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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| For a 66-year-old male with Parkinson’s disease Hoehn-Yahr stage 2, diagnosed 5 years ago, is rhythmic auditory stimulation with a metronome during gait training more effective than conventional gait training for increasing cadence and stride length during gait? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| A 66-year-old male with Parkinson’s disease (PD) Hoehn-Yahr stage 2 that had been diagnosed 5 years prior was evaluated in an outpatient clinic. The patient presented with deficits in balance and gait upon his initial evaluation, ambulating with a decreased step length and decreased cadence. The patient stated that his goal for therapy was to improve his gait in order to keep up with his wife when out shopping and not feel as though he was slowing her down. The patient was not using an assistive device at the time of evaluation; however, it is something that was suggested to him given his balance deficits. Treatment sessions focused mostly on conventional gait training but improvements were not as significant as originally anticipated. Given my limited experience treating patients with PD, I became curious in what other treatment options were out there for someone with this diagnosis. Building off of what we know about PD, we began to question the use of an external stimulus as a way to improve gait. Individuals with PD often respond better to external stimuli and so I believe incorporating an external auditory stimulus during gait training could have been an effective way to improve this patients gait.1 A metronome is easily accessible and the use of it in a clinical setting would be feasible and could serve as an additional treatment option for therapists working with this population. This topic should be of great interest to physical therapists in all areas that treat patients with PD because the gait patterns exhibited by this patient are extremely common. The use of rhythmic auditory stimulation could offer therapists an additional treatment option for patients with this diagnosis that are not responding well to conventional gait training techniques. |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| * Eight studies were identified that best fit the inclusion/exclusion criteria, including one RCT, one systematic review with meta-analysis, two prospective non-randomized two-group studies, one prospective non-randomized three-group study, one single-group pretest-posttest intervention study, and two cross-sectional studies. The two studies with the lowest risk of bias and highest level of evidence were selected for detailed analysis.
* Rhythmic auditory stimulation (RAS) paired with gait training can lead to statistically and clinically significant short-term improvements in gait speed, step length and stride length. Gait training with RAS has been shown to be effective when training both overground and on the treadmill.
* There were no statistically or clinically significant improvements in cadence following gait training with RAS.
* Future research should focus on the long-term effects gait training with RAS can have on the gait of individuals with Parkinson’s disease. Future studies should also have larger samples sizes and investigate the effectiveness of less frequent treatments with a shorter duration to increase applicability to clinical practice.
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**CLINICAL BOTTOM LINE**

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| The current evidence suggests that rhythmic auditory stimulation (RAS) paired with gait training would be an effective intervention for improving gait parameters such as velocity, step length and stride length for a 66-year-old with Parkinson’s disease Hoehn-Yahr stage 2. While it is effective at improving some gait parameters, there is currently no strong evidence that supports the use of this intervention to significantly improve cadence. Evidence shows that the treatment can be implemented either on the treadmill or overground and can be used as a supplement to conventional therapy. Physical therapists can utilize the information from these studies to guide their intervention; however, further research is needed to assess the long-term effects on gait in this population. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT*

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| “Parkinson’s disease”Parkinson’s | walk\*gait“gait train\*”metronome“auditory cue\*”“rhythmic cue\*”“Rhythmic Auditory Stimulation” | Walk\*Gait“gait train\*” | “step length”“stride length”cadence“step frequency” |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*



Search #9 (top line in this image) was the final search strategy.

*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **Pubmed****Cochrane****Web of Science** | **36****20****128** | **Not applicable****Not applicable****10 – Filters applied: Published after year 2000, English, systematic review** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * Studied a population of older adults (over 60) with Parkinson’s disease
* Measured stride length before and after intervention
* Measured cadence / step frequency before and after intervention
* Used auditory cuing during gait training
* Published since 2000
* Published in English
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| **Exclusion Criteria** |
| * Articles that are not published in English
* Abstracts
* Conference proceedings
* Letters to the editor
* Case studies
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**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| **Author (Year)** | **Risk of bias (quality score)\*** | **Level of Evidence\*\*** | **Relevance** | **Study design** |
| **Thaut et al (2018)**2 | **PEDro scale: 10/11** | **Level 2b** | **High** | **Randomized Controlled Trial** |
| **Bella et al (2017)**1 | **Downs and Black Checklist: 13/29** | **Level 2b** | **Moderate** | **Prospective, Non-randomized two-group study** |
| **Arias et al (2010)**3 | **Downs and Black Checklist: 14/29** | **Level 2b** | **Moderate** | **Prospective, Non-randomized three-group study** |
| **Hausdorff et al (2007)**4 | **Downs and Black Checklist: 14/29** | **Level 2b** | **Moderate** | **Prospective, Non-randomized two-group study** |
| **Pau et al (2017)**5 | **Downs and Black Checklist: 17/29** | **Level 3b** | **High** | **Single-group pretest-posttest intervention study** |
| **Freedland et al (2002)**6 | **Downs and Black Checklist: 15/29** | **Level 3b** | **Moderate** | **Cross-sectional study** |
| **Suteerawattananon et al (2004)**7 | **Downs and Black Checklist: 13/29** | **Level 3b** | **High** | **Cross-sectional study** |
| **Rocha et al (2014)**8 | **AMSTAR: 9/11** | **Level 1a** | **High** | **Systematic Review** |

