Project FP7-ICT-2013-10-610633

BeatHealth

"Health and Wellness on the Beat"

Collaborative Project
Personalized health, active ageing and independent living

Deliverable D6.8
Report on training activities

Due date of deliverable: 2015/09/30

Actual submission date: 2015/10/06

Starting date of the project: October 1st, 2013 **Duration:** 36 months

Lead contractor: UM1 **Revision:** 0.0

Dissemination Level		
PU	Public	**X**
PP	Restricted to other program participants (including the Commission services)	
RE	Restricted to a group specified by the consortium (including the Commission services)	
CO	Confidential, only for members of the consortium (including the Commission services)	

SUMMARY

This deliverable quickly detailed the training sessions held during the second period (M12-M24) of the BeatHealth project. Three training sessions were organized, at the occasion of our quarterly steering committee:

1. Valérie Cochen de Cock (CHRU) – Clinical aspect of PD patients. San Sebastian (Spain) – March 2014
2. Marc Leman (UGent) – Systematic musicology. Ghent (Belgium) - July 2014
3. Paula Alexandra (NUIM) – UI design. Maynooth (Ireland) – March 2015

The slides of the first two training sessions are provided.

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1. Introduction

According to the DOW (Task 6.4): *"When breaking new ground, it is essential to provide efficient means to train young researchers working in the future in the same research field, by providing them with the necessary interdisciplinary background for conducting studies in this research area. In order to train future scientists in the area of rhythmic stimulation for performance enhancement, in this task we will ensure this training opportunity by organizing training sessions during the frequent exchanges associated with the project (long-term visits, PhD co-supervision, kick off meeting, steering board meetings, etc.)."*

During the second period, in addition to the various exchanges between partners, short-term visits etc… which were good occasion to organize "in-the-lab" training sessions, three formal training sessions were organized. Two

1. Valérie Cochen de Cock (CHRU) – Clinical aspect of PD patients @San Sebastian – March 2014
2. Marc Leman (UGent) – Systematic musicology @Ghent – July 2014
3. Paula Alexandra (NUIM) – UI design @Maynooth – March 2015

The first two sessions were organized by BeatHealth workpackage leaders, and the slides are presented below.

For the third session, we invited an expert in User Interface Design, Paula Alexandra Silva, lecturer in innovation at NUIM (https://www.maynoothuniversity.ie/faculty-social-sciences/our-people/paula-alexandra-silva). Dr Paula Alexandra Silva is a Human-Computer Interaction researcher and practitioner, who focuses on designing user interfaces for older adults. She gave an inspirational 2-hours BeatHealth tutorial on the design of UI in general, and more specifically of UI adapted to an elderly population (slides not available).

Following the later presentation and follow-up exchanges within the consortium, and because the design of the BeatPark UI is a crucial element of the project (see D.4.4. Design Report on user interface design in Task 4.3), we decided to hire a master student in Interface Design from NUIM in Montpellier, during a 2 months internship, to contribute to train our members (mostly CHRU and UM scientists and doctors) to conduct properly our evaluation studies. Details of the evaluation studies can be found in D4.4.

2. Annex: Slides from Dr. Cochen's training session and from Pr. Leman's training session

WP5: Beathealth evaluation

Valérie Cochen De Cock

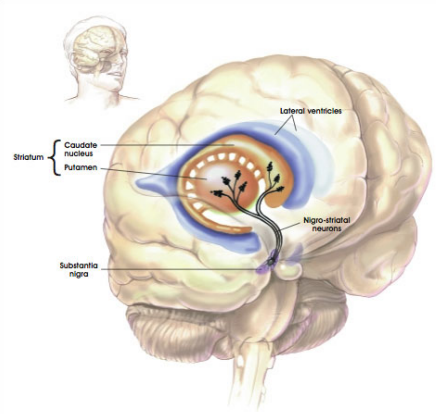
Parkinson's Disease

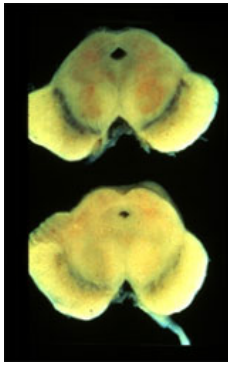
Parkinson's disease – Epidemiology

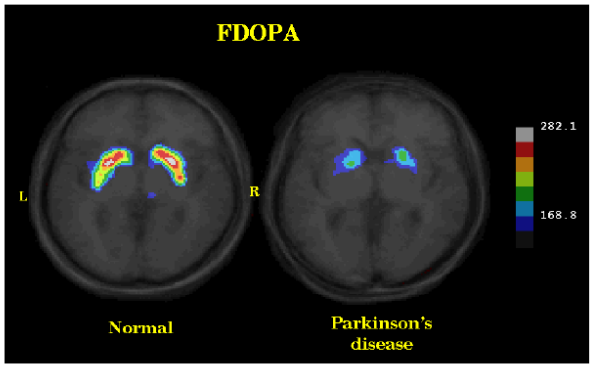
- 2% of people over 65 (France : 150 000)
- Median age of onset is 60 years (mean duration is 15 yeas)
- 10% of people with the disease are younger than 45 years old

Pathophysiology

- Dopaminergic depletion



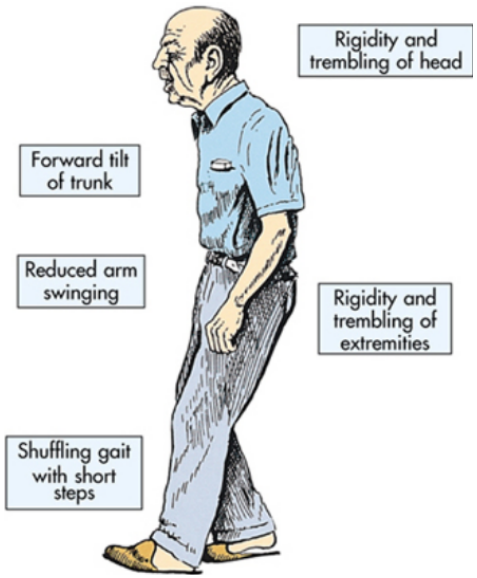




Parkinson's disease

Motor clinical features

- Tremor
- Bradykinesia Hypokinesia
- Rigidity
- Postural instability
- Gait disorders



