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Interpolated Activity Effects in Distributed Practice

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The purposes of this study were to evaluate the effect of different rest interval activities in distributed practice (DP) upon the rate of learning a PA task, to evaluate the effectiveness of different rest interval activities in controlling rehearsal, and to investigate the role of rehearsal in DP performance.

Three experiments compared three different pairs of rest interval activities. One pair of activities, color naming (CN) and sequential addition (SA), was machine paced (MPA). A second pair, cartoon reading (CR) and symbol cancellation (SC), was self paced (SPA). The third pair required no formal activity (NFA), Ss were instructed to rehearse (R) or not to rehearse (NR). Besides different rest interval activities two other independent variables were manipulated. The length of the

intertrial period was set at either 30 or 60 seconds. Two lists differed in items but were constructed to be comparable. The dependent variables were the number of trials required to learn the list to a criterion of one perfect trial and the responses of Ss to a questionnaire on the amount and method of rehearsal. Ss were 240 college students. Data from the three experiments were analyzed separately by analysis of variance and then combined to make an overall comparison with analysis of variance with tasks considered as nested factors. After completing the paired associates (PA) task, each S was administered a questionnaire to determine if he had rehearsed and if so the amount, time, and method of rehearsal. Analysis of the data showed the CN, SA, CR, and SC produced no significant difference in rate of learning, nor did NR and R differ. Overall comparison showed that NR and R produced faster learning than the CR and SC. The analysis of the questionnaire showed that the different tasks varied in amount of control of rehearsal, but there were no differences in rate of learning related to amount of rehearsal reported.

The conclusions drawn were that the facilitative affect of rehearsal is unproven, that requiring formal activity produces slower learning than having no formal rest interval task and that the SA should be used to nearly eliminate rehearsal.

INTERPOLATED ACTIVITY EFFECTS IN DISTRIBUTED PRACTICE

by

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CHAPTER I

INTRODUCTION

In comparing the effects of massed and distributed practice (DP) on verbal learning it is necessary to control subjects' behavior during rest periods in order to eliminate or control implicit practice (rehearsal). Otherwise, any differences obtaining between the two conditions of practice may be due to additional practice permitted DP subjects. Although everyone has seen the necessity of controlling rehearsal there has never been a systematic investigation of the role of rehearsal in distributed practice phenomena. Consensus of opinion seems to be that rehearsal will facilitate acquisition (e.g., Deese, 1960). Jones (unpublished data) compared performance as a function of amount of activity required of subjects during a one minute rest interval and found that performance over 20 trials was inversely related to percentage of rest interval activity required. That is, groups with no interpolated activity made fewest errors and groups with the rest period entirely filled made most errors. Surprisingly, the experimenter observed very little overt evidence that Ss were using the unfilled interval for rehearsal. Furthermore, in response to casual questioning the majority of subjects reported that they had tried rehearsing early in the practice session but had stopped because they felt rehearsal was more of a hindrance than an aid to learning. On the surface it seems quite improbable that these subjects were correct. However, Rohrer

(1949) compared the performance of a group which had been instructed to rehearse during the rest interval with a group for whom rehearsal, presumably, had been controlled and found no differences in favor of the rehearsal group. Similarly, Postman and Phillips (1961) found that granting Ss opportunity to rehearse did not facilitate performance on a verbal task. Evidence that rehearsal may have adverse effects on performance has been contributed by Rathkopf and Coke (1963) who found that rehearsal in the absence of the response to be mastered, the usual situation in DP studies, depressed performance relative to no rehearsal conditions. These data demonstrate that currently the relative contribution of rehearsal in studies of distributed practice cannot be specified and indicate the need for further research along these lines. Thus, one purpose of the present research program is to investigate the role of rehearsal in DP performance.

Historically, the most common method of controlling rest interval activity has been to require S to participate in some activity which E deems unrelated to the experimental task. Unfortunately, this method of control poses two serious methodological problems which have been ignored almost completely.

