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Cognitive neuroscience neuroimaging repository for the adult lifespan

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ABSTRACT

With recent advances in neuroimaging technology, it is now possible to image human brain function *in vivo*, which revolutionized the cognitive neuroscience field. However, like any other newly developed technique, the acquisition of neuroimaging data is costly and logistically challenging. Furthermore, studying human cognition requires acquiring a large amount of neuroimaging data, which might not be feasible to do by every researcher in the field. Here, we describe our group's efforts to acquire one of the largest neuroimaging datasets that aims to investigate the neural substrates of age-related cognitive decline, which will be made available to share with other investigators. Our neuroimaging repository includes up to 14 different functional images for more than 486 subjects across the entire adult lifespan in addition to their 3 structural images. Currently, data from 234 participants have been acquired, including all 14 functional and 3 structural images, which is planned to increased to 375 participants in the next few years. A complete battery of neuropsychological tests was also administered to all participants. The neuroimaging and accompanying psychometric data will be available through an online and easy-to-use data sharing website.

Introduction

Investigating the neuronal underpinnings of cognitive decline in normal aging with neuroimaging requires sampling the entire adult lifespan with many different imaging modalities. Imaging cognition is an active area of research and a challenging task. One possibility is to image the brain while performing a few tasks targeting the same cognitive domain. A direct consequence of such approaches is the need for a large collection of images on a single subject, which is not only costly but also logistically difficult. The Cognitive Neuroscience Neuroimaging Repository (CNR) contains cross-sectional neuroimaging data from past and ongoing projects in the Cognitive Neuroscience Division of Neurology Department and Taub Institute at Columbia University. It contains fMRI data from 14 different cognitive tasks targeting four cognitive domains (vocabulary, perceptual-speed, fluid reasoning, and memory). Even though fMRI is the dominant modality in these studies, other modalities are also collected to provide valuable information. Thus, CNR includes MPRAGE, DTI, and FLAIR images as part of the structural image acquisition. CNR also includes resting state continuous ASL, and resting state fMRI as the baseline functional neuroimaging data. In addition 14 well-known cognitive tasks representing distinct cognitive domains have been modified and computerized to be executable during scan acquisition. Block, event-related, and mixed designs are all used for implementing these tasks.

Participants in this repository were sampled from six decades of the adulthood life span (from 20 to 80 years) while controlling for many known confounding factors including but not limited to: education, handedness, medical/psychiatric conditions/medications, native-speaking English, and area of residence. Currently, there are more than 635 participants in our studies with 486 having at least some neuroimaging data and 234 with a completed neuroimaging data set. The goal is to have at least 50 participants in the first three decades and 75 in the last three decades, resulting in complete data on 375 participants (meaning to have at least 3 fMRI scans in each of the four cognitive domains). Table 1 summarizes the current number of images for each fMRI task and the rest of the modalities.

In addition to neuroimaging data, a complete battery of neuropsychological tests has been administered to all participants. The neuropsychological data are also stored in the same repository, which will be linked to neuroimaging data through our new Collaborative Informatics and Neuroimaging Suite (COINS) database. We are currently in the process of migrating our data to COINS, which will make storing, retrieving, mining, and sharing convenient.

To study the normal aging brain in contrast to pathological aging, a subset of the participants in the last two decades ($n \sim 100$) has received PET scanning for fibrillar forms of beta amyloid with ^{18}F-florbetaben.

Scanners and acquisition parameters

All MRI scans in CNR were acquired with the same 3.0 Tesla Achieva Magnet Philips scanner (software R2.6.3.6) with functional MRI, ASL, and DTI options. Table 2 summarizes the acquisition parameters for each of the MRI modalities acquired in this database. Studies acquiring data from multiple scanners are often limited because the scanners themselves account for a majority of variance in the data (Biswal

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Table 1
Demographic of the participants in CNR.

