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**Further Evidence on Secondary Task
Interference in Tracking**

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Abstract

Two experiments indicate that (1) presence of a second task throughout training in pursuit tracking resulted in a learning as well as a performance decrement at either transfer or retention tests, (2) the locus of the interference appears to be in the selection of an overt response for the second task, since a "covert" response condition did not lead to a decrement in either task, nor, when divested of any response selection requirement, did an overt response condition interfere with tracking performance.

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Further Evidence on Secondary Task

Interference in Tracking¹

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The effects of a verbal secondary task on pursuit tracking performance were described in an earlier report (Trumbo, Noble & Swink, in press). In addition to demonstrating interference, the results indicated that one locus of the interference was in the response requirement of the second task. Thus, Ss required to anticipate stimulus items and Ss required to make the same responses, but in a free response-choice condition, showed the same loss in tracking proficiency. However, since the latter condition required a modicum of decision-making in the response selection, an interpretation solely in terms of competition among peripheral responses was not completely warranted.

In the prior research, secondary tasks were introduced only after considerable training on the tracking task, or during a retention session. Therefore, there was no evaluation of the effects of a second task on acquisition of skill. Consequently, the present experiments were designed to (a) evaluate the effects of a secondary task on acquisition of tracking skill, and (b) provide further evidence on the locus of interference.

Experiment I

Method. The apparatus, primary and secondary tasks were identical with

those used in Experiments II and III of the prior report (Trumbo, et al., in press). The primary task was pursuit tracking of a step-function sequence of 12 discrete target events at one target per sec. This sequence was repeated four times per 48 sec. trial with 15 sec. between trials. Vertical target and cursor lines were displayed on a 5 in. CRT and a lateral arm rest served as a positional control. The performance criterion was absolute error integrated over 48 sec. trials. The secondary task required the verbal anticipation of a sequence of the numbers 1 through 5, programmed via an intercom, with digram probabilities of .90 and .10, and presented at 3 sec. intervals throughout the middle 39 sec. of each trial.

Twenty-four University males were assigned, eight each, to three experimental conditions. All Ss received 15, 20, and 20 trials in three daily sessions. In the Control Condition (C), Ss received both the primary and secondary tasks throughout training and retention. Ss in a Retention Test Condition (R) trained on both tasks, but were tested on the tracking task alone after an 8-day retention interval. Finally, in a Transfer Test Condition (T), Ss trained on both tasks for 40 trials, then transferred to the primary task alone for the last 15 trials on Day 3.

Results

Integrated error data for the three conditions are presented in Fig. 1B. For comparison, Fig. 1A presents data from Experiment III of the prior report, wherein Ss trained on the tracking task alone received the secondary task at transfer (T') or retention (R'). Groups T and R

showed almost identical improvement in error scores upon removal of the secondary task at the end of training and at retention, respectively. However, t-tests between condition T of the present study and the combined R' and C' condition of the prior study were significant at Blocks 9 ($p < .05$) and 10 ($p < .05$), but not different ($p > .05$) at Block 11. Thus, removing the secondary task did not immediately eliminate the decrement in tracking performance associated with its presence; rather, it resulted in a gradual reduction in error. Also, it may be noted that introduction of the secondary task for Groups T' and R' of the prior study degraded tracking performance to a level similar to that in the present study for conditions involving the same amount of training, but with secondary task. (Compare: Groups T' and R, Blocks 9 - 11). Finally, failure of Condition R to perform better than Condition C at retention reflects the difference between these two groups at Block 11 ($p < .05$), which must be attributed to sampling error since they were treated identically.