\*Indicate tool name and score

\*\*Use Portney & Watkins Table 16.1 (2009); if downgraded, indicate reason why

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * **Effects of external cues on gait parameters of Parkinson’s disease patients: a systematic review (Rocha et al)**
	+ This is the only systematic review found during the search that met the inclusion and exclusion criteria. It is the study with the highest level of evidence (1a) and it has a low risk of bias as assessed by the AMSTAR tool. The study is highly relevant to my PICO question based on the interventions used and outcomes assessed in the reviewed studies.
* **Rhythmic auditory stimulation for reduction of falls in Parkinson’s disease: a randomized controlled study (Thaut et al)**
	+ This is the only RCT found that met the inclusion and exclusion criteria. The study has a low risk of bias as assessed by the PEDro scale and is considered level 2b evidence. The study also was rated highly relevant to my PICO question based on the intervention utilized in the study and key outcomes measured including cadence, stride length and gait velocity.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of Effects of External Cues on Gait Parameters of Parkinson’s Disease Patients: A Systematic Review by Rocha, Porfirio, Ferraz, and Trevisani (2014)**8

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| **Aim/Objective of the Study/Systematic Review:** |
| This systematic review aimed to evaluate how effective the use of external cues during gait training was on the gait of patients with Parkinson’s disease (PD). The objective was to determine the impact external cues had on quality of life, gait parameters, psychomotor performance, and freezing, as well as to analyse which types of external cues had the potential to lead to the most significant gains. |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * This study is a systematic review with meta-analysis of randomized and quasi-randomized studies that assessed gait parameters such as step length, stride length, speed, and cadence, in addition to freezing of gait, quality of life, and psychomotor performance of adults with Parkinson’s disease.
* **Search Strategy:**  The literature search was performed from March to August of 2013 using the Cochrane Library, PubMed, Lilacs, CINHAL, Pedro, and Sumsearch databases. The following key words were used to complete the literature search: Parkinson’s disease, feedback, biofeedback, neurofeedback, psychology biofeedback, cue, cues, cueing, rehabilitation, physical therapy, physiotherapy, exercise, locomotion, gait, neurologic gait disorders, optical flow field, visual, auditory, sensory, and tactile. All of the references for the collected articles were analyzed by the authors and a manual search was performed on “Movement Disorders, Physical Therapy, and annals of the Movement Disorders Society” (pg. 128).
* **Selection Criteria:**
	+ There were no time period or language limitations for the studies.
	+ Inclusion criteria:
		- Studies that provided the inclusion criteria they used. Examples of this include elderly people diagnosed with PD, female or male, walkers with or without assistive device, and patients on medication for PD.
		- Studies that assessed gait parameters, freezing of gait, quality of life, or psychomotor performance.
		- Studies that analyzed the influence of external cues such as visual, auditory, somatosensory or cognitive cues on gait parameters.
		- Studies that compare two types of external cues or compare one cue with another physical therapy intervention or no intervention.
		- Randomized or quasi-randomized studies.
	+ Exclusion criteria:
		- Studies that analyzed other diseases or forms of Parkinsonism
		- Studies that compared healthy elderly patients with patients with PD.
		- Studies that had designs that were non-randomized.
		- Studies that did not analyze any gait parameters.
		- Studies that did not have a control group.
* **Data Collection:** Two investigators searched for articles in the various databases independently. Articles that met the inclusion criteria were then read in their entirety and the data was collected and analyzed. A consensus meeting was held in order to settle any discrepancies between the two evaluators. While reviewing the studies, the evaluators contacted the authors of studies with inadequate data and the data was re-analyzed.
* **Risk of Bias:** The risk of bias was evaluated by the Cochrane risk of bias tool for all studies.
* **Heterogeneity:** The heterogeneity was assessed according to the principles of the Cochrane Collaboration. Methodological heterogeneity and statistical heterogeneity were assessed. The I2 test was used to assess statistical heterogeneity. For heterogeneity, a score of “0% to 40% was considered not important, 30% to 60% represented moderate heterogeneity, 50% to 90% represented substantial heterogeneity, and 75% to 100% indicated considerable heterogeneity” (pg. 129).
* **Meta-analysis / Sub-group analysis:** The authors used the calculations of the difference of the mean values and the standard deviation with a 95% confidence interval to perform an analysis of the data with continuous variables. The authors also performed sub-group analyses based on the type of cues used, such as visual, auditory, sensory, combined or verbal instruction, as well as based on the outcomes including step length, cadence, speed, stride length, and UPDRS III.
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| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| The location was unspecified but given the intervention it is assumed to be in a lab or outpatient setting.  |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * Initially 37 studies met the inclusion criteria, but this systematic review included only seven studies. Six of the studies were randomized controlled trials and one was a quasi-randomized study.
* Six of the studies were published in English and one was published in Portuguese.
* There was a total of 204 individuals with Parkinson’s disease in the seven included studies. There were 114 males and 60 females accounted for with a mean age of 68.8 years. One study did not specify the gender of the participants.
* The mean Hoehn-Yahr stage for all of the included studies was 2.4.
* Four of the studies utilized the UPDRS scale in their analysis. Three of these studies used only the motor part of the UPDRS and one used the entire scale.
* Six of the seven studies specifically stated that the assessments and treatments were completed while the participants were in the “on” period of their medication.
* Two of the studies examined the effectiveness of visual cues, two looked at auditory cues, one utilized verbal instructions as the cue, one combined auditory and visual, and one used sensory cues during training.
* Most of the studies focused on the assessment of gait parameters but none of the studies assessed quality of life at any point throughout the intervention.
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| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| * The control group for three of the studies was the group that received no intervention.
* In three of the studies the control group was the group receiving conventional overground gait training without external cues.
* Subjects that completed gait training overground with visual and auditory cues were considered the control in one study.
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| *Experimental* |
| * Gait training on the treadmill with external cues was the main intervention group in the majority of the studies. In the remaining three studies, the intervention group performed gait training overground with external cues.
* The number of sessions ranged from 10 to 28 with the average number of sessions being 19.1.
* The treatment sessions ranged from 20 minutes to an hour with a frequency ranging from three times per week to seven sessions per week.
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| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| **Gait Parameters*** Gait speed (assed by 100% of studies)
	+ Gait speed was assessed in centimeters per second.
	+ MDC is 0.18 m/s for patients with Parkinson’s disease.9
* Cadence (assessed by 86% of studies)
	+ Cadence is measured in steps per minute.
	+ The MDC is 15.1 steps/minute for patients with Parkinson’s disease.10
* Stride length (assessed by 43% of studies)
	+ Stride length is measured in centimeters.
	+ The MDC is 0.14 meters for patients with Parkinson’s disease.11
* Step length (assessed by 43% of studies)
	+ Step length is measured in centimeters.
	+ The MDC is 0.047 meters for patients with Parkinson’s disease.12
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| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| **\*This section focused only on the main findings relevant to the PICO question.**Step length (cm) for the one study that used auditory cues* For the only study that was identified as assessing step length after an auditory cue intervention, a significant effect was found in favour of the intervention group (p=0.03)
* The means (SD) were 69.1 cm (7.7) and 61.7 cm (7.7) for the intervention and control groups respectively.
* The mean difference was 7.40 cm with a 95% CI of (0.65, 14.15).
* Heterogeneity: not applicable