→ Risk of falls

→ Mobility reduction

↙ QoL

↗ Institutionalization

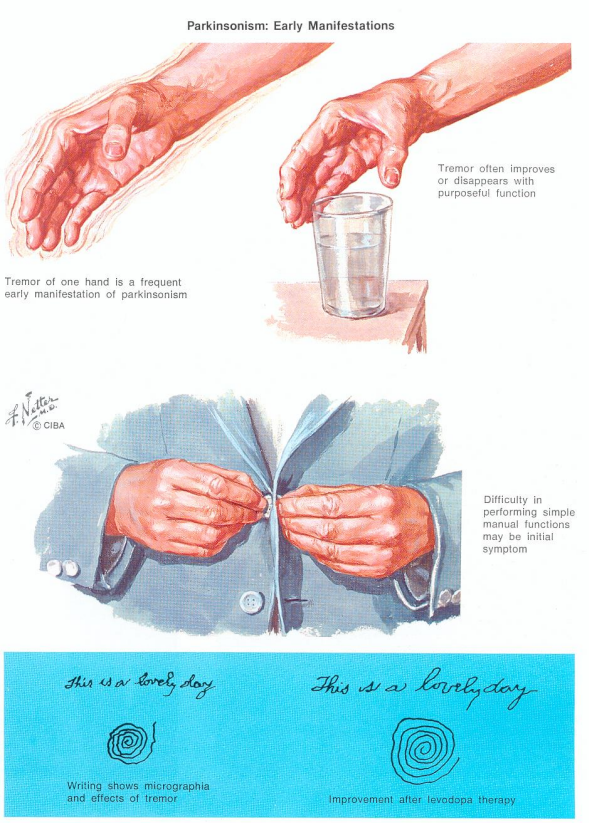
Tremor

- At rest
- Unilateral

No Problem for Beathealth

Tremor

- Attitude
- Action

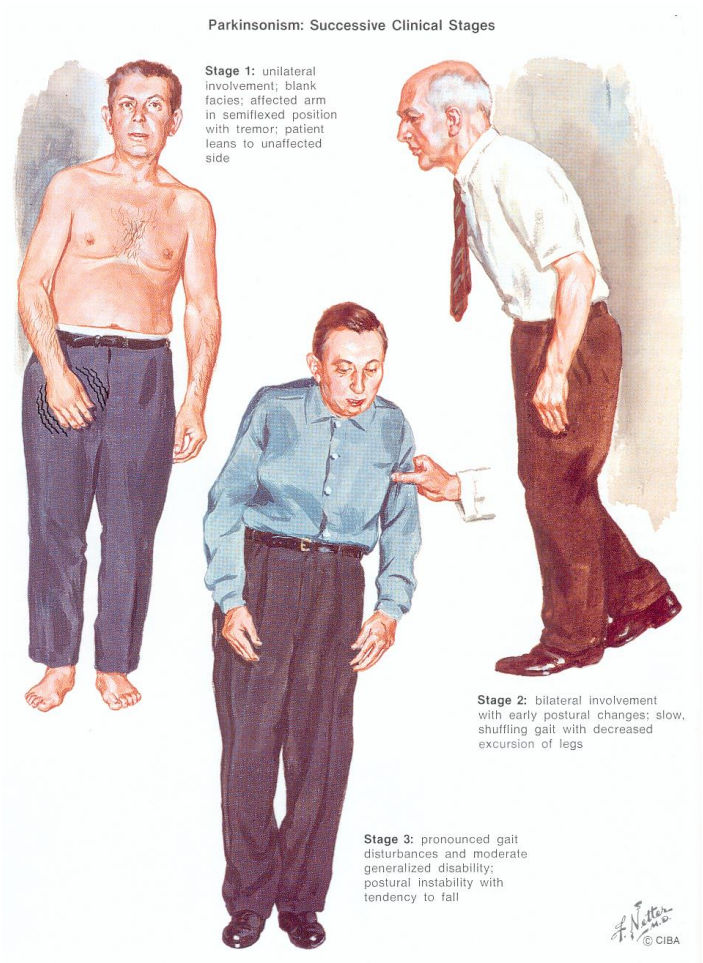


Problem for Beathealth

Bradykinesia/Hypokinesia/Akinesia

Postural instability

Postural abnormalities



Gait disorder

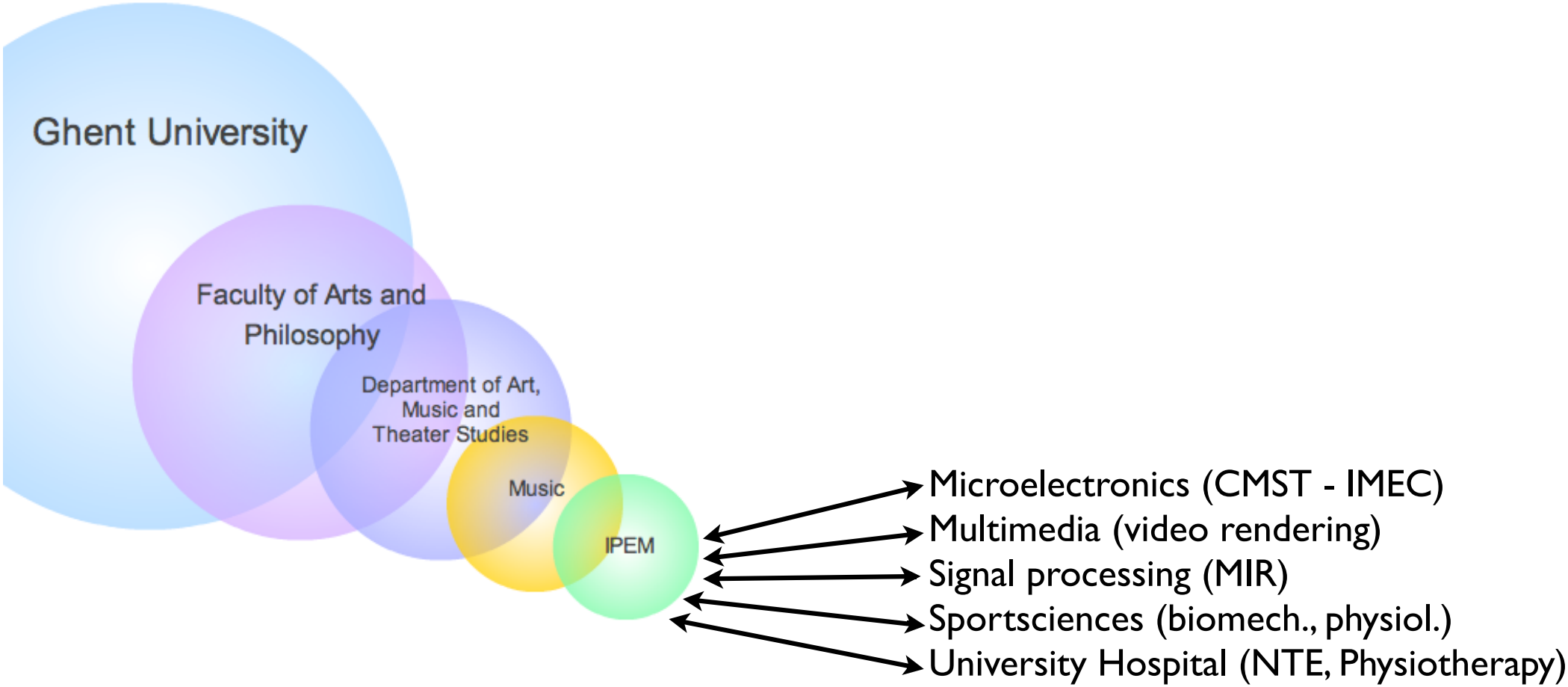
Freezing of gait

Should be improved by Beathealth

