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A Memory Training Procedure for Learning the Ordering of Machine Set Up Instructions

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A MEMORY TRAINING PROCEDURE FOR LEARNING THE ORDERING OF MACHINE SET UP INSTRUCTIONS

by

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Douglas Stephen Johnson

TABLE OF CONTENTS

INTRODUCTION

When an industrial worker sets up his machine for an operation, he often must adhere to a sequence of steps. Failure to follow correct order can result in machine damage, human injury, and scrap. Hence, the experimenter has sought a system to teach the order of instructions more efficiently than conventional techniques.

This search has led him to analyze the methods employed by mnemonists who have gained recognition by virtue of their abilities to memorize large quantities of material during short periods of time. Unfortunately, this type of biographical research, or research based upon self-reports, is considered inadequately scientific by most psychologists since the anecdotal accounts lack the rigor of control-experimental studies and are not generalized to final principles as easily. These inadequate techniques have often been the only ones available during the beginning stages of sciences and they have often yielded unique and fruitful hypotheses in the absence of controlled studies.

The efficacy of mnemonic techniques has been known for over twenty centuries. In one of the first accounts of the utilization of memory plans, Simonides, the Greek orator and mnemonist, unerringly identified the bodies of more than 300 persons killed when a building collapsed during a banquet. While speaking at the banquet earlier that day,

Simonides noted the persons present and where they were sitting. To identify the dead (many of whom were mangled beyond the recognition of their relatives), Simonides visualized the hall as it was when he left it by taking an imaginary walk from place to place (Cohen, 1969, p. 56).

The anonymous Ad C. Herennium libri IV, and Quintilian's *Institutio oratoria*, were cited by Norman (1969, pp. 108-112) as two treatises on rhetoric in which memory was discussed as a part of rhetoric. Both of these treatises were written over 20 centuries ago. Translations of Ad C. Herennium libri IV provided by Norman, specified how the orator could develop his memory by equipping himself with a large number of "places." These places were mainly architectural components (e.g., a doorway) or furnishings within buildings (e.g., a picture or a chair) and were remembered in permanent serial order. The orator learned the order of things he wished to discuss by placing mental images of them in the pre-learned places. During the oration, the items could be remembered in their proper order by mentally revisiting the places in their proper order.

Yates (1966, pp. 74-75) revealed the memory plans of Thomas Acquinas. These were strikingly similar to the plans that the Greeks and the Romans had developed over 15 centuries earlier since both plans involved placing mental images in pre-learned positions. Acquinas stressed the importance of frequently reviewing the items to be remembered.

Fauvel-Gouraud (1845, pp. 73-82) discussed a system for memorizing lists of words in their proper order that was proposed by M. Gregor Von Feinaigle. Feinaigle, whose fame in devising unusual memory plans resulted in the adoption of the slang term "finagle," divided the floor of each room in a house into nine squares of equal size. To remember a series of words, images of the words were mentally put into the places which were later revisited during the recall process. Feinaigle developed the unique system shown below, which allowed the memorizer to systematically revisit the places in the same order as he would read the lines of a book. Typical picture words which might be visualized within the places are also shown.

1 boat	2 pipe	3 ship
4 apple	5 mouse	6 tree
7 soap	8 doll	9 tankard

Next, Feinaigle connected the images through a process of story telling (e.g., A boat on the sea ran into a submerged pipe and the passengers were rescued when a ship came by and each was given an apple. . . .).

Using a similar plan, Hersey (1968, pp. 28-37) selected five large household items from each of four rooms in a house (the items were: sink, stove, chair, table, refrig-

erator, rug, easy chair, lamp, TV set, window shade, bathtub, lavatory, medicine cabinet, mirror, towel, bed, bureau, wastebasket, end table, and alarm clock). Hersey stressed that this list would provide 20 permanent places for mental images. Next, he discussed how the reader could quickly remember a shopping list consisting of 20 groceries by depositing exaggerated images of these groceries in the pre-learned positions. The first item on the list was "mustard" and the reader was instructed to see himself washing dishes in the first position (the kitchen sink) which was full of mustard.

Young and Gibson (1962, pp. 235-256) discussed some of the techniques used by mnemonists who lived during the last four centuries. Robert Pasfield, who lived during the beginning of the sixteenth century, won acclaim by demonstrating that he could repeat entire sermons from memory after hearing them once. Young and Gibson explained his technique as follows:

> He formed a leather girdle, so long that it went twice around his waist. He divided it into sections, each representing a book of the Bible. He fixed knotted thongs for chapter divisions, with smaller knots for groups of verses.
>
> Pasfield wore this when he went to meeting and as he listened to the sermon, he found the knot corresponding to each new text and fingered it during that portion of the discourse, while noting what was said.
>
> His familiarity with the scriptures enabled him to find the knots in their right order later. . . (pp. 254-255).

Also cited by Young and Gibson was the English mnemonist, William John Bottell. Known as "Datas," Bottell entertained variety audiences during the first half of this century by answering anything that he was asked on any general subject. When discussing his recall methods, Bottell emphasized that he relied upon connections between ideas and upon a vast storehouse of <u>images</u> which he called up while memorizing.

> I am asked the date of the Great Fire of London. I give the correct answer, 1666, and immediately there arises before me a panoramic scene of that calamity, from its start in Pudding Lane to its finish in Pie Corner. . . .
>
> When you are called upon to answer any questions, endeavor to call up some 'mind pictures' for you will find their help of immense value. Remember that failure is the result of a weak mental impression due to lack of concentration on the subject matter you are endeavoring to commit to memory. . . .
>
> One idea begets another; therefore, when memorizing one idea, kill two birds with one stone and also memorize the corresponding idea. . . . When you have ideas which are unconnected, you should establish an intermediary idea as a connecting link (p. 248).

