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MNEMONIC ENHANCEMENT AND GENERAL TECHNICAL ABILITY

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Douglas Griffith and Tomme R. Actkinson

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ARI FIELD UNIT AT FORT HOOD, TEXAS

U. S. Army
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September 1978

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To increase both training effectiveness and the operational proficiency of the soldier, techniques which increase the cognitive capacities of soldiers appear to have considerable potential. The current experiment is the first in a series of studies designed to examine techniques which purport to enhance the effectiveness of human memory. This first experiment examined the utility of a simple pegword menmonic for Army enlisted personnel representing three levels of general technical (GT) ability: 90 and below, 91 to 109, and 110 and above. Twenty-four personnel were sampled from each of the

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three GT levels. Half the personnel in each group were instructed in the use of a rhyme pegword mnemonic. All personnel learned three lists of digit-noun associations. The digits one through ten were employed as the cues for all lists. The response items were rated in terms of their potential for evoking memory images. One list had low imagery values, one intermediate, and one high. At the end of the experiment, the personnel attempted to recall all three lists. It was found that the initial acquisition of the lists is a positive function of the imagery level of the response items as well as a positive function of the GT level of the personnel. It was also found that only the high GT group (GT ≥ 110) is able to employ the mnemonic to advantage. The final recall test indicates a precipitous loss of information across lists for all conditions. The following conclusions are offered: (1) the utility of implementing the training of high GT personnel with mnemonic instruction needs to be examined; (2) whenever possible, concrete, highly imageable words should be employed in training materials; (3) conditions under which low and moderate GT ability personnel can employ mnemonics successfully need to be investigated; (4) techniques for remediating the precipitous information loss when pegwords are employed repeatedly need to be developed.

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Technical Paper 336

MNEMONIC ENHANCEMENT AND GENERAL TECHNICAL ABILITY

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FOREWORD

The Fort Hood Field Unit of the Army Research Institute for the Behavioral and Social Sciences conducts research to develop a technology base in support of field testing. To this end research is conducted to identify potential areas of training which enhances soldierly performance in an operational environment. Since effective memory is key to the performance of many military tasks, factors which have the potential of enhancing memory deserve experimental attention. The current research is concerned both with the identification of factors which may enhance memory, and with the identification of individuals who might benefit from explicit memory training.

The entire project is responsive to special requirements of the Office of the Deputy Chief of Staff for Personnel and to Army Project 2Q762722A765.

JOSEPH ZEIDNER
Technical Director

MNEMONIC ENHANCEMENT AND GENERAL-TECHNICAL ABILITY

BRIEF

Requirement:

To assess the utility of two techniques (i.e., mnemonic instructions and words rated high on norms of imageability) for enhancing mnemonic information processing with personnel of varying general technical (GT) test ability.

Procedure:

Groups comprising three ranges of GT levels were employed: (90 and below; 91 to 109; 110 and above). Twenty-four enlisted personnel were employed in each group. Half of each group was instructed in the use of a mnemonic technique. The remaining half served as a non-instructed control. Each participant learned three lists of words rated respectively in imagery as high, intermediate, and low.

Findings:

Only the high GT group was able to employ the mnemonic technique to advantage. Generally speaking, personnel with higher GT scores performed better, and recall was a positive function of the imagery level of the materials.

Utilization of Findings:

This experiment demonstrates the utility of mnemonic instructions with high (110 or above) GT personnel.

The enhancement of information processing afforded by high imagery materials is demonstrated.

A need is identified for research concerning mnemonic training for low and moderate ability personnel.

A need is identified for research concerning techniques for eliminating or reducing retroactive effects when memory pegwords are employed repeatedly.