Improvement by auditory stimulation

The goal of Beathealth : delay this

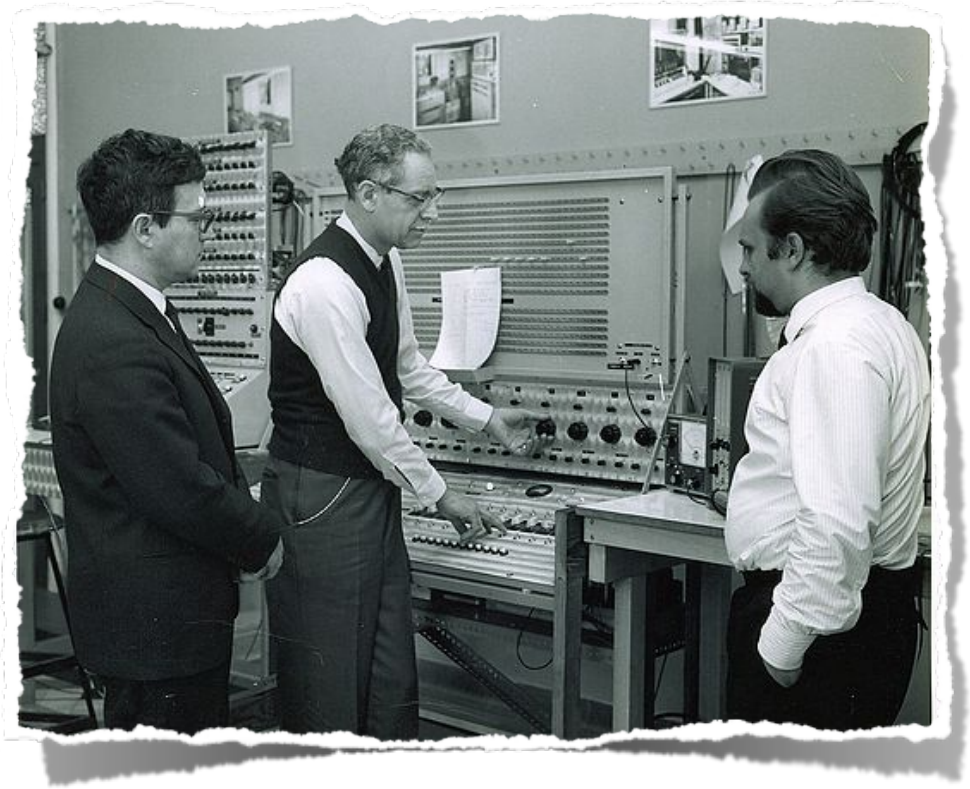
Situating IPEM



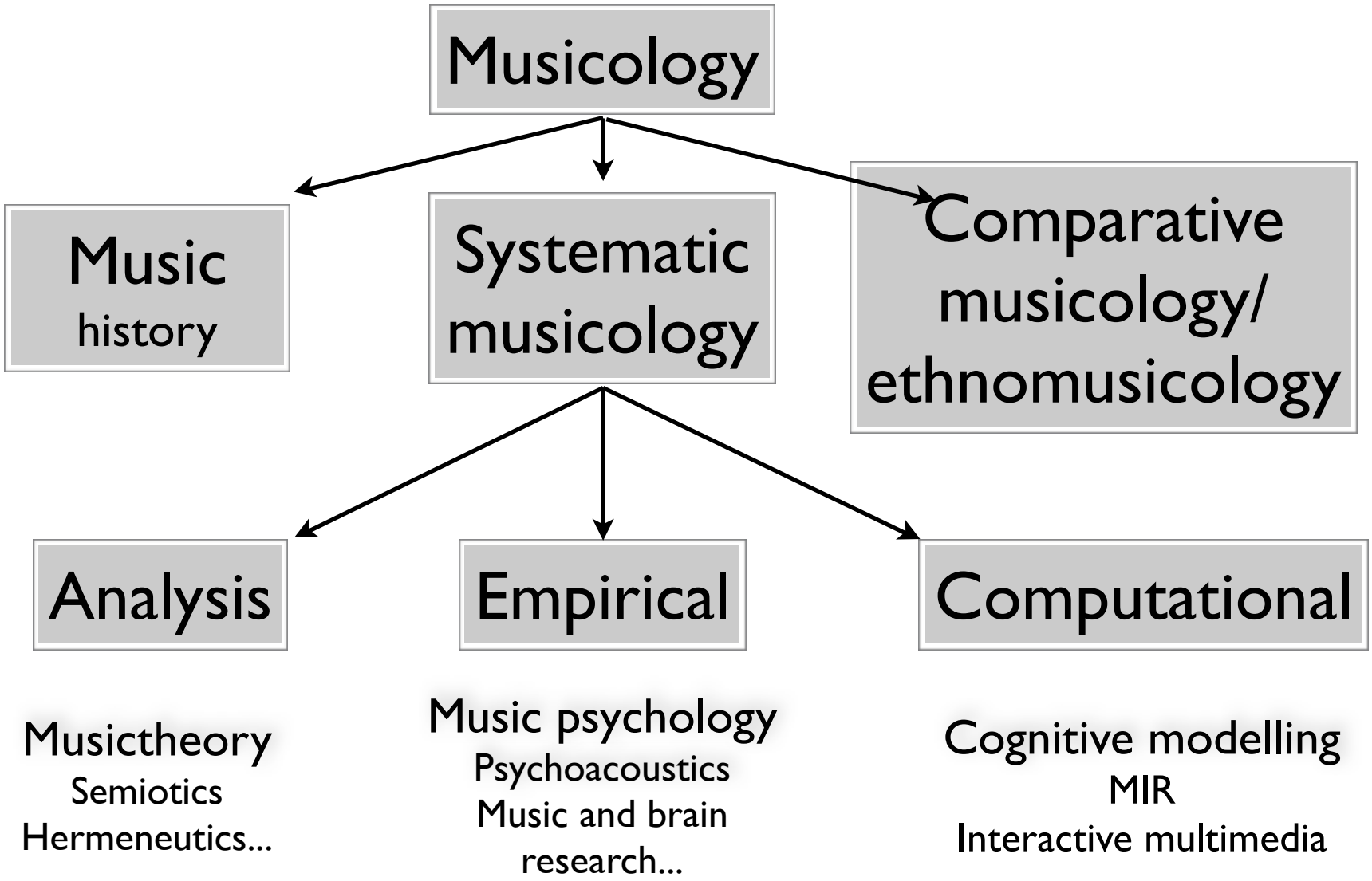
What is IPEM?

Institute for Psychoacoustics and Electronic Music

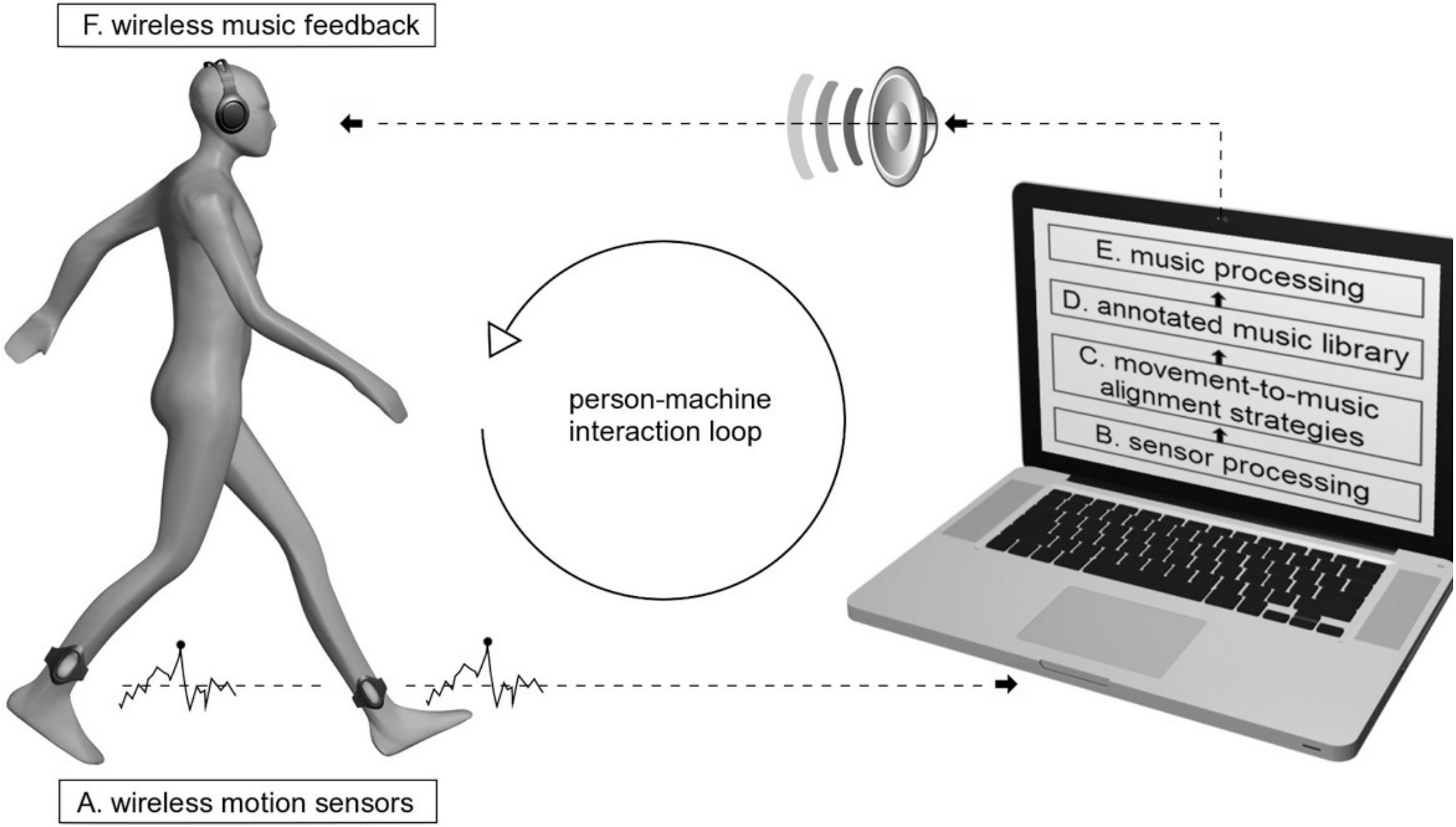
- 1963-1987: Studio for electroacoustic music, linked with national broadcasting company (BRT)
- 1987-: Centre for research in systematic musicology (“Methusalem” since 2007) - IPEM 50 !!!



