CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For a 67 year old male patient with Parkinson's Disease, is auditory cuing with metronome or music of equivalent frequency effective in increasing step length during gait?

AUTHOR

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CLINICAL SCENARIO

During a clinical rotation at an outpatient clinic, I worked with a 67 year old man who had been diagnosed with Parkinson's Disease several years previously. The patient was independent with ambulation and still able to drive himself to the clinic. He presented with forward head, rounded shoulders, and increased kyphosis, and had a history of 2 falls during community ambulation. He also had some memory deficits and dementia-like symptoms. An activity he often performed during his treatment sessions was ambulating over mini hurdles to try and promote larger step lengths and exaggerated hip flexion, and decrease tendency towards a shuffling gait pattern. Although the patient would initially perform the exercise slowly and with focus, he quickly reverted to a faster speed where he often would knock over the hurdles rather than stepping over them. Adopting a slower gait speed was helpful for the patient, however due to the memory deficits he would often forget to continue a slower gait speed.

Having more knowledge about external cueing during gait, and particularly auditory cues would likely have improved my ability to try different treatment approaches to figure out what was most effective for this particular patient. Although there is research on the potential benefits that a metronome can have on improving gait in patients with Parkinson's, I am interested to learn about whether music has similar implications, or if there are any differences.

SUMMARY OF SEARCH

[Best evidence appraised and key findings]

- A total of 8 articles were reviewed which met the inclusion/exclusion criteria for this Critically Appraised Topic. The articles contained 2 randomized control trials (RCTs), 1 Matched Subjects Design, 2 Quasi-Experimental Designs, and 3 Single Cohort Repeated Measures Design.
- Both metronome and music have been found to increase stride length, cadence, and gait velocity in patients with Parkinson's disease. The study that used metronome looked at the immediate effects of various cuing rates on a variety of gait parameters. The study that utilized music implemented a gait training program in which the rate of auditory cues was gradually progressed.
- Studies that utilize music have used music rhythms designed specifically for the study that highlight the beat that ambulation is supposed to be synchronized with
- Most of the studies on this topic are of low-moderate quality and have small sample sizes

CLINICAL BOTTOM LINE

The current evidence suggests that use of external auditory cues are associated with increases in stride length in patients with Parkinson's Disease while walking overground. These changes have been seen to occur during exposure to metronome, as well as through the use of music as auditory cuing in a gait training program. However, the differences in effects of music and metronome have not been compared in a single study thus far. Metronome has been shown to improve stride length with exposure to both slower-than-normal beats (90%), as well as faster-than-normal beats (110%), when compared to ambulation without auditory cues. The assessment of effects of music thus far have primarily included musical tracks that have been specially designed to highlight the beat of the music and enable people to easily detect the rhythm.

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

Guneet Chawla

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
Parkinson's Disease PD Parkinson*	Auditory Cu* Metronome Auditory rhythmic cue	Music	"step length" Gait Walk*

Final search strategy (history):

Show your final search strategy (full history) from PubMed.

1. "Parkinson's Disease" OR PD OR Parkinson*
2. Auditory Cu* OR metronome
3. Music
4. "step length" OR gait OR walk*
5. #1 AND #2 AND #3 AND #4
6. (#1 AND #2 AND #4) OR (#1 AND #3 AND #4)

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

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
PubMed	**20**	Article types: Systematic Reviews, Meta-Analyses, Clinical
Cinahl	**57**	Excluded dissertations
Embase	**45**	article OR review Music (+ 6 synonyms) **Revised number of results: 22**

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Participants were ambulatory (with or without assistive device) and diagnosed with Parkinson's disease • The frequency (in bpm) of the auditory cues is listed
Exclusion Criteria
Conference proceedings, letters to the editor, narrative review articles, abstracts, not available in English

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).

