

Open Science Data in Biomechanics and Motor Control

Marcos Duarte

<http://pesquisa.ufabc.edu.br/bmclab/>

Universidade Federal do ABC

Open science data

- “**Open science data** is a type of open data focused on publishing observations and results of scientific activities available for anyone to analyze and reuse.”
- Open science data maximizes scientific impact, reproducibility, reuse, and cost reduction.
- To open: data, software code ...

https://en.wikipedia.org/wiki/Open_science_data

<https://gigascience.biomedcentral.com/articles/10.1186/s13742-016-0127-4>

Characteristics of Open Science Data

- Valuable.

...just like with anything else in science.

Data Repositories

Generalists:

- [Figshare](#)
- [Open Science Framework](#)
- [Zenodo](#)
- [Mendeley Data](#)
- [Science Data Bank](#)

See full list at: <https://www.nature.com/sdata/policies/repositories>

Datasets in Biomechanics and Motor Control

Open data is not new in BMC, e.g.:

- Winter's book 1st ed (1978)
- <http://www.clinicalgaitanalysis.com/data/> (~2000)

A curated list of large datasets in BMC:

- <https://github.com/modenaxe/awesome-biomechanics#datasets-dvd>

A data paper (data descriptor)

- A publication that provides detailed descriptions of research datasets, including the methods used to collect the data and technical analyses supporting the quality of the measurements.
- Data Descriptors focus on helping others reuse data, rather than testing hypotheses, or presenting new interpretations, methods or in-depth analyses.

Journals for publishing data papers

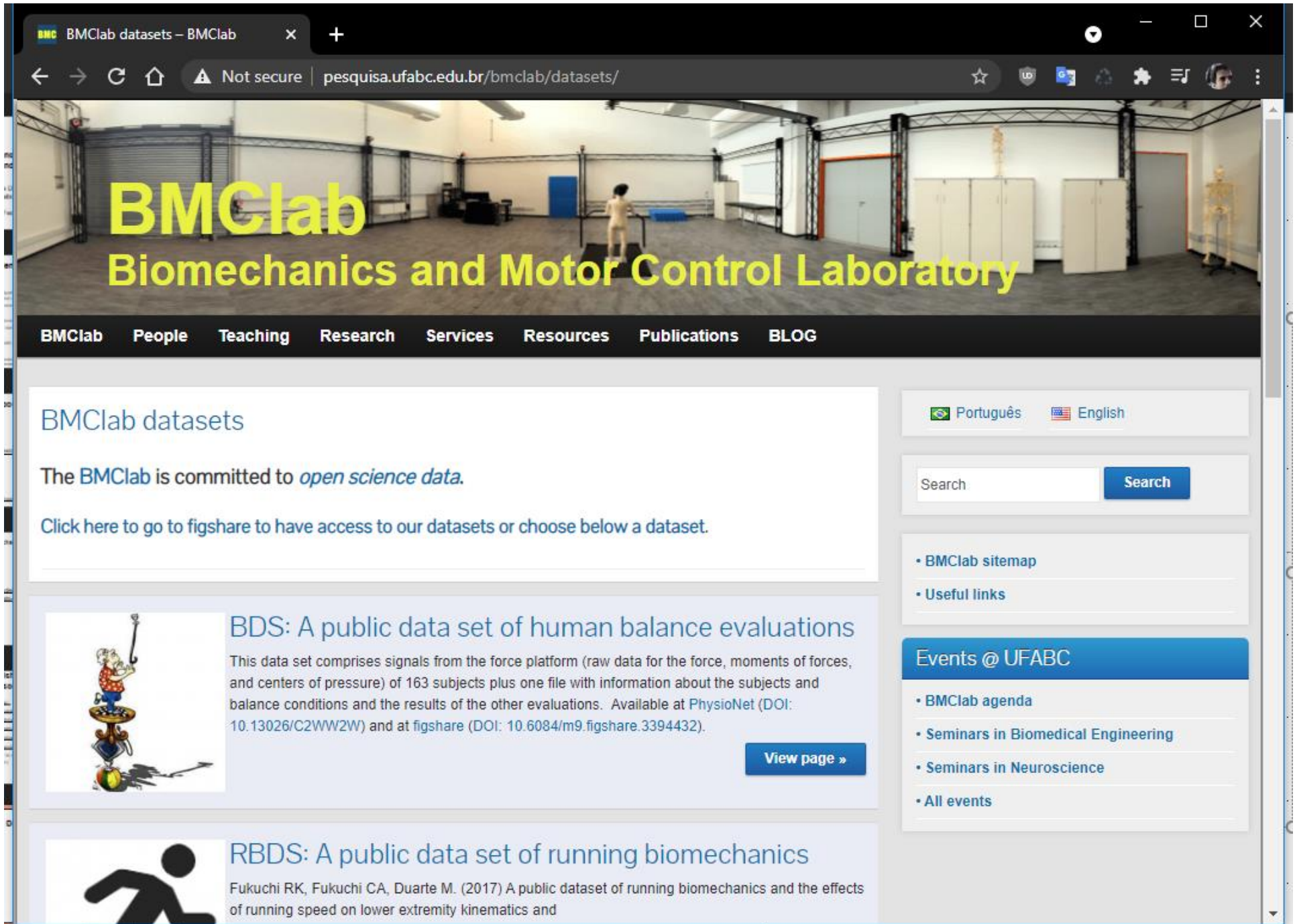
- <https://www.nature.com/sdata/>
- <https://www.journals.elsevier.com/data-in-brief>
- <https://www.mdpi.com/journal/data>
- <https://academic.oup.com/gigascience>
- <https://openhealthdata.metajnl.com/>
- <https://bmccresnotes.biomedcentral.com/>
- <https://peerj.com> (not explicit to data papers, it has to be wrapped as a research article)
- ...

Guideline for Open Science data holdings

FAIR Data Principles:

- Findable – Digital Object Identifier (DOI)
- Accessible
- Interoperable – how external services can Interact with
- Reusable

Open Science Data: example



The screenshot shows a web browser window with the address bar displaying "pesquisa.ufabc.edu.br/bmclab/datasets/". The page features a large banner image of a laboratory with the text "BMClab Biomechanics and Motor Control Laboratory" overlaid in yellow. Below the banner is a navigation menu with links: BMClab, People, Teaching, Research, Services, Resources, Publications, and BLOG. The main content area is titled "BMClab datasets" and includes a statement: "The BMClab is committed to *open science data*." It also provides a link to "Click here to go to figshare to have access to our datasets or choose below a dataset." On the right side, there are language options for "Português" and "English", a search bar with a "Search" button, and a list of links: "BMClab sitemap" and "Useful links". Below these is a section titled "Events @ UFABC" with a list of events: "BMClab agenda", "Seminars in Biomedical Engineering", "Seminars in Neuroscience", and "All events". The main content area also features two data set descriptions: "BDS: A public data set of human balance evaluations" and "RBDS: A public data set of running biomechanics". Each description includes a brief overview of the data and a "View page »" button.

