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A novel cognitive cueing approach to gait retraining in Parkinson's disease: A pilot study

Stephanie Morrison
stephjmorrison@gmail.com

Sandi Spaulding
The University of Western Ontario, sspauldi@uwo.ca

Jeff Holmes
The University of Western Ontario, jeff.holmes@uwo.ca

Mary Jenkins
The University of Western Ontario, mary.Jenkins@lhsc.on.ca

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A novel cognitive cueing approach to gait retraining in Parkinson's disease: A pilot study

Abstract

Background: Parkinson's disease (PD) impairs gait performance, which can lead to falls and decreased quality of life. This study examined the feasibility of implementing a novel home-based intervention designed to elicit gait improvement in individuals with PD.

Methods: Five participants with PD completed a two-week home-based gait retraining intervention designed around guided video feedback. Semi-structured interviews were conducted postintervention and two months postintervention to acquire feedback from the participants about their experience with the intervention. Spatiotemporal parameters of gait and functional mobility were assessed pre and postintervention and at two months postintervention.

Results: Participants reported high levels of usability and expressed they believed that the intervention improved their gait and led to a fortified sense of ability and revived sense of empowerment. Comparisons of spatiotemporal and mobility parameters of gait identified that improvements occurred between preintervention and postintervention—step length ($\bar{x}$ = 10.7%), gait velocity ($\bar{x}$ = 15.1%), and TUG scores ($\bar{x}$ = 9.8%)—and between preintervention and two months postintervention—step length ($\bar{x}$ = 3.9%), gait velocity ($\bar{x}$ = 9.9%), and TUG scores ($\bar{x}$ = 4.2%).

Conclusions: Guided home-based video training has potential to be an effective treatment strategy for improving gait impairment among individuals with PD.

Keywords

home-based intervention, motor learning, video feedback

Credentials Display

Stephanie Morrison, M.Sc., Sandi Spaulding, PhD, Jeff Holmes PhD, OTReg.(Ont.), Mary Jenkins, MD, FRCPC

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Parkinson's disease (PD) is a neurodegenerative disorder characterized by resting tremor, rigidity, slowness of movement, and postural instability resulting from a loss of dopaminergic neurons in the pars compacta of the substantia nigra (Meissner et al., 2011). It is widely accepted that PD impairs gait performance. For example, individuals within this population often present with a gait pattern that is characterized by shortened step length and reduced velocity. As the disease progresses, gait impairments worsen and individuals may develop a festinating gait pattern with short, rapid steps, or freezing of gait, which may lead to falls and decreased quality of life (Grimbergen, Munneke, & Bloem, 2004; Shulman, 2010; Shulman et al., 2008).

While medication has been found to improve some symptoms, including bradykinesia and rigidity, it has been only partially effective in improving gait. Despite the neuropathology of the disease, evidence suggests that individuals with PD are capable of improving their gait via motor learning strategies (Felix et al., 2012; Fok, Farrell, McMeeken, & Kuo, 2011; Pendt, Reuter, & Müller, 2011; Rochester et al., 2010; Werner & Gentile, 2010), as evidenced by the fact that exercise and movement strategy training have been found collectively to contribute to improvements in gait (Rochester, Nieuwboer, & Lord, 2011). For example, research focused on the nonpharmacological management of gait impairment in PD has found that the use of external cues is generally effective (Morris, Iansek, Matyas, & Summers, 1996; Rochester et al., 2010; Rochester et al., 2005; Spaulding et al., 2012). Specifically, previous research has found that individuals with PD who experience gait impairment are able to execute quality gait patterns when aided by external visual or auditory cues (Spaulding et al., 2012). A potential drawback of this approach, however, is that these strategies typically require assistive devices (e.g., a cane with laser lights or listening devices with rhythmic auditory signals) that may be expensive and impractical in certain environments. Moreover, results have predominantly shown only short-term benefits of lab-based external cueing of this nature (Morris et al., 1996; Rochester et al., 2010).

As a means to overcome the aforementioned limitations, researchers have also investigated cognitive cueing strategies that involve individuals with PD using verbal instructional cues to improve gait performance. Fok, Farrel, McMeeken, and Kuo (2011) completed a systematic review of the literature that explored the effects of verbal instructions on gait among individuals with PD. In their review, Fok et al. (2011) identified 13 studies that examined either independently or in combination one the following sets of verbal cues: (a) "walk fast" (Behrman, Teitelbaum, & Cauraugh, 1998; Ferrandez & Blin, 1991; Morris, Iansek, Matyas, & Summers, 1994), (b) "take big steps" (Baker, Rochester, & Nieuwboer, 2007, 2008; Behrman et al., 1998; Canning, 2005; Iansek, Huxham, & McGinley, 2006; Lehman, Toole, Lofald, & Hirsch, 2005; Morris et al., 1996; Werner

& Gentile, 2003), (c) “walk fast and take big steps” (Canning, Ada, & Woodhouse, 2008), (d) “swing arms while walking” (Werner & Gentile, 2003), and (e) “count rhythm while walking” (Behrman et al., 1998). While 11 of these studies examined the immediate effects of employing the instructional sets in a single laboratory-based testing session, Canning et al. (2008) and Lehman et al. (2005) investigated the effects of weekly training sessions. Specifically, Canning et al. (2008) required participants to undergo 30 minutes of training once a week for three weeks, and Lehman et al. (2005) required participants to engage in a 10-day training program that was delivered over a two-week period. Overall findings from the systematic review indicate that while there is insufficient evidence to support the use of verbal instructional cueing for immediate improvement, best evidence synthesis suggests that with training, benefits are possible. Findings from the review also indicate that while there is some evidence to support that the verbal instruction to “take big steps” can lead to improvements in step length, the evidence for the other verbal instructions is lacking.

Building on the promising findings of this aforementioned research, Werner and Gentile (2010) examined two instructional strategies during intensive walking practice. One treatment group (n = 6) received verbal instructions to “take big steps,” and a second treatment group (n = 6) received the same verbal instructions with video feedback and performance cues between each of the 15 walking performances. Both groups performed 15 walking trials during each of the four 90-minute training sessions occurring over a period of two weeks (two sessions per week). Though the authors did not identify differences between the two training groups, both groups showed improvement in stride length and gait velocity pre to posttraining, and all of the participants assessed in longer-term retention tests (i.e., three, six, or 12 months) maintained stride length and gait velocity improvement above pretraining levels.