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Benoit, et.al (2014)	Downs & Black: 12/29	4 (downgraded based on quality score- high potential for selection bias, low external validity and lack of power analysis)	Low	Matched Subjects Cohort Design
Thaut, et.al (1996)	Pedro: 5/11	Level 2B (downgraded because of level of variability for outcomes data)	Mod	RCT
Bukowska, et.al (2015)	Pedro: 6/11	1B	Low-mod	RCT
McIntosh, et.al (1997)	Downs & Black:13/29	4 (downgraded based on quality score- high potential for selection bias and lack of power analysis)	low	Non-equivalent groups pretest-posttest control group design (Quasi-Experimental)
Howe, et.al (2003)	Downs & Black: 16/29	4 (downgraded based on quality score - potential for selection bias, low external validity, and lack of power analysis)	high	Single Cohort, Repeated Measures Design (Experimental)
Ford, et.al (2010)	Downs & Black: 16/29	4 (downgraded based on quality score - potential for selection bias, low external validity, and lack of power analysis)	High	Single Cohort, Repeated Measures Design (Experimental)
Freedland, et.al (2002)	Downs & Black: 17/29	4 (downgraded based on quality	Mod	Within Subjects Design, Single group pretest-

		score - potential for selection bias, low external validity, and lack of power analysis)		posttest design (Quasi-Experimental)
Picelli, et.al (2010)	Downs & Black: 17/29	2b	High	Single Cohort, Repeated Measures Design (Experimental)

*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:

- Ford, et.al (2010) – This study has high relevance to my clinical question due to the utilization of music and measurement of gait mechanics in people with Parkinson's. The sample characteristics also match the patient included in the clinical scenario.
- Picelli, et.al (2010) - This study has high relevance to my clinical question due to the utilization of metronome and measurement of gait mechanics in people with Parkinson's. In addition, the study classifies as level 2B on the hierarchy of evidence, indicating a good-quality design and methodology.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of Gait Training with Progressive External Auditory Cuing in Persons with Parkinson's Disease by Ford et al, 2010[1]

Aim/Objective of the Study/Systematic Review:
The purpose of this study was to assess the effect of progressively increasing external auditory cues during an 8 week gait training program on stride length, gait velocity, and cadence in patients with Parkinson's Disease.
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.
• Single Cohort, Repeated Measures Design (Experimental) • Convenience sampling • No blinding of participants or investigators • Outcomes were measured a total of 6 times during each of the 24 sessions. (Details of the measurement schedule are listed under "Outcome Measures")
Setting [e.g., locations such as hospital, community; rural; metropolitan; country]
• Therapeutic Recreation & Fitness Facility (Lakeshore Foundation, Homewood, Alabama)
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.

14 individuals diagnosed with idiopathic Parkinson's Disase were selected for this study via convenience sampling, and agreed to participate. However, two participants dropped out of the study due to exacerbation of back pain with training. The data reported is based on the 12 participants who completed the study. The ages ranged from 50-79 years old, and there were 7 males and 5 females included in this group. The participants ranged from Stage I-III on the Hoehn and Yahr Scale (average of Stage 1.9).

To be eligible for participation in this study, individuals had to be able to ambulate independently, and were excluded if they presented with any perceptual impairments (ie. Memory impairments).

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

There was no control group, due to the single-cohort study design

Experimental

Gait training lasted for 8 weeks – with 3, 30-minute sessions each week. Participants were given a heart rate monitor, iPod, and headphones during each training session.

Each session involved 2 evaluation periods, and 2 training periods. One evaluation period was at the very beginning of the session, where participants were assessed for their comfortable cadence. Then they performed a training period by taking steps in sync with the external auditory cues being provided to them through the iPod – which matched their cadence from the first evaluation period.

The second evaluation period occurred between minutes 13 and 15, during which the participants were assessed for if they would be able to walk at a rate of 10 bpm higher than that in the first training session, while maintaining cadence (within 15 bpm less than new target), and maintaining or increasing stride length and gait velocity. If the participant was able to do this, then they would train at a rate that was 10 bpm faster during the 2nd training session. If they were unable to do this, then they would train at the same rate during training session 2 as they did in training session 1.

