A **4-week home study** investigating the effects of movement sonification on body perception to support adherence to physical activity in real-life contexts

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Introduction

- Physical inactivity is the fourth risk factor in health and mortality.
- Need to consider psychological and emotional barriers related to the perception of one's body to overcome physical inactivity [1], [2].
- Many currents technologies help users to become more aware of their problems, but they cannot solve this problem by themselves. [3]

Approach:

- Metaphorical movement sonification (real-time auditory feedback of body movement) [9].
- Exploits bottom-up multisensory mechanisms related to body perceptions (BP) to ultimately support physical activity (PA) [4]–[7].

Aim: to examine the impact of movement sonifications on body perception and PA in everyday contexts, while also exploring the evolution of these effects and the potential maintenance of PA adherence over time through repeated exposure.

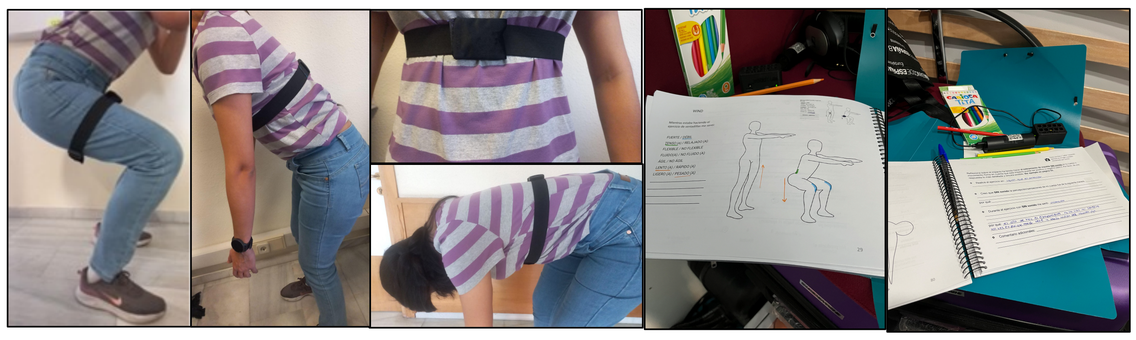


Fig 1. Fig 1. (Left) Examples of how participants used the SoniBand prototype in squats and back stretching exercises. (Right) Photos taken by a participant filling out the diary and body maps at home.

Experimental design

Methods and Materials

- 4 weeks home study
- 30 participants (Age: Mean=26.68, years, SD=9.47, Range=20-59; 10 male, 19 female, 1 Prefer not to say).
  - 86 screened: IPAQ low or moderate-low & 2hrs max of PA [8].

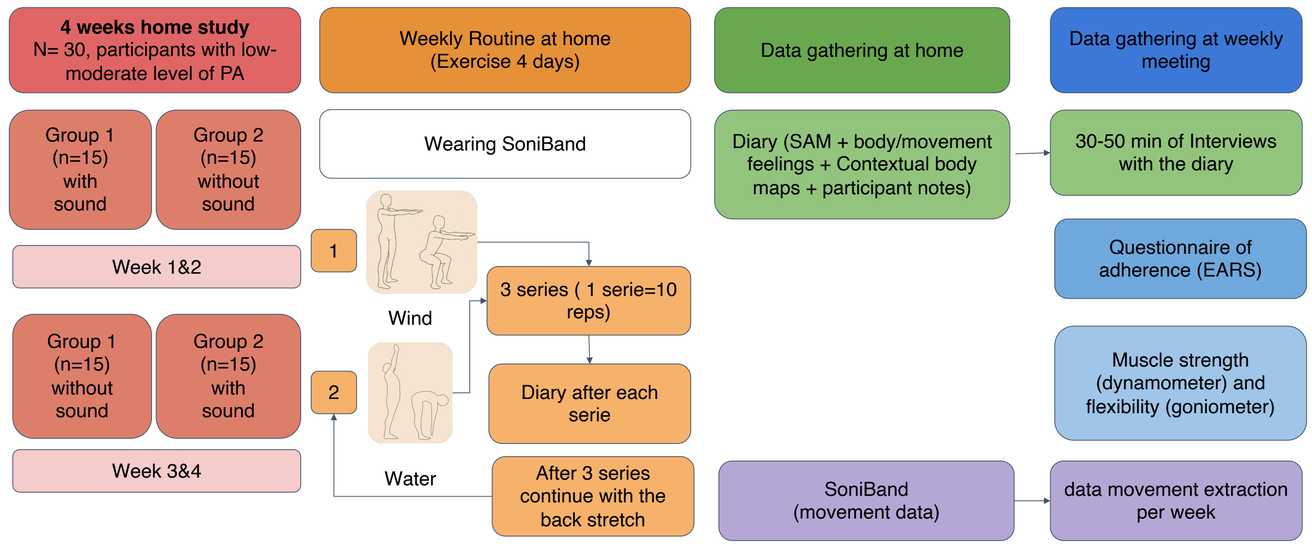
Apparatus

- SoniBand: a wearable self-locking band equipped with a hand-sewn cloth pocket [9], Fig 2.
- Raspberry Pi Zero + Web application

