Sitting Posturography for Fatigue Meaurements

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Tired ?

Background

- **Fatigue** is a leading factor to cause accidents in daily life.
- **Detecting fatigue** would contribute to
  - Warn people against possible accidents
  - Protect people from possible health problems
- **Non-disturbing monitoring** is desired in our usual life/work.

Posturography

Posturography is a technique to quantify postural control ability in upright position.

Measure the degree of ossilations of the body.

Possible to detect fatigue ?

"The center position of foot pressure **in a fatigue** condition **shifted more widely** than in a non-fatigue condition" [Vuillerme *et al.*, 2002].

It would be more useful if this is the case even for a sitting condition (person).

Our objective

To investigate the possibility of sitting posturography for measuring the degree of fatigue

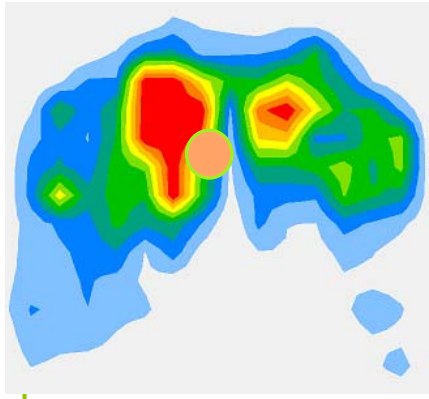
1. Reconfirm the relationship between the degree of fatigue and the degree of sway in usual **standing posturography**.
2. Investigate the correlation between standing and **sitting posturography**.

Measurement of sway

Pressure sensor sheet

-*256 pressure sensors*

-*A sensor has*
-*Diameter 9.53mm*
-*Max load 4.4N*
-*Thickness 0.2mm*



Three measruement

-*Total sway distance*
-*Horizontal (L<>R) sway range*
-*Vertical (F <> B) sway range*