Speed (cm/s) for the 2 studies that used auditory cues only* A significant effect was found in favour of the intervention group (p<0.00001).
* The mean difference for the two combined studies was 23.46 cm/s with a 95% CI of (14.97, 31.95).
* Heterogeneity: I2=82%

Speed (cm/s) for the one study that used visual and auditory cues* A significant effect was found in favour of the intervention group (p=0.01).
* The means (SD) were 100 (30) and 80 (20) in the intervention and control groups respectively.
* The mean difference was 20.00 cm/s with a 95% CI of (4.20, 35.80).
* Heterogeneity: not applicable

Cadence (steps/minute) for the 2 studies that used auditory cues only* No significant effect was found (p=0.07).
* The mean difference for the two studies was 5.35 with a 95% CI of (-0.43, 11.14).
* Heterogeneity: I2=40%

Stride length (cm) for the 2 studies that used auditory cues only* No significant effect was found (p=0.06).
* The mean difference for the two studies was 10.90 cm with a 95% of (-0.50, 22.29).
* Heterogeneity:I2=9%

The authors found that overall the use of external cues “resulted in improvements in the step length (p<0.0001), speed (p<0.00001), cadence (p<0.001), and stride length (p<0.00001)” (pg. 130). |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| The use of external cues such as auditory, visual, and sensory cues, during gait training for patients with Parkinson’s disease, can cause “significant improvements in gait parameters, psychomotor performance and freezing episodes” (pg. 132). There is currently a lack in the available literature on the impact of external cues during gait on quality of life in this population. |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| * **AMSTAR score: 9/11**
	+ A priori design: Yes; Two independent data extractors: Yes; Comprehensive search: Yes; Status of publication: No; List of included and excluded studies: Yes; Characteristics of included studies: Yes; Quality of studies used in conclusions: Yes; Appropriate methods: Yes; Publication bias assessed: No; Conflict of interest: Yes
* **Strengths:** Two evaluators analyzed the quality of each of the studies and a figure was provided to represent the risk of bias for each of the studies. There was a full list of the included studies and a chart detailing the frequency and duration of each of the studies and the type of interventions utilized. The authors provided reference to each of the excluded studies that initially met the inclusion criteria and stated the full reasoning behind why they ended up being excluded. Another strength of this systematic review was that it only assessed RCT.
* **Weaknesses / Limitations:** As the authors discussed, all of the included studies differed in their methodology regarding the intensity of the stimulus, thus limiting the ability for other therapist to replicate this intervention. For example, the number of therapy sessions, the frequency and distribution of sessions each week, the length of the study and the duration of the sessions was not the same in any of the studies. Given the lack of uniformity in methodology, it is difficult for a conclusion to made on which type of cue is truly the most useful. A full list of the search terms used to conduct the literature search were provided by the authors; however, they neglected to provide the final search strategy that was used. The lack of the final search strategy makes this search almost impossible to replicate. The authors mentioned at the beginning of the systematic review that some of the studies assessed the motor score of the UPDRS; however, there was no mention of the amount of change seen in these studies in the results section. Also, there is one section in which it is unclear whether the authors are discussing p-values for the individual studies that used auditory cues or the results of the meta-analysis because the values differ from those in the forest plot. This lack of clarity has the potential to confuse readers as to whether the outcomes were actually significant or not.
* Overall the quality of the systematic review was fairly high; however, the quality of the included studies was mixed. Two of the included studies were determined to have a low risk of bias; whereas, the others were found to have either a high risk of bias or the risk of bias was unclear.
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| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