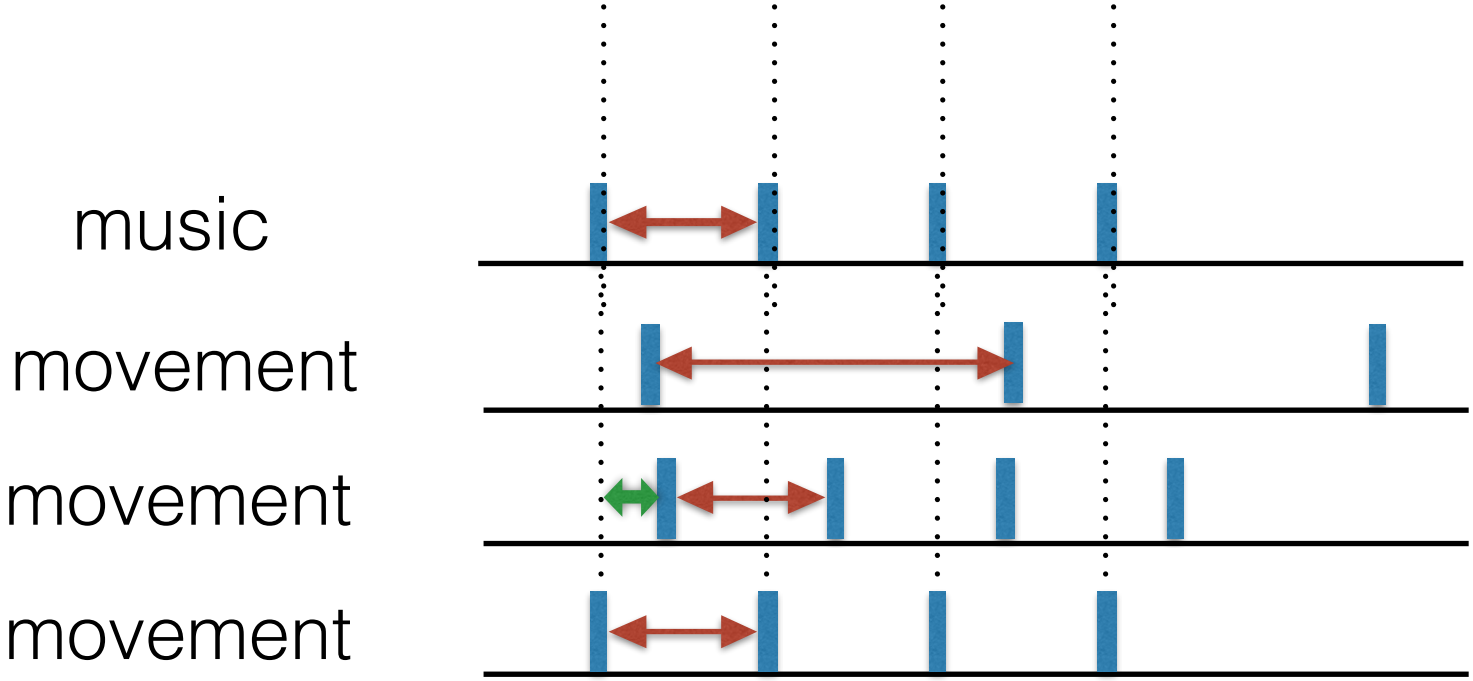
Organigram musicology



DJogger is an adaptive music player



period alignment
phase alignment

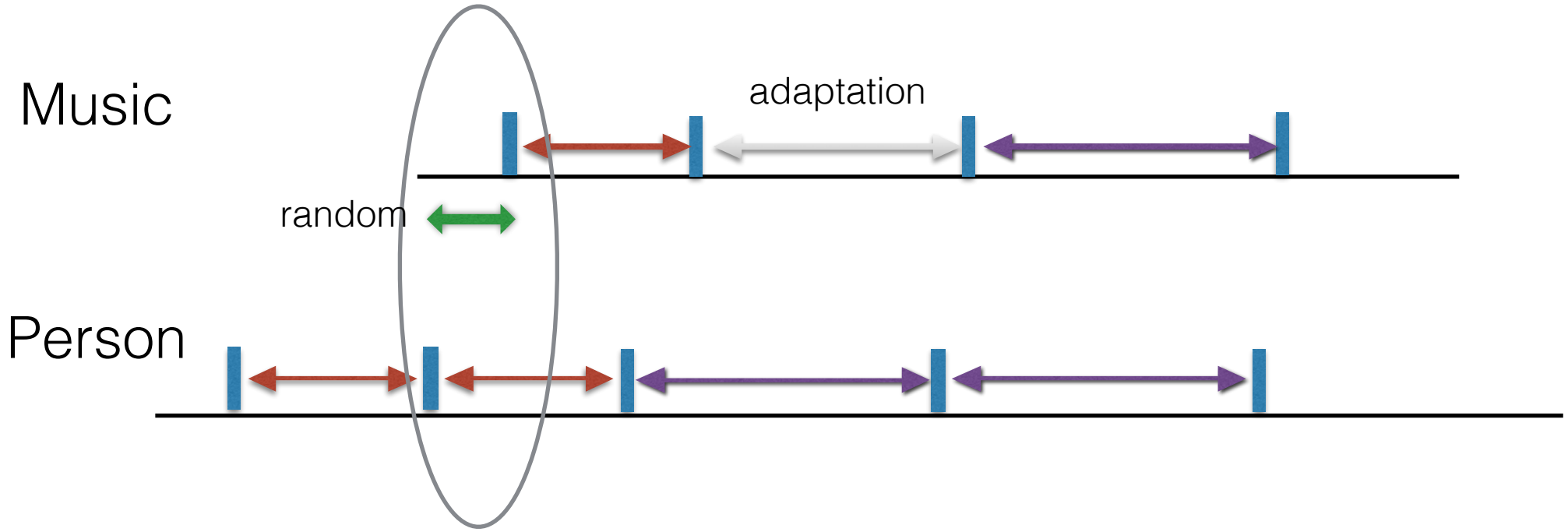


Entrainment is the adaptation to match period and/or phase.
Alignment is the match of period and/or phase

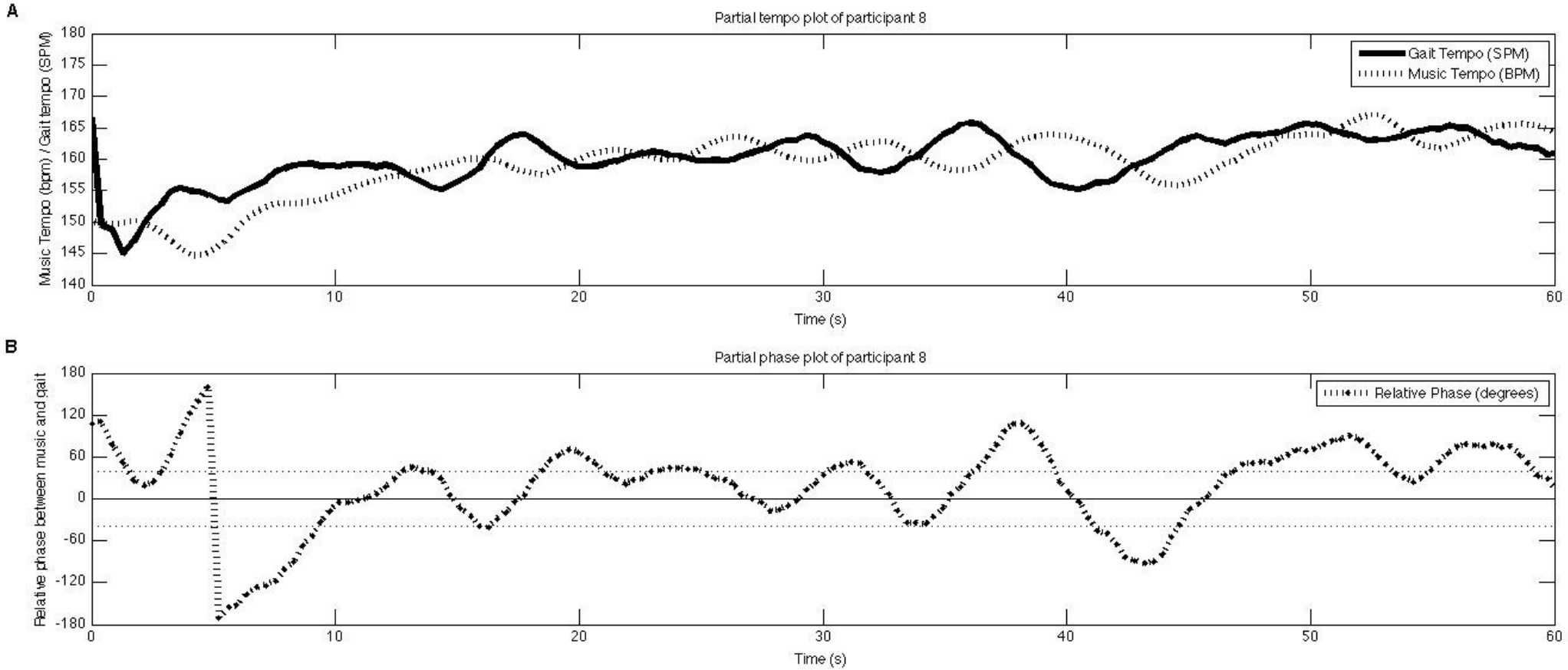
Overview of 4 experiments

Alignment Strategy	1	2	3	4
Period adaption	Adaptive	Fixed	Adaptive	Adaptive
Phase adaption	Random	Random	Fixed starting phase	Adaptive to 0°
Participants (N)	150	100	12	12
Participants Age	22 ± 12	21 ± 1.5	21 ± 2	24 ± 3
Setup	PC	Mobile	PC	PC
Walking area	Treadmill	Outdoor	Treadmill	Treadmill
Stimuli	pop selection	pop selection	pop selection	motivational pop
Tasks	Any tempo	Walk	Any Tempo	Run
Duration	Voluntary	2km walk	15 minutes	30 minutes
Recorded valid steps	52050	29419	19875	104334

