Towards a Bounded Rational Analysis of Multitasking while Driving

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Consider dialing a phone while driving. Here people tend to interleave dialing in bursts of three or four digits at a time with checks of the heading of the vehicle and steering control in between (Salvucci, 2005). Why do people interleave tasks at this particular interval? The answer seems rather obvious: Deprived of regular attention, driving performance rapidly falls below criterion, with potentially disastrous consequences. However, the benefits of interleaving must also be played against the costs of switching between tasks that are associated with both physical realignment of the body relative to external resources and the mental recovery of state information associated with each task.

We aim to develop a bounded rational analysis (Howes et al., in press) of concurrent multitask behavior in the context of driving, in order to explain both why, and also when, people are likely to interleave steering control with the completion of a secondary task. In particular, we explore the trade-off between the benefit and costs of interleaving dialing with steering control in terms of measures of driver performance. To build on our previous work (Brumby et al., 2007), we develop a simple control model of steering based on analyses of driver performance data. The model makes minimal commitments to human cognitive architecture and minimal assumptions of the constraints imposed by the environment.

The model of steering control is used to derive predictions of the effect of varying the time interval between steering updates on the average lateral deviation of the vehicle over a 60 second period of simulated driving. The performance of the model, averaged over 1,000 trials, is presented in Figure 1 and shows that with increasing time between corrections to the heading of the vehicle that the lateral deviation of the vehicle from the center of the lane increases. Regression analysis found that an exponential function fit the model data well (R^2 = 0.99) allowing quantitative predictions for how driving performance declines with time away from task to be derived.

We next use the steering performance function shown in Figure 1 to make predictions for dual-task performance. Assume for the moment that steering updates cannot occur while the drivers attention is directed towards a secondary in-car task. If we assume that a 10-digit number takes approximately 5 s to enter and that switching between tasks carries a time cost of 0.185 s to move the eyes from one location to another, then the interval between steering updates increases from an assumed baseline in regular driving of 0.15 s (Salvucci, 2005) to an interval of 5.52 s while dialing (i.e., 5 s + 0.185 s x 2 + 0.15 s). Based on Figure 1, we might predict that at an interval of 5.52 s between steering updates would likely have catastrophic consequences for the driving task.

In contrast, interleaving dialing in bursts of three or four digits at a time with checks of the heading of the vehicle and steering control would decrease the effect that completing the dial task has on the interval between steering updates. For instance, dividing dial time into three equal sized "chunks" would result in a 2.19 s interval between steering updates (i.e., 5 s / 3 + 0.185 s x 2 + 0.15 s). In this case, we predict that lateral deviation would increase from baseline performance, but would nevertheless give a reasonable assurance of safety in the context of the primary driving task. Moreover, the analysis shows that more interleaving between tasks would generally lead to safer performance.

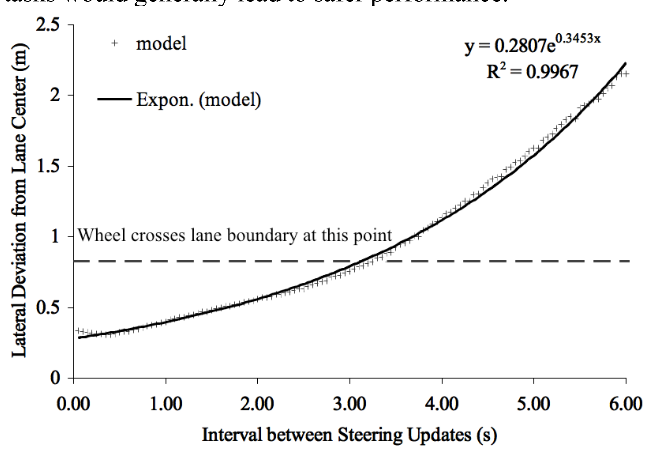

Figure 1 Data plot showing relationship between steering update interval and average lateral deviation.

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