Although the research findings of Werner and Gentile (2010) have contributed to our understanding of the effects of implementing a cognitive cueing approach with video feedback as a possible strategy to improve gait, widespread clinical implementation would prove to be difficult, given the substantial amount of time and resources required. The two training interventions used in their protocol required approximately six hours of laboratory-based training per patient over a two-week period. The authors appropriately acknowledged this limitation, stating that far more time was spent in clinical gait training than is typically available for an individual with PD. The positive outcomes associated with their study, however, warrants future research to investigate gait training interventions of this nature that would be less demanding on clinical resources and, therefore, more feasible for clinical rehabilitation. One way to potentially minimize the demands associated with this type of intervention would be to deliver the program as a home-based intervention. Although video-based guided coaching is promising, it is

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currently unknown whether this type of approach would be suitable for delivery in a home setting. The purpose of this study was to examine the feasibility and utility of delivering a home-based gait retraining intervention, similar to the one adopted by Werner and Gentile (2010), that combines cognitive cueing techniques and motor learning principals aimed at improving kinematic variables of gait and functional mobility among individuals with PD.

Method

Participants were recruited for this study from the practice of one of the authors (M. E. J.), a neurologist specializing in movement disorders. The authors collected a convenience sample based on the inclusion criteria of diagnosis with mild to moderate PD with reported PD-related gait impairment. Participants were excluded if they had any indication of orthopedic or other neurological conditions that would impair gait performance or any medical conditions that would limit gait performance or practice (e.g., heart disease). Participants were also excluded if they were determined to be cognitively impaired to the extent that they would be unable to understand verbal instructions. Based on clinical assessment, the neurologist determined that none of the recruited participants had considerable cognitive impairments. Further, none of the recruited participants had experience using video feedback for gait improvement. The University Research Ethics Board approved this study, and as per this approval each participant read a letter of information pertaining to the study and provided written informed consent prior to participation.

Five patients between 56 and 83 years of age participated in this pilot intervention. Table 1 offers a description of the participant characteristics. All testing took place in a university-based biomechanics gait laboratory. The participants were assessed at three different time points throughout the course of the study: (a) baseline (within one week prior to starting the gait training program); (b) post-intervention (within one week after completing the gait training program); and (c) two-month follow-up (two months after formally completing the gait training intervention). During each testing session, the participants were tested at their self-determined peak or "ON" phase of their medication cycle. To help ensure that all of the participants were in their "ON" phase, testing was conducted approximately two hours after the participants took their usual medications, per the recommendations of Gauntlett-Gilbert & Brown (1998).

Table 1
Participant Characteristics

	P1	P2	P3	P4	P5
Gender	Male	Female	Female	Male	Male
Age	83	56	72	72	73
H&Y	3	2	2.5	2	2.5
UPDRS	46	22	26	33	33
Years with PD	5	6	12	10	9
Medication	Levodopa 400 mg/day	Levodopa 300 mg/day, Pramipexole 0.25 mg/day	Levodopa 300 mg/day	Levodopa 800 mg/day, Pramipexole 4.5 mg/day, Amantadine 300 mg/day	Levodopa 700 mg/day, Entacapone 1400 mg/day

Note. P1-P5 = Participant 1 – 5; H&Y = Hoehn & Yahr; UPDRS = Unified Parkinson's Disease Rating Scale measured "ON" medication.

Baseline Testing

At the beginning of the baseline testing session, the participants were assessed by M. E. J., a neurologist specializing in movement disorders, on the Unified Parkinson's Disease Rating Scale (UPDRS Subsection III) and the Modified Hoehn and Yahr Staging scale (Shulman et al., 2008). Functional mobility was then assessed as the participants completed three consecutive Timed-Up-And-Go (TUG) tests. The average of the three trials was used for subsequent comparisons. This test has been shown to have good test-retest reliability (r = 0.80) (Huang et al., 2011) and high interrater reliability (ICC ≥ 0.87) (Morris, Morris, & Iansek, 2001) in people with PD and good intrarater reliability in elderly people (Podsiadlo & Richardson, 1991). Next, spatiotemporal parameters of gait during both non-cued and cued walking were measured using a GAITRite® instrumented carpet (CIR Systems, Inc., Sparta, NJ). This system has been previously used to evaluate gait among individuals with PD and has been found to be a valid assessment tool for this population (Chien et al., 2006; Nelson et al., 2002).

Each participant was asked to complete three non-cued walking trials wherein they were instructed to walk the length of the GAITRite® at a comfortable, self-determined pace. The participants then completed three blocks of cued walking comprised of three trials each. For each block, the participants were provided with a verbal cue, such as "take big steps" or "take long steps", and asked to focus on performing the action of the cue while they walked the length of the GAITRite® at a comfortable, self-determined pace. The researchers averaged the data across trials in each condition in order to obtain a single value for each outcome measure in each condition. Video of all walking trials with and without instructional cueing was captured using a digital video camera (SONY DCR-TRV730).

Video Intervention

A personalized gait training intervention video was created for each participant by editing the video that was captured during the baseline testing session using iMovie (®Apple Inc.). The gait training video consisted of footage of both non-cued and cued gait. For the cued gait portion of the training video, the researchers included only footage cues deemed to be beneficial for a particular participant. To determine which cued trials to include, members of the research team analyzed video footage and a consensus decision was made. See Table 2 for a description of the specific cues prescribed to each participant.

Once the researchers identified the cued trials to include, all selected video footage was imported into a video template structured to allow the participants to view approximately 50 seconds of their own non-cued and cued gait performance, followed by three minutes of practice with attention explicitly directed to execution of the specific cue featured in the gait performance immediately preceding the practice period. Figure 1 provides an overview of the video intervention. The sequence of watching gait performance and practicing cued gait performance was repeated three consecutive times, which amounted to an average video duration of 16 minutes and 33 seconds. Multiple brief transition and instructional periods were included in natural intermittent positions.