Alignment strategy 1:
period adaptation
phase not controlled

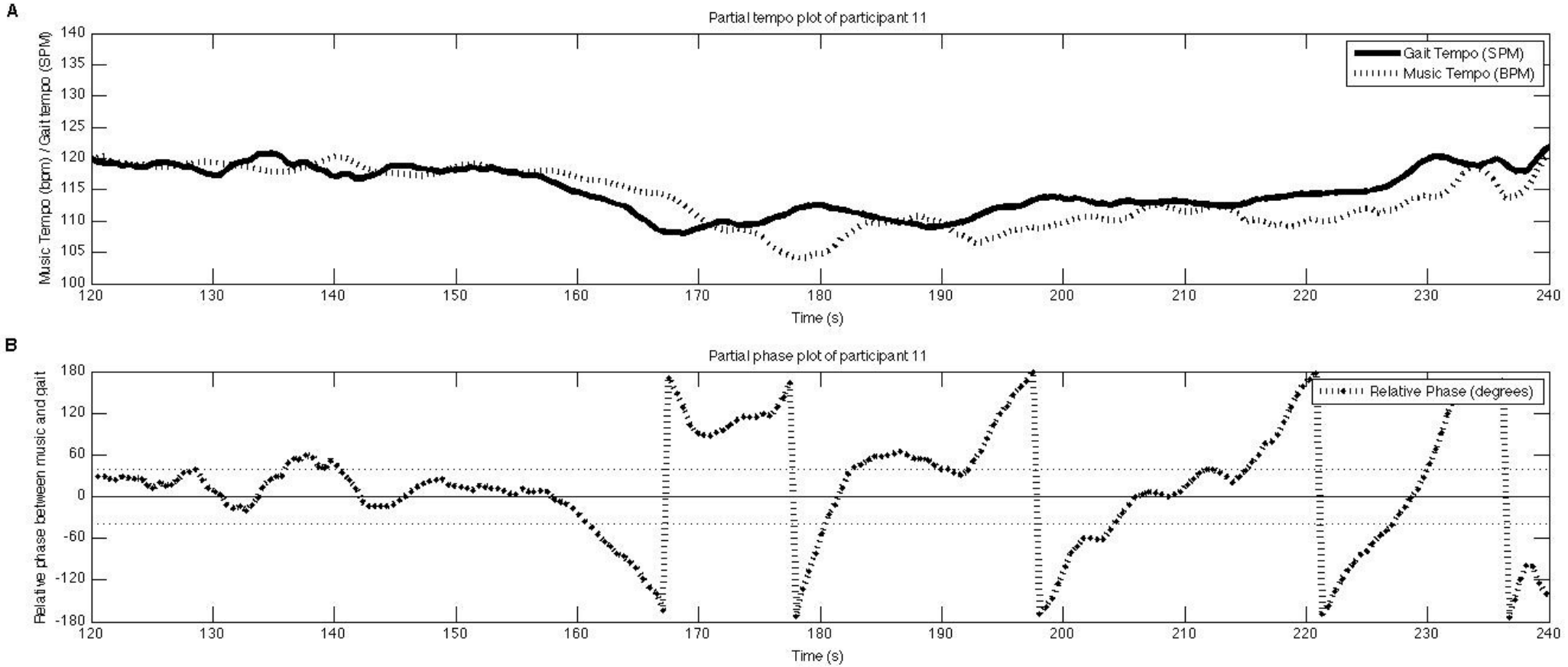


Alignment strategy 1:
period-adaptive, phase not controlled

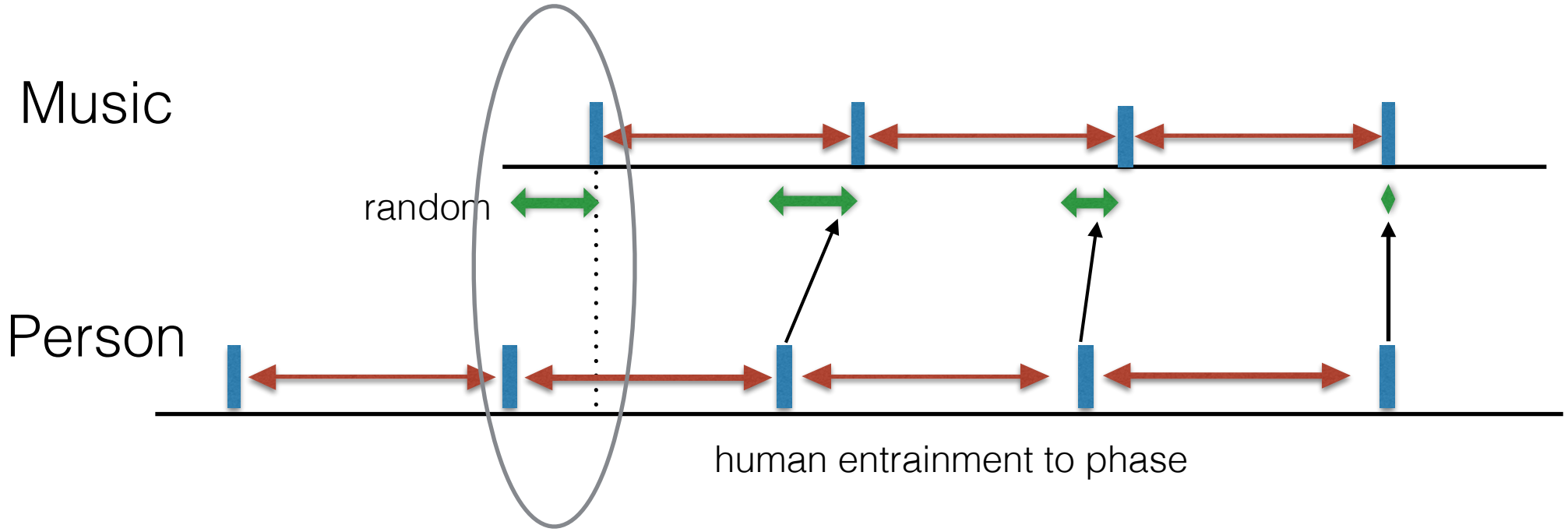


Wobbling behaviour: synchronisation is unstable.
Human adapts, but system “thinks” that period changes, hence phase doesn’t get aligned

