

fMRI Tasks – CogRes Study

Both tasks: TR = 2000msec, voxel size = 2 x 2 x 3 mm

1. **Executive Control Function (ECF)**

Summary: ECF is a cued switching task with a no-go component. Participants are presented with a letter on the screen whose color serves as the task cue. Participants respond to each letter with a right-hand/left-hand button press or with no press at all. A green letter signals that participants should respond to the quality of the letter as a vowel/consonant (left press for vowel, right press for consonant). A red letter signals that participants should respond to the quality of the letter as lower/upper-case (left press for lower-case, right press for upper-case). A white letter signals that nothing should be pressed.

Domains evaluated: Set switching

References: Gazes, Y., Rakitin, B. C., Habeck, C., Steffener, J., & Stern, Y. (2012). Age differences of multivariate network expressions during task-switching and their associations with behavior. *Neuropsychologia*, 50(14), 3509-18. doi: 10.1016/j.neuropsychologia.2012.09.039. PubMed PMID: 23022342.

Koechlin, E., Ody, C., & Kouneiher, F. (2003). The architecture of cognitive control in the human prefrontal cortex. *Science*, 302(5648), 1181-85.

2. **Letter Sternberg**

Summary: LS is a delayed-match-to-sample task in which participants are asked to remember a set of one, three, or six capital letters presented on the screen. After a short interval of time, a probe letter appears on the screen in lowercase and participants are tasked with indicating whether or not that letter was present in the original letter set (left press for “Yes”, right press for “No”). Subjects were instructed to respond as accurately as possible. No feedback about their performance was given.

Domains evaluated: Working memory

References: Habeck, C., Rakitin, B. C., Moeller, J., Scarmeas, N., Zarahn, E., Brown, T., & Stern, Y. (2004). An event-related fMRI study of the neurobehavioral impact of sleep deprivation on performance of a delayed-match-to-sample task. *Cognitive Brain Research*, 18(3), 306-21. doi: 10.1016/j.cogbrainres.2003.10.019. PubMed PMID: 14741317.

Sternberg, S. (1966). High-speed scanning in human memory. *Science*, 153(3736), 652-4. doi: 10.1126/science.153.3736.652. PubMed PMID: 5939936.

Sternberg, S. (1969). Memory-scanning: mental processes revealed by reaction-time experiments. *Am. Sci.*, 57(4), 421-57. PubMed PMID: 5360276.

Contrast images are available for data sharing. Subject-level modeling are described below:

1. **Executive Control Function (ECF)**

Participants received a total of 36 blocks, broken into 6 fMRI runs. Twenty-four blocks, each 33.5 s, included twelve 2.4 s trials, with an instruction cue presented for 2.8 s, followed by a blank screen for 1.9 s, followed by a letter-stimulus. A first level analysis was run on each of their 6 task-based runs with four regressors. The regressors represented one of the following task conditions: single-task congruent trials, single-task incongruent trials, dual-task congruent trials, dual-task incongruent trials. The regressors were generated by convolving FSL’s double gamma canonical HRF with the duration of presentation of the stimulus to the participants. A second level analysis was run on each participant by combining all six first level results for each run. At this level, four new contrasts were created from the combined first level task regressors for

each participant: (1) dual-task trials greater than all single-task trial activations; (2) dual-task incongruent trials greater than single-task incongruent trials; (3) incongruent trial activations greater than congruent trial activations; and (4) single-task incongruent trials greater than single-task congruent trials.

2. Letter Sternberg

Each trial lasted a total of 16 s. The sequence of trial events was as follows: first, a fixed 3-s period of blank presentation marked the beginning of trial; then, during the stimulus period of the task, an array of 1, 3, or 6 capital letters were presented for 3 s (“stimulus phase”). With the offset of the visual stimulus, subjects were instructed to focus on the blank screen and hold the stimulus items in mind for a 7-s maintenance interval (“retention phase”). Finally, a probe appeared for 3-s (“probe phase”), which was a lowercase letter centered in the field of view. Each experimental block contained 10 trials for each of three set sizes with five true negative and five true positive probes per set size. Three experimental blocks were run in total, yielding $10 \times 3 \times 3 = 90$ experimental trials per scanning session. The FEAT module in FSL was used for subject-level analysis using event-related design. Regressors included each of the task phases (stimulus presentation, retention, and probe) for each accurate, on-time trial separated by the set size (1, 3, or 6 letters) and trial type (true negative and true positive). The first level design matrix was convolved with a model of the hemodynamic response function, yielding one contrast image per subject.