Development of a new scoring system for bilateral upper limb function and performance in children with cerebral palsy using the MIRA interactive video games and the Kinect sensor

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ABSTRACT

Background. Play is a central part of children's life. Objective occupational therapy assessments for upper limb function and performance for children with cerebral palsy are time consuming. Certain tasks used in the occupational therapy field can be translated into a virtual environment using Microsoft's Kinect® sensor of motion and adapted interactive video games, making the activity entertaining, motivational and fun. The instant scoring system offered by the games could objectively quantify the upper limb function and performance.

Aims. The aim of the study is to develop a reliable and valid occupational therapy scoring system for the assessment of bilateral upper limb function and performance in children with Cerebral palsy(CP) using adapted MIRA interactive video games and Kinect 360 Xbox sensor.

Methods. 16 healthy children and 11 children diagnosed with Cerebral palsy played the MIRA testing schedule for two times in less than 7 days interval. The average age in the CP group was 7.8±2.4 and the average age in the healthy group was 7.1±1.6. Children with cerebral palsy were stage 1 to 3 according to both the GMFCS scale and the MACS scale. MIRA testing schedule consisted of 4 games: Catch, Follow, Move and Grab. The first three games were performed by each hand separately and Grab was performed by both hands thus leading to a session of 7 games, with a total duration of 15 minutes. Three parameters provided by the game were used in order to evaluate upper limb function and performance: distance (m), average acceleration (m/s^2) and points. The reliability and the validity of the method were tested.

Results. All intraclass correlation coefficients (ICC) for the points achieved in the seven games were above 0.81. The ICC for the total points was 0.94 resulting in good reliability. The Cronbach alpha coefficient revealed a high internal consistency (overall alpha=0.97). Each of the variables taken into account contributed positively to the overall alpha value. The Bland Altman graphs used to test the repeatability of the two examinations revealed that more than 95% of the data plots lied within the ±2 standard deviations for average acceleration and points in each game. The total points in the healthy group were significantly higher than in the CP group (1557.9±157 versus 1262.4±405, p=0.018). Except for Grab, all of the six games points were significantly higher in the healthy group than the CP group. Univariate logistic regression with the presence of illness revealed that total points and points in each game except for Grab were significant predictors of cerebral palsy in the study group. Negative correlations were found between the MIRA testing parameters and the MACS stage using Pearson's and Spearman's correlation coefficients. Thus, a higher score was associated to a lower MACS stage. In ROC curve analysis satisfactory areas under the curve (higher than 0.8) were found for Catch left wrist points, Follow left and right wrist points. The Grab game showed the smallest area under the ROC curve, associated with the lowest sensitivity and specificity for CP.

Conclusions. The scoring of the MIRA testing interactive video games adapted for children with neurologic impairments using the Microsoft's Kinect 360 Xbox sensor of motion seems to be a reliable and valid occupational therapy tool for the assessment of bilateral upper limb function and performance in children with cerebral palsy. Of all games, Grab seemed to be the least appropriate for this purpose.