Table 2
Prescribed Cues

	P1	P2	P3	P4	P5
Take big, long steps	✔		✔	✔	
Take long steps	✔				✔✔
Walk heel-toe, heel-toe					✔
Keep your head up			✔	✔	
Walk heel-toe with long steps	✔		✔	✔	
Bend at the Knee		✔✔✔			

Note. P1-P5 = Participant 1 – 5; number of ✔ represents the number of times a cue was prescribed for home use. The participants were prescribed one, two, or three cues, depending on which cues were observed to be effective during the preintervention laboratory session. When fewer than three cues were deemed effective, one of the cues was prescribed more than once.

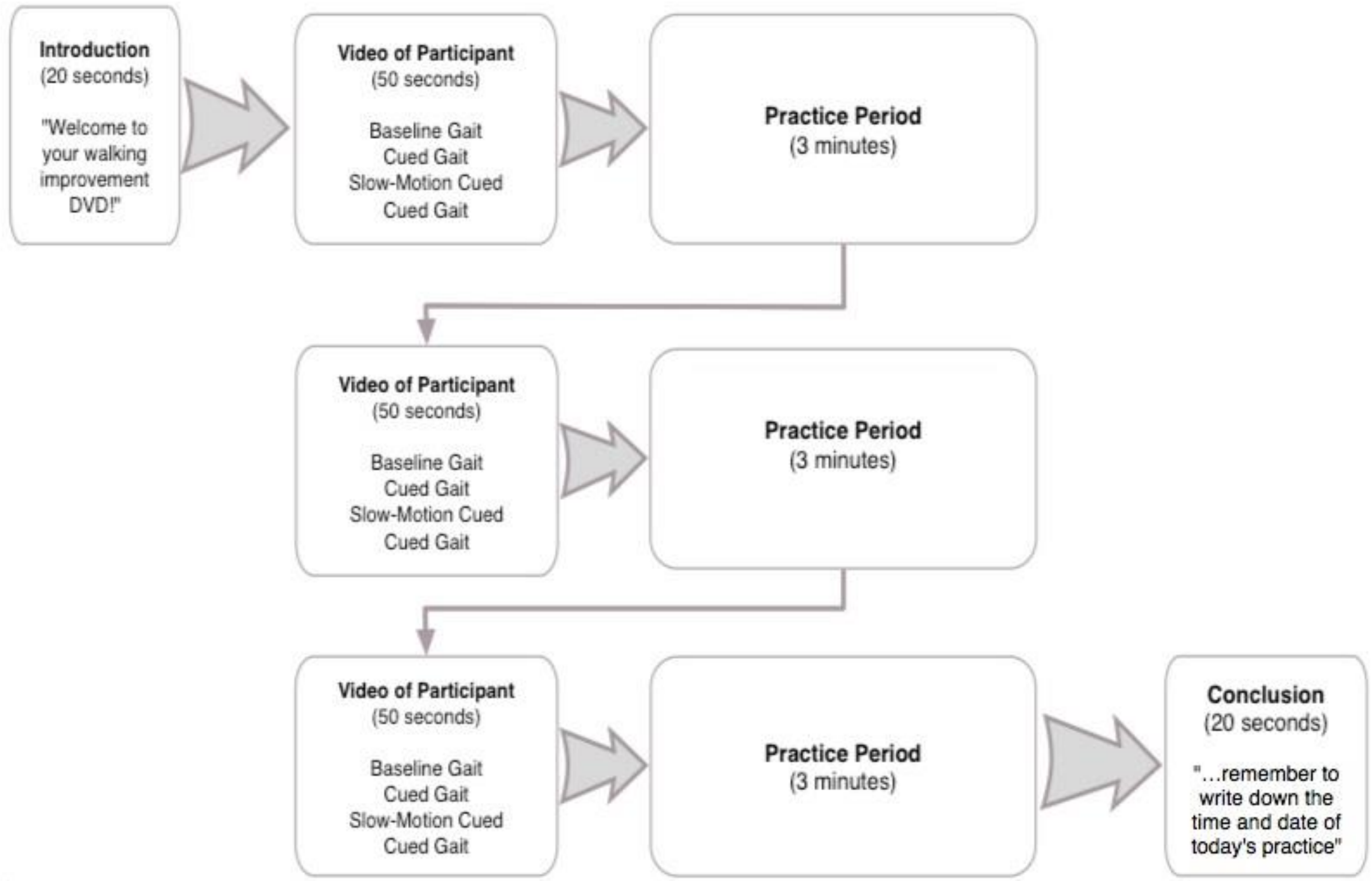

Figure 1. Times indicated are an approximation of the duration of time allocated to each aspect of the intervention video.

Within one week of completing the baseline testing session, the video intervention was delivered to the participants' homes as either .M4V files burned onto a DVD, or as .M4V files transferred directly onto the participant-owned iPads (®Apple Inc.). At this time, the participants were given instructions to practice with their video every other day for a two-week period and were asked to complete a practice journal to record the date and time of practice along with observations or feedback from the practice session. In addition, feedback regarding the intervention and the participants' experiences throughout the intervention were collected from the participants during laboratory visits after a two-week intervention period and after a two-month unprescribed practice period. To solicit feedback, brief semi-structured interviews were conducted at the conclusion of each of the two testing sessions. The researchers asked probing questions designed to elicit feedback regarding the participants' experiences of using the intervention (both positive and negative) and the participants' perceptions of how, if at all, the intervention affected their gait.

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Postintervention Testing

Within one week of completing the gait training intervention, the participants were re-assessed in the laboratory. During this session, functional mobility and non-cued walking patterns were assessed in an identical manner as during the preintervention visit by way of using the TUG test and GAITRite® instrumented carpet, respectively. Upon completing the postintervention testing, the participants were instructed to use their video intervention as frequently or infrequently as they wished and were invited to return for a two-month follow-up session. The purpose of this follow-up was to test retention of any improvements made during the postintervention stage. The participants were told that they did not have to use their video interventions at all during this follow-up period. The decision not to require the participants to use their video intervention during this phase of the study allowed the research team to gain an ecological perspective of whether the participants would continue to employ the cognitive cueing strategies freely (without direction from study investigators) or whether the participants would abandon the cognitive cueing strategy over time. After this two month unprescribed period, four of the five participants returned for a final laboratory session. Once again, the participants had their functional mobility and non-cued gait patterns assessed as per previous study protocol via the TUG and GAITRite® instrumented carpet.

