Center for Lifespan Psychology

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

Adult Age Differences in Functional Brain Activation During Spatial Working Memory Performance

Irene E. Nagel, Hauke R. Heekeren, Claudia Preuschhof, Shu-Chen Li, & Ulman Lindenberger

Theoretical Background & Hypotheses

Background

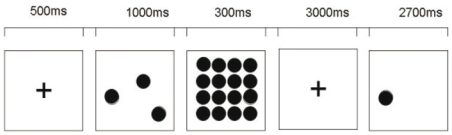
- Working memory (WM) and the associated prefrontal functional circuitry decline during aging.
- Details of age-related changes in WM functioning and their neural correlates are not well understood.
- WM load might be an important modulator of age differences in brain activity.
- Additional activation typically found in older adults relative to younger adults can be either compensatory or dysfunctional.

Hypotheses

1. Older adults show lower task performance and more brain activation than younger adults.
2. Age differences increase with task difficulty.
3. If aging-induced activation increase is dysfunctional, low-performing older adults should activate more regions than high-performing older adults, especially in lateral prefrontal cortex (PFC).

Methods

Experimental Task: Spatial Working Memory



Design

- Event-related design (mini blocks, 7.5 s)
- 3 conditions: 1-, 3-, and 7-points
- ISI 0.5 - 13.0 s
- 4 runs (150 volumes per run), 50 trials per condition

Participants

N=68: 34 young (20-30 yrs.), 34 old (60-70 yrs.)

Data Analysis

Group-based GLM analyses were conducted using a mixed effects model as implemented in FSL 3.3 and were thresholded with $z > 2.6$, corresponding to an alpha level of $p < .005$ uncorr.

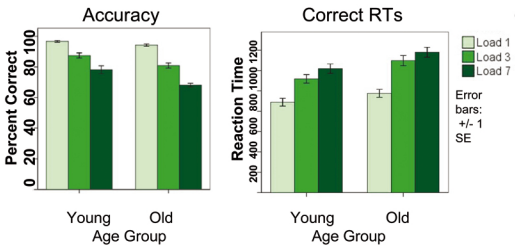
Scanner Parameters

1.5 Tesla Siemens scanner (EPI, TR = 2.5 s, TE = 40 ms, FA = 90°), slice thickness = 4 mm , 0.5 gap, field of view = 256 mm, in-plane matrix = 64 x 64)

Results

Behavioral Performance

Lower performance in older adults than in younger adults, especially at higher load levels

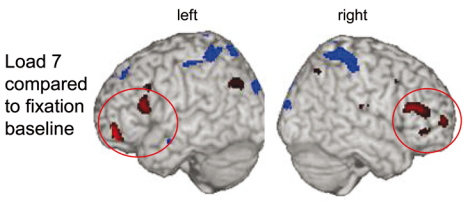


Significant effects ($p<.005$) of load, age, load x age for accuracy and reaction times on correct trials

Functional Brain Activation

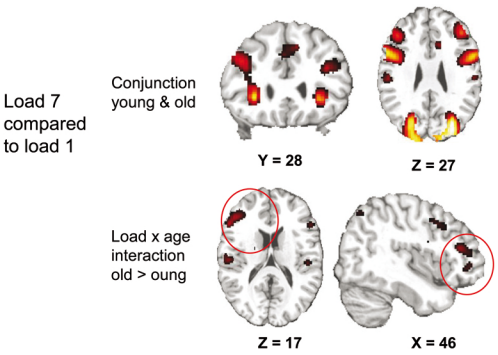
Spatial WM Network: (right) lateral PFC, PMC, PPC

Age Effect: More activation in both hemispheres in older adults, especially in lateral PFC



red = old; blue = young

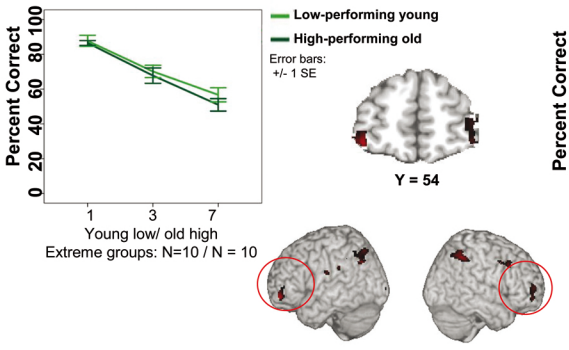
Load Effect: Common as well as old-age specific increase of BOLD signal with task load



Results Continued

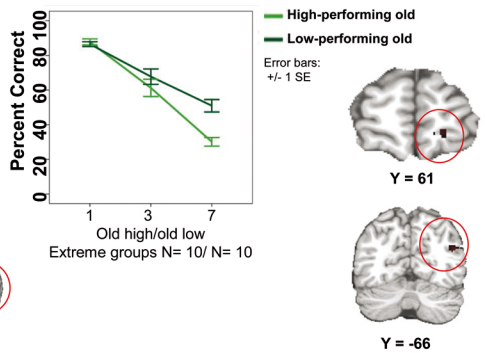
Old-high vs. Young-low Performing Adults

Older adults activate additional regions compared to younger adults even when matched for performance



Old-low vs. Old-high Performing Adults

Low-performing older adults activate an additional region in bilateral dlPFC relative to high-performing older adults



Main Findings

- Increase of activation and decline in performance with age (H1).
- Greater increase of BOLD response in PFC with load found in older adults -> task difficulty modulates age differences in functional brain acitvation (H2).
- Additional activation in PFC in low performing older adults -> indication for dysfunctional increase of activation (H3).

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