MANIPULATING SENSORY INFORMATION: Obstacle avoidance strategies between children and young adults

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Purpose
Understand children’s single and double obstacle crossing strategies under various sensory conditions

Hypothesis
Children’s obstacle crossing characteristics will differ due to the amount of sensory information

Implications
Understand the development of adaptive locomotion and sensory integration

Introduction
• Adaptive locomotion involves altering speed of locomotion to avoid obstacles, accommodate different terrains, and change the direction of locomotion
• Obstacle crossing challenges an individual in the anterior-posterior (AP), medio-lateral (ML), and vertical direction
• Obstacle crossing involves appropriate trail and lead limb foot placements, toe elevation, and toe clearance of the obstacle
• The visual system primarily guides locomotion however the amount of somatosensory information alters an individual’s stability during obstacle crossing
• Appropriate planning is required when crossing multiple obstacles
• Young adults (YA) determine the avoidance of the second obstacle prior to the avoidance of the first obstacle
• Children 7-9 years of age are able to successfully cross a single obstacle similar to YA
• Opposite to YA, children 7 years of age do not plan for the avoidance of the second obstacle until the first obstacle is cleared during a multiple obstacle crossing task

Method
Participants:
• 16 young adults (YA) (22y ± 0.96)
• 16 Typically developing (TD) children (10y ± 1.07)

Experimental Set-up:
• Trunk and foot kinematic data was collected using the Optotak motion analysis system (60Hz)
• 0, 1, or 2 obstacles (0.8m in width) were projected on the ground 1m apart from each other

Protocol:
• Participants walked along a 7mx2m pathway to reach a goal
• Participants were instructed to avoid stepping on the obstacles by stepping over the obstacles
• The number of obstacles and whether the obstacle appeared at the beginning of the trial or two steps prior to crossing were randomized
• A total of 36 trials were completed, 18 trials on flat ground and 18 trials on foam

Data Analysis:
• Trail Limb Anterior-Posterior (AP) foot position before the first obstacle
• Lead Limb AP foot position after the first obstacle

Statistical Analysis:
• Three-way repeated measures ANOVA between YA and TD (3 within factors: obstacle number, visual condition, and terrain, and 1 between factor: age group, each with two levels)

Results & Discussion
• Significant interaction between groups, number of obstacle, and vision F[1,30]=6.02, p=0.02
• The introduction of a second obstacle and the reduction of visual information increased both groups’ AP lead limb foot placement compared to a single obstacle (Figure 1)
• Significant interaction between the number of obstacles and groups F[1, 30]=8.97, p=0.005
• Children (8-12 years old) are able to plan for the avoidance of two obstacles by increasing their AP lead and trail limb foot position similar to young adults (Figure 2)

Next Steps
• Compare walking speed and trunk pitch variability before and during obstacle crossing between groups
• Analyze gaze information and compare between groups
• Analyze children with a motor disorders’ behaviour during this multiple obstacle crossing task compared to TD

Key References

Figure 1: AP lead limb foot placement based on the number of obstacles and amount of visual information between young adults and children

Figure 2: AP trail limb foot placement based on number of obstacles between young adults and children