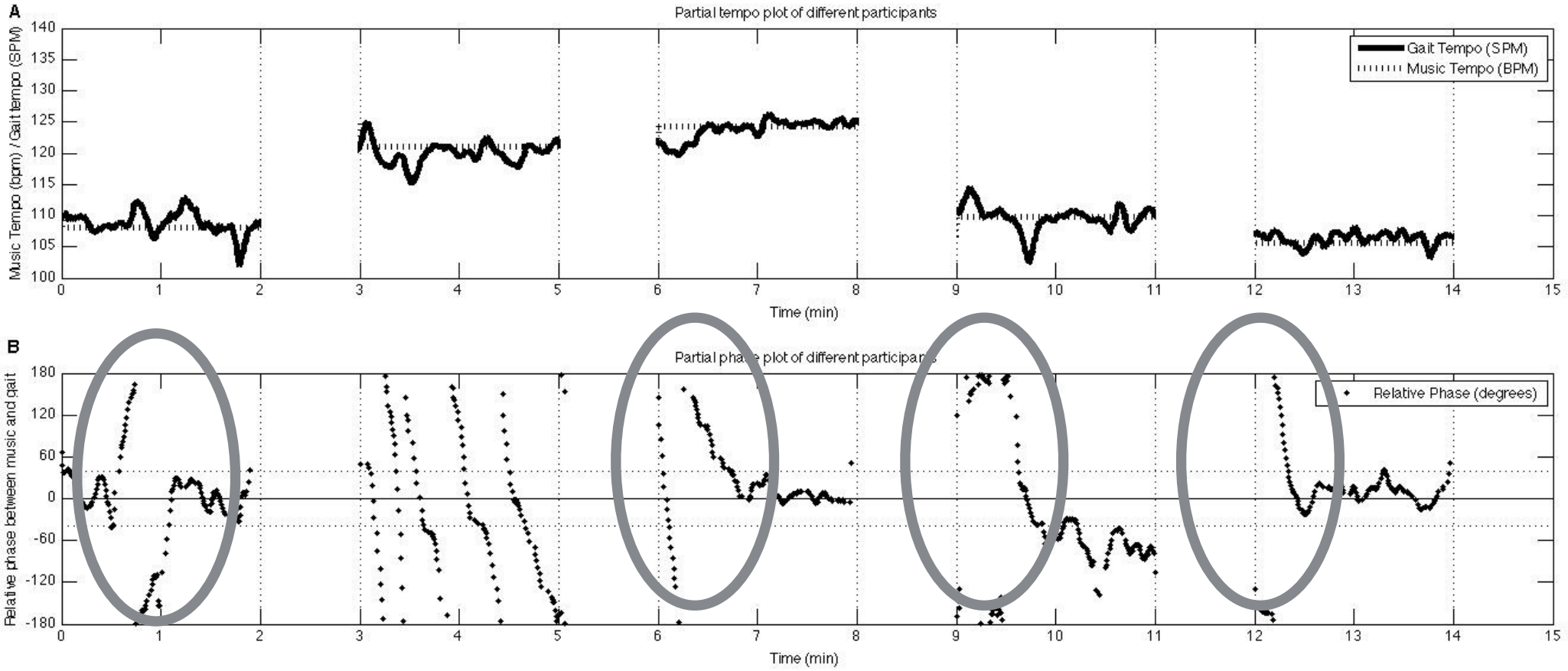
Alignment strategy 1:
period-adaptive, phase not controlled