The Russian psychologist, A. R. Luria (1968), wrote a book covering studies done with the Russian mnemonist, Solomon-Veniaminovich. He reported that the established ideas on memory did not hold for Veniaminovich. After reviewing studies which he and other Russian psychologists had done with Veniaminovich over a period of two decades, Luria wrote:

> . . . he would sometimes apply his technique of "coding the material into images," a technique he mastered in his career as a professional mnemonist.
>
> . . . the established ideas on memory simply did not hold for S. In his case, traces left by one stimulus did not inhibit those of another; they showed no sign of becoming extinguished with time, nor did they become any less selective with the years. It was impossible to establish a point of limit to the capacity or the duration of his memory, or to find in him any indication of the dynamics whereby memory traces are extinguished in the course of time (p. 61).
>
> The course his technique of using eidetic images took, then, was to abbreviate images and abstract from them the vital details that would allow him to generalize to the whole. He worked out a similar method whereby he could eliminate the need for any detailed, intricate images (pp. 42-43).

Luria's descriptions of Solomon-Veniaminovich are similar to the self-descriptions provided by Bottell since we see a heavy reliance upon mental images.

Dale Carnegie (1956, pp. 62-65) proposed a system of position coding through the use of rhymes that could be used for memorizing key words related to the main ideas in lectures. Under this system, "one" would be rhymed with "gun," and the memorizer would see the first object that he wanted to recall on a gun or at the end of a gun barrel; two would rhyme with "shoe," so the second object or word to be memorized would be pictured on or in a shoe, and so forth. Carnegie also mentioned an anecdote by Mark Twain in which the latter writer revealed how he had learned to speak with-

out using notes:

> It was then that the idea of pictures occurred to me. Then my troubles passed away. In two minutes I made six pictures with my pen, and they did the work of the eleven catch-sentences and did it perfectly. I threw the pictures away as soon as they were made, for I was sure I could shut my eyes and see them any time. That was a quarter of a century ago; the lecture vanished out of my head more than twenty years ago, but I could rewrite it from the pictures--for they remain (pp. 61-62).

Loisette (1899, p. 125) and Brothers (1957, pp. 184-200) emphasized the role of mediating images while discussing how to remember names through facial peculiarities. If a cross-eyed man's name was Mr. Archer, the following associations could be made: cross-eyed . . . cross-bow . . . bowman . . . Mr. Archer. Again, mental images mediate the recall.

Despite historical evidence and suggestions offered by mnemonists, discussions by Norman (1969) reveal the attitudes of many psychologists toward mnemonists' techniques:

> We tend to ignore these techniques today because they are mere tricks and sophistry--the practitioners exhibit themselves as stage entertainers or advertise themselves and their methods in unrespectable classified advertisements--but we cannot deny that the techniques work (p. 98).

Cohen (1969) corroborates Norman's conclusions:

> Mnemonic aids have suffered from paralogistic prejudice; Francis Bacon, for example,

> equated mnemonics with "the tricks and antics of clowns and rope dancers" and later researchers viewed them as odious tactics used by iniquitous learners to avert proper and ethical memorizing (p. 60).

Finally, a few psychologists began to mitigate this negative attitude. Just how effective visual associations might be in aiding recall was not widely understood until Wallace, Turner, and Perkins (1957) tested subjects' upper limits for forming such associations with respect to the length of paired associate word lists. Miller, Galanter, and Pribram (1960) provide us with an account of their findings:

> W. H. Wallace, S. H. Turner, and C. C. Perkins of the University of Pennsylvania have found that a person's capacity for forming associations is practically unlimited. They presented pairs of English words to their subjects, who, proceeding at their own pace, formed a visual image connecting the two words. The list of paired associates was given only once. Then the subjects were given one member of each pair and asked to write the other. Starting with lists of twenty-five pairs they worked up to lists of 700 pairs of words. Up to 500 pairs, the subjects were remembering about ninety-nine percent; at 700 pairs it dropped to ninety-five percent. . . . What is more, little had been forgotten two or three days later (pp. 136-137).

Miller et al. (pp. 134-136) were among the first psychologists to support more complete mnemonic plans involving imaging and placing images of objects in pre-memorized positions. They suggested that a rhyming position coding system could be useful for memorizing lists of words.

Under this system, they proposed using items which rhymed with numbers for positions (e.g., one = bun, two = shoe, etc.). Next, they proposed that a list of words could be remembered by mentally placing them in the successive positions (e.g., if the first word was "ashtray," it could be remembered by mentally placing it inside of a bun; if the second word was "firewood," it could be remembered by visualizing a shoe full of firewood). This plan was advanced as a method for remembering ten words in their proper order after hearing them once (note that an identical plan was proposed earlier by Carnegie). Cohen (1969, p. 58) indicated that similar plans are easily used for remembering 100 words in their proper order after hearing them once, but he did not reference experimental evidence to support his contention.

At about the same time that Miller et al. made their suggestions, Epstein, Rock, and Zukerman (1960) found an interesting principle while studying paired associate learning. Concrete nouns (nouns which conveyed a picture--e.g., "cat") were paired with other concrete nouns. Abstract nouns (nouns not immediately conveying a picture to most people--e.g., "virtue") were paired with other abstract nouns. Finally, verbs were paired with other verbs. The words in the lists of concrete nouns were reinforced with pictures to aid Ss in visualizing them (e.g., the paired associate "knee-mask" would also appear as a picture of a

knee next to a picture of a mask). All word lists were of identical length and the presentation times for all word lists were standardized. After a standard recall interval (30 seconds) Ss were given the original list of words with the words arranged in scrambled order. They were then asked to write down the words previously associated with each list word. Ss' performances (measured by the number of associates correctly paired) were significantly better when they paired the associates of the concrete nouns than when they paired the associates of either the verbs or the abstract nouns. No differences were found in abilities to pair the associates of abstract nouns and verbs. Apparently, the visualization process added substantially to the Ss' abilities to remember.