|  Gait training with auditory cuing created statistically significant improvements in both gait speed and step length, but there were no statistically significant improvements in cadence and stride length. The p-values for step length and gait speed for these auditory studies were 0.03 and 0.00001 respectively; however, the p-values for cadence and stride length were 0.07 and 0.06. Also, the confidence intervals for cadence and stride length included zero, pointing to non-statistically significant effects. It can also be concluded from these results that combining external cues, such as visual and auditory cues, can be an effective treatment during gait training as well in order to improve gait speed. The p-value for the study combining these interventions was 0.01 with a 95% confidence interval that did not include zero. The authors did not discuss much about clinical significance but the comparison of the mean differences to the MDC’s shows that clinically significant improvements were found for both step length and velocity. The results of the meta-analysis did not show clinical significance for stride length; however, the results still favored the intervention group. This meta-analysis has a low risk of bias as shown by the AMSTAR score of 9/11; however, it is important to note that the results are limited by the small number of studies assessed and the lack of studies included that looked solely at auditory cuing. Another concern from these findings is the heterogeneity. Given the substantial amount of heterogeneity (I2=82%) found for the two studies that assessed gait speed with the auditory intervention, it is important to interpret these results with caution. The differences between the studies included in the meta-analysis should lead readers to be cautious about generalizing the results from the meta-analysis to patients. It is reasonable to conclude from these results that auditory cues were effective in creating significant changes in step length and gait speed in this patient population; however, for the other gait parameters the results were not significant. |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
|  This systematic review with meta-analysis is directly applicable to the PICO and clinical scenario given the similarities between the subjects in the included studies to the patient in the given clinical scenario. The included studies looked at subjects with an average age in the mid-sixties, diagnosed with Parkinson’s disease, with an average Hoehn-Yahr stage of 2. This description of the participants perfectly describes the patient in the PICO question. The studies also looked at a mix of males and females; therefore, the results can likely be applied to both male and female patients in the clinic with this diagnosis. The main findings from the meta-analysis show that there are statistically and clinically significant improvements in gait speed; therefore, it can be concluded that utilization of this intervention in my patient would be effective for improving gait speed. It is also reasonable to conclude that this intervention would be effective at improving step length for my patient which is a measure of interest for this PICO. Another measure of interest was stride length but this meta-analysis does not point to this being a very effective treatment for improving stride length for my patient. The results of the two studies assessed by this meta-analysis differed in whether or not they found auditory cues to be effective at changing stride length; therefore, it can be inferred that there might still be some positive benefits for my patient. Lastly, this study shows that RAS during gait training might not be an effective treatment for improving cadence in this population.  In general, these results demonstrate applicability to my patient and point to this being a useful intervention to address specific gait parameters. This intervention could easily be implemented in an inpatient rehab or outpatient therapy session, as long as the clinic has the proper safety equipment. In order to safely implement this training on the treadmill a harness is recommended to reduce the risk of falls; therefore, completing the treadmill training is only recommended in settings that have this equipment. Therapists should take into account the Hoehn-Yahr stage and severity of impairments and utilize clinical reasoning when deciding to implement this intervention given the lack of evidence provided for individuals in the other stages. Therapists would also need to be mindful of the time allotted for each of the treatment sessions given the studies included in this review had treatment times ranging from 20 minutes to an hour which is likely not feasible in a regular outpatient clinic. For patients of similar age and Hoehn-Yahr stage, it can be inferred that implementing gait training with an external auditory cue would be beneficial for improving gait speed and step length. While there would likely be some improvements in cadence and stride length, this meta-analysis found that overall they were not significant; therefore, according to this study use of this intervention for these impairments is likely not as effective for patients like mine. |

**(2) Description and appraisal of Rhythmic Auditory Stimulation for Reduction of Falls in Parkinson’s Disease: A Randomized Controlled Study by Thaut, Rice, Janzen, Hurt-Thaut, and McIntosh (2018)**2

