Isolating Aspects Of Gait Through The Use Of Pacing Signals: A Pilot Study

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INTRODUCTION

- Walking studies have used isochronous pacing signals in replicating effects of aging and regulating gait parameters in pathological populations [1,2].
- Fractal ($1/f^{\alpha}$) pacing signals more appropriately replicate healthy gait, thus demonstrating their importance in rehabilitation [3].
- Despite prevalent use of pacing signals, more research is needed to understand the features that are being tuned into as the participants walk.
- We hypothesize that both the autocorrelation (ACF) and probability distribution (PDF) of the stride time intervals is important when creating a pacing signal.

METHODS

- Ten participants (mean ±SD; age 23.5±1.73, 3F) walked in five conditions for approximately 15 minutes each (Figure 1).
- The conditions were: self-paced walking (SPW), pink noise pacing signal (PPS), shuffled pink noise pacing signal (SHPS), Gaussian distributed random pacing (GRPS) and a uniformly distributed random pacing signal (URPS).

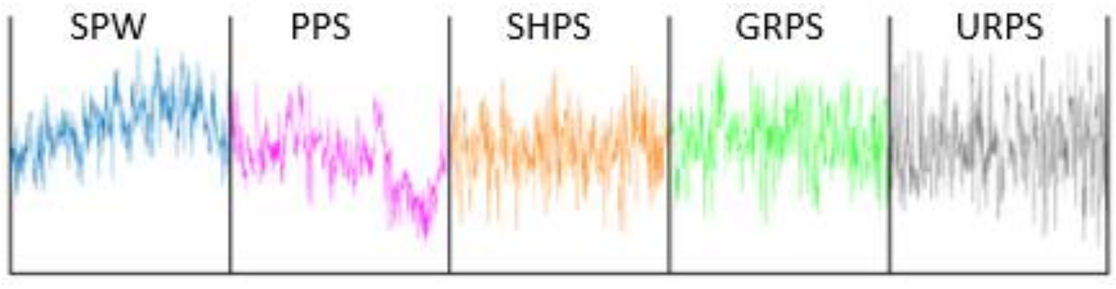

Figure 1. A graphical representation of the experimental design using one participants stride. 5-minute breaks between conditions are indicated by the vertical black lines

- Participants were shown a continuous pacing signal (Figure 2. a) via HDMI glasses (VUFINE. Sunnyvale, CA) (Figure 2. b)
- Heel strikes were collected using Noraxon footswitches (Noraxon USA, Inc., Scottsdale, AZ).
- Only the middle 600 strides were used in data analysis.

Figure 2. a. pacing signal viewed by participants. The grey bar moves up and down, turning red at the top to indicate when right heel strike should occur and **b.** The glasses with HDMI attachment.

RESULTS (IN PROGRESS)

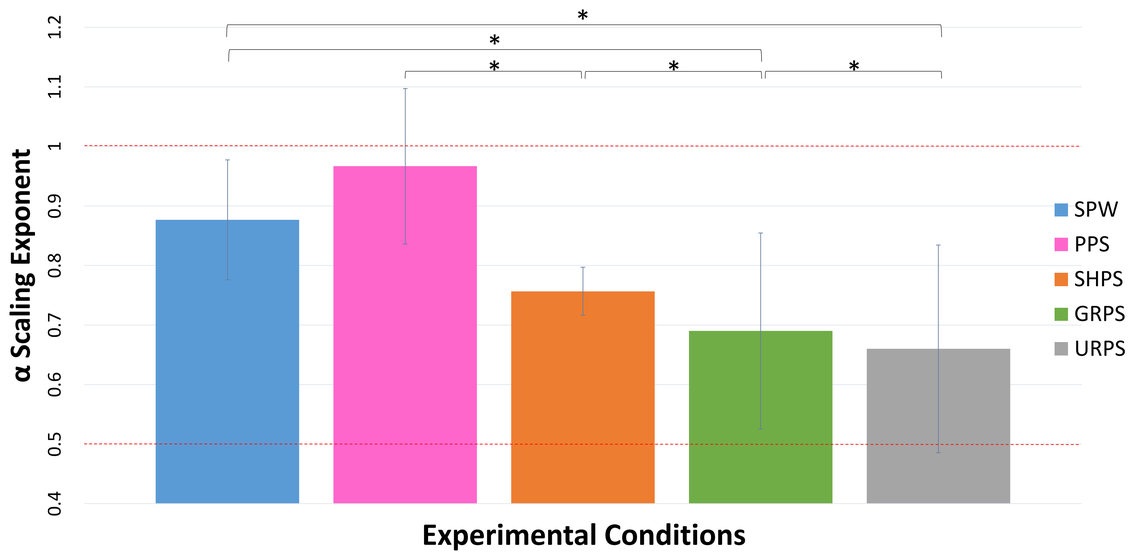

Figure 3. Mean stride time DFA of all participants.

Dashed lines are theoretical α values for healthy (1.0) and pathological (0.5) adults. This suggests (1) PPS produces ideal stride fluctuations, whereas (2) increasing dissimilarity between pacing signal and natural gait produces fluctuation patterns more consistent with pathological gait. ** p = 0.05*

DISCUSSION/CONCLUSION

- The results provide support for the hypothesis that both the PDF and ACF of a pacing signal are important aspects to consider (Figure 3).
- Pairwise comparisons showed PPS had a larger α than SHPS (p=.0004), GRPS (p=.0002), and URPS (p=.000005).
- Interestingly, SHPS did not different significantly from SPW .
- When PDF most closely resembled healthy walking, α tended to be higher.
- There is a general decreasing trend in α as PDF and ACF become less similar to SPW.
- This suggests that people are able to tune into the PDF when coordinating lower limb timing to an external pacing signal.

References:
1. Thaut, M. H, et al. *Neurorehabilitation and Neural Repair*, **21**(5), 455–459, 2007.
2. Ebersbach, G, et al. Movement Disorders : Official Journal of the Movement Disorder Society, **14**(4), 619–625, 1999.
3. Kaipust, J. P, et al *Annals of Biomedical Engineering*, **41**(8), 1595-1603, 2013.

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