ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2013;94:562-70

REVIEW ARTICLE (META-ANALYSIS)

Cueing and Gait Improvement Among People With Parkinson's Disease: A Meta-Analysis

Sandi J. Spaulding, PhD,[a] Brittany Barber, MSc,[a] Morgan Colby, MSc,[a] Bronwyn Cormack, MSc,[a] Tanya Mick, MSc,[a] Mary E. Jenkins, MD[b]

From the [a]Faculty of Health Sciences, The University of Western Ontario, London, ON; and [b]Clinical Neurological Sciences, Schulich School of Medicine and Dentistry, The University of Western Ontario, London, ON, Canada.

Abstract

Objective: To compare the relative efficacy of visual versus auditory cueing on gait among individuals with Parkinson's disease (PD).

Data Sources: A systematic search was completed up to September 2011, using the following databases: EMBASE, Scopus, Medline, CINAHL, and PubMed.

Study Selection: Four authors searched the databases using the following terms: *Parkinson's disease* (including abbreviations), *gait*, *cadence*, *step*, *pace*, *cueing*, *cues*, and *prompt*. All studies that evaluated the effect of cueing on gait in PD were selected by consensus of 2 pairs of authors who reviewed the titles and abstracts. Each pair of authors then applied the inclusion and exclusion criteria to each study, and 25 articles were chosen. Inclusion criteria were cueing studies that reported pre- and postoutcome measures of gait parameters. Exclusion criteria were lack of data and studies that evaluated gait aids.

Data Extraction: Gait measures of cadence, stride length, and velocity, before and after cueing, were collected from each study. If data were represented in graphs, a pair of authors extracted the data points individually, then compared and averaged values.

Data Synthesis: The data were synthesized using a meta-analysis based on cue type. Auditory cueing demonstrated significant improvement of cadence (Hedge $g=.556$; 95% confidence interval [CI], .291−.893), stride length (Hedge $g=.497$; 95% CI, .289−.696), and velocity (Hedge $g=.544$; 95% CI, .294−.795). In contrast, visual cueing significantly improved stride length only (Hedge $g=.554$; 95% CI, .072−1.036).

Conclusions: The findings suggest that auditory cueing is more effective for treating gait disorders in PD. Further research is needed to determine the optimum auditory cueing strategy for gait improvements.

Archives of Physical Medicine and Rehabilitation 2013;94:562-70

Parkinson's disease (PD) is a neurologic disorder caused by the progressive degeneration of dopamine-producing cells in the substantia nigra pars compacta.[1] Progressive degeneration of these cells results in the 4 cardinal symptoms of PD, which include tremor, rigidity, postural instability, and bradykinesia. These symptoms translate into a wide range of physical impairments including a particularly destructive effect on gait.[1] Gait impairment is a common cause of disability in people with PD.[2] PD can cause gait instability and patterning difficulty characterized by increased cadence, reduced stride length, freezing of gait, and reduced velocity.[3,4] Despite pharmacologic management strategies, gait deficits remain persistent in PD and are associated with reduced independence and safety, validating the importance of adopting alternative approaches to the management of these problems.

There are a number of medications used to treat PD, with levodopa (a precursor of dopamine) and dopamine agonist being the most commonly prescribed. Medication is successful in managing some of the symptoms of PD and is fairly effective in preserving function, mobility, and quality of life for a number of years in those living with PD.[5] However, gait impairments and postural instability are only partially responsive to medication treatment.[6] Furthermore, over time, these medications become less effective with the appearance of fluctuating on/off phases. Off phases feature a worsening in gait, rigidity, slowness, and tremor, whereas on phases produce more fluid movement. Advanced PD on phases may also be associated with disabling and embarrassing dyskinesias.[5] The partial improvement of gait and balance

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

0003-9993/13/$36 - see front matter © 2013 by the American Congress of Rehabilitation Medicine
http://dx.doi.org/10.1016/j.apmr.2012.10.026

impairments in PD with medications, the decline of the effects of Parkinson's medications over time, and their potentially debilitating side effects present a need to investigate the use of rehabilitation treatments to help maintain physical functioning, including gait.