Experiment II

The apparatus, tracking task, and training schedule for Experiment II were identical with Experiment I, except that 5-trial blocks were separated by 48 sec. test periods. Sixty University males were assigned, 12 each, to five secondary task conditions: Group AR (anticipating response) received the secondary task from Experiment I throughout training; for Group FR (free response) the secondary task numbers were replaced by relay clicks with Ss free to respond to each click with any number "1" through "5"; but not to repeat the same number immediately; Group ER (no overt

response) was instructed to learn the secondary task, but to make no overt responses during training; Group SR (stimulus repetition) simply repeated each number after it was presented, and Group C (control) had no secondary task. Thus, Conditions AR and FR were identical with Secondary and "Response" tasks used previously, while Condition ER eliminated the overt response requirement, but maintained the attentional and learning requirements of the secondary task, and Condition SR maintained the overt response, but not the response-selection requirement of Task FR. On test trials, only secondary task conditions were presented. For Conditions AR, FR and SR, these were unchanged, but for Condition ER anticipatory responding was required and the Control (C) was given the FR task as a rehearsal control. Groups AR, ER, and SR received a six-trial posttest on the AR task alone, i.e., overt anticipatory responding by all Ss.

Results

Integrated error data, presented in Fig. 2, indicate no differences among Conditions ER, SR and C, but greater error for Condition AR and FR. A Groups by Blocks analysis of variance indicated a significant Group effect with $F(4,55) = 2.56, p < .05$, a significant Blocks effect ($p < .01$), but no significant interaction. Duncan's test showed Group AR differed ($p < .05$) from all except Group FR, but the difference between Group FR and Groups ER, SR and C only approached significance ($.15 > p > .10$).

Secondary task performance for Groups ER, SR and C is shown in Fig. 3 as the mean number of correct anticipations per 13 item test trial. The no overt response (ER) group's performance parallels that of Group SR throughout Test and Posttest trials. However, the repetition group (SR),

showed only chance performance on the first anticipation trial and did not achieve the level of Groups AR and WR during the posttest. In fact, when compared with an independent group of 10 Sc given six trials on the second task only (broken line) Group SR showed no evidence of incidental learning during training. An F-test of the means of posttest trials 2-6 yielded an $F(2,33)=26.7, p < .01$. As indicated by Duncan's test, Group SR differed from both Groups AR and WR ($p < .01$), but the latter groups did not differ.

Discussion

Experiment I demonstrated, on one hand, that removing the second task resulted in the same improvement at retention as at transfer. On the other hand, the evidence also indicates that presence of the secondary task during training interfered with skill learning as well as skill performance, since only partial and gradual improvement occurred at transfer.

Tracking error at the end of dual-task training was comparable to that for the prior study when the secondary task was introduced after training on the primary task alone, which suggests a rather constant performance decrement from the second task. This is further supported by the consistency of the decrement for Group AR throughout training.

Experiment II failed to support an interpretation of interference solely in terms of competition among peripheral responses. Both Groups FR and SR made overt responses of the same class, but differed in that Group FR has a response-selection requirement. The difference in tracking between these Groups, while not highly reliable, suggests that one locus of interference is in the response-selection requirement. Further support of this comes from the tendency of Group FR to improve, relative to the other Groups,

since, with continued practice, 3s in Group FR tended to subvert the response-selection requirement by settling on a fixed pattern of responses such as "1, 2, 3, 4, 5," etc. Group AR also had a response-selection requirement but one which could not readily be subverted.

Neither the sharing of attention nor the concurrent learning of a second task, both of which were requirements of the ER Condition, appeared to interfere with the acquisition of tracking skill. The 3s in the ER Condition learned the second task about as well as the AR Group, yet showed no decrement in tracking performance.

The stimulus repetition group (SR) showed no evidence of incidental learning on the initial posttest trial, despite the fact that they had repeated 858 stimulus numbers during the training and test trials.

Our major findings appear to be consistent with Adam's (1966) recasting of the one-channel mechanism (Welford, 1958) as a decision mechanism that functions to resolve event uncertainty, but only to the extent that this resolution process involves the selection of an overt response. When no overt response selection is required for one of the tasks (Condition ER) two simultaneous inputs are processed without any apparent decrement in the performance of either task. Put another way, inputs from two channels can be handled simultaneously and in such a way as to modify responses, provided one input is effectively stored for overt response at a later time.