Exercise + Sound

- Squats (Strength): Wind sound vs No Sound
- Back stretch (flexibility) exercise: Water sound vs No Sound

Fig 2. Band with movement sensors (accelerometer & gyroscope).



Measures

- **Diary (Fig 1-Rigth)**, with:
  - Affective experiences, SAM [12]
  - Body/movement feelings, Contextual body maps + 15 items (7-point Likert-type) [4]
- **Physical adherence** -> EARS questionnaire [10] (analysis in progress)
- **Physical measures** -> dynamometer and goniometer [11]
- **Semi-structured interviews** (analysis in progress)
- **Movement behaviour** -> acc/deceleration, velocity, time, angles (analysis in progress)

Results

Squats & Back stretch

Analyses per movement

Affective experiences and body feelings, 2x2 ANOVA (one for each exercise) on aligned rank transform (ART) data:

- **Condition** (Sound: (Squats: Wind), (Back stretch: Water), vs No sound)
- **Order** (1 & 2)

An additional ANOVA to see the effects over time: Week (1 to 4)

– Order*Condition with squats: n.s. main effect or interaction

– Order with back stretch: n.s. main effect or interaction

Physical measures, non-parametric ANOVAs on ART data:

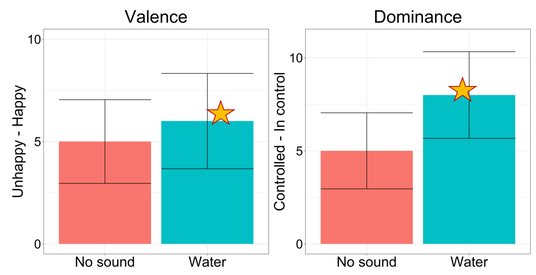
- Condition (Base, Sound, No sound)
- Order (1 & 2)
  - Squats: n.s. main effect or interaction
  - Back stretch: (F (1,28)=5.424, p=0.027, η2 = 0.162)

An additional ANOVA to see the effects over time:

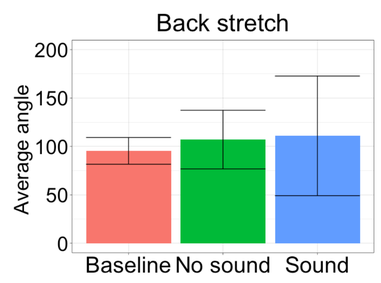
- Week:
  - Squats (F (4,116)=2.914, p=0.024, η2 = 0.913)
  - Back stretch (F (4,116)=9.000, pz0.001, η2 = 0.236)

Affective experiences & Body feelings

For **back stretch** there were significant differences:
Valence (F(1,28)= 5.570, p=0.024, η2 = 0. 168),
Dominance (F(1,28)= 4.451, p=0.043, η2 = 0.091),

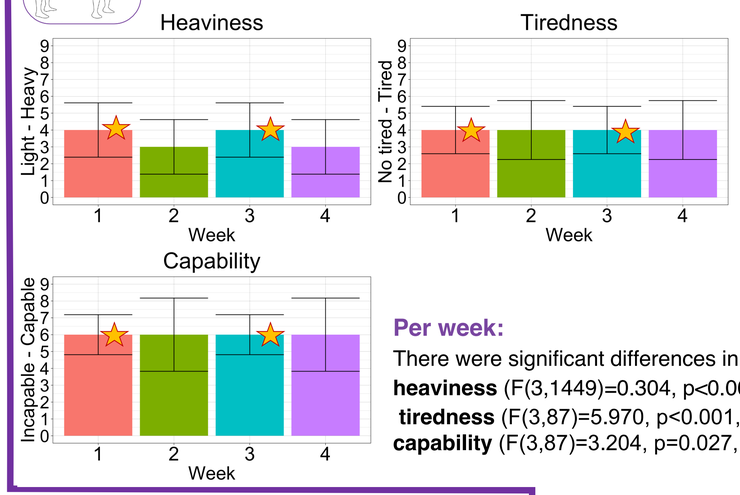


Physical measures



Back stretch (F(2,56)= 10.548, p< 0.001, η2 = 0.273),
Baseline vs **No sound** (t(56) = -2.324, p = 0.061)
Baseline vs **Sound** (t(56) = -4.593, p < 0.001)
No sound vs **sound** (t(56) = -2.268, p = 0.068)