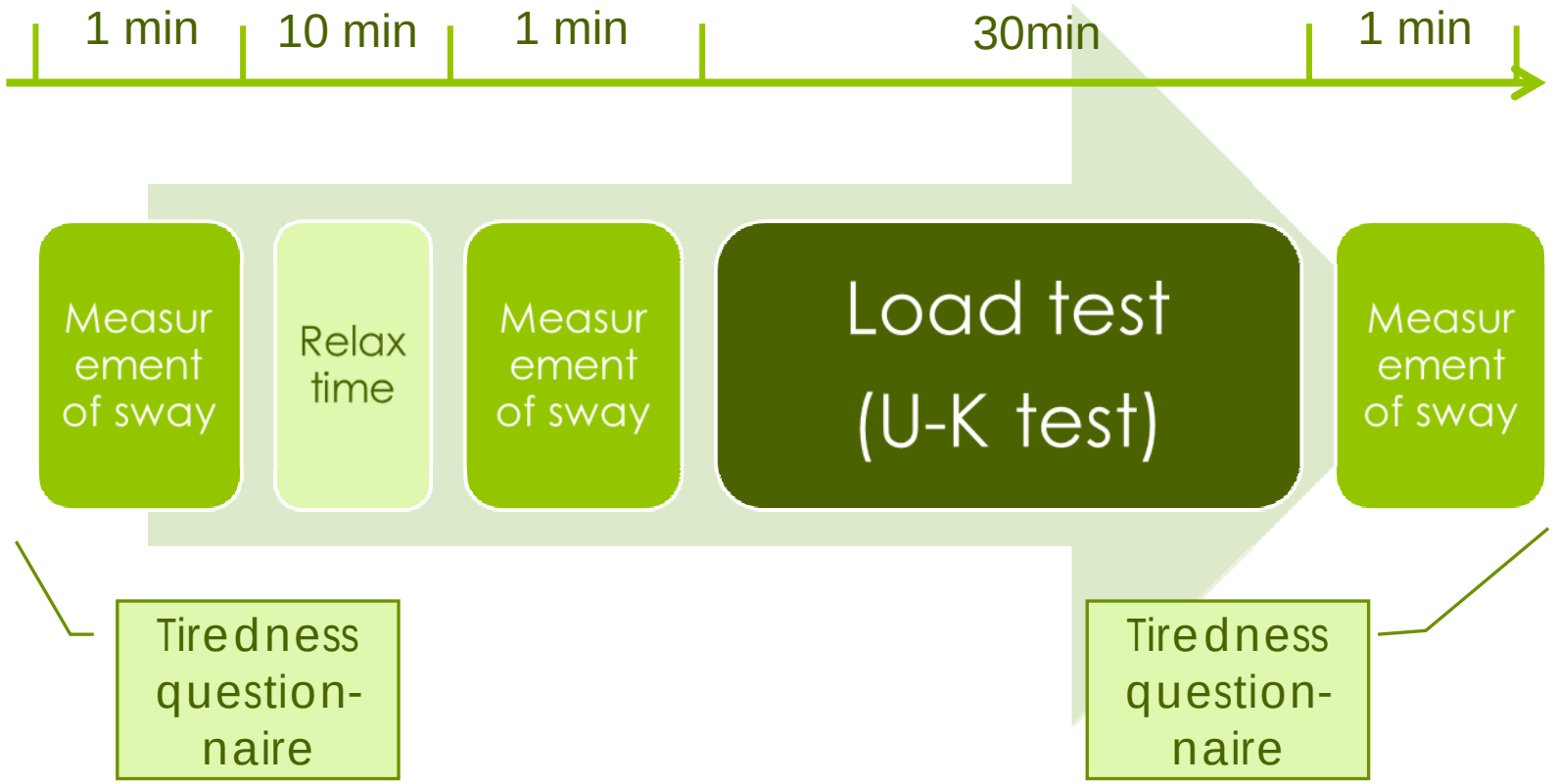
Center of pressure

Experimental Device

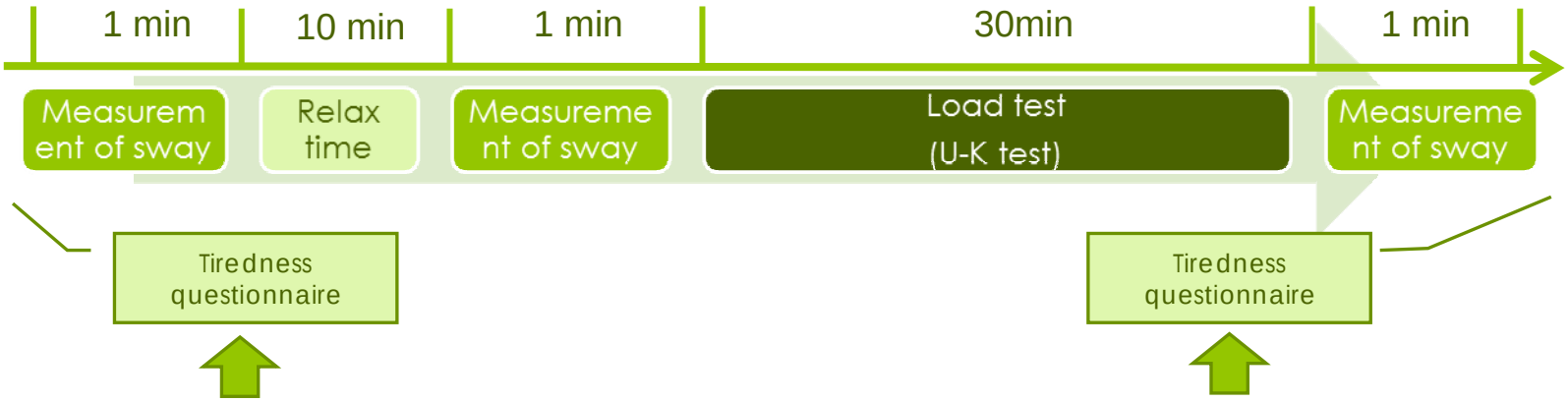
FSA pressure sensor sheet is

The number of Sensors	256 (16 × 16)
Measurable Area	43 × 43[cm]
Measurable Range	0-200[mmHg]

Experiment


1 min
10 min
1 min
30min
1 min
Measur ement of sway
Relax time
Measur ement of sway
Load test (U-K test)
Measur ement of sway
Tiredness question-naire
Tiredness question-naire

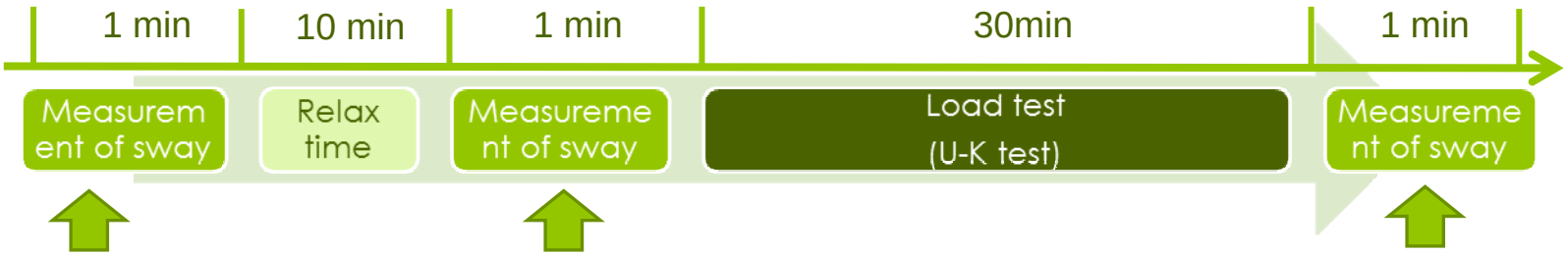
Tiredness questionnaire



How is your condition ?

- Mental tiredness (1:Nothing - 5:Very tired)
- Physical tiredness (1:Nothing - 5:Very tired)
- Sleepiness (1:Nothing - 5:Very tired)
- Comments

Measurement of **COP (Center of Pressure)** movement



Measure *the degree of sway* in **STAND** and **then SITTING** cases in turn.

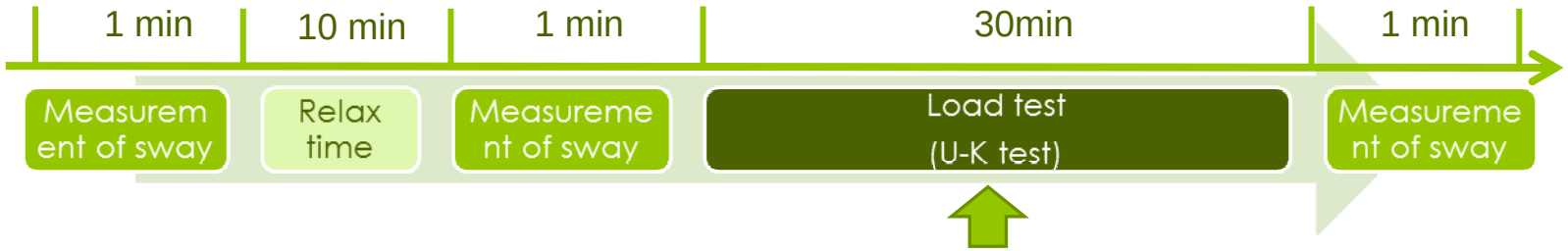
Subjects: 9 Male and 1 Female aging 21-34

Sitting Posturography

Instruction for measurement:

1. Close your toes and heels
2. Put your hands on side of the legs.
3. Face forward, close your eyes and stand still.

Uchida-Kraepelin test



Calculate simple addition of two values as fast and correctly as possible, which requires much **Concentration**

Too easy for normal science-major college students to solve, so that they are ***NOT TIRED.***

Make it ***HARDER.***

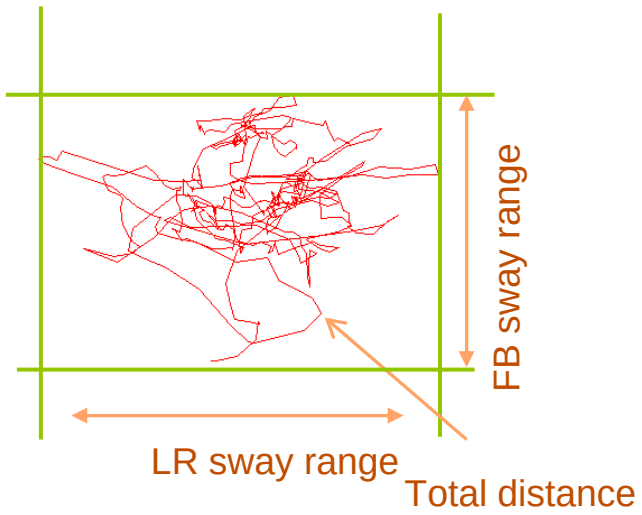
22 45 51 13 34 (1min)
2 4 5 3 4 (1min)

18 09 ..
6 9 ..