MNEMONIC ENHANCEMENT AND GENERAL TECHNICAL ABILITY

CONTENTS

	Page
INTRODUCTION	1
METHOD	1
Design and Subjects	1
Procedure	3
Lists	4
Dependent Variables	4
RESULTS	4
Trials to Criterion	4
Number Correct on First Trial	6
Final Recall Data	8
CONCLUSIONS	8
REFERENCES	11
APPENDIX A. IMAGERY SUBJECT INSTRUCTIONS	13
B. CONTROL SUBJECTS INSTRUCTIONS	17
C. LIST OF EXPERIMENTAL WORDS AND ASSOCIATED DIGITS	21
DISTRIBUTION	23

LIST OF TABLES

Table 1. Counterbalancing sequence	2

LIST OF FIGURES

Figure 1. Mean number of trials to criterion	5
2. Mean number correct on first trial	7
3. Final recall as a function of list order	9

MNEMONIC ENHANCEMENT AND GENERAL-TECHNICAL ABILITY

INTRODUCTION

The ability to store and retrieve information is key to the performance of many tasks. Hence, techniques which enhance an individual's ability to store and retrieve information have potential for increasing both the training efficiency and the operational effectiveness of the soldier. The present experiment represents an initial effort to investigate the utility of various techniques for enhancing the mnemonic capacity of the soldier. Two techniques for enhancing memory performance were examined over a sample of Army enlisted personnel from three ranges of general-technical ability.

By far, the most potent theoretical construct in studies of memory enhancement is the construct of imagery (Paivio, 1971). Two manipulations predominate in the study of imagery and its relation to memory. One manipulation is instructional set. Here an experimental group is instructed to transform the to-be-recalled (TBR) material into a visual image, and to form an interacting image between the TBR material and a readily accessible retrieval cue. Typically the group instructed in the imagery mnemonic recalls significantly more information than a control group which is merely instructed to learn the material.

A second major manipulation is the varying of the imagery level (IL) of the TBR material. There are norms (Paivio, Yuille, & Madigan, 1968) in which words have been rated in terms of their capacity for evoking mental images. These normative ratings are proven powerful predictors of memory performance. Typically, recall is a positive function of the IL of the material, i.e., the higher the IL the higher the recall.

A question remains concerning the generality of the above findings, as a heavy majority of research on imagery and mnemonics has employed college students as subjects. The purpose of the present experiment was to assess whether effects similar to those obtained with college students could be replicated with a representative military sample.

METHOD

Design & Subjects

A 2 (Instructional Set) by 3 (GT Level) by 3 (Imagery Level) factorial design was employed. The experimental group was instructed in the use of a rhyme pegword mnemonic whereas the second group served as a noninstructed control. The three GT levels encompassed the following ranges: 90 and

below, 91 to 109, and 110 and above. Imagery level was manipulated within subjects. Each subject learned three word lists, one each with high, intermediate, and low imagery ratings, respectively. The order in which the subjects learned the word lists was counterbalanced according to the scheme portrayed in Table 1. Each of the sequences was represented twice in each cell of the experimental design.

Table 1

Counterbalancing Sequence

Sequence	List 1	List 2	List 3
1	HI	II	LI
2	II	LI	HI
3	LI	HI	II
4	LI	II	HI
5	II	HI	LI
6	HI	LI	II

Note. HI = high imagery
II = intermediate imagery
LI = low imagery

A total of 72 subjects, 24 from each of the GT levels, was employed in the data analysis. Subjects were randomly assigned to instructional sets and list orders with the restriction that an equal number of subjects from each GT level be employed in all conditions. The subject sample included both males and females and both combat and noncombat MOS's. Two subjects in the low GT imagery condition needed replacements. One subject did not speak enough English to serve in the experiment. Another subject could not understand the experimental instructions.

Procedure

Subjects were run individually. At the outset of the session the subject was informed that he was participating in a study on memory. The instructions for the experimental (imagery) and control subjects are presented in Appendixes A and B respectively. It should be noted that these instructions were spoken rather than read to the subjects. The experimental subjects were instructed in the use of a rhyme pegword mnemonic. In this technique, rhyme words (pegwords) are associated with the digits 1 to 10, e.g., one is a bun, two is a shoe, etc. Interacting images are then formed between the rhyme pegwords and the to-be-recalled (TBR) items. This particular mnemonic technique was chosen because it can be taught in a brief period of time. Moreover, the use of pegwords is integral to most memory systems (Lorayne & Lucas, 1974).