BMClab datasets – BMClab

Not secure pesquisa.ufabc.edu.br/bmclab/datasets/

BMClab Biomechanics and Motor Control Laboratory

BMClab People Teaching Research Services Resources Publications BLOG

BMClab datasets

The BMClab is committed to *open science data*.

Click here to go to figshare to have access to our datasets or choose below a dataset.

Português English

Search Search

- BMClab sitemap
- Useful links

Events @ UFABC

- BMClab agenda
- Seminars in Biomedical Engineering
- Seminars in Neuroscience
- All events

BDS: A public data set of human balance evaluations

This data set comprises signals from the force platform (raw data for the force, moments of forces, and centers of pressure) of 163 subjects plus one file with information about the subjects and balance conditions and the results of the other evaluations. Available at [PhysioNet](#) (DOI: 10.13026/C2WW2W) and at [figshare](#) (DOI: 10.6084/m9.figshare.3394432).

View page »

RBDS: A public data set of running biomechanics

Fukuchi RK, Fukuchi CA, Duarte M. (2017) A public dataset of running biomechanics and the effects of running speed on lower extremity kinematics and

Balance & Postural Control

- **Posture:** relative position between segments
- **Control:** to maintain/regulate a dynamical system in a desired state/reference over time.

Postural Control of all body segments during upright standing

- For now, postural control, equilibrium control, and balance control are equivalent terms.

Balance Discontrol & Falls

When we stand still, we don't stay motionless, we sway.

A non-trivial task

- One in four adults aged 65 yr. and older falls each year. Falling once doubles your chances of falling again.
- One out of five falls causes a serious injury such as broken bones or a head injury.*
- Over 800,000 patients a year are hospitalized because of a fall injury, most often because of a head injury or hip fracture.*

* Data for the United States - <https://www.cdc.gov/>

Fall Prevention for older adults

general recommendation

- Talk to your doctor
- Be active (do strength and balance exercises)
- Have your eyes checked
- Make your home safer

Postural Control of all body segments during upright standing?

- The exact nature of the control mechanisms that allow humans to stand in an upright posture is unknown (or at least it is still matter of controversy).

Methods for human balance evaluation

- There is no single method/technique able to *clinically* **diagnose** human balance,
- in part because the maintenance of balance is a complex skill affected by several factors.

Methods for human balance evaluation

- Broadly, the different methods for evaluation of human balance can be divided in:
- **‘Qualitative’ methods:** simple to use, low cost, field measurement, more functional, more subjective
- **‘Quantitative’ methods:** more objective, use of instrumentation, high cost, in a laboratory setup

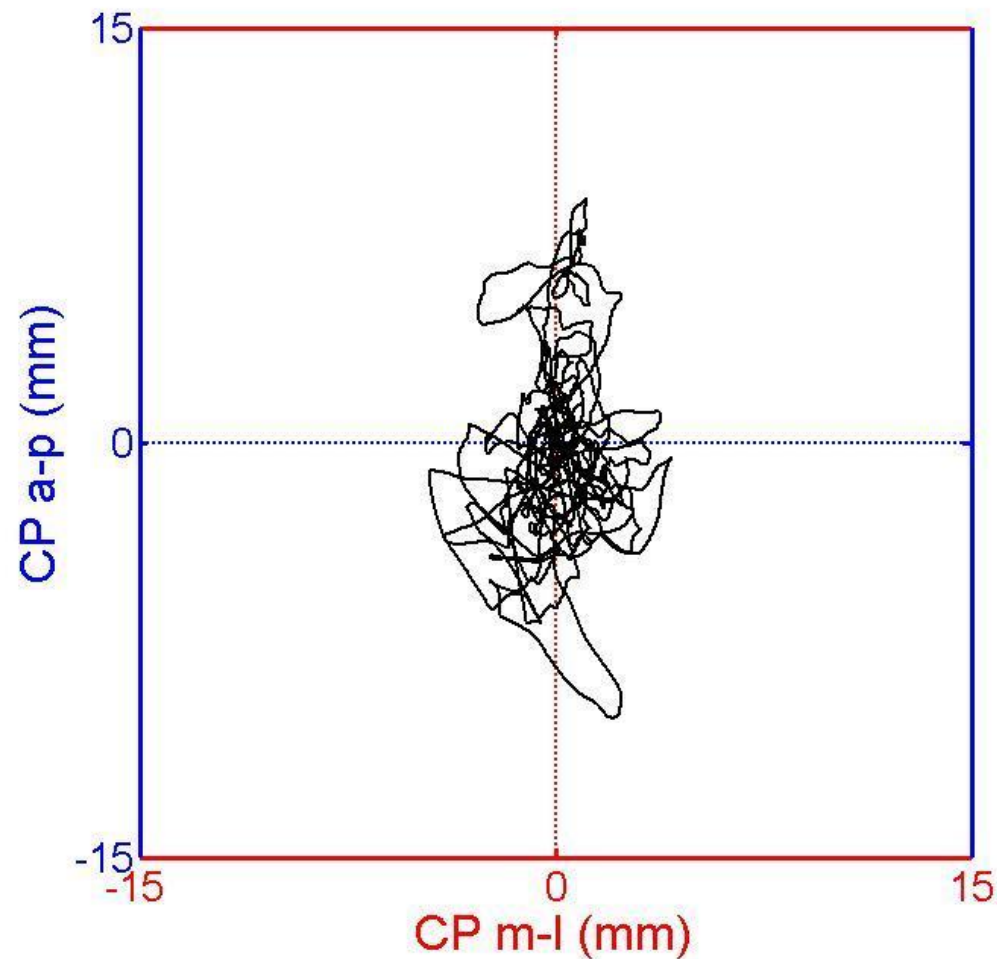
Research approach

- In research, quantitative methods are typically preferred for the evaluation of human balance.

