Effects of Rhythmic Auditory Stimulation on Gait and on Cortical Activation with Mental Imagery of Walking in Patients with MS .

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BACKGROUND AND AIMS

- Up to 75% of patients with multiple sclerosis (MS) experience walking limitations at some point in the course of their disease. [1]
- Rhythmic auditory stimulation (RAS) improves gait in patients with Parkinson's Disease [2] and stroke. [3] Two pilot studies showed improvement of gait parameters after a home based walking program using RAS in patients with MS. [4] [5]
- Mental imagery of walking was shown to be associated with activation of the supplementary motor area (SMA) in healthy individuals. [6]

The goals of this cross-sectional uncontrolled study are to measure immediate changes in spatiotemporal (ST) gait parameters with RAS, and to assess cortical activation patterns related to mental imagery of walking with and without RAS in patients with MS.

METHODS

- Patients diagnosed with MS, and with a gait disturbance primarily due to spastic paresis, completed a single assessment visit after providing informed consent.
- To assess the effects of RAS on gait, the subjects were first asked to complete a series of 5 walks at a comfortable speed on the GAITRite® computerized walkway (W1). They subsequently completed 5 walks under various conditions (without RAS, with RAS at comfortable walking cadence, with RAS 10% and 20% above their comfortable walking cadence, and without RAS) (W2).
- To assess the effects of RAS on cortical activation, the subjects were visually cued to perform mental imagery of walking, then to stop performing imagery, in 48-second segments, repeating the sequence 4 times. This was performed with (W+) and without (W-) RAS .

A repeated measures ANOVA was used to test for within-subject changes in gait parameters with and without RAS. Functional MRI data was analyzed for activation using a least-squares fit method to produce individual activation maps. For each task, the scan with RAS was compared to the scan without RAS. For each subject, Student t-maps were generated for correlation to the walking imagery paradigm. All subjects maps were spatially normalized and a voxelwise paired t-test was performed between the map from the W+ to the W- conditions. The significance level was set at $p<0.05$, without correction for multiple comparisons since this is an exploratory study.

Disclosures

F. Bethoux has received honoraria or consulting fees from Acorda Therapeutics, Allergan, Biogen Idec, Concert Pharmaceuticals, GW Pharma, Medtronic Inc., and Merz Pharmaceuticals; and research funding from Acorda Therapeutics, Innovative Neurotronics, and Medtronic Inc.

Mark Lowe, Katherine Koenig, Darlene K Stough, Lisa Gallagher, and Dwyer Conklyn have nothing to disclose.

RESULTS

Description of the study population (Table 1)