43 55 72 38 90 ...
4 5 7 3 0 ...

11 98 74 46 ...
1 9 7 6 ...

Analysis

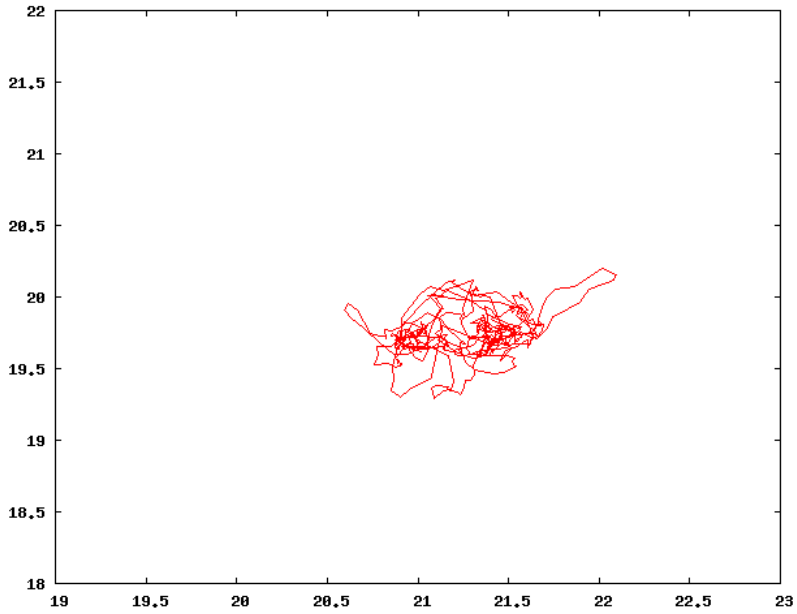


Subjects: 9 Male and
1 Female aging 21-34

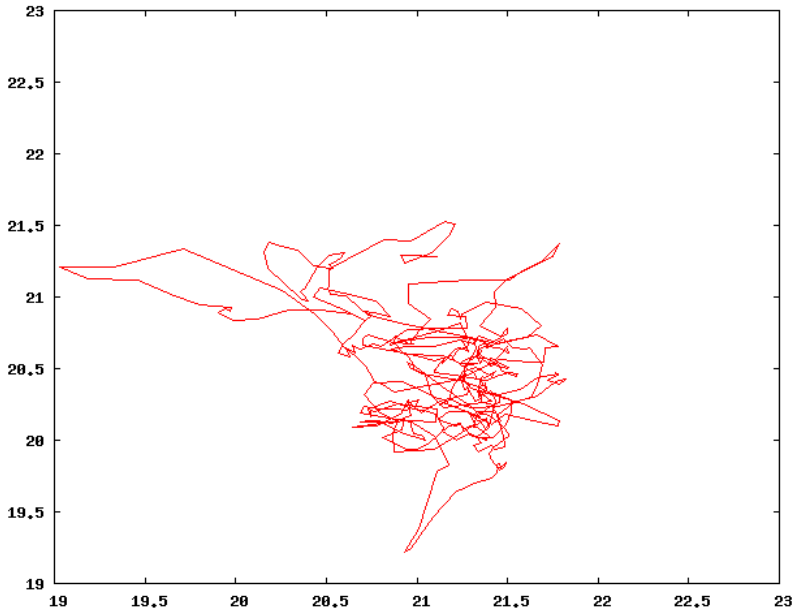
1. Three kinds of difference are measured: **total movement distance, L-R sway range, F-B sway range**) for all ten subjects and calculate the amount of increase.

2. Calculate the **correlation coefficients** between (**Tiredness (Questioned) vs. Standing posturography**) and (**Standing posturo. vs. Sitting posturo**.).

Typical case (in standing)

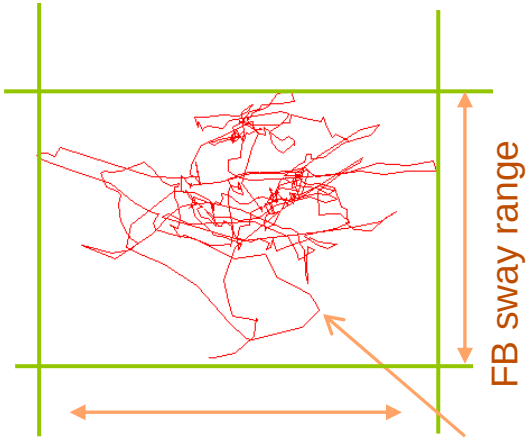


Before load test



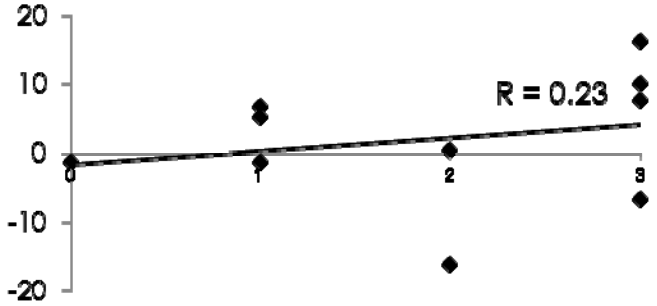
After load test

Standing case



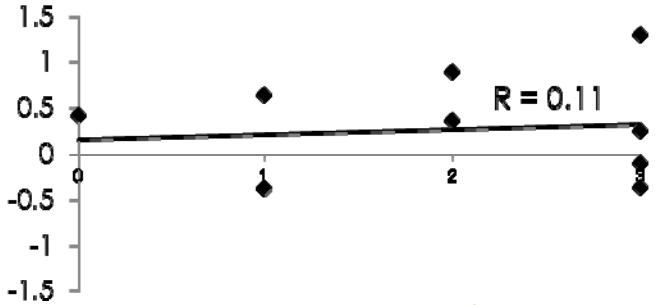
Mental Fatigue	Before Load test	After Load test	Difference
Subject A	1	4	3
Subejct B	4	2	-2

