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Virtual Reality Feedback for Gait Improvement in Patients with Idiopathic Senile Gait Disorders and in Patient with History of strokes

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To the Editor: It has been demonstrated that sensory stimuli may improve the walking abilities of patients with movement disorders. In particular, earth-stationary visual cues were found to have a beneficial effect on gait in patients with Parkinson's disease (PD)[1,2]. In a previous study we demonstrated the closed-loop effects of real-world visual cues on the regulation and stabilization of gait[3]. This has led to the development of a wearable closed-loop virtual reality (VR) apparatus[4] which, employing an inertial feedback system to incorporate the patient's body motions in the display, creates a visual sensation of moving with respect to earth-stationary tiles. The visual feedback device was found to be more effective for gait improvement in patients with PD than the open-loop version, displaying fixed-velocity motion[5]. The device was also found to improve gait in patients with multiple sclerosis (MS)[6]. In the present study, we employed this device to study the effects of visual feedback cues on gait in patients with idiopathic senile gait (SG), some of whom had previous history of strokes (PS).

The study was approved by the Israel Ministry of Health and the institutional Helsinki committees, and informed consent was obtained from each participants, once the nature of the procedure was explained. Twenty one randomly selected old-

age home residents suffering from SG, including six with PS, participated in the study. Exclusion criteria: considerable visual deficit not compensated by correction, ocular movement dysfunction (egs. diplopia, nystagmus), and gait disturbances due to pronounced muscle weakness, lower limb spasticity, sensory ataxia, or considerable general fatigue. Visual cues were generated by the closed-loop VR device shown in Figure 1. Tests were performed at two old-age homes in Haifa, Israel at about the same time in the morning. Examination of each patient comprised two stages, each consisting of the patient walking a straight track of 10 meters four times: Stage 1: The patient was verbally instructed to "walk normally" without the device. The time to complete the 10m track and the number of steps were recorded. Stage 2: The device was put on the patient and turned on. The patient was instructed to walk on the virtual tiles, while imagining walking on real tiles, attempting to reach the next tile in each step. The time to complete the 10m track and the number of steps were recorded. The walking speed (meters/second) and the stride length (meters) were calculated from the time and the number of steps needed to complete the 10m track. The results were averaged for each stage.

Thirteen patients (13/21) improved their walking speed or stride length or both. Nine patients improved their walking speed or stride length or both by more than 10%. In patients with baseline performance above the median, the average improvement was considerably higher (6.31 ± 12.59 in walking speed and $6.41\% \pm 11.11\%$ in stride length) than in patients with baseline performance below the median ($-0.72\% \% \pm 22.75\%$ in walking speed and $3.39\% \pm 11.26\%$ in stride length). Four (4/6) patients with PS improved their walking speed or stride length or both by more than 10%. While all 4 patients with left hemisphere vascular accident improved their gait, both patients with right hemisphere vascular accident did not improve. In the PS patients with baseline performance above the median, improvement was considerably higher ($13.2\% \pm 6.0\%$ in walking speed and $16.6\% \pm 4.7\%$ in stride length) than in patients with baseline performance below the median ($-9.93\% \pm 27\%$ in walking speed and $-7.67\% \pm 12.31\%$ in stride length). The VR visual feedback cues did not improve gait in patients with vascular risk factors but without history of PS. Education was a relatively good predictor of improvement (e.g., for the three patients with 8 years of study, average improvement in walking speed was $-8.83\% \pm 23.81\%$ and in stride length $-4.67\% \pm 15.30\%$, for the four patients with 12 years of study, average improvement in walking speed was $-1.85\% \pm 26.83\%$ and in stride length $3.82\% \pm 9.75\%$, and for the two patients with 20 years of study average improvement in walking speed was $6.75\% \pm 0.49\%$ and in stride length $14.55\% \pm 12.66\%$).

The results of the present study indicate that it is possible to use VR cues, superimposed on the real world in a closed-loop fashion, to help patients with senile gait, and, in particular, patients with a history of strokes, control their gait. The degree of improvement was found to be related to the baseline walking speed and

stride length and to the level of education. Future studies should explore the long-term effects of training with such cues for therapeutic and rehabilitation purposes.

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Conflict of interest: Dr. Baram is the developer of the virtual reality device used in this study. Dr. Aharon-Peretz has nothing to disclose. Dr. Lenger has nothing to disclose.

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Figure 1: Visual-feedback virtual reality device used in tests