Analysis

Given that this was a pilot study, the intent was to examine the feasibility and direction of impact of this novel gait retraining intervention. As such, qualitative evaluation of the participants' responses from the semi-structured interview and practice journals was conducted. Specifically, a directed content analysis approach as described by Hsieh and Shannon (2005) was conducted, wherein the researchers categorized participant feedback into the following themes: results-oriented feedback, positive aspects of the intervention, and areas of the intervention that could have been improved upon. In addition, based on the recommendations of Leon, Davis, and Kraemer (2011) and Arain, Campbell, Cooper, and Lancaster (2010), the researchers did not calculate inferential statistics including effect size estimates. Although the researchers did not perform formal inferential statistical calculations, descriptive statistics were computed for each outcome measure (step length, velocity, and TUG score) in order to make comparisons that allowed for an examination of absolute change from baseline and percentage change from baseline for postintervention and the two-month follow-up.

Results

Feasibility Analysis

At the outset of the study the initial protocol was to have all of the participants watch the training video on a traditional TV-DVD setup. However, once the study started, two of the participants (PD2 and PD4) expressed interest in adopting different technological platforms. PD2 requested to use a laptop so she could practice outside in her driveway, as she thought this would make practicing easier than in her house where space and distractions were more likely to impede her practice. Similarly, PD4 requested to use his iPad because his tv was located in his basement, and he believed the iPad would make practicing easier and more accessible. As such, three participants used the traditional TV-DVD setup, one used a laptop, and one used an iPad. With the exception of one participant who experienced some difficulty when attempting to use the iPad to practice the intervention outdoors, the participants reported having no problems (technical or otherwise) with carrying out the intervention in the home setting. Irrespective of the technology used, a review of the participants' practice journals identified that there was 100% adherence to the frequency and duration of the practice protocol. Specifically, all of the participants reported engaging with their intervention seven times over two weeks, as directed by the researchers.

Participant Feedback

The majority of feedback from the participants focused on various positive aspects of the intervention. When asked about the usefulness of receiving video feedback, the participants expressed that they felt the video was helpful, and, in most cases, the participants indicated that the contrasting video from "non-cued" gait to "cued" gait was a particularly useful and motivating aspect of the intervention. Four of the participants explicitly commented on using both the video images and cueing strategies to improve their walking outside of the intervention practice time. These comments illuminated the usefulness of the specific cueing strategies and suggested that the participants became aware of their ability to shift from difficult or poor walking to improved walking. The participants also commented on the usefulness of the audio coaching that was embedded throughout the intervention, with specific feedback relating to the coaching embedded during each of the three-minute walking practice periods.

When questioned about the utility of the intervention, each of the five participants reported feeling that either their gait, specifically, or their mobility, generally, had improved through their experience with the intervention. At the two-month follow-up visit, one participant reported that by incorporating cueing strategies he believed he experienced fewer freezing episodes and falls. Overall, all of the participants reported that either they and/or their spouse felt that the intervention had improved their walking. Of note, both of the female participants reflected on the feeling of empowerment that they experienced after completing the intervention. Specifically, one of them commented that the self-cueing strategies she had learned gave her the feeling of "having control again" and she continued to elaborate on how the cueing strategies contributed to her self-esteem.

Although all of the participants were explicitly asked to provide feedback on areas of the intervention that could have been improved, only two participants commented. One participant suggested that the initial two-week intervention

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period may have been too short, stating that it may take "a little longer than two weeks" to benefit from the video. This comment came after the two-month unprescribed practice period, at which point the participant had sufficient ability to reflect on the two-week intervention experience. A second participant noted that the DVD progressed too slowly and that the slow motion sections of the cued gait footage were not necessary. Additionally, this participant reported that the iPad was "a little too touchy" to carry during walking, which was a problem because he had hoped to practice with the intervention in an outdoor environment where the iPad could not be left behind.

Gait and Mobility Analysis

Comparison of the descriptive gait kinematics during the initial preintervention visit showed that the verbal instructional cueing strategies offered to the participants were immediately effective in the short term (see Table 3). All five of the participants experienced step length increases during cued gait compared to non-cued gait in the preliminary laboratory visit, with a mean step length increase of 10.1 cm. In contrast, gait velocity decreased during cued gait compared to non-cued gait for four of five of the participants.

At the postintervention visit, after having participated in two weeks of home-based training with the gait improvement DVD, all five of the participants had increased non-cued step length ($\bar{x}$ increase 6.4 cm / 10.7% change). Of note, four of the five participants also had increased gait velocity ($\bar{x}$ increase 16.1 cm/s / 15.1% change), and four of the five participants had improved functional mobility as indicated by decreased TUG testing times ($\bar{x}$ decrease 1.1 seconds / 9.8% change) (see Table 4).

Table 3

Non-Cued and Cued Gait Kinematics During the PreIntervention Session

	Step Length (cm)			Velocity (cm/s)		
	Non-Cued	Cued [a]	Δ	Non-Cued	Cued [a]	Δ
P1	47.3	56.3	*9.0*	94.3	83.0	*-11.3*
P2	67.4	78.5	*11.1*	122.0	110.5	*-11.5*
P3	62.6	66.2	*3.6*	96.2	82.7	*-13.5*
P4	61.0	69.9	*8.9*	115.4	111.1	*-4.3*
P5	57.8	75.9	*18.1*	99.4	111.6	*12.2*

Note. P1-P5 = Participant 1 – 5. [a] Cued data represent measurements from only those cues that were prescribed for home-based practice in the video intervention.

