Effect of verbalization over an increasing number of trials on the efficiency of the learning of a manipulative task

Robert Earl Hoff

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THE EFFECT OF VERBALIZATION OVER AN INCREASING
NUMBER OF TRIALS ON THE EFFICIENCY OF THE
LEARNING OF A MANIPULATIVE TASK

by

ROBERT EARL HOFF
B.A., Montana State University, 1953

Presented in partial fulfillment of the
requirements for the degree of
Master of Arts

MONTANA STATE UNIVERSITY
1954

Approved by:

[Signatures]

Chairman, Board of Examiners
Dean, Graduate School

Aug 6, 1954
ACKNOWLEDGMENTS

The author is especially indebted to Professor Bert R. Sappenfield for his generous assistance and constant guidance throughout the entire work and his wife Patricia who has aided and encouraged him throughout.

R. E. H.
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<td>8</td>
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</table>
CHAPTER I

REVIEW OF THE LITERATURE

This study is concerned with investigating the effects of verbalization on the efficiency of learning a manipulative task. It becomes necessary therefore to describe the work leading up to this study.

In 1924 C. J. Warden\(^1\) published an experiment relative to this study. The problem was to analyze the various modes of attack by subjects who were wholly naive as to the methods to be employed, and who, therefore were left to


<table>
<thead>
<tr>
<th>Mode of Attack</th>
<th>No. of Subjects</th>
<th>Percent of Total No.</th>
<th>Trials Required to Learn</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>Mean</td>
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<td>Word Reaction</td>
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<td>32.2</td>
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<td>Visual Imagery</td>
<td>18</td>
<td>30.0</td>
<td>67.9</td>
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<tr>
<td>Motor Reaction</td>
<td>17</td>
<td>28.3</td>
<td>123.9</td>
</tr>
</tbody>
</table>
"hit upon" such modes of reaction as each was able to do in mastering the situation. Two forms of a stylus maze were used with accompanying written instructions. The written instructions contained no reference as to how to approach the problem, just that the subject was to "go through" the maze three times out of four without an error. Then a follow-up questionnaire was given to find out how the subjects had approached the problem. The different methods were compared with the number of trials required to reach the criterion. It was found that the word reaction required one-half as many trials as the visual imagery and one-fourth as many trials as the motor reaction.

In 1931 R. W. Husband\textsuperscript{2} reported a study on methods of learning. The problem was to study "internal aspects" of the learning process. A four-section multiple-U high relief

\begin{table}[h]
\centering
\begin{tabular}{llll}
\hline
Mode of Attack & Trials & Score Errors & Time Seconds \\
\hline
Verbal & 10.1 & 20 & 358 \\
Visual & 15.0 & 29 & 505 \\
Motor & 25.6 & 23 & 802 \\
\hline
\end{tabular}
\caption{Table II}
\end{table}

finger maze was set as the task for blindfolded adults; the subjects were divided into four groups of eighty each, practicing on one, two, three and four sections respectively. It was found that three qualitative methods were used in learning, verbal, motor, and visual, as well as combinations of these; and that individuals sometimes shifted from one method to another. The verbal (counting) was used by the greatest number of subjects, the visual (imagery) by the fewest. As measured by learning scores the verbal method was found to be the most efficient, and the motor method the least so.

In a study conducted in 1944 by L. M. Thompson, six groups of children learned to assemble a mechanical puzzle. To each group the experimenter demonstrated the assembly procedure, but with different amounts of verbal explanation. A report of the results is found in Table III on the following page. It was concluded that the greater the amount of verbalization, the more rapidly the children learned the task.

According to C. E. Ragsdale, motor activities are learned through observation, trial and error, and reflective thinking. They are learned as means to ends, efficient learning implying interest in the end result. Ill health, poor motivation, poor equipment or inadequate method or

---

<table>
<thead>
<tr>
<th>Group</th>
<th>Procedure</th>
<th>Number of Subjects</th>
<th>Average No. of Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Silent demonstration given, with child required to count in order to prevent verbalization of the task.</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>Silent demonstration but child describes the procedure orally.</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>3.</td>
<td>Demonstrator gives partial description of the task and the child watches silently.</td>
<td>25</td>
<td>16.2</td>
</tr>
<tr>
<td>4.</td>
<td>Demonstrator describes procedure fully, and child watches.</td>
<td>25</td>
<td>14.1</td>
</tr>
<tr>
<td>5.</td>
<td>Child describes procedure. Teacher makes corrections when child's description is in error.</td>
<td>25</td>
<td>12.4</td>
</tr>
<tr>
<td>6.</td>
<td>Same as in five (above) except that the pieces are numbered in the order in which they are to be assembled.</td>
<td>25</td>
<td>9.5</td>
</tr>
</tbody>
</table>
style may inhibit progress. Such maturational factors as strength, endurance, speed and mental and social maturity have important relations to motor activity.4

