Integrating target interception and obstacle avoidance

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BACKGROUND

Previous work [1,2,3] modeled locomotor behavior as a dynamical system in which targets and obstacles function as attractors and repellers of an agent's target-heading angle. Four components have been developed for the basic locomotor behaviors of:

1. Steer to goal
2. Avoid stationary obstacles
3. Intercept moving target
4. Avoid moving obstacles

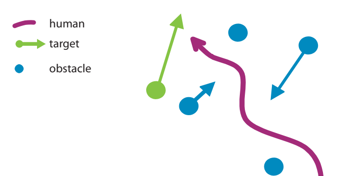
Purpose: Testing whether a general model, based on a linear combination of these four components, can predict locomotor behavior for more complex dynamic environments.

RESEARCH QUESTION

Testing the model for situations of intercepting a moving target in the presence of a stationary obstacle. The conditions were designed to evoke a switch in behavior. Participants had to pass an obstacle either on the inside or on the outside [B].

Qualitative and quantitative model predictions:

1. Under what conditions do participants switch from inside to outside passes, and can the model predict such a switch?
2. What is the nature of participants' paths (when and where do they start to avoid the obstacle), and can the model account for the human paths at such a detail?

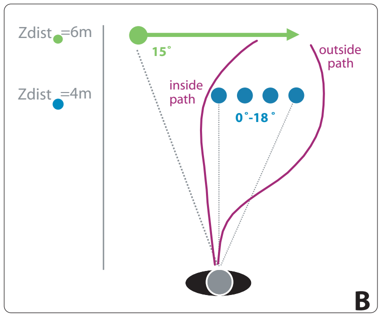


Moving target $\ddot{\phi} = -b\dot{\phi} - k_t\dot{\beta}(e^{-c_1 d} + c_2)$

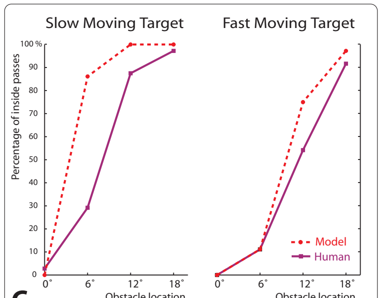
Avoid obstacle $\ddot{\phi} = -b\dot{\phi} + k_o(\phi - \psi_o)\, e^{-c_3|\phi - \psi_o|}(e^{-c_4 d_0})$

Combined $\ddot{\phi} = -b\dot{\phi} - k_t\dot{\beta}(e^{-c_1 d} + c_2) + k_o(\phi - \psi_o)\, e^{-c_3|\phi - \psi_o|}(e^{-c_4 d_0})$

A



B



C

DESIGN & METHODS

The experiment had a 2x3 design; two levels of target speed (.6 & .9 m/s), and three levels of obstacle location (at on offset of 0, 6, 12, 18˚) [B].

Testing is done in the VENLab, a 40 x 40 ft virtual environment in which participants can walk freely. Participants wear a head-mounted display (60˚H x 40 ˚V) that presents a textured ground plane with colored poles that serve as obstacles and targets. Head position is recorded at 30Hz.

RESULTS OF QUALITATIVE MODEL PREDICTIONS

Humans are more likely to take inside passes when the target is moving slower and when the obstacle is placed further towards the side [C]. The predicted number of inside passes is somewhat different, and more so for the slow moving target. Predictions are biased towards a higher number of inside passes.

RESULTS OF QUANTITATIVE MODEL PREDICTIONS

For most conditions, the predicted path matches the most prevalent human path, and conversely does not match the uncommon human path [D]. This pattern of results does not hold up for the condition of a slow moving target and the obstacle at a 6˚ offset. The model predicts an inside path that cuts very near to the obstacle whereas participants mostly traversed an outside path.

1. Fajen & Warren (JEP:HPP, 2003); 2. Warren & Fajen (Psychonomics 2002); 3. Warren, Sun, & Fajen (VSS 2003).
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CONCLUSIONS

The model [A] predicts the dominant human locomotor behavior for most of the conditions of a moving target & a stationary obstacle. Where different, the predictions are biased towards inside passes. It appears as if the model takes on a higher risk in passing very near to the obstacle.

IMPLICATIONS

The current study demonstrates that locomotor paths may emerge on-line from the interaction between an agent and a structured environment, rather than being explicitly planned. Such control predicts human switching behavior, and brings into question what choice participants had.

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