In a later study, Tulving, McNulty, and Ozier (1965) equated the meaningfulness of three word lists (the definition of "meaningfulness" used in this study was that provided by Noble (1952) in which an appropriate index of meaningfulness was derived from the average number of written associations made to a word by a sample of subjects during a specified interval of time). The three word lists differed along the dimension of vividness--one list contained highly vivid words, a second list contained words of medium vividness, and a third list contained words that were low in vividness ("vividness" referred to the probability of a word eliciting mental images and to the quality of these

images--this dimension was agreed upon by a panel of judges with a reliability among raters exceeding .80). In a free recall learning situation, it was found that the ability to recall a word list was an increasing function of the vividness of that list. Again, the dimension of visibility resulted in superior learning.

Taking leads from Miller et al. and from Epstein et al., Bugelski, Kidd, and Segmen (1968) asked experimental group Ss to memorize a list of words that rhymed with the numerals 1 through 10 (the list was: bun, shoe, tree, door, hive, sticks, heaven, gate, wine, and hen). The experimental group subjects were then told to picture each word contained in a novel list in connection with the word in the corresponding sequence in the pre-learned list. The Ss in the experimental group were significantly better at recalling word lists learned in this fashion than were subjects in the rhyme control group (who just learned the rhyming words but were not instructed in their use) or subjects in the standard control group (who were not taught the list of rhyming words or the principles of position coding). No significant differences were found between the latter two groups.

Machine set up instructions are often presented in consecutively numbered sentences. Within each sentence, a unique word can usually be found which does not appear in the other sentences. The research of Bugelski et al. suggests that these unique words are more likely learned in their

proper order if they are associated with a pre-learned list of words through mental images. After experimental group subjects learn the new list of words in its proper order, the words in it might provide them with information on the proper ordering of the sentences which comprise the machine set up instructions if they can identify the words in their proper sentences. The only additional requirement for the Ss in addition to the requirements in the Bugelski et al. study would be that the subjects relate the code words to the proper stimulus arrays provided by the sentences in which they appear. The experimenter hypothesizes that machine set up instructions in sentence format which are position coded by associating words within the sentences with words within a pre-learned word list are more likely learned in correct order than uncoded instructions.

METHOD

The Subjects

The subjects were 26 Western Michigan University students selected from two general psychology classes and 6 high school students attending a physics orientation program at Western Michigan University. The Ss were divided into two groups of 15 and 17 Ss each.

The Procedure

Figure 1 (p. 19) outlines the procedure and may serve as a convenient aid for following the procedure since it simplifies much of what is said in the following paragraphs.

Before test period$_1$, two pilot Ss were given all memorization forms to predetermine how much time should be allowed for the memorization conditions with the Conventional and Mnemonic machine set up Instruction Memorization Forms (these forms appear on pages 31 and 35 respectively). The determination of an appropriate memorization time limit for the subjects was important to insure that the relative effects of the Conventional and Mnemonic Instruction Memorization Forms on the order retention of machine set up instructions could be measured accurately. The measurement of order retention of the machine set up instructions was done with the Instruction Ordering Test Form which appears on page 32. Failure

to give the subjects sufficient time could result in a "cellar effect." This effect would effectively eliminate any differences between the control group (which was to receive the Conventional Instruction Memorization Form when learning the order of the machine set up instructions) and the experimental group (which was to receive the Mnemonic Instruction Memorization Form when learning the order of the machine set up instructions) that might occur if more memorization time was allowed. The cellar effect would occur in a condition in which no subject in either group could have sufficient time to begin memorizing the ordering of the machine set up instructions. Giving the subjects too much memorization time could result in a "ceiling effect." This effect would effectively eliminate any differences between the control and experimental groups that might occur if less memorization time was allowed. Under this effect, so much time would be allowed that subjects in both groups could memorize the ordering of the instructions with 100% accuracy. Evidence gained when testing the pilot subjects suggested that two minutes of memorization time would avoid both effects.

During test period$_1$, the experimenter asked each class to memorize the order of machine set up instructions by using the Conventional Instruction Memorization Form (p. 31) which contained the instructions in their proper sequential order (the instructions were taken from Burghardt, Axelrod, and Anderson, 1959, p. 449). Without delay, Ss in both

classes were tested for their retention of the proper order of the instructions with the Instruction Ordering Test Form (p. 32) which contained the instructions in the Conventional Instruction Memorization Form in a scrambled order. Finally, both classes were given the Household Item Form (p. 33) which contained a list of fourteen household items which were to be memorized before their next class meeting. The Household Item Form contained exercises to aid in the thorough mastery of the list of household items.

Twenty-four hours separated test period$_1$ and test period$_2$. During this time, the experimenter averaged the test period$_1$ test scores of each class on the Instruction Ordering Test Form. To increase the credibility of any significant improvements due to later treatment effects, the class with the lower mean score became the experimental group.

At the beginning of test period$_2$, the control and experimental groups took the Household Item Test (p. 34), which assessed their mastery of the list of household items on the Household Item Form, by requiring them to write this list in its proper sequential order.

Next, the control group was asked to memorize the order of the machine set up instructions by using the Conventional Instruction Memorization Form which contained the instructions in their proper sequential order. This was the same form which they used for memorization during period$_1$.