Table 4

Non-Cued Gait Kinematics and Functional Mobility Across Study Timeline

	Step Length (cm)			Velocity (cm/s)			TUG Test (s)		
	Pre-Intervention	2-Weeks (% Δ)	2-Months (% Δ)	Pre-Intervention	2-Weeks (% Δ)	2-Months (% Δ)	Pre-Intervention	2-Weeks (% Δ)	2-Months (% Δ)
P1	47.3	49.7 (5.1)	47.5 (0.4)	94.3	91.6 (-2.9)	92.4 (-2.0)	28.0	30.0 (7.1)	25.9 (-7.5)
P2	67.4	72.1 (7.0)	70.7 (4.9)	122.0	138.3[a] (13.4)	135.6[a] (11.1)	8.6	8.3 (-3.5)	8.3 (-3.5)
P3	62.6	68.7 (9.7)	64.9 (3.7)	96.2	113.5[a] (18.0)	107.5[a] (11.7)	12.0	11.1 (-7.5)	11.5 (-4.2)
P4	61.0	69.3 (13.6)	64.9 (6.4)	115.4	130.7[a] (13.3)	123.4[b] (6.9)	13.3	11.3 (-15.0)	13.1 (-1.5)
P5	57.9	68.4 (18.1)	- -	99.4	115.0[a] (15.7)	- -	11.5	10.0 (-13.0)	- -

Note. P1-P5 = Participant 1 – 5; % Δ calculated relative to baseline measurement; A negative change in TUG is an improvement (required less time to complete the task).
[a] Substantial change of ≥ 10 cm/s improvement as defined by Perera, Mody, Woodman, and Studenski (2006). [b] Small meaningful change of ≥ 5 cm/s improvement as defined by Perera et al.

Four of the five participants completed the two-month follow-up visit, which measured retention following prolonged unprescribed cueing practice. All four of the participants who were measured at this time point had maintained step length improvements relative to preintervention levels ($\bar{x}$ improvement = 2.4 cm / 3.9%). Three of the four participants maintained improved gait velocity from preintervention levels ($\bar{x}$ improvement 11.0 cm/s / 9.9%), and all four of the participants maintained TUG score improvements from preintervention levels ($\bar{x}$ decrease 0.8 seconds / 4.2%). One participant was not measured at this time point due to personal reasons unrelated to the study protocol. Refer to Table 4 for a complete description of these two-month results.

Discussion

The changes in gait kinematics observed in this study suggest that individuals with mild to moderate PD are capable of cognitively using verbal instructional cueing strategies to improve gait, and that after a two-week period of active practice these improvements may be sustainable with little or no explicit practice over a period of at least two months. These positive results support the need for further exploration of this novel home-based gait retraining intervention. Further, results suggest that this relatively inexpensive and resource-light intervention may have empowered individuals with

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PD to self-cue, a prospect that has previously been raised by Werner and Gentile (2010).

Stride length and gait velocity are two of the most common meaningful outcome measures used by researchers in PD gait rehabilitation, and given the nature of this study, it was appropriate to employ these as outcome measures (Spaulding et al., 2012; Werner & Gentile, 2010).

The improvements in gait velocity observed in four of the participants at the two-week time point and in three of the participants at the two-month time point are clinically meaningful, according to the standards set by Perera, Mody, Woodman, and Studenski (2006). Perera et al. investigated meaningful gait speed improvements in a population of older adults with mobility difficulties, subacute stroke survivors, and community-dwelling older people and determined that a small meaningful change in gait velocity is ≥ 5 cm/s, while a substantial change in gait velocity is ≥ 10 cm/s. To our knowledge, there is no published research investigating meaningful gait velocity improvements in a PD-specific population, to which the current results could be compared.

The decrease in velocity seen during initial laboratory-based cueing, before the participants engaged with their home intervention, may be related to the principle described by Fitts' Law where speed and accuracy are inversely related (Schmidt & Lee, 2011). The inverse relationship between step length and gait velocity observed during the cueing phase of this study suggests that verbal instructional cueing from researchers may have directed the participants to focus on gait performance, as denoted by step length, as a "cost" of gait speed. This observation suggests that attentional resources were divided between aspects of gait performances and the act of thinking about the gait cueing strategy during the initial laboratory-based cueing (Yogev-Seligmann, Rotem-Galili, Dickstein, Giladi, & Hausdorff, 2012). However, the effects of this proposed suspected speed-accuracy trade off were only present during the initial cueing session, suggesting that cueing strategies may have been learned and were no longer novel or attention demanding at the postintervention follow-up session.

Our results support the possibility of "cue learning" by individuals with PD, which was also observed by Werner and Gentile (2010). Specifically, Werner and Gentile noted that the participants in both groups appeared to have learned cueing strategies after intensive laboratory practice. One group in the Werner and Gentile study received the verbal instruction to "take a big step", while the other group received this same verbal instruction in addition to videotape feedback of their own walking taken from an immediately prior gait performance. The results of their 2010 study indicated positive short-term effects with longer-term retention of the two intensive gait-retraining strategies among an initial group of 12 individuals with PD. In comparison to the time-intensive training protocol adopted by Werner and Gentile, the current study implemented a gait training intervention that would be less demanding on clinical resources and, therefore, more feasible for implementation within a clinical rehabilitation context. Although the exact amount of time that clinicians would need to devote to implement this intervention remains unknown, it seems reasonable to expect that it would require no more than two hours. This approximation was based on the following breakdown of events: One 45 minute session with the client to determine best cueing strategies and videotape non-cued and cued gait, 45 minutes for the clinician (independent of client) to edit the video and create the intervention DVD, and one 30 minute session with the client to review the DVD and provide education regarding practice expectations.

The home-based intervention examined within the present study weaved together principles from the field of experimental motor learning, including guiding principles for practice distribution (Schmidt & Lee, 2011) and self-modeling in skill acquisition (Ashford, Bennett, & Davids, 2006; Braaksma, Rijlaarsdam, & van den Bergh, 2002; SooHoo, Takemoto, & McCullagh, 2004), with traditional cueing approaches commonly used in the management and treatment of PD. By design, the intervention requires fewer resources and can be implemented at a relatively lower cost than traditional therapies that require research and/or clinic visits on a regular basis. This intervention also moved training out of a laboratory setting and into a more natural environment in order to offer an ecologically relevant rehabilitation protocol.