Posturography (stabilometry)

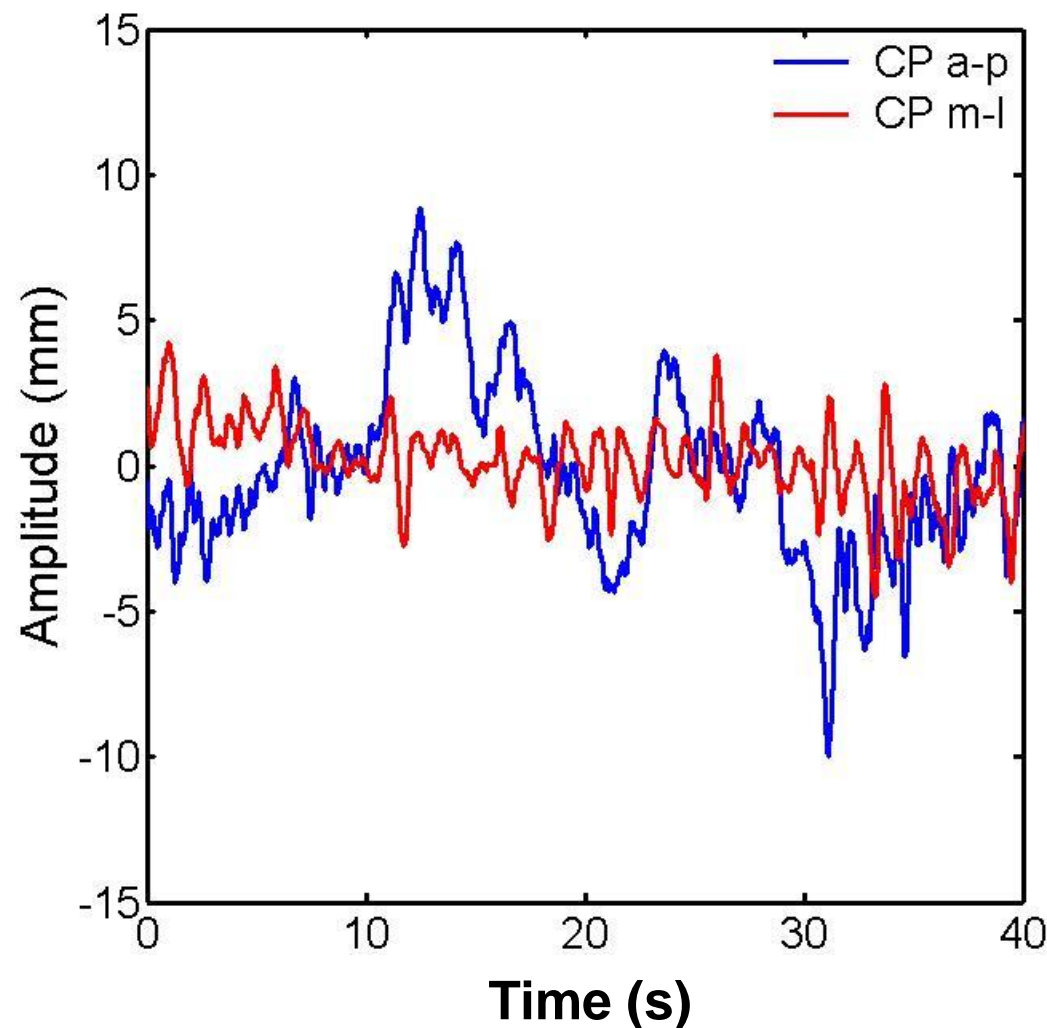
- Posturography is the technique concerned with measuring the postural sway.
- Instead of measuring the sway of each segment, commonly, measures related to the whole body sway are used: the displacement of center of gravity (COG) and of the center of pressure (COP).

Posturography: COP data



Stabilogram during quiet standing for 40s.

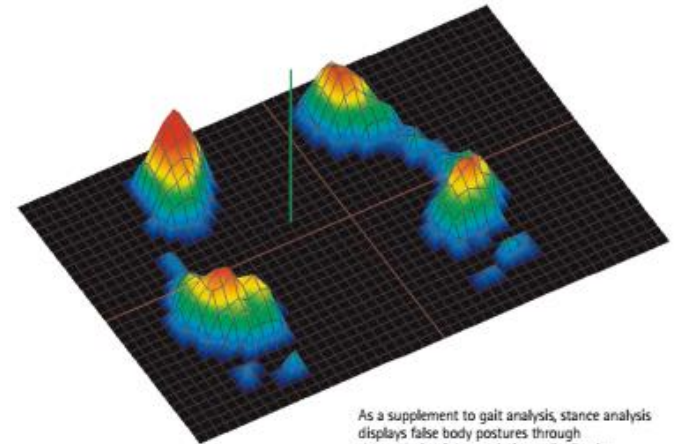
Statokinesigram during quiet standing for 40s.



High-end sensors of postural sway

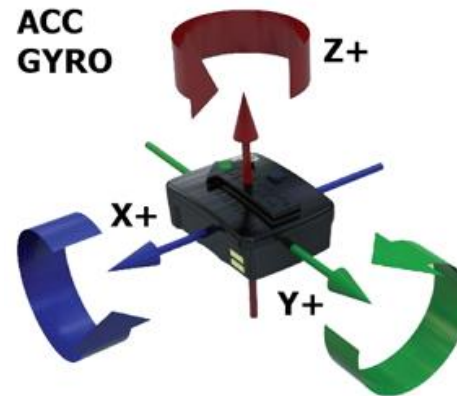


<http://www.amti.biz>



As a supplement to gait analysis, stance analysis displays false body postures through the analysis of the static force distribution.