✌Total-dist



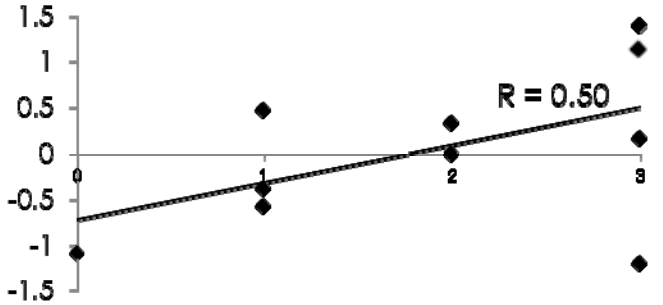
✌fatigue

✌LR-range



✌fatigue

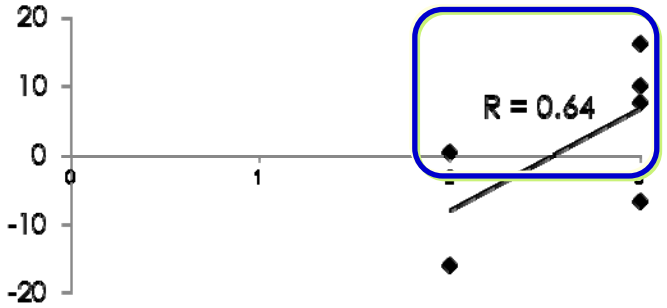
✌FB-range



✌fatigue

Standing case

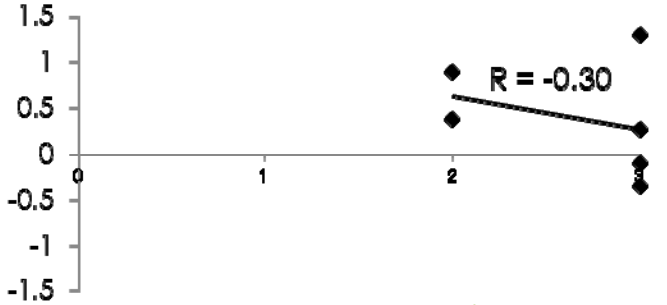
✌Total-dist



✌fatigue

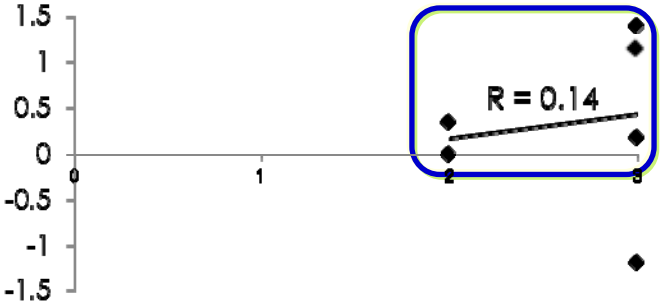
Tired subjects
(✌fatigue >=2)

✌LR-range



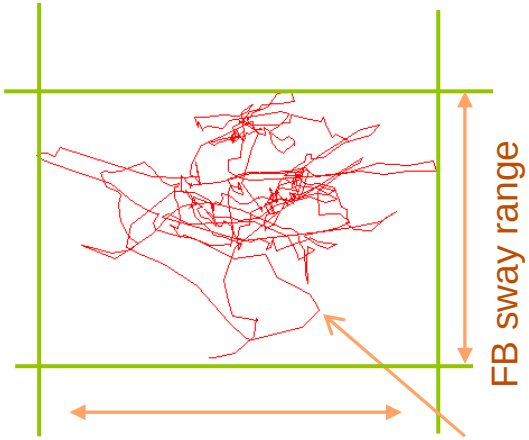
✌fatigue

✌FB-range

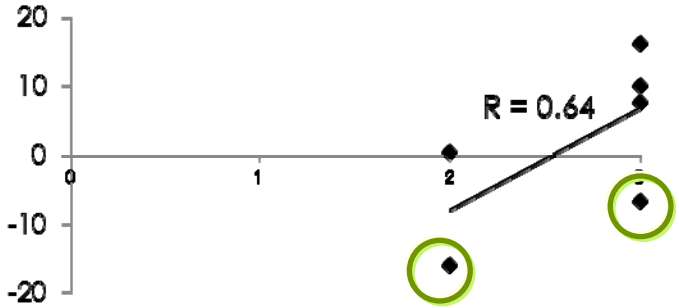


✌fatigue

Sceptical subjects



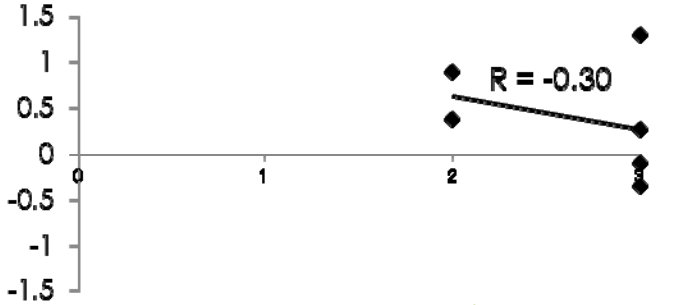
- Total-dist



- fatigue

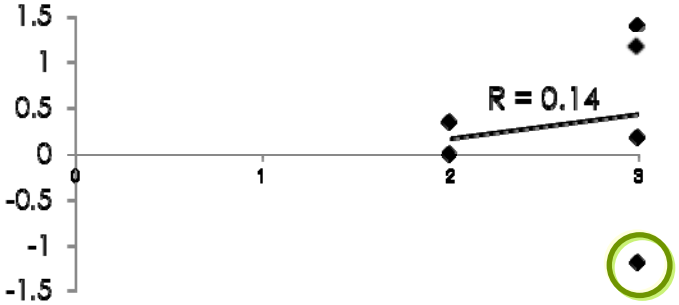
Total-dist	Before Relax	After Relax	After Load test
Subject F	40.7	55.7	49.1
Subejct G	38.1	65.8	49.7