References

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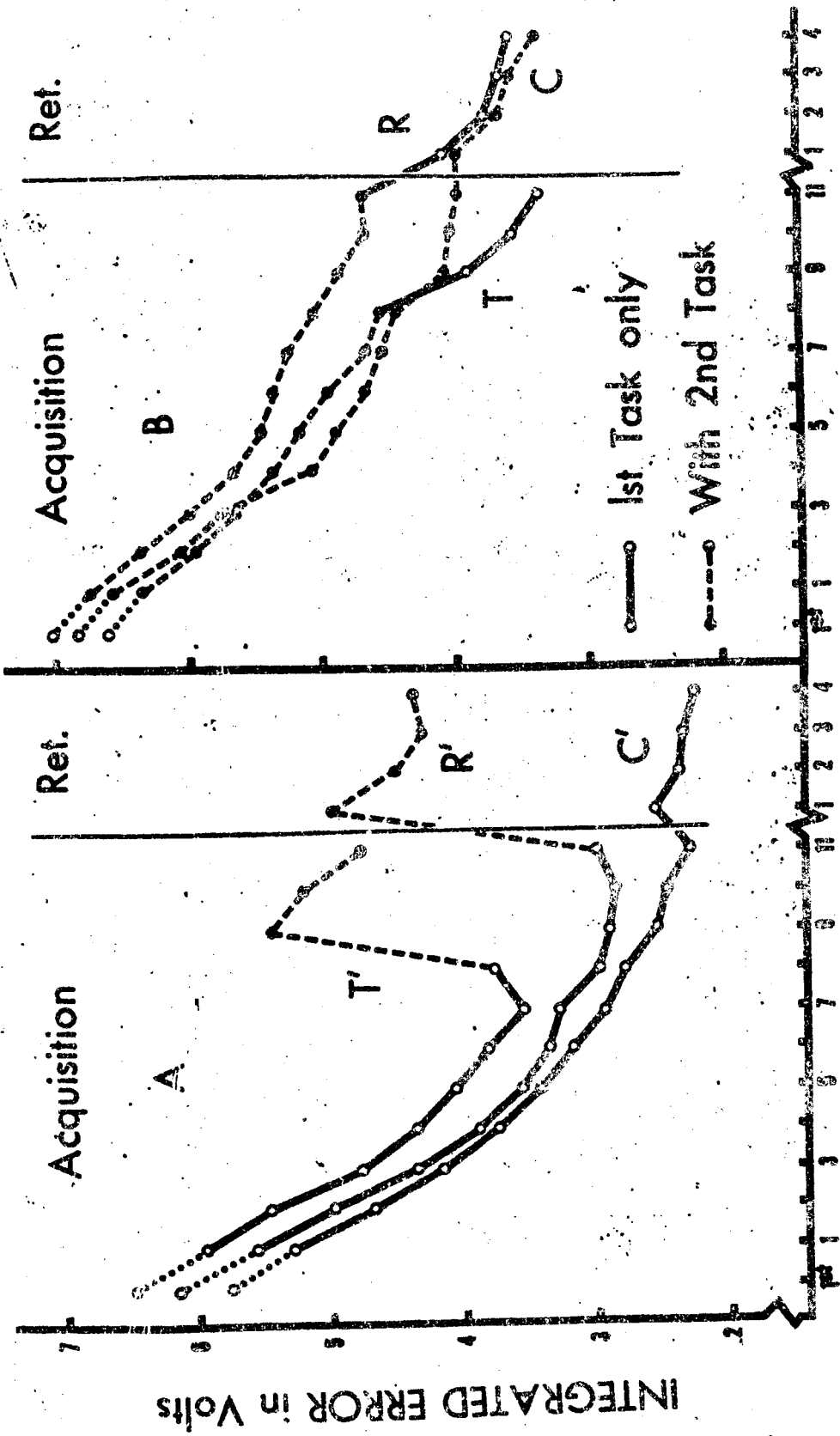
Footnotes

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² Now with Douglas Aircraft, Inc., Santa Monica.






