YORK UNIVERSITÉ UNIVERSITY | YorkU Centre for Aging Research & Education (YU-CARE)

AGING RESEARCH SPOTLIGHT on EXECUTIVE CONTROL

Dr. Gary Turner

In recent months, YU-CARE Steering Committee member Dr. Gary Turner from the Department of Psychology has significantly contributed to the study of the cognitive neuroscience of aging.

Dr. Turner's research uses MRI techniques to investigate how brain functioning is related to cognitive changes that occur in older adulthood. His recent studies expand beyond the commonly held assumption that cognitive aging is short-hand for cognitive decline. His research has shown that cognitive aging is also associated with cognitive gains in areas such as creative thinking as well as wisdom in solving real world problems. Dr. Turner and his students are also working to develop cognitive training programs to improve concentration and focus in later life.

Read the abstracts for Dr. Turners' recent research on cognitive aging and neuroscience below and follow the journal links for the full articles.

Abstracts and Links

Turner, G.R., Novakovic-Agopian, T., Kornblith, E., Adnan, A., Madore, M., Chen, A.J.W., & D'Esposito, M. (2019). Goal-Oriented Attention Self-Regulation (GOALS) training in older adults. ***Aging & Mental Health.***

Abstract: Objectives**:** A common cognitive complaint of older adulthood is distractibility, or decline in ability to concentrate and maintain focus, yet few evidence-based interventions exist to address these deficits. We implemented s pilot trial of an evidence-based executive function training program, to investigate whether training in applied goal-directed attention regulation and problem solving would enhance executive control abilities in a sample of cognitively normal older adults with self-reported complaints of concentration problems.

Method: Consecutively recruited participants were placed into small groups and randomized to either Goal-Oriented Attentional Self-Regulation training (GOALS; *N* = 15) or a closely matched

Brain Health Education program (BHE; *N* = 15).

Results**:** GOALS participants significantly improved on: neurocognitive measures of mental flexibility ($p = 0.03$, partial eta squared = 0.23); real-world setting functional performance measures of: task failures ($p = 0.02$, Cohen's $d = 0.88$), task rule breaks ($p = 0.02$, Cohen's $d = 1.06$), and execution ($p = 0.04$, Cohen's d = 0.76); and in-lab functional assessment of goal-directed behaviour divergent thinking scale ($p = 0.03$, Cohen's $d = 0.95$). All participants improved on a neurocognitive measure of planning ($p = 0.01$, partial eta squared = 0.031). BHE participants' improvement over and above GOALS participants was limited to: rule adherence on the real world task ($p = 0.04$, Cohen's $d = 0.99$), and evaluator rating ($p = 0.03$, Cohen's $d = 0.56$), and average score ($p = 0.02$, Cohen's $d = 0.71$) on the in-lab functional task.

Conclusion**:** Participation in GOALS training can enhance executive control, and lead to real-world functional improvements, for cognitively normal older adults with self-reported attention difficulties.

Spreng, R.N. & Turner, G.R. (2019). The shifting architecture of cognition and brain function in older adulthood. ***Perspectives on Psychological Science.***

Abstract: Cognitive aging is often described in the context of loss or decline. Emerging research suggests that the story is more complex, with older adults showing both losses and gains in cognitive ability. With increasing age, declines in controlled, or fluid, cognition occur in the context of gains in crystallized knowledge of oneself and the world. This inversion in cognitive capacities, from greater reliance on fluid abilities in young adulthood to increasingly crystallized or semanticized cognition in older adulthood, has profound implications for cognitive and real-world functioning in later life. The shift in cognitive architecture parallels changes in the functional network architecture of the brain. Observations of greater functional connectivity between lateral prefrontal brain regions, implicated in cognitive control, and the default network, implicated in memory and semantic processing, led us to propose the *default-executive coupling hypothesis of aging*. In this review we provide evidence that these changes in the functional architecture of the brain serve as a neural mechanism underlying the shifting cognitive architecture from younger to older adulthood. We incorporate findings spanning cognitive aging and cognitive neuroscience to present an integrative model of cognitive and brain aging, describing its antecedents, determinants, and implications for real-world functioning.

Adnan, A., Beaty, R., Siliva, P., Spreng, R.N., & Turner, G.R. (2019). Creative aging: functional brain networks associated with divergent thinking in older and younger adults. ***Neurobiology of Aging.***

Abstract: Creative thinking is associated with connectivity between the default and executive control networks in the young brain. In aging, this pattern of functional coupling has been observed across multiple tasks. We have described this as the Default-Executive Coupling Hypothesis of Aging and suggest that this connectivity pattern may also be associated with creativity in older adulthood. However, age differences in brain networks implicated in creativity

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have yet to be investigated. The overarching goal of the present study was to examine age-related changes to functional brain networks associated with creativity. Specifically, we explored functional connectivity patterns among default and executive control brain regions associated with creative thoughts in older and younger adults. In a cross-sectional design, young (mean age = 21 y; n = 30) and older (mean age = 70 y; n = 25) participants completed a divergent thinking task during fMRI, which was examined using region of interest functional connectivity analyses. Consistent with predictions, analyses demonstrated that default and executive networks are more functionally coupled during creative thinking for older than younger adults. Critically, despite similar performance on an in-scanner creativity task, increased network efficiency was associated with creative ability for older adults only. These findings provide novel evidence of default-executive coupling as a putative mechanism associated with creative ability in later life.

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