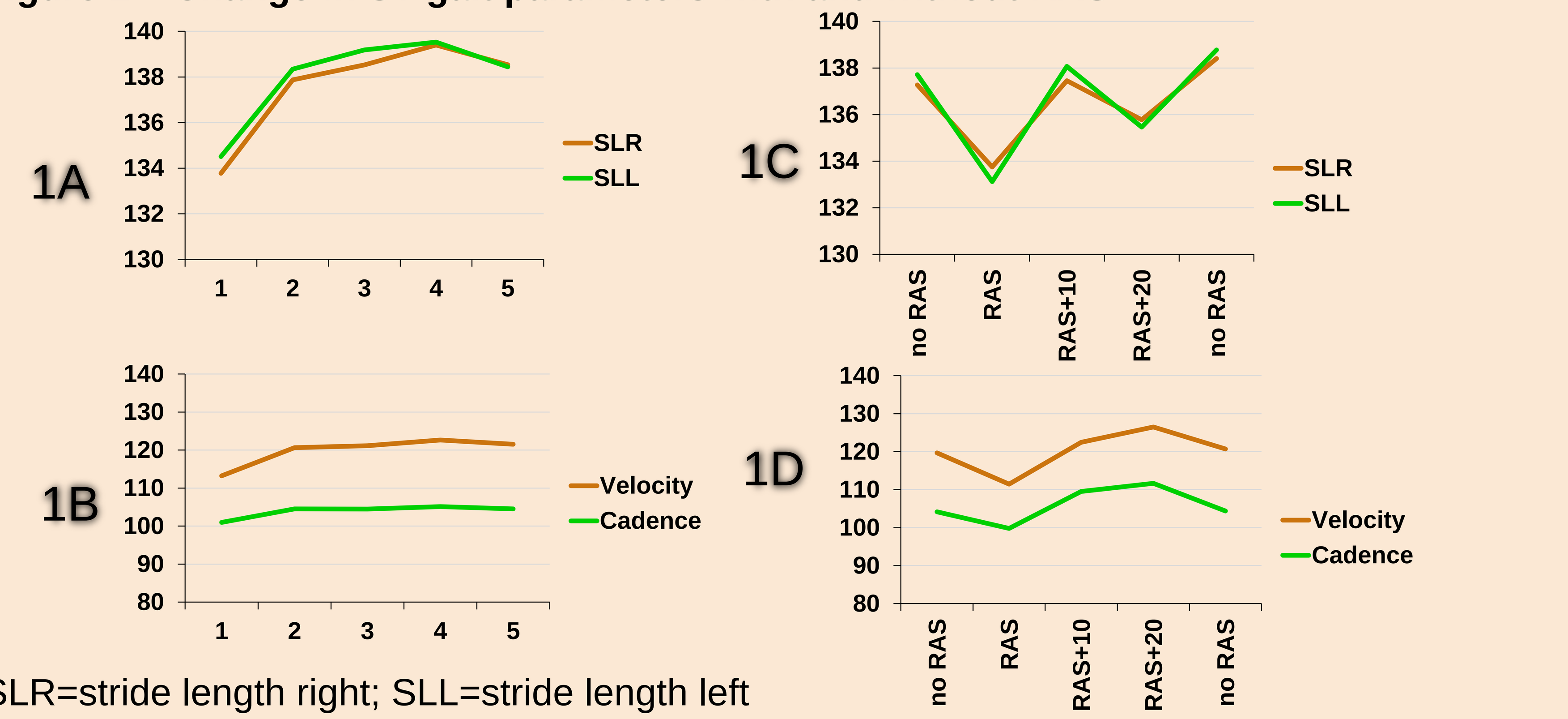
Table 1 – Characteristics of the study population (N=10)	
Age	51.8 (4.9) years
Sex	60% Women
Symptom duration	17.5 (8.5) years
Disease course	60% RR, 40% SP
Assistive device	50% none, 30% unilateral, 20% bilateral
AFO	40% Yes
Fall count in the past month	40% none, 50% one, 10% two

RR=relapsing-remitting; SP=secondary progressive; AFO=ankle-foot orthosis
All values expressed as mean (SD) unless otherwise specified

Change in ST gait parameters with and without RAS (n=7, Figure 1)

- In the W1 walk sequence, there was a statistically significant improvement of stride length (p=0.03 left side, p=0.004 right side) and velocity (p=0.02), with most of the improvement occurring during the first and second walks (Figures 1A and 1B
- In the W2 sequence, there was a significant improvement of cadence (p=0.01) and a trend for improvement of velocity (p=0.05) with RAS (Figures 1C and 1D)