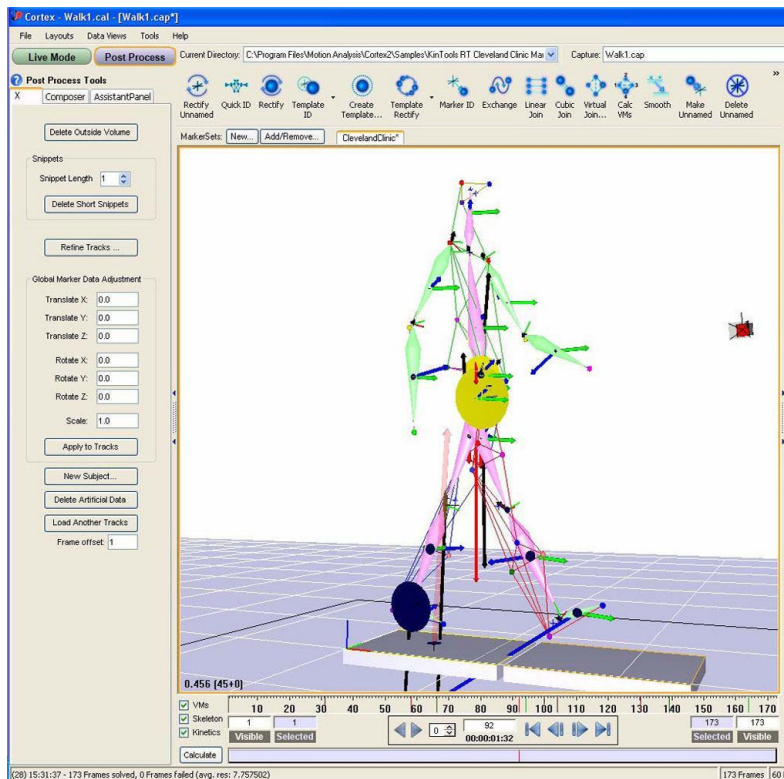
<https://www.zebvis.de>



<https://www.delsys.com>

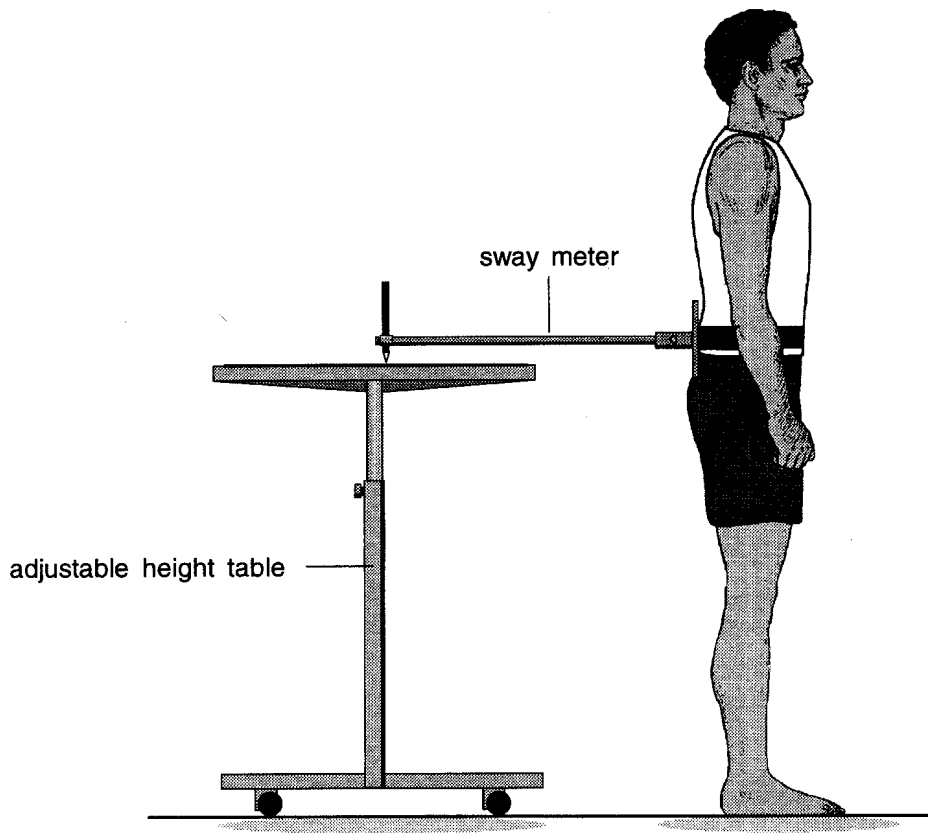


<http://balanceandmobility.com>

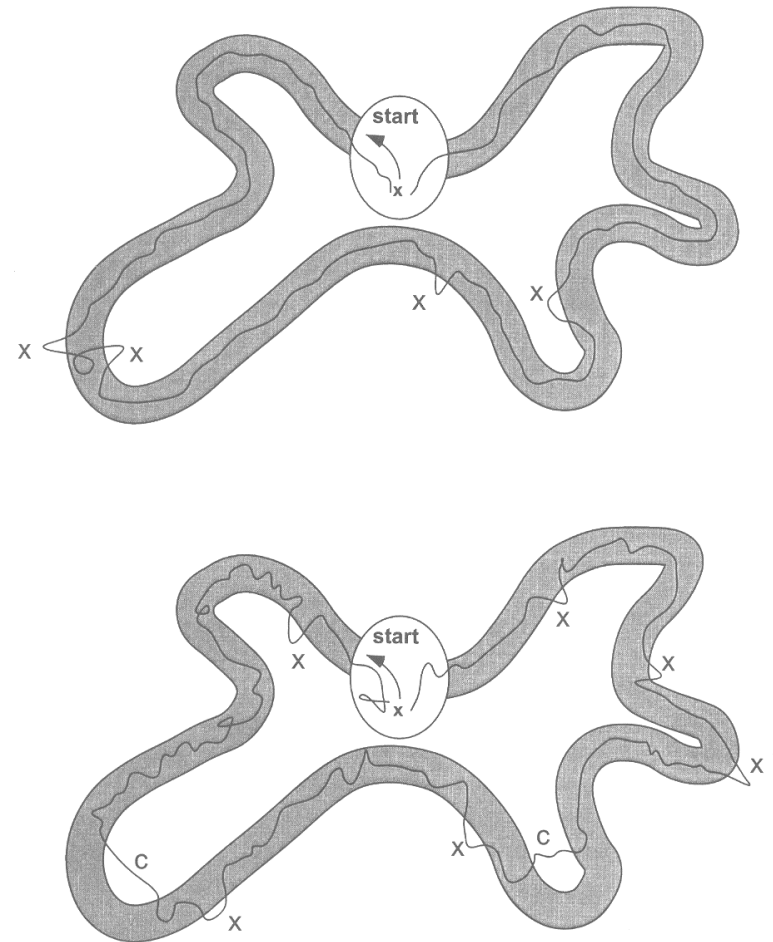


<https://www.motionanalysis.com>

Low-cost sensor of postural sway



evaluation



training

Sway meter (Lord et al., 1991)

Research approach

- In research, quantitative methods are typically preferred for the evaluation of human balance.
- A challenge in the area is that there are several different methods and analyses for evaluation of human balance.
- These different methods and analyses are often based on small samples with different subjects across laboratories.

Human Balance Open Data

- A public data set of human balance evaluations

<https://doi.org/10.6084/m9.figshare.3394432.v2> (1930 files, 360 MB)