Image Modality/Task	Age Range												Total	
	20–30		30–40		40–50		50–60		60–70		70–80			
	# Subjects (Female%)	Education Mean ± Std	# Subjects (Female%)	Education Mean ± Std	# Subjects (Female%)	Education Mean ± Std	# Subjects (Female%)	Education Mean ± Std	# Subjects (Female%)	Education Mean ± Std	# Subjects (Female%)	Education Mean ± Std	# Subjects (Female%)	Education Mean ± Std
T1	115 (63%)	15.63 ± 1.97	63 (67%)	16.37 ± 2.52	41 (46%)	15.73 ± 2.62	56 (50%)	15.77 ± 2.21	123 (52%)	16.05 ± 2.68	51 (57%)	17.37 ± 2.54	449 (57%)	16.07 ± 2.47
FLAIR	105 (63%)	15.64 ± 2.05	59 (66%)	16.31 ± 2.48	42 (45%)	15.76 ± 2.6	52 (50%)	15.75 ± 2.23	120 (52%)	16.08 ± 2.68	49 (55%)	17.49 ± 2.5	427 (56%)	16.1 ± 2.49
DTI	103 (62%)	15.65 ± 2.05	60 (68%)	16.37 ± 2.5	42 (45%)	15.76 ± 2.6	48 (50%)	15.9 ± 2.13	118 (51%)	16.11 ± 2.67	48 (54%)	17.44 ± 2.5	419 (56%)	16.13 ± 2.48
ASL	107 (63%)	15.59 ± 1.99	61 (67%)	16.37 ± 2.48	42 (45%)	15.76 ± 2.6	53 (51%)	15.79 ± 2.23	118 (53%)	16.07 ± 2.69	49 (55%)	17.49 ± 2.5	430 (57%)	16.09 ± 2.48
Resting state fMRI	106 (62%)	15.64 ± 2.04	61 (67%)	16.37 ± 2.48	42 (45%)	15.76 ± 2.6	52 (50%)	15.75 ± 2.23	119 (51%)	16.08 ± 2.69	49 (55%)	17.49 ± 2.5	429 (56%)	16.1 ± 2.49
Antonym	58 (64%)	15.64 ± 2.01	56 (66%)	16.3 ± 2.52	41 (46%)	15.73 ± 2.62	52 (50%)	15.71 ± 2.17	46 (46%)	16.13 ± 2.8	46 (52%)	17.54 ± 2.42	299 (55%)	16.16 ± 2.5
Synonym	59 (63%)	15.64 ± 1.99	56 (66%)	16.3 ± 2.52	40 (47%)	15.68 ± 2.63	52 (50%)	15.71 ± 2.17	45 (47%)	16.09 ± 2.82	46 (52%)	17.54 ± 2.42	298 (55%)	16.15 ± 2.5
Picture naming	58 (64%)	15.64 ± 2.01	56 (66%)	16.3 ± 2.52	41 (46%)	15.73 ± 2.62	51 (49%)	15.67 ± 2.17	45 (44%)	16.23 ± 2.76	45 (53%)	17.62 ± 2.39	296 (55%)	16.18 ± 2.5
Digit symbol	59 (63%)	15.64 ± 1.99	56 (66%)	16.3 ± 2.52	41 (46%)	15.73 ± 2.62	52 (50%)	15.71 ± 2.17	46 (46%)	16.13 ± 2.8	46 (52%)	17.54 ± 2.42	300 (55%)	16.16 ± 2.5
Letter comparison	58 (64%)	15.64 ± 2.01	56 (66%)	16.3 ± 2.52	41 (46%)	15.73 ± 2.62	51 (49%)	15.67 ± 2.17	46 (46%)	16.13 ± 2.8	46 (52%)	17.54 ± 2.42	298 (55%)	16.16 ± 2.51
Pattern comparison	58 (64%)	15.64 ± 2.01	56 (66%)	16.3 ± 2.52	41 (46%)	15.73 ± 2.62	51 (49%)	15.67 ± 2.17	45 (44%)	16.23 ± 2.76	46 (52%)	17.54 ± 2.42	297 (55%)	16.17 ± 2.5
Paper folding	61 (64%)	15.71 ± 2.03	56 (64%)	16.32 ± 2.61	40 (45%)	15.9 ± 2.58	52 (48%)	15.79 ± 2.1	51 (45%)	16.33 ± 2.64	48 (52%)	17.4 ± 2.47	308 (54%)	16.23 ± 2.47
Matrix reasoning	62 (65%)	15.72 ± 2.01	56 (64%)	16.32 ± 2.61	40 (45%)	15.9 ± 2.58	52 (48%)	15.79 ± 2.1	50 (44%)	16.36 ± 2.66	48 (52%)	17.48 ± 2.39	308 (54%)	16.24 ± 2.46
Letter set	61 (64%)	15.71 ± 2.03	56 (64%)	16.32 ± 2.61	40 (45%)	15.9 ± 2.58	52 (48%)	15.79 ± 2.1	50 (44%)	16.36 ± 2.66	48 (52%)	17.48 ± 2.39	307 (54%)	16.25 ± 2.46
Logical memory	61 (64%)	15.71 ± 2.03	56 (64%)	16.32 ± 2.61	40 (45%)	15.9 ± 2.58	52 (48%)	15.79 ± 2.1	50 (44%)	16.36 ± 2.66	49 (53%)	17.39 ± 2.45	308 (54%)	16.23 ± 2.47
Word order	61 (64%)	15.71 ± 2.03	56 (64%)	16.32 ± 2.61	40 (45%)	15.9 ± 2.58	52 (48%)	15.79 ± 2.1	50 (44%)	16.36 ± 2.66	48 (52%)	17.48 ± 2.39	307 (54%)	16.25 ± 2.46
Paired associates	61 (64%)	15.71 ± 2.03	56 (64%)	16.32 ± 2.61	40 (45%)	15.9 ± 2.58	52 (48%)	15.79 ± 2.1	49 (45%)	16.32 ± 2.67	48 (52%)	17.48 ± 2.39	306 (54%)	16.24 ± 2.46
Letter Sternberg	54 (67%)	15.54 ± 1.95	7 (86%)	17 ± 1.41	0	NA	2 (50%)	18 ± 2	86 (57%)	16.34 ± 2.71	5 (80%)	17 ± 2.68	154 (62%)	16.13 ± 2.46
Executive control	71 (65%)	15.51 ± 1.94	7 (86%)	17 ± 1.41	0	NA	2 (50%)	18 ± 2	104 (54%)	16.07 ± 2.68	5 (80%)	17 ± 2.68	189 (60%)	15.94 ± 2.42