Affective experiences & Body feelings

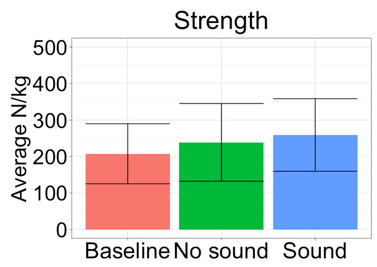


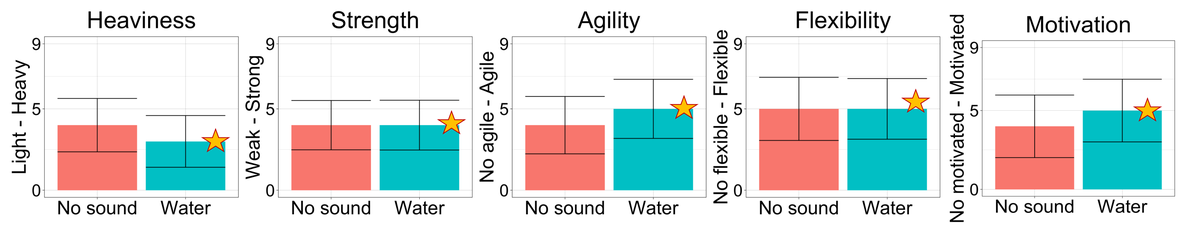
Per week:

There were significant differences in:
heaviness (F(3,1449)=0.304, p<0.001, η2 = 0.194),
tiredness (F(3,87)=5.970, p<0.001, η2 = 0.171),
capability (F(3,87)=3.204, p=0.027, η2 = 0.099)

Physical measures

Squats (F (2,56)=3.751, p=0.0295, η2 = 0.118)
Baseline vs **No sound**
(t(56) = -2.616, p = 0.030)





In body feelings, there were significant differences:
heaviness (F(1,28)= 10.535, p=0.003, η2 = 0.273),
Strength (F(1,28)=9.429, p=0.004, η2 = 0.251),
Agility (F(1,28)=8.635, p=0.006, η2 = 0.235),
Flexibility (F(1,28)=4.895, p=0.035, η2 = 0.148),
Speed (F(1,28)=4.305, p=0.047, η2 = 0.133),
Difficulty (F(1,28)=4.883, p=0.035, η2 = 0.148),
Fluidity (F(1,28)=5.509, p=0.026, η2 = 0.164),
Motivation (F(1,28)=7.738, p=0.009, η2 = 0.216).

Discussion

Contribution

- A 4-week home study using movement sonification to investigate the effects of metaphorical sound on Affective experiences, body Perception and physical changes.
- Two experiments investigating the effects of metaphorical sounds (Wind and Water) on squats and back stretch movement, affective experiences, body and movement feelings, physical adherence muscle strength and stretching.

Most significant results

We found effects of sounds movement sonification on Back stretch exercise using Water sound on affective experiences (Valence and Dominance), body feelings (Heaviness, Flexibility, Agility, speed, Fluidity), endurance to perform exercise (Difficulty, Strength), Motivation, as well as on physical changes, that is stretching angle with back stretch using Water sound.

Wind sound

Body feelings:

- Participants started feeling heavier, tired but feeling more capable of performing the exercise and it seems when their condition change in 3rd week, they felt heavier, tired again.

Muscle strength :

- Wind sound (vs No sound) showed a difference when participants' muscles were working compared when their baseline.

Water sound

Affective experiences:

- Participants felt happier, in control of the technology with the Water sound (vs No sound).

Body feelings:

- Participants felt with the water sound (vs No sound) lighter, stronger, agile, flexible, more motivated, faster, easier, and their movement more fluid .

Stretching:

- Participants stretched their backs more when their movement was done with Water sound (vs No sound).

Conclusion

- Results provide the first quantitative evidence that metaphorical sounds affect affective experiences, body feelings, and physical condition in a long-term study and that they could be used in every day contexts to change body perceptions and increase physical activity.
- The observed effects in subjective feelings related to the body, emotional state, and physical condition open opportunities for exercise; and have implications for the design of sound-based applications supporting physical activity, rehabilitation, and movement expression.

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