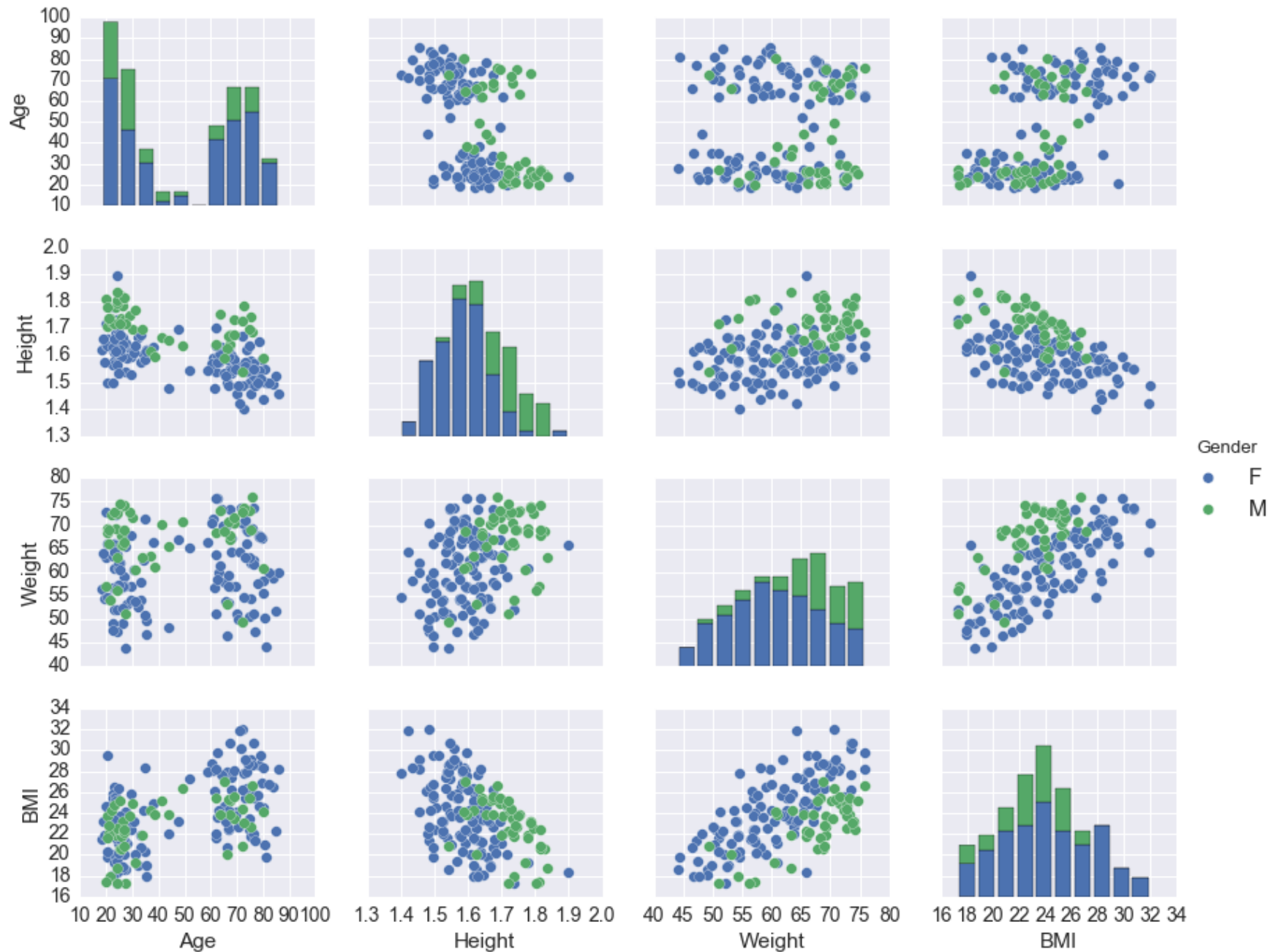
Complete raw data with qualitative and quantitative balance evaluations and detailed information (60 metadata) about socio-cultural, demographic, and health characteristics of 87 young adults and 76 older adults.

- A data set with kinematic and ground reaction forces of human balance

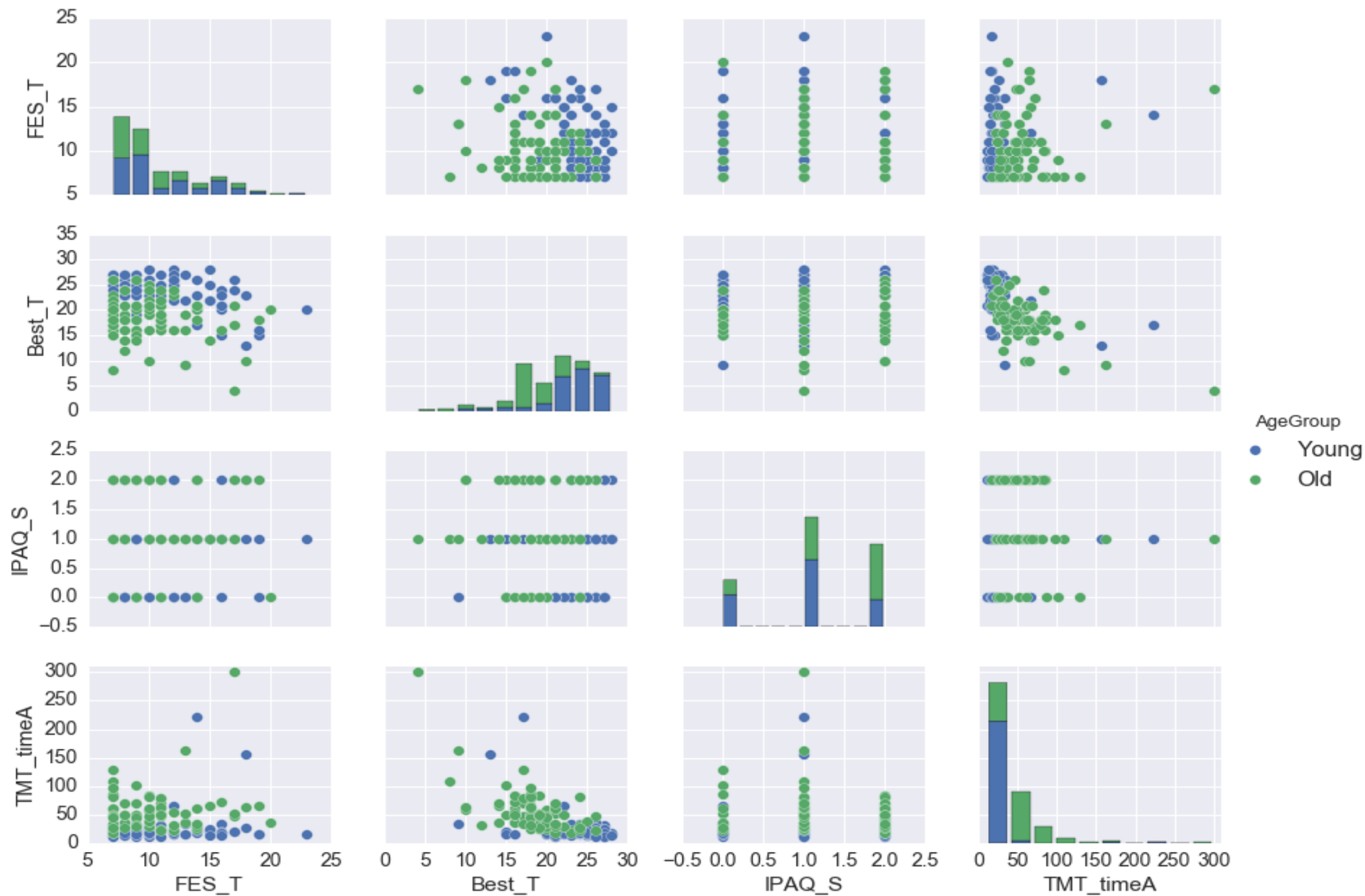
<https://doi.org/10.6084/m9.figshare.3394432.v2> (1813 files, 6.93 GB)

Complete raw data with quantitative balance evaluations and detailed information (24 metadata) about socio-cultural, demographic, and health characteristics of 27 young adults and 22 older adults.

