Generalizing longitudinal age effects on brain structure: a two-study comparison approach

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Introduction:

Cross-sectional studies report normal aging to be accompanied by changes in brain structure, i.e. decreases in grey and white matter together with increases in cerebrospinal fluid [1]. Especially during older ages, however, high inter-individual variability might either obscure or dissemble the intra-individual trajectories of the aging process [2]. Further, methodological differences in study designs, e.g. brain metrics assessed, hamper the generalizability of study results. Therefore, the current study aimed at comparing longitudinal age-related changes in brain structure (measured through cortical thickness (CT)) in two large independent samples of healthy older adults.

Methods:

Participants were recruited from two independent study populations: the Longitudinal Healthy Aging Brain (LHAB) database project at the University of Zurich [3] and 1000BRAINS at the Research Center Juelich [4]. The two samples were matched for age (at timepoint one) and sex using Propensity Score Matching resulting in 161 datasets per site (LHAB: mean age = 69.9 ± 4.1; 85 females, mean interval = 4.2 ± 0.1; 1000BRAINS: mean age = 69.2 ± 4.6, 76 females, mean interval = 3.7 ± 0.7). T1-weighted 3D images (LHAB: 3T Philips Ingenia; 1000BRAINS: 3T Tim-TRIO) were processed using the same automated surface-based processing pipeline, implemented in FreeSurfer 6.0. Mean CT [5, 6] was calculated for both hemispheres and regions of the Desikan-Killiany Atlas [7]. Individual annual percentage changes (APC) of CT were calculated as the following: [(Value at last measurement occasion in the study / Value at baseline)$^{1/(\text{total years in study})}$-1]*100. We then used these APCs in CT 1) to estimate cortical thinning separately for the two groups using one-sample t-tests and 2) to estimate between-sample differences adopting General Linear Models with baseline age, sex, education and Euler number (as quality measure for surface reconstructions) as covariates. Results reported were significant at $p < .05$ (Bonferroni corrected for multiple comparisons).

Results:

While the matched samples did not differ in terms of age (T = -1.39) and sex (W = 13685), participants from LHAB had a higher education level (W = 11000, p = .01). Both samples showed significant negative APCs of CT (e.g. left hemisphere (lh) - LHAB: -0.29 ± 0.45, 1000BRAINS: -0.15 ± 0.45; right hemisphere (rh) – LHAB: -0.3 ± 0.42, 1000BRAINS: -0.14 ± 0.4). While we found slightly stronger changes for LHAB, regional variations of annual percentage changes were highly comparable between the two samples (Figure 1). After including relevant covariates (baseline age, sex, education, image quality), however, neither the two hemispheres (lh: F = 1.83; rh: F = 4.35) nor regions of the Desikan-Killiany atlas showed significant effects of time. Sample differences were only marginally present, i.e. inferior frontal gyrus (pars triangularis [lh: F = 13.67, rh: F = 16.54] and pars opercularis [rh: F = 21.43]) and transverse temporal gyrus (rh: F = 20.47).

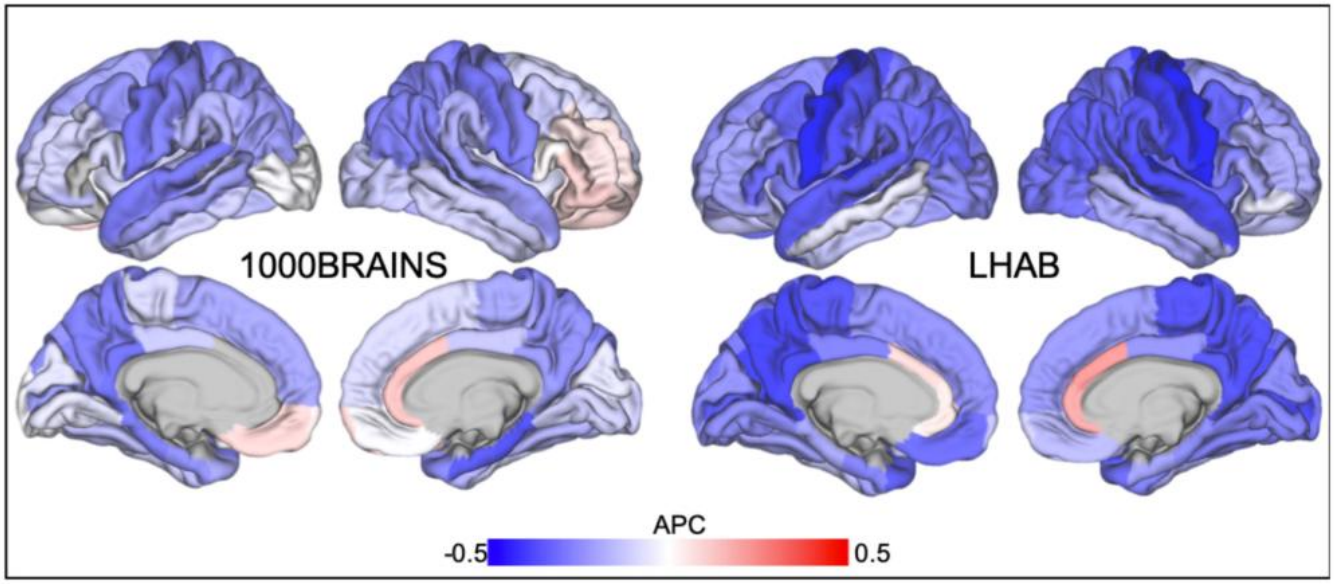

Figure 1: Annual percentage changes of cortical thickness for 1000BRAINS and LHAB

(https://files.aievolution.com/prd/hbm2101/abstracts/abs_1224/Apc_2.jpg)

Conclusions:

Our findings indicate highly similar patterns of age-related changes in CT in two independent samples of older adults. In both samples we found most pronounced cortical thinning within paracentral, medial parietal and temporal regions. While being largely consistent with previous reports on longitudinal grey matter changes across the adult lifespan [8], the current results extend these observations to the older adult population. Importantly, our analyses revealed only slight CT decreases over a time period of three to four years that did not remain significant when correcting for relevant covariates, thus, stressing the importance of including influencing factors when investigating intra-individual age trajectories. The lack of substantial sample differences in our study supports the assumption that general developmental trends in aging are generalizable over independent samples provided that the same methodology is used and similar sample characteristics are present.

Lifespan Development:

Aging [1]

Neuroanatomy, Physiology, Metabolism and Neurotransmission:

Cortical Anatomy and Brain Mapping [2]

Keywords:

Aging
Cortex
NORMAL HUMAN
STRUCTURAL MRI

[1|2]Indicates the priority used for review

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No

Please indicate below if your study was a "resting state" or "task-activation" study.

Other

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Healthy subjects

Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

Yes

Was any animal research approved by the relevant IACUC or other animal research panel? NOTE: Any animal studies without IACUC approval will be automatically rejected.

Not applicable

Please indicate which methods were used in your research:

Structural MRI

For human MRI, what field strength scanner do you use?

3.0T

Which processing packages did you use for your study?

Free Surfer

Provide references using author date format

Lutz Jäncke & Svenja Caspers contributed equally to this study

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