



# Cam-CAN Imaging Study Data

This dataset contains details of data from the Cambridge Centre for Ageing and Neuroscience (CamCAN) project. Nearly 3000 adults aged 18-90 completed a home interview, and a subset of nearly 700 (100 per decade from 18-88; the "CC700") were scanned using structural Magnetic Resonance Imaging (MRI), functional MRI (both resting and task-based), magnetoencephalography (MEG), and completed multiple cognitive experiments.

## Background

Stage I of the CamCAN study recruited 3000 participants, from GP lists in Cambridge, to take part in a series of interviews and assessments. From that study, 100 participants were chosen from each decile, from the below table, to take part in stage II (target N = 700: 50 men, 50 women from each age decade).

	<b>Decile 1 (18-27)</b>	<b>Decile 2 (28-37)</b>	<b>Decile 3 (38-47)</b>	<b>Decile 4 (48-57)</b>	<b>Decile 5 (58-67)</b>	<b>Decile 6 (68-77)</b>	<b>Decile 7 (78-87)</b>	<b>Decile 8 (88+)</b>
<i>Contact</i>	750	775	850	950	1250	1400	2850	1700
<i>Interview</i>	250	250	275	300	400	450	850	500

In stage II of the CamCAN study, participants were recruited to attend testing sessions at the Medical Research Council (UK) Cognition and Brain Sciences Unit (MRC-CBSU) in Cambridge, UK. In this stage, structural and functional MRI scans, MEG recordings, and cognitive task data were collected over three separate sessions. Physiological data (height, weight, and blood pressure) were also collected, and a saliva sample was taken for future genetic analysis.

In stage III, a subset of participants (target N = 280: 20 men, 20 women from each decade) were recruited to attend further MRI and MEG sessions within 3 years of their assessment in Stage 2. Over three sessions, structural MRI and physiological measures were collected, along with fMRI and MEG data on a variety of cognitive tasks. Structural MRI scans (all participants) included a repeat T1-weighted structural image, as well as T2-weighted FLAIR, and arterial spin labelling (ASL). Functional MRI tasks (target N = 140 each) investigated emotion regulation, emotional memory, fluid intelligence, picture naming, response selection and inhibition, sentence comprehension, and visual short-term memory; repeat resting-state data and field maps for distortion correction were also collected. Height, weight, and blood pressure, which were measured in Stage 2, were re-measured at the Stage 3 MRI session. MEG tasks investigated incidental memory, oddball processing, picture naming, response selection and inhibition, sentence comprehension, and word recognition, as well as a resting state.

# Assessments

## Stage I (Interviews)

	<b>Assessment Name</b>	<b>Assessment Description</b>
<i>Demographic Information</i>	Basic participant information	Including date of birth and gender, and measure participant characteristics that may affect experimental measures including handedness, as assessed by the Edinburgh Handedness Inventory.
	Detailed demographic information	Including information on marital status, accommodation, employment, income, education, birthplace, ethnicity, and English language history.
	The Lifetime of Experiences Questionnaire (LEQ)	The LEQ is a questionnaire to determine both current mental activity levels and how active the participant has been over their lifetime.
	European Prospective Investigation into Cancer Study-Norfolk Physical Activity Questionnaire (EPIC-EPAQ2)	The EPAQ2 is a self-completed questionnaire that collects past year self-reported physical activity behaviours in a dis-aggregated way such that the information may be re-aggregated according to the dimension of physical activity that is of interest.
<i>Cognitive Functioning</i>	MMSE	30-point questionnaire that is used to measure cognitive impairment. The MMSE test includes simple questions and problems in a number of areas: the time and place of the test, repeating lists of words, arithmetic such as the serial sevens, language use and comprehension, and basic motor skills.
	Addenbrooke's Cognitive Examination (ACE-R)	ACE-R is a brief battery that provides evaluation of six cognitive domains (orientation, attention, memory, verbal fluency, language and visuospatial ability) (Mioshi et al., 2006). It is useful for detecting dementia and mild cognitive impairment.
	Wechsler Memory Scale Third UK edition (WMS-III UK)	An individually administered measure of memory for verbal and figural stimuli, memory for meaningful and abstract material, and delayed and immediate recall.
	Spot the Word	Involves presenting the subject with pairs of items comprising one word and one non-word, and requiring the subject to identify the word.
	The Cambridge Memory Questionnaire (the Cambridge 10MQ)	A set of 10 questions probing whether participants have memory problems.
<i>Response Time Measurements</i>	"Simple" Response Time Task (SRT)	In the SRT, participants view an image of a hand with blank circles above each finger, while resting their right hand on a response box with four buttons, one for each finger. When the index finger circle turns black on the image, they press with their index finger as quickly as possible. On pressing the button (or after maximum 3 seconds), the circle becomes blank again, and the variable inter-trial interval (ITI) begins. The ITI varies pseudo-randomly with positively skewed distribution, minimum 1.8 seconds, mean 3.7 seconds, median 3.9 seconds, and maximum 6.8 seconds. There are 50 trials, and the principle outcome measure is the reaction time from stimulus onset to button press.
	"Choice" Response Time Task (CRT)	In the CRT, timing parameters are the same as for SRT, but on each trial any one of the four circles above the fingers could become black, and the participant must press the corresponding finger as quickly as possible (maximum 3 seconds response time). There are 67 trials, and the principle outcome measures are the reaction time from stimulus onset to button press (averaged across all four fingers) and the rate of commission errors (pressing an incorrect button).
<i>Social Contact</i>	Social Contact Questions	In addition to questions elsewhere about social relationships (e.g. marital status), and activities (e.g. hobbies), interviewers ask a number of targeted questions about social support including communications with friends and relatives, participation in community, religious, or social organisations, and whether or not participants have children.
	Health Conditions	Participants provide self-rated assessment of their general health, family history of specific health problems (e.g. heart disease, stroke, and diabetes), and a self-report of their own experience of specific health conditions including those relevant to cardiovascular health (high blood pressure, high cholesterol, etc), mental health (e.g. depression, insomnia), cancer, and a range of other serious health conditions
	Balance	Participants are also asked about their history of falls, and perform two tests of balance: first they balance on one leg for 30 seconds, with their eyes open and