The experimental group was asked to memorize the order of the same machine set up instructions by using the Mnemonic Instruction Memorization Form (p. 35). This form contained the instructions which appeared in the Conventional Instruction Memorization Form. These instructions appeared in the left-hand column of the Mnemonic Instruction Memorization Form. A word group, a word, or a word part of each instruction in that column was underlined and the subjects were instructed to picture what was underlined or to picture a designated word with a similar sound (a clang associate). The picture word(s) appeared in the right-hand column where the subjects were instructed to visualize each picture word(s) in a designated manner with a household item. The sentence containing the picture word(s) and the household item with which the word(s) was visualized occupied the same sequential position on the memorization forms and the household item list.

Without delay, the control and experimental groups were tested for their retention of the order of the machine set up instructions with the Instruction Ordering Test Form (p. 32).

Finally, as an ethical procedure, the control group received the Mnemonic Instruction Memorization Form and was retested with the Instruction Ordering Test Form. The experimenter felt that this retesting was necessary so that the control group could understand the rationale for memorizing

the list of household items on the Household Item Form.

After test period$_2$, the procedures shown in Figure 2 (p. 20) were followed. Two subjects were lost from the control group (which originally contained 17 Ss) due to substandard scores (scores less than 100%) on the Household Item Test. The experimenter felt that this elimination was necessary since all subjects in the experimental group scored 100% (as required) on the Household Item Test. Failing to eliminate the substandard subjects from the control group would be tantamount to failing to equate for motivation to learn between the experimental and the control groups. This variable could affect the Instruction Ordering Test Form scores of the subjects independent of the relative effects brought about by their use of the two different instruction memorization forms.

At this point, it is important to note that the requirement that all experimental group subjects receive 100% on the Household Item Test (a requirement that did not result in the elimination of any experimental group subjects since they all scored 100%) also has special implications for the measurement of the pure relative effects of the two different instruction memorization forms upon memorization. This is so since the instructions containing the picture word(s) on the Mnemonic Instruction Memorization Form had the same sequential positions on this form as the household items with which they were associated had on the list in

the Household Item Form. Therefore, if a subject failed to memorize the household item list in its proper sequential order, he would not be able to make the correct multiple association from (1) a code word(s) to (2) the associated household item to (3) the number of the household item which, in turn, was (4) the same as the number of the instruction containing the code word(s). Hence, he would not be able to identify the sequential order (or number) of an instruction on the Instruction Ordering Test Form, and his resulting low test score on this form would be due to his failure to study the household item list in the Household Item Form rather than to any inadequacy of the Mnemonic Instruction Memorization Form.

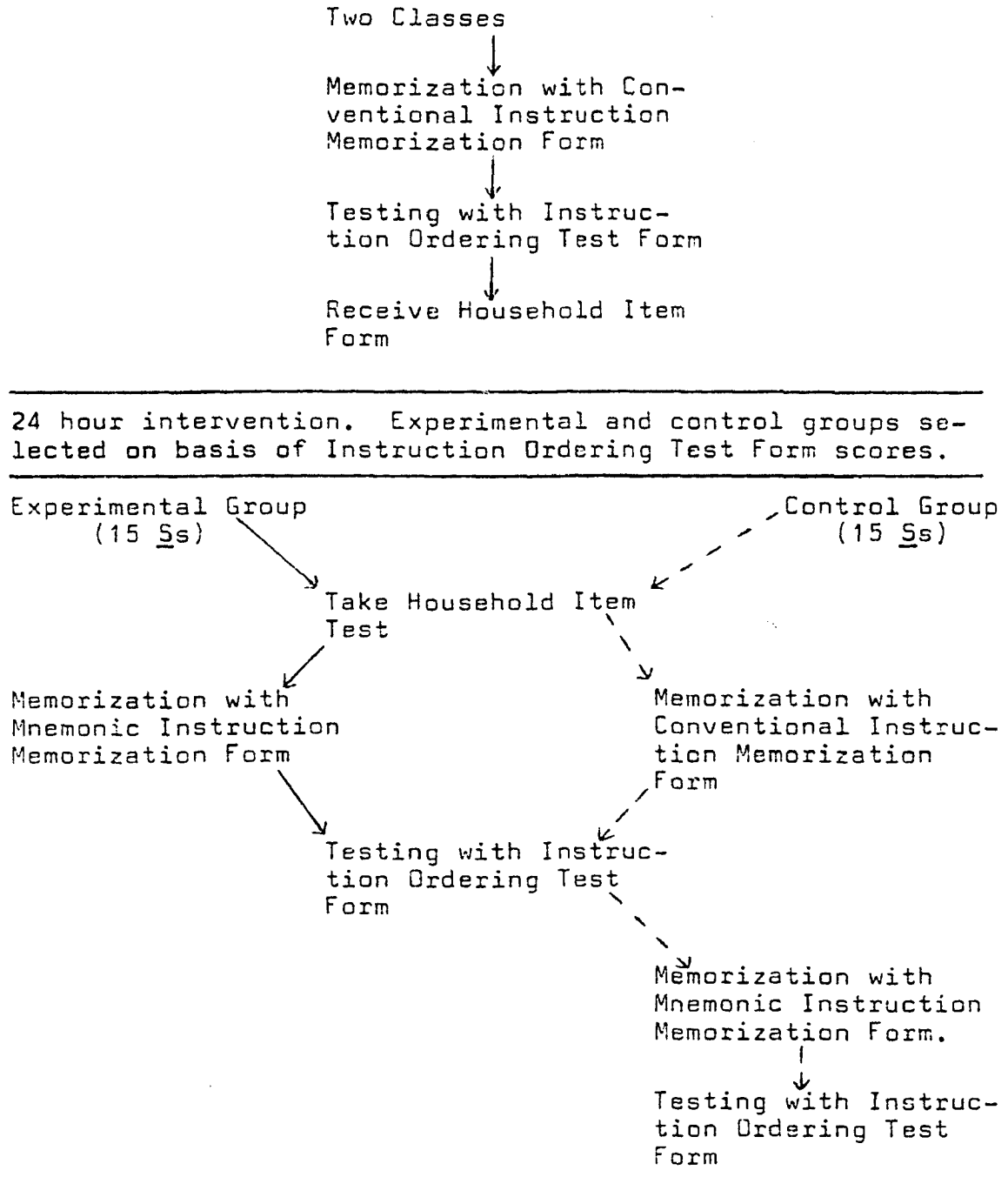

Figure 1. Partial outline of the procedure.