Francis Van Dusen and Harold Schlosberg published the results of a study in 1948, in which fifty-one subjects learned to locate and actuate ten pairs of switches, so connected that a buzzer sounded when each correct pair was turned on. At the same time they learned ten pairs of nonsense syllables, attached as labels to the switches. After three correct trials, they were given a pre-retention test on the two types of materials separately, and divided into three groups. The groups came back for post-retention tests after one, seven and twenty-eight days respectively. There were no significant differences in retention between the two types of materials after any of the retention intervals. The actuation of the paired switches is believed to be a perceptual-motor activity, fairly free from verbal elements. Therefore, the results disprove the hypothesis that motor materials are retained better than verbal ones if both are organized in the same manner.5

The present study is concerned with a modification

---


of a study done by William Cary, Jr. at Purdue University in 1950. The purpose of the Purdue study was to determine if a manipulative task as he performed it, would require fewer trials to meet a criterion of mastery than one who had not verbalized. The subjects, students at Purdue University, were divided into two matched groups and individually taught to assemble Sub-test A-4 of the Purdue Mechanical Assembly Test. During the instruction period, the experimental group verbally described each operation of the task as they performed it and the control group performed the task without verbalizing. The groups then repetitively performed the task until they reached a pre-established criterion of performance. The number of trials and the time and errors on each trial were recorded. An analysis of the differences of the means and standard deviations between the experimental and control groups on the measures of performance revealed that all differences were non-significant. It should be pointed out that the subjects verbalized on only one trial. The possibility exists that verbalization over a greater number of trials might have a positive effect on the ability

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6 William Cary, Jr., "The Effects of Verbalization on the Number of Trials Required to Learn a Manipulative Task," M. A. Thesis, Purdue University, 1950.


8 William Cary, Jr., op. cit.
ILLUSTRATION I

SUB-TEST A-2

PURDUE MECHANICAL ASSEMBLY TEST
ILLUSTRATION II

SUB-TEST A-4

PURDUE MECHANICAL ASSEMBLY TEST
of a learner to perform a task.

The review of the literature indicates that verbalization may possibly have a positive effect on the learning of certain types of motor tasks. Much experimentation remains to be done before the role of verbalization can be adequately understood. It is the purpose of this study to attempt to contribute evidence in this area.
CHAPTER II

THE PROBLEM AND DEFINITIONS USED

After the United States entered World War II, it faced a lack of trained manpower. As a consequence of the situation the Job Instructor Training Program was set up by the War Manpower Commission. The purpose of the program was to show employers how to teach their employees the new jobs in the most efficient manner. The four procedural steps contained in the Job Instruction Training Manual are stated as follows:

Step I  Prepare the Worker
Put him at ease.
State the job and find out what he already knows about it.
Get him interested in learning job.
Place in correct position.

Step II  Present the Operation
Tell, show and illustrate one important step at a time.
Stress each key point.

Instruct clearly, completely, and patiently, but no more than he can master.

Step III  **Try Out Performance**
Have him do the job. Correct errors.
Have him explain each key point to you as he does the job again.
Continue until you know he knows.

Step IV  **Follow-Up**
Put him on his own. Designate to whom he goes for help.
Check frequently. Encourage questions.
Taper off extra coaching and close follow up.\(^2\)

I. **STATEMENT OF THE PROBLEM**

Contained in Step III above is the instruction to the learner to explain each key point to the instructor as he does the job. The implications of this statement are that verbalization of the operations involved in the task will increase the efficiency of the learning process. This is a widely accepted principle for training industrial employees. Although it is an accepted principle its

\(^2\)Ibid., pp. 13-14.
validity has not been satisfactorily demonstrated. This study is primarily concerned with investigating the effects of verbalization on the efficiency of the learning of a manipulative task. The hypothesis may be stated: verbalization will increase the efficiency of the learning of a manipulative task.

II. DEFINITION OF TERMS

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbalize</td>
<td>To express in speech; to name or describe in words.</td>
</tr>
<tr>
<td>Manipulate</td>
<td>To treat, work or operate with the hands, or by mechanical means.</td>
</tr>
<tr>
<td>Learner</td>
<td>Defined in this study as the subjects participating in this experiment.</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Defined in this study as the amount of time required to perform the</td>
</tr>
<tr>
<td></td>
<td>manipulative task.</td>
</tr>
<tr>
<td>Task</td>
<td>Defined in this study as Sub-tests A-2 and A-4 of the Purdue Mechanical</td>
</tr>
<tr>
<td></td>
<td>Assembly Test.</td>
</tr>
</tbody>
</table>

4Ibid.
5Maurice R. Graney, op. cit.
III. DESCRIPTION OF TASK

The Purdue Mechanical Assembly Test was designed and built by Maurice R. Graney at Purdue University in 1942. The test consists of eight sub-tests, in two forms (A and B). The two forms were matched so that A-1 is equivalent to B-1, A-2 to B-2, A-3 to B-3 and A-4 to B-4. The parts of each form increase in difficulty from A-1 to A-2 to A-3 to A-4. The test has a reliability of .77. Two factors were found to be present which influenced the test, mechanical insight and mechanical experience. In this study sub-tests A-2 and A-4 were used.7

6 Ibid.
7 See Illustrations one and two.
CHAPTER III

DESCRIPTION OF PROCEDURE

In order to investigate the effect of verbalization over an increasing number of trials, on the learning of a manipulative task, it was necessary to divide the experimental design into two phases. The first phase will be known as the pilot phase. The second phase will be known as the experimental phase.