<i>Measures of physical health, disease and frailty</i>		then with their eyes closed; second, they perform five chair rises from a seated position.
	Hearing & Vision Test	In addition to self-reports of hearing and vision problems, participants receive screening measures of hearing and vision. The Siemens HearCheck Screener tests participants' hearing for three sound pressure levels (75 dB SPL, 55 dB SPL, and 35 dB SPL) at two frequencies (1000 Hz and 3000 Hz). The test is performed without hearing correction (i.e. hearing aids) to mimic conditions in the MRI and MEG sessions of Stage 2 and Stage 3.
	Pittsburgh Sleep Quality Index (PSQI)	To assess specifics of sleep disturbances, participants. This measure was designed for purposes of assisting diagnosis of sleep disorders, and provides seven subcomponents of sleep quality as well as an overall score of sleep disturbance.
	Medication	Participants provide details of medication that they are currently taking, including all prescription and over-the-counter medication.
	Drug Abuse Screening Test (DAST-20)	These include questions about current and past alcohol and tobacco use, as well as drug use.
	Diet	Participants provide information on aspects of their diets (e.g. servings of vegetables per day, frequency of eating processed meats).
	EPIC-EPAQ2	A detailed description of their habitual physical activity
<i>Mental Health</i>	Hospital Anxiety and Depression scale (HADS)	Provides an aid to diagnosis and continuous measures of the severity of symptoms of anxiety and depression.
	Anxiety/Depression self-report	Self-report of whether they had been diagnosed and treated for anxiety and depression and at what age.
<i>Measures for older adults</i>	Cambridge Cognitive Examination (CAMCOG)	participants older than 65 years are asked a series of nine questions probing their historical memory knowledge
	Daily Living Questionnaire	participants older than 65 years complete a series of 33 questions about activities of daily living

## Stage II (Cognitive/Behavioural Tasks)

Fourteen behavioural tasks are used to assess cognitive processing across five core cognitive domains: executive function, emotional processing, motor and action function, language processing, and memory.

1. Emotion expression recognition
2. Emotional memory
3. Emotional reactivity and regulation
4. Face recognition: familiar faces
5. Face recognition: unfamiliar faces
6. Fluid intelligence
7. Force matching
8. Hotel task
9. Motor learning
10. Picture-picture priming
11. Proverb comprehension
12. Sentence comprehension
13. Tip-of-the-tongue task
14. Visual short-term memory

# MRI & MEG Sessions

## Stage II

Approximately, 700 participants who are MRI compatible and have no serious cognitive impairment are taken from the 2300 participants in stage 1 and given MRI and MEG measures (100 per decile).

Session	Modality	Measure	Approx. duration (mins)
<i>Session 1</i>	MRI	T1-weighted structural image	5
		T2-weighted structural image	5
		Diffusion-weighted images	10
		Magnetisation Transfer Ration images	5
	fMRI	Resting state T2*-weighted	9
		Movie Watching T2*-weighted	8
		Sensorimotor T2*-weighted	9
		Field Maps	1
<i>Session 2</i>	MEG	Resting	9
		Sensorimotor	12

## Stage III

280 participants were then taken from stage 2 and given further MRI and MEG measures (40 per decile).