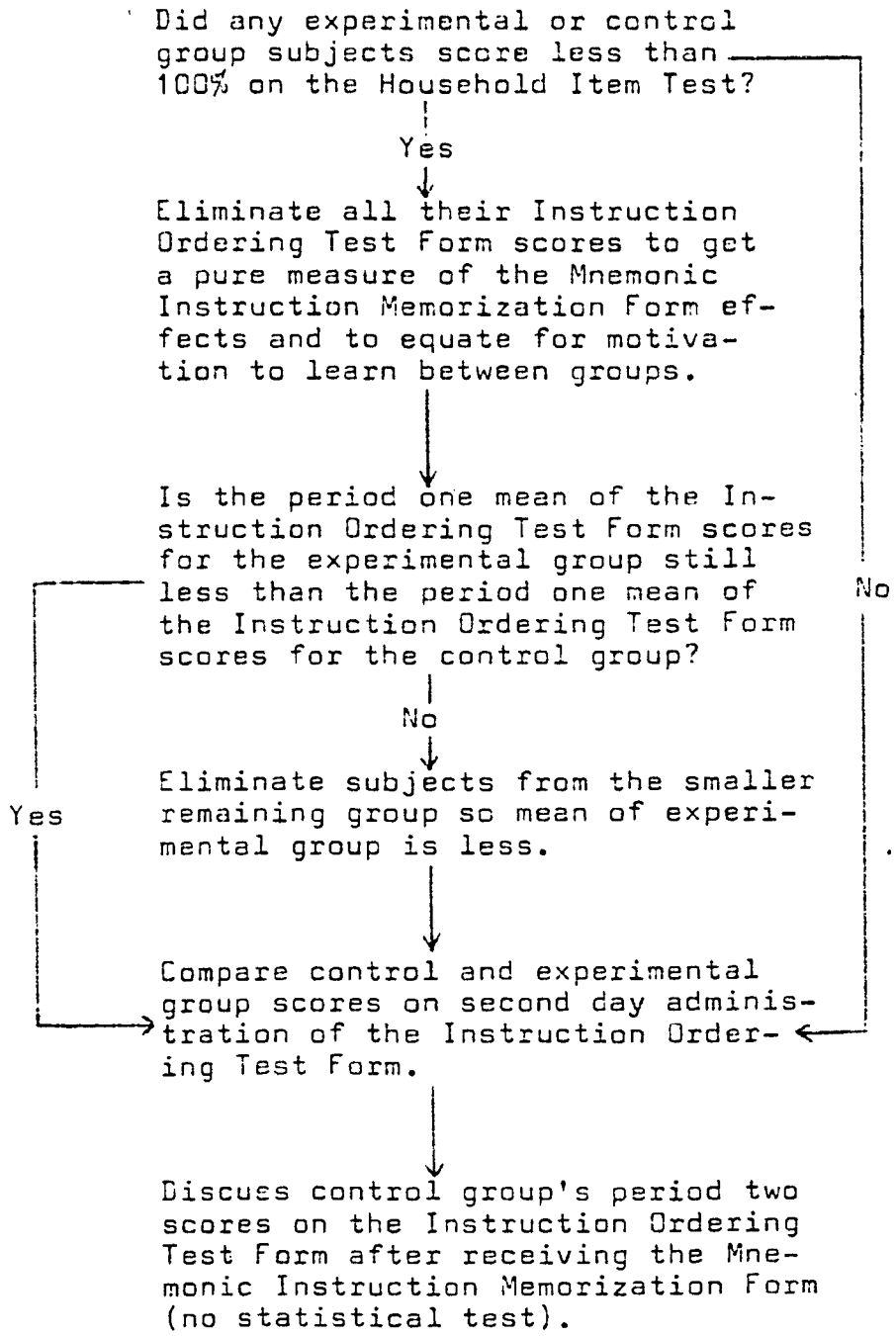

Figure 2. Flow diagram for procedures followed before analyzing the data.

RESULTS

Test scores on the Instruction Ordering Test Form represented the number of machine operating instructions correctly ordered. The mean test scores of the experimental and control groups are shown in Table 1 (p. 23). A one-tailed independent samples *t*-test showed no difference between the means of the experimental and the control groups (see Table 1, second row) although the nonsignificant difference was in the direction predicted ($t = .51$, $df = 28$, $p = .31$).

After receiving the Mnemonic Instruction Memorization Form, the Instruction Ordering Test Form scores of the control group rose slightly (see Table 1, second and third rows under "control group"). A matched group *t*-test was not performed to determine whether this increase was significant, since the stability of the dependent variable (i.e., Instruction Ordering Test Form score) independent of treatment effects could not be justified (we would expect an increase in the numerical value of this variable in the control group with their successive readings of the Conventional Instruction Memorization Form).

It was believed that a statistical test that would take into account the pre-treatment inferiority of the experimental group by utilizing change scores would yield greater power. Therefore, an independent samples *t*-test for gain

(or change) scores was calculated. The increase in power resulting from the use of this statistic was not sufficient to yield statistical significance (t = 1.02, df = 28, p = .16).

