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

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

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

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

Load 7 compared to load 1
Load x age interaction

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 dPFC 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 activation (H2).
- Additional activation in PFC in low performing older adults -> indication for dysfunctional increase of activation (H3).

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