I. PILOT PHASE

In the pilot phase it was necessary to find how predictive the performance on sub-test A-2 is of performance on A-4.\(^1\) It also allowed the experimenter to become familiar with the standardized procedure for administering sub-tests A-2 and A-4.\(^2\) Forty subjects, students at Montana State University, were used in the pilot phase. Each subject was individually taught to assemble sub-test A-2. This was accomplished by having each subject watch as the experimenter articulately described each operation as it was performed. Then the subjects performed the assembly

\(^1\)Maurice R. Graney, *op. cit.*

\(^2\)See Appendix A.
as the instructor verbalized the standard training procedure instructions. The subjects were then given one practice trial, with assistance if desired. After the practice trial, three time-trials were given. The time required to perform the assembly on each trial was recorded and an average of the times was assigned to each subject as his score on sub-test A-2. The same procedure was followed on sub-test A-4. A form of the pearson product moment correlation formula was used in determining the correlation coefficient between the scores on A-2 and A-4. A correlation coefficient of .67 was found.

II. EXPERIMENTAL PHASE

As has been stated, the implications of the directions contained in the Job Instruction Training Manual are that verbalization of the instructions, by a learner, will positively affect the learning, and hence the performance, of an industrial task. The study by William Cary, Jr. reported that there were no significant differences between the number of trials required to learn a manipulative task when one group verbalizes, on one practice trial, and the other group does not. The possibility exists however, that verbalization may affect the learning in

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3 See Table IV, pp. 16-17.
4 Job Instructors Training Manual, op. cit.
5 William Cary, Jr., op. cit.
## TABLE XV

**DATA FROM PILOT STUDY**

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TABLE IV

DATA FROM PILOT STUDY (CONTINUED)

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<td>49.6</td>
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terms of some other criterion such as time required to learn. This study has investigated the effects of verbalization over an increasing number of trials on the learning (performance time) of a manipulative task.

The experimental design may be stated as follows: Fifty subjects, male students at Montana State University, were used in the experimental phase. In group I the subjects were individually taught to assemble sub-test A-2, following the standard training procedure described in the pilot phase and Appendix A. The average time for their three timed trials was recorded. The subjects were then placed in the control group (C1). When someone else performed on A-2 in the same average time as that of a subject already in the control group (C1), (plus or minus one second), he was placed in the experimental group (E1). This allowed the matching to be done as the experiment progressed. The subjects in the control group (C1) were then presented with A-4. The experimenter articulately described each operation of the task as he assembled it. The subjects observed as the experimenter performed the task. Then the subjects in the control group (C1) were given one practice trial, with help if desired. Following this, one time trial was given and the time required to perform the task was recorded. The procedure for the experimental group (E1) was the same, except that on the practice trial each member of the experimental group (E1) received the instruction to describe
to the experimenter each operation as he (the subject) performed it. The mean of the time scores made by the control group (Cl) and by the experimental group (El) were compared. This was accomplished by finding the value of "t" (sometimes called the critical ratio) and comparing the differences to find whether any of the differences were statistically significant. The results are reported in the following chapter. The procedure for groups II, III, IV and V was the same, except that the number of practice trials was increased by one for each successive group.

6See Appendix B.
CHAPTER IV

STATISTICAL ANALYSIS OF THE DATA

The purpose of this chapter is to present the findings of the study. The problem was to investigate the effects of verbalisation on the learning of a manipulative task over an increasing number of trials. The subjects were divided into five matched groups. Group I received one trial, group II two trials, group III three trials, group IV four trials and group V five trials. The findings are presented and discussed in this order.

Data on group I. Data for group I are found in Table V. The experimenter performed one assembly on subtest A-4 articulately describing the correct procedure as the subjects watched. The subjects were then given one practice trial. The control group (Cl) did not verbalize the instructions on their practice trial and the experimental group (El) did. Each group received one timed trial. The mean performance time for the control group (Cl) was 91.6 seconds while the mean performance time for the experimental group (El) was 89.8 seconds. The experimental group (El) required 1.8 seconds less time than the control group (Cl) to perform the assembly. The value of "t", 

-20-
### TABLE V

**DATA ON GROUP I**

<table>
<thead>
<tr>
<th>Control Group I</th>
<th>Experimental Group I</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub. No.</strong></td>
<td><strong>Ave. Time</strong> on A-2</td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>42.5</td>
</tr>
<tr>
<td>2.</td>
<td>36.6</td>
</tr>
<tr>
<td>3.</td>
<td>38.3</td>
</tr>
<tr>
<td>4.</td>
<td>49.0</td>
</tr>
<tr>
<td>5.</td>
<td>36.0</td>
</tr>
</tbody>
</table>

Mean = 91.6
Mean = 89.8

Correlation = .10

"t" (or critical ratio) = 1.636
sometimes called the critical ratio, was 1.636. The value of "t" indicated that the difference between the means was not significant at the 5% level. In order to reject the "null hypothesis" at the 5% level of confidence the value of "t" would have to reach a value of 2.776. It may be concluded that verbalization, on one practice trial, will not significantly affect the performance on sub-test A-4.

