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Comparison of the Performances of Analyzers and Non-analyzers During Alternation Practice on a Perceptual-Motor Task[1]

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Abstract. A total of 15 analyzers and 15 non-analyzers were given an initial five standard trials and then 58 units of alternation practice on the Iowa Pursuitmeter. Each unit of alternation practice consisted of three reversed trials followed by one standard trial. The specific purpose of the study was to determine whether or not individual differences in the amount of interference displayed during alternation practice can be attributed, at least in part, to a tendency to analyze. The results lend some support for the view that the analyzers were less susceptible to interference than the non-analyzers.

Miles (1956, 1957) has shown that *analytic tendency* is a significant factor in the performance of male undergraduates on the Iowa Pursuitmeter. The identification of tendency to analyze was based on the manner of solving block design problems of the Kohs type. Those subjects whose verbal reports of their way of solving the problems indicated that they had conceptually divided the design into parts before moving the blocks were classified as analyzers. Those subjects were classified as non-analyzers who indicated a more haphazard approach, such as moving the blocks around until they looked right. For an elaboration on this procedure and a picture of the designs used, see Behrens and Miles (1957).

Inferring that analyzers habitually tend to figure out the essential features of a novel task, as they had apparently done on the block design test, Miles predicted that they would perform better than the non-analyzers on the Pursuitmeter during original learning (OL), show less proactive loss when a reversed version of the same task was given during interpolated learning (IL), and show less retroactive loss upon reverting to the first task during relearning (RL). For the most part, these predictions were verified in his two studies (1956, 1957). The analyzers performed significantly better on the standard task during OL, as well as on the reversed task during IL. They also showed less retroactive loss, as measured by percent loss in performance from the end of OL to RL, but this difference was not statistically dependable at the .05 level.

The superior performance of the analyzers on the reversed task during IL suggests that they are less susceptible to interference, but

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as Miles points out, control groups would be necessary to see what performance might have been had previous practice on the standard task not occurred. However, since the results for RL in both studies were in the predicted direction, there is some indication that the analyzers may suffer less than non-analyzers from interference effects.

It was thought that if the amount and persistence of interference effects could somehow be increased, then individual differences among performers would be more pronounced and so provide for a more conclusive study of the relationship between the analytic tendency and susceptibility to interference. Alternation practice, a technique devised by Spieth and Lewis, was chosen as the procedure to be used. In this procedure, as the name implies, the subject alternates between the two tasks according to a fixed sequence.

The specific purpose of the present study, therefore, was to determine whether or not individual differences in the amount of interference displayed during alternation practice can be attributed, at least in part, to a tendency to analyze. It was predicted from Miles' findings that the analyzers would perform better on both tasks than the non-analyzers and thus, by inference, might be regarded as less susceptible to interference.

Apparatus

The two motor tasks were provided by the Iowa Pursuitmeter, the response unit of which consists of two pistol-grip type handles placed at about chest height. Movements of these handles control a spot of light which the subject tries to keep on a moving target located about five feet from his face. The target consists of three concentric circles, much like an ordinary firing range target. The amount of time that the spot of light falls on the innermost circle, or bullseye, is recorded to the nearest hundredth of a second. The two tasks used were the *standard,* so named because the required movements are compatible with the customary habits of steering and pointing, and the *reversed,* for which the required movements are exactly opposite to those of the standard task. A schematic drawing and a more complete description of this apparatus can be found in Miles (1956, 1957) and Miles and Lewis (1956).

Subjects

A total of 44 male volunteers from a course in elementary psychology took the block design test. Of these, 21 were classified as analyzers and 23 as non-analyzers. Two subjects were disqualified as being unable to perform on the Pursuitmeter because of physical handicaps, six were lost because of an improper adjustment of the apparatus, and six were either unable to meet on five consecutive days or were unwilling to do so. The results of the present study

are based on the remaining 30 subjects, of whom 15 were analyzers and 15 non-analyzers.

Procedure

Each subject was given a total of 237 trials on the Pursuitmeter. These trials were distributed as follows: five standard task trials followed by ten units of alternation practice on the first day, and 12 units of alternation practice on each of the next four consecutive days. Each unit of alternation practice consisted of three reversed trials followed by one standard trial. This pattern was adopted from the findings of Spieth and Lewis on the Turret Pursuit Apparatus, which is essentially like the Pursuitmeter in the requirements imposed on the subject.

The trials were 30 seconds in length, separated by 30-second rest periods. A 5-minute break was given after the fourth unit of alternation practice on the first day and after the sixth unit on the other four days. The subject was informed whenever the control settings were changed from one task to the other.