et al., 2010). Using a single scanner has the benefit of controlling for this confounding factor.

PET images were acquired over a period of 20 min in 4 × 5 min frames on an MCT PET/CT scanner (Siemens) in dynamic, 3D imaging mode beginning 50 min after injection of ^{18}F-florbetaben. Transmission scans were done prior to the scan. An accompanying structural CT scan (in-plane resolution = 0.58 × 0.58 mm, slice thickness = 3 mm, field of view (FOV) = 296 × 296 mm, number of slices = 75) was also acquired in the same machine at the same time of the PET scan.

Recruitment and participants

Participants were recruited through random market-mailing within 10 miles of the Columbia University Medical Center. This recruitment approach was intended to obviate cohort effects that might be present by using convenience samples. All subjects were compensated for participation. Informed consent was obtained prior to testing, with approval from the Columbia University Medical Center Institutional Review Board. All subjects were required to be native English speakers, strongly right-handed, and have at least a fourth grade reading level. Subjects were screened for MRI contraindications and hearing or visual impairment that would impede testing. Subjects were free of medical or psychiatric conditions that could affect cognition. Careful screening ensured that the older subjects did not meet criteria for dementia or mild cognitive impairment (MCI). A score greater than 130 was required on the Mattis Dementia Rating Scale (Mattis, 1988). Further, performance was required to be within age-adjusted normal limits (one and a half standard deviation below each age-decade median word recall) on a list-learning test (SRT; Buschke and Fuld, 1974), and participants were required to have no or minimal complaints on a functional impairment questionnaire (Blessed et al., 1968). A neuroradiologist reviewed each subject's T1 scan and confirmed that there were no clinically significant findings for any of the subjects. Any significant findings were conveyed to the participant's primary care physician. However, no clinically significant findings were identified or removed.