The intensity of training was based on the age predicted target heart rate for each individual. The auditory cuing consisted of musical rhythms that were created at the Center for Biomedical Research in Music at Colorado State University. They were designed in a way that really emphasized the beat at which participants were being instructed to match their steps to.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

Walking Velocity, stride length, and cadence were the primary outcome measures used in this study. They were measured by the investigators twice at all of the following time periods: between minutes 1 and 3, minutes 10 and 12, minutes 17 and 19, and minutes 27 ad 30. The measurements were also taken during each of the evaluation periods, which were used to determine the rate at which the participant would be cued to walk at for the training session that immediately followed it.

The outcome measure of interest to this PICO question was stride length (meters), which was calculated by dividing a set distance walked (9 meters) by the number of steps taken by the person to cover that distance. Gait velocity was calculated by timing how long it took the individual to walk a certain distance, and then converting it into m/s. During this measurement, the number of steps taken were also counted, so that cadence (steps/min) could be calculated.

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.]

The table below represents Table 4 on page 1258 of the article, and contains the Mean Pre-training and Post-training Walking Velocity, Stride Length, and Cadence Measures for Comfortable and Fast Walking

Walking Condition	Walking Speed (m/s)	Stride Length (m)	Cadence (steps/min)
Pre-Comfortable	0.99	1.13	104
Post Comfortable	1.17*	1.26*	110*
Pre-Fast	1.44	1.37	125
Post-Fast	1.56*	1.43	128

Note: Pre-comfortable describes measurements taken at the beginning of the session (Evaluation Period 1). Post-comfortable measurements were taken between minutes 10-12. Pre-fast measurements taken between minutes 17-19. Post-fast measurements were taken between minutes 27 and 30.

There was a statistically significant increase in walking velocity, stride length, and cadence (P<.01) before and after training sessions at the comfortable training condition. The values that were significant are marked by an asterisk (*). There was also a statistically significant difference in walking speed after training with a faster frequency of auditory cues (P<.04), however the post-fast changes in stride length and cadence were not significant (P<.19 and P<.08 respectively).

In addition, between session 1 and session 24 (the last one), participants demonstrated a 33% improvement in the rate of external auditory cues that they were able to walk to during training periods. This was due to the improvements in walking velocity (19%), stride length (15%), and cadence (21%) that were seen between the first and last session and are shown in the table below:

	Percent Increase	1st session Mean ± SD	24th session Mean ± SD
Walking Velocity	19%*	1.28 ± .23	1.58 ± .28
Stride Length	15%	1.36 ± .20	1.46 ± .21
Cadence	21%*	110 ± 8	129 ± 13

The improvement in walking velocity, stride length, and cadence were found to be statistically significant (p<.01). The change in stride length over the course of the entire intervention was not considered to be statistically significant.

The study also measured how long it took (in number of sessions) for a participant to "plateau," or have 3 training periods in a row (over 2 sessions) where they trained at the same rhythm (in other words, they did not meet the criteria necessary to increase the rhythm by 10 bpm). The average number of sessions that patients progressed through before reaching their maximum training rhythm was 6 ± 3 sessions (the standard deviation was calculated based on data provided in the article). The average "maximal" rate that the participants trained at was 157 bpm.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

The authors concluded that utilizing progressively greater frequencies of external auditory cues can lead to significant increases in in comfortable gait speed, stride length, and cadence in patients with Parkinson's.

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.]

The Downs & Black tool[2] was used in the process of appraising this article by Ford et al. The study received a score of 16/29, indicating moderate quality and risk of bias. There was no control group utilized in the study, and details of the recruitment process were not provided by the researchers beyond "convenience sample (page 1255)".

The sample size was small – with only 12 individuals who completed the study – and included individuals across Stage I-III on the Hoehn & Yahr Scale. This increases the risk for greater variability in the data, simply due to a variety of presentations and levels of disease progression. Based on this demographic

information and the Downs & Black score, the internal validity for this study was moderate. The population from which the participants were picked is not homogenous

The fact that participants were of different stages of Parkinson's, however, does help the external validity of this study, in that the findings could be utilized with a larger population. Although including all of these stages into the analysis increases the risk of bias due to variability in performance as a result of disease progression, the inclusion criteria does result in the participants all being relatively higher functioning and independent with ambulation. This helps to reduce some of the risk of variability that comes from the sample being heterogeneous.