Data on group II. Data on group II are found in Table VI. The experimenter performed one assembly on sub-test A-4, articulately describing the correct procedure, as the subjects watched. The subjects were then given two practice trials. The control group (C2) did not verbalize the instructions on the two practice trials and the experimental group did. Both groups were then given one timed trial. The mean performance time for the control group (C2) was 19.1 seconds while the mean performance time for the experimental group (E2) was 22.0 seconds. The experimental group (E2) required 2.9 seconds longer than the control group (C2) to perform the assembly. The value for "t" was 1.760, a value that is not significant at the 5% level. Although the difference between the means of the time scores seems to indicate that verbalization interfered with the performance on A-4, it may be concluded that the difference resulted from chance factors alone and that verbalization on two practice trials cannot be expected to
TABLE VI

DATA ON GROUP II

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>11.</td>
<td>49.0</td>
<td>115</td>
<td>16.</td>
<td>50.0</td>
<td>110</td>
</tr>
<tr>
<td>12.</td>
<td>32.6</td>
<td>72</td>
<td>17.</td>
<td>31.6</td>
<td>76</td>
</tr>
<tr>
<td>13.</td>
<td>53.3</td>
<td>86</td>
<td>18.</td>
<td>53.3</td>
<td>115</td>
</tr>
<tr>
<td>14.</td>
<td>33.6</td>
<td>79</td>
<td>19.</td>
<td>33.6</td>
<td>80</td>
</tr>
<tr>
<td>15.</td>
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<td>66</td>
<td>20.</td>
<td>34.3</td>
<td>65</td>
</tr>
</tbody>
</table>

Mean = 83.6

Mean = 89.2

Correlation = .54

"t" (or critical ratio) = 1.760
affect the performance on A-4.

**Data on group III.** Data on group III are found in Table VII. The experimenter performed one assembly on sub-test A-4, articulately describing the correct procedure as the subjects watched. The subjects were then given three practice trials. The control group (C3) did not verbalize the instructions on the three practice trials and the experimental group (E3) did. Each group then received one timed trial. The mean performance time for the control group (C3) was 79.4 seconds while the mean of the times for the experimental group (E3) was 74.8 seconds. The experimental group (E3) required 4.6 seconds less time to assemble sub-test A-4 than the control group (C3). The value of "t" was 1.181, a value that is not significant at the 5% level of confidence. Since the value of "t" was not significant, the difference between the mean performance times is attributable to chance factors alone. It is concluded that verbalization on three practice trials will not affect the performance on sub-test A-4.

**Data on group IV.** Data on group IV are found in Table VIII. The experimenter performed one assembly on sub-test A-4, articulately describing the correct procedure as the subjects watched. The subjects were then given four practice trials. The control group (C4) did not verbalize the instructions on the four practice trials and the
TABLE VII

DATA ON GROUP III

<table>
<thead>
<tr>
<th>Control Group III</th>
<th>Experimental Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.</td>
<td>45.0</td>
</tr>
<tr>
<td>22.</td>
<td>47.3</td>
</tr>
<tr>
<td>23.</td>
<td>35.0</td>
</tr>
<tr>
<td>24.</td>
<td>32.0</td>
</tr>
<tr>
<td>25.</td>
<td>41.6</td>
</tr>
</tbody>
</table>

Mean = 79.4
Mean = 74.8

Correlation = .45

"t" (or critical-ratio) = 1.181
experimental group (E4) did. Both groups were then given one timed trial. The mean performance time for the control group (C4) was 63.8 seconds while the mean performance time for the experimental group (E4) was 65.6 seconds. The experimental group (E4) required 1.8 seconds longer to perform on sub-test A-4 than the control group (C4). The value of "t" was .3754, a value that is not significant at the 5% level of confidence. It is concluded that verbalization on four practice trials will not significantly affect the performance on sub-test A-4.