Figure 1 – Change in ST gait parameters with and without RAS

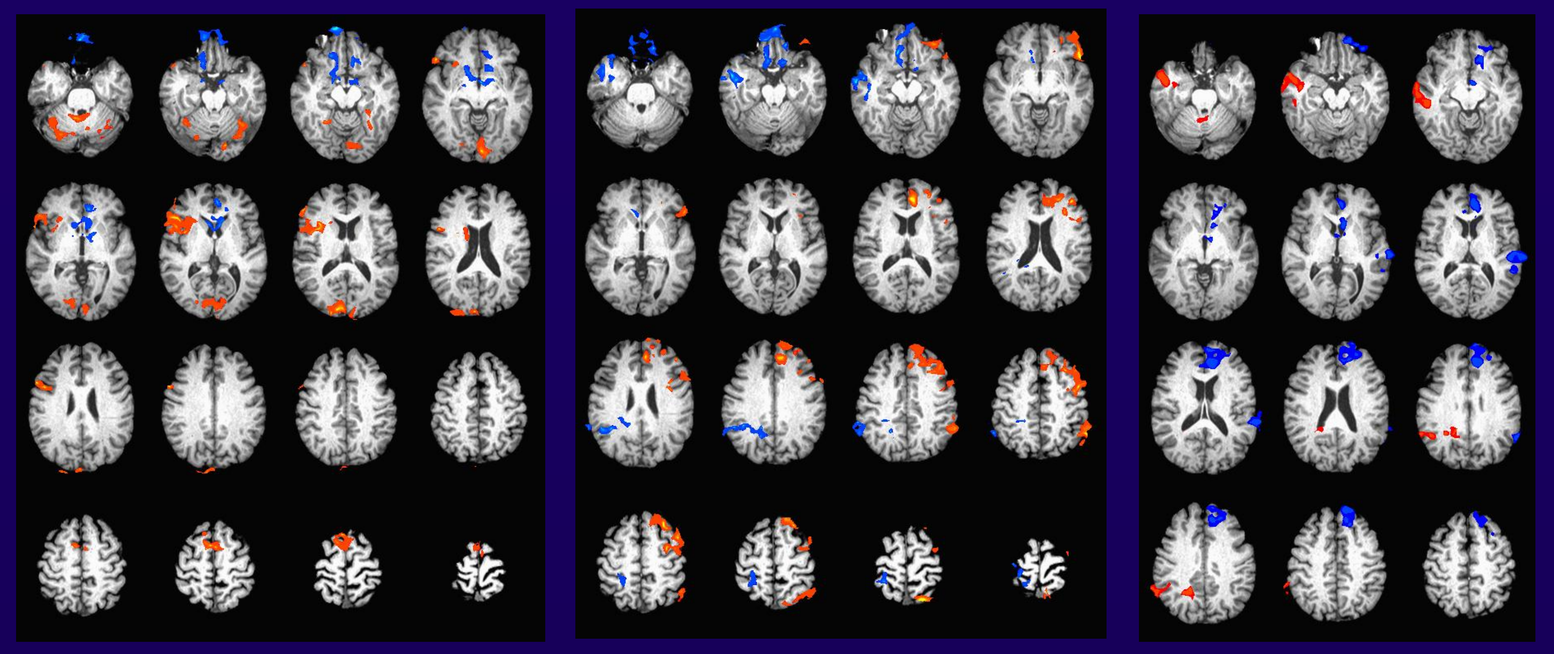


SLR=stride length right; SLL=stride length left

Changes in cortical activation with and without RAS (n=4, Figure 2)

Increased activation with RAS vs no RAS		Increased activation with no RAS vs RAS	
Left superior frontal gyrus	(p=0.01)	Cerebellum	(p=0.05)
Left anterior cingulate	(p=0.01)	Right middle temporal gyrus	(p=0.01)
Left superior temporal gyrus	(p=0.05)	Right supramarginal gyrus	(p=0.05)

Figure 2 – fMRI activation maps



without RAS | with RAS | RAS vs. no RAS

Conclusions

- Use of RAS while walking produces an immediate improvement in cadence, demonstrating the subjects' ability to synchronize their gait to the stimulus.
- The pattern of cortical activation related to mental imagery of walking is affected by the RAS stimulus. In particular, when comparing RAS to no RAS, there was an increase in activation in the left superior frontal gyrus, typically thought to be involved in working memory, spatial processing, and self-awareness; the left anterior cingulate, involved in attention, motivation, and error detection; and the left superior temporal gyrus, which is involved in audition.
- We initiated a longitudinal randomized controlled trial of a home walking program with RAS, which will allow further assessment of the effects of RAS on walking, gait, and cortical activation.

Acknowledgements

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