It is both interesting and important to note that the researchers originally designed this study to be only two weeks in duration, with the aim to pilot the delivery of the video intervention over a relatively brief two-week period. However, at the conclusion of the two-week intervention period, all of the participants expressed the intention to continue using the cueing strategies that were prescribed in the home videos. Given this overwhelming uptake of the intervention, the researchers revised the ethics protocol to permit the participants to continue practicing with the video intervention for an additional two months and to be reassessed in the laboratory once again. Accordingly, the researchers invited the participants back to the lab two months after the formal two-week intervention period concluded. The researchers instructed the participants that formal practice with the video was not necessary during the two-month period but asked the participants to take note of any formal practice in which they engaged. Of note, those participants who attended the two-month follow-up visit gave anecdotal indication that while they did not formally engage with their video intervention they continued to incorporate the cueing strategies into day-to-day gait performance.

Overall, the participants and their spouses who attended the research sessions had an overwhelmingly positive response to the intervention. The participants reported feeling that the intervention improved their gait, and they also reported positive emotional effects, such as a fortified sense of ability and a revived sense of empowerment. While not formally assessed in this research study, these qualitative aspects of the intervention came across as important to the participants. Future studies should consider objectively assessing the participants' attitudes toward their gait abilities before and after home-based gait retraining. One possible assessment that may serve this purpose is the Activities-Specific Balance Confidence Scale (ABC). This scale is a brief self-report measure that quantifies an individual's level of confidence in completing several functional gait activities, such as walking around the house, walking up and down stairs, and walking outside across a mall parking lot. Moreover, it would also be worthwhile to consider if positive emotional experiences, such as those conveyed by the participants, are related to the outstanding practice adherence self-reported throughout the study.

While the authors incorporated specific principles of motor learning into the current intervention design, the aim of this intervention was not to reach skill automaticity, as is the usual goal of motor learning and skill acquisition. Given the neurological underpinnings of PD, the authors chose to use motor learning principles as tools to facilitate self-cueing and thus incorporated observational learning through self-modeling in the intervention design. This approach appeared to teach the participants strategies to control their own gait; therefore, we consider the intervention a "cognitive cueing approach." This term refers to the process whereby the participants reported being able to cognitively recognize a decrease in gait quality and choose to incorporate verbal instructional cueing strategies in order to improve gait performance. This process resulted in improved non-cued gait performance in laboratory sessions that followed the two-week intervention period and after a two-month unprescribed practice period.

Impact on Occupation

Given the overwhelming evidence indicating that gait impairments limit independence, reduce quality of life, and place individuals at an increased risk for falls and injury (Moore, Peretz, & Giladi, 2007), strategies that help mitigate these issues are likely to lend themselves to fostering improved occupational participation. For example, not only does the cognitive cueing approach have the potential to benefit mobility directly by way of improvements to spatial-temporal parameters of gait (i.e., velocity and step length), these improvements may positively impact mobility by affecting ones' psychosocial functioning. For example, teaching participants to recognize a decrease in their quality of gait and subsequently empowering them to employ cueing strategies that are invisible to those around them is likely to foster an increased sense of control and confidence in relation to their mobility. This is important as discussed by Holmes, Lutz, Ravenek, Rudman, and Johnson (2013); individuals with PD often reject the use of alternate management strategies (i.e., mobility aids), associating these devices with dependency, disability, and weakness (Haahr, Kirkevold, Hall, & Østergaard, 2011; Sunvisson, 2006). Moreover, with an enhanced sense of self-confidence, individuals will be less likely to experience apprehension or anxiety that is known to impact gait negatively (Nuti et al., 2004), and instead would be more inclined to participate in activities that are meaningful and bring purpose to their lives, thereby improving their quality of life.

Limitations

The intervention tested in this study was novel; therefore, it was appropriate to conduct a pilot study. However, the small study population imposes a limitation in that results reported here cannot be presumed to be generalizable. A necessary next step is to implement this intervention in a sample size large enough to detect statistically meaningful treatment effects. An additional limitation of the study is the reliance on participant self-reporting of practice protocol adherence. Efforts were made to minimize potential over-estimations of practice adherence by soliciting specific details relating to the date, time, and experiences of each practice session. During the two-week intervention period, the participants reported 100% adherence to the practice protocol. While this perfect adherence may appear suspect, the participants reported feeling that the intervention was effective and that their gait improved with practice. These comments suggest that throughout the intervention the participants experienced a growing sense of self-efficacy, a factor known to be important in promoting good practice adherence (Schechter & Walker, 2002; Sirur, Richardson, Wishart, & Hanna, 2009). Further, if this over estimation of practice adherence occurred, then the implication would actually be positive, as it would suggest that the participants achieved meaningful gait improvement with less practice than the authors expected would be required. In future investigations, a more objective measure of participant protocol compliance could be obtained if the intervention were to be delivered via a secure Internet portal. In doing so, researchers could track the days and times the participants completed their training via an electronic log. Although possible, one potential downfall to this approach is that not all of the participants may be technologically versed or have access to the Internet, thus restricting their engagement with the intervention.

Conclusion

The clinical implications for this gait improvement strategy are important. If further testing in a larger sample size supports our preliminary results, this tool would help clinicians support their patients in a cost-effective way. The feasibility of this gait retraining approach is enhanced due to the minimal upfront costs and small amount of time required for implementation. Further, it is easily updated as patients progress through the course of their disease, in either a positive or negative direction. This intervention indicated that patients are able to articulate and implement their own cueing strategies, and this method of involving patients in their own care is promising and should be pursued. Perhaps the most noteworthy aspect of this gait retraining intervention was the observation that positive gait changes were muted but not extinguished after a prolonged passive practice period, indicating that even a small amount of directed home-based practice may maintain meaningful long-term effects on gait improvement among individuals with PD. Further investigation of this strategy is therefore warranted.