Data on group V. Data on group V are found in Table IX. The experimenter performed one assembly on sub-test A-4, articulately describing the correct procedure as the subjects watched. The subjects were then given five practice trials. The control group (C5) did not verbalize the instructions on the five practice trials and the experimental group (E5) did. Each group was then given one timed trial. The mean performance time for the control group (C5) was 64.6 seconds while the mean performance time for the experimental group (E5) was 67.8 seconds. The experimental group required 3.2 seconds longer than the control group to perform on sub-test A-4. The value of "t" was .4200, a value that is not significant at the 5% level of confidence. It may be concluded that verbalization on five practice trials will not significantly affect the performance on sub-test A-4.
**TABLE VIII**

**DATA ON GROUP IV**

<table>
<thead>
<tr>
<th>Control Group IV</th>
<th>Experimental Group IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub. No.</strong></td>
<td><strong>Ave. Time on A-2</strong></td>
</tr>
<tr>
<td>31.</td>
<td>41.6</td>
</tr>
<tr>
<td>32.</td>
<td>30.6</td>
</tr>
<tr>
<td>33.</td>
<td>36.6</td>
</tr>
<tr>
<td>34.</td>
<td>53.3</td>
</tr>
<tr>
<td>35.</td>
<td>34.6</td>
</tr>
</tbody>
</table>

**Mean** = 63.8  
**Mean** = 65.6

Correlation = .69

"t" (or critical ratio) = .3754
TABLE IX

DATA ON GROUP V

<table>
<thead>
<tr>
<th>Control Group V</th>
<th></th>
<th>experimental Group V</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>41.</td>
<td>44.6</td>
<td>75</td>
<td>46.</td>
</tr>
<tr>
<td>42.</td>
<td>41.6</td>
<td>67</td>
<td>47.</td>
</tr>
<tr>
<td>43.</td>
<td>48.6</td>
<td>59</td>
<td>48.</td>
</tr>
<tr>
<td>44.</td>
<td>35.3</td>
<td>56</td>
<td>49.</td>
</tr>
<tr>
<td>45.</td>
<td>37.6</td>
<td>66</td>
<td>50.</td>
</tr>
</tbody>
</table>

Mean = 64.6

Mean = 67.8

Correlation = .49

"t" (or critical ratio) = 4200
Table X provides comparisons of the means, the differences between the means, the correlations between groups, and the values of "t" for each of the five control groups and experimental groups. Analysis of the differences between the mean performance times for the control and experimental sub-groups reveal that none of the differences was statistically significant. It may be concluded that verbalization of the instructions will not significantly affect the performance on sub-test A-4.
TABLE X

COMPARISON OF MEANS, DIFFERENCES BETWEEN MEANS,
CORRELATIONS AND "t" SCORES BETWEEN
THE CONTROL AND EXPERIMENTAL
SUB-GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean of Control</th>
<th>Mean of Exper.</th>
<th>Differences</th>
<th>Correlations</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>91.6</td>
<td>89.8</td>
<td>1.8</td>
<td>.10</td>
<td>1.636</td>
</tr>
<tr>
<td>II</td>
<td>83.6</td>
<td>89.2</td>
<td>-4.4</td>
<td>.54</td>
<td>1.760</td>
</tr>
<tr>
<td>III</td>
<td>79.4</td>
<td>74.8</td>
<td>4.6</td>
<td>.54</td>
<td>1.181</td>
</tr>
<tr>
<td>IV</td>
<td>63.8</td>
<td>65.6</td>
<td>-1.8</td>
<td>.69</td>
<td>.375</td>
</tr>
<tr>
<td>V</td>
<td>64.6</td>
<td>67.8</td>
<td>-3.2</td>
<td>.49</td>
<td>.420</td>
</tr>
</tbody>
</table>
CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

The principle that verbalization of the instructions, by a learner, will increase the efficiency of the learning of an industrial task is widely accepted in industry. However the validity of this principle has not been satisfactorily demonstrated.

A review of the literature indicated that verbalization may increase the efficiency of learning in certain experimental situations. Only one other study aimed at investigating the hypothesis that verbalization of the instructions will increase the efficiency of learning an industrial task. That study, by William Cary, Jr., indicated that verbalization will not affect the number of trials required to reach a given criterion of learning.

This study investigated the effects of verbalization over an increasing number of trials on the amount of time required to perform a manipulative task. The hypothesis was that verbalization will increase the efficiency of learning a manipulative task. In this study verbalization referred to the articulation of the instructions (or procedure) by
the subjects in the experimental groups. The criterion of learning was established as the amount of time, in seconds, required to perform the assembly of sub-test A-4 of the Purdue Mechanical Assembly Test. The apparatus consisted of sub-tests A-2 and A-4 of the Purdue Mechanical Assembly Test. The two tests were matched in the pilot phase of this study, in which the correlation between the two sub-tests was found to be .67. Fifty subjects, students at Montana State University, were divided into five matched groups. Group I received one practice trial and one timed trial. The control group (G1) did not verbalize the instructions on the one practice trial and the experimental group (E1) did. The procedure for Groups II through V was the same except that the number of practice trials was increased by one for each following group. A comparison of the mean performance times for the control and experimental sub-groups for each of the five matched groups revealed that none of the differences was statistically significant.