Table 1

Mean Instruction Ordering Test Form Scores

Test period	Experimental group (15 Ss)	Control group (15 Ss)
$Period_1$	3.9=	4.7=
$Period_2$	9.4*	8.8=
$Period_2$	---	10.6*

=The preceding memorization period was spent with the Conventional Instruction Memorization Form.

*The preceding memorization period was spent with the Mnemonic Instruction Memorization Form.

DISCUSSION

The nonsignificant results did not confirm the experimenter's hypothesis that machine set up instructions in sentence format which are position coded by associating words within the sentences with words within a pre-learned word list are more likely learned in correct order than uncoded instructions.

This negative finding is neither consistent with the findings of Bugelski et al., nor with the inferences from the biographical, self-report, and experimental information which the investigator has cited. Perhaps the additional requirements (in addition to the requirements of Bugelski et al.) that the subjects recognize the code words, or their clang associates, among a stimulus array within a sentence and infer the sentence numbers from the numbers of the code words, exceeded their abilities to process information within a limited time period--especially since the experimenter's system was novel. This possible information processing overload was not apparent when the pilot subjects were tested.

Extensive questioning of the subjects did not conclusively reveal whether the additional requirements exceeded their information processing abilities. Unfortunately, most of the subjects were unable to evaluate the Mnemonic Instruction Memorization Form due to the fact that they did not use it when asked to. Instead, they reported that they began

developing their own mnemonic systems during the period, memorization with the Conventional Instruction Memorization Form. Most of these systems were of the "acronym" type rather than the "image" or "position coding" types. For example, many subjects reported memorizing the first letter of each sentence. When two or more sentences began with the same letter, a key letter was sought elsewhere within each sentence. When Ss received the Mnemonic Instruction Memorization Forms, they failed to use them, since they wanted to develop their own mnemonic systems rather than resort to a new system which was possibly more complex to them by virtue of its novelty. Therefore, any significant differences between experimental and control groups would have reflected differences in abilities to develop impromptu mnemonic systems.

The fact that subjects began to develop their own mnemonic systems should have come as no surprise. Miller et al. (1960) provide us with a humorous but thought provoking account of this:

> If you ask a man who has just memorized his first list of nonsense syllables to tell you what he did in order to master the list, he will have quite a lot to say. . . . He will say that he was trying to connect things up and make sense of them. . . . it wasn't easy, but he did it. Now, that first nonsense syllable, BOF, was just plain remembered the way it came, but the second one reminded him of "XAJerate," and the third one turned into "MIBery," and the fourth turned from

> ZYQ to "not sick." So he had a kind of sentence, "BOF exagrates his misery because he is not sick," instead of the cryptic BOF, XAJ, MIB, ZYQ, and he could imagine a hypochondriac named BOF who continually complained about his health (p. 126).

Norman (1969) also confirms the viewpoint that subjects use systems other than those which the experimenter intended:

> The problem that confronts us, then, is that on the one hand psychologists have studied the various factors that go into the formation and retention of simple associations in rote memory tasks; on the other hand, people are poorest at learning things by rote memory, instead they use tricks, gimmicks, and mnemonics to transform the nonsense of the psychologist into the sense that they find easiest to remember (p. 100).

Miller et al. (1960, p. 127) indicate the attitudes of many experimental psychologists toward Ss' personal systems by quoting from Woodworth and Schlosberg (1954):

> Such aids in memorizing are naturally regarded with much favor by O, but E would like to get rid of them. They make the learning task less uniform and introduce variability and unreliability into the quantitative results. Besides, E wants to study the formation of new associations, not O's clever utilization of old ones (p. 708).

For those interested in pursuing the topic of subjects' personal memorization systems further, Miller et al. (1960, pp. 126-127, 130-134) discuss plans which are formed independently of the intentions of the E.

New methods should be adopted in future studies to insure use of the experimenter's mnemonic system (or at least

to make this utilization more likely). One possibility is that of conducting a special training session during which the experimental group is introduced to the system. Pre-experimental familiarity might induce more Ss to use the experimenter's system and might reduce its apparent "complexity." Diagnostic tests conducted after the study might reveal which Ss used the experimenter's system. Such tests might ask the Ss to list the experimenter's code words in their proper order. Ss scoring below a criterion could be eliminated from the experimental group under the assumption that failure to learn the code words reflects a corresponding failure to read the Mnemonic Instruction Memorization Form.

Perhaps some subjects are unwilling or unable to form the mental images required when using the Mnemonic Instruction Memorization Form. Such subject tendencies could be diagnosed in future studies by administering The Betts Qmi Vividness of Imagery Scale (Betts, 1909; Richardson, 1969, pp. 148-154), and The Gordon Test of Visual Imagery Control (Gordon, 1949; Gordon, 1950) or a slightly altered form of it (Richardson, 1969, pp. 155-156). These tests would be used to diagnose subjects' abilities to form and to manipulate mental images. Subjects scoring low on the tests (i.e., those unable to form strong mental images and to manipulate them easily) could be eliminated from the experimental group with the rationale that they could not ben-

efit from the Mnemonic Instruction Memorization Form. Any significant effects occurring as a result of memorizing with the form would then be qualified by describing the types of persons that could and could not benefit from its use.

