Arm-trunk coordination during virtual reality training

Ongolo-Zogo, C.[1], Legendre, M.[2], Robb, T.[1], Sheehy, L.[3,4], and Sveistrup, H.[2,3,4]
Schools of Interdisciplinary Health Sciences[1], Human Kinetics[2] and Rehabilitation Sciences[3], Faculty of Health Sciences.
University of Ottawa; Bruyère Research Institute, Bruyère Continuing Care[4]

INTRODUCTION

Virtual reality training (VRT) can be used to challenge sitting balance and upper extremity reaching movements during stroke rehabilitation.[1] A common compensatory movement strategy observed in stroke patients when they reach for objects at or past arm length is increased forward trunk displacement. However, the extent to which trunk forward displacement compensates for upper extremity reaching movements during VRT is unclear.[2]
The objectives of this cross-sectional observational study are to determine how much trunk compensation occurs in young and older healthy adults and stroke survivors during VRT, and to compare the degree of trunk compensation in two levels of the same game, across the different groups.

Evaluation of trunk compensation during VRT will guide rehabilitation professionals in their choice of games to achieve their treatment goals for their stroke patients.

METHODS

Participants

Participants included 2 healthy young adults (2 females), 2 healthy older adults (1 female) and 1 stroke patient (1 female).
Upper extremity function in the stroke patient was documented using the arm section of the Chedoke-McMaster Assessment Test.

Experimental Procedure

Reflective markers were attached to the shoulder, elbow, index finger and wrist of both arms, to the trunk and forehead of each subject. Subjects sat on a wheel chair with feet supported by a stable force platform. The Jintronix setup (TV, Kinect, computer) was placed across each subject and the distance was adjusted to ensure adequate detection of movements during the games.
A Vicon motion capture system consisting of seven cameras was used to track the markers while each subject performed three VRT games, each at two levels of difficulty in restrained and unrestrained conditions.

Data Analysis

Data collected on the ranges of anterior-posterior trunk movement and hand endpoint were analyzed. Displacement during one reach was defined as the range of movement in the y-plane compared to the maximum range of movement during calibration. Arm trunk coordination for each subject was reported as a ratio of the range of hand endpoint displacement to the range of trunk displacement.. The degree of trunk compensation in each subject was analyzed by comparing trunk forward displacement in restrained and unrestrained conditions.

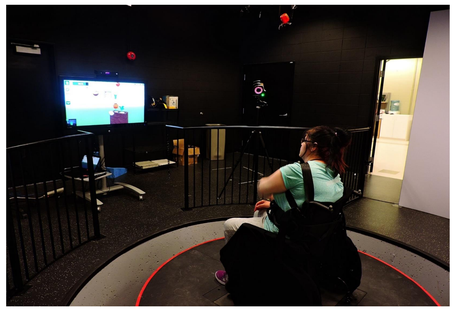

Figure 1: Set up

Figure 2 : Subject with reflective markers in (a) restrained condition (b) unrestrained condition

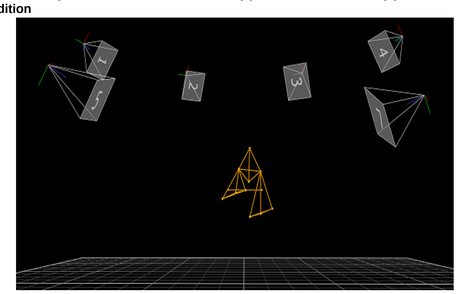

Figure 3 : Vicon motion capture. Grey numbered items indicate camera location. Gold lines illustrate stick figure created from reflective marker locations.

RESULTS

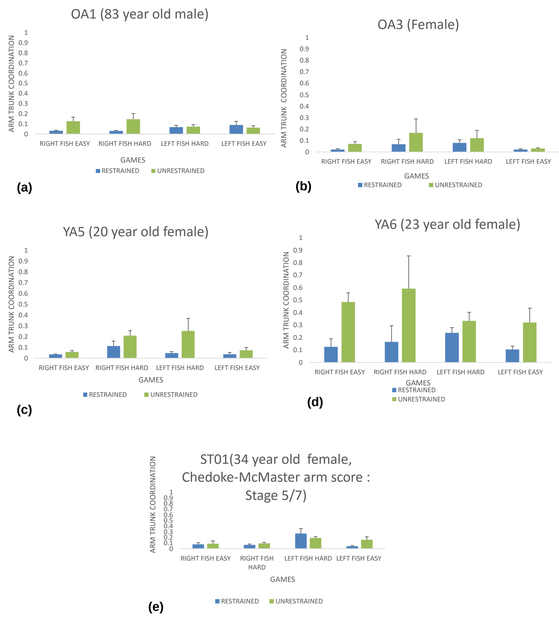

Figure 4 (a,b,c,d,e) : Arm Trunk Coordination (Mean + Standard deviation) for each subject during Fish Frenzy.

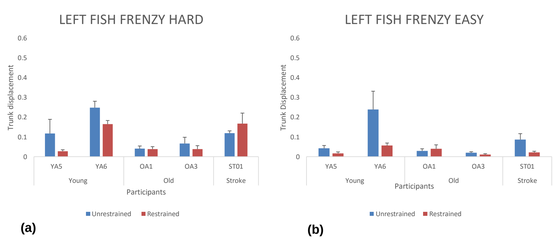

Figure 5 : Trunk displacement (mean + standard deviation) across groups during (a) Left Fish Frenzy Hard and (b) Left Fish Frenzy Easy

DISCUSSION

The presence of trunk compensation was defined by two factors: a significant difference between trunk forward displacements in restrained and unrestrained conditions and a very high trunk forward displacement in the unrestrained condition (ratio close to 1). Only one healthy subject fulfilled both requirements; thereby indicating the presence of trunk compensation (YA6 during Right Fish Hard).

Left Fish Frenzy was used for comparison across groups. Trunk compensation was not indicated in any healthy participant but trunk forward displacement was highest in young adults. In the stroke patient, trunk displacement in the unrestrained condition was not high enough to ascertain the presence of trunk compensation. This patient was in recovery and her impaired arm was fairly functional (as determined by the arm assessment test).
However during the hard version, the stroke participant used more trunk displacement in the restrained condition. This observation might support previous evidence that trunk compensatory strategies might be detrimental to recovery because they might decrease motivation to carry out reaching without recruiting the trunk [2].

CONCLUSION

The findings from this study suggest that the game Fish Frenzy does not cause significant trunk forward displacements to compensate for arm reaching movements. However harder versions of the game trigger more trunk displacement compared to easier versions. Further testing is required to analyze and establish the degree of trunk compensation in this game.

REFERENCES

[1] Levin, M. F., Knaut, L. A. M., Magdalon, E. C., & Subramanian, S. (2009). Virtual reality environments to enhance upper limb functional recovery in patients with hemiparesis. In *Studies in Health Technology and Informatics* (Vol. 145, pp. 94–108). http://doi.org/10.3233/978-1-60750-018-6-94
[2] Levin MF, Michaelsen SM, Cirstea CM, Roby-Brami A. Use of the trunk for reaching targets placed within and beyond the reach in adult hemiparesis. *Exp Brain Res*. 2002;143(2):171-180. doi:10.1007/s00221-001-0976-6.

ACKNOWLEDGMENTS

The authors wish to thank the participants in the study and the University of Ottawa Office of Undergraduate Research .

For more information :
congo056@uottawa.ca