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| **Aim/Objective of the Study/Systematic Review:** |
| This study aimed to determine the effectiveness of a “home-based rhythmic auditory stimulation (RAS) gait training program” at reducing falls and improving clinical and kinematic parameters in adults with Parkinson’s disease that have a history of falls (pg. 2). |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| * Randomized controlled trial
* The study was a two group, randomized withdrawal/discontinuation design.
* The subjects were all randomly selected and a computer specialist implemented a computerized random selector program in order to assign participants to the experimental and control groups. In order to appropriately assure allocation, the researchers utilized a computer specialist that was not involved in the study.
* The allocation was concealed in an envelope and given to the study coordinator at the baseline session.
* The Physical Therapists were blinded to the allocation schedule.
* All of the outcome measures were assessed at various points over the course of 24 weeks including at baseline and weeks 8, 16, and 24. The assessments were administered by PT’s blinded to the study design. The main outcome measures were focused on gait parameters and number of falls. The assessments were also all completed 2 hours after the patients took their medicine.
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| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| The setting was not specifically stated but it is assumed that the interventions were completed at each individual patients’ home as it was a home-based treatment. It is assumed that the assessments were completed in a lab setting given the equipment used.  |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| * The study participants were selected at random from a number of different referral lists of local Parkinson’s disease support groups and neurology clinics.
* There were a total of 60 participants with a diagnosis of Parkinson’s disease that were initially allocated to groups.
* There were 25 people in the intervention group and 22 individuals in the control group that completed the full 24 weeks of treatment. There were 5 drop outs from the intervention group and 8 dropouts from the control group. Males made up 68% of the participants that completed the intervention in the experimental group and 68% of the control group.
* The age of the participants ranged from 62 to 82 years old. The average ages of the experimental and control groups were 71±7 and 73±8 respectively.
* The average Hoehn-Yahr stage was 3.6 for the experimental group and 3.4 for the control.
* The average disease duration for participants in the experimental group was 10.9±5 years and it was 11.2±6 years for participants in the control group.
* Participants in the experimental group had an average number of 4.5 falls and the participants in the control group had an average of 4.2 falls.
* The characteristics of the participants in the control and intervention groups were comparable at baseline. The p-values for the between group demographic variables: age (p>0.05), Hoehn-Yahr stage (p>0.05), falls (p>0.05), disease duration (p>0.05). There p-values are all not significant indicating there was no significant differences between the two groups at baseline.
* **Eligibility criteria**
	+ Inclusion criteria:
		- Diagnosis of Parkinson’s disease with Hoehn-Yahr stage III or IV
		- History of two falls in the past 12 months
		- Stable antiparkinsonian medication regime
		- Ability to ambulate independently for at least 50m
	+ Exclusion criteria:
		- Diagnosis of another neurological or orthopaedic condition
		- Medically diagnosed hearing loss
		- Dementia (Mini Mental Status Exam score <24)
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| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| * The control group was provided a home training program by a physical therapist.
* The participants kept home exercise and fall incidence logs that were reviewed each week by the therapists.
* The control group completed training daily at home from baseline until week 8. This group stopped the training from week 8 to week 16 and then started again from week 16 to week 24. The subjects followed a 6-step standardized training protocol.
* The treatment consisted of a 30-minute walk with “metronome click-embedded music downloaded to an MP3 player” (pg. 3). The participants were able to listen to the music free-field or with headphones.
* The music was either folk or classical instrumental music with a 2/4 tempo and there were “metronome beats inserted into the music for enhanced beat perception” (pg. 3).
* Participants could choose from three metronome rates (rates were a percentage of the baseline cadence)
	+ First 8 weeks (first training segment): 100%, 105%, and 110%
	+ Last 8 weeks (second training segment): 105%, 110%, 115%
	+ During the last 8 weeks the control subjects were allowed to request a faster metronome rate if they felt comfortable at these other rates.
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| *Experimental* |
| * The experimental group was provided a home training program by a physical therapist.
* The participants kept home exercise and fall incidence logs that were reviewed each week by the therapists.
* The experimental group completed the training daily for 24 weeks and they followed a 6-step standardized training protocol.
* The intervention was the same as the control group; however, the metronome rates they could choose from varied slightly. (rates were a percentage of the baseline cadence)
	+ First 8 weeks: 100%, 105%, and 110%
	+ Second 8 weeks: 105%, 110%, and 115%
	+ Last 8 weeks: 110%, 115%, and 120%
 |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| All of the outcomes were assessed by a PT. The bolded items represent the outcomes that are the most relevant to this PICO. Items with \*\* represent measures that were analyzed by the B&L Engineering computerized stride analyser and the VICON-MOTUS four-camera motion analysis system. “The stride analyser system consisted of a microprocessor that the subjects wore on a gait belt, sensors in the bottom of the subjects shoe, a system that downloaded data from the microprocessor to the computer, and data analysis software” (pg. 3). * **Velocity\*\***
	+ The velocity was measured in meters/minute.
	+ The MDC is 0.18 m/s.9
* **Cadence\*\***
	+ The cadence was measured in steps/minute.
	+ The MDC is 15.1 steps/minute.10
* **Stride length\*\***
	+ The stride length was measured in meters.
	+ The MDC is 0.14 meters.11
* Ankle dorsiflexion\*\*
	+ DF was measured in degrees.
* Berg Balance Scale
	+ The BERG is a self-report measure that has 14 items assessing balance impairments during specific tasks.
	+ Each item is rated on a 0 to 4 scale, with “0 representing the lowest level of function and 4 representing the highest level of function” (pg. 3).
* Timed Up and Go
	+ The TUG is measured in seconds.
	+ This measure assesses the ability of an individual to “stand up from a chair, walk three meters, turn around, walk back and sit down in the chair” (pg. 3).
	+ The TUG was used to analyze fall risk and balance.
	+ Better function is indicated by a quicker score.
* Falls Efficacy Scale
	+ A 10-item self-report measure assessing fear of falling.
	+ The subjects are asked to rate their confidence in performing 10 different activities. A rating of 0 represents no confidence and a score of 10 represents complete confidence.
	+ The possible scores range from 0-100.
* Fall Index
	+ The Fall Index was calculated by a therapist from self-reports of subjects or their caregivers.
	+ A 1 represents an incomplete fall or a loss of balance that was stabilized by an object or another person.
	+ A 2 represents a complete fall that did not cause any injury.
	+ A 3 represents a complete fall that resulted in an injury requiring medical attention.
 |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
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| **Cadence (steps/minute)** |
| **Measurement Time** | **Experimental Group** | **Control Group** | **Mean Difference, 95% CI** |
| Baseline | 105 (7.2) | 106 (9.7) | -1 (-5.32, 3.32) |
| Week 8 | 112 (5.8) | 111 (10.6) | 1 (-3.60, 5.60) |
| Week 16 | 113 (5.4) | 107 (9.0) | 6 (1.81, 10.19) |
| Week 24 | 113 (4.2)\* | 111 (8.8) | 2 (-1.87, 5.87) |