References

Arain, M., Campbell, M. J., Cooper, C. L., & Lancaster, G. A. (2010). What is a pilot or feasibility study? A review of current practice and editorial policy. *BMC Medical Research Methodology*, *10*(67), 1-7. http://dx.doi.org/10.1186/1471-2288-10-67

Ashford, D., Bennett, S. J., & Davids, K. (2006). Observational modeling effects for movement dynamics and movement outcome measures across differing task constraints: A meta-analysis. *Journal of Motor Behavior*, *38*(3), 185-205. http://dx.doi.org/10.3200/JMBR.38.3.185-205

Baker, K., Rochester, L., & Nieuwboer, A. (2007). The immediate effect of attentional, auditory, and a combined cue strategy on gait during single and dual tasks in Parkinson's disease. *Archives of Physical Medicine and Rehabilitation*, *88*(12), 1593-1600. http://dx.doi.org/10.1016/j.apmr.2007.07.026

Baker, K., Rochester, L., & Nieuwboer, A. (2008). The effect of cues on gait variability—reducing the attentional cost of walking in people with Parkinson's disease. *Parkinsonism & Related Disorders*, *14*(4), 314-320. http://dx.doi.org/10.1016/j.parkreldis.2007.09.008

Behrman, A. L., Teitelbaum, P., & Cauraugh, J. H. (1998). Verbal instructional sets to normalise the temporal and spatial gait variables in Parkinson's disease. *Journal of Neurology, Neurosurgery & Psychiatry*, *65*(4), 580-582. http://dx.doi.org/10.1136/jnnp.65.4.580

Braaksma, M. A. H., Rijlaarsdam, G., & van den Bergh, H. (2002). Observational learning and the effects of model-observer similarity. *Journal of Educational Psychology*, *94*(2), 405-415. http://dx.doi.org/10.1037//0022-0663.94.2.405

Canning, C. G. (2005). The effect of directing attention during walking under dual-task conditions in Parkinson's disease. *Parkinsonism & Related Disorders, 11*(2), 95-99. http://dx.doi.org/10.1016/j.parkreldis.2004.09.006

Canning, C. G., Ada, L., & Woodhouse, E. (2008). Multiple-task walking training in people with mild to moderate Parkinson's disease: A pilot study. *Clinical Rehabilitation*, *22*(3), 226-233. http://dx.doi.org/10.1177/0269215507082341

Chien, S. L., Lin, S. Z., Liang, C. C., Soong, Y. S., Lin, S. H., Hsin, Y. L., . . . Chen, S. Y. (2006). The efficacy of quantitative gait analysis by the GAITRite system in evaluation of Parkinsonian bradykinesia. *Parkinsonism & Related Disorders*, *12*(7), 438-442. http://dx.doi.org/10.1016/j.parkreldis.2006.04.004

Felix, K., Gain, K., Paiva, E., Whitney, K., Jenkins, M. E., & Spaulding, S. J. (2012). Upper extremity motor learning among individuals with Parkinson's disease: A meta-analysis evaluating movement time in simple tasks. *Parkinson's Disease*, Article ID 589152, 1-7. http://dx.doi.org/10.1155/2012/589152

Ferrandez, A. M., & Blin, O. (1991). A comparison between the effect of intentional modulations and the action of L-dopa on gait in Parkinson's disease. *Behavioural Brain Research*, *45*(2), 177-183. http://dx.doi.org/10.1016/S0166-4328(05)80083-X

Fok, P., Farrell, M., McMeeken, J., & Kuo, Y. L. (2011). The effects of verbal instructions on gait in people with Parkinson's disease: A systematic review of randomized and non-randomized trials. *Clinical Rehabilitation*, *25*(5), 396-407. http://dx.doi.org/10.1177/0269215510387648

Gauntlett-Gilbert, J., & Brown, V. J. (1998). Reaction time deficits and Parkinson's disease. *Neuroscience & Biobehavioral Reviews*, *22*(6), 865-881. http://dx.doi.org/10.1016/S0149-7634(98)00014-1

Grimbergen, Y. A. M., Munneke, M., & Bloem, B. R. (2004). Falls in Parkinson's disease. *Current Opinions in Neurology*, *17*(4), 405-415. http://dx.doi.org/10.1097/01.wco.0000137530.68867.93

Haahr, A., Kirkevold, M., Hall, E. O. C., & Østergaard, K. (2011). Living with advanced Parkinson's disease: A constant struggle with unpredictability. *Journal of Advanced Nursing*, *67*(2), 408-417. http://dx.doi.org/10.1111/j.1365-2648.2010.05459.x

Holmes, J. D., Lutz, S., Ravenek, M., Rudman, D. L., & Johnson, A. M. (2013). Enhancing client-centeredness in Parkinson's disease care: Attending to the psychosocial implications of lived experience. *The Open Journal of Occupational Therapy*, *1*(4), Article 7.

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277-1288. http://dx.doi.org/10.1177/1049732305276687

Huang, S. L., Hsieh, C. L., Wu, R. M., Tai, C. H., Lin, C. H., & Lu, W. S. (2011). Minimal detectable change of the Timed "Up & Go" test and the Dynamic Gait Index in people with Parkinson disease. *Physical Therapy*, *91*(1), 114-121. http://dx.doi.org/10.2522/ptj.20090126

Iansek, R., Huxham, F., & McGinley, J. (2006). The sequence effect and gait festination in Parkinson disease: Contributors to freezing of gait? *Movement Disorders*, *21*(9), 1419-1424. http://dx.doi.org/10.1002/mds.20998

Lehman, D. A., Toole, T., Lofald, D., & Hirsch, M. A. (2005). Training with verbal instructional cues results in near-term improvement of gait in people with Parkinson disease. *Journal of Neurologic Physical Therapy*, *29*(1), 2-8. http://dx.doi.org/10.1097/01.NPT.0000282256.36208.cf

Leon, A. C., Davis, L. L., & Kraemer, H. C. (2011). The role and interpretation of pilot studies in clinical research. *Journal of Psychiatric Research*, *45*(5), 626-629. http://dx.doi.org/10.1016/j.jpsychires.2010.10.008

Meissner, W. G., Frasier, M., Gasser, T., Goetz, C. G., Lozano, A., Piccini, P., . . . Bezard, E. (2011). Priorities in Parkinson’s disease research. *Nature Reviews Drug Discovery*, *10*(5), 377-393. doi:10.1038/nrd3430

Moore, O., Peretz, C., & Giladi, N. (2007). Freezing of gait affects quality of life of peoples with Parkinson’s disease beyond its relationships with mobility and gait. *Movement Disorders*, *22*(15), 2192-2195. http://dx.doi.org/10.1002/mds.21659

Morris, M. E., Iansek, R., Matyas, T. A., & Summers, J. J. (1994). The pathogenesis of gait hypokinesia in Parkinson’s disease. *Brain*, *117*(5), 1169-1181. http://dx.doi.org/10.1093/brain/117.5.1169

Morris, M. E., Iansek, R., Matyas, T. A., & Summers, J. J. (1996). Stride length regulation in Parkinson’s disease: Normalization strategies and underlying mechanisms. *Brain*, *119*(2), 551-568. http://dx.doi.org/10.1093/brain/119.2.551

Morris, S., Morris, M. E., & Iansek, R. (2001). Reliability of measurements obtained with the Timed “Up & Go” test in people with Parkinson disease. *Physical Therapy*, *81*(2), 810-818.