One strength of this study was the use of a detailed protocol in determining the appropriate time at which to progress the rate of auditory cuing during training sessions (Figure 1, page 1257). This allows for other researchers to be able to reproduce or build upon the study, and clinicians to have more objective ways to progress a patient's therapy. However, the researchers also stated that the progression criteria used in the protocol was "a priori" rather than evidence-based (page 1260). This could reduce the overall validity of the study, and might also make it less applicable to any individual patient.

Overall, this study is of moderate quality. The level of evidence was downgraded from 2b to 4 due to its score of 16/29 on the Downs & Black assessment due to risk of selection bias, lack of blinding of participants or those measuring outcomes, and lack of power analysis provided in the study.

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.]

This study allows clinicians to see how patients can undergo training with the use of auditory cuing. It demonstrates that the use of music as auditory cuing can result in immediate increases walking speed, cadence and stride length immediately after training at a rhythm equivalent to their comfortable cadence, as well as over the course of a training program that utilizes progressively increasing rates of auditory cues.

The fact that most of the patients plateaued in their improvements by session 6 is helpful for clinicians making a plan of care, as well as for educating patient on when gains are most likely to occur. 2-3 weeks is also more feasible to conduct or incorporate into a course of care, as opposed to 8 weeks.

However, it should be noted that the music utilized in this study to provide auditory cues was specifically designed to emphasize the beats in the song that participants were supposed to match their steps to. The average patient or therapist does not have access to specially designed music of this type. Thus, the feasibility of applying this intervention to other patients is somewhat limited. It is difficult to generalize these cuing effects of the music to other publically available songs, due to the fact that the beat is not always highlighted and may be difficult to detect.

In order to determine the clinical utility of using general music of a particular frequency as the auditory cues during ambulation, additional research is necessary.

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 study is certainly relevant to the clinical question and scenario due to its use of music to provide auditory cuing during ambulation in patients with Parkinson's Disease, and its measurement of stride length as one of the primary outcome measures. However, the use of music that was specially crafted for this study makes the protocol less applicable to clinical use. Music that is not easily accessible is not very practical to use in the clinic or by patients in the community. The findings could still be relevant if clinicians train patients using publically available songs that do have a distinguishable beat and match the appropriate cadence– however it would likely take some additional time in trying to find a selection of appropriate songs.

The patient described in the clinical scenario did present with some memory impairment – which would have excluded him from being a participant in this study. Other than that, however, he was independent with ambulation and was fairly high functioning.

The techniques used to measure stride length in this study are easy to reproduce and described in detail in the article – increasing the feasibility of using this intervention program.

(2) Description and appraisal of Three-dimensional motion analysis of the effects of auditory cueing on gait pattern in patients with Parkinson's disease: a preliminary investigation by Picelli et al, 2010 [3]

Aim/Objective of the Study/Systematic Review:
The purpose of this study was to assess the effect of metronome auditory cuing on spatiotemporal, kinematic, and kinetic gait variables in patients with Parkinson's Disease using a three-dimensional motional analysis system.
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.
• Single Cohort, Repeated Measures Design (Experimental) • Subjects and investigators were not blinded • A number of outcomes were measured. The most relevant ones are stride length (primarily), cadence, and gait speed.
Setting [e.g., locations such as hospital, community; rural; metropolitan; country]
Laboratory 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.
This study had a total of 8 participants who were diagnosed with Parkinson's Disease – 5 males and 3 females. The mean age was 65.1 years old (range: 58-71), and the average duration of symptoms was 6.5 years (range: 5-8 years). The patients were recruited from the Rehabilitation Unit at G.B. Rossi University Hospital in Verona Italy between March 2007 and July 2007. Some eligibility criteria to note is that patients had to be classified as Stage II on the Hoehn and Yahr Scale, have a score of 41 or higher on the Berg Balance Scale, and be able to walk at least 15 meters without an assistive device. All participants were tested during their "on" phase of the medication cycle.
Intervention Investigated [Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]
Control
There was not a control group in this study, due to the study design being single-cohort repeated measures design.
Experimental
Participants performed a total of 12 walks across 4 different conditions (3 trials per condition) of different auditory cue rhythms (using a metronome). For the first condition, Uncued Normal Walking (W0), participants were instructed to ambulate at their normal, comfortable pace. The average cadence from this condition was then used to determine the frequency of auditory cuing that would be used in the remaining conditions: 90% cued walking (W1), 100% cued walking (W2), and 110% cued walking (W3). Participants

