# 利用人工智慧與虛擬實境探討發展協調障礙兒童體感覺與動作評估方式及運動介入之效益

# Investigating somatosensory and motor assessments and the effects of exercise intervention using AI and virtual reality systems in children with developmental coordination disorder

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Developmental coordination disorder (DCD) is a neurodevelopmental disorder characterized by poor motor skill learning and uncoordinated movements that significantly interfere with a child's activities of daily living, academic achievement, and vocational activities. Estimates indicate that up to 6-10% of all school-age children suffer from DCD. At present, assessments of DCD's motor difficulties rely primarily on a product-oriented, standardized Movement Assessment Battery for Children second edition (MABC-2). However, the limitation lies in the testing procedure of MABC-2 being time-consuming for children and labor-insensitive for researchers/teachers [1, 2]. Given these concerns, this study aims to employ virtual reality (VR) and artificial intelligence (AI) technology in assessing motor skills in children, seeking to provide objective measures in screening motor abnormalities in children with DCD. Three domains of MABC-2 motor functions were examined. For manual dexterity, we developed a VR-based 3D drawing system to assess upper limb motor functions (see Figure 1). Participants were asked to complete seven levels of drawing tasks consisting of geometric shapes (e.g., circle, triangle) and modified drawing tasks of MABC-2 in VR. By capturing movement trajectories, the kinematic data (i.e., movement time, error distance) across different measures were automatically calculated. For ball skills and balance skills, computer vision technology was used to examine motor performances during a throwing task (see Figure 2) and a single leg stance task (see Figure 3). Without wearing reflective markers and motion sensors, quantitative movement outcomes (i.e., precision and accuracy of ball throwing/catching; balance duration, sway trajectory during the single-leg stance) and time-series data visualization can be obtained to track children's motor performances across times (see Figure 3A). The data of TD and DCD children on three domains of motor function are shown in Figures 1-3. In conclusion, our results confirmed the feasibility and practicality of using the newly developed VR/AI system to assess upper and lower limb motor functions in children with DCD. This preliminary result also opens an avenue for designing exercise programs (i.e., VR spots training) in children with DCD. Future studies would be required to include a larger sample size covering a wider age group to optimize the VR/AI system in tracking and screening motor abnormalities in children with DCD.

**References**

[1] French, B., Sycamore, N. J., McGlashan, H. L., Blanchard, C. C., & Holmes, N. P. (2018). Ceiling effects in the Movement Assessment Battery for Children-2 (MABC-2) suggest that non-parametric scoring methods are required. *Plos one*, *13*(6).

[2] Palmer, K. K., Stodden, D. F., Ulrich, D. A., & Robinson, L. E. (2021). Using process-and product-oriented measures to evaluate changes in motor skills across an intervention. Measurement in Physical Education and Exercise Science, 1-10.

**Figure 1** VR-based 3D assessment of manual dexterity. **A)** The workflow with the VR drawing system. **B)** Three exemplars of motor trajectories on a young adult (left), a TD child (middle), and a child with DCD (right) [1]..

