Decoupling the Biomechanics of Locomotion and the Direction of Spatial Updating During Blind-walking Tasks

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Decoupling the Biomechanics of Locomotion and the Direction of Spatial Updating During Blind-walking Tasks

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Introduction

- Does the direction of locomotion affect spatial updating?
- Do the biomechanics of locomotion influence the accuracy of spatial updating during open-loop walking?
- Spatial updating, or the process of keeping track of locations of objects relative to one’s spatial position while moving, is critical to a variety of navigation tasks.
- Although updating is likely to occur automatically during sighted walking, walking without vision (open-loop walking) requires imagined updating of the spatial relationships that change concurrently with movement.
- Dynamic spatial updating likely underlies accurate performance when blind-walking to previously seen targets (Reser, Ashmead, Talor, & Youngquist, 1990).
- Studies of imagined walking suggest that the biomechanical information from locomotion influences the accuracy of spatial updating during blind-walking (Kunz, et al., 2009).
- Although less common, backward blind-walking is nearly as accurate as forward blind-walking (Paquet, Rainville, Lajoie, & Tremblay, 2007).
- We investigated the role of biomechanical information in spatial updating by manipulating the biomechanics of locomotion and the direction of spatial updating during 3 blind-walking experiments.

General Method

- View a target, create a mental image of the target in the surrounding environment, and walk forward or backward without vision to the target.
- Forward and backward blind-walking to targets on floor
  - 9 trials to 3, 4.5 & 6 meters for each walking direction
- Experiment 1: Walking direction consistent with direction of spatial updating
- Experiment 2: Removing spatial updating component from backward walking
- Experiment 3: Decoupling walking direction and direction of spatial updating during backward walking

Experiment 1

- Forward walking with forward spatial updating
- Backward walking with backward spatial updating
- No effect of walking direction
- A significant difference in meters walked between target distances
- Distance walked increased with target distance
- Accurate walking to target distances in both walking directions

Experiment 2

- Forward walking with spatial updating
- Backward walking without spatial updating; distance matching
- No effect of walking direction
- A significant difference in meters walked between target distances
- Distance walked increased with target distance
- Significantly undershot 3m and 4.5m

Experiment 3

- Forward walking with spatial updating
- Backward walking with imaged forward walking and consistent forward spatial updating
- No effect of walking direction
- A significant difference in meters walked between target distances
- Distance walked increased with target distance

Results

- Backward Walking Comparison
  - No significant main effect of Experiment on distance walked in the backward walking conditions
  - Compared to Experiment 1, distance walked in Experiment 3 was significantly less to the 3 m target (p = .002) and to the 4.5 m target (p = .026)
  - No significant differences between Experiments 1 and 2 or Experiments 2 and 3
- Forward Walking Comparison
  - No significant main effect of Experiment on distance walked in the forward walking conditions
  - Across all three experiments, there was no significant difference in distance walked between forward and backward blind walking.
  - For backward blind walking, walking distance was the most accurate in Experiment 1 (consistent direction of locomotion and spatial updating) and the least accurate in Experiment 3 (inconsistent direction of locomotion and spatial updating), suggesting that the biomechanical information from walking direction influences the accuracy of spatial updating.
  - The task directions for the backward walking conditions may have affected the participants’ abilities to accurately spatially update position while walking during the forward walking conditions.

Conclusion and Discussion

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References