The main findings that are the most pertinent to the PICO question are summarized in this section.

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| **Velocity (meters/minute)** |
| **Measurement Time** | **Experimental Group** | **Control Group** | **Mean Difference, 95% CI** |
| Baseline | 53 (16.8) | 58 (10.8) | -5 (-12.15, 2.15) |
| Week 8 | 59 (17.3) | 65 (10.4) | -6 (-13.84, 1.84) |
| Week 16 | 62 (15.4)\*\* | 55 (9.8) | 7 (-0.50, 14.50) |
| Week 24 | 65 (13.2)\*\* | 60 (9.5) | 5 (-1.66, 11.66) |

\*Indicates p<0.05; \*\*Indicates p<0.005 (Looking at experimental vs control)Values reported as mean (SD)* At week 24, the difference between the experimental and control groups for cadence was significant in favour of the experimental group with p<0.05.

\*Indicates p<0.05; \*\*Indicates p<0.005 (Looking at experimental vs control)Values reported as mean (SD)* At week 16, the difference between experimental and control groups for velocity was significant in favour of the experimental group with p=0.0001.
* At week 24, the difference between groups for velocity was still significant in favour of the experimental group with p<0.005.

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| **Stride Length (meters)** |
| **Measurement Time** | **Experimental Group** | **Control Group** | **Mean Difference, 95% CI** |
| Baseline | 1.01 (0.14) | 1.10 (0.19) | -0.09 (-0.17, -0.01) |
| Week 8 | 1.08 (0.16) | 1.17 (0.09) | -0.09 (-0.02, -0.16) |
| Week 16 | 1.15 (0.17)\*\* | 1.0 (0.11) | 0.15 (0.07, 0.23) |
| Week 24 | 1.19 (0.14)\*\* | 1.10 (0.14) | 0.09 (0.01, 0.17) |

\*Indicates p<0.05; \*\*Indicates p<0.005 (Looking at experimental vs control)Values reported as mean (SD)* At week 16, the difference between groups for stride length was significant and in favour of the experimental group with p<0.0001.
* At week 24, the difference between groups for stride length was still significant and in favour of the experimental group.

There were no significant differences between groups for any of the outcomes at week 8.The most significant gains were made in the first 8 weeks for the following measures: velocity (p=0.0001), stride length (p=0.0096), and cadence (p=0.0001).At week 16, Pearson correlation coefficients were determined between all variables.

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|  | **Cadence** | **Velocity** |
| **Velocity** | r=0.29 |  |
| **Stride length** | r=0.35 | r=0.71\*\* |