Initially the imagery subjects were read the digits and their pegwords (see list of words, page A-1, Appendix A). The experimenter then prompted the subject with the digit and asked him to supply the pegword. This procedure was essentially subject-paced and each subject was taken to a criterion of two successive perfect recitations. Imagery subjects were then instructed in the technique of forming images between the rhyme pegwords and the TBR material. First the technique was illustrated with two response terms. Then each subject was asked to describe the images he formed for these additional high imagery items. Subjects were provided feedback on their images and the technique was reiterated if the subject apparently did not understand the technique. Subjects were then instructed how to employ the imagery technique with abstract words. Subjects were provided with two examples of imagery mediation with abstract words and then required to describe three additional examples on their own. Feedback was provided after each example.

Control subjects also learned the rhyme pegwords to a criterion of two successive correct repetitions. Cue words for the control subjects, however, were those rhyming with the pegwords rather than digits, e.g., pun-bun, clue-shoe, etc. (See list of words, page B-1, Appendix B.) This procedure was followed to keep warm-up and practice efforts comparable between the two groups and at the same time to avoid A-B, A-C interference effects. The same response words were used in the sample list for the control subjects as were used for the imagery subjects during the imagery training.

After the instructional phase each subject learned three 10-word lists, one each high, intermediate, and low imagery (see Appendix C). The digit-noun pairs were presented via a Kodak Carousel Slide Projector. The pairs were presented at an 8-second rate in a random order. After all 10 pairs had been presented, a blank slide occurred and the digits were presented individually for eight seconds each. Subjects responded orally. If the subject did not recall at least nine pairs correctly, another blank slide appeared and the study-test cycle was repeated, using a different random order. Altogether three random orders were employed throughout the experiment. A maximum of five trials was allowed to reach criterion on each list. Approximately 45 seconds elapsed between each list--just enough time to change slide trays. After being presented the three lists, the subject was provided a sheet of paper showing digits 1 to 10 with three blank spaces alongside each digit. The subject was requested to write down as many words as he remembered having been projected and, if possible, to record them with the appropriate digit. No time limit was set for the final recall.

Lists

Three lists of items (see Appendix C) were constructed from the Paivio, Yuille, & Madigan 1968 norms. Thirty nouns were randomly selected with the following restrictions: (1) that they all have A or AA Thorndike-Lorge frequency counts and (2) that 10 have imagery values below 3.02, 10 have imagery values between 3.02 and 6.24, and 10 have imagery values above 6.24. These subsets of 10 items each comprised the response terms for the low, intermediate, and high imagery levels, respectively. The words within each subset then were paired randomly with the digits 1-10 with the restriction that one noun be paired with each digit.

Dependent Variables

Two dependent measures are regarded as primary: the number correct on the first trial and the number of trials to criterion. Subjects who did not reach criterion within five trials were assigned a score of 6. In addition, a final recall test was administered at the end of the experiment to assess the accessibility of information across lists.

RESULTS

Trials to Criterion

Figure 1 indicates the effect of GT level and item imagery, and also indicates that an effect of instructional set is obtained only with the high GT group. These data were examined by a 2 (Instructional Set) by 3 (GT Level) by 3 (Imagery Level) analysis of variance with repeated measures on the last factor. The Newman-Keuls test was employed for post hoc comparisons. A statistical significance level of .05 was chosen as the criterion for rejecting the hypothesis of no difference between the various levels of Instructional Set, GT Scores, and Imagery.

