fMRI Tasks – RANN

All tasks: TR = 2000msec, voxel size = 2 x 2 x 4mm

I. Session I

1. Antonyms

Summary: This task requires participants to match a given word to its antonym, or to the word most different in meaning. In each of the 15 trials, a probe word is presented in all capital letters at the top of the screen, and four numbered choices are presented below. Duration: 6 min 34 sec.

Reference Ability: Vocabulary

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

Salthouse, T. A., & Kersten, A. W. (1993). Decomposing adult age differences in symbol arithmetic. *Mem Cognit, 21*(5), 699-710. PubMed PMID: 8412720.

2. Synonyms

Summary: This task requires participants to match a given word to its synonym, or to the word most similar in meaning. In each of the 15 trials, a probe word is presented in all capital letters at the top of the screen, and four numbered choices are presented below. Duration: 6 min 34 sec.

Reference Ability: Vocabulary

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

Salthouse, T. A., & Kersten, A. W. (1993). Decomposing adult age differences in symbol arithmetic. *Mem Cognit, 21*(5), 699-710. PubMed PMID: 8412720.

3. Digit Symbol

Summary: A code table is presented on the top of the screen, consisting of numbers one through nine, each paired with an associated symbol. Below the code table an individual number/symbol pair is presented. Participants are asked throughout 90 trials to indicate whether the pair presented is the same as that in the code table or different, using a differential button press. Duration: 7 min 6 sec.

Reference Ability: Speed of Processing

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

4. Letter Comparison

Summary: Sixty trials of two strings of letters, each consisting of three to five letters, are presented alongside one another. Participants indicate whether the strings are the same or different using a differential button press. Duration: 6 min 36 sec.

Reference Ability: Speed of Processing

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage*, *144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

Salthouse, T., A., & Babcock, R., L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology, 27*(5), 763-76. doi: 10.1037/0012-1649.27.5.763.

5. ***Pattern Comparison***

Summary: Two figures consisting of varying numbers of lines connecting at different angles are presented alongside one another. Participants indicate throughout 60 trials whether the figures are the same or different using a differential button press. Duration: 6 min 26 sec.

Reference Ability: Speed of Processing

References: Salthouse, T., A., & Babcock, R., L. (1991). Decomposing adult age differences in working memory. *Developmental Psychology, 27*(5), 763-76. doi: 10.1037/0012-1649.27.5.763.

6. ***Picture Naming***

Summary: This task requires participants to verbally name pictures. Target pictures consist of 40 colored bitmap images. Audio recordings of responses are filtered using a custom adaptive noise filtering procedure, and then transcribed and scored by researchers. Duration: 6 min 26 sec.

Reference Ability: Vocabulary

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

Salthouse, T. A. (1998). Independence of age-related influences on cognitive abilities across the life span. *Dev Psychol, 34*(5), 851-64. PubMed PMID: 9779733.

Woodcock, R. W., Johnson, M. B., & Mather, N. (1989). *Woodcock-Johnson Psychoeducational Battery – revised*. DLM Teach. Resources.

II. **Session II**
    1. ***Paper Folding***

    Summary: A number of figures representing a sequence of paper folds is presented, with the final step always depicting a hole punched in the folded paper. Participants identify from 5 options the resulting pattern of holes that would be present once the paper were to be unfolded. Duration: 14 min 26 sec.

    Reference Ability: Fluid reasoning

    References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

    Ekstrom, R., B, French, J., W., Harman, H. H., & Dermen, D. (1976). Manual for Kit of Factor-Referenced Cognitive Tests. Educational Testing Service.

    2. ***Logical Memory***

    Summary: Participants are instructed to pay attention to stories presented on the computer screen. The stories are followed by multiple-choice questions about details of the story, with four possible answer choices. Duration: 7 min 6 sec.

Reference Ability: Episodic memory

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

3. Matrix Reasoning

Summary: Participants are given a matrix that is divided into nine cells, in which the figure in the bottom right cell is missing. Below the matrix, they are given eight figure choices and instructed to evaluate which of the figures would best fill the missing cell to complete the matrix. Duration: 14 min 26 sec.

Reference Ability: Fluid reasoning

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

Raven JC. (1962). *Advanced Progressive Matrices, Set II*. H.K. Lewis.

4. Word Order Recognition

Summary: A list of 12 words is presented one at a time on the screen, and participants are instructed to remember the order in which the words are presented. Participants are then given a probe word at the top of the screen, and four additional word choices below. They are instructed to select the word that immediately followed the word presented above. The task has two wordlists, with ten questions following each list. Duration: 7 min 2 sec.

Reference Ability: Episodic memory

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

5. Letter Sets

Summary: Participants are presented with five sets of letters, where four out of the five sets have a common rule (e.g., have no vowels), with one of the sets not following this rule. Participants are instructed to infer the common rule in the set and then to select the unique set that does not follow this rule. Duration: 14 min 26 sec.

Reference Ability: Fluid reasoning

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

Ekstrom, R., B, French, J., W., Harman, H. H., & Dermen, D. (1976). Manual for Kit of Factor-Referenced Cognitive Tests. Educational Testing Service.

6. Paired Associates

Summary: Six pairs of words are presented, one at a time, on the screen, and participants are instructed to remember the pairs. Following the pairs, they are given a probe word at the top of the screen and four additional word choices below. Participants are asked to choose the word that was originally paired with the probe word. The task contains two lists of pairs, with six probe questions for each list. Duration: 3 min 24 sec.

Reference Ability: Episodic memory

References: Razlighi, Q. R., Habeck, C., Barulli, D., & Stern, Y. (2017). Cognitive neuroscience neuroimaging repository for the adult lifespan. *Neuroimage, 144*(Pt. B), 294-98. doi: 10.1016/j.neuroimage.2015.08.037. PubMed PMID: 26311605.

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

Each participant's 12 task-activation fMRI scans were preprocessed in FSL (Smith et al., 2004) using the following steps: (1) within-participant histogram computation for each participant volume to identify noise (FEAT); (2) participant-motion correction (MCFLIRT); (3) slice-timing correction; (4) brain-mask creation from first volume in participant's fMRI data; (5) high-pass filtering (T=128 sec); (6) pre-whitening; (7) General-Linear-Model (GLM) estimation with equally temporally filtered regressors and double-gamma hemodynamic response functions; and (8) registration of functional and structural images with subsequent normalization into MNI space (FNIRT).

General linear models (GLM) for each participant and each task consisted of block-based time-series analysis for Speed of Processing and Vocabulary tasks, and event-related modeling for Episodic memory and Fluid Reasoning tasks. For Episodic Memory, only the recognition phase of the trial was analyzed. Other than for Episodic Memory, there was no separation of stimulus presentation or behavioral response in the task design. For all fitted neural responses, whether event-related or block-designed, incorrect and correct responses were not separated, but analyzed indiscriminately, in the GLM-fitting process.