Psychometric measurements

Every participant enrolled in the study was administered the same neuropsychological battery; the Mattis Dementia Rating Scale (Mattis, 1988), WAIS-III Letter-Number Sequencing (Wechsler, 1997), American National Adult Reading Test (Grober et al., 1991), Selective Reminding Test immediate recall (SRT; Buschke and Fuld, 1974), WAIS-III Matrix Reasoning (Wechsler, 1997), SRT delayed recall and delayed recognition (Buschke and Fuld, 1974), WAIS-III Digit-Symbol (Wechsler, 1997), Trail-Making Test (Reitan, 1958), Controlled Word Association (C-F-L) and Category Fluency (animals) (Benton and Hampshire, 1976), Stroop (Golden, 1975), Wechsler Test of Adult Reading (Wechsler, 2001), WAIS-III Vocabulary (Wechsler, 1997), WAIS-III Block Design (Wechsler, 1997), and Wisconsin Card Sorting Test (Grant and Berg, 1993).

Each participant was also given a packet of questionnaires to complete. The packet included the Blessed Functional Activities Scale (Blessed et al., 1968), the International Personality Item Pool (Goldberg, 1999), as well as several questionnaires developed in-house: an occupational survey, two exercise questionnaires, a leisure activities questionnaire, a sociodemographic questionnaire, an education questionnaire, and a risk factor survey.

A subset of participants also underwent evaluation with portions of the NIH EXAMINER battery to assess executive function (Kramer et al., 2014). Tasks administered from this study include the Flankers task, the continuous performance task, the anti-saccades task, and the set shifting task. A total of 246 participants have currently undergone this battery.

Table 2
Acquisition parameters for all image modalities in CNR.

Sequences	TE/TR (ms)	Flip Angle (deg)	In-plane Resolution	Voxel Size (mm)	Acquisition Time	Slice Thickness/Gap (mm)	Slices
EPI	20/2000	72	112 × 112	2 × 2 × 3	Task Depend	3/0.0	41
MPRAGE	3/6.5	8	256 × 256	1 × 1 × 1	~4′55″	1/0.0	180
FLAIR	125/11000	90	256 × 192	1 × 1 × 5	4′24″	4/0.5	30
DTI (55 dir)	69/11032	90	112 × 112	2 × 2 × 2	12′56″	2/0.0	75
ASL	30/5000	90	64 × 64	3.5 × 3.5 × 6.5	~4′30″	7.5/1.5	15

fMRI tasks and designs

In total, there were fMRI data for 14 different cognitive tasks in addition to resting state data. Twelve tasks were intended to represent four latent cognitive abilities: vocabulary, perceptual-speed, fluid reasoning, and memory. Two additional tasks tap working memory and executive control.

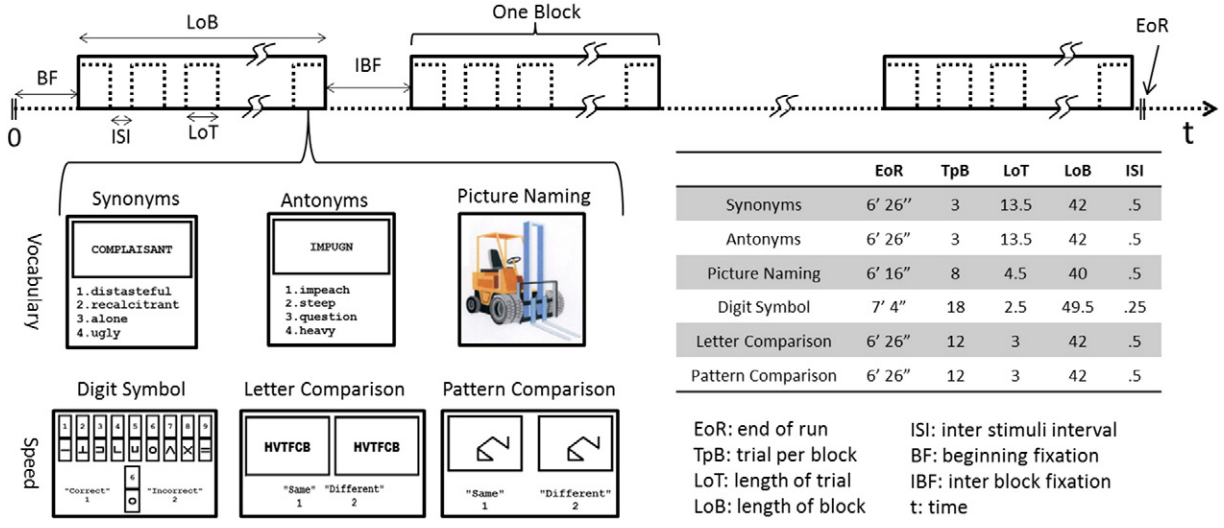
Three vocabulary and three perceptual-speed tasks were implemented with a similar structure. Fig. 1 shows the timing of these block design tasks along with a table representing the parameters of each task in this design. Snapshots of each task are also provided in this figure. All six tasks have 36 s of initial fixation (IF) and 28 s of inter-block fixation (IBF).

