

**At-home training with virtual reality cues for improvement of gait in patients with
Parkinson's disease**

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ABSTRACT

Background: Shuffling and freezing of gait impair function in Parkinson's disease (PD). Open-loop devices providing fixed-velocity visual or auditory cues can improve gait but may cause confusion or exacerbate freezing of gait in PD.

Objective: To evaluate the effects of at-home training with a closed-loop, accelerometer-driven, wearable visual-and-auditory virtual cueing system on gait velocity, stride length, and cadence in PD patients with off-state gait impairment.

Methods: Thirteen PD patients with off-state gait impairment were studied. Gait velocity, stride length, and cadence were measured in the practically-defined off state using a validated electronic gait analysis system in five conditions at baseline and after 2 weeks of daily 30-minute at-home use of a virtual cueing device. Subjects underwent standard motor assessment and completed a self-administered Freezing of Gait Questionnaire (FOGQ; range 0-24, lower is better).

Results: After training, device use improved walking velocity by 19% (from 60.1 ± 19.5 to 72.1 ± 26.4 cm/sec; $p = 0.006$) and stride length by 14% (from 74.3 ± 16.4 to 84.0 ± 18.5 cm; $p = 0.004$). The improvement in cadence was not significant. Upon device removal, walking velocity increased by a further 18% (from 65.5 ± 21.7 to 76.2 ± 21.5 cm/sec; $p = 0.0004$) and stride length by 15% (from 79.0 ± 20.3 to 88.8 ± 17.7 cm; $p = 0.003$), suggesting significant immediate residual benefit. Nearly 70% of the subjects improved by at least 20% in either walking velocity, stride length, or both. The FOGQ improved from 14.2 ± 1.9 to 12.4 ± 2.5 ($p = 0.019$).

Conclusions: Gait velocity and stride length were improved in PD patients after training with a virtual reality visual-and-auditory feedback cueing system, with a marked residual effect. Devices utilizing closed-loop sensory feedback are desirable non-pharmacologic interventions to improve walking in PD.