The Effect of Rhythmic Auditory Stimulation on Gait Outcomes in Adults with Non-Progressive CNS Diagnoses: A Systematic Review
Authors:

Jordan Cominsky SPT
Coleen Joyce SPT
Madeline Raab SPT
Suzanne Leschen SPT
Jennifer Schwartz PT, DPT, NCS
Renee Hakim PT, PhD, NCS
Rhythmic auditory stimulation (RAS) is a novel and inexpensive tool that involves the use of rhythmic sensory cueing to influence movement.

RAS affects the sense of rhythm through sound auditory stimuli and activates various areas of the brain by synchronizing the motor and sensory areas.
Rhythm serves as an anticipatory and continuous time reference on which movements are mapped.

The relationship between the auditory rhythm and motor response serves to stabilize and regulate gait patterns.
Overview$^1,3$

- RAS has been frequently studied as an intervention for patients with Parkinson’s disease and has been effective in improving:
  - Gait rhythmicity
  - Gait velocity
  - Cadence
  - Stride length
  - Tremor reduction
  - Freezing
  - Rigidity reduction
  - Balance

- Recent data suggests that rehabilitation processes involving movements which are highly repetitive and rhythmically patterned are particularly effective in gait training for patients with stroke.
The purpose of this systematic review was to determine the effects of rhythmic auditory stimulation (RAS) on gait outcomes in adults with non-progressive CNS diagnoses.
Methods

A literature search (2006-2016) was conducted using:
- Cochrane Library
- CINAHL
- ScienceDirect
- MEDLINE/PubMed
Search Terms

- (Rhythmic auditory stimulation OR auditory rhythm OR externally controlled stimulation OR mechanically controlled cueing OR music therapy)
- AND (gait training OR gait OR walking OR ambulation OR treadmill training)
- AND (non-progressive neurological diagnoses OR stroke OR cerebrovascular accident OR Traumatic brain injury)
Methods

- Search limits:
  - English, human subjects, and peer-reviewed RCTs

- Selection criteria:
  - Adults 18 years and older with non-progressive CNS diagnoses
  - Intervention including RAS training and a measure of gait outcomes
  - Two reviewers independently assessed each article for methodological quality and came to a consensus using PEDro guidelines
# PEDro Scores

<table>
<thead>
<tr>
<th>Study</th>
<th>Eligibility Criteria</th>
<th>Random Allocation</th>
<th>Concealed Allocation</th>
<th>Baseline Comparison</th>
<th>Blinded Subjects</th>
<th>Blinded Therapists</th>
<th>Blinded Assessors</th>
<th>Adequate Follow-Up</th>
<th>Intention-to-Treat Analysis</th>
<th>Between Groups Comparison</th>
<th>Point Estimate and Variability</th>
<th>PEDro Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cha et al. (2014)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7/10</td>
</tr>
<tr>
<td>Thaut et al. (2007)</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7/10</td>
</tr>
<tr>
<td>Johannsen et al. (2010)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7/10</td>
</tr>
<tr>
<td>Suh et al. (2014)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>7/10</td>
</tr>
<tr>
<td>Kim et al. (2011)</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>5/10</td>
</tr>
<tr>
<td>Chouhan et al. (2012)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>6/10</td>
</tr>
</tbody>
</table>
Records identified through database searching (n=27)

Records after duplicates removed (n=17)

Records excluded after screening by title and abstract (n=6)

Full-text articles assessed for eligibility (n=11)

Studies included (n=6)

Full-text articles excluded (n=5)
1. Language not English (n=1)
2. Unrelated Title (n=4)
3. Revised Edition (n=1)

1. Are the subjects older than 18? (n=1)
2. Is the diagnosis non-progressive (n=0)
3. Is the study an RCT? (n=3)
4. Does the study test gait? (n=0)
5. Does the study assess RAS as in intervention? (n=1)
Results

- A total of 27 articles were screened for eligibility
- Following detailed appraisals, 6 RCTs met the criteria
- PEDro scores ranged from 5 to 7/10 (avg=6.5)
- Samples ranged from 16 to 155 subjects (total=272) with acute (200) and chronic stroke (72)
- Treatment parameters varied widely with durations ranging from 4 days to 6 weeks in clinical settings
Results

Primary outcome measures included:
- Gait parameters
- Dynamic Gait Index (DGI)
- Timed Up and Go (TUG)
- 10 Meter Walk Test

Secondary outcomes measures included:
- Berg Balance Scale (BBS)
- Standing balance (Biosway)
- Fugl-Meyer lower extremity scale
- Stroke Specific Quality of Life (SS-QOL) Scale
- EMG recordings
Results

- 5 of 6 studies were clinically and statistically significant in gait outcomes using RAS\(^{1-5}\).
- 4 of 6 studies found significant improvements in:\(^{1,2,4,6}\)
  - Velocity
  - Stride length
  - Cadence
  - Swing symmetry
  - Double support
  - Step length
Results

- 2 studies found significant improvements in DGI and TUG scores\textsuperscript{3,5}

- 2 studies found significant gains in BBS scores and standing balance\textsuperscript{1,4}

- Additional benefits of utilizing RAS included increased EMG activity of the lower extremity, peak-to-peak joint angular displacement, and quality of life\textsuperscript{5}
Conclusion

- There is moderate to strong evidence supporting the use of RAS in gait training for patients with non-progressive CNS disorders, in particular patients with acute and chronic stroke.
Limitations

- Sample size
- Lack of long-term follow-up
- Short study durations
- Databases
Clinical Relevance

- Clinicians should consider the use of RAS gait training in patients with non-progressive CNS disorders to improve gait outcomes.
- RAS is feasible and easily implemented in the clinic in order to improve gait outcomes and recovery in functional ability.
Recommendations

- Improvements can be seen in as few as 4 days, but the literature most commonly suggested 30 minutes/day, 5x/week, for 3 to 6 weeks duration.
Future Research

- Focus on developing a uniform protocol to be used by clinicians in the rehabilitation of patients post-stroke
- Determine if there is a difference in gait outcomes when utilizing RAS via metronome or music
- Determine the stage of recovery during which RAS has the greatest effect on gait training
- Implement long term follow-up in future research
Acknowledgements

- Jennifer Schwartz PT, DPT, NCS
- Renee Hakim PT, PhD, NCS
- John Sanko PT, EdD
- Tracey Collins PT, PhD, MBA, GCS
- Bonnie Oldham MS, MLS, AB
- DPT faculty and students
Thank You!

Any questions?
References