Firstly, it is obvious that rest-interval activities may vary tremendously in the degree to which they actually prevent rehearsal. Indeed, recent data suggest that Ss can rehearse in spite of rather elaborate controls to the contrary (Reynolds and Huston, unpublished data). It is possible that several substantive issues in the experimental literature have arisen because of the use of different rest interval activities on the part of different experimenters. For

example, Underwood (1960) has suggested that the discrepancy between his results and those of Wright and Taylor (1949) are probably due to the fact that the rest interval task used by Wright and Taylor did not prevent rehearsal. The second purpose of this proposed research is to evaluate how effectively certain rest interval tasks prevent rehearsal.

Secondly, rest interval tasks may have direct effects upon performance and thus interact with and confound DP effects. In this vein, Irion cautioned, "If rehearsal is to be controlled by filling the rest interval with some unrelated activity, it is probably necessary that the nature of this activity be rigidly specified and standardized, lest the 'control' introduce a more serious error than it prevents" (McGoech and Irion, 1952; page 142). Data substantiating the relevance of this warning were contributed by Underwood (1952) who, using a serial learning task, compared distributed practice with color naming and digit symbol cancellation as rest interval activities. He found that color naming resulted in higher overt error rate and slight, though statistically unreliable, facilitation of learning. In interpreting these results Underwood concluded, "the differences in learning and in error frequency are a function of a positive effect of color naming and not a function of a depressant effect produced by symbol cancellation" (Underwood, 1952; page 328). Conversely, it is not unreasonable to expect some rest interval tasks to "depress" performance relative to digit symbol cancellation. For example, because of its similarity to the experimental task, cartoon reading (Wright and Taylor, 1949) might logically be expected to interfere with DP performance. A third purpose of this proposed research is to evaluate the extent to which DP

performance is affected directly by different rest interval activities.

Two possible sources of differences in DP performance have been suggested; (a) task specific effects and (b) the relative efficiency of rest interval activities in preventing rehearsal. In order to evaluate task specific effects, four rest interval activities will be compared; color naming (CN), sequential addition (SA), cartoon reading (CR), and symbol cancellation (SC). Roughly speaking, rest period tasks can be grouped under two major headings; (a) machine-paced tasks, e.g., color naming (Riley, 1952) and sequential addition (Jones, unpublished data) and (b) self-paced tasks, e.g., cartoon reading (Wright & Taylor, 1949) and digit symbol cancellation (Underwood, 1960).

Irion (1949) found that color naming as a warm-up task facilitated recall of a serial list. These data, in conjunction with Underwood's (1952) results, suggest that in comparison to self-paced tasks, machine-paced tasks may facilitate DP performance by maintaining Ss response set during rest intervals. Or, in other words, machine-paced tasks requiring Ss to respond verbally at approximately the same rate as the learning task prevent a loss of warm-up during rest intervals thereby facilitating performance. If this hypothesis is correct, an interaction between rest interval length and type of interpolated activity would be expected. For example, as the rest period is lengthened there is increasing opportunity for loss of warm-up and therefore, an activity which maintains warm-up should become increasingly beneficial to overall performance. Thus, warm-up, or its loss, is seen as one possible source of differential performance as a function of rest interval activity and will be considered in the overall research program.

Another task specific effect is suggested by interference theory. Interference theory assumes that the facilitative effect of DP generally found when DP is compared with massed practice (MP) is caused by extinction of incorrect responses in fewer trials. Incorrect responses are believed to arise from past learning of associations, responses, or verbal habits. A rest period activity that reinforces past verbal habits, such as CR, should produce slower learning than a task that gives less reinforcement of past verbal habits, such as SC. One aspect of this study will be a comparison of rates of learning of two groups having rest interval activities of CR and SC.