Results

Figure 1 summarizes the results of Pursuitmeter performance of

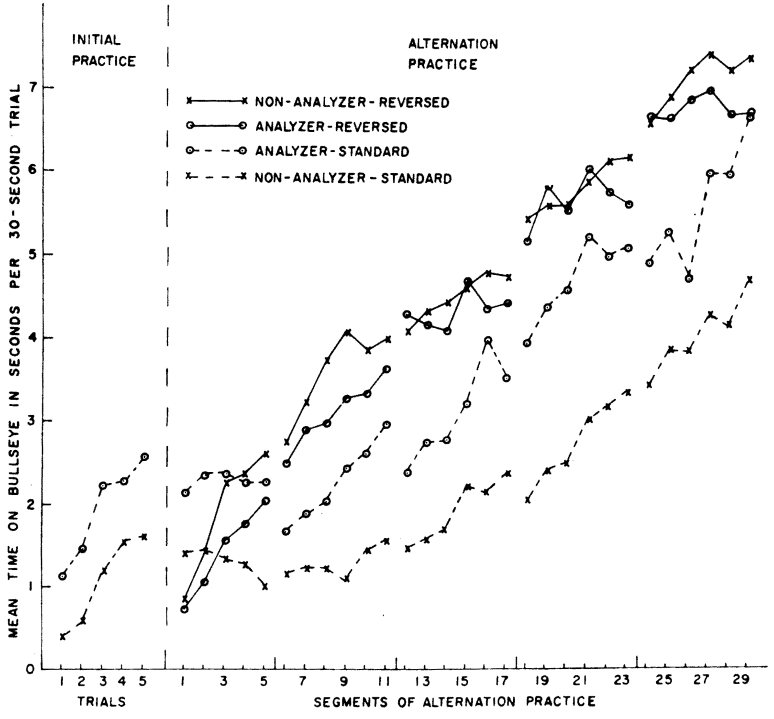

Figure 1. Means of time on bullseye in seconds per 30-second trial plotted against (a) every trial during initial practice and (b) segments of two units of alternation practice.

the two groups of subjects on the two tasks. In the figure, the means of time on bullseye in seconds per 30-second trial are plotted against (a) single trials for initial practice and then (b) segments of two units of alternation practice. Thus each point on the two broken-line curves for alternation practice represents the mean of two standard trials, and each point on the two solid-line curves represents the mean of six reversed trials. The data were combined in this manner in order to reduce the irregularities in the trend lines and to simplify the statistical treatment.

The initial practice period of five standard trials was given to see if the performance of analyzers and non-analyzers were similar to those of comparable groups on standard trials 1-5 of OL in Miles' studies (1956, 1957). The hope was that the performances of the present groups on the standard trials in the first seven units of alternation practice could be dirctly compared with the performance on standard trials 6-12 of Miles' subjects, to determine the amount of loss attributable to interposed reversed trials. Unfortunately, this comparison was not possible. Although the curves for initial practice in Figure 1 show that the analyzers performed at a higher level than the non-analyzers, as predicted, they show neither the expected divergence nor the general level of proficiency reported by Miles for similarly dichotomized subjects.

An inspection of the two broken-line curves for alternation practice shows that the analyzers maintained their superiority on every standard task trial. On the first day, both groups displayed losses as soon as alternation began, but the analyzers tended to maintain a constant level, whereas the performance of the non-analyzers was characterized by a slow but steady decrease. On subsequent days, the two curves show some tendency to diverge, suggesting less interference in the case of the analyzers.

On reversed practice, represented in Figure 1 by the solid-line curves, the over-all performance of the analyzers was not superior, as predicted, but was slightly inferior to that of the non-analyzers. However, the over-lapping of the two curves on days 3 and 4 indicates that the two groups may have been about equally proficient in performing this task.

Performance on the three reversed trials within each alternation unit was generally characterized by steady improvement, that is, proficiency on the third trial was greater than on the second, and greater on the second than on the first. For practice sessions wherein a rest not over 30 seconds in length occurred, the performance on the first reversed trial of a unit, with few exceptions, was markedly below that on the third reversed trial of the preceding unit. In fact, the losses at the points of shifting to the reversed task were so pronounced during the last three days of practice that there was little acquisition of additional skill within any practice session. How-

ever, when a 5-minute break or an overnight interval occurred between a standard trial and the first reversed trial in the ensuing alternation unit, either small loss or a gain was manifested on the reversed trial. Thus, most of the improvement in performance on the reversed task during the last three days of practice appeared in the form of reminiscence following the breaks. On the other hand, there was usually a marked loss in proficiency on the first standard alternation trial of each day. This trial came, of course, after three reversed trials. Improvement in performance on the standard task during the last three days was fairly regular. There were relatively large gains on the first standard trial following the 5-minute breaks.