Alignment strategy 2:
period fixed
phase random

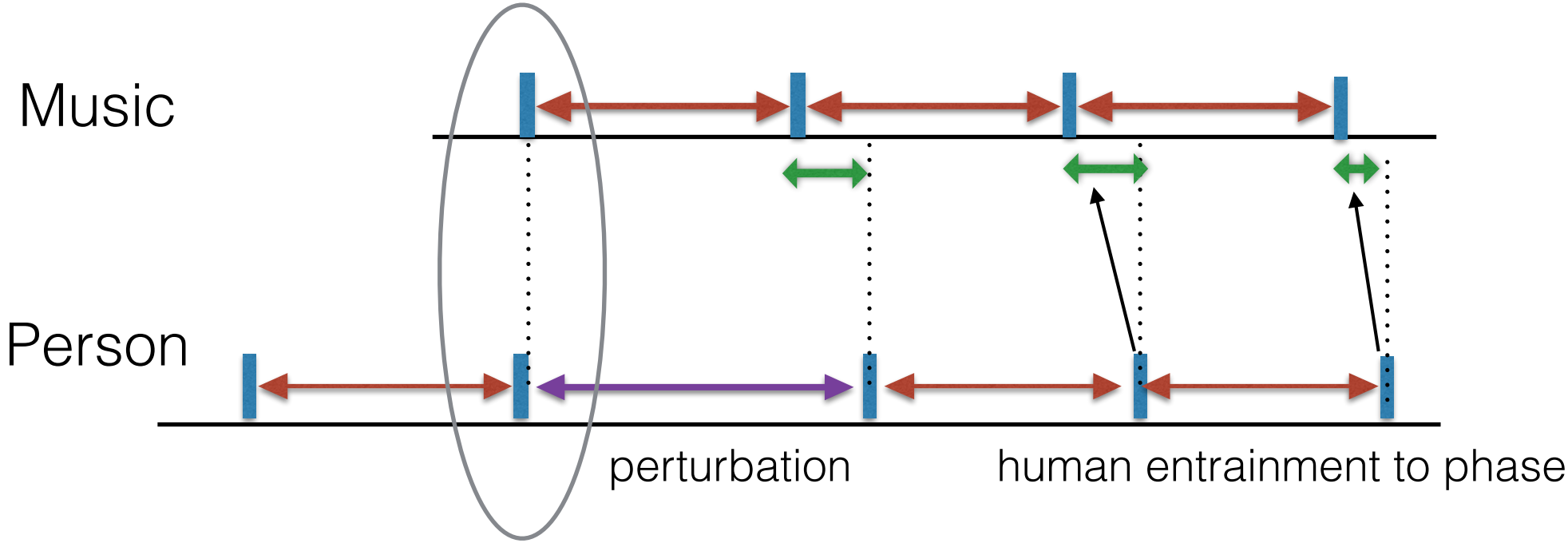


Alignment strategy 2: period-fixed phase-random

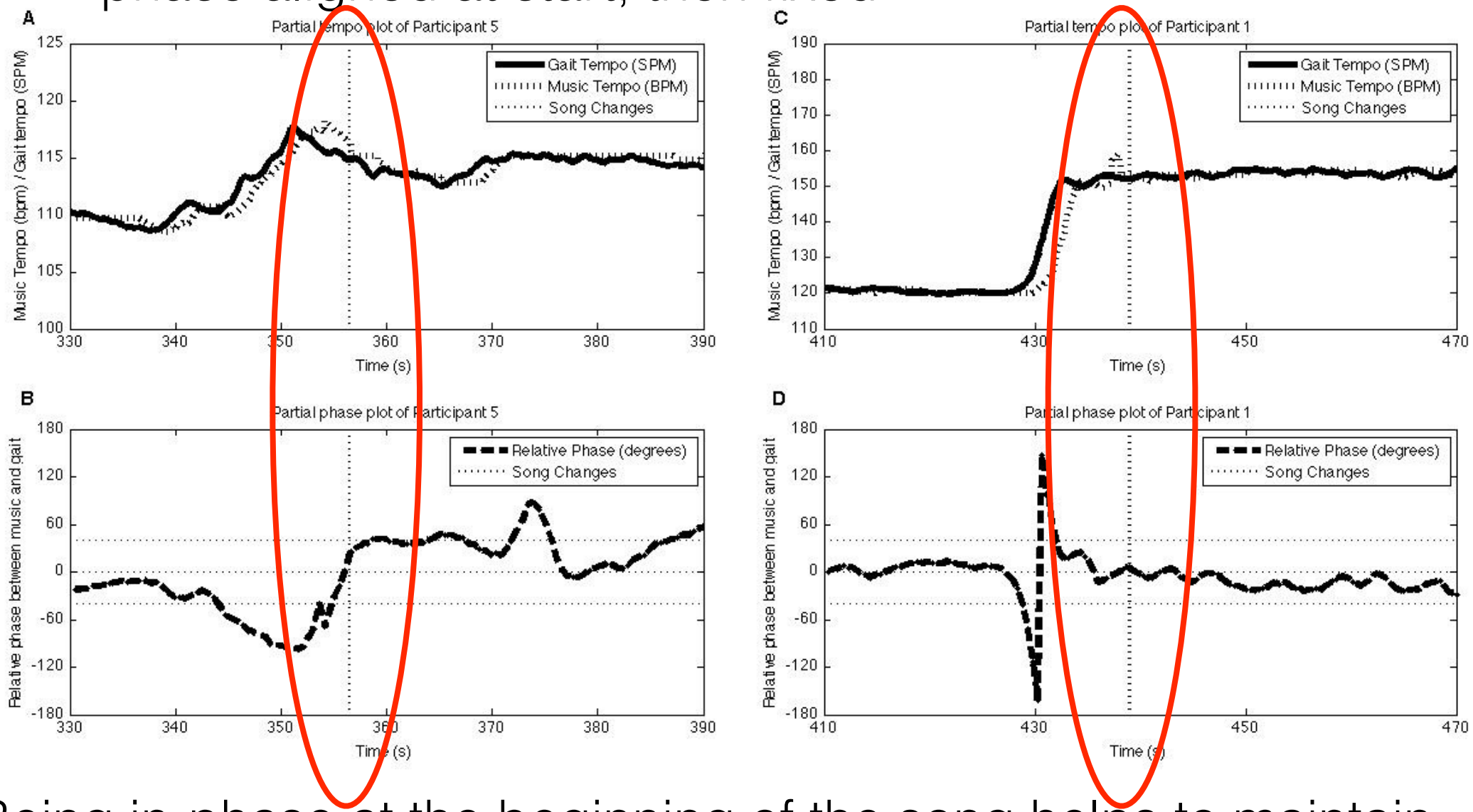


After entrainment to phase, good stability can be obtained

Alignment strategy 3:
period adaptation
phase aligned at start, then fixed

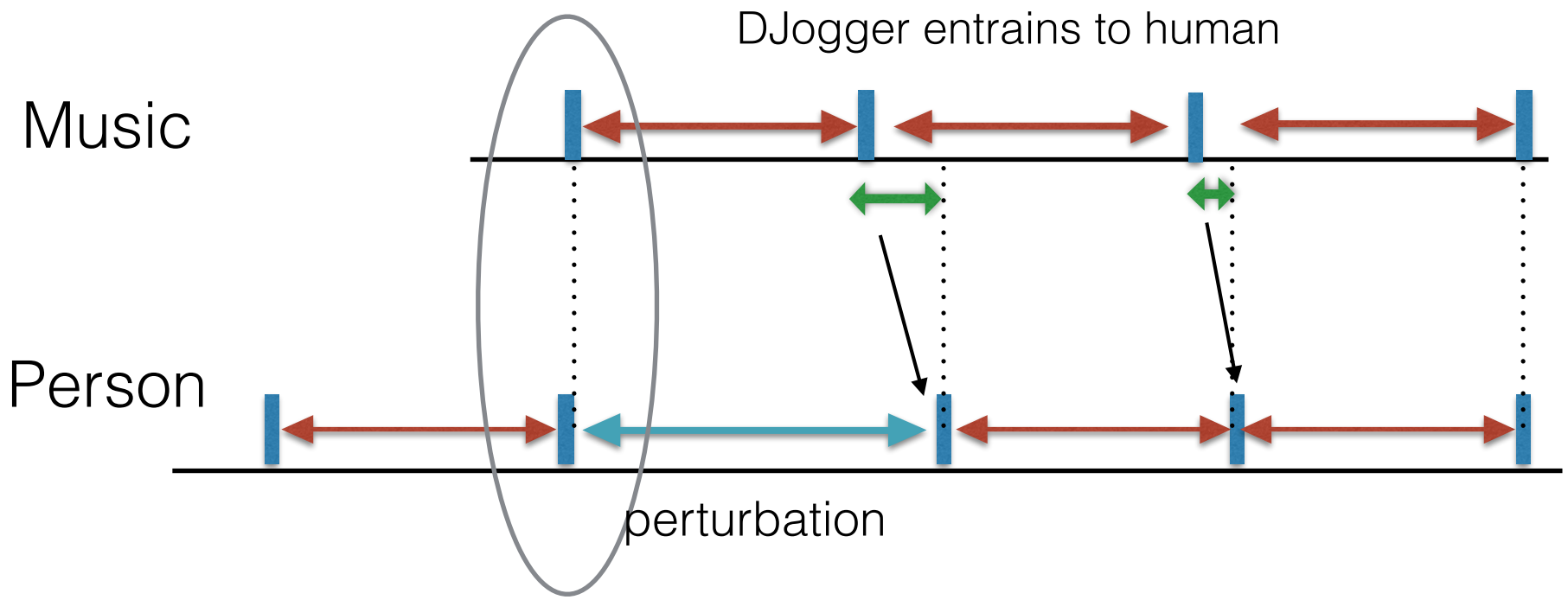


Alignment strategy 3:
period adaptation
phase aligned at start, then fixed

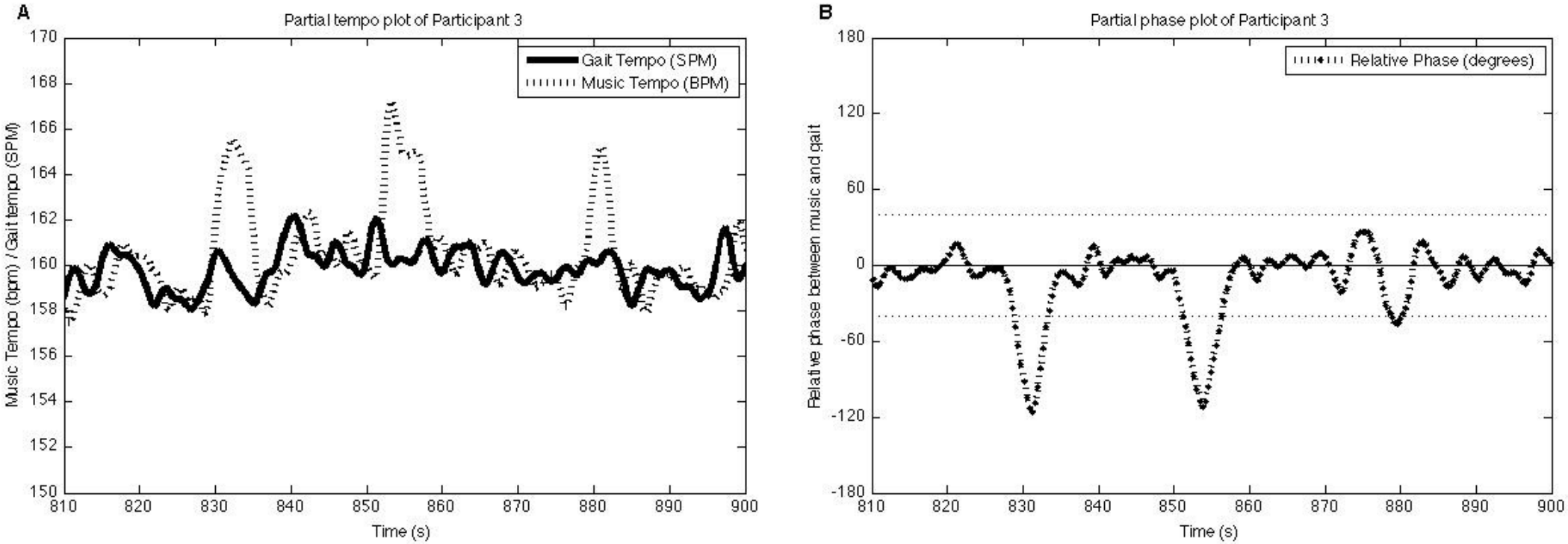


Being in-phase at the beginning of the song helps to maintain stable synchronisation immediately

Alignment strategy 4:
period adaptation
phase adaptation

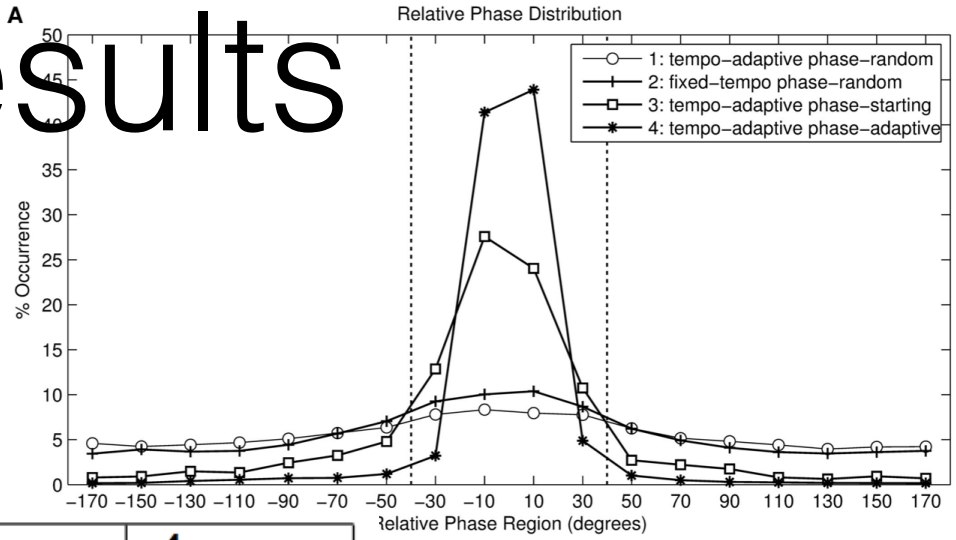


Alignment strategy 4:
period adaptation
phase adaptation



Period and phase are aligned with the human.
Peaks show adaptation of period to adjust a series of stable phase differences (so that relative phase = zero).