In order to evaluate the extent to which failure to control rehearsal contributes to overall performance, it will be necessary first to determine the effects of rehearsal on performance. Thus, rehearsal shall serve as one type of interpolated activity. The performance of rehearsal control groups will serve as a base against which to compare the performance of groups using formal rest interval tasks. At the conclusion of the practice session, Ss will be informed of the purpose of the experiment and given a standardized questionnaire. The questionnaire will be designed to answer the following questions; (a) did S rehearse during the rest periods, (b) approximately what percent of the total time did S utilize for rehearsal, (c) how was rehearsal distributed during the practice session, i.e., did S rehearse more during the early or late stages of practice, (d) what were S's subjective feelings about the value of rehearsal to his overall performance?

The questionnaire will provide information regarding the effectiveness of the various activities in controlling rehearsal. Comparisons

can be made across tasks with regard to the proportions of Ss admitting and denying rehearsing within specific groups.

The questionnaire may provide additional information concerning the value of rehearsing during the temporal course of practice. For example, it is possible that rehearsal early in the practice session, when S has learned only a few pairs, is less valuable than later in practice when S has only a few pairs yet to learn. Such information may lead to specific hypotheses which can be evaluated in later experiments.

CHAPTER II

METHOD

Three specific experiments will be done. In order to maximize information derived from these studies all three will be in progress simultaneously. Subjects will be assigned at random to experimental conditions in all three experiments, thus permitting analyses of the combined data.

The experimental learning task shall consist of a list of eight pairs of low frequency nonsense trigrams selected from the Underwood and Schulz list. In order to insure that the results are not specific to the particular list used, two comparable lists shall be constructed and half of the Ss in each experimental condition shall learn each list. The list will be typed on paper tape and presented on a Hull-type memory drum at a two second rate. In order to prevent serial memorization of responses, the list will be presented in four different serial orders constructed such that no pair appears twice in any quarter of the list. All Ss will practice the list to a criterion of one perfect trial. At the conclusion of the practice session S will be informed of the purpose of the experiment and will be given the standardized questionnaire described previously. Twenty Ss will serve in each experimental condition and will be assigned randomly to Experiments I, II and III.

In Experiment I, the effects of instructions in controlling rehearsal will be investigated under two lengths of intertrial intervals

(30 and 60 seconds). Rehearsal Ss will be instructed to rehearse as much as possible during each of the rest intervals. Non-rehearsal Ss will be instructed that rehearsal will impede their performance and that they should avoid rehearsal to the best of their ability. Further instructions will be given on ways of avoiding rehearsal, e.g., if the words keep popping into your head, try thinking of some pleasant episode you have recently enjoyed. Trials necessary for one perfect trial will be used as the dependent variable and these data will be analyzed in a 2 x 2 x 2 factorial analysis of variance.

In Experiment II, the effects of two different paced rest interval activities (color naming and sequential addition) will be compared under two lengths of intertrial intervals (30 and 60 seconds).

In color naming conditions, color chips will be affixed directly onto the tape, between repetitions of the P-A list, and will be presented at the same rate as the list (2 seconds). Subjects will be required to name each chip as it appears and try to guess the next color.

The sequential addition task will be typed directly on the tape between successive repetitions of the list. Immediately following the last pair in the list, a three-digit number will appear and will be followed by a series of single digits. When the three-digit number appears S will recite it out loud and then add successively each single digit, reciting out loud the new total. Trials to criterion will be submitted to a 2 x 2 x 2 analysis of variance.

Experiment III will compare the effects of two unpaced rest interval activities on DP performance. The two unpaced tasks are CR

and SC. For both types of activity the memory drum will be stopped during the rest interval and Ss will participate in the rest interval activity for either 30 or 60 seconds. Subjects will be instructed that their performance on the rest interval activity is crucial to the total experiment. For example, digit symbol cancellation Ss will be told that they will be given scores regarding the accuracy and speed of their performance on the digit symbol task. CR Ss will be instructed that a short quiz will be given at the conclusion of the experiment.

The data will be submitted to a 2 x 2 x 2 analysis of variance to test for main and interaction effects.