- LR-range



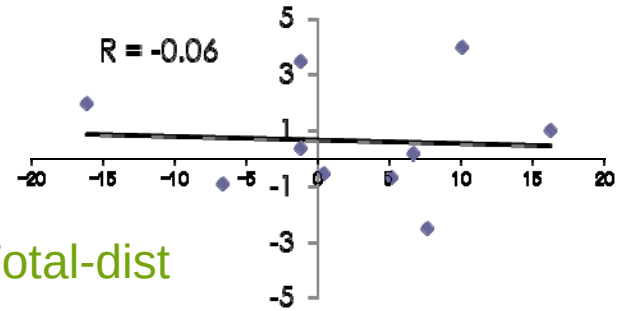
- fatigue

- FB-range

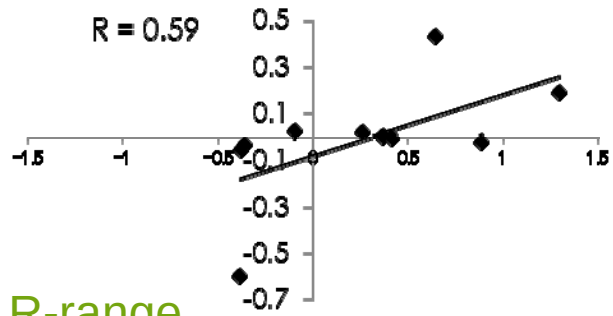


- fatigue

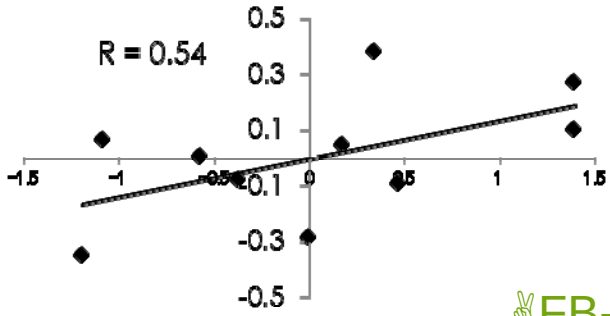
Correlation between Standing and Sitting sway



