DYNAMIC STABILITY DURING VIRTUAL HEIGHT EXPOSURE IN CHILDREN WITH CEREBRAL PALSY – A CASE-CONTROL PILOT STUDY

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Introduction

Cerebral palsy (CP) often affects dynamic stability and postural control [1], leading to walking impairments and a higher risk of falling [2]. Previous work has shown that the variability of spatiotemporal parameters can be used as a predictor of dynamic stability and fall risk [3]. Virtual reality (VR) is an increasingly used technology to induce such real-world postural challenges in a controlled environment [4].

The aim of this study was to investigate whether virtual height exposure can elicit changes in spatiotemporal parameters, self-perceived instability, and fear-of-falling (FoF) in children with CP or typical development (TD) and whether these parameters differ with virtual height between CP vs TD.

Methods

This case-control pilot study included 5 participants with CP. Main inclusion criteria were age 7-18 years, spastic CP, and gross motor function classification level 1 or 2. Excluded were children with orthopedic surgeries in the lower extremities (<1y) or botulinum toxin A (<6m). For comparison, 5 age-matched participants with TD were included. Participants were equipped with reflective markers and a head-mounted display. Following a short habituation time to adjust to the virtual environment, 6 walking trials were recorded barefoot (motion capture system) for each virtual plank height (Figure 1), applied in a randomized order.

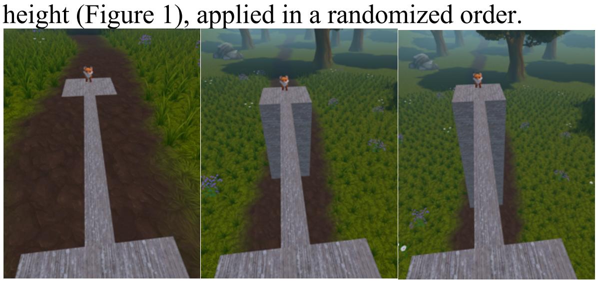

Figure 1: Virtual plank heights 0m,3m,5m (left to right).

Dynamic stability was assessed by calculating the coefficient of variation of step time (CV-ST), stride width (CV-SW) and double support (CV-DS). A two-way ANOVA was performed to analyze the effect of the study group and virtual height on these parameters. Self-perceived instability and FoF were quantified for each height using a numeric rating scale (NRS, 0-10). Mann-Whitney U test with Bonferroni correction was used for between-group comparisons (CP vs TD).

Results

Participants with CP showed a steady increase of CV-ST and CV-DS from 0m to 5m, whereas participants with TD showed a decrease in both parameters from 0m to 3m and an increase from 3m to 5m. CV-SW in CP decreased from 0m to 3m and increased from 3m to 5m, whereas in TD it steadily decreased (Table 1). Simple main effects analyses revealed that the study group had a statistically significant effect on CV-ST (p=0.01) and CV-SW (p<0.01), and the virtual height on CV-SW (p=0.02).

	CV-ST			CV-SW			CV-DS		
	0m	3m	5m	0m	3m	5m	0m	3m	5m
CP	9.4	9.9	11.0	28.7	17.7	19.6	18.8	22.4	23.1
TD	5.5	4.7	7.1	35.0	30.8	25.9	15.4	11.8	20.9

Table 1: Coefficient of variation (%) of step time (CV-ST), stride width (CV-SW), double support (CV-DS).

Compared to TD, participants with CP showed significantly higher self-perceived instability at 3m and 5m (both p=0.02). FoF was not significantly different between both groups (Table 2).

	Instability (NRS)			FoF (NRS)		
	0m	3m	5m	0m	3m	5m
CP	0(0/0)	6(3/6)	5(4/7)	0(0/0)	4(3/7)	5(3/7)
TD	0(0/0)	0(0/0)	0(0/0)	0(0/0)	0(0/1)	1(0/1)

Table 2: Numeric rating scale (NRS), median (Q1/Q3).

Discussion

This study showed that virtual height exposure up to 5m can be used to elicit self-perceived instability and FoF, particularly in participants with CP. Both CP and TD respond to the virtual height by adapting their gait pattern variability. The results of this study underpin the potential of VR to analyze changes in dynamic stability in more challenging environments.

References

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