Nelson, A. J., Zwick, D., Brody, S., Doran, C., Pulver, L., Rooz, G., . . . Rothman, J. (2002). The validity of the GaitRite and the Functional Ambulation Performance scoring system in the analysis of Parkinson gait. *NeuroRehabilitation*, *17*(3), 255-262.

Nuti, A., Ceravolo, R., Piccinni, A., Dell’Agnello, G., Bellini, G., Gambaccini, G., . . . Bonuccelli, U. (2004). Psychiatric comorbidity in a population of Parkinson’s disease patients. *European Journal of Neurology*, *11*(5), 315-320. http://dx.doi.org/10.1111/j.1468-1331.2004.00781.x

Pendt, L. K., Reuter, I., & Müller, H. (2011). Motor skill learning, retention, and control deficits in Parkinson’s disease. *PLoS ONE*, *6*(7), e21669. http://dx.doi.org/10.1371/journal.pone.0021669

Perera, S., Mody, S. H., Woodman, R. C., & Studenski, S. A. (2006). Meaningful change and responsiveness in common physical performance measures in older adults. *Journal of the American Geriatrics Society*, *54*(5), 743-749. http://dx.doi.org/10.1111/j.1532-5415.2006.00701.x

Podsiadlo, D., & Richardson, S. (1991). The timed “Up & Go”: A test of basic functional mobility for frail elderly persons. *Journal of the American Geriatrics Society*, *39*(2), 142-148.

Rochester, L., Baker, K., Hetherington, V., Jones, D., Willems, A. M., Kwakkel, G., . . . Nieuwboer, A. (2010). Evidence for motor learning in Parkinson's disease: Acquisition, automaticity and retention of cued gait performance after training with external rhythmical cues. *Brain Research*, *1319*, 103-111. http://dx.doi.org/10.1016/j.brainres.2010.01.001

Rochester, L., Hetherington, V., Jones, D., Nieuwboer, A., Willems, A. M., Kwakkel, G., & Van Wegen, E. (2005). The effect of external rhythmic cues (auditory and visual) on walking during a functional task in homes of people with Parkinson's disease. *Archives of Physical Medicine and Rehabilitation*, *86*(5), 999-1006. http://dx.doi.org/10.1016/j.apmr.2004.10.040

Rochester, L., Nieuwboer, A., & Lord, S. (2011). Physiotherapy for Parkinson’s disease: Defining evidence within a framework for intervention. *Neurodegenerative Disease Management*, *1*(1), 57-65. http://dx.doi.org/10.2217/nmt.11.1

Schechter, C. B., & Walker, E. A. (2002). Improving adherence to diabetes self-management recommendations. *Diabetes Spectrum*, *15*(3), 170-175. http://dx.doi.org/10.2337/diaspect.15.3.170

Schmidt, R. A., & Lee, T. D. (2011). *Motor control and learning : A behavioral emphasis* (5th ed.). Champaign, IL: Human Kinetics.

Shulman, L. M. (2010). Understanding disability in Parkinson's disease [Special Issue]. *Movement Disorders*, *25*(S1), S131-S135. http://dx.doi.org/10.1002/mds.22789

Shulman, L. M., Gruber-Baldini, A. L., Anderson, K. E., Vaughan, C. G., Reich, S. G., Fishman, P. S., & Weiner, W. J. (2008). The evolution of disability in Parkinson disease. *Movement Disorders*, *23*(6), 790-796. http://dx.doi.org/10.1002/mds.21879

Sirur, R., Richardson, J., Wishart, L., & Hanna, S. (2009). The role of theory in increasing adherence to prescribed practice. *Physiotherapy Canada*, *61*(2), 68-77. http://dx.doi.org/10.3138/physio.61.2.68

SooHoo, S., Takemoto, K.Y., & McCullagh, P. (2004). A comparison of modeling and imagery on the performance of a motor skill. *Journal of Sport Behavior*, *27*(4), 349-366.

Spaulding, S. J., Barber, B., Colby, M., Cormack, B., Mick, T., & Jenkins, M. E. (2012). Cueing and gait improvement among people with Parkinson's disease: A meta-analysis. *Archives of Physical Medicine and Rehabilitation*, *94*(3), 562 -570. http://dx.doi.org/10.1016/j.apmr.2012.10.026

Sunvisson, H. (2006). Stopped within a track: Embodied experiences of late-stage Parkinson's disease. *International Journal of Qualitative Studies on Health and Well-Being*, *1*(2), 91-99. http://dx.doi.org/10.3402/qhw.v1i2.4921

Werner, W. G., & Gentile, A. M. (2003). Instructional cues and Parkinsonian gait: A pilot study. *Neurology Report*, *27*(1), 8-14. http://dx.doi.org/10.1097/01253086-200327010-00003

Werner, W. G., & Gentile, A. M. (2010). Improving gait and promoting retention in individuals with Parkinson's disease: A pilot study. *Journal of Neurology*, *257*(11), 1841-1847. http://dx.doi.org/10.1007/s00415-010-5619-z

Yogev-Seligmann, G., Rotem-Galili, Y., Dickstein, R., Giladi, N., & Hausdorff, J. M. (2012). Effects of explicit prioritization on dual task walking in patients with Parkinson's disease. *Gait & Posture*, *35*(4), 641-646. http://dx.doi.org/10.1016/j.gaitpost.2011.12.016