Cueing is a major component of rehabilitation, and refers to the use of a temporal or spatial stimulus to regulate movement. Cueing is often delivered in the form of auditory or visual stimuli. It is suggested that cueing can have a direct and significant effect on the gait performance in people with PD.[2] This matching of the person's gait to an external stimulus or cue is done with a plan to alter the kinematic characteristics of gait and has been shown to improve gait cadence, stride length, velocity, and postural stability.[7,8]

Auditory cueing has been demonstrated to increase velocity from studies involving questionnaires and clinical measures such as the Timed Up & Go test.[9,10] This form of cueing is an emerging rehabilitation strategy for individuals with PD and may include strategies such as the use of music, counting, or the beat of a metronome as a rhythmic auditory cue.[10,11] The beat of the metronome is matched with baseline cadence and then either increased or decreased in an attempt to determine an optimal walking pace. The effective mechanisms of auditory cueing remain unclear, however, it is hypothesized that these cues may compensate for the degenerated rhythm within the basal ganglia.[12] In their randomized controlled trial of auditory cueing in PD, Ledger et al[9] tested the iPod Shuffle, which provided a metronome beat as a cue. Their findings suggested that by presenting a cueing frequency that is 10% lower than the client's self-selected velocity, gait and gait pattern were improved. A research review conducted by Rubinstein et al[7] identified 3 studies in which people with PD matched their cadence to a beat that was 10% faster than baseline values. This auditory stimulus also significantly improved the participants' cadence, stride length, and velocity.

Visual cues have also been found to help improve gait in people with PD. These cues include, but are not limited to, the use of laser pointers, adaptive glasses, or lines marked on the floor. Stride length markers are an example of a visual cue. The markers are placed perpendicularly along a walking path at intervals corresponding to normalized step length. It is unclear exactly how these visual cues help to improve gait; however, it has been hypothesized that the lines on the floor may draw attention to the stepping process.[13] More specifically, it is theorized that clients with PD do not receive the adequate sensory information required to perform walking as an automatic function. McAuley et al[14] demonstrated improvement in walking time by at least 10% through the use of their visual cue glasses. Morris et al[15] identified enhanced stride regulation in people with PD through the use of visual cue training. In this study the visual cue intervention transferred to walking without the use of the cue, and demonstrated an improvement in the patient's cadence, stride length, and velocity.

Problems with gait and balance are common in individuals who have dementia as well as PD. Visual and auditory cueing have also been used with patients who have dementia. For example, in a study by Rochester et al,[10] participants with mild cognitive impairment (median Mini-Mental State Examination [MMSE] = 22/30) were cued via auditory rhythmic cues and were found to demonstrate improvement in gait. The results of this study further increase the generalizability of these cueing modalities, because cues are proven beneficial for clients in the later stages of PD with dementia.

The literature available on cueing and gait patterns is sufficient to suggest that cueing may have a positive effect on gait. In this research, we have chosen to analyze the effects of auditory and visual cueing on gait parameters of cadence, stride length, and velocity of those living with PD. The aim of this study was to conduct a meta-analysis on the available evidence that addresses the use of external cues to improve gait in people with PD, and to identify the cueing modality, auditory or visual, or a combination of these cueing modalities that produce maximal improvement of gait patterns.

List of abbreviations:

CI **confidence interval**
HY **Hoehn and Yahr**
MMSE **Mini-Mental State Examination**
PD **Parkinson's disease**

Methods

Literature search

A search of existing literature was completed using the following databases: EMBASE, Scopus, Medline, CINAHL, and PubMed. The search was started using single term queries. Additional terms were then parsed with the initial terms. A snowball technique was then used through additional searching of references found in the relevant studies. Four authors (B.B., B.C., M.C., T.M.) were each randomly assigned a single database and conducted a thorough search using the terms listed in table 1.

All researchers kept a log of terms and strategies used in order to maintain consistency throughout the search process. The initial search yielded 103 articles.

Inclusion and exclusion criteria for meta-analysis

Inclusion criteria consisted of the following: (1) studies that evaluated the effect of auditory and/or visual cueing of gait in people with PD; (2) studies that objectively reported biomechanic measures of the kinematic parameters of gait cadence, step length, and velocity; (3) studies that evaluated the impact of the intervention of auditory and/or visual cueing on the parameters of gait; and (4) studies that were published in English.

Exclusion criteria consisted of the following: (1) studies that had insufficient biomechanic data; (2) studies that only evaluated other types of cueing, such as cognitive cueing; (3) studies that evaluated the effect of gait aids; (4) abstracts or unpublished research; and (5) qualitative studies, including expert findings or case studies. Sample size was not an exclusion criterion.

It was planned that in the case of a discrepancy between members of the pair of researchers, a third researcher would be recruited to aid in the decision-making concerning the inclusion or

Table 1 Terms used for the database search

Parkinson's Disease	Gait	Cueing
Parkinson	Walking	Cue
PD	Gait	Cueing
Parkinson's	Cadence	Cues
Parkinson's disease	Step	Prompt
Parkinson disease	Pace	