✌Total-dist



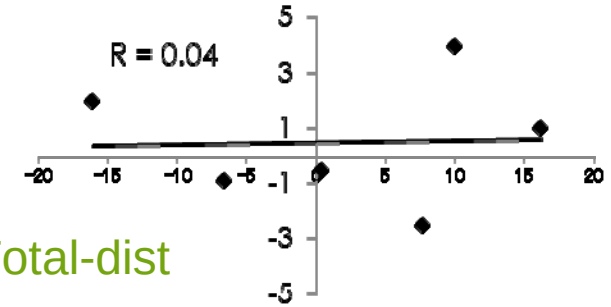
✌LR-range



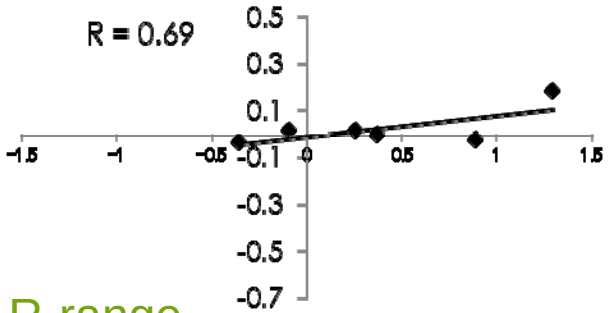
✌FB-range

Correlation between Standing and Sitting sway

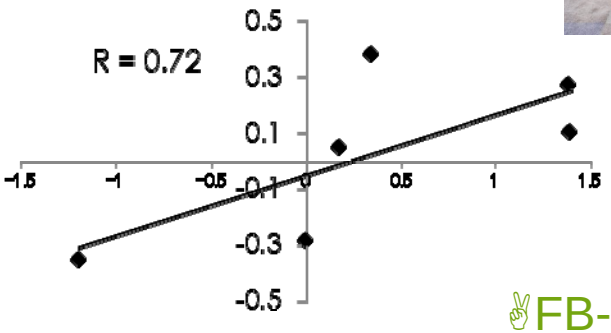
Only tired 6 subjects



✌Total-dist

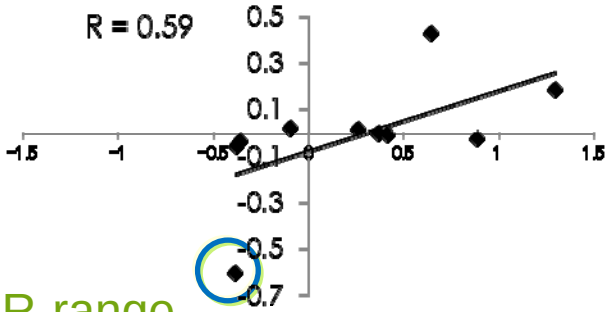


✌LR-range

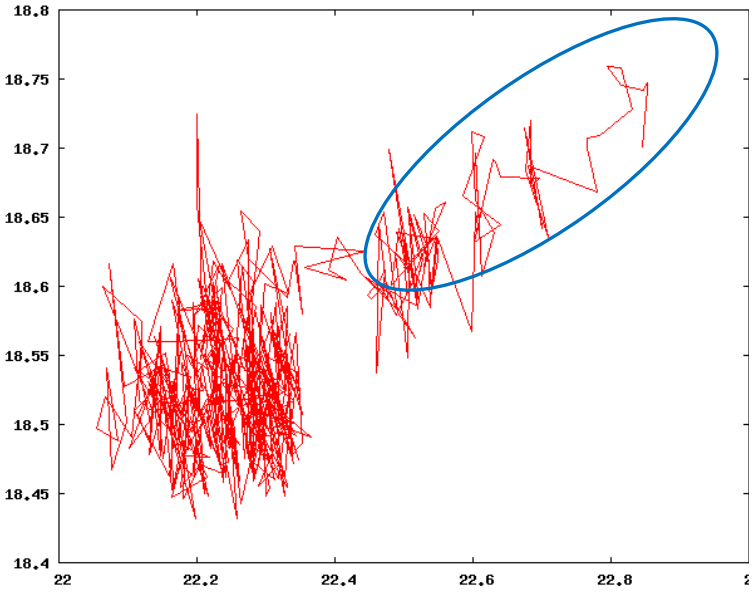


✌FB-range

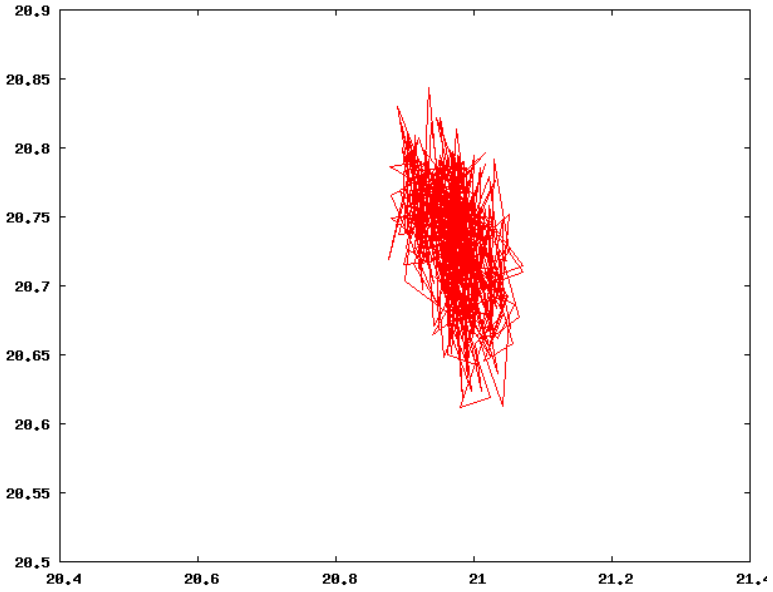
Possible misleading



✌LR-range

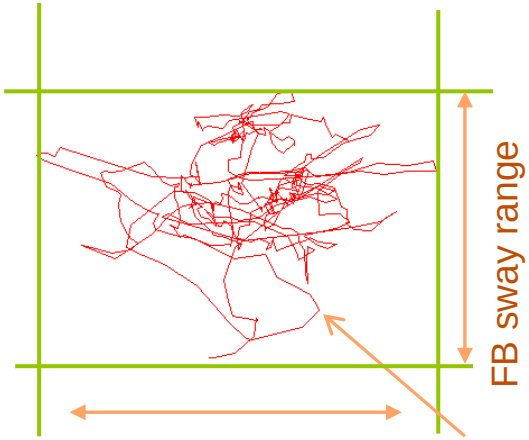


Before load test

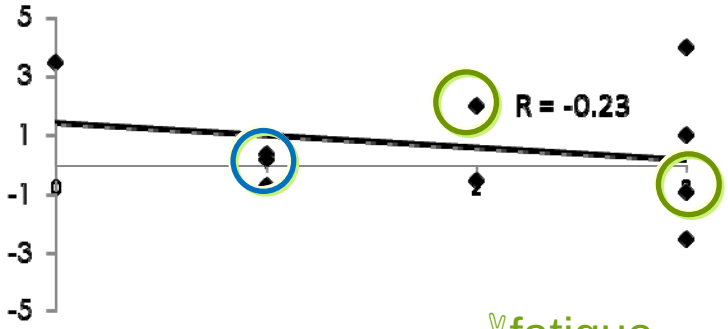


After load test

Sitting case



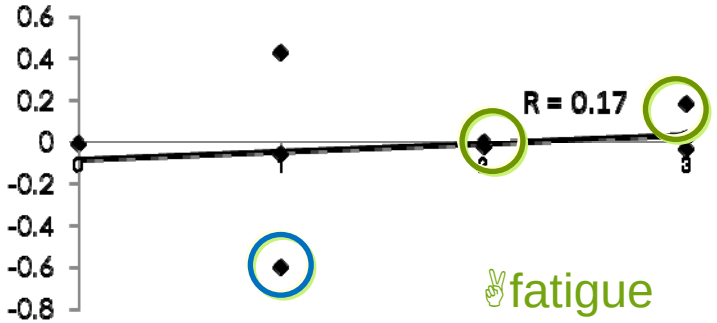
✌Total-dist



✌fatigue

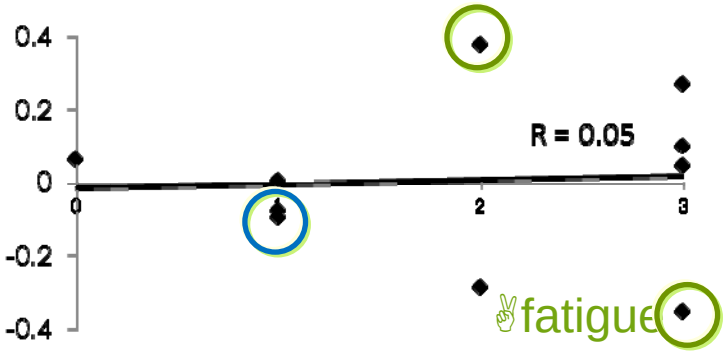
✌Total-dist	Before Relax	After Relax	After Load test
Subject F	40.7	55.7	49.1
Subejct G	38.1	65.8	49.7