Session	Modality	Measure	Approx. duration (mins)
<i>fMRI Session 1</i>	MRI	T1-weighted structural image	5
		T2-weighted FLAIR structural image	5
	fMRI	Arterial Spin Labelling	4
		Emotional expression recognition	15
		Free selection	12
		Fluid intelligence	7
<i>fMRI Session 2</i>	MRI	T1-weighted structural image	5
		T2-weighted FLAIR structural image	5
	fMRI	Arterial Spin Labelling	4
		Fluid intelligence	7
		Picture Naming	15
		Sentence Comprehension	32
<i>fMRI Session 3</i>	fMRI	Resting state	5
		Emotional memory encoding	25
<i>fMRI Session 4</i>	fMRI	Resting state	5
		Emotional reactivity and regulation	30
		Visual short-term memory	35
		Field maps	1
<i>MEG Session 1</i>	MEG	Resting state	5
		Incidental memory	10
		Multi-mismatch	18
		Stop-signal, Go/No-Go	30
<i>MEG Session 2</i>	MEG	Resting state	5
		Picture naming	20
		Sentence comprehension	18
		Word recognition	10

# MRI Protocols

All MRI datasets were collected at a single site (MRC-CBSU) using a 3 T Siemens TIM Trio scanner with a 32-channel head coil. Participants were scanned in a single 1-hour session. Before scanning, physiological measurements were taken, and two behavioural experiments were run. In the scanner, memory foam cushions were used for comfort and to minimise head movement.

## Stage II

In Stage 2, (target N = 700: 50 men, 50 women from each age decade) were recruited to attend testing sessions at the Medical Research Council (UK) Cognition and Brain Sciences Unit (MRC-CBSU) in Cambridge, UK. Owing to recruitment problems for the youngest decade (18–27), only 56 (27 men) were tested from this decade. In this stage, structural and functional MRI scans, MEG recordings, and cognitive task data were collected over three separate sessions.

### Structural MRI protocol

Scan Type	Sequence	TR (ms)	TE (ms)	Flip Angle	FOV (mm)	Voxel size (mm)	Other
T1-weighted	MPRAGE	2250	2.99	9	256 × 240 × 192	1 × 1 × 1	GRAPPA: 2; TI: 900 ms
T2-weighted	SPACE	2800	408	9	256 × 240 × 192	1 × 1 × 1	GRAPPA: 2
Diffusion-weighted							
<i>b</i> = 1000	Twice-refocused SE	9100	104		192 × 192	2 × 2 × 2	directions: 30; slices: 66 (axial); averages: 1
<i>b</i> = 2000	Twice-refocused SE	9100	104		192 × 192	2 × 2 × 2	directions: 30; slices: 66 (axial); averages: 1
<i>b</i> = 0	Twice-refocused SE	9100	104		192 × 192	2 × 2 × 2	slices: 66 (axial); images: 3
Magnetisation transfer							
<i>Baseline</i>	MT-prepared SPGR	30	5		192 × 192	1.5 × 1.5 × 1.5	bandwidth: 190 Hz/px
<i>MT</i>	MT-prepared SPGR	30	5		192 × 192	1.5 × 1.5 × 1.5	bandwidth: 190 Hz/px; RF pulse applied <sup>b</sup>

### Functional MRI protocol

Scan Type	Sequence	TR (ms)	TE (ms)	Flip Angle	FOV (mm)	Voxel size (mm)	Volumes (n)	Slices (n)	Slice thickness (mm)
Resting State	EPI	1970	30	78	192 × 192	3 × 3 × 4.44	261	32	3.7
Movie	Multi-echo EPI	2470	5 echoes	78	192 × 192	3 × 3 × 4.44	5 × 193	32	3.7
Sensori-motor	EPI	1970	30	78	192 × 192	3 × 3 × 4.44	261	32	3.7
Field map									
<i>Magnitude</i>	PE-GRE	400	2 echoes	60	192 × 192	3 × 3 × 4.44	1	32	3.7
<i>Phase</i>	PE-GRE	400	2 echoes	60	192 × 192	3 × 3 × 4.44	1	32	3.7

## Stage III

In Stage 3, a subset of participants (target N = 280: 20 men, 20 women from each decade) were recruited to attend further MRI and MEG sessions within 3 years of their assessment in Stage 2. Over three sessions, structural MRI and physiological measures were collected, along with fMRI and MEG data on a variety of cognitive tasks.

# MEG Collection

All MEG datasets were collected at a single site (MRC-CBSU) using a 306-channel VectorView MEG system (Elekta Neuromag, Helsinki), consisting of 102 magnetometers and 204 orthogonal planar gradiometers, located in a light magnetically shielded room (MSR). Data were sampled at 1 kHz with a highpass filter of 0.03 Hz. Recordings were taken in the seated position. Head position within the MEG helmet was estimated continuously using four Head-Position Indicator (HPI) coils to allow for offline correction of head motion. Two pairs of bipolar electrodes were used to record vertical and horizontal electrooculogram (VEOG, HEOG) signals to monitor blinks and eye-movements, and one pair of bipolar electrodes records the electrocardiogram (ECG) signal to monitor pulse-related artefacts.

## MEG Data

Recording Type	Sampling rate (Hz)	Duration (min:s)	Task
Resting State	1000	08:40	Rest with eyes close
Sensorimotor task	1000	08:40	Audio-visual stimuli and manual response
Audio-visual task	1000	02:00	Separate auditory and visual stimuli, no manual response