were instructed to step to the beat of the metronome during each trial. The total pathway over which participants ambulated was 10 meters, with "measurement area" making up the middle 6 meters.

There was a 3- minute rest break built in between each walk.

The study only required participation in a single session. The intervention was the exposure to the external stimulus; outcomes were measured during the intervention to assess the immediate effect of the intervention. Testing was conducted by the investigators.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

The following parameters were measures from each category:

- Spatiotemporal
  - Stride length, stride time, cadence, mean gait speed, single support duration, double support duration
- Kinematic
  - Range of motion of hip, knee, and ankle throughout gait cycle
- Kinetic
  - Maximal power exerted by ankle and hip joints

All of these variables will be measured under each of the four conditions described above (W0, W1, W2, and W3), using data collected through Vicon (the 3-D motion analysis system), a force plate, and 16 reflective markers that were placed according to the Davis Protocol.

The primary outcome measures of interest based on the PICO question, and to allow for the best comparison to the first article, are stride length (meters), cadence (cycles/minute), and gait speed (m/s).

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.]

Below is a table representing the mean values and standard deviations for gait speed, stride length, and cadence across all four conditions:

Parameter	Uncued Normal Walking (W0)	90% Cued Walking (W1)	100% Cued Walking (W2)	110% Cued Walking (W3)
Stride Length (m)	1.1681 ± 0.1709	1.2250 ± 0.1722	1.2356 ± 0.1673	1.2443 ± 0.1601
Cadence (cyc/min)	121.8750 ± 7.0130	118 ± 4.5607	123.8750 ± 5.9651	132 ± 9.6332
Gait Speed (m/s)	1.205 ± 0.1883	1.2331 ± 0.1497	1.2662 ± 0.1429	1.3631 ± 0.1657

In general, average stride length, cadence, and gait speed were all higher when the participants were walking with auditory cues versus no cues. In addition, increasing the rate of cuing also demonstrated increases in all three parameters of interest.

Significant differences in stride length (m) were found between conditions W0-W1 (P=0.008), W0-W3 (P=0.014), W1-W2 (P=0.005), and W2-W3 (P=0.005). Cadence was significantly different between W0-W3 (P=0.002) and W1-W2 (P=0.0). Differences in gait speed were also found to be significant different in the following conditions: W0-W3 (P=0.002), and W1-W3 (0.008).

Note: There were additional significant findings in this study, but they were not discussed here due to not being as relevant to the PICO question.

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

The researchers concluded that in patients with Parkinson's Disease who are in the ON phase of their medication, use of auditory cuing (with metronome) can result in adjustments of spatiotemporal, kinematic

and kinetic gait parameters. Of particular interest, increases in stride length, cadence, and gait speed were seen while imposing external auditory cues with a metronome.

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.]

The Downs & Black tool[2] was used to assess the quality of this study and help with the appraisal process. The score for this research article by Picelli et.al. was 17/29.

One primary weakness of this study is the small sample size which can result in greater variability in outcome measures. In looking at the three outcome measures of interest, stride length and gait speed had moderate levels of variability based on the standard deviation values and standard error bars presented in Figure 1 (page 46). With cadence, however, there is little variability across all of the conditions. One step taken by the researchers that can help to decrease the influence of outliers or errors in the data is performing multiple walking trials under each condition, and taking the average. This is important to consider, especially since the distance over which outcomes were being measured was only 6 meters. By including multiple trials, it allows for a greater number of steps to be taken into account – which are more likely to be representative of the person's gait for that given condition than a fewer number of steps.

