Is obstacle avoidance controlled by perceived distance or time-to-contact?

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BACKGROUND

Our locomotor dynamics model (1) takes distance as an input variable but could alternatively use time-to-contact (A).

At various speeds the model predicts different paths around an obstacle. Changes were principally different between Distance and Time-To-Contact predictions (B). Here we evaluate these predictions against human data on obstacle avoidance. Physical Walking Speed also affects the body's momentum, which we hypothesize is related to resistance to turning (damping)

MANIPULATIONS

We independently varied Physical Walking Speed and the Visual Gain. Manipulations produced similar optical speeds but only the physical walking speed affected the momentum of the body.

VENLAB

Experiment was performed in the VENLab, an ambulatory virtual environment (10 x10m) with head-mounted display (60 H x 40 V) and sonic/inertial tracking system (~50ms latency).

1. Fajen & Warren (JEP:HPP, 2003);

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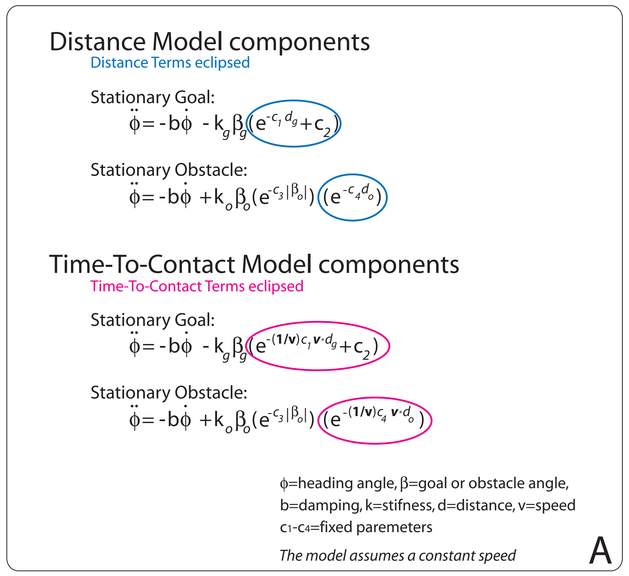

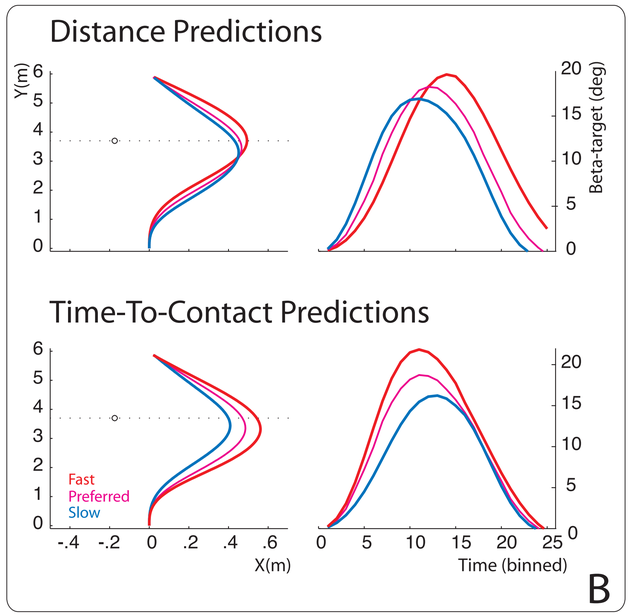

DESIGN & METHOD

Participants walked to a stationary goal 6m straight ahead and around an obstacle whose position varies across trials--initial distance of 3.7 or 4.7m and .2m to the left or right of the straight path (C).
Participants were instructed to walk at three speeds. These were partially crossed with three visual gains, such that the optical motion in the display was slower, matched, or faster than the actual walking speed (C).

RESULTS

With Visual Gain change, the human paths are very consistent with the Distance prediction but not Time-To-Contact (D).

With Physical Speed change, the human paths shift with respect to the Visual Gain condition, so turns occur earlier at the fast speed and later at the slow speed. The data are not consisted with either of the models (D).

CONCLUSIONS

All human paths are inconsistent with the Time-To-Contact prediction. With Visual Gain change paths are very consistent with the Distance prediction. With Physical Walking Speed change, the shift in human paths is probably caused by the related changes in momentum of the body.

We currently evaluate the relation between the body's momentum and the resistance to turning, and attempt to simulate its effects by altering the damping term in the model.