Exploring Musical Feedback for Gait Retraining: A Novel Approach for Orthopedic Rehabilitation

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INTRODUCTION

Gait retraining → Correct abnormal walking pattern

- Several rehabilitation sessions
- Continuous guidance of physical therapist

REAL-TIME MUSICAL FEEDBACK

- Portable – any location.
- Improves motor learning in clinical populations – knee osteoarthritis, hip arthroplasty and ankle fracture. [1-5]
- Enhances motor perception by transforming movement data into auditory feedback. [6]
- Literature: beep-like sound and single-instrument feedback.
- Music provides a motivational framework that potentially improves enjoyment and engagement.

AIM: Medially shift center of pressure (COP) in healthy subjects using musical feedback and assess spatiotemporal gait changes.

RESULTS

- 20 healthy participants (9 female, 29 ± 5 years old).
- All participants medialized their gait line (Fig.1)
- COP: ranged from -2.3% to -19% (-9.38% ± 4.37)
- Medial plantar pressure increased after practice (Fig.2)
- No changes in speed, cadence and stride length. (Table 1)

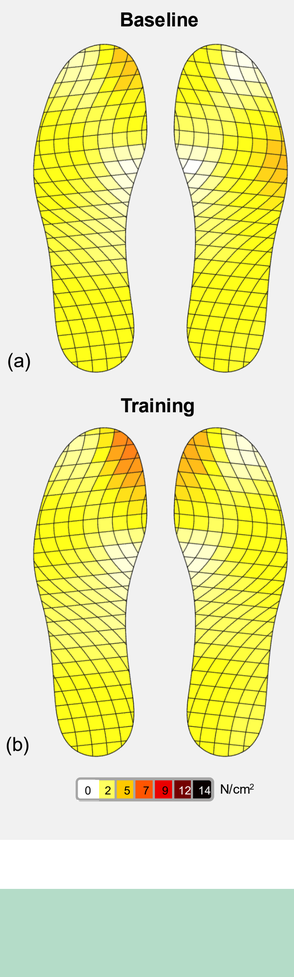


Figure 2. Mean plantar pressure throughout the stance phase at baseline (a) and after training (b) with musical feedback for one subject.