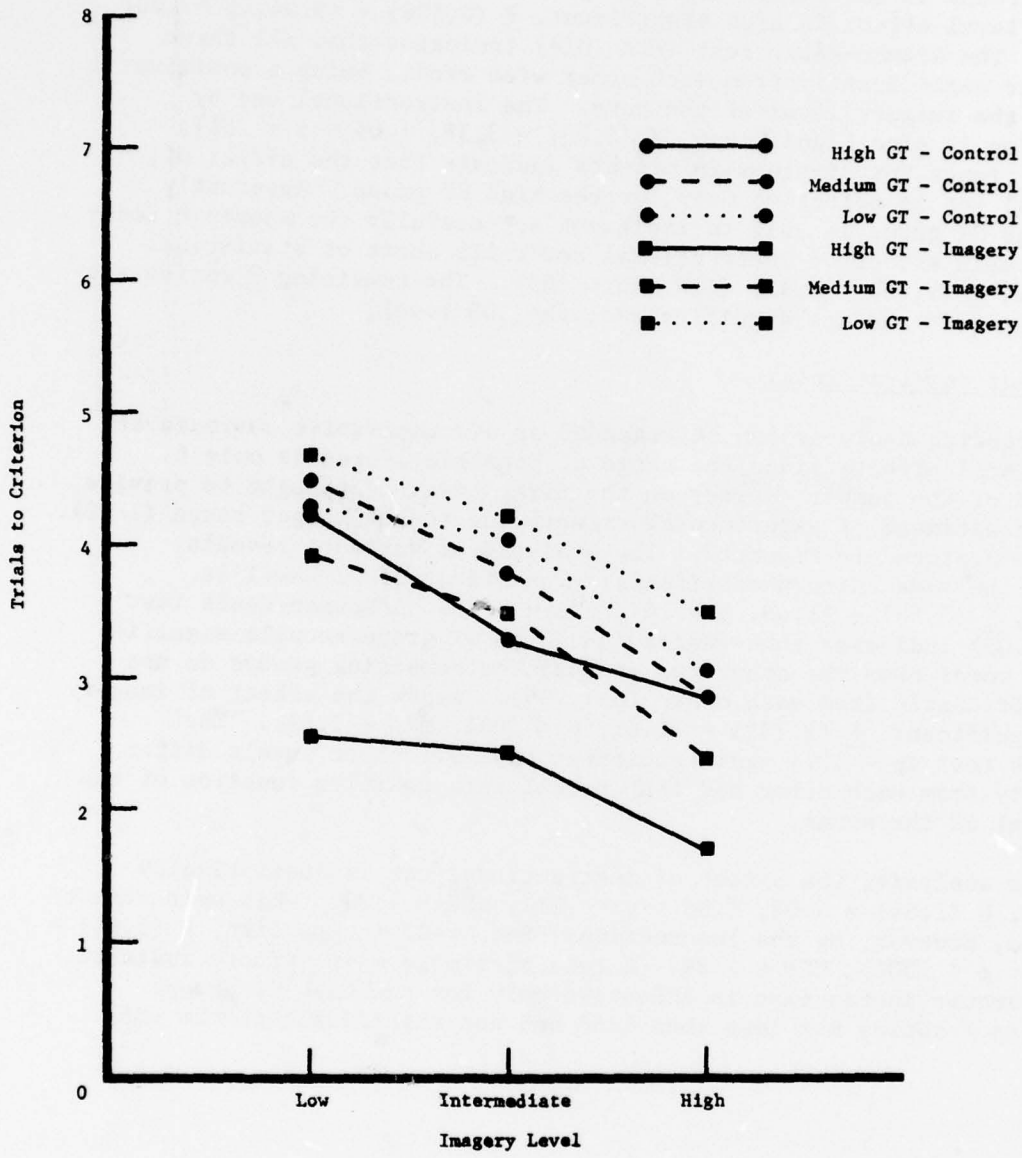

Figure 1. Mean number of trials to criterion.

