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Locomotor adjustments during stair ascent in children with Down Syndrome: Comparison between walking and crawling strategies

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Locomotor adjustments during stair ascent in children with Down syndrome: Comparison between walking and crawling strategies

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Introduction

Stair negotiation provides an important yet different paradigm to study environment navigation. As one has to constantly move himself up while adjusting step length and foot placement due to the stair constraints, this paradigm is ideal to study motor strategy and adaptation in children with and without disabilities.

Down syndrome (DS) is the most common genetic condition and causes significant delays in motor and cognitive development [1]. Children with DS show poor postural control and less efficient gait patterns. When negotiating obstacles, they often select a more conservative strategy (i.e. crawling instead of walking) [2]. This study aimed to examine motor strategy and spatiotemporal gait patterns in children with DS while ascending stairs of different heights.

Method

Participants:

Fourteen children with DS (4M/10F, mean age: 8.6 years) participated in this study. Mean age, body mass, and height were 8.6 years, 27.2 kg, and 1.18 m, respectively.

Data collection:

The participants walked along a 5-meter walkway and used a strategy of their choice to ascend 3-step staircases of different heights: 17cm (LS), 24cm (MS), or 31cm (HS). Five trials were collected for each stair condition. A 3D Vicon motion capture system and a full-body marker set were used to collect spatiotemporal data.

Data analysis:

Motor strategy was coded as *avoidance*, *crawling*, or *walking* for each trial.

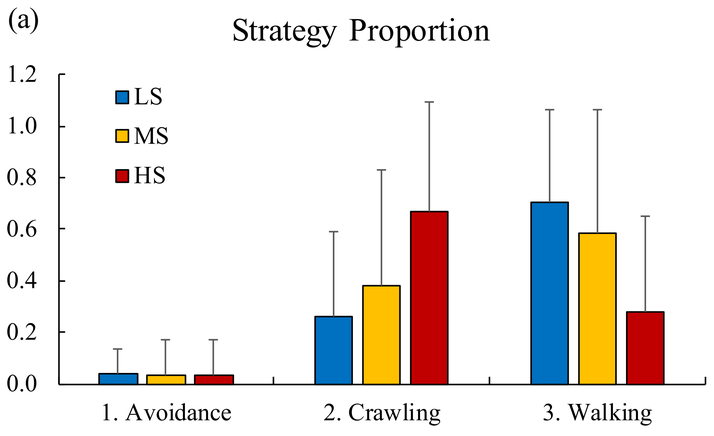
The first two steps of stair ascending were used to analyze the spatiotemporal gait pattern. The first foot ascending the staircase was defined as the leading foot, and the other foot was considered as the trailing foot. Vertical toe clearance and horizontal toe velocity were calculated when the leading or trailing toe was above the outer edge of each step of the stairs.

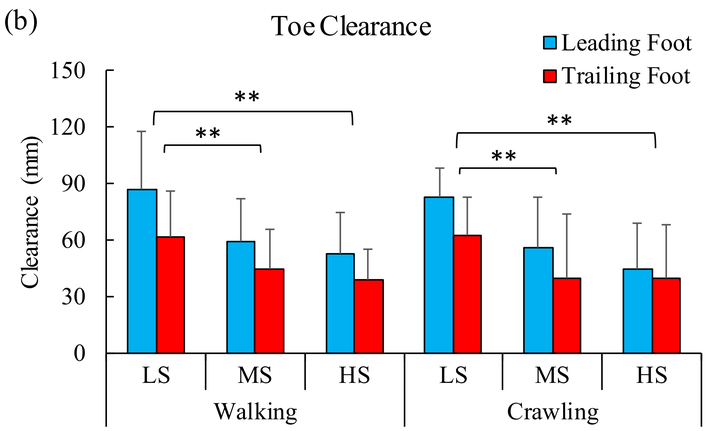
Statistical analysis:

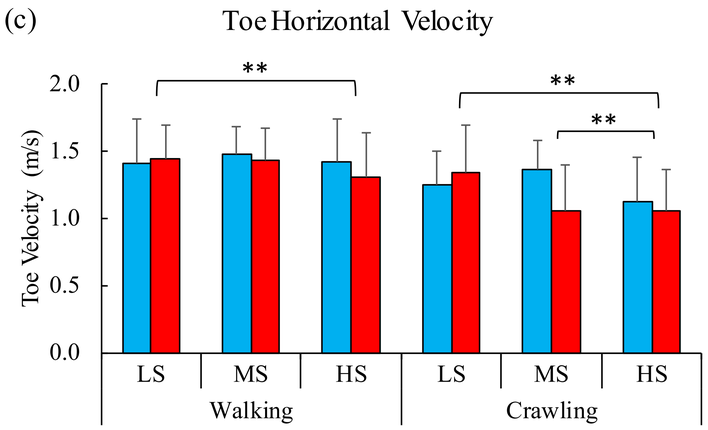
Three-way (2 strategy x 3 stair x 2 foot) mixed ANOVAs with repeated measure on all three factors were conducted on toe clearance and horizontal toe velocity. Statistical significance was set at α=0.05.

Results

Results show that children with DS primarily walked up the stairs (65%) in the LS condition, nearly equally chose the walking (47%) or the crawling (51%) strategy in the MS condition, but mainly crawled up (79%) in the HS condition (Fig. a). Regardless of motor strategy, children with DS generally decreased toe clearance and horizontal toe velocity with the increase of stair height (Fig. b & c). Further, children with DS displayed a higher toe clearance for the leading than the trailing foot. Between the two motor strategies, there was no difference in toe clearance or horizontal toe velocity.







Discussion

The results suggest that although walking is a more advanced strategy than crawling, children with DS might control the trajectory and speed of their foot similarly regardless of motor strategy to ensure a safe clearance of stairs both vertically and horizontally. Our results also indicate that children with DS may not be able to scale their toe clearance appropriately to different stair heights due to their physical and motor limitations.

References

1. Block ME (1991) Adapted Physical Activity Quarterly. 8 (3) 179-209.
2. Rigoldi C, Galli M, Albertini G (2011) Res Dev Disabil. 32 (1) 158-163.