A HYPOTHESIS EXPLORING GENDER DIFFERENCES IN GAIT VARIABILITY USING RHYTHMIC AUDITORY STIMULATION IN INDIVIDUALS WITH PARKINSON'S DISEASE

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Summary
Parkinson's Disease (PD) is an incurable and progressive neurodegenerative disorder with worldwide prevalence. The application of external cueing devices to mitigate motor symptoms of PD and improve gait has gained significant attention in recent decades. Many of these studies have yielded significant findings, but often overlook gender-related differences potentially underlying significant outcomes in longitudinal PD studies. A review of existing literature shows significant gender differences within this population including differences in disease epidemiology, gait, and dual-tasking abilities. Thus, this paper presents the hypothesis that because males tend to be more severely affected by PD, females are more likely to benefit from external cueing devices such as Rhythmic Auditory Stimulation (RAS). Preliminary data using a small cohort supports this hypothesis, warranting further investigation. Validation of this hypothesis will highlight the importance of incorporating gender-specific considerations into treatment plans will improve device efficacy and the life of individuals managing Parkinsonian symptoms.

Introduction
Parkinson's Disease (PD) is a prevalent neurodegenerative disease that causes both motor and non-motor symptoms, resulting in disability and a reduced quality of life [1-4]. With no cure currently, management of symptoms is essential. Supportive therapies, such as external cueing devices, are considered the most preferred and well-established form of PD symptom management. Various visual, auditory, and tactile cueing devices have been developed but a need for more gender-specific cueing parameters still exist.

The Hypothesis
Rhythmic Auditory Stimulation (RAS), an external cueing device, enhances motor symptoms such as speed, stride length, and other spatiotemporal gait parameters [5-7]. However, it has been hypothesized that because males tend to be more severely affected by PD, females are more likely to benefit from RAS. Based on this premise, we propose that future cueing device parameters and recommendations account for gender differences and disease severity within the PD patient population.

Evolution of the Hypothesis
A review of the literature found that given the elderly population (mean PD onset is 70.5 years [8]), gender- and age-related differences may underlie significant outcomes in longitudinal studies. Gender differences in (i) disease epidemiology [8,9], (ii) gait [5], and (iii) dual-tasking [10]

hold a significant impact on cueing device intervention efficacy. A preliminary study with a small cohort using RAS [5] shows support for this hypothesis (see Figure 1).
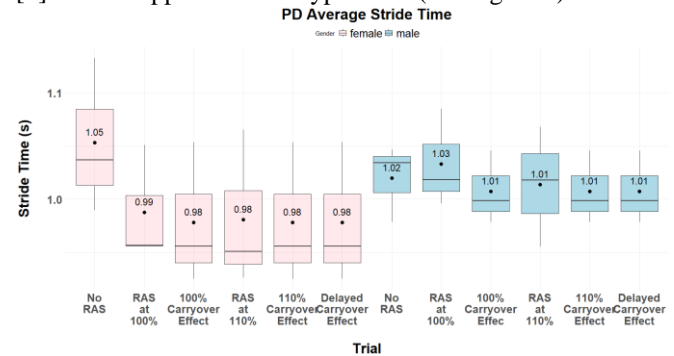

Figure 1: Average stride time (s) for six trials with six gender- and age-matched Parkinson's disease subjects.

Conclusions
This hypothesis highlights the importance of conducting inclusive research studies and design approaches. Due to the disease's epidemiology, personalized treatment must account for gender, disease severity, and symptom manifestation. Incorporating gender-specific considerations into treatment plans will optimize the efficacy of these therapies and thus lead to a more significant and widespread reduction in disability and improvement in life for individuals managing the symptoms of PD.

References
[1] R. Balestrino and A. H. V. Schapira (2020). *Eur J Neurol*, **27**: 27-42
[2] B. M. Koeppen et al. (2018). *Physiology*; Elsevier.
[3] M. F. Bear et al. (2015). *Neuroscience: exploring the brain*; Jones & Bartlett Learning.
[4] R. Gisbert and M. Schenkman (2015). *Phys Ther*, **95**: 299-305
[5] J. M. Hausdorff et al. (2007). *Eur J Neurosci*, **26**: 2369-2375
[6] R. S. Calabrò et al. (2019). *J Neuroeng Rehabil*, **16**: 68
[7] T. T. C. Capato et al. (2020). *J Parkinsons Dis*, **10**: 333-346
[8] S. K. Van Den Eeden et al. (2003). *Am J Epidemiol*, **157**: 1015-1022
[9] C. A. Haaxma et al. (2007). *J Neurol Neurosurg Psychiatry*, **78**: 819
[10] T. E. Raffegeau et al. (2019). *Parkinsonism Relat Disord*, **62**: 28-35