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Motor strategy and locomotor adjustments in children with and without Down Syndrome while negotiating stairs

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Introduction

Children with Down Syndrome (DS) often show impaired motor control, and walk with a slower speed and a shorter step length than typically developing (TD) children [1]. When negotiating an obstacle, children with DS often stop for a longer duration [2], choose a more conservative crawling strategy and display a smaller toe clearance than their TD peers [3].

Stairs negotiation is a different setting which requires moving the center-of-mass up constantly. This study aimed to understand motor strategy and gait adaptation in children with and without DS while negotiating stairs.

Method

Participants: Fourteen children with DS (4M/10F) and 14 age- and sex-matched TD children (4M/10F) participated in the study. Mean (SD) age of the DS group was 8.6 (1.9) years, height 1.18 (0.11) m, and mass 27.2 (10.4) kg. Mean (SD) age of the TD group was 8.2 (1.9) years, height 1.31 (0.11) m, and mass 29.4 (7.0) kg.

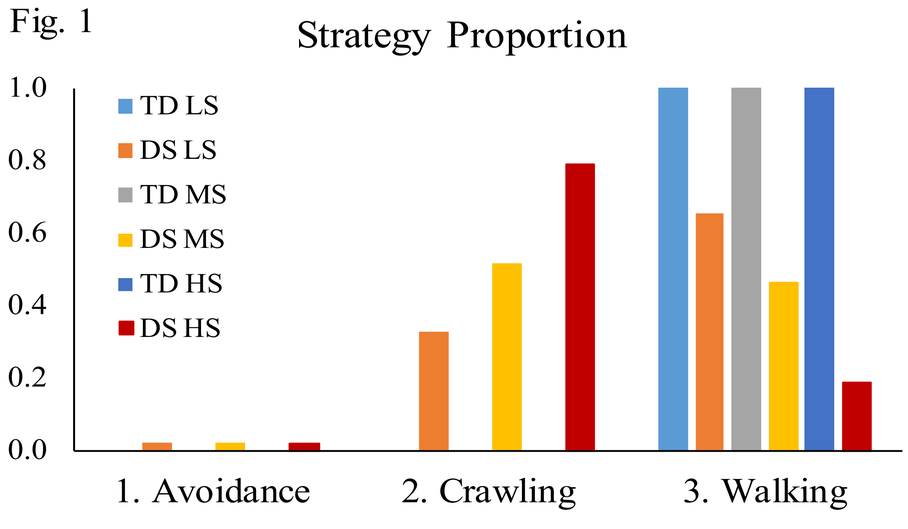
Experimental design: A Vicon full-body PSIS model and an 8-camera Vicon motion capture system were used for data collection. Participants walked along the 5-meter walkway, and stepped up the 3-step staircase without handrails. There were three riser heights: 17cm (LS), 24cm (MS), and 31cm (HS). There were two loading conditions: without load (NL) or with ankle load (AL) equaling to 2% of the bodyweight above each ankle.

Data analysis: Motor strategies were categorized as: *avoidance, crawling, or walking*. The proportion of each strategy was calculated for each subject and for each group. The placements of the foot (i.e., the distance between the toe and the staircase) and stance time before ascending were calculated for both the leading and trailing feet. Moreover, vertical toe clearance was calculated for both feet when the subject used the *walking* strategy.

Statistical analysis: A series of 4-way (group × stair × load × foot) mixed ANOVA were conducted on foot placement, stance time, and toe clearance. Post-hoc pairwise comparisons with Bonforreni adjustments were conducted when appropriate. Statistical significance was set at $\alpha = 0.05$.