A dataset of human balance evaluations

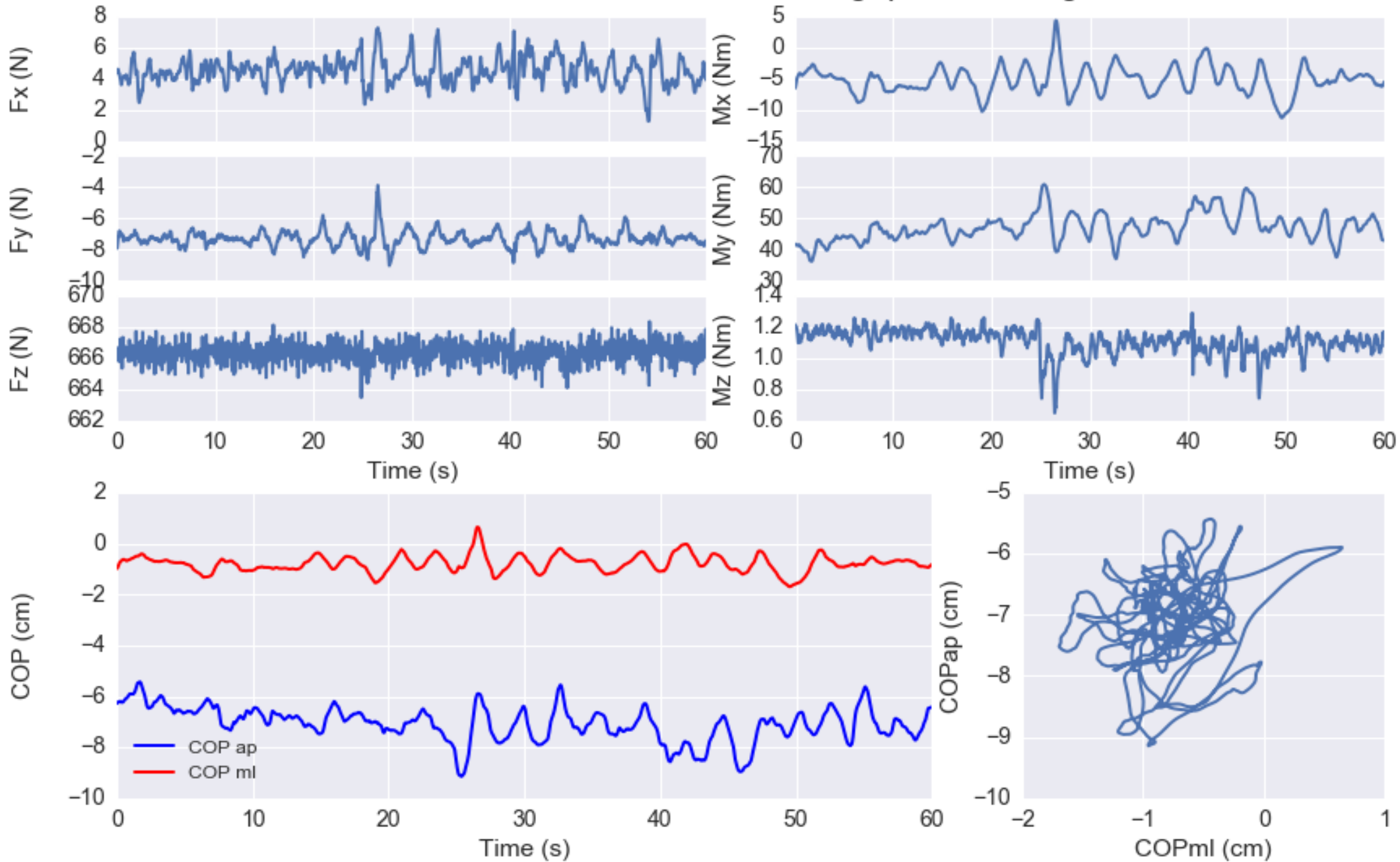


Qualitative evaluations

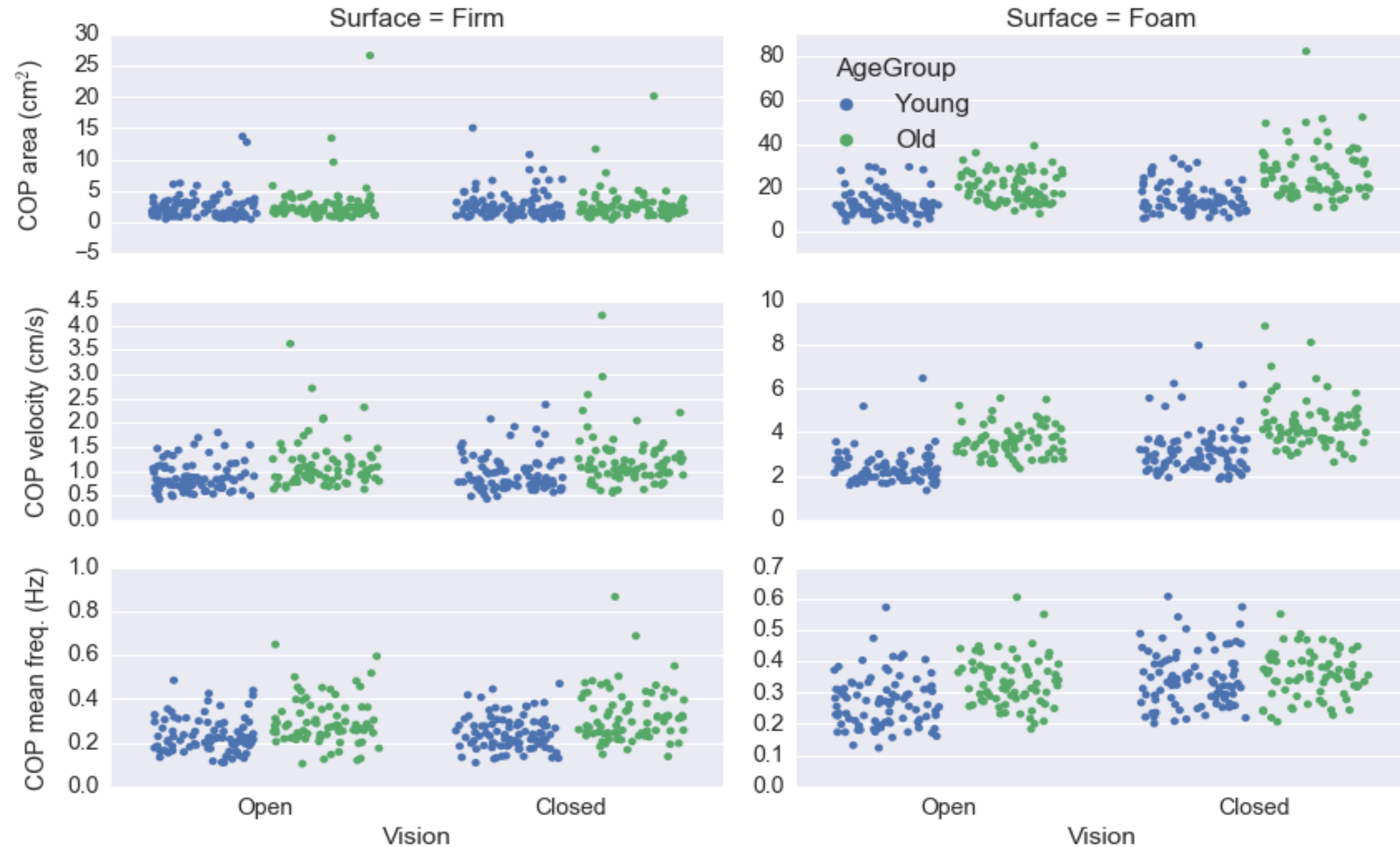


Stabilography

Ground reaction force data during quiet standing



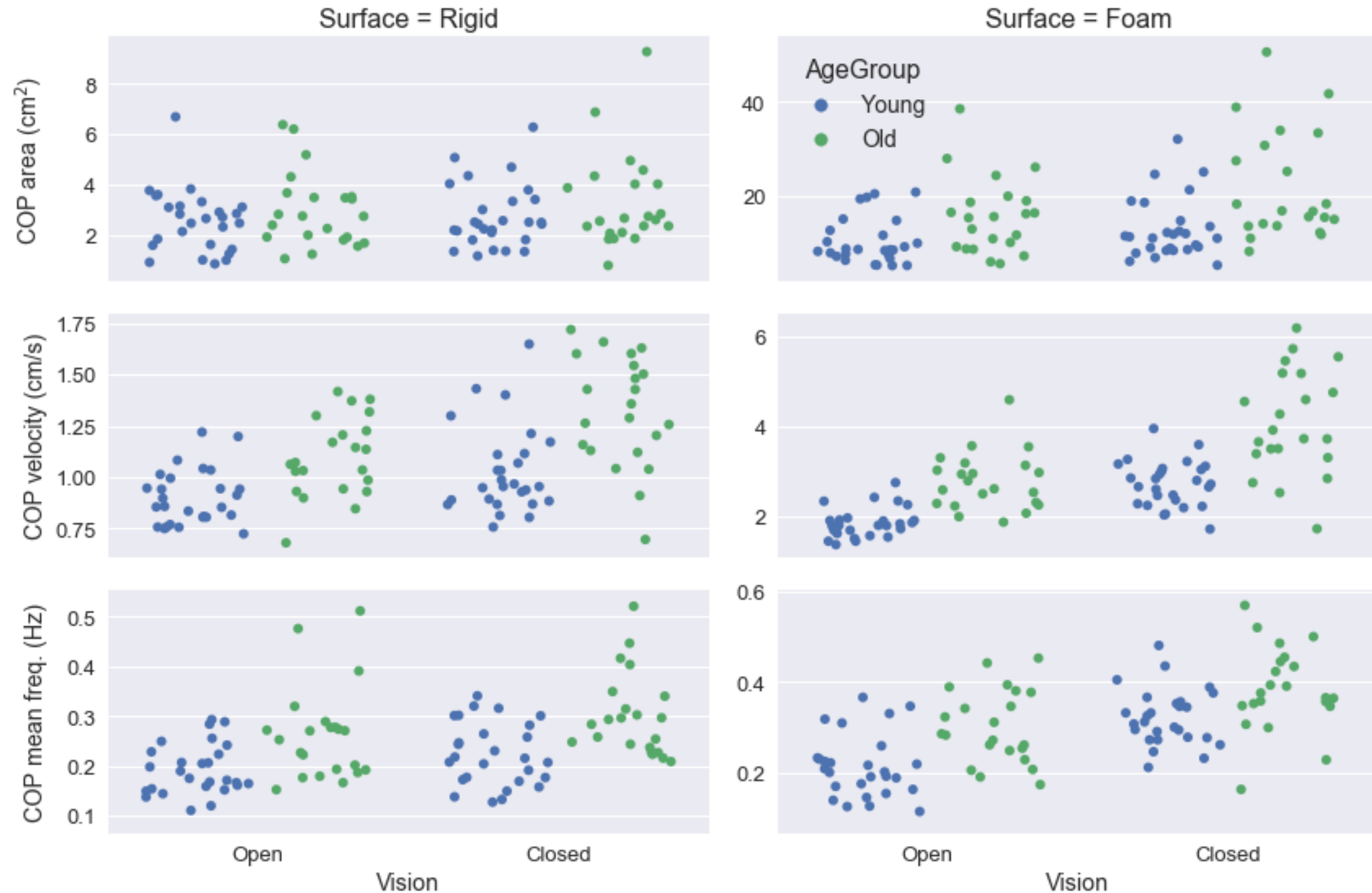