A trend analysis deemed best for the statistical evaluation of these data is outlined in Lewis (in press), with the Analytic variable as the *between* effect and Trials as the *within* effect. The analysis provides for treating the following hypotheses: (a) the over-all means of the performance of analyzers and non-analyzers are the same, (b) the performance curves for the two groups on each task are parallel, and (c) the trial means do not differ. The third hypothesis is of minor importance for this study and therefore will not be discussed.

Table 1 summarizes the trend analysis for initial practice. The

Table 1

Summary of the Trend Analysis of the Performances of the Analyzer and Non-analyzer Groups on the Standard Pursuitmeter Task During the Five Trials of Initial Practice

	Source	SS	df	ms	F	p
tbI	—Total between Individuals	133.80	29	4.61		
bA	—Between Analytic Groups	28.20	1	28.20	7.48	.02
bI	—Between Individuals	105.60	28	3.77		
wI	—Within Individuals	116.08	120	.97		
bT	—Between Trials	40.79	4	10.20	15.22	.001
TxA	—Interaction Trials by Analytic Groups	.60	4	.15	0.22	Not sign.
rem	—Remainder	74.69	112	.67		
Total		249.88	149			

F-ratio of 7.48 (df=1 & 28, p=.02) reveals that the over-all mean performance of the analyzers was significantly superior to that of the non-analyzers. The difference between the slopes of the curves was not statistically dependable (F=.22, df=4 & 112).

The analysis of the performances on the standard task during alternation practice is summarized on Table 2. As expected from

Table 2

Summary of the Trend Analysis of the Performances of the Analyzer and Non-analyzer Groups on the Standard Pursuitmeter Task During the 29 Segments of Alternation Practice

	Source	SS	df	ms	F	p
tbI	—Total between Indivduals	2330.3	29	80.36		
bA	—Between Analytic Groups	394.8	1	394.80	5.71	.025
bI	—Between Individuals	1935.5	28	69.13		
wI	—Within Individuals	2454.7	840	2.92		
bT	—Between Trials	1371.1	28	48.97	37.10	.001
TxA	—Interaction, Trials by Analytic Groups	46.3	28	1.66	1.25	.20
rem	Remainder	1037.3	784	1.32		
Total		4785.0	869			

the wide separation between the broken-line curves in Figure 1, the over-all mean performance of the analyzers was found to be significantly superior to that of the non-analyzers ($F=5.71$, $df=1$ & 28, $p=.025$). There was no significant difference between the slopes of the trend lines ($F=1.25$, $df=28$ & 784, $p=.20$).

The analysis of the performances on the reversed task during alternation practice is given in Table 3. No significant difference was found for either the over-all mean performances of the two

Table 3

Summary of the Trend Analysis of the Performances of the Analyzer and Non-analyzer Groups on the Reversed Pursuitmeter Task During the 29 Segments of Alternation Practice

	Source	SS	df	ms	F	p
tbI	—Total between Individuals	1206.4	29	41.60		
bA	—Between Analytic Groups	22.2	1	22.20	0.52	Not sign.
bI	—Between Individuals	1184.2	28	42.30		
wI	—Within Individuals	3865.4	840	4.60		
bT	—Between Trials	2898.7	28	103.52	85.55	.001
TxA	Interaction, Trials by Analytic Groups	17.3	28	0.62	0.51	Not sign.
rem	—Remainder	949.4	784	1.21		
Total		5071.8	869			

groups ($F=.52$, $df=1$ & 28) or the slopes of the trend lines ($F=.51$, $df=28$ & 784). In Miles' studies, the analyzers performed

significantly better than the non-analyzers on the reversed task during IL. Since the present two groups performed about equally well on the reversed task, this suggests that the analyzers were probably somewhat more susceptible than the non-analyzers to interference effects. However, the wide separation between the two performance curves for the non-analyzers indicates that they were less able than the analyzers to learn the two mutually incompatible tasks concurrently. In fact, three of the 15 non-analyzers (but none of the analyzers) failed to show any improvement on the standard task after alternation practice began. Therefore, it would be expected that the non-analyzers would suffer less performance loss on the reversed task as a result of the interpolated standard trials.

