NeuropsychBrainAge: a biomarker for conversion from mild cognitive impairment to Alzheimer's disease.

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BrainAge models based on neuroimaging data have diagnostic classification power but have replicability issues due to site and patient variability. BrainAge models trained on neuropsychological tests could help distinguish stable mild cognitive impairment (sMCI) from progressive MCI (pMCI) to Alzheimer's disease (AD). A linear regressor BrainAge model was trained on healthy controls using neuropsychological tests and neuroimaging features separately. The BrainAge delta, predicted age minus chronological age, was used to distinguish between sMCI and pMCI. The cross-validated AUC of the ROC curve for sMCI vs pMCI was 0.91 for neuropsychological features in contrast to 0.68 for neuroimaging features. The BrainAge delta was correlated with the time to conversion, the time taken for a pMCI subject to convert to AD. The BrainAge delta from neuropsychological tests is a good biomarker to distinguish between sMCI and pMCI. Other neurological and psychiatric disorders could be studied using this strategy.

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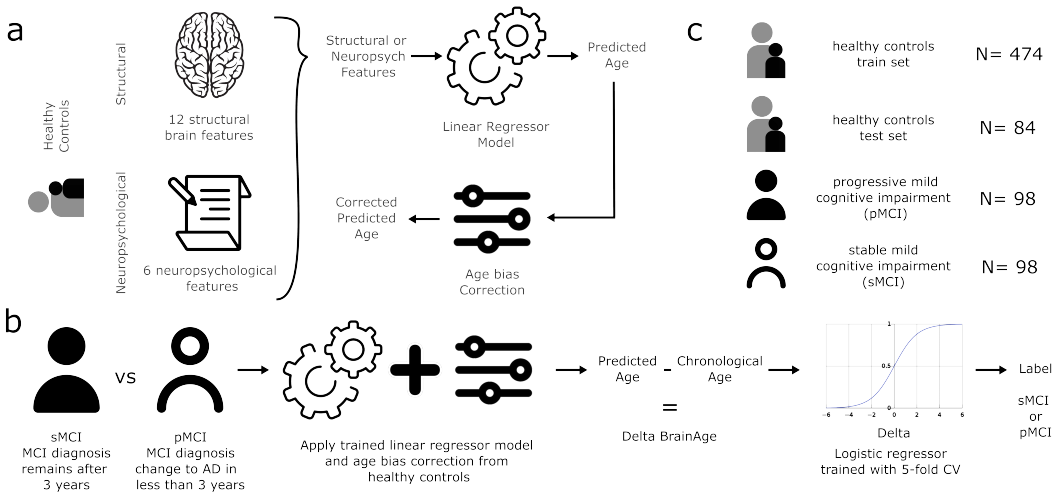

FIG. 1. Overview of the BrainAge model and classification task. a) Training of the BrainAge model on healthy controls with input data consisting of structural features or neuropsychological features. A total of 12 structural brain features were used, consisting of volume measured in mm3 for: white matter, grey matter, peripheral grey matter, cerebrospinal fluid, thalamus, caudate, putamen, pallidum, hippocampus, amygdala, accumbens and brainstem. A total of 6 neuropsychological features were used: MMSE, ADAS, FAQ, MoCA, ADNI Memory and ADNI Executive Function. After training the linear regressor on the healthy controls age estimation task, an age bias correction was applied to deal with the inherent bias of regression to the mean problem. b) Description of the classification task between stable mild cognitive impairment (sMCI) and progressive mild cognitive impairment (pMCI). First, features were extracted for each subject as with healthy controls. Then, using either neuropsychological features or structural features, the trained model and bias correction were applied to obtain a predicted age. The BrainAge delta was calculated by subtracting the chronological age from the predicted age. This delta was then used as an input to a logistic regressor to determine a threshold for labelling using a 5-fold CV scheme. c) Number of subjects used for training with healthy controls, the number of subjects used to test the performance of BrainAge models on unseen healthy controls, and number of sMCI and pMCI used in the classification task.