Studies of Eye-Hand Coordination: Models of Pilot Behaviour

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Adaptive Model Theory

Dynamic Optimization
Consider the simple task of picking up a glass. There are an infinite number of paths between the current position of your hand and the glass. So how does the human brain select one path from the infinite number possible?

Many researchers have used dynamic optimization theory to explain this problem. This approach defines a movement objective, such as minimum energy or maximum smoothness, and then selects a single hand path to satisfy this movement objective.

Adaptive Model Theory (AMT) is based on optimization theory and proposes the minimization of acceleration as the movement objective (equivalent to minimum energy). Minimization of jerk (rate of change of acceleration) is another possible movement objective and it defines smoothness of movement.

Computer Tracking Simulation

The computer tracking simulation is a computational simulation of human movement control based on the concepts of AMT. It was implemented previously using MATLAB™ and Simulink™.

The minimum acceleration and minimum jerk movement objectives were both implemented within the response planning stage of the AMT computer tracking simulation. The tracking responses are shown.

A randomly varying input signal is applied (blue curve) and the simulator attempts to track it (green curve). The minimum jerk simulation resulted in a more “jerky” response compared with the minimum acceleration model. This was an unexpected result as the movement objective defined by the minimization of jerk is ‘smoothness’ of movement.

One possible explanation for this result was proposed to be a combination of prediction errors, and the estimation of instantaneous values by using a differencing method.

Prediction

A prediction of the initial and final states of each planned movement are required by the response planning stage in order to generate desired responses in real time. The graph above illustrates ten step-ahead prediction performed in the simulation. The further ahead in time the response is predicted, the bigger the prediction error.

The prediction of acceleration is required for the minimum jerk model but not for the minimum acceleration model. The ability of the central nervous system to predict acceleration has little support in the literature to date.