

Age Related Adaptability of Postural Control as Assessed by Recurrence Quantification Analysis

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Introduction

Age related declines in postural stability may be associated with less flexible control.

If degrees of freedom are reduced by mechanical constraints, a flexible system would be expected to change its control strategy.

Such strategies can be quantified using recurrence quantification analysis (RQA) of the ground reaction force center of pressure (CoP) movement.

In this study we used RQA to examine CoP motion in free and constrained quiet stance in healthy younger and older adults to assess the adaptability of their postural control systems.

Methods

Subjects & Task

- 12 young subjects (Y: 27 ± 3 yrs)
- 12 old subjects (O: 71 ± 5 yrs)
- Quiet stance on a force plate for 30 s

Conditions (Figure 1)

- Free (F) & Constrained (C)
- Lightweight wooden backboard, restricting motion to the ankle joint (sagittal plane)

Data Analysis

- Anterior-posterior CoP time series (100 Hz)
- RQA (Hasson et al. 2008)

Assessment of Postural Dynamics

RQA Variables:

- \uparrow Determinism [DET] = \uparrow Repeatability
- \uparrow Entropy [ENT] = \uparrow Complexity
- \uparrow Laminarity [LAM] = \downarrow Intermittency

Statistics

- Paired t-tests:
Free vs. Constrained
Young vs. Old

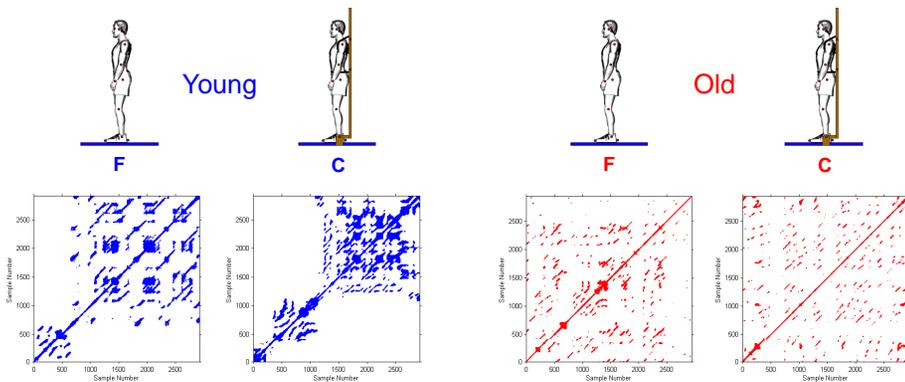


Figure 1. Example recurrence plots for a young and old subject. Embedding parameters: Embedding Dimension = 5, Time Delay = 13-20; RQA Parameters: Radius = 25% of mean distance, Line Min = 3. For a more detailed description of these parameters, see Hasson et al. (2008).

Results

Free vs. Constrained (Figure 2)

- Young - all three RQA variables increased with the backboard constraint
- Old - no change with constraint

Young vs. Old

- DET higher in old subjects (F: $p = .02$; C: $p = .06$)
- LAM higher in old subjects (F: $p = .01$; C: $p = .03$)
- ENT not different (F: $p = .18$; C: $p = .83$)

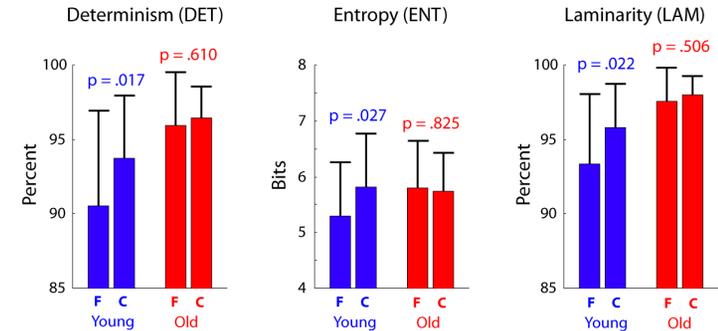


Figure 2. Mean (+ 1 standard deviation) determinism (DET), entropy (ENT) and laminarity (LAM) for the young and old subject groups in free (F) and constrained (C) conditions.

Discussion

Younger subjects adapted to the constraint, while older subjects did not. Compared to the younger subject group, the older subjects acted as if constrained in *both* conditions.

These results agree with observations that older individuals do not change upper body coordination between constrained and free postural tasks (Gariépy et al. 2008).

Together, these data suggest that the postural control system of older adults is less adaptable, using a similar control strategy for both free and constrained standing.

Acknowledgements

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References

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