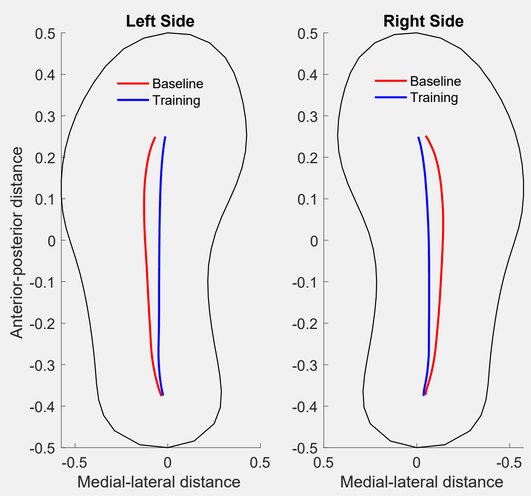


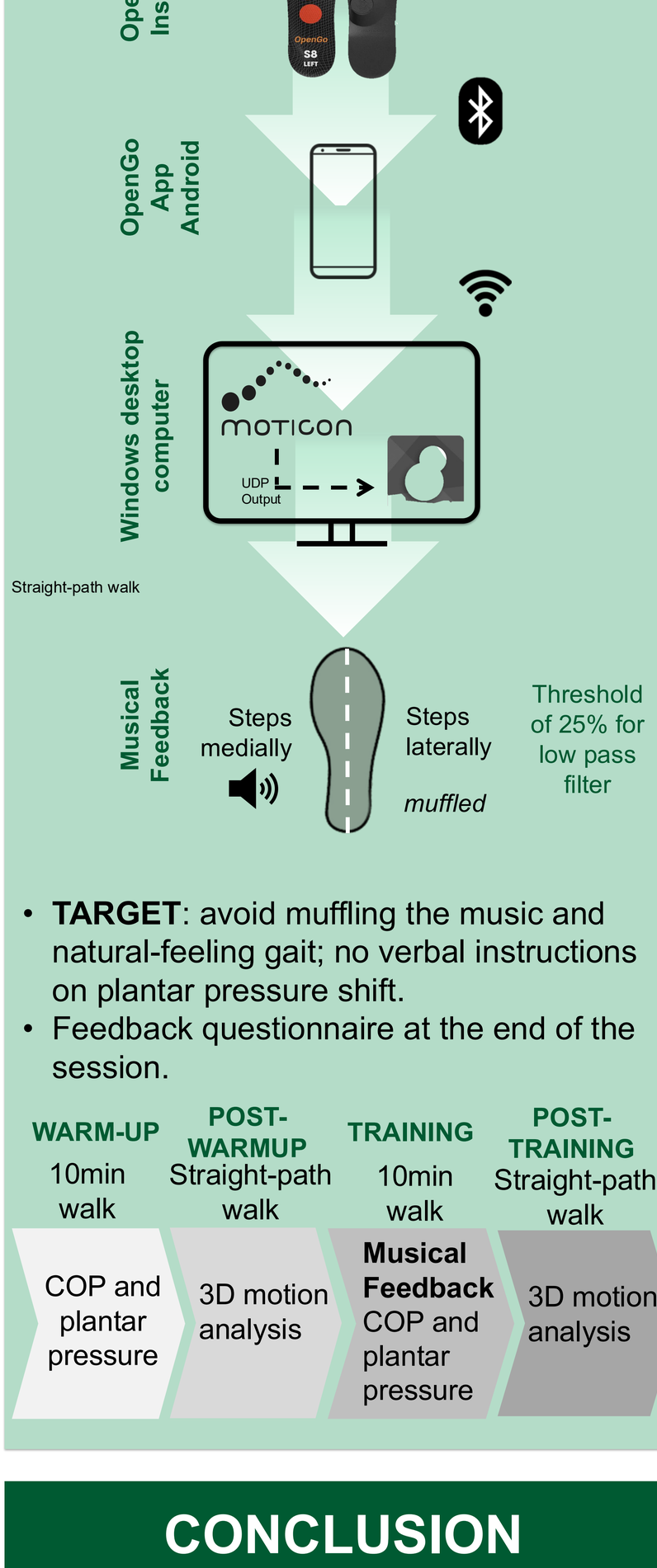
Figure 1. Gait line at baseline and after training with the musical feedback.

Table 1. Spatiotemporal gait parameters, center of pressure, and plantar pressure at baseline and after training

	Baseline				After Training			
Speed (m/s)	1.35 ± 0.19				1.36 ± 0.18			
Cadence (strides/min)	55.31 ± 3.47				55.32 ± 3.59			
Stride Length (m)	1.47 ± 0.15				1.48 ± 0.13			
	Left		**Right**		**Left**		**Right**	
Mean Peak COPy [+Med]	-0.14 ± 0.04		-0.15 ± 0.03		-0.07 ± 0.03**		-0.08 ± 0.03**	
COPx at Mean Peak COPy [+Ant]	0.03 ± 0.12		-0.01 ± 0.12		-0.08 ± 0.24		-0.10 ± 0.15**	
	Lat	**Med**	**Lat**	**Med**	**Lat**	**Med**	**Lat**	**Med**
Mean Plantar Pressure (N/cm²)	15.93± 2.46	15.83± 2.09	16.15± 2.46	15.34± 2.85	12.50± 3.19**	19.13± 2.66**	12.70± 2.09**	18.69± 2.96**

*COP: center of pressure; Lat: lateral; Med: medial; *p < 0.05; **p < 0.01*

METHODS



- **TARGET**: avoid muffling the music and natural-feeling gait; no verbal instructions on plantar pressure shift.
- Feedback questionnaire at the end of the session.

WARM-UP	POST-WARMUP	TRAINING	POST-TRAINING
10min walk	Straight-path walk	10min walk	Straight-path walk
COP and plantar pressure	3D motion analysis	**Musical Feedback** COP and plantar pressure	3D motion analysis

DISCUSSION

- All participants medialized their COP guided solely by the musical feedback.
- Participants were still able to reproduce the new walking pattern without the feedback.
- No reduction in cadence and speed when the musical feedback is introduced → slowdown of movement is generally expected when a new walking pattern is introduced.
- **Musical feedback** → might motivate the patient to maintain their walking cadence while adapting to a new walking pattern.
- **Limitations**: young healthy subjects, short period of training, and testing sessions inside a laboratory.

USER FEEDBACK

All participants agreed or strongly agreed that they understood the instructions and changes in the sound. No adverse effects were reported, only slight soreness on the foot or leg.

CONCLUSION

Subjects were able to shift their COP medially using musical feedback cues without decreasing cadence and speed. Musical feedback is a promising tool for orthopedic clinical conditions that exhibit asymmetries and poor movement patterns.

ACKNOWLEDGMENTS

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