II. CONCLUSION

In most experiments of this nature the best that is usually accomplished is a redefinition of the major hypothesis. The study done by William Gary, Jr. indicated that verbalization of instructions does not significantly affect the number of trials required to learn a manipulative task. The present study has yielded a similar generalization.
However, before a final conclusion may be drawn, there are certain factors which must be taken into consideration. First, it must be recognized that the subjects in this study were college students. It is possible that quite different results would be found with a different population. The second consideration to be taken into account is the nature of the experimental apparatus. The correlation between the performance on sub-test A-2 and A-4 of the Purdue Mechanical Assembly Test was .67. Although a correlation of this size is often found between two tests which purportedly measure the same function, the error involved in prediction is still quite large. This factor decreases the efficiency of the matching process and ultimately the probability of finding statistically significant results. The possibility also exists that the learning of the nomenclature of the parts for each test contained in the standardized training procedure instructions would interfere with the ability of the subjects to learn the relationships between the parts. This is an observation of the experimenter and has not been satisfactorily demonstrated. The analysis of the results of this study indicated that the differences between mean performance scores for those subjects who verbalized the instructions (or procedure) and for those subjects who did not were statistically non-significant.

Though verbalization of the instructions (or procedure) by those subjects did not significantly affect the
time required to perform the assembly of sub-test A-4 of the Purdue Mechanical Assembly Test, it is still possible to hypothesize that verbalization may be expected to increase the efficiency of learning other manipulative tasks.
APPENDIX A

PROCEDURE FOLLOWED IN PILOT PHASE

I. PREPARE THE LEARNER

PROCEDURE

A. Put him at ease. Explain to him the purpose of the experiment and briefly what is expected.

INSTRUCTIONS TO THE LEARNER

"The purpose of this experiment is to compare two tests.

"First, I will teach you how to assemble this box (pointing to A-2). After I have taught you the correct procedure, you will then assemble the box three times. I will then average your times on these three trials.

"I will then teach you to assemble this box (pointing to A-4). After I have taught you the correct procedure, you will then assemble the box three times. I will then average your times on these three trials and compare your performances on the two tests."
STANDARD TRAINING PRACTICE FOR SUB-TEST A-2

II. PRESENT SUB-TEST A-2

PROCEDURE

A. Have the learner over and behind you in proper position for correct angle and perspective and proceed to tell and show him the correct procedure to be followed in assembling the box.

INSTRUCTIONS TO THE LEARNER

"This is the correct procedure to be followed in assembling this box.

"Grasp the long rod by the pin with the left hand. Hold the rod so that the pin is up and to the left. With the aid of the right hand, guide the rod through the slot in the right-hand side of the box and position the rod on the two rectangularly grooved posts so that the pin is in line with the gear post.

"Grasp the link with the box-like projection with the left hand. Preposition the link so that the box-like projection is up and the pin is closest to you. Holding the link in the left hand, grasp the thumbscrew in the right hand. Insert in the hold of the projection and tighten as far as possible. With the screw facing you,
position the link on the two rectangularly grooved posts to
the far side of the box. Align the pin with the gear post
and the rod pin.

"Grasp the link with the slotted end with the left
hand. Turn the link so that the slotted end is pointing
away from you. Position the link over the three pins, with
the slotted end going over the far pin. Grasp the crank-
shaft with the right hand. Position the longer shaft with
the gear (pointing to the part) over the pivot of the near
bearing post. Push the shaft firmly against the pivot
forcing the pivot inward. Slowly relax the pressure on the
pivot and guide the other shaft over the pivot on the
opposite bearing post. Turn the wishbone down.

"With the left hand grasp the connecting rod and
position the curved end (pointing to curve) over the
thumbscrew. Push the assembly slightly to the left so that
the other end can be positioned on the wishbone of the
crankshaft.

"Grasp the shaft with the right hand. Guide the
shaft through the hole in the left hand side of the box.
Insert the shaft in the grooves of the two gear posts.
Push the shaft to the left so that the base of the bevel
gear fits snugly against the bearing post. Exert pressure
on the shaft next to the bearing post and snap the shaft
into position.

"Grasp the bearing cap on the sides with the thumb
and index finger of the right hand. Position the cap on
the bearing post placing the pin in the smaller hole.

"Grasp the handle with the left hand and position on
the shaft protruding from the left-hand side of the box.

"This completes the assembly."

III. TRY OUT PERFORMANCE

PROCEDURE

A. Seat the learner noting that he is comfortable.
Tell him what he is expected to do. Speak slowly and
emphasize key point.

INSTRUCTIONS TO THE LEARNER

"This time I will describe each operation for assemb-
ling the box and you will perform each operation as I so
indicate. (The instructions given to the learner will be
substantially the same as those described in step II.)

PROCEDURE

B. Slide the box to the side of the subject and
disassemble it returning each part to its correct position
on the mounting board. Then position the box in front of
the subject and proceed with the instructions.
INSTRUCTIONS TO THE LEARNER

"You will have one more practice trial on this box. This time I want you to assemble the parts in the box as I have shown you. Ask me any question which might occur."

IV. TEST TRIALS

PROCEDURE

A. After the subject has assembled the box, slide it to the side and disassemble it. Then position the box in front of the subject.