There is also the possibility that the experimental subjects would have used the Mnemonic Instruction Memorization Form if they had not received the Conventional Instruction Memorization Form earlier. The rationale for this speculation lies in the fact that the subjects would not have begun developing their own systems on the Conventional Instruction Memorization Form. Hence, they would have no rudimentary systems to adhere to for purposes of further development during the later memorization session with the Mnemonic Instruction Memorization Form. It is suggested that future experimenters eliminate the pretesting of both groups with the Conventional Instruction Memorization Form by selecting large groups in a way that will insure reasonable homogeneity between experimental and control groups. The possible alternative of pretesting subjects on an alternate form of the Conventional Instruction Memorization Form is not an attractive one, since it would not eliminate the development of rudimentary systems prior to the treatment condition, and these systems would probably be transferred to the alternate (mnemonic) form during the second testing.

However, the experimenter must concede to the possibility that the mnemonic system used in this study was too com-

plex for the instruction ordering task. Perhaps the simpler techniques used by the Ss are superior when the proper order of a small group of instructions is to be memorized. If this is so, the position coding system used in this experiment could be simplified by eliminating the requirement of placing the images in pre-memorized positions. This simplification might make the system a more attractive alternative for the Ss. However, the probability of remembering a list of images without placing them in positions might be reduced. Sentence number retrieval might also take longer due to the possible necessity of "counting" through the list of images associated with the code words in order to identify the image numbers.

Another alternative to the method in the present study is that of making the experimental task more difficult under the rationale that simple acronym based mnemonic systems adopted by the Ss will not work under conditions of increased difficulty. Increasing the number of instructions to be memorized in correct order while keeping the time limit constant is one possibility for augmenting the difficulty level. Another is changing the requirements of the experimental task by asking multiple choice questions based upon the information contained within the instructions. However, the latter possibility would probably require a more complete mnemonic system employing descriptive pictures which would summarize the contents of the instructions.

The experimenter also suggests that the Mnemonic Instruction Memorization Form be revised in future studies. The code word of the third instruction (line which was rhymed with the clang associate lion who was pictured on a chair) also appears in the thirteenth instruction but is not the code word there. This type of duplication could reduce any potential efficacy that the Mnemonic Instruction Memorization Form might have by causing subjects to confuse the 3rd and 13th instructions. The experimenter went through all the Instruction Ordering Test Forms which the experimental group completed in order to assess the extent of this possible confusion. The suspected confusion was not apparent, but this may only be a function of the fact that subjects did not read the Mnemonic Instruction Memorization Form. Therefore, future experimenters wishing to use this form should select a new code word from the third instruction that does not appear in any of the other instructions (suggestion: live is such a word--it might be changed to the clang associate hive and each subject in the experimental group might see himself accidentally sitting down in his chair onto a beehive).

APPENDIX A

Conventional Instruction Memorization Form

THE FOLLOWING IS PART OF A PROCEDURE FOR CUTTING A SCREW THREAD IN A LATHE. PLEASE MEMORIZE THE ORDER OF THESE 14 INSTRUCTIONS. YOU WILL HAVE TWO MINUTES.
ARE THERE ANY QUESTIONS?
DO NOT BEGIN UNTIL TOLD TO DO SO.

1. Select stock to be threaded.
2. Face both ends using a facing tool.
3. Center stock, first making sure that the live and dead centers are in line.
4. Mount stock between centers in the lathe.
5. Turn the piece to the proper outside diameter. Use a round nose tool. "Mike" the piece to make sure that the diameter is correct.
6. Chamfer the right end of the piece.
7. Set the gearbox for the correct number of threads per inch.
8. Set the lathe for the proper cutting speed which is four times slower than for ordinary turning.
9. Set the compound rest at 29 deg. for thread cutting.
10. Place a right-hand threading tool, ground to the American National form, in a toolholder and tighten. Leave about $\frac{1}{2}$ in. of the tool protruding from the toolholder.
11. Place the toolholder in the tool post and adjust tool so that the point is exactly at the same height as the point of the dead center.
12. Hold the tool in this position and tighten the tool-post setscrew.
13. Set the tool with the aid of a center gage to the center line of the lathe.
14. Adjust threading stop.

Instructions 1 through 14 are taken from Machine Tool Operation, Part 1, by Burghardt, Axelrod, and Anderson. Copyright 1959 by McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.

APPENDIX B

Instruction Ordering Test Form

NAME _____

HERE ARE THE 14 INSTRUCTIONS IN SCRAMBLED ORDER. PLEASE PLACE THE CORRECT NUMBER OF EACH INSTRUCTION ON THE BLANK WHICH PRECEDES IT. DON'T FORGET TO SIGN YOUR NAME. YOU WILL HAVE TWO MINUTES.

ARE THERE ANY QUESTIONS?

DO NOT BEGIN UNTIL TOLD TO DO SO.

____Turn the piece to the proper outside diameter. Use a round nose tool. "Mike" the piece to make sure that the diameter is correct.

____Set the tool with the aid of a center gage to the center line of the lathe.

____Place a right-hand threading tool, ground to the American National form, in a toolholder and tighten. Leave about $\frac{1}{2}$ in. of the tool protruding from the toolholder.

____Select stock to be threaded.

____Mount stock between centers in the lathe.

____Set the lathe for the proper cutting speed which is four times slower than for ordinary turning.

____Hold the tool in this position and tighten the tool-post setscrew.

____Set the gearbox for the correct number of threads per inch.

____Face both ends using a facing tool.

____Adjust threading stop.

____Set the compound rest at 29 deg. for thread cutting.

____Place the toolholder in the tool post and adjust tool so that the point is exactly at the same height as the point of the dead center.

____Chamfer the right end of the piece.

____Center stock, first making sure that the live and dead centers are in line.

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APPENDIX C

Household Item Form

BEFORE NEXT CLASS, PLEASE MEMORIZE THE FOLLOWING LIST OF ITEMS. VISUALIZE THEM IN THE DESIGNATED ROOMS OF YOUR HOME. THEN I WILL SHOW YOU HOW TO INCREASE THE EFFICIENCY OF YOUR MEMORY BY USING THIS LIST.

