- Friday, August 7, 1998
  Manual Aiming and Prehension

1.0 This meeting was given by Heather Carnahan from Kinesiology, University of Waterloo and was entitled: "The use of visual and haptic information in the control of manual aiming and prehension"

1.1 Carnahan first reviewed some of the principles of reaching towards a moving target and mentioned some of the neurophysiological and clinical data that has hinted at some of the mechanisms involved.

1.2 Her hypothesis was that there is an internal representation of a target trajectory that is built up during early views of a target's motion and that enables you to predict its future position.

1.3 Carnahan has developed a technique that attempts to get at this internal representation which exploits the fact that the speed of a target influences how fast you move towards it. She had a target moving at a constant velocity (in mm/s) from the bottom of a screen into a target zone and subjects had to move a probe to arrive there at the same time starting from a different location. Although the probe was controlled by a mouse, the idea was that it simulated reaching for the moving target.

1.4 The peak velocity of the ?reach' correlated with the target velocity. Interestingly, if there was a delay of up to 7 secs between the target's actual motion and the subject's reach, the peak velocity of the reach was unaffected. Being able to "download" a target's motion from memory to carry out this task indicated a central store or representation.

1.5 There was some discussion about whether a single optical variable might be discovered that could be controlling this behaviour in a Gibsonian "invariant feature" style.

2.0 Carnahan's next experiments set out to disconfound time-of-travel and target velocity. In the previous experiments, the target went through a fixed distance and therefore took longer if it was going slowly. When time was kept constant (so it went further for slow speeds and less far for faster speeds) the peak velocity of the reach was NOT correlated with the velocity of the target suggesting that time-of-travel was somehow extracted.

2.1 By altering velocity and apparent mass of the target, Carnahan looked for an effect of momentum (velocity x mass) of the visual target. Momentum did not seem to affect reach velocity, although it might be used for aspects of grasp.

3.0 So what feature of an object's movement might a person be using to deduce the time-of-travel and to reach for it correctly? The next experiments used a more complex target movement profile where the target accelerated to a peak velocity either early in its run, at the middle or towards the end. The peak velocity of reaching mimicked this manipulation although the variation in the times to peak velocity were by no means as widely spaced as the variations in the stimulus profiles. These results were found even if the subject saw only the first part of the profile, even if this did not include the time of the stimulus' peak velocity.

3.1 Since the subjects knew the distance of travel of the target and that it's peak velocities was always the same (although the time that peak velocity was reached was not known), they were able to predict the time of arrival where they were supposed to meet it with the probe based on a probabilistic estimate of the profile of the target's motion given only a sample of its movement. Can we use experiments of this kind to decide whether the target's velocity or acceleration are being used?

4.0 Taken together, these findings suggest that there is an internal representation of a target's movement and that it is not obvious what is being represented. It might be velocity or acceleration or it might be flexible depending on the task in hand.

5.0 Discussion focused on this question, with consideration of whether the units would be angular or linear...

Heather Carnahan
Waterloo