Figure Legends

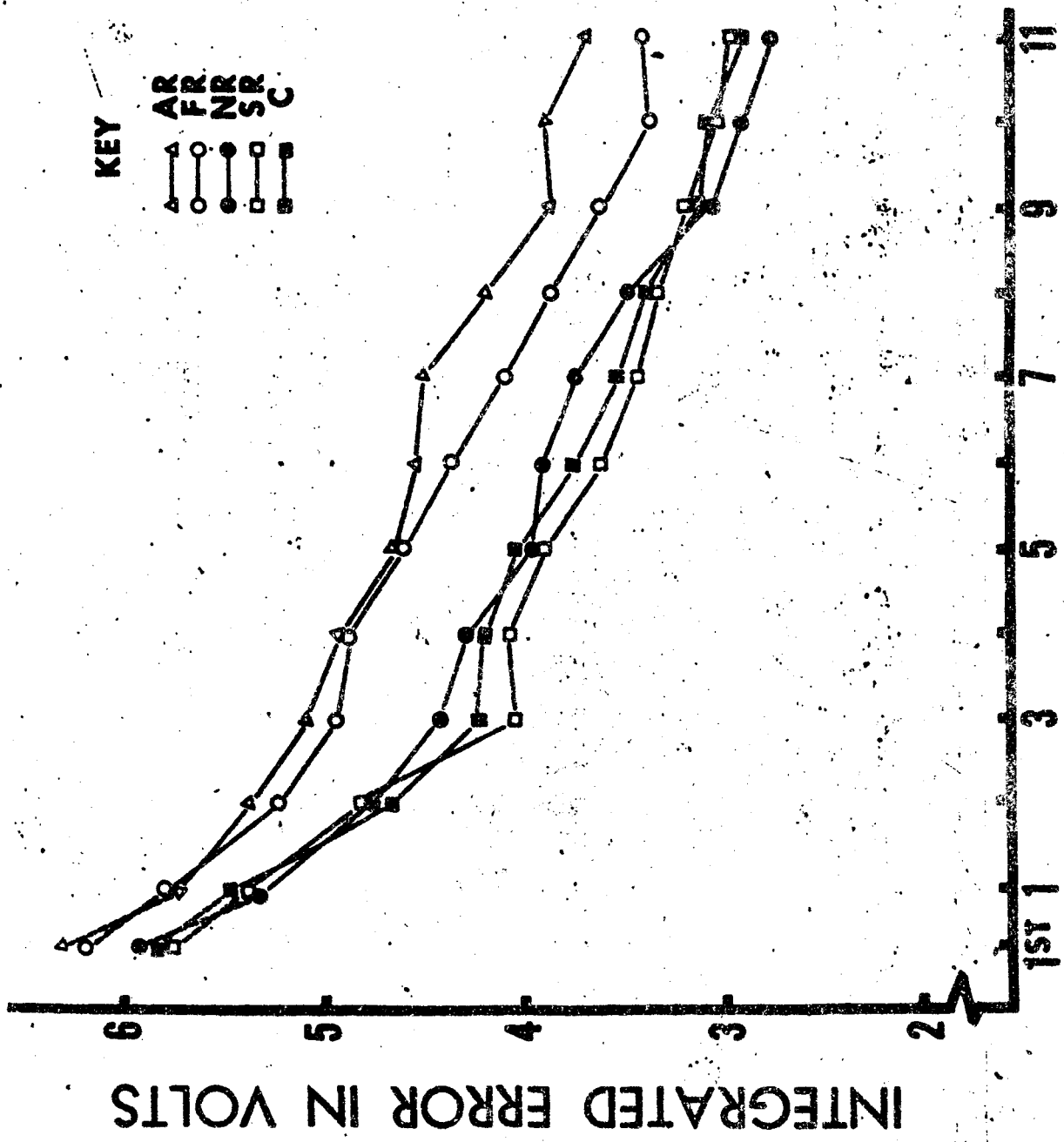
- Fig. 1. Integrated error for S_a with second task introduced after primary task training (A) and with second task present during primary task training (B).
- Fig. 2. Integrate error in tracking for various secondary task conditions in Experiment II.
- Fig. 3. Number correct anticipations per test trial on the Secondary task. The broken line represents 10 control S_a who were given the posttest only.