The vocabulary tests included (1) *Synonyms*: subjects match a given word to the word most similar in meaning. The probe word is presented in all capital letters at the top of the screen, and four numbered choices are presented below. (2) *Antonyms*: participants match a given word to the word most different in meaning. The probe word is presented in all capital letters at the top of the screen, and four numbered choices are presented below. (3) *Picture naming*: subjects verbally name pictures. Target pictures consisted of 40 colored bitmap images, adapted from the picture naming task of the WJ-R Psycho-Educational battery (Woodcock et al., 1989).

The perceptual speed tasks included (1) *Digit symbol*: this task uses a code table to associate symbols with digits. The 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. Subjects are asked to indicate whether the individual pair is the same as that in the code table using a differential button press. (2) *Letter comparison*: in this task, two strings of letters, each consisting of three to five letters, are presented alongside one another. Subjects indicate whether the strings are the same or different using a differential button press. (3) *Pattern comparison*: in this task, two figures consisting of varying numbers of lines connecting at different angles are presented alongside one another. Subjects indicate whether the figures are the same or different using a differential button press.

Fig. 2 illustrates the timing and trials of three fluid reasoning tasks along with specific parameters used for each one. (1) *Paper folding*: participants select the pattern of holes that would result from a sequence of folds and a punch through the folded paper. The folding sequence is given on the top of the screen, and five unfolded options are given underneath in one row. (2) *Matrix reasoning*: subjects select which pattern best completes the missing cell in a matrix. Subjects 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 they are instructed to evaluate which of the figures would best complete the missing cell. (3) *Letter sets*: subjects select which of five groups of letters is different from the others. Subjects 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. Subjects are instructed to select the unique set.

Three episodic memory tasks, one working memory tasks, and one set-switching task are implemented as mixed design. The timing and parameters of these tasks along with a snapshot of their instruction and probe questions are given in Fig. 3. The episodic memory tasks are: (1) *Logical memory*: this task measures the number of details recognized across two stories. Subjects are required to remember specific details from stories presented on the computer screen, then asked to answer detailed multiple-choice questions about the story, with four possible answer choices. (2) *Word order recognition*: a list of twelve words is presented one at a time on the screen, and subjects are instructed to remember the order in which the words are presented. Following the word list, they are given a probe word at the top of the screen, and four additional word choices below. They are instructed to choose the word that immediately followed the word given above. (3)



	EoR	TpB	LoT	LoB	ISI
Synonyms	6′ 26″	3	13.5	42	.5
Antonyms	6′ 26″	3	13.5	42	.5
Picture Naming	6′ 16″	8	4.5	40	.5
Digit Symbol	7′ 4″	18	2.5	49.5	.25
Letter Comparison	6′ 26″	12	3	42	.5
Pattern Comparison	6′ 26″	12	3	42	.5

EoR: end of run
TpB: trial per block
LoT: length of trial
LoB: length of block
ISI: inter stimuli interval
BF: beginning fixation
IBF: inter block fixation
t: time

Fig. 1. Timing, snapshot, and parameters of the six vocabulary and speed tasks.

