, $K = 40$)
- Larger effects on mathematics than reading
- These effect is short of expected educational interventions
- Doubts about real effectiveness in practice.
- Publication is an important factor
- >25 h was in the expected range

Study name	Statistics for each study			
	Hedges's g	Lower limit	Upper limit	p-Value
Sala & Trinchero (in preparation) - M1	-0.114	-0.626	0.398	0.664
Gliga & Flesner (2014) - M1	-0.061	-0.840	0.718	0.877
Sala, Gobet, Trinchero, & Ventura (submitted) - M2	-0.030	-0.685	0.624	0.927
Eberhard (2003)	-0.028	-0.382	0.326	0.878
Scholz et al. (2008) - M1	0.020	-0.705	0.745	0.957
Romano (2011)	0.026	-0.078	0.130	0.624
Gliga & Flesner (2014) - M2	0.087	-0.669	0.843	0.822
Fried & Ginsburg (n.d.) - S2	0.100	-0.721	0.920	0.812
Forrest, Davidson, Stucksmith, & Glendinning (2005) - M1	0.101	-0.531	0.733	0.753
Aciego, Garcia, & Betancort (2012)	0.118	-0.185	0.422	0.444
Garcia (2008) - M1	0.122	-0.451	0.696	0.676
Scholz et al. (2008) - M2	0.122	-0.396	0.641	0.643
Fried & Ginsburg (n.d.) - S1	0.125	-0.698	0.947	0.766
Rifner (1992) - M2	0.147	-0.634	0.929	0.712
Yap (2006) - M2	0.152	-0.096	0.399	0.230
Hong & Bart (2007)	0.152	-0.473	0.777	0.633
Rifner (1992) - M1	0.173	-0.628	0.975	0.672
Forrest, Davidson, Stucksmith, & Glendinning (2005) - M2	0.236	-0.368	0.841	0.444
Kramer & Filipp (n.d.) - M2 *	0.262	-0.039	0.562	0.088
DuCette (2009) - M2	0.263	0.026	0.501	0.030
Yap (2006) - M1	0.273	0.025	0.520	0.031
Margulies (1992)	0.275	0.077	0.474	0.007
Christiaen & Verhofstadt-Denève (1981) - M1	0.280	-0.313	0.873	0.355
Sala & Trinchero (in preparation) - M2	0.287	-0.345	0.920	0.374
Sala, Gobet, Trinchero, & Ventura (submitted) - M1	0.333	-0.304	0.969	0.306
Trinchero & Sala (2016)	0.344	0.168	0.520	0.000
Garcia (2008) - M2	0.364	-0.221	0.948	0.222
DuCette (2009) - M1	0.373	0.138	0.608	0.002
Christiaen & Verhofstadt-Denève (1981) - M2	0.410	-0.186	1.006	0.177
Trinchero & Piscopo (2007)	0.411	0.027	0.795	0.036
Sala, Gorini, & Pravettoni (2015)	0.454	0.227	0.681	0.000
Gliga & Flesner (2014) - M3	0.563	-0.072	1.198	0.082
Kramer & Filipp (n.d.) - M1 *	0.627	0.319	0.936	0.000
Kazemi, Yektayar, & Abad (2012) - S2 - M2	0.649	0.272	1.027	0.001
Kazemi, Yektayar, & Abad (2012) - S2 - M1 *	0.743	0.378	1.108	0.000
Kazemi, Yektayar, & Abad (2012) - S1 - M2	0.790	0.245	1.335	0.004
Sigirtmac (2012) *	1.060	0.540	1.581	0.000
Kazemi, Yektayar, & Abad (2012) - S1 - M1 *	1.193	0.607	1.779	0.000
Barrett & Fish (2011)	1.232	0.457	2.007	0.002
Aydin (2015)	1.657	0.836	2.478	0.000
	0.338	0.242	0.435	0.000