To get a better picture of the marked interference effects on the reversed task within a practice session, the mean performance level for each reversed trial of an alternation unit was compared with the third reversed trial of the preceding unit. Because of reminiscence, this comparison was not made if a 5-minute break or an overnight interval occurred between the two units. The results of the t-tests for the means of these differences for both the analyzers and the non-analyzers are summarized in Table 4. Part A shows that, on the average, the analyzers kept the spot of light on the bullseye 0.31

Table 4

Summary of Separate T-tests for Testing the Hypothesis That the Means of Differences Between Times on Bullseye for Analyzers and Non-analyzers on the First, Second, and Third Reversed Trials of An Alternation Unit and Times on the Third Reversed Trial of the Preceding Unit Are Zero

where: $t = \frac{M_D}{\sqrt{\frac{s_d^2}{N-1}}} = \frac{\Sigma D}{\sqrt{\frac{\Sigma (D-M_D)^2}{N(N-1)}}}$, $df = N-1$

A. First Reversed Trial.

Group	M_D	s_d	t	df	p
Analyzers	−.31	.46	4.62	47	.001
Non-analyzers	−.36	.47	5.25	47	.001

B. Second Reversed Trial.

Group	M_D	s_d	t	df	p
Analyzers	−.14	.43	2.23	47	.03
Non-analyzers	−.11	.39	1.93	47	.06

C. Third Reversed Trial.

Group	M_D	s_d	t	df	p
Analyzers	.04	.43	.64	47	.55
Non-analyzers	.08	.43	1.28	47	.25

second less during the first reversed trial of a unit than they did on the third reversed trial of the preceding unit. This loss was statistically dependable ($t=4.62$, $df=47$, $p=.001$). A comparable loss of 0.36 second was found in the case of the non-analyzers, which was significant at the .001 level ($t=5.25$, $df=47$). From Table 4B, it can be seen that both groups performed at a lower level on the second reversed trial than they did on the third reversed trial of the preceding unit. For the analyzers, the difference of 0.14 second is associated with a probability of .03 ($t=2.23$, $df=47$); and for the non-analyzers the difference of 0.11 second is associated with a probability of .06 ($t=1.93$, $df=47$). Table 4C shows that the interference effects were so persistent that even during the third trial of any unit, neither group is performing significantly better than it was on the last reversed trial of the preceding unit. The analyzers, on the average, hit the target only 0.04 second longer ($t=.64$, $df=47$, $p=.55$), and the non-analyzers only 0.08 second longer ($t=1.28$, $df=47$, $p=.25$). As would be expected from the similar values given in Table 4, there were no statistically dependable differences between analyzers and non-analyzers.

Discussion

The results lend some support for the view that the analyzers were less susceptible than the non-analyzers to interference during alternation practice, but they are far from conclusive. The most convincing evidence was that the non-analyzers had the greater difficulty mastering the two incompatible tasks concurrently, as shown by their markedly inferior performance of the standard task.

Inasmuch as both groups performed poorly on the standard task as compared with the reversed task, a greater relative number of standard task trials might have served to increase the amount of interference on both tasks. A recent exploratory study using four reversed trials followed by two standard trials as the basic alternation unit gave promising results. A total of 14 analyzers and 15 non-analyzers were given eight initial standard task trials and then 14 units of alternation practice over a two day-period. Surprisingly, the two groups performed almost identically during initial practice, thus making it safer to conclude that differences observed during alternation practice were due to interference. The analyzers were superior to the non-analyzers on the reversed task by an amount just short of the 5 percent level of significance ($t=1.99$, $df=27$, $p=.06$), and displayed a slight superiority on the standard task.

In conclusion, a few qualitative comparisons should be made with the earlier alternation studies of Spieth (1951) and Spieth and Lewis. The main difference between their results and the present findings was that performance on the standard Turret task was superior to that on the reversed task for almost all of alternation practice. This

difference might have been an outgrowth of the fact that when operating the Turret, the subject rotates in the tub as he steers to move the spot of light to the right or left, whereas he sits in a stationary chair when performing on the Pursuitmeter. The trend lines for both tasks in all three studies show the same general characteristics. On the standard task there was (a) an initial, prolonged decrement, more pronounced on the Turret than on the Pursuitmeter, (b) a loss of proficiency on the first standard trial following an overnight interval, and (c) a fairly regular improvement in performance within each practice session. Performance on the reversed task was characterized by (a) a generally steady improvement within each alternation unit, (b) pronounced losses from the third reversed trial of one alternation unit to the first trial of the succeeding unit within practice sessions, and (c) small losses and frequently gains when a longer break or an overnight interval occurred after the interpolated standard trial. The gains (reminiscence) were probably an outgrowth of recovery from work decrement.

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