EFFECT OF VIRTUAL OBSTACLES NEGOTIATION ON TEMPORAL-SPATIAL GAIT IN HEALTHY YOUNG ADULTS

Mohammad Al-Amri [1,*] Omowumi Dairo [1] Robert van Deursen [1]

[1] School of Healthcare Sciences, Cardiff University, Cardiff, United Kingdom

Introduction and Objectives: Negotiating obstacles is a complex motor-control task that is described as the most common cause of falling during walking [1-2]. Successful obstacle negotiation may be compromised in individuals with gait problems [3]. Understanding how individuals negotiate obstacles while maintaining a stable and safe walking pattern is therefore important for development of interventions based on motor learning. Virtual reality can provide controlled stimuli in a meaningful, safe environment for rehabilitation and motor-control assessment [4]. This study aimed to explore how healthy individuals respond to different presentations of virtual obstacles (VOs). The expectation was that the similar changes would occur in their motor-control as seen for real-world obstacle clearance. Changes in average values of gait parameters were used as performance indicators whereas changes in variability of these parameters were used to indicate altered motor-control.

Methods: Twenty healthy subjects (Age: 25.5±3.9 years; Height: 1.71±0.07 m; Mass: 68.7±11.9 kg; Gender: 12 male & 8 female) walked on a GRAIL system (Gait Real-time Analysis Interactive Lab, Motek Medical B.V.); which consists of an instrumented dual-belt treadmill and a 12-camera Vicon tracking system. Using the self-paced mode, subjects walked under three conditions with a simple 3D endless speed-matched scene presented onto an integrated synchronised 180° screen including projection on the treadmill: 1) Free walking (WalkFR); 2) while clearing regular spaced VOs projected on the treadmill (WalkOT); 3) while clearing regular spaced VOs by controlling spheres representing the toe markers projected on the screen (WalkOS). The VOs in this study were designed in the form of a threshold across the walkway with dimensions 1.0 m x 0.2 m x 0.1 m. Each condition lasted for 3 minutes.

The average and variability (standard deviation) of 1 minute of continuous gait were calculated for: gait speed (GS), cadence (CA), stride length (SL), stride time (ST), and stance duration (SD). A repeated measures ANOVA was used to explore changes in these variables associated with the above walking conditions. The assumption was that the order of difficulty was: WalkFR, WalkOT, and WalkOS. This was tested by means of a polynomial (linear) contrast. The level of statistical significant was set at $p<0.05$.

Results: Descriptive statistics for gait parameters (GS, CA, SL, ST, and SD) are presented in Table 1. GS and CA decreased significantly whilst ST and SD increased significantly with performing the obstacle negotiation tasks. There were no significant changes for SL.

For the gait variability, the results suggest that there were significant changes for all gait variables. Polynomial contrast analysis indicated that there were significant linear differences for GS, CA, ST, and SD related to the predicted order of difficulty: WalkFR, WalkOT, and WalkOS.

Conclusion: Reported results suggest that, as hypothesised, motor-control strategies changed with demand of obstacles negotiation in young healthy subjects. Results indicate that clearing VOs projected on the screen was more difficult than while clearing VOs projected on the treadmill. It may be that differences in demand on cognition and attention can explain

why WalkOS was more difficult than WalkOT. Further studies are needed to clarify these effects and consolidate this conclusion.

Table:

	WalkFR	WalkOT	WalkOS	p-values	polynomial contrast
Average Values of Temporal-Spatial Gait Parameters					
Speed (m/s)	1.33±0.265	1.32±0.215	1.21±0.21	0.019	0.027
Cadence (step/min)	104.75±8.95	99.59±10.19	95.06±9.76	<0.001	<0.001
Stride Length (m)	1.52±0.197	1.59±0.156	1.53± 0.166	0.086	N/A (0.710)
Stride Time (s)	1.05±0.09	1.09±0.116	1.15± 0.115	<0.001	<0.001
Stance Duration (s)	0.699±0.0717	0.720±0.086	0.757±0.091	0.005	0.004
Variance Values of Temporal-Spatial Gait Parameters					
Speed (m/s)	0.13±0.01	0.15±0.016	0.157±0.022	<0.001	<0.001
Cadence (step/min)	10.19±1.07	13.54±1.869	14.36±2.9	<0.001	<0.001
Stride Length (m)	0.058±0.017	0.135±0.030	0.17±0.058	<0.001	<0.001
Stride Time (s)	0.018±0.006	0.063±0.02	0.085±0.048	<0.001	<0.001
Stance Duration (s)	0.017±0.005	0.047±0.015	0.056±0.023	<0.001	<0.001

Caption: Descriptive statistics (means and standard deviations) of gait parameters during three walking conditions: WalkFR (walking on the treadmill with 3D scene without negotiating obstacles; WalkOT (walking on the treadmill with 3D scene while clearing regular spaced VOs projected on the treadmill); and WalkOS (walking on the treadmill with 3D scene while clearing regular spaced VOs by remotely controlling spheres representing the toe markers projected on the screen). p-Values indicate the comparison between these conditions while polynomial contrast refers to the p-values of polynomial test of within-subjects contrasts.

References: [1] Galna et al, Gait & Posture. 30: 270-275, 2009.

[2] Connell and Wolf, Arch Phys Med Rehabil. 78:179-186, 1997.

[3] Kovacs, Journal of Applied Gerontology. 24:21-34, 2005.

[4] Mirelman et al, J Gerontol A Biol Sci Med Sci., 66: 234-240, 2011.

Disclosure of Interest: None Declared