✌LR-range



✌fatigue

✌FB-range



✌fatigue

Conclusion

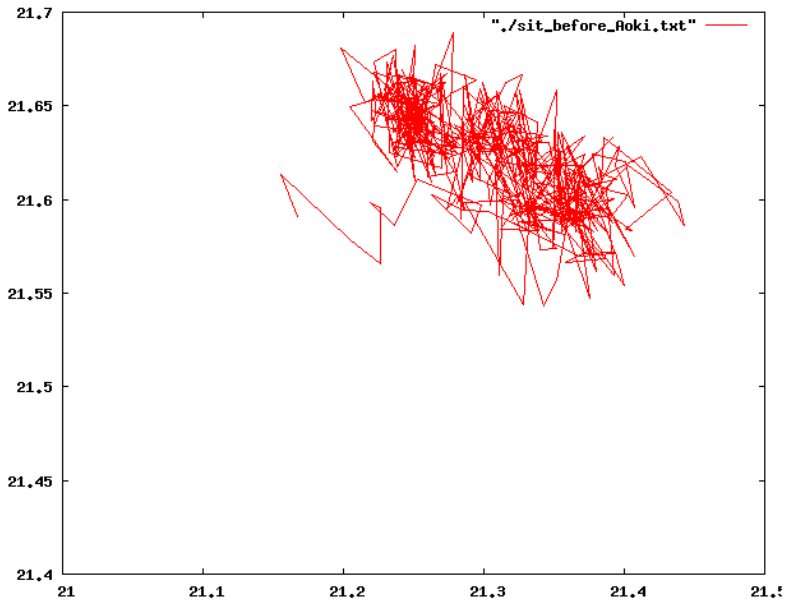
- As reported so far, an increase of the degree of sway for tired subjects was confirmed (0.64 correlation rate) in **STANDING posturography (esp., total distance and FB-range)**.
- A **medium strong correlation** (0.54-0.75) between **STANDING** and **SITTING posturography (in LR-range and FB-range only)** is observed**.**
- It implies a relatively high **possibility of sitting posturography**, but more subjects and more detailed experiments are necessary.

Questions and Furthermore

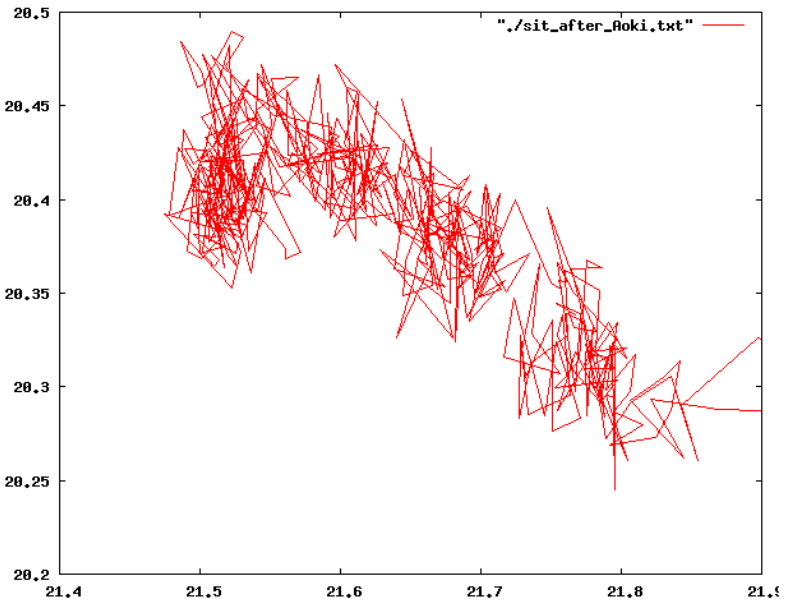
- The questionnaire is a weak evidence of tiredness. We need a subjective evidence (ground truth).
- Daily and Weekly tiredness measurements are desired.

増加例(E;Aoki, sitting)