Stabilography



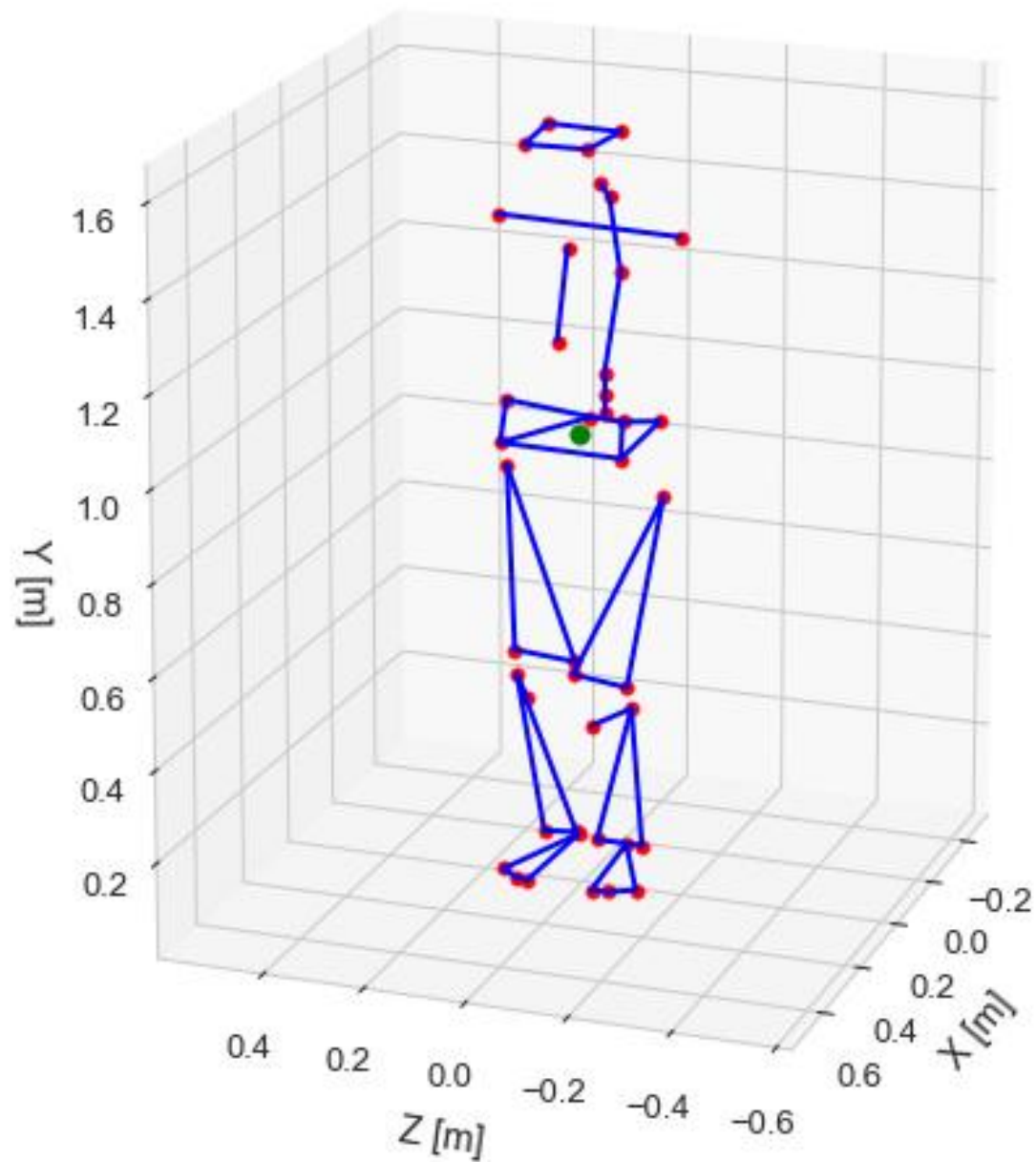
A dataset with kinematic and ground reaction forces of human balance



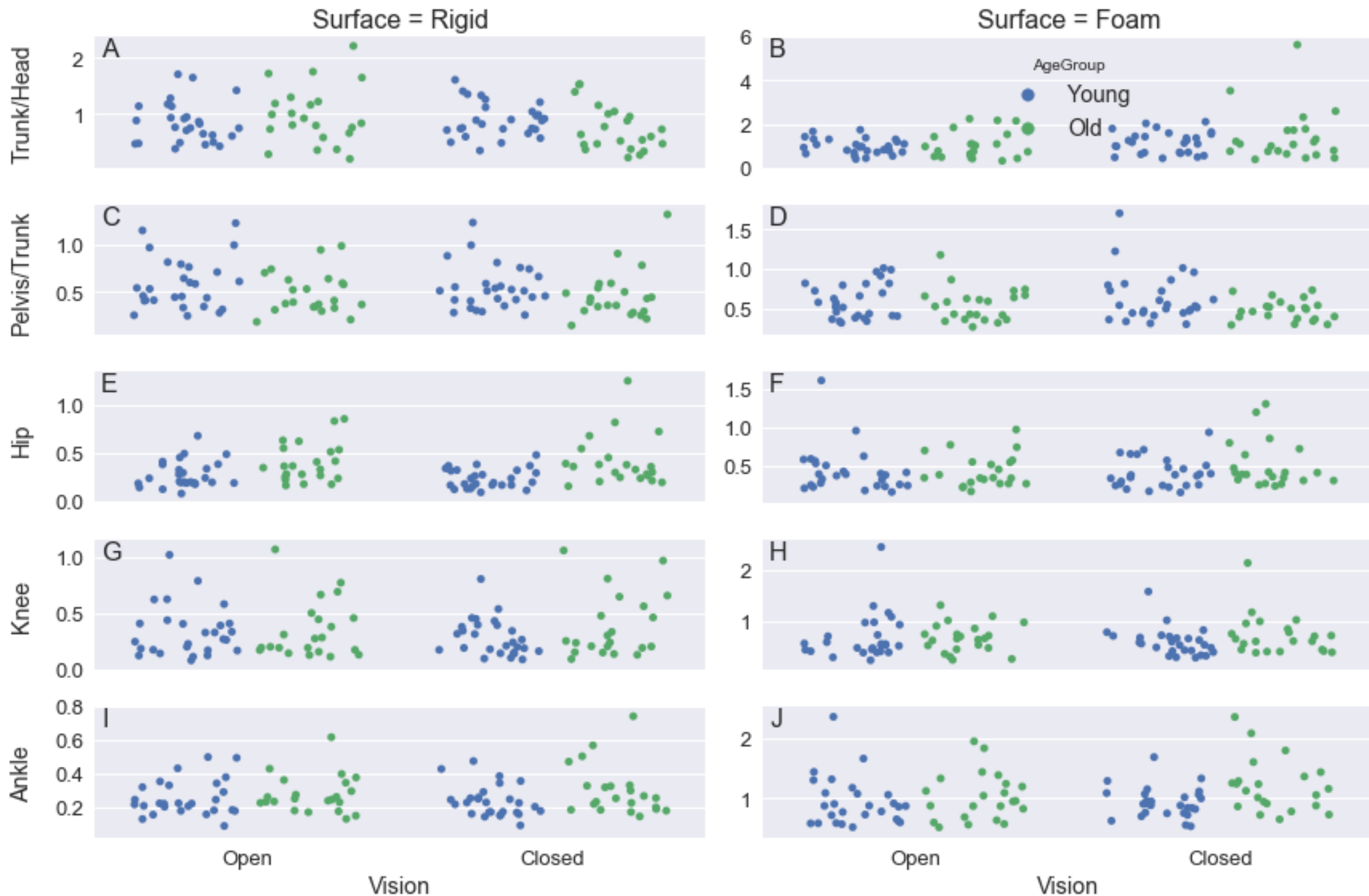
Stabilography



3D kinematics



Joint kinematics



In conclusion ...

- I hope what I have said today is useless for you ...
- ... this time because the next generation of thinkers (you) consider absurd that on the quest for the well-being of society, we hide information from each other.