\*\*Indicates p<0.005* At week 16, increases in stride length were significantly correlated with increases in velocity.
 |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| “A home-based rhythmic auditory stimulation (RAS) gait training program can significantly reduce falls, improve fear of falling and improve gait parameters” (pg. 9) such as velocity, stride length, and cadence in patients with Parkinson’s disease. The most significant improvements in terms of the gait parameters occurred with in first eight weeks, whereas fall risk improved throughout the entire 24 weeks of training. |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| * **PEDro score: 10/11**
	+ Eligibility criteria specified: Yes; subjects randomly allocated: Yes; allocation allocation concealed: Yes; groups similar at baseline: Yes; blinding of subjects: No; blinding of therapists: Yes; blinding of assessors: Yes; measures of 85%: Yes; subjects received treatments as allocated: Yes; between-group statistical comparisons: Yes; point measures and measures of variability: Yes
* **Strengths:** The risk of bias for this RCT is low given the PEDro score. Some of the significant strengths of the study were the randomization, blinding of the assessors and therapists, and the inclusion of a control group. The authors included detailed information about the clinical characteristics of the patients at baseline allowing readers to determine whether or not the study might apply to similar patients in the clinic. Due to the randomization, the experimental and control groups were similar at baseline. Having similar groups at baseline is a major strength because it helps to reduce any confounding variables that may interfere with the outcome. A strength noted by the authors was the use of a randomized withdrawal design. This study design required the control subjects to discontinue treatment for eight weeks while the experimental group continued the intervention, allowing authors to make a direct comparison of the effects of RAS on the various outcome measures. This design also allowed authors to assess the consequences associated with “short-term discontinuation of the intervention” (pg. 8). Lastly, as the authors noted, they were able to assess whether or not the original treatment effect could be restored after the control group started the intervention again in the last 8 weeks providing the reader with more information about how the intervention should be used with patients in the future.
* **Weaknesses / limitations:** The authors stated that the intervention was completed daily at a home-based environment but it never specified whether or not the therapists were there during that time. A weakness of the study is the possible evolution of the treatment if the therapists were not there to oversee the intervention. A major limitation of the study was that the participants got to pick the metronome rate so there was no real consistency among subjects, making it difficult for readers to replicate with patients in the clinic. The results of the study are also misleading because the authors determined significance based solely on the p-values. There were no confidence intervals given; therefore, some of the scores they reported as significant are actually not significant. The use of only p-values increases the likelihood of the authors making a type I error through inclusion of the null value in the confidence interval. Also, not only were the statistical significance values misleading, there was not really much mention of clinical significance throughout the authors discussion. While the outcomes all improved, statistically significant or not, there is no way to know if these improvements persisted in the long-term due to the lack of follow up. As the authors noted, since there was no alternative treatment provided it’s difficult to discern whether the changes really were coming from the rhythmic auditory stimulation part of the treatment or if they were simply improving because they were walking for a total of 30 minutes every day.
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| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| Given the available data it is easy to see that the stride length, velocity, and cadence all improved for the experimental and control groups by the end of the intervention. The authors reported the between group differences were significant for all three of these measures with a p-value less than 0.05; however, this does not match up with the independently calculated confidence intervals. When looking at both the provided p-values and the 95% confidence intervals that were calculated, stride length is the only outcome measure of interest that was significant between groups. At 16 weeks the p-value was 0.0001 and the mean difference was 0.15 m with a 95% CI of (0.07, 0.23). The significant p-value and the exclusion of zero in the CI points to statistical significance. The CI and p-value were also significant for stride length at 24 weeks. While the p-values were significant for gait speed and cadence as stated by the authors, the 95% CI’s included zero indicating no statistical significance. There was no mention of clinical significance by the authors; however, comparison of the intervention group to accepted minimal detectable change values (MDC’s) shows that the change in velocity for the experimental group was clinically significant. The MDC for gait speed in this population is 0.18m/s and the intervention group saw a change of 0.2m/s.9 The only outcome that was not clinically significant for the experimental group was the cadence, which only saw a change of eight steps per minute. The comparison of the mean differences to the MDC’s are not as helpful in this case for determining clinical significance because the control group did the same intervention for 16 of the 24 weeks which might be why the authors didn’t spend much time discussing clinical significance. If the control had done no intervention for the 24 weeks that would have been more helpful in terms of determining whether or not the intervention was more effective than no intervention. It is also important to note that the biggest gains in all of the measures were accomplished in the first 8 weeks for both groups. From baseline to week 8 the intervention group saw a 7 steps per minute increase in cadence, a 6 meters per minute increase in velocity, and a 0.07 meter increase in stride length.It can also be concluded that there is a relationship between stride length and gait speed, based on the provided Pearson’s correlation coefficients. A positive relationship with r=0.71 and a p-value of less than 0.005 points to a fairly strong relationship for these two outcomes. This result can be interpreted such that as stride length increases, the gait speed is also expected to increase. Overall, it is reasonable to conclude from these results that rhythmic auditory stimulation is effective for improving these various gait parameters; however, the changes might not always be statistically significant. In addition, clinically significant improvements in gait speed and stride length can be made with the use of this intervention for patients with Parkinson’s disease. |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
