Degraded Fractal Activity Regulation Predicts Elevated Risk of Alzheimer’s Disease in the Elderly*

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Introduction

- Healthy physiological systems exhibit fractal regulation, generating similar fluctuation patterns in their outputs across different time scales from seconds to hours [1].
- Fractal regulation is mechanistically linked to sleep and circadian control [2,3].
- Sleep and circadian disturbances may be early signs of Alzheimer’s disease [4].
- Cross-sectional studies have shown that fractal regulation is degraded in elderly subjects and in people with dementia [5].

Hypothesis

- Degradation of fractal regulation predicts elevated risk for Alzheimer’s dementia and faster cognitive decline.

Data and Methods

- Continuous actigraphy lasting for up to 10 days were recorded in the Rush Memory and Aging Project (MAP) [6].

Activity counts

- Actiwatch (Phillips Respironics Actical, Bend, OR)
- Accelerometer sensitivity: < 0.01 g
- Epoch length: 15, 30, 45, 60 sec
- Actical (Phillips Respironic Actical, Bend, OR)

Aims

- Does not differ between sexes
- Equivalent to the effect of being 5 years old
- Does not differ between sexes
- Independent from total daily activity, sleep fragmentation, and inter-daily stability (actigraphy-based)
- Consistently observed in episodic memory, working memory, and perceptual speed.

Results

- Positive temporal correlations in motor activity
- Consistent over a range of time scales (~1 - 90 min)
- Gaussian-like distribution of all α
- α ranges from -0.6 to ~1.2
- The two representative subjects have α’s at the 10th and 90th percentiles, respectively

Discussion

- Motor activity of two representative subjects.

Conclusions

- Global cognition is a composite measure z-scored from the average z-scores for 5 cognition domains.
- Red and blue lines show the cumulative hazard of the two representative subjects.

References


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Future Plan

- How does degradation of fractal regulation link to brain pathology?
- Can fractal degradation predict the risk in middle to old aged population?