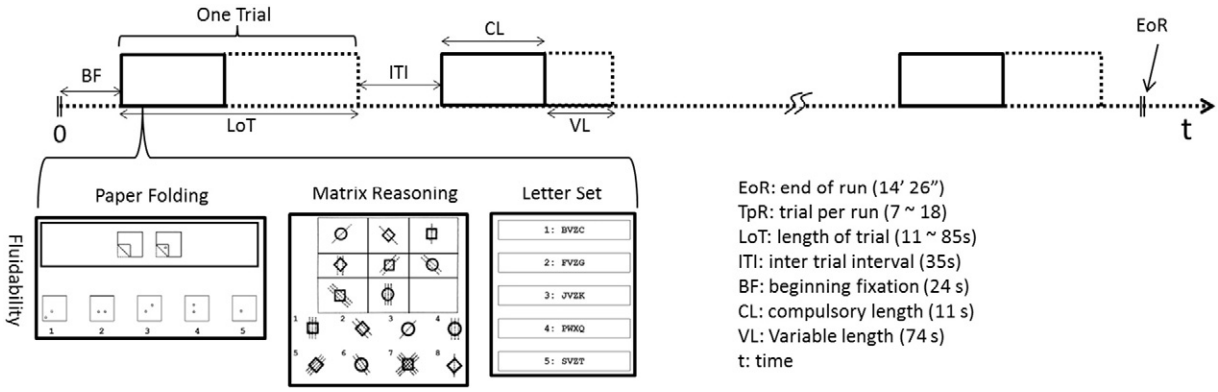


Fig. 2. Timing, snapshot, and parameters of the three fluid ability tasks.

Paired associates: subjects are supposed to recognize the second words from word pairs. Six pairs of words are presented, one at a time, in the instruction phase, and subjects 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.

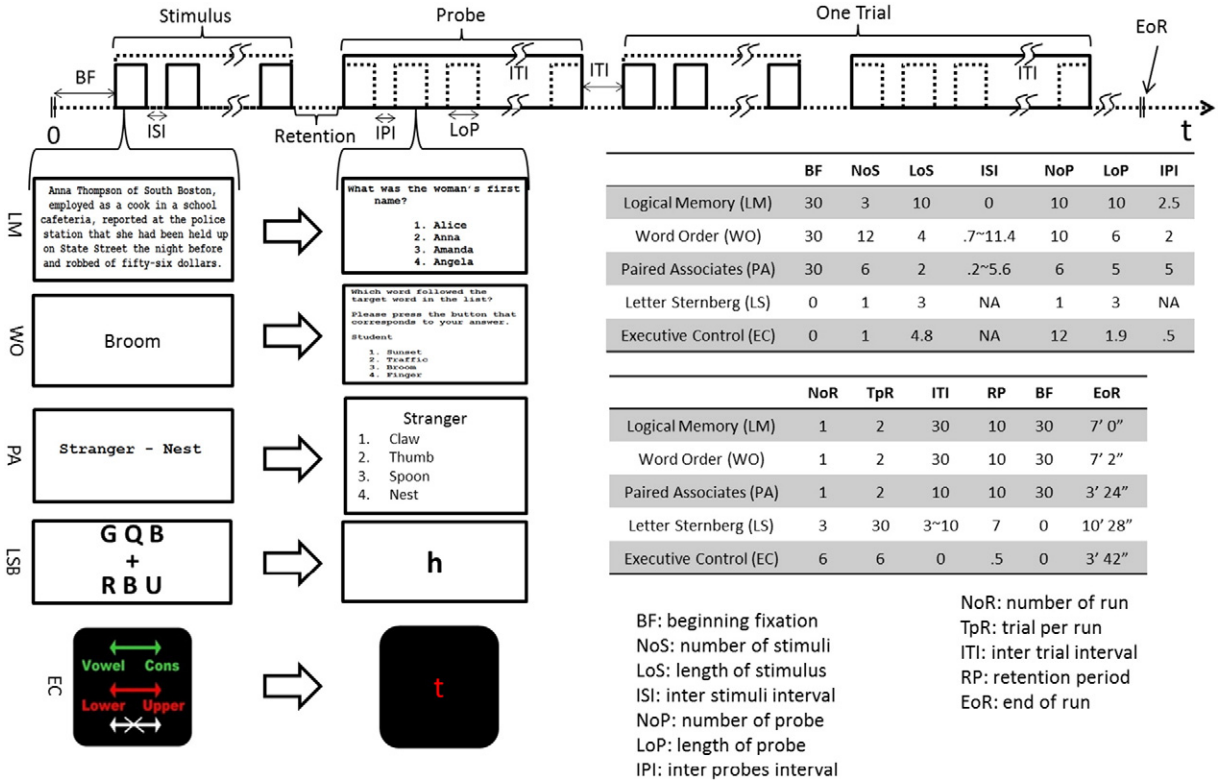
The working memory test is *Letter Sternberg*. Subjects view a set of uppercase letters (of 1, 3, or 6 items) for 3 s, and are asked to memorize them during an extended delayed-retention phase. Then, a probe lowercase letter is presented during a retrieval phase and subjects indicate whether or not the presented probe letter was in the previously viewed set of uppercase letters.