before

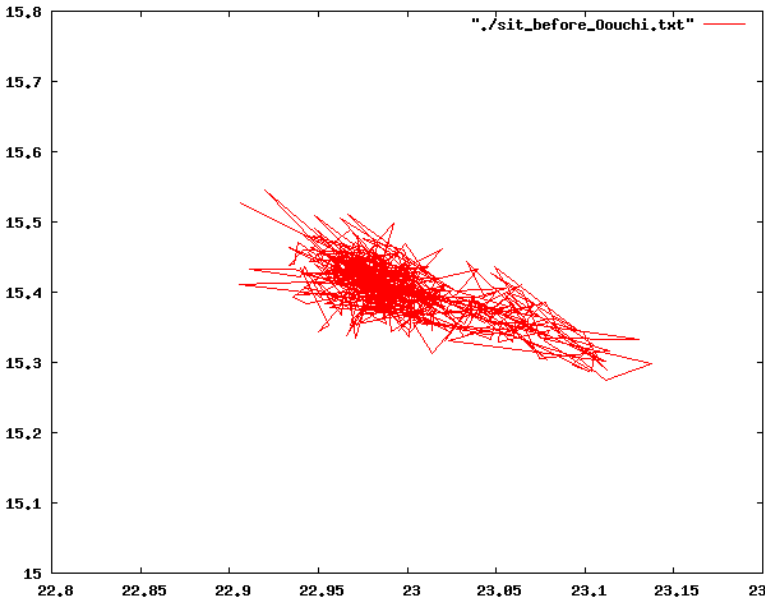


after

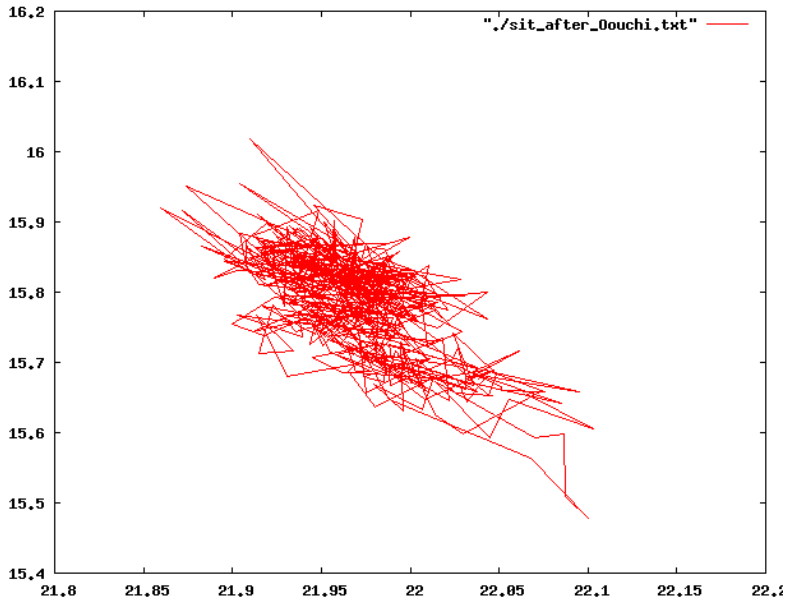


増加例(I;Oouchi, sitting)

before

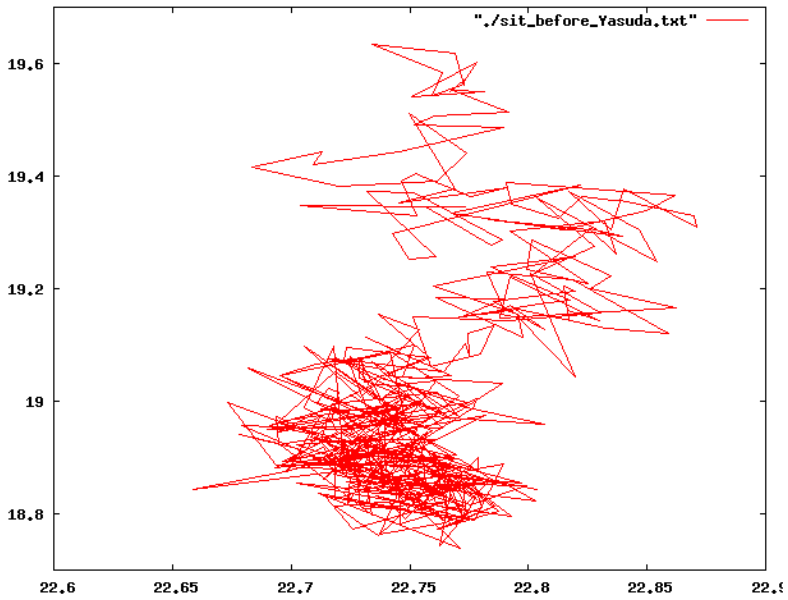


after

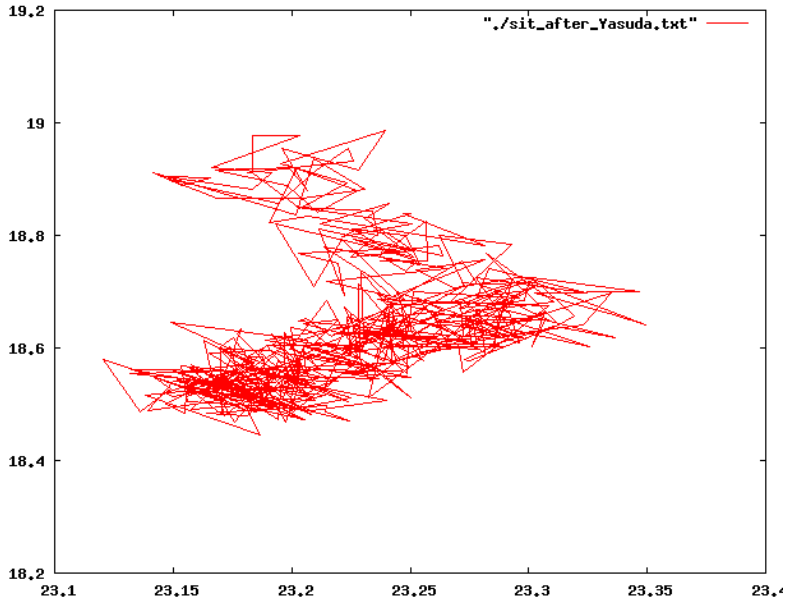


減少例(F;Yasuda, sitting)

before



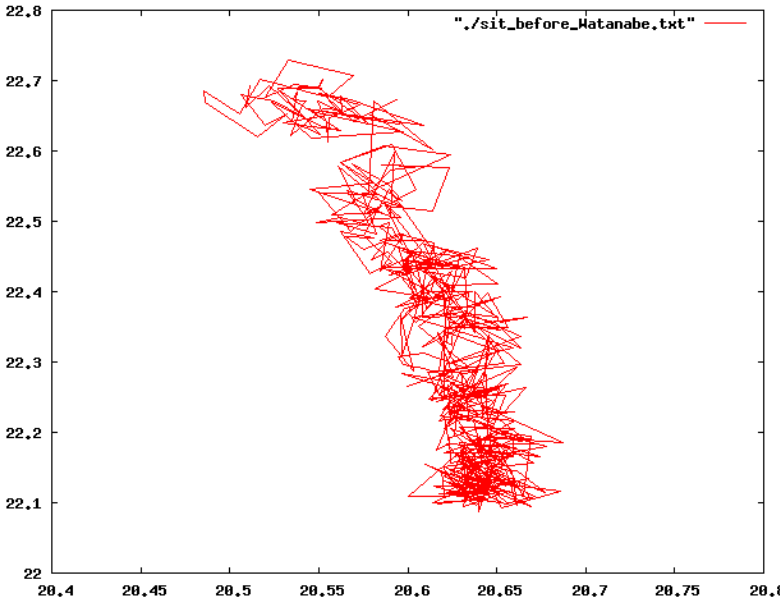
after



・4名例示したが、個人ごとに課題前・後で移動傾向が似ている

減少例(D;Watanabe, sitting)

before



after