

## Cognitive Control Deficits in Healthy Aging: Neuroimaging Investigations

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### Introduction:

Previous computational modeling work and behavioral studies (Braver et al., 2000) suggest that age-related dysfunction in dorsolateral prefrontal cortex (PFC) produces impairments in older adults ability to appropriately process contextual information, particularly in task situations that require context information to be internally represented and actively maintained over time. The current study tested this hypothesis using fMRI to assess cortical activation in healthy older and younger adults during performance of a cognitive task designed and validated to be sensitive to context processing.

### Methods:

Participants were 16 healthy older and 21 healthy younger adults. All subjects were scanned while performing blocks of short or long delay trials of a task in which participants were required to respond target to the word "FATE," but only if it followed the word "LIME." Thus, participants needed to represent and maintain the context provided by the cue (LIME or not) to determine their response to the subsequent probe (FATE or not). Each trial lasted 10 sec, with a stimulus duration of 750 ms. On short delay trials there was a 1 sec delay between cue and probe and a 7.5 sec ITI, placing a low demand on context maintenance. On long delay trials, there was a 7.5 sec delay between cue and probe and a 1 sec ITI, placing a greater demand on context maintenance. All scanning was performed on a 1.5T Siemens VISION with a standard head coil. Structural images were acquired using a high resolution sagittal 3-D MP-RAGE T1-weighted sequence. Functional images were acquired using an asymmetric spin-echo echo-planar sequence (TR=2500 ms, TE= 50 ms, flip = 90°). During each run, 114 sets of 16 contiguous, 8 mm thick axial images were acquired parallel to the anterior-posterior commissure plane (3.75x3.75mm in plane). The 10s trial duration allowed us to scan the full set of 16 slices four times sequentially in each trial. Subjects performed each task condition in a run lasting 255 sec (4 runs total). Each run contained 4 blocks, with 2 "task" and 2 "fixation" blocks in alternating order. Each task block consisted of 10 trials (either all short delay or all long delay). Fixation blocks lasted 25 secs. Functional imaging data were movement corrected, co-registered, smoothed, and pooled across subjects. All analyses were performed using ANOVAs treating subjects as a random factor, with group (young, older) as a between subject factor and condition (task, fixation) and delay (short, long) as within subject factors.

### Results:

In younger adults, analyses identified delay-related activity in dorsolateral and inferior PFC. Based on the dynamics of activity in these regions, we hypothesize that the dorsolateral PFC supports context representation and maintenance, while inferior PFC supports phonological rehearsal processes. Further analyses focused on examining the dynamics of activity in dorsolateral and inferior PFC among older adults, particularly in response to the delay manipulation, as well as activation in control regions predicted not to be dysfunctional among older adults.