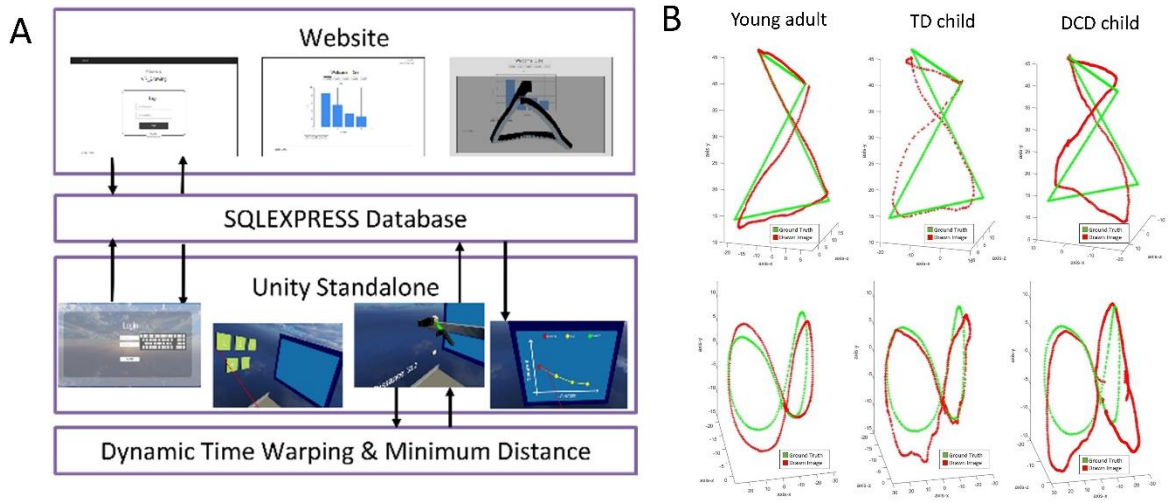



**Figure 2** The use of imaging recognition technology on ball skills in children.

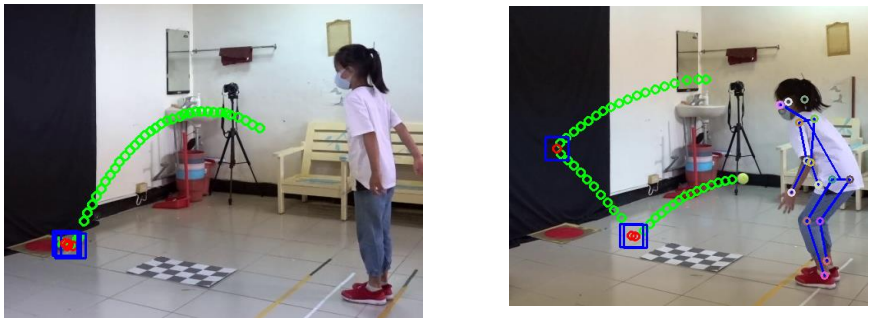
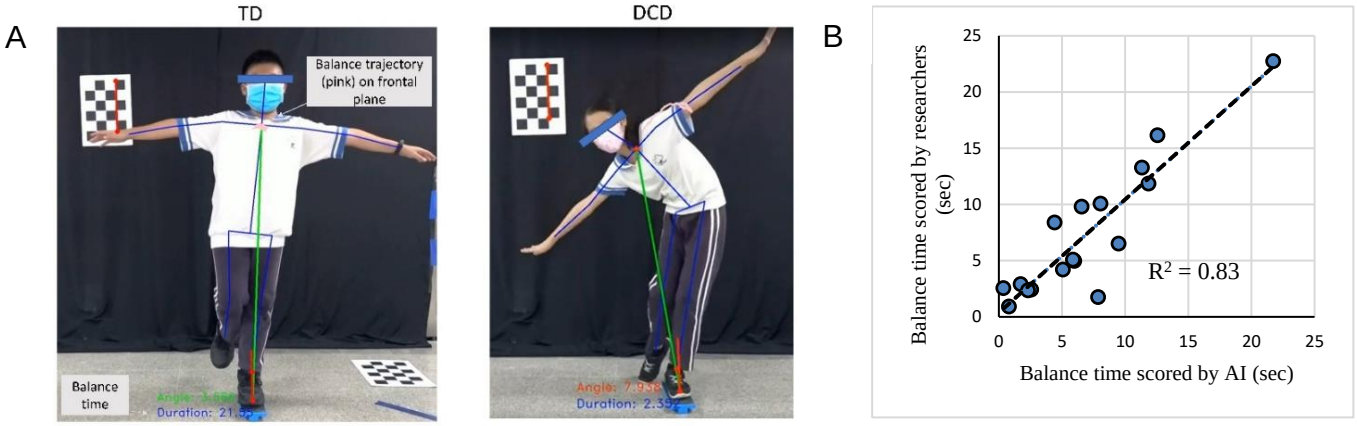


**Figure 3** Balance performans during single leg stance on a balance board. **A)** Two exemplars within TD versus DCD group. **B)** The Correlation analysis showed that the balance duration captured by AI significantly predicted that of traditional MABC-2.




[1] NOTE: We initially identified 36 children with DCD and 36 age-/gender-matched TD children aged 8-11 years. Due to COVID-19 and the close of the public schools, we were unable to complete all children data collection during our project year. We will continue to work on it before early 2022.