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The effect of GT level is statistically significant, F (2,66) = 7.55, $p < .01$, MSe = 2.98. The Newman-Keuls test indicates that whereas the high GT group requires significantly fewer trials to criterion than the intermediate group ($.01 < p < .05$) and the low group ($p < .01$*), the intermediate and low GT groups do not differ significantly from each other ($p < .05$*). The imagery level effect is also significant, F (2,132) = 49.94, $p < .001$, MSe = .719. The Newman-Keuls test ($p < .01$*) indicates that all three levels differ significantly from each other with recall being a positive function of the imagery level of the noun. The instructional set by GT interaction is also significant, F (2,66) = 3.38, ($.05 < p < .01$), MSe = 2.98. Tests for simple main effects indicate that the effect of instructional set is effective only for the high GT group. Apparently only the high GT group is able to implement successfully the mnemonic technique. The main effect of instructional set falls short of statistical significance, F (1,66) = 3.43, ($.10 < p < .05$). The remaining F ratios are all less than 1.25 and not significant at the .05 level.

Number Correct on First Trial

The preceding analysis can be regarded as a conservative estimate of the experimental effects since the range of possible scores is only 6. The analysis of the number correct on the first trial is thought to provide a more valid estimate of experimental effects due to the larger range (1-10). The data are depicted in Figure 2. The analysis of variance reveals essentially the same pattern of effects. The effect of GT Level is significant, F (2,66) = 11.46, $p < .01$, MSe = 7.29. A Newman-Keuls Test ($.01 < p < .05$) indicates that whereas the high GT group recalls significantly more words than the other two groups, the remaining groups do not differ significantly from each other ($p < .05$). Again the effect of imagery level is significant, F (2,132) = 36.61, $p < .001$, MSe = 2.517. The Newman-Keuls test ($p < .01$) again indicates that all three levels differ significantly from each other and that recall is a positive function of the imagery level of the nouns.

In this analysis, the effect of instructional set is statistically significant, F (1,66) = 5.03, ($.05 < p < .01$), MSe = 7.29. This main effect is qualified, however, by the Instructional Set by GT interaction, F (2,66) = 6.94, ($.01 < p < .001$), MSe = 7.29. A test of simple main effects indicate that the mnemonic instruction is effective only for the high GT group. The remaining F-ratios are less than 1.68 and not significant at the .05 level.

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*Tables of critical values for the Newman-Keuls test were available only for the values of $\alpha = .01$ and $\alpha = .05$.