The set-switching task is *Executive Control Function*: subjects view a single letter in the center of the screen and are asked to distinguish whether the letter is upper/lower case or if it is a vowel/consonant. The required task is indicated by the color of the letters. An instruction provided at the beginning of each block describes the task for that block. In total, there were three instruction types, two single and one set-switch instructions. In the single instruction blocks, subjects were simply required to decide whether the presented letter was upper/lower case or vowel/consonant, with red letters associated with the former task and green with the latter task. In the single task blocks, all letters were of the same color and the task remained constant throughout the block. In the dual task blocks, letters appeared in both colors, requiring subjects to switch between the two tasks. All task blocks also contained white letters, indicating a no-go trial. (More details of this task are provided in Koechlin et al., 2003).

Letter Sternberg and Executive Control Function tasks were implemented and computerized in PsyScope (Cohen et al., 1993), and the rest of the tasks were implemented and computerized in E-Prime (Schneider et al., 2012).

Pre-processing and data analysis

Each subject's structural T1 scan was reconstructed using the FreeSurfer v.5.1 software package (http://surfer.nmr.mgh.harvard.edu/), which segments both cortical and subcortical regions based on



	BF	NoS	LoS	ISI	NoP	LoP	IPI
Logical Memory (LM)	30	3	10	0	10	10	2.5
Word Order (WO)	30	12	4	.7~11.4	10	6	2
Paired Associates (PA)	30	6	2	.2~5.6	6	5	5
Letter Sternberg (LS)	0	1	3	NA	1	3	NA
Executive Control (EC)	0	1	4.8	NA	12	1.9	.5

	NoR	TpR	ITI	RP	BF	EoR
Logical Memory (LM)	1	2	30	10	30	7′ 0″
Word Order (WO)	1	2	30	10	30	7′ 2″
Paired Associates (PA)	1	2	10	10	30	3′ 24″
Letter Sternberg (LS)	3	30	3~10	7	0	10′ 28″
Executive Control (EC)	6	6	0	.5	0	3′ 42″

BF: beginning fixation
NoS: number of stimuli
LoS: length of stimulus
ISI: inter stimuli interval
NoP: number of probe
LoP: length of probe
IPI: inter probes interval

NoR: number of run
TpR: trial per run
ITI: inter trial interval
RP: retention period
EoR: end of run

Fig. 3. Timing, snapshot, and parameters of the three memory tasks, Letter Sternberg, and Executive Control Function.

the morphology of the gyri and sulci in each individual participant. Each subject's white and gray matter boundaries as well as gray matter and CSF boundaries were visually inspected slice by slice by a single trained/experienced technician. Manual control points were added in the case of any visible discrepancy, and reconstruction was repeated until satisfactory results were reached for every subject (Fjell et al., 2009). Second-level quality assurance was done by a separate expert who overlaid the borders of the segmented cortical and subcortical regions on top of the original image to minimize/eliminate any inaccuracy in the segmentation process.

