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Inter-individual differences in neurophysiology vary with age and disease

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Background

Neuroscience aims to understand the **biological** nature of individual traits

To date, most neuroimaging research has focused on **group averages**—ignoring potentially meaningful individual differences

Recent findings suggest that individuals' **functional connectomes**, recorded using fMRI imaging, are **unique**

Inter-individual differences of functional connectomes are very stable, and can differentiate individuals >90% accuracy

Background

Like a fingerprint, functional connectomes are **characteristic** to individuals and **predict** behaviour

It remains unclear if we can achieve the same results with **electrophysiology**...

Electrophysiology and hemodynamics capture different signals

Understanding inter-individual diversity of brain activity will help researchers train better **brain-behaviour** models

electrophysiological brain-fingerprints

MEG Fingerprinting

(a) datasets for fingerprinting

i) within-session



ii) between-session





iii) between-session shortened





We tested our ability to fingerprint individuals with 3 challenges:

i- within-session fingerprinting (N=158)

ii- between-session fingerprinting (N=47)

iii- shortened fingerprinting (N=47)

MEG Fingerprinting

We differentiated individuals from i) functional connectomes and ii) the topography of spectral power





Brain-fingerprinting

In brain-fingerprinting, we differentiate individuals

Is your brain activity strongly correlated to yourself?

P1 PN (dataset Ľ







Differentiability

How easy is it to differentiate Jason?

person easy to differentiate

person somewhere in the middle

person hard to differentiate



Similarity (Pearson correlation)

Between session fingerprinting



(a) between-session fingerprinting

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Connectome

Spectral



Between session fingerprinting

(b) differentiability does not decrease with time





Brain-fingerprints of older adults

a | individual differentiation accuracy is stable across age groups



b | self-similarity is not related to age

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Brain-fingerprints & inter-individual differences

Our results indicate that **spectral features** are **characteristic** to individuals (brain-fingerprints)

Previous work argues that **functional connectomes predict** inter-individual differences in **behaviour** (brain-behaviour models)

Is this also true of spectral brain-fingerprints?



Brain-fingerprints & inter-individual differences

a | decoding of fluid intelligence performance from brain-fingerprints



Summary so far...

Individuals can be **differentiated** from large cohort based on both **connectome** and **spectral features**

Individual differentiation is **robust** against environment and physiological artifacts

We can **differentiate** individuals from brain-fingerprints **recorded weeks apart** and from **brief 30-second** segments

Spectral brain-fingerprints **predict** inter-individual differences in **fluid intelligence**

Brain-fingerprints of Parkinson's disease

Brain fingerprints altered by disease?

Inter-individual differences in neurophysiology are robustly estimated from young and older adults

Little is known about how **disease** may affect inter-individual differences

Some preliminary findings suggest that **neurodegenerative diseases**, like Parkinson's disease (PD), may increase within-session variability of brain activity

Does PD destabilize inter-individual differences?

Methods

We assessed spectral brain-fingerprinting using the QPN and Prevent-AD datasets

We computed the resting-state brain-fingerprints from 79 patients with Parkinson's disease and 54 healthy age-matched controls



a | inter-individual differentiation





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c | self-similarity decreases faster with gap duration between brain-fingerprint datasets in Parkinson's disease



The most differentiable features in PD

The most salient features for individual differentiation differ between patients and healthy controls

a | PD patients are better differentiated from somatomotor regions



Decoding of disease staging

a | decoding of disease staging from rhythmic spectra

earlier (H&Y < 2) vs later (H&Y \ge 2) disease stage









b | disease staging is related to the most salient features of the PD brain-fingerprint



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individual differentiation

Conclusions



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Take homes & discussion

Brain **oscillations** are **characteristic** to individuals, particularly fast oscillations (i.e., beta band)

Inter-individual differences in brain oscillations **predict** inter-individual differences in **fluid intelligence**

Inter-individual differences in brain oscillations **change** across the lifespan and throughout disease in meaningful ways

Population differences in brain-fingerprints may explain **challenges** in brain-behaviour **transfer learning**

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Thank you!

