

Interaction of Multiple Gait Rehabilitation Techniques

Fatemeh Rasouli, Seok Hun Kim, Kyle Reed

University of South Florida

Objective--

To investigate changes in gait asymmetry when two walking conditions are applied simultaneously. We hypothesize that changes in gait symmetry following walking on a treadmill with asymmetric rhythmic auditory cueing (ARAC) or split-belt speed (SBS) will significantly relate to the symmetry changes after walking with a combination of ARAC and SBS.

Design--

Prospective cohort study.

Subjects walked on an instrumented treadmill with a four different combinations of walking conditions using ARAC and SBS: (1) SBS+symmetric rhythmic auditory cueing, (2) tied-belt speed+ARAC, (3) SBS+ARAC congruently, and (4) SBS+ARAC incongruently. The auditory cueing was provided using metronomes.

Setting--

A computer-assisted rehabilitation environment of a university.

Participants--

Four healthy young individuals participated in this study.

Interventions--

Not applicable.

Main Outcome Measure(s)--

Spatiotemporal (i.e., step time and step length) and kinetic gait variables (i.e., peak vertical force, peak push-off, and peak braking force) were measured during walking at four time periods: early adaptation, late adaptation, early after-effect, and late after-effect. Regression analysis was used to identify whether combining SBS and ARAC congruently (condition 3) or incongruently (condition 4) would achieve the similar change in gait symmetry as a weighted combination of SBS and ARAC combined independently (conditions 1 and 2)

Results--

The weighted model used twenty points (five gait parameters at four time periods) to find the best fit. The weight on condition 1 was 0.96 and 0.52 for condition 2. Subtracting the gait symmetry changes of $0.96 \times \text{condition 1}$ from $0.52 \times \text{condition 2}$ showed a similar pattern as condition 3 with an R-squared of 69%. The same weighted model summing conditions 1 and 2 resulted in an R-squared of 88% compared to condition 4.

Conclusions--

Combining SBS and ARAC contains a partial effect of each individual walking condition on spatiotemporal and kinetic gait parameters. This method can possibly be used to improve overall gait symmetry.

Funding--

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Presented poster on next page.



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Fatemeh Rasouli,¹ Seok Hun Kim,² Kyle B. Reed¹

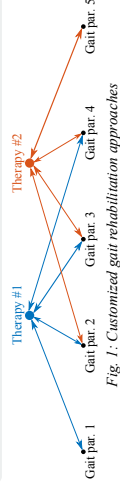
¹ Department of Mechanical Engineering, University of South Florida, Tampa

² School of Physical Therapy and Rehabilitation Sciences, University of South Florida, Tampa



Introduction

- Typical therapy uses one treatment at a time.
- This study evaluates how two treatments can be **combined**.
- Customizing gait rehabilitation by modulating individual gait parameters in a way that is not possible with a single therapy.



Objectives

Main Objectives:

- Investigate changes in gait symmetry when two walking conditions are applied **simultaneously**.
- A novel method of therapy: Asymmetric Rhythmic Auditory Cueing (ARAC) provided by two metronomes for left and right steps with an asymmetric duration ratio of 2:1

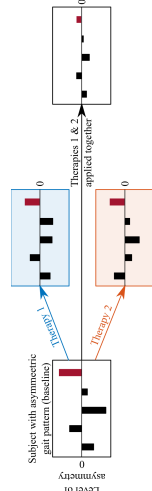


Fig. 2: Effects of combined therapy 1/2 single therapy

Hypothesis

Changes in gait symmetry following walking on a treadmill with asymmetric rhythmic auditory cueing (ARAC) or split-belt speed (SBS) alone will significantly correlate with the symmetry changes after walking with a combination of ARAC and SBS.

Methods

Four different combinations of walking conditions:

- SBS+symmetric rhythmic auditory cueing
- Tied-belt speed+ARAC
- SBS+ARAC congruently
- SBS+ARAC incongruently.

- * The auditory cueing was provided using sound cues.
- * SBS was applied using a split-belt treadmill.

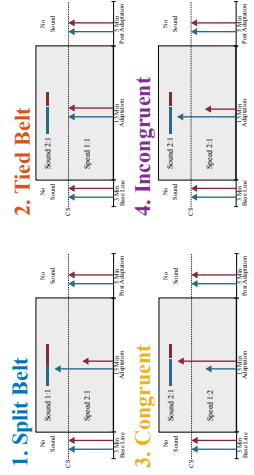


Fig. 3: Combination of therapies applied in each condition for all subjects
* Four healthy individuals participated in all four conditions.
* Each trial was conducted in a different day to avoid fatigue and aftereffects. Motion capture system recorded data.

Results

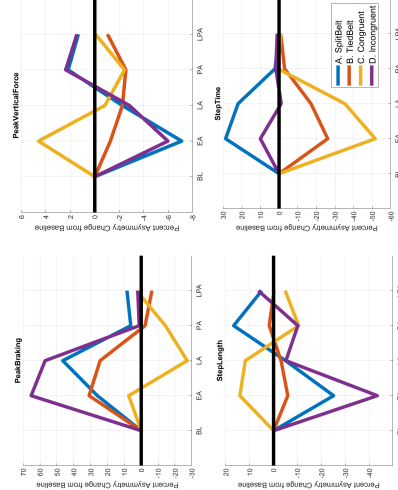


Fig. 4: Results of two spatiotemporal (step length and step time) and two kinetic gait variables (peak vertical and peak braking forces). x-axis represents five time periods. BL: baseline, EA: early adaptation, LA: late adaptation, PA: post-adaptation, and LPH: late post-adaptation

Weighted model: 20 points (five gait parameters x four time periods) to find the best fit.

- The weight on condition 1 was 0.96 and 0.52 for condition 1
- Subtracting gait symmetry changes of 0.96 x condition 1 from 0.52 x condition 2 showed a similar pattern as condition 3 with R-squared of 69%.
- The same weighted model summing conditions 1 and 2 resulted in R-squared of 88% compared to condition 4.

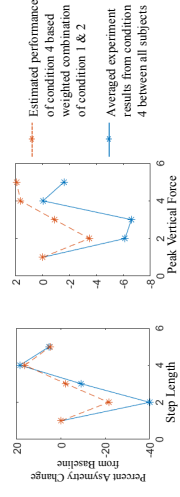


Fig. 5: Results of estimated values from the weighted model for one spatiotemporal (step length) and one kinetic gait variables (peak vertical force) compared to actual experiment results

Conclusions

Regression analysis was used to identify whether combining SBS and ARAC congruently or incongruently (condition 3 or 4) would achieve the similar change in gait symmetry as a weighted combination of SBS and ARAC combined independently (conditions 1 and 2).

Combining SBS and ARAC contains a partial effect of each individual walking condition on gait parameters.

This method can be used to improve overall gait symmetry.

Acknowledgment

This material is based upon work supported by the USA National Science Foundation under Grant Number IIS-1910434.

- References:
- [1] Thaut, Michael H., and Mutsaers, Arie. "Rhythmic auditory stimulation in rehabilitation of movement disorders." *Journal of Music Therapy* 40.1 (2008): 1-10.
 - [2] Shannon, K. "The effect of rhythmic auditory stimulation on the gait parameters of patients with incomplete spinal cord injury: an exploratory pilot study." *International Journal of Rehabilitation Research* 31.2 (2008): 155-157.

For more information, contact: frasouli@mail.usf.edu