Due to the study design, there was no control group included. This lowers the quality of the study as a whole, and also limits the ability to know how healthy individuals would respond to the various rhythms of auditory cuing.

The internal validity is good for this study, based on the criteria on the Downs & Black tool, as well as the inclusion and exclusion criteria used for recruitment of participants. All of the participants were classified as Stage II on the Hoehn & Yahr scale, could ambulate 15m independently, and can be assumed to be fairly high functioning based on mean score on the Berg Balance Scale (52.50 ± 3.96), Mini Mental State Examination (26.88 ± 1.96). The extensive criteria for participation in the study help to decrease the risk of confounding variables.

On the other hand, due to the specific nature of the population that this study drew participants from, the findings cannot be applied to the general population of patients with idiopathic Parkinson's Disease. Thus, it can be concluded that there would be low external validity There is considerable variation in disease presentation, and moreover there many patients who are in other stages, require an assistive device, or may have cognitive impairments that would have excluded them from being in this study.

Overall, this study is of moderate quality. The level of evidence was 2b, which is of good quality. However it is of moderate quality based on the Downs & Black assessment due to lack of randomization, lack of lack of blinding of participants or those measuring outcomes, and lack of power analysis provided in the study.

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.]

Despite the weaknesses and moderate quality characteristics of the study described above, the findings still do demonstrate that individuals with Stage II Parkinson's Disease do have the ability to adjust their steps to match the rhythm of auditory cues being provided with a metronome. The patients at this point are able to match their steps to both slower rhythms and faster rhythms – as evidenced by the analysis performed between the different metronome conditions.

The results demonstrated that walking with auditory cues – whether the cues were slower (90%) than their normal cadence or faster (110%) – resulted in increased stride length, cadence, and gait speed compared to walking without any metronome cues. For stride length, both of these rhythms produced significant improvements compared to the uncued, whereas for cadence and gait speed, only the 110% rhythm was significantly greater than uncued.

Clinically, these findings suggest that auditory cues help improve gait mechanics in patients with Parkinson's Disease. The rhythm of the auditory cues to would depend on the specific measure of interest and target performance. However, it is important to note that these results are based on performance during the exposure to auditory cues, rather than any carry over effect. This study does not provide any information regarding a training program that utilizes metronome auditory cues or what the long term outcomes might be.

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 clinical question was focused specifically on increasing stride length with the use of auditory cues. This study demonstrates that use of metronome while walking does help to increase stride length as compared to ambulation without any auditory cuing. In addition, rhythms that are 90% of comfortable cadence or 110% of comfortable cadence both demonstrate significant improvement in stride length compared to uncued walking, and thus would allow the clinician greater flexibility in utilizing a rhythm (faster or slower) that works well for the patient.

For the patient in the clinical scenario, information regarding the stage he was classified as on the Hoehn & Yahr Scale was not available from his neurologist. In addition, the patient did present with some memory impairments. Thus, further testing – such as the administration of the UPDRS or Mini Mental State Examination might be helpful in determining whether outcomes similar to those in the study can be expected for this patient.

Although use of the 3-D motion analysis system may not be feasible in a clinical setting, stride length can still be calculated manually fairly easily. Additionally, the intervention of using metronome cuing during gait can easily be reproduced in the clinic, home, or community setting.

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.]

The two studies picked for the CAT were primarily picked for their relevance to the clinical scenario and question. They both were of moderate overall quality based on the risk for bias, although the Picelli et al article was of good quality – at a level of 2B on the hierarchy of evidence.