Following individual analyses, the data may be combined in a number of ways. For example, if no significant interactions are obtained in Experiments I, II or III, the data may be analyzed as a three factor experiment, with length of intertrial interval and type of interpolated activity as the major experimental variables and differences within major types of activity as a nested factor. This design would permit a major evaluation, across experiments, for the effect of the types of rest interval activity (e.g., paced, self-paced and rehearsal), plus assessment of interactions between length of intertrial interval and types of activity.

Experiment I will answer the question whether rehearsal can be adequately controlled with instructions. Comparisons across Experiments I, II, and III will answer the question of how important rehearsal is to overall performance on the verbal tasks. Comparison between the results of Experiments II and III will give information concerning the effects of paced versus unpaced activity on performance.

CHAPTER III

RESULTS

Two different types of data were collected and analyzed in this study, data from the PA learning task and data from the questionnaire. The data from the PA learning task were the number of trials necessary for each S to reach a criterion of one perfect trial. See Table I. The data from the three experiments conducted were combined and subjected to an analysis of variance, with tasks considered as a nested factor. Experiments, tasks within experiments, lists, and length of intertrial interval were the main effects. Two effects, lists and experiments were significant sources of variance. See Table II. List 2 took significantly fewer trials to learn, F (1, 214) = 5.94, $a < .05$. List 1 took an average of 22.0 trials for Ss to learn. List 2 took an average of 19.2 trials. The three experiments were also a significant source of variance, F (2, 214) = 3.62, $a < .05$. Ss in Experiment I took an average of 21.4 and those in Experiment III took an average of 21.9. Tukey's test was used to determine which experiments varied significantly from the others. Experiment I, which compared a group instructed to rehearse with a group instructed not to rehearse, took significantly fewer trials to learn than Experiment III, which compared self-paced tasks of CR and SC. See Table I. Experiment II, which compared machine-paced tasks of color naming and sequential addition, did not vary significantly from either of the other experiments. The lack of a significant difference

TABLE I

MEAN NUMBER OF TRIALS TO CRITERION

	EXPERIMENT I No Formal Activity		EXPERIMENT II Machine-Paced Activity		EXPERIMENT III Self-Paced Activity	
	Rehearsal	No Rehearsal	Color Naming	Sequential Addition	Symbol Cancellation	Cartoon Reading
30 Seconds	17.2	19.8	21.1	21.5	23.3	23.6
60 Seconds	19.2	18.1	21.4	21.5	19.2	21.8
TOTAL	18.1	18.9	21.2	21.5	21.2	22.7
Overall	18.6		21.4		21.9	

TABLE II

F TABLE OF INDIVIDUAL EXPERIMENTS

	EXPERIMENT I			EXPERIMENT II			EXPERIMENT III		
	df	MS	F	df	MS	F	df	MS	F
Task	1	11	<1	1	1	<1	1	41	<1
DP	1	1	<1	1	.02	<1	1	171	2.60
Lists	1	65	1.04	1	414	4.446*	1	59	<1
Task X DP	1	65	1.04	1	.8	<1	1	23	<1
Task X List	1	37	<1	1	218	2.34	1	44	<1
List X DP	1	174	2.79	1	91.8	<1	1	2	<1
T XL X DP	1	96	1.54	1	72.2	<1	1	52	<1
SS/G	72	62.4		72	93.11		72	65.8	

* $a < .05$

between Experiment II and Experiment III indicates that the two machine-paced activities of Experiment II have no facilitative effect through preservation of warm up when compared to the two self-paced tasks of Experiment II.

The difference in length of intertrial period was not a significant source of variance. The difference in rate of learning failed to reach significance and varied in direction.