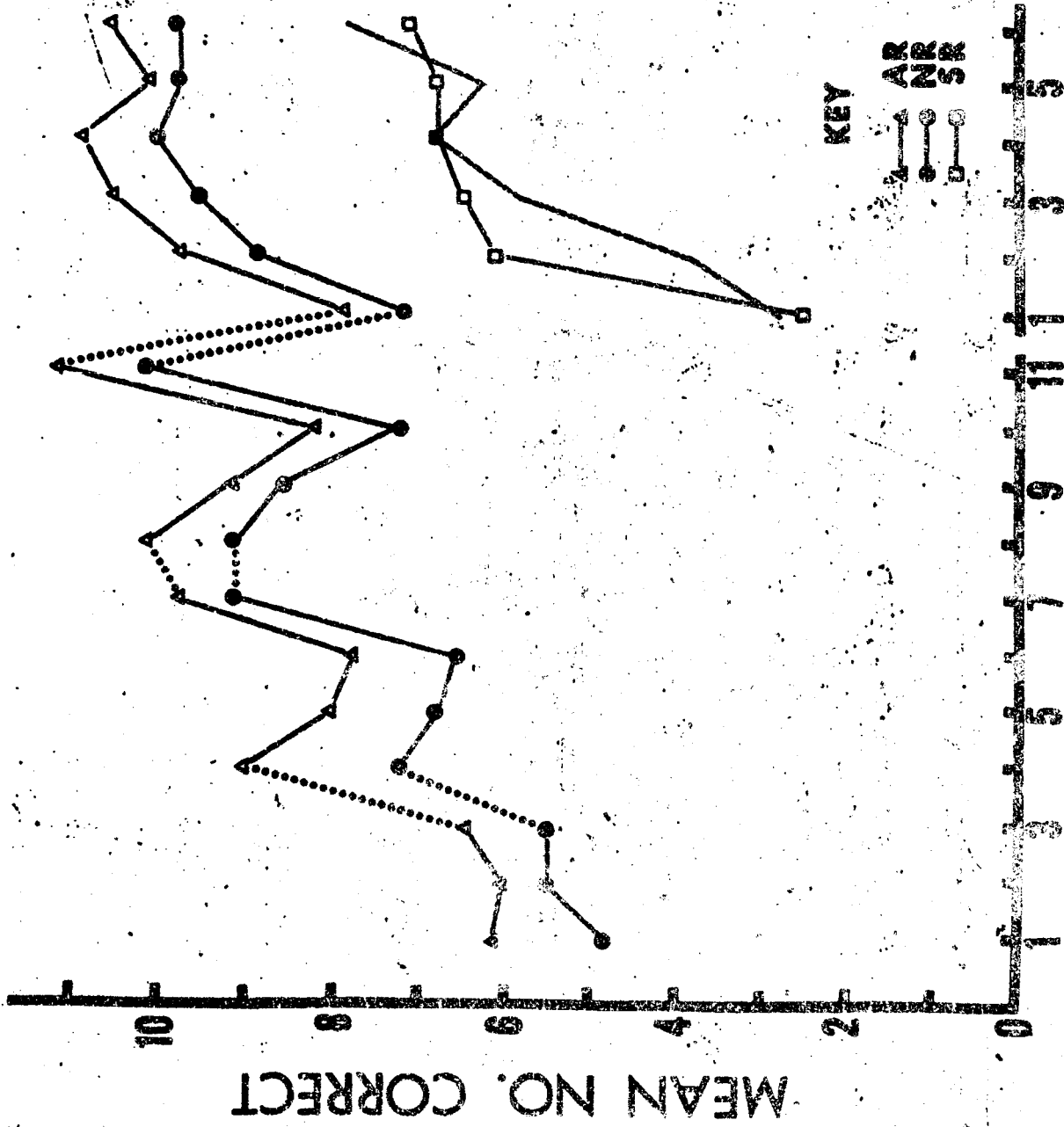
BLOCKS OF 5 TRIALS

KEY

- AR 
- FR 
- NR 
- SR 
- C 



BLOCKS OF 5 TRIALS



KEY
 AR
 NR
 SR

TEST TRIALS POST TEST