Ford et.al. implemented a gait training program that utilized music as the form of auditory cuing; the rate of cuing was gradually progressed as participants demonstrated the ability to maintain or increase stride length with the increased rate of auditory cues. The results demonstrated that there was a significant increase in gait velocity, stride length, and cadence between session 1 and session 24. In addition, participants plateaued in terms of the musical rhythm they were able to progress to by session 6 on average - after which there were no significant increases in the outcome measures. [1]

The Picelli et.al. article utilized different frequencies of metronome (90%, 100%, 110%) and assessed the concurrent effects on many different gait parameters. When compared to performance in the non-cued condition, stride length, gait velocity, and cadence all increased with the exposure to auditory cues. This study also demonstrated that the participants were able to adjust their steps in response to the different rates of cuing, based on the significant differences in these gait parameters between the different cued conditions. [3]

Although data for the same outcome measures is provided by both studies, it is not appropriate to compare them due to the difference methodology by which the metronome and music cues were implemented. However, both music and metronome demonstrated increases in stride length during gait.

It should be noted that the music utilized in the Ford et.al article was specially designed for the study, and it highlighted the beats throughout the composition. This emphasis on the beats was done using a metronome, while the remaining composition included "melody, chords, bass, [and] percussion (page 1257)[1]." However, creating music to use in gait training is not very practical or feasible. Thus based on the existing literature and review of these two articles, it can be concluded that metronome may be the more feasible option to use with a patient in the clinic – until there is research that looks at the use of publically available music.

One of the major weaknesses of both of these studies we well as the other 6 studies reviewed over the course of this semester is that the sample sizes are quite small – ranging from 8 to 31[4,5,6,7,8,9,3,1]. With a smaller sample size, there is increased risk of bias and variability, and it is more difficult to generalize the findings to a specific patient or the larger population. In addition, due to the lack of control groups in the majority of the studies, it is difficult to know the effects of auditory cuing on gait parameters in healthy individuals. It would also be of benefit to conduct a study that compared metronome and music cues to determine if one is more effective than the other in obtaining the target outcomes.

REFERENCES

[List all references cited in the CAT]

1. Ford MP, Malone LA, Nyikos I, Yelisetty R, Bickel CS. Gait training with progressive external auditory cueing in persons with Parkinson's disease. *Arch Phys Med Rehabil* 2010;91(8):1255-1261. doi:10.1016/j.apmr.2010.04.012.
2. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomised and non-randomised studies of health care interventions. *J Epidemiol Community Health* 1998;52(6):377-384. doi:10.1136/jech.52.6.377.
3. Picelli A, Camin M, Tinazzi M, et al. Three-dimensional motion analysis of the effects of auditory cueing on gait pattern in patients with Parkinson's disease: a preliminary investigation. *Neurol Sci* 2010;31(4):423-430. doi:10.1007/s10072-010-0228-2.
4. Benoit C-E, Dalla Bella S, Farrugia N, Obrig H, Mainka S, Kotz SA. Musically cued gait-training improves both perceptual and motor timing in Parkinson's disease. *Front Hum Neurosci* 2014;8:494. doi:10.3389/fnhum.2014.00494.
5. Thaut MH, McIntosh GC, Rice RR, Miller RA, Rathbun J, Brault JM. Rhythmic auditory stimulation in gait training for Parkinson's disease patients. *Mov Disord* 1996;11(2):193-200. doi:10.1002/mds.870110213.
6. Bukowska AA, Krężałek P, Mirek E, Bujas P, Marchewka A. Neurologic Music Therapy Training for Mobility and Stability Rehabilitation with Parkinson's Disease - A Pilot Study. *Front Hum Neurosci* 2015;9:710. doi:10.3389/fnhum.2015.00710.
7. McIntosh GC, Brown SH, Rice RR, Thaut MH. Rhythmic auditory-motor facilitation of gait patterns in patients with Parkinson's disease. *J Neurol Neurosurg Psychiatr* 1997;62(1):22-26. doi:10.1136/jnnp.62.1.22.
8. Howe TE, Lövgreen B, Cody FWJ, Ashton VJ, Oldham JA. Auditory cues can modify the gait of persons with early-stage Parkinson's disease: a method for enhancing parkinsonian walking performance? *Clin Rehabil* 2003;17(4):363-367. doi:10.1191/0269215503cr621oa.
9. Freedland RL, Festa C, Sealy M, et al. The effects of pulsed auditory stimulation on various gait measurements in persons with Parkinson's Disease. *NeuroRehabilitation* 2002;17(1):81-87.