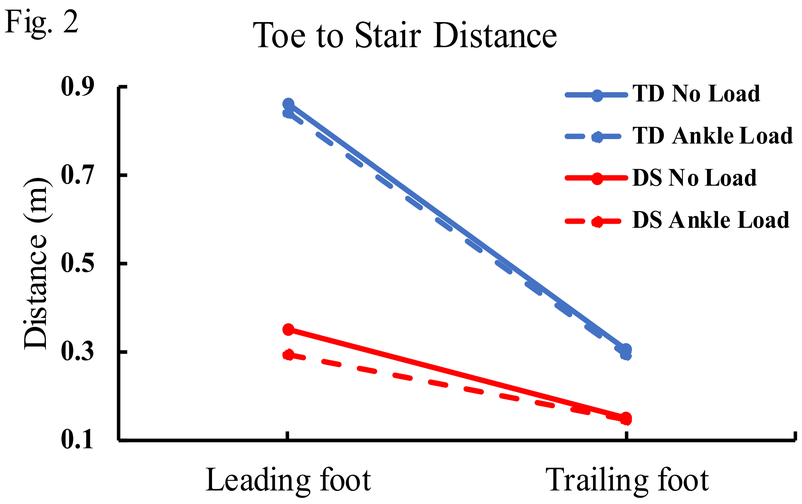
Results and Discussion

Fig. 1



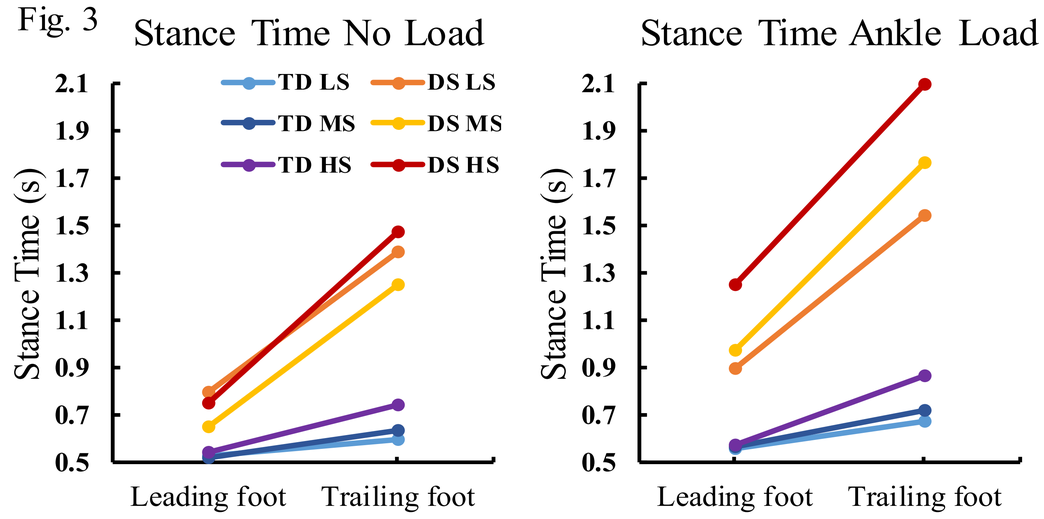
The TD group used the *walking* strategy in all the conditions (Fig. 1). The DS group primarily used the *walking* strategy in the LS condition but the *crawling* strategy in the HS condition.

Fig. 2



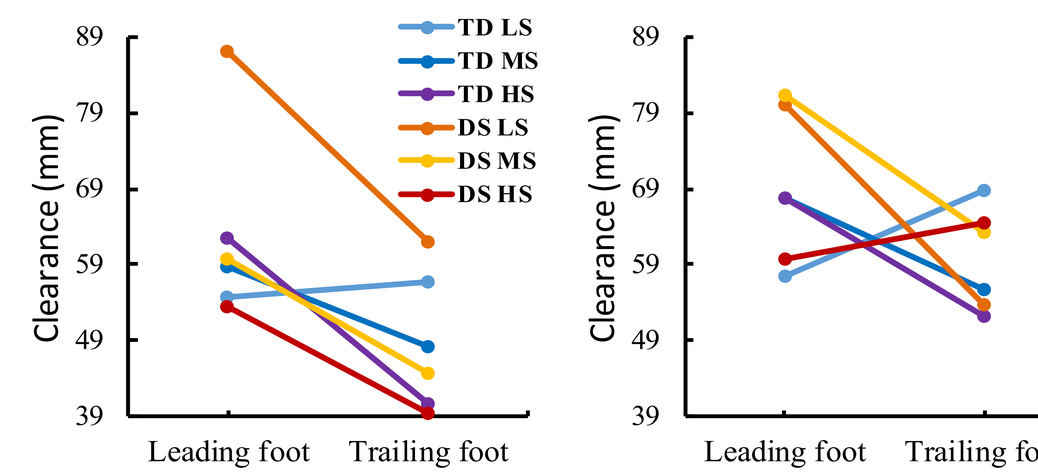
Both groups placed the leading foot further away from the staircase than the trailing foot (Fig. 2). The DS group placed their feet closer to the stairs, and closer to each other than the TD group.

Fig. 3



The DS group had a longer stance time than the TD group, and both groups had a longer stance time for the trailing foot than the leading foot (Fig. 3).

Fig. 4



Both groups mostly showed a higher toe clearance for the leading foot than the trailing foot (Fig. 4).

Conclusions

When ascending stairs, the DS group used a conservative *crawling* strategy for higher staircases. Before ascent, the DS group placed their feet closer to the stairs, and took a longer time than their TD peers. The DS group did not show as good adjustments as the TD group in toe clearance. The results suggest that the DS group had limited motor ability when adapting to challenging stairs.

References

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3. Mulvey G, et al. *Res Q Exerc Sport* **82**, 210-219, 2011.