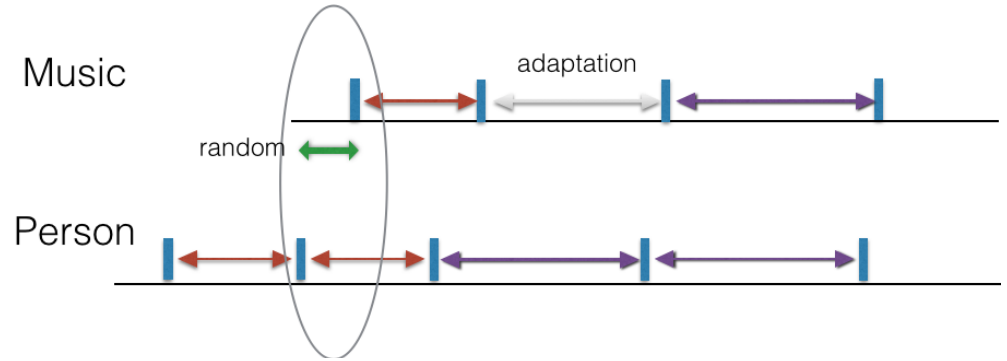
Summary of results



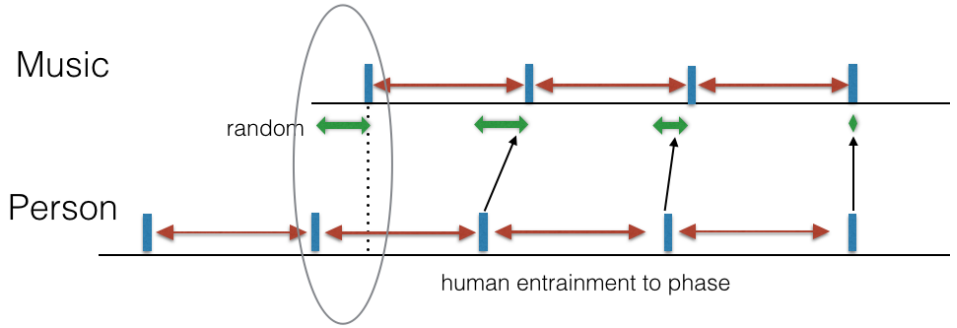
Alignment Strategy	1	2	3	4
Mean angle $\bar{\phi}$	-5.6°	-4.7°	-4.7°	0.14°
High Limit L_1	-3.5°	-3.0°	-4.1°	0.29°
Low Limit L_2	-7.6°	-6.5°	-5.4°	-0.004°
Resultant vector length R	0.17	0.27	0.73	0.92
Variance S	0.83	0.73	0.27	0.08
Angular deviation s	1.30	1.2	0.73	0.4
Circular skewness b	0.015	0.0095	0.042	0.024
Circular kurtosis k	0.066	0.13	0.52	0.84

Alignment strategy influences synchronisation.
Spontaneous human entrainment is most effective in 3,
human entrainment is largely eliminated in 4.

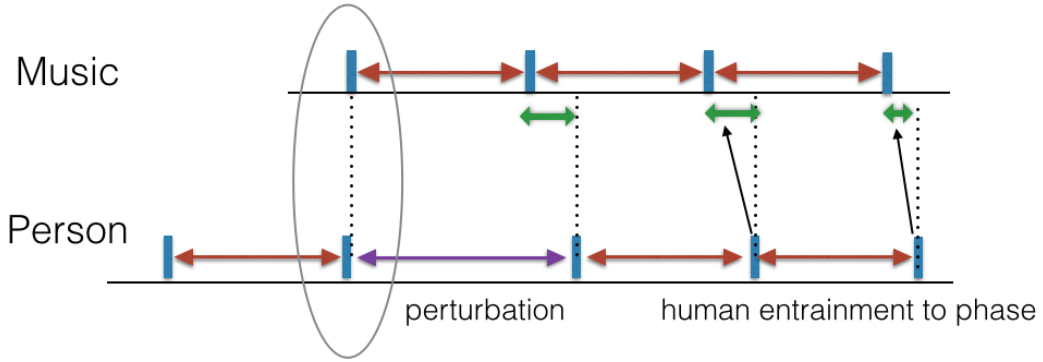
Alignment strategy 1.



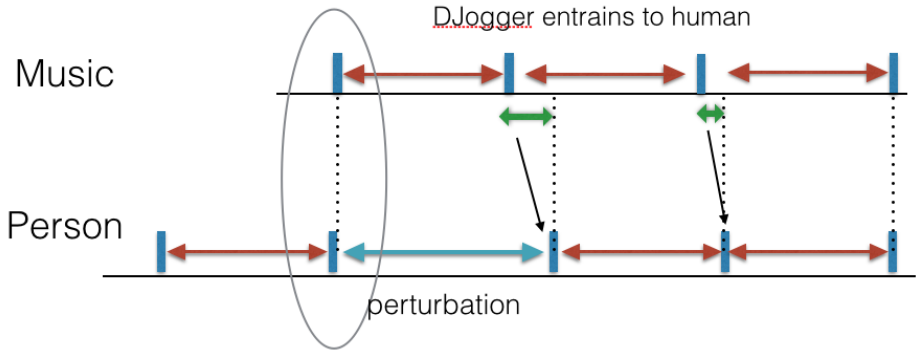
Alignment strategy 2.



Alignment strategy 3.



Alignment strategy 4.



Summary of the alignment strategies

1. period adaptive during the song, no control of phase—> human entrains to phase, difficult, unstable

2. period fixed at the beginning of the song, no control of phase —> human entrains to phase, difficult but stable

3. period adaptive during the song, with an in-phase start, no further change of phase during the song —> human entrains to phase, easy and stable

4. period adaptive during the song, with continuous phase adaptation —> machine entrains to phase, very easy, no attuning

Conclusions

- **Different alignment strategies** for synchronisation are possible: Some strategies elicit human entrainment, others DJogger entrainment. The outcomes results from an interaction
- All strategies evoke **spontaneous** entrainment
- Human and DJogger operate as a **coupled oscillatory system,** with footstep and beat indicating timing
- Entrainment **drives** the coupled oscillatory system towards stable (in-phase) alignment
- Alignment is **stable** when the oscillators are in-phase

Conclusions

- Strategies that lock the human in-phase with the music are superior: Reasons: entrainment is not needed to **find** the in-phase alignment, only to **keep** the in-phase alignment. **Less effort** is needed to keep the alignment, than to find the alignment.

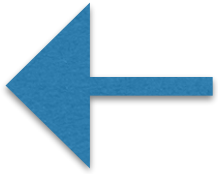
- Alignment strategy 4 eliminates human entrainment, and the human stays aligned in-phase with the music. Provisional conclusion: the power of music is **not based on human entrainment but human alignment** ("being locked into the beat").

- Attraction depends on the **strength** of the oscillators. Reason: Influencing factors, in addition to period and timing, are, (i) for humans: intrinsic variability (1/f), motor resonance, dynamic attending, (2) for music: the character and style

Open questions

- Which strategy is actually the best? And in what respect? This may depend on the task and the context.
- Is there a difference between spontaneous synchronisation and intended synchronisation?
- How to use these strategies for (re)training, rehabilitation, assistive tools (e.g. smart walkman for Parkinson patients)

Factors that influence the "strength" of the oscillation, and hence the interaction

- Human factors:
    - variability, 1/f noise (Diniz et al. 2011)
    - motor resonance (Styns et al. 2007)
    - dynamic attending and prediction (Large & Snyder 2009)
- Musical factors:
    - character of song (Leman et al. 2013)
    - playback: tempo and phase  this study

DJogger for neuroscience? Conclusion

- DJogger is an assistive technology to motivate people to move. Could be useful in studies that address the effect of movement on the brain.
- People that are not capable to follow the beat can be helped with a system that adapts to them. Can that be useful?
- DJogger allows the study of human interaction dynamics in a neuroscience context, using simple control of period and phase of audio stimuli (metronome ticks and music)
- What does it mean for the brain that movement and sound are aligned? What does it mean for the brain to entrain?
- DJogger is the core technology of the EU-project **BeatHealth** with athletes and Parkinson patients as target population