HESITATION IN TRACKING INDUCED BY A CONCURRENT MANUAL TASK

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When people are required to track with one hand and perform occasional discrete responses with the other hand, there is a strong possibility that errors will be induced in tracking attributable to the simultaneous action by the other hand. We have been investigating this problem by pairing pursuit tracking (right hand) with a handle movement response (left hand) guided by an auditory stimulus. Tracking is assumed to represent flight control and the left hand response to represent other aspects of aircraft system management. The general goal of this research is to identify the types of errors induced into tracking by the requirement of a secondary response with the other hand.

In the previous Annual Manual conference (Klapp, Kelly, Battiste, & Dunbar, 1984) we reported that hesitations frequently occur in this situation. We defined a hesitation as holding the joy stick motionless for at least 1/3 sec. while the cursor was beyond the assigned tolerance. Overall, hesitations occurred on 48% of the instances of tracking sequences when accompanied by left hand secondary response, but only 6.5% of equivalent control instances with no secondary response. However, when tracking was emphasized by instruction and auditory alarm for out of tolerance cursor position, the rate of hesitations was reduced to 29% with left hand secondary response, and 4.5% on the control. This reduction in right hand hesitations was at the expense of increased left hand response simple reaction time (RT).

Now we report an attempt to determine if hesitations can be reduced further by combining tracking emphasis with a higher degree of practice. In addition a different type of joy stick controller was employed to determine whether the occurrence of hesitations generalizes beyond the particular joy stick and muscle groups involved in the earlier report. This new joy stick utilized finger muscles instead of those of the wrist and arm. Under these conditions hesitations occurred on 13.6% of the opportunities when the left hand response was present (but only on 0.78% of the control instances of tracking

unaccompanied by the left hand response). Although hesitations occurred each day, the frequency of hesitations decreased over days of practice (Table 1), $F(3,21) = 3.6$, $p < .05$.

The reduction of hesitations with practice was accompanied by a decrease in the RT of the secondary task, $F(3,21) = 10.5$, $p < .001$ (Table 1). Thus, the improvement of right hand tracking with practice cannot be attributed to developing a strategy of emphasis on tracking at the expense of left hand performance. By contrast to this effect of practice, emphasis on tracking improved tracking at the expense of left hand RT (Klapp, et al., 1984).

	Tracking Hesitations		Left Hand RT (msec.)
	Probe	Control	
Day 1	26.6%	0	480
Day 2	13.1%	0	416
Day 5	9.8%	0	380
Day 6	4.7%	3.1%	362
Mean	13.6%	.78%	409

Table 1. Hesitation rate and left hand reaction time.

An additional experiment is in progress which uses a third type of joy stick. Unlike the joy stick used in the experiment just reported, this one was spring loaded to bias movement in one direction. We assumed that subjects might release the stick rather than hesitate, so that the joy stick would move in the direction of the spring bias. Apparently this is not the case, because hesitations occur even with this joy stick. Four subjects have completed this experiment and hesitations occur on 18.6% of the instances in which the left hand must respond (and on 3.1% of the control responses). Apparently our subjects tend to "freeze" their right hand rather than to "let go."

We conclude that there is a tendency to freeze the tracking response when a discrete simultaneous response is required of the other hand. This type of error might be dangerous in flight control. Emphasis on tracking reduces hesitations at the expense of longer RT for the left hand response (Klapp, et al., 1984). By contrast, practice seems to reduce hesitations while also improving left hand

RT. Thus there appears to be a mode of control which permits tracking and discrete simultaneous responses to occur together. It would be desirable to understand how this is possible and how it might be facilitated.

Reference

Klapp, S. T., Kelly, P. A., Battiste, V., & Dunbar, S. (1984). Types of tracking errors induced by concurrent secondary manual task. In E. J. Hartzell and S. Hart (Eds.) Proceedings of the Twentieth Annual Conference on Manual Control., Vol. 2, pp. 299-304.

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