News Release

Title

An unbiased data-driven age-related structural brain parcellation for the identification of intrinsic brain volume changes over the adult lifespan

Key Points

- **An unbiased, data-driven, age-related brain parcellation generated using anatomical brain images from participants of our ongoing aging cohort study was introduced**
- **Gray matter volume associated with most parcels negatively correlated with age with some parcels showing more vulnerability to aging effects than others**
- **Regional gray matter co-variations showing either interhemispheric, short-distance, positive correlations or inter-lobar, long-distance, negative correlations were also observed**
- **Linear combination of parcels reliably predict chronological age with mean predictive error of 7.2 years**

Summary

In a recently published paper, researchers from the Brain and Mind Research Center of Nagoya University introduced an unbiased, data-driven, age-related brain parcellation to systematically investigate the intrinsic changes the brain undergoes over the adult lifespan using a cohort of 293 healthy volunteers participating in the center's ongoing aging study. The parcellation, generated from the anatomical brain images from all participants, subdivided the brain into 192 components that homogeneously co-vary with age.

The research team's findings showed that of the 192 components, 90% significantly correlated with the brain's total gray matter volume that also exhibited significant decrease with age. In addition, 24% of the components showed either an accelerated regional gray matter loss or relative preservation as compared to the total gray matter volume. Some components also showed nonlinear relationship with age. In particular, 3 components including the bilateral amygdala, left parahippocampal gyrus, and bilateral hippocampus showed an initial increase in gray matter in early adulthood followed by a rapid decline in late adulthood, while 4 components including the left putamen, left superior temporal gyrus, lingual gyrus, and middle frontal gyrus showed an initial gray matter decline in early adulthood followed by relative preservation in late adulthood. Linear combination of these components was also shown to reliably predict chronological age with mean prediction error of 7.2 years. Moreover, the regional gray matter changes were also shown to exhibit structural co-variation, characterized by either interhemispheric, short-distance, positive correlations or inter-lobar, long-distance, negative correlations, across all participants. Network measures computed from the structural co-variation also exhibited either a U- or an inverted U-shaped relationship with age with the vertex occurring at around 45 to 50 years old.

Overall, the team's findings demonstrated the brain's heterogeneous and asynchronous response to the aging process with some regions showing more vulnerability to the aging effects than others. These findings could help provide a framework to distinguish intrinsic brain changes due to the normal aging process from that associated with age-related neurodegenerative disorders.

Research Background

Healthy aging is associated with structural as well as functional changes in the brain even in individuals without any neurodegenerative diseases. Understanding how the brain changes during the aging process may provide critical insights into the underlying processes that could lead to the transition from normal aging to neurodegeneration. In this study, intrinsic changes in the regional gray matter (GM) volume over the adult lifespan were systematically investigated using 293 healthy volunteers ranging in age from 21 to 86 years old who participated in Nagoya University's Brain and Mind Research Center Aging Cohort Study (BMRC-ACS).

Research Results

Using anatomical brain images from all study participants, an unbiased, data-driven, age-related brain parcellation was generated. This parcellation identified 192 components, subdividing the brain into regions that homogenously co-vary with age. Of the 192 components, 90% had GM values that significantly correlated with total GM volume, which exhibited significant decrease with age. In addition, 24% showed either accelerated GM loss or preservation relative to the total GM volume. Components exhibiting nonlinear response with age were also identified with 3 components showing an inverted U-shaped trajectory of GM progression with age and 4 components showing a U-shaped trajectory. Linear combination of these components also provided reliable prediction of chronological age with mean prediction error equal to 7.2 years. Moreover, structural co-variation of regional GM values showed strong interhemispheric, short-distance positive correlations and inter-lobar, long-distance negative correlations across all participants. Network measures computed from this structural co-variation also exhibited either a U- or an inverted U-shaped relationship with age with the vertex occurring at around 45 to 50 years old.

Research Summary and Future Perspective

These findings are indicative of the brain's heterogeneous and asynchronous response to the healthy aging process, with some regions showing more vulnerability to the aging effects than others. Although regionally specific, the observed intrinsic brain volume changes were also spatially inter-related.

Publication

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