|  The participants in this study are not as similar to the patient in the clinical scenario as the above systematic review. The participants in the experimental group had an average age of 71 and there was an average age of 73 in the control group; however, since the participants ranged in age from 62 to 82 the results are likely still applicable to the 66-year-old patient discussed in the clinical scenario. The study subjects had an average Hoehn-Yahr stage of 3.6 and 3.4 for the experimental and control groups respectively, whereas my patient was stage 2. Another difference between my patient and the study participants is the duration of disease. The patient in the clinical scenario has only been diagnosed for 5 years, whereas the experimental and control groups in this study have been diagnosed for 10.9 and 11.2 years. While there are some similarities between my patient and the participants in the study, there remain some differences between the two that require clinical judgement when determining applicability. Based on the patients’ presentation at the time of his evaluation, I believe that he would be able to complete this intervention without much difficulty. This intervention requires some cognitive skills as well in order to motor plan taking steps on beat with the metronome; therefore, it can be assumed that since my patient is slightly younger with less severe impairments, he might be able to show even greater improvements.  This particular intervention does not require the use of much equipment, making this a practical intervention to use in the clinic with patients with this diagnosis; however, there are some risks associated with it. There is likely an elevated risk of falling given the participants have to walk with a faster than normal cadence; therefore, having some supervision is likely a good idea if this intervention was used in the clinic. This study had the participants perform the intervention in a home-based environment and it was done daily; however, that is a huge time commitment and is likely not practical for all patients. During a normal therapy session there are likely not 30 minutes to set aside just for walking with the metronome; therefore, therapists would need to rearrange other activities or try to utilize this intervention with a shorter walking period. Although the authors were not able to determine the long-term effects the treatment could have on gait parameters, therapists can be confident that at least in the short-term there are some improvements. This intervention focuses on aspects of treatment that are often already emphasized in patients with Parkinson’s disease, such as increasing the size of movements; therefore, including this as a part of the plan of care is not too far of a jump for therapists. It is reasonable to conclude that gait training with rhythmic auditory stimulation would be an effective intervention for the patient in the clinical scenario, as well as individuals that have impairments in gait speed, cadence and stride length. |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| **Evidence Synthesis**The evidence reviewed in this analysis suggests that individuals with Parkinson’s disease may benefit from gait training with an auditory stimulus. The method of RAS with gait training is based on the idea that external cues help to stimulate gait initiation and continuation.1 The use of rhythmic auditory stimulation has been researched in a variety of populations including Parkinson’s disease, spinal cord injury and stroke, and has shown to be successful at improving gait kinematics, reducing falls and improving freezing episodes.2 Impaired gait is a major challenge that is focused on in therapy for individuals with Parkinson’s disease and the reviewed evidence suggests that RAS combined with gait training is effective at improving gait speed, step length, stride length, and cadence in this population. There were statistically and clinically significant improvements in gait speed, step length and stride length; however, the improvements in cadence were not found to be significant. The systematic review by Rocha et al found that while the improvements in stride length were in favour of the intervention group, they were not significant; however, the Thaut et al study found statistically significant improvements. Given the review of the two studies and the heterogeneity of the studies assessed in the systematic review, it can be concluded that this intervention can in fact result in significant improvements in stride length. The studies in this analysis looked at both training on a treadmill and overground and found that both were viable options. Both studies looked at subjects of similar age and Hoehn-Yahr stage to the patient in clinical scenario thus increasing the applicability to this case; therefore, it is reasonable to except similar outcomes in this patient. Overall there is good quality evidence to support the use of this intervention for short-term improvements in individuals with Parkinson’s disease that demonstrate mild to moderate limitations in gait.**Implications for Clinical Practice**Parkinson’s disease has been shown to effect up to 3.3% of the population over the age of 65.8 Motor and gait impairments associated with the disease generally do not have a good response to pharmacological management; therefore, it is common to encounter patients with this condition in the clinic.8 The prevalence of this condition and the associated motor symptoms make the results found in this analysis clinically relevant. Physical therapists often focus on increasing the amplitude of movements for individuals with Parkinson’s disease, making this intervention a reasonable supplement to conventional therapy. Considering the research shows it is effective both on the treadmill and overground, it is an intervention that can be easily implemented in the clinic, but physical therapists should use clinical judgement in conjunction with the available evidence when determining which patients could benefit from this intervention. None of the studies assessed the safety of the intervention; therefore, the use of this treatment is recommended only for patients that can ambulate independently and the intervention should be supervised by a PT to reduce the risk of falls. Thaut et al found that the greatest improvements in gait parameters were found within the first eight weeks of treatment allowing therapists to implement this for patients that are only being seen for two months. The research points to this being an effective intervention for patients with Hoehn-Yahr stages 2 through 4, which allows therapists to implement this treatment with a number of different patients. The control groups in the reviewed studies varied in the treatments they received making it difficult to say it is a better intervention than conventional therapy; therefore, therapists should use their own judgement as to whether it is the main intervention or simply a supplement to treatments already being implemented.**Implications for Future Research**More high quality evidence is needed on the topic in order to provide better guidance for clinicians about the use of this as an intervention in the clinic. The two reviewed studies provide a solid foundation for future research, but more prospective research using randomized controlled trials should be done to assess the effectiveness of this intervention in different settings and with individuals with varying levels of impairments. A lot of the current research assesses the use of this intervention in a lab setting; therefore, future studies should assess the effectiveness of the intervention in an outpatient environment. Also, in order to increase the generalizability, future studies should look at larger sample sizes. More specifically, future research should focus on determining a more realistic dose and frequency of treatment. A lot of the current available literature had patients complete 30 minutes or more of training, every day of the week. While the results have been promising for these studies, the time commitment required is unreasonable for most patients and therapists. There is likely not 30 minutes per treatment session in the average outpatient setting that can be spent focusing solely on walking with RAS; therefore, determining the minimum amount of treatment would help to increase applicability of the intervention. This research should also look at the duration of the intervention to see if training for only a few weeks is as effective as the 24-week treatment utilized in the reviewed RCT. The long-term effects of treatment should be determined in future studies through the incorporation of follow-up assessments at varying intervals after the cessation of training to give a more holistic view of whether or not it is worth the therapists and patients time. |

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