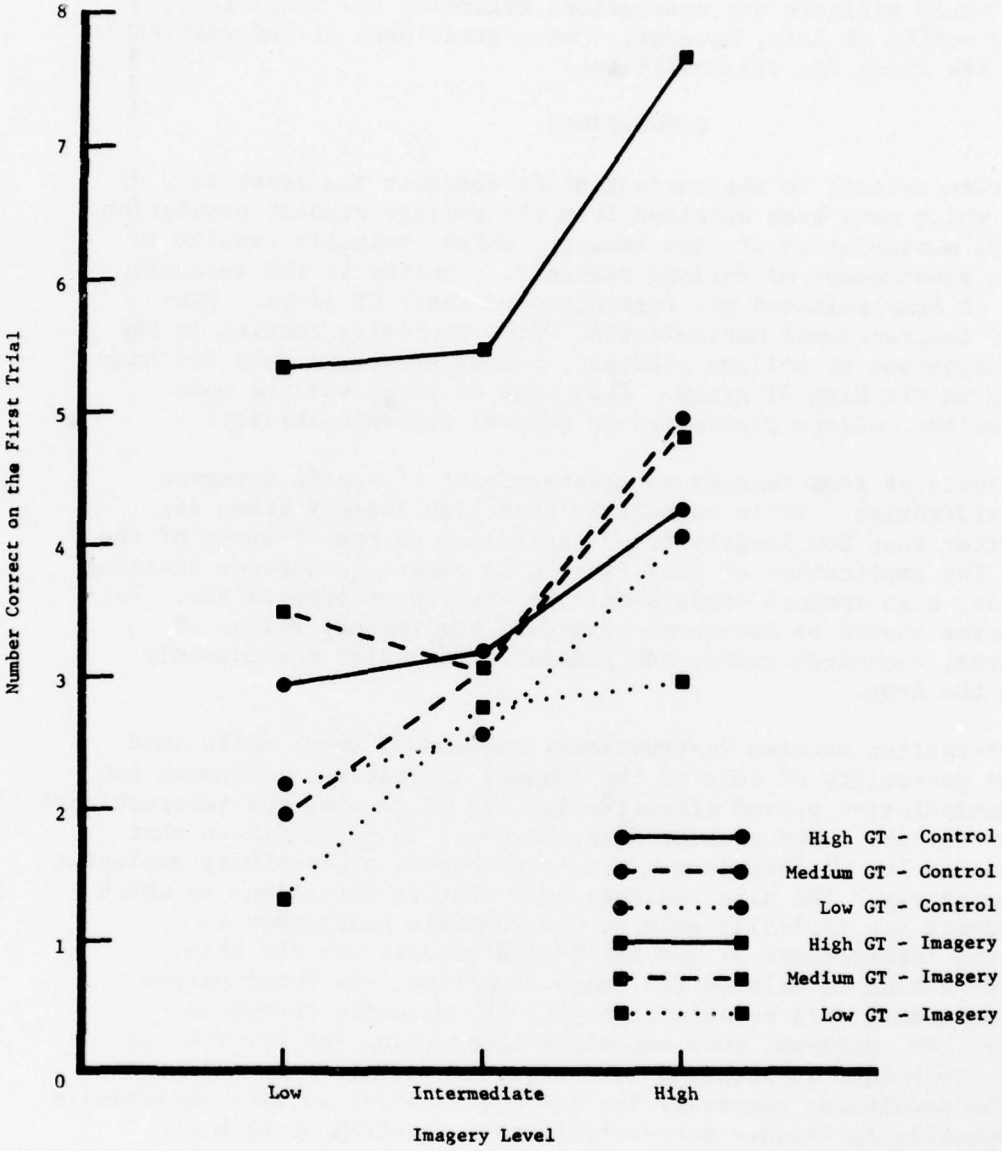

Figure 2. Mean number correct on the first trial.

Final Recall Data

The data from the final recall test are summarized in Figure 3. No statistical analyses are provided since the differences in initial acquisition would mitigate any conclusions regarding the final recall data. It is worthy of note, however, that a great deal of information is lost across the lists for all conditions.

CONCLUSIONS

A question central to the current study concerns the generality of the results which have been obtained from the college student population. The normative manipulation of item imagery, which typically results in the mnemonic enhancement of college students, resulted in the mnemonic enhancement of Army enlisted men regardless of their GT level. Conversely, the instructional manipulation, which typically results in the mnemonic enhancement of college students, proved effective only for Army enlisted men in the high GT group. This high GT group was the most comparable to the college population in general academic ability.

The potency of item imagery as a determinant of recall deserves special consideration. It is noteworthy that high imagery items are recalled better than low imagery items regardless of the GT level of the personnel. The implication of this finding is clear--to enhance training effectiveness, high imagery words should be used whenever possible. To this end, norms should be developed regarding the imagery values of military terms, technical terms, and general words which are commonly employed in the Army.

The interaction between instructional set and GT level calls into question the generality of some of the imagery literature. Although the normative manipulation proved effective for all GT levels, the instructional manipulation did not. The present data, however, do not indicate that intermediate and low GT individuals are incapable of successfully employing a mnemonic strategy. The data indicate only that in situations in which college students are typically able to use mnemonic techniques to advantage, the intermediate GT and low GT individuals are not able. Perhaps if more time is allowed for image formation, the intermediate and low GT personnel will be able to employ the mnemonic technique successfully. Or, perhaps, more extensive instruction and practice in the mnemonic technique is required for these individuals. The identification of the conditions necessary for low and moderate ability individuals to employ mnemonic techniques successfully is a research problem of immediate interest.