INSTRUCTIONS TO THE LEARNER

"You will now assemble the box three times. In the event you make a mistake correct it and finish the assembly. I will record the length of time it takes you to assemble the box on each assembly.

"Are there any questions?"

"Ready?"

"Go!" (start watch)

PROCEDURE

B. Upon completion of the task tell the subject the length of time in which he assembled the box and record it in seconds.
C. Slide the box to the side and disassemble it. Then position the box in front of the subject.

D. Have the subject assemble the box twice more. Record the time in seconds after each assembly.

E. Average the times for the three trials.

STANDARD TRAINING PRACTICE FOR SUB-TEST A-4

I. PRESENT SUB-TEST A-4

PROCEDURE

A. As the subject is already familiar with the purpose and procedure of the experiment, proceed to demonstrate box A-4. Have the learner over and behind you slightly to the left. Tell and show him the correct procedure to be followed in assembling the box.

INSTRUCTIONS TO THE LEARNER

"I will now demonstrate the correct procedure for assembling this box (pointing to A-4).

"First, note the numbers on the bearing caps (pointing to them) and the numbers on the bearing posts (pointing to them). The number on the bearing cap corresponds to a number on the bearing post on which the cap should be positioned."
"Grasp the rod with the rack with the left hand. With the rack up and to the left, guide the other end through the slot in the right-hand side of the box. Position the slots in the rod over the two smallest gear posts.

"Grasp the large crankshaft with the right hand. As you bring the part to the box, flip the part so that the wishbone is down and the gear is pointing toward you. Holding the part in this position, place it on bearing posts numbered 5 and 6 making certain that the gears mesh.

"Grasp the bearing cap number 6 on the ends with the thumb and index finger of the right hand. Keeping the back three fingers out of the box, line up the pin with the smaller hole and position on bearing post number 6. Cap number 5 is positioned in the same manner.

"With the left hand grasp the smaller crankshaft. As you carry the part to the box, turn your hand completely over so that the longer shaft with the collar is to the right and the groove on the collar is up. Holding the part in this position, grasp the washer with the right hand and position on this shaft, matching the hole in the washer with the groove in the collar. Grasp the bottom bevel gear with the pin with the right hand and position on the shaft, inserting the pin through the hole in the washer and the groove in the collar. Letting the right thumb remain on the gear, position the index and middle fingers over the back half of the wishbone. Position the assembly between bearing
posts numbered 3 and 4, bringing the piece in at a slight angle so that your thumb will miss the gear post.

"Grasp bearing cap number 4 on the ends with the thumb and index finger of the right hand. Keeping the back three fingers out of the box, line up the pin with the smallest hole and position on post number 4. Cap number 3 is grasped and positioned in the same manner.

"Grasp the connecting rod with the left hand. Both ends are just alike. Position the ends over the wishbones of the crankshafts.

"This completes the back half of the box. (Place right hand in the box so that it is divided into an assembled and unassembled part.)

"Grasp the gear with the smaller opening with the left hand and the bevel gear with the right hand. Invert the gear in the left hand so that the set screw is up (point to set screw). Position the groove on the bevel gear over the set screw so that the two parts fit snugly together. With the left hand, position the assembly over the gear post with the bevel gear on the bottom. Make certain that the gears are meshed by turning the assembly.

"Grasp the gear with the recessed opening with the left hand and the helical gear with the right hand. Position the hole of the helical gear over the pin in the opening of the gear in the left hand. The easiest way to do this is to hold the parts at an angle to each other and line up the
hole with the pin. Start the pin into the hole and lift up the helical gear so that it can be positioned in the recessed opening. Holding the part like a hypodermic with the thumb on top of the helical gear, position on the gear post.

"Grasp the shaft and worm gear with the right hand. Preposition so that the worm gear is to the right. Guide the other end through the hole in the left-hand side of the box. Position the shaft in the grooves of the bearing posts so that the shoulders on the shaft straddle gear post number 2.

"Grasp bearing cap number 2 on the sides with the thumb and index finger of the right hand, thumb being to the left. Preposition the cap so that the pin will be placed in the smaller hole. Position the cap on gear post number 2. Bearing cap number 1 is placed on gear post number 1 in the same manner.

"Grasp the handle with the left hand. Position on the shaft protruding through the hole on the left-hand side of the box.

"This completes the assembly."
II. TRY OUT PERFORMANCE

PROCEDURE

A. Seat the learner noting that he is comfortable. Speak slowly and emphasize key points.

INSTRUCTIONS TO THE LEARNER

"This time I will describe each operation for assembling the box and you will perform each operation as I so indicate." (The instructions given to the learner will be substantially the same as those described in step I.)

PROCEDURE

B. Slide the box to the side of the subject and disassemble it returning each part to its correct position on the mounting board. Then position the box in front of the subject and proceed with the instructions.