The data from each of the three experiments were subjected to a 2 x 2 x 2 analysis of variance to provide specific comparisons between rest interval activities. In each of these analyses, lists, length of intertrial periods, and intertrial tasks were main effects. See Table III. The only main effect or interaction to reach a .05 level of significance in any of the experiments was lists in Experiment II, F (1, 72) = 4.45, $p < .05$. See Table II. List 2 was learned in fewer trials in all experiments, but only in Experiment II did the difference reach significance. None of the two tasks compared in any experiment was a significant source of variance.

Experiment III compared the effect upon rate of learning of CR and SC. CR did not reduce the rate of learning compared to SC as had been predicted on the basis of interference theory, F (1, 72) = .62.

The data from the questionnaire was first evaluated to see if there was a difference in the percentage of Ss reporting rehearsal during different intertrial activities and different lengths of intertrial periods. See Table IV. The percentage of Ss reporting rehearsal was subjected to an arc sine transformation followed by an analysis of variance. The two main effects, tasks F (5, 5) = 11.0, $p < .05$ and

TABLE III

F TABLE COMPARISON OF INDIVIDUAL EXPERIMENTS

Source	df	MS	F
Experiment	2	264.8	3.62*
Task with Experiment	3	14.4	< 1
DP	1	47.7	< 1
Lists	1	434.7	5.94*
Experiment X DP	2	62.1	1.69
Experiment X List	2	51.8	< 1
List X DP	1	192.6	2.63
Task with Experiment X DP	3	29.4	1.21
Task with Experiment X List	2	71.1	1.94
SS/Groups	214	73.1	

* $a < .05$.

length of intertrial period F (1, 5) = 16.3, $p < .05$ were significant sources of variance. A significantly larger percentage of Ss reported rehearsing in the 60 second interval than in the 30 second interval.

Cheffe's test was applied to determine which of the six tasks differed significantly in percentage of Ss reporting rehearsal. Two groups differed from each other and all others. A greater percentage of Ss instructed to rehearse in Experiment I reported doing so than in any other group. The percentage of Ss reporting rehearsal was less in

TABLE IV

PERCENTAGE OF SUBJECTS REPORTING REHEARSAL

	NR	R	CN	SA	CR	SC
30 seconds	45	100	45	5	32	20
60 seconds	55	100	55	10	60	50

SC in Experiment II than in any other activity. No other differences were significant.

To evaluate the effects of rehearsal on the rate of learning the rates of learning of the two groups was found to differ the most in percentage of Ss reporting rehearsal when compared using a t test. There was no difference in rate of learning. Rehearsal apparently had no facilitating effect upon DP performance.

CHAPTER IV

DISCUSSION

This study was designed to fulfill three purposes. One purpose was to evaluate the extent to which DP performance is directly affected by different rest interval activities. Three different experiments were conducted and each compared two tasks from one of the three general types of intertrial activities. The three general types of intertrial activities were self-paced activities (SPA), machine-paced activities (MPA), and no formal activity (NFA). The two activities in SPA were cartoon reading (CR) and symbol cancellation (SC). The two activities in MPA were color naming (CN) and sequential addition (SA). The two tasks in NFA were instructions to rehearse (R) and instructions not to rehearse (NR).

The three experiments were compared using a 3 x 2 x 2 x 2 analysis of variance. The overall comparison of the three different types of activity showed no clear pattern. The results of the analysis of variance indicated that the means of the three types of activity were not equal. Tukey's test revealed a significant difference between NFA and SPA but not between NFA and MPA or between MPA and SPA. This anomalous result is explained by the fact that the difference between NFA and SPA was just barely significant. Examination of Table I shows that the means of MPA and SPA are very close and that they differ more from NFA than from each other. The means of the four tasks in MPA and SPA are

also very similar. Of the four tasks in MPA and SPA, the two which differed the most were compared in SPA, and they were not shown to differ significantly. The tasks in which length of intertrial period had the largest average effect were also compared in SPA and the difference was not found to be significant.

Comparison of the means of MPA and SPA with the mean of NFA indicates a difference exists. NFA apparently produces faster learning than either MPA or SPA. However, it should be noted that the 60 seconds rest period in SC produced learning as fast or faster than half of the four conditions in NFA recorded in Table I.