Other points of major interest are the independent effects of instructional set and item imagery. Typically the effects of these manipulations are additive rather than interactive (Paivio, 1971). In the current study the normative rating affects all GT levels, whereas the instructional manipulation affects only high GT personnel. These

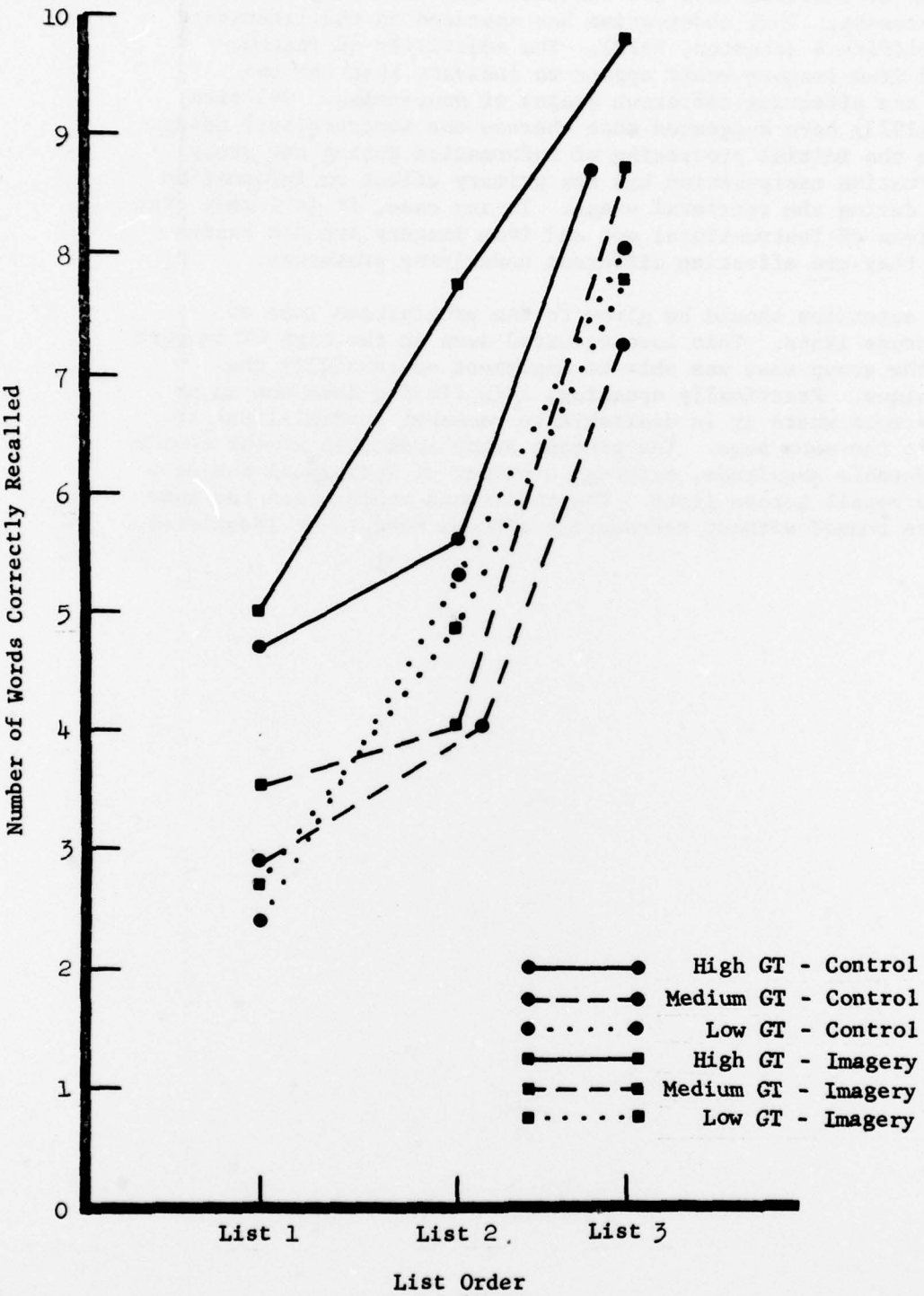

Figure 3. Final recall as a function of list order.

findings appear to indicate that the variables are affecting different underlying processes. This observation has appeared in the literature previously (Griffith & Johnston, 1973). The additivity of instructional set and item imagery would appear to indicate that the two manipulations are affecting