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, a task commonly-used to assess distance perception (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 $p < .0001$
  - Accurate walking to target distances in both walking directions $p > .05$ for all target distances

**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 $p < .0001$
  - Significantly undershot 3m ($p = .007$) and 4.5m ($p = .023$)

**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 $p < .0001$
  - Significantly undershot all target distances $p < .0001$ for all target distances

**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 ($p = .025$)
  - 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, walked 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.
  - Individual differences in spatial updating / spatial imagery, motor imagery abilities may account for differences in backward walking performance, particularly when the walking direction and direction of spatial updating are decoupled.
  - Follow-ups to this series of experiments include blocking and counterbalancing walking direction and condition and increasing target distances. Differences between forward and backward walking may be apparent at longer target distances.

**References**

**Acknowledgements**
Thanks to Natalie Anderson, Ryan Fuentes, Kevin Longacre, Natalya Lynn, Nicole Schlieter, and Adam Siz for their assistance in conducting this research.