-2,00   -1,00   0,00   1,00   2,00
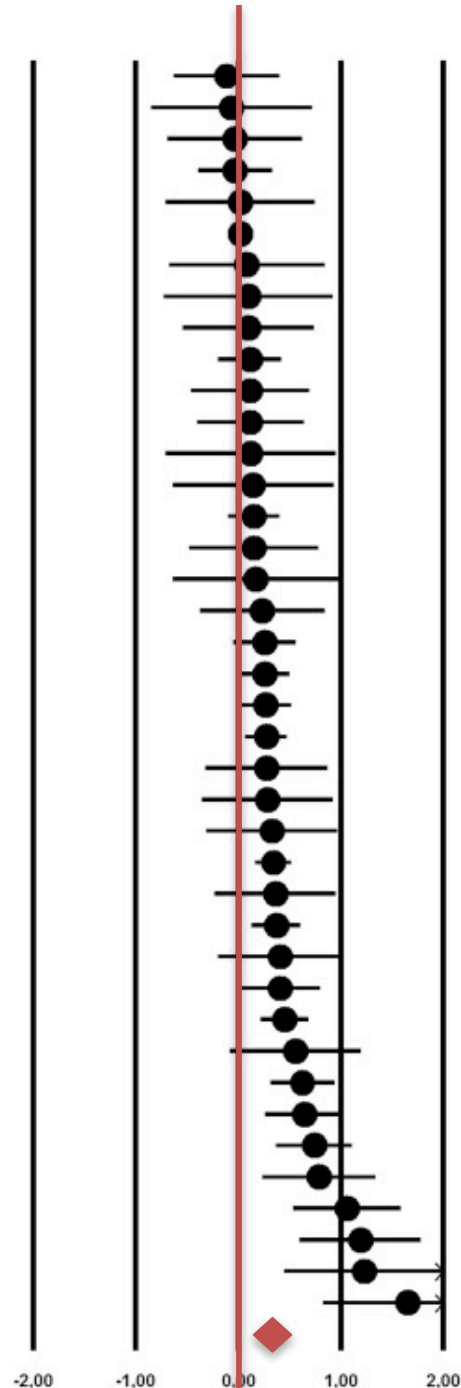
Myths and facts about "cerebral" games

We think playing videogames makes you aggressive.

We think playing videogames makes you smarter.

Fact: Experienced gamers > Novices on perceptual skills and attention control

But this does not prove that training on video games will improve these skills

What is common between chess and video games?

- Not all games are created equal.
    - *Ray et al., under review*
- Turn-based or real-time strategy video games involve similar cognitive mechanisms as in chess.
- Therefore, research from one domain can advance our understanding of the other domain.

Strategy Video Game Training in Adults

Q 1: Can video game training in older adults improve higher-level complex cognitive skills?

Basak et al., 2008, Psych & Aging.

Basak et al., in preparation.

Q 2: Does more volume in certain brain regions or initial brain state (EGG) predict improvement in videogame performance?

Basak et al, 2011, Brain & Cognition.

Erickson, Boot, Basak, et al., 2010, Cerebral Cortex.

Mathewson, Basak et al. in press, Psychophysiology.

Q3: Are there any strategies to enhance learning, brain function & memory?

Boot, Basak, et al., 2010, Acta Psychologica.

Voss et al., 2012, Neuroimage

Basak & O'Connell, 2016; Frontiers of Psychology

Real-Time Strategy (RTS) Video Game
Rise of Nations

- Build cities and farms
- Generate revenues
- Assign citizens to work
- Monitor multiple cities
- Monitor available resources
- Expand a national border

Basak et al., 2008, Psychology & Aging

Chess training in children

Can **attention control** in children be improved with training on this classic strategy game?

Projects in collaboration with Jim Stallings and UTD's Chess Club

http://www.utdallas.edu/chess/education-camp/camp.html

Ages: 7-14 years Camp groups include
    Beginners, who master the basic rules and fundamentals of chess
    Intermediate players, who build on basic chess knowledge with key strategies and ideas
    Advanced players, who sharpen their competitive edge with advanced strategies for tournament play

Research questions:
1) What are cognitive predictors of chess learning?
2) Does cognition improve with short duration of intensive chess training?

Age: 7-12 years

Preliminary results (n=12)

- Children recruited from the chess camp improved in focusing attention to the target and in multi-tasking skills.
- These improvements suggest that chess instruction has the potential to improve the "building blocks" of complex cognitive skills.

Stay tuned in late fall!

Take home ideas

- Inability to focus attention to the relevant task is an issue in children, particularly those diagnosed with ADHD.
- Ignoring distractors and focusing on task at hand is important for most cognitive tasks and educational achievements.
- Learning chess or related strategy games may induce efficient focusing of attention in children, by enhancing underlying neural networks.
- Talk to children about "brain plasticity".
- Play strategy-based board games with children.
- Don't judge all video games to be same. Some may prove to be beneficial not only for your child, but also for your parent.
- Grandparents and children can both benefit from strategy game training. What about grandparent-child summer camps!

Thanks to
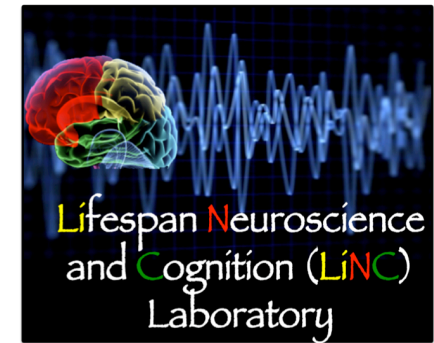
LiNC lab team!

- Evan Smith
- Nicholas Ray
- Eva Qin
- Alex Hinerman

UT Dallas' Summer Chess Camp

- Jim Stallings

LiNC lab of UT Dallas
  - linc@utdallas.edu
  - Call lab phone: 972-883-3761/3767