In your kitchen:	In your living room:	In your bathroom:
1. Sink	6. Rug	11. Bathtub
2. Stove	7. Drapes	12. Towel
3. Chair	8. Lamp	13. Mirror
4. Table	9. Sofa	14. Medicine cabinet
5. Refrigerator	10. Television	

.....

EXERCISES

(Fold page back along the dotted line so that you cannot see the list as you practice.)

A. Go down the columns. Repeat until you can consistently identify the number of each item at a rate of one number per second.

mirror	sofa
television	medicine cab.
refrigerator	rug
bathtub	chair
stove	mirror
sink	lamp
medicine cab.	towel
table	refrigerator
towel	bathtub
rug	stove
lamp	television
chair	drapes
drapes	sink
sofa	table
stove	chair
sink	refrigerator
medicine cab.	lamp
television	sink
chair	chair
bathtub	drapes
table	sofa
drapes	mirror
sofa	stove
towel	television
refrigerator	medicine cab.
mirror	bathtub
lamp	rug
rug	towel

B. Go down the columns. Repeat until you can consistently identify the item associated with each number at a rate of one item per second.

4	6
7	13
10	11
3	4
9	12
1	8
8	7
12	1
6	9
13	5
11	2
14	14
2	3
5	10
12	8
1	2
7	10
5	3
14	6
8	5
10	11
13	14
6	7
11	1
2	12
4	4
9	9
3	13

APPENDIX D

Household Item Test

Name _____

PLEASE WRITE THE LIST YOU WERE ASKED TO MEMORIZE IN ITS PROPER ORDER. DON'T FORGET TO SIGN YOUR NAME. YOU WILL HAVE ONE MINUTE.
ARE THERE ANY QUESTIONS?
DO NOT BEGIN UNTIL TOLD TO DO SO.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____

APPENDIX E

Mnemonic Instruction Memorization Form

IN THE LEFT-HAND COLUMN IS PART OF A PROCEDURE FOR CUTTING A SCREW THREAD IN A LATHE. PLEASE MEMORIZE THE ORDER OF THESE 14 INSTRUCTIONS BY FOLLOWING THIS PROCEDURE:

1. BRIEFLY GLANCE AT THE UNDERLINED CODE WORD IN THE FIRST LEFT-HAND COLUMN SENTENCE. DO NOT READ THE SENTENCE.
2. READ THE COMMENT WITH THE SAME NUMBER IN THE RIGHT-HAND COLUMN AND ASSOCIATE THE CODE WORD WITH THE PRE-MEMORIZED HOUSEHOLD ITEM AS DIRECTED. PICTURE WHAT YOU READ.
3. CONTINUE THIS PROCEDURE THROUGH NUMBER 14. YOU WILL HAVE TWO MINUTES. SINCE YOU WILL PROBABLY FINISH BEFORE TIME IS CALLED, START AGAIN WITH NUMBER ONE.

IMPORTANT: BY KNOWING A CODE WORD AND ITS NUMBER, YOU WILL KNOW THE IDENTICAL NUMBER OF THE SENTENCE IN WHICH IT APPEARS.

ARE THERE ANY QUESTIONS?

DO NOT BEGIN UNTIL TOLD TO DO SO.

1. Select stock to be threaded.	1. See Richard Nixon standing in your SINK. As you look down, he says, "If you elect me, I will. . . ."
2. Face both ends using a facing tool.	2. Look on top of your STOVE and see a large face sticking out where the burners used to be.
3. Center stock, first making sure that the live and dead centers are in line.	3. See a lion (line) sitting on your CHAIR. He roars at you and has a napkin around his neck.
4. Mount stock between centers in the lathe.	4. See a mount (horse) on your TABLE. He hears the lion's roar and gallops around terrified.
5. Turn the piece to the proper outside diameter. Use a round nose tool. "Mike" the piece to make sure that the diameter is correct.	5. You hear breathing inside your REFRIGERATOR so you open it and find a giant nose.

(Please turn)

The 14 instructions in the left-hand column are taken from Machine Tool Operation, Part 1, by Burghardt, Axelrod, and Anderson. Copyright 1959 by McGraw-Hill Book Company. Used with permission of McGraw-Hill Book Company.

6. Chamfer the right end of the piece.	6. See a camper (chamfer) camping on your RUG. He has a tent pitched and is roasting marshmallows.
7. Set the gearbox for the correct number of threads per inch.	7. See your DRAPES covered with pictures of boxes full of gears (gearboxes).
8. Set the lathe for the proper cutting speed which is four times slower than for ordinary turning.	8. See the number "4" (four) written all over your LAMPshade.
9. Set the compound rest at 29 deg. for thread cutting.	9. See a pile of thermometers covering the seat of your SOFA. They all register 29 degrees.
10. Place a right-hand threading tool, ground to the American National form, in a toolholder and tighten. Leave about $\frac{1}{2}$ in. of the tool protruding from the toolholder.	10. You turn on your TELEVISION and see a map of America. A program is on called The American Nation.
11. Place the toolholder in the tool post and adjust tool so that the point is exactly at the same height as the point of the dead center.	11. You look into your BATHTUB and see the points of a thousand nails sticking up from the bottom.
12. Hold the tool in this position and tighten the tool-post setscrew.	12. See a foot long screw sticking out of your TOWEL.
13. Set the tool with the aid of a center gage to the center line of the lathe.	13. You look into your MIRROR but cannot see yourself because your MIRROR is covered with band-aids.
14. Adjust threading stop.	14. You open your MEDICINE CABINET and see an eight-sided stop sign.

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