We analyzed FLAIR images for white matter hyper-intensities using in-house software (Brickman et al., 2011) and manually inspected by a designated and trained technician. The quantified white matter hyper-intensity volumes were stored and we did not exclude subjects based on their volumes.

DTI data were analyzed using FSL (FMRIB's Software Library v. 5.0.7) and FreeSurfer through a processing stream called TRACULA (Tracts Constrained by Underlying Anatomy) distributed as part of the FreeSurfer v. 5.2 library (Yendiki et al., 2011). FMRIB's Diffusion Toolbox (FMRIB's Software Library v. 4.1.5) standard DTI processing steps including eddy current correction, tensor estimation, and bedpost was used to prepare the data for TRACULA.

ASL data were processed using SPM8. For each voxel, computation of CBF was weighted by the tissue-type posterior probability. To remove any signal from scalp and non-brain tissue, a mask including only voxels with an SE-EPI intensity of >0.80 was obtained and used to yield an average CBF image for each subject before any statistical analysis. For the voxelwise analysis (in both multi- and univariate versions), CBF images were spatially smoothed with a 6 mm kernel. No smoothing was carried out for the ROI analysis.

All fMRI images were pre-processed and statistically analyzed using the FSL standard pre-processing pipeline. Images were visually inspected for imaging artifacts, neurological pathology, and excessive head motion. All volumes in the fMRI data are spatially aligned/registered to the middle volume using rigid-body transformation. The timing of each slice's time-series were temporally adjusted to the middle slice sampling time using *Sinc* interpolation. Spatial smoothing with 5 mm^3 non-linear kernel was applied to all volume data. Intensity normalization was carried out such that the 50th percentile of all volume intensities after removing the background noise was 10^4 for every subject. The time-series were then high pass–filtered using a Gaussian filter with a cutoff frequency of 0.008 Hz. For analysis in standard space, spatial normalization was performed by combining two transformations obtained from (1) non-linear registration of the accompanying T1 image to MNI152 template and (2) inter-modal rigid-body co-registration of each subject's mean volume and T1 image. Autocorrelations within the time-series were corrected for by pre-whitening the data. Resting state fMRI images were also analyzed in the subjects' native space using in-house developed software package (Razlighi et al., 2014).

De-identification, database, and sharing

Once the responding volunteer passed the initial phone screening and scheduled for the first on-site appointment, a subject ID was assigned to him/her. This subject ID also indicates for which study the subject is recruited. Once the subject ID was assigned, there was no use for subject names or any other identification type (birth date, social security number, etc.) in any of the clinical assessments, questionnaires, psychometric data, or neuroimaging data. The subject identifier key was the only link between subject ID and identifying information. This subject identifier key is encrypted and only accessible with IRB-approved personnel and it is only used for contacting the participants in the future.

Currently, all imaging data were pushed into our DICOM server by the scanner and then transferred to our 120 TB RAID storage and converted to NIFTI format. We are in the process of migrating our in-house built database to a COINS database. COINS is web-based neuroimaging and neuropsychology database software suite that offers flexible, automatable data upload/import/entry options, fast and secure sharing of data among researchers, querying and exporting of data, real-time reporting, and HIPAA and IRB compliant study-management tools suitable to large institutions as well as smaller-scale researchers (Scott et al., 2011). Using this database, we are hoping to increase the reliability and accessibility of our data. We also aim to build a stronger relation between psychometric data and neuroimaging data. Once the migration is completed, we should be in a position to share our data through an on-line and easy-to-use database system provided by COINS.

Conclusion

We are in the process of building a large, comprehensive cross-sectional database that includes comprehensive neuroimaging and behavioral data for subjects across the adult lifespan. Our efforts to harmonize data acquisition and data analysis procedures together with our newly implemented web-based databasing system will facilitate collaboration with other investigators who are interested in age-related cognitive differences. We hope that our efforts result in a valuable resource for the field.

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