The lack of significant difference between MPA and SPA indicates that there is little or no facilitation of learning due to preservation of warm up by MPA. This is in general agreement with Underwood (1952) who compared CN and SC and also found no difference in rate of learning.

The three experiments each compared two different rest interval activities. No significant difference was found between any of the activities compared in the respective experiments. One of the two groups in NFA was instructed to rehearse and the other instructed not to rehearse. Rohrer (1949) also found that instructions to rehearse did not facilitate learning when he compared three groups, one group instructed to rehearse and two groups given tasks.

The two tasks compared in SPA were CR and SC. This comparison was felt to be a test of interference theory which explains the facilitative effect found under DP by assuming that DP causes extinction of incorrect responses in fewer trials than massed practice. Incorrect

responses are believed to arise from past learning of associations, responses or verbal habits. Interference theory was interpreted as predicting slower learning by Ss reading cartoons because reinforcement of past verbal habits by reading would slow their extinction. However, no significant difference was found between the two groups. The fact that the 60 second condition in CR learned in fewer trials than the 30 second is also not in accord with interference theory. Most other attempts to substantiate the effects of past verbal habits on laboratory performance have also failed (Underwood, 1966).

A second purpose of this study was to evaluate how effectively certain rest interval activities prevent rehearsal. Analysis of the questionnaire showed that two groups differed from all others in the percent of Ss reporting rehearsal during the rest interval. Significantly fewer Ss performing SA reported rehearsing than Ss in any other rest interval activity. Significantly more Ss instructed to rehearse reported rehearsing than in any other activity. No other differences between activities were significant. Based upon subjective reports it would appear that SA almost eliminates rehearsal.

A third purpose of the study was to investigate the role of rehearsal in DP performance. The role of rehearsal was evaluated by comparing the rate of learning for the two groups which differed the most in percent of Ss reporting rehearsal during the rest interval (the group instructed to rehearse and the group with the sequential addition task). No difference was found in the rate of learning of the two groups. Although the amount of rehearsal was measured by subjective report, the lack of significant difference in the rate of learning makes uncertain the facilitative effect of rehearsal.

Studies that have attempted to evaluate the effect of rehearsal in verbal learning have been limited to those studying rehearsal during intratrial periods. Glanzer and Meiner (1967) compared two groups in a serial learning experiment, one of which repeated each item aloud six times and another which did not. The group which did not repeat the items scored higher on a free recall test. They concluded that "the results indicated that simple repetition lowers overall recall. Effective rehearsal consists of some other activity . . . . Effective rehearsal probably consists of linking individual list words into pairs of longer strings" (Glanzer and Meiner, 1967; page 934). Rock (1957) concluded that repetition played no role in learning associations on a PA task although it may strengthen associations once they are formed. Sampson (1969) reported a study which he interpreted as showing rehearsal facilitated learning. Two groups were presented 24 items, either with or without instructions to learn them. The Ss instructed to learn them recalled more of them on a test of free recall and a greater percentage of them reported rehearsing during presentation of the items. Sampson assumed that more rehearsal caused the better performance.

Three conclusions may be drawn from the results of this study. The first relates to the effect of intertrial activities on rate of learning. The results of this study suggest that some formal rest interval activity results in slower learning than having no formal rest interval activity. However, there were no reliable differences in rate of learning attributable to the four separate types of formal activity required.

A second conclusion relates to the effect of intertrial tasks upon amount of intertrial rehearsal reported by Ss. Only two tasks cause a significant difference in amount of rehearsal reported. Significantly fewer Ss with SA for an intertrial task report rehearsing. If rehearsal is to be eliminated, SA should be used for an intertrial task.

It may also be concluded from this study that although rehearsal is often assumed to facilitate learning, the facilitative effect of rehearsal during the intertrial period in DP studies is unproven.

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