INSTRUCTIONS TO THE LEARNER

"You will have one more practice trial on this box. This time I want you to assemble the parts in the box as I have shown you. Ask me any questions which might occur."
A. After the subject has assembled the box, slide it to the side and disassemble it. Then position the box in front of the subject.

INSTRUCTIONS TO THE LEARNER

"You will now assemble the box three times. In the event you make a mistake correct it and finish the assembly. I will record the length of time it takes you to assemble the box on each assembly.

"Are there any questions?"

"Ready?"

"Go!" (start watch)

PROCEDURE

B. Upon completion of the task tell the subject the length of time in which he assembled the box and record it in seconds.

C. Slide the box to the side and disassemble it. Then position the box in front of the subject.

D. Have the subject assemble the box twice more. Record the time in seconds after each assembly.

E. Average the times for the three trials.

F. Compare scores on A-2 and A-4 using a correlation chart.
APPENDIX B

PROCEDURE FOLLOWED IN EXPERIMENTAL PHASE

I. PREPARE THE LEARNER

PROCEDURE

A. Put him at ease. Explain to him the purpose of the experiment and briefly what is expected.

INSTRUCTIONS TO THE LEARNER

"The purpose of this experiment is to compare two methods of learning.

"First, I will teach you how to assemble this box (pointing to A-2). After I have taught you the procedure, you will then assemble the box three times. I will record the length of time on each assembly and average your times on these three trials. On the basis of your average time on these three trials you will be matched with another subject who has the same average time, plus or minus one second.

"Then I will teach you how to assemble this box (pointing to A-4), by one method and your unknown partner by another method. I will then compare your time score with that of your unknown partner."
II. PRESENT SUB-TEST A-2

PROCEDURE

A. Have the learner over and behind you in proper position for correct angle and perspective and proceed to tell and show him the correct procedure to be followed in assembling the box.

INSTRUCTIONS TO THE LEARNER

The instructions given to the learner will be substantially the same as described in Appendix A, step II, page 36.

III. TRY OUT PERFORMANCE

PROCEDURE

A. Seat the learner noting that he is comfortable. Tell him what he is expected to do. Speak slowly and emphasize key points.

INSTRUCTIONS TO THE LEARNER

"This time I will describe each operation for assembling the box and you will perform each operation as I so indicate. (The instructions given to the learner will be
substantially the same as those described in step II.)

PROCEDURE

B. Slide the box to the side of the subject and disassemble it returning each part to its correct position on the mounting board. Then position the box in front of the subject and proceed with the instructions.

INSTRUCTIONS TO THE LEARNER

"You will have one more practice trial on this box. This time I want you to assemble the parts in the box as I have shown you. Ask me any questions which might occur."

IV. TEST TRIALS

PROCEDURE

A. After the subject has assembled the box, slide it to the side and disassemble it. Then position the box in front of the subject.

INSTRUCTIONS TO THE LEARNER

"You will now assemble the box three times. In the event you make a mistake correct it and finish the assembly. I will record the length of time it takes you to assemble the box on each assembly."
"Are there any questions?
"Ready?
"Go!" (start watch)

PROCEDURE
B. Upon completion of the task tell the subject the length of time in which he assembled the box and record it in seconds.
C. Slide the box to one side and disassemble it. Then position in front of the subject.
D. Have the subject assemble the box twice more. Record the time in seconds after each assembly.
E. Average the times for the three trials.

I. PRESENT SUB-TEST A-4

PROCEDURE
A. As the subject is already familiar with the purpose and procedure of the experiment, proceed to demonstrate box A-4. Have the learner over and behind you slightly to the left, tell and show him the correct procedure to be followed in assembling the box.

INSTRUCTIONS TO THE LEARNER
The instructions to the learner will be substantially
the same as those described in step I, Appendix A, page 40.

II. TRY OUT PERFORMANCE (GROUP I)

PROCEDURE

A. Seat the learner noting that he is comfortable. Speak slowly and emphasize key points.

INSTRUCTIONS TO THE LEARNER

CONTROL GROUP

B. "You will have one practice trial on this box and one time trial."

EXPERIMENTAL GROUP

B. "You will have one practice trial on this box and one time trial.

C. "During your practice trial I want you to describe each operation of the assembly to me as you perform it."

PROCEDURE

D. If the subject does not verbalize on an operation tell him that you did not understand
what he had done and have him explain it.

III. TEST TRIALS

PROCEDURE

A. After the subject has assembled the box, slide it to the side and disassemble it. Then position the box in front of the subject.

INSTRUCTIONS TO THE LEARNER

"You will now have one time trial. In the event you make a mistake correct it and finish the assembly. I will record the length of time it takes you to assemble the box.

"Are there any questions?
"Ready?
"Go!" (start watch)

PROCEDURE

B. Subjects in the experimental group are to be told they need not verbalize on the time trial.

C. Increase the number of practice trials by one for each group, II through V. Otherwise the instructions are the same.

D. Compare the differences between the means of the
the time trials for each group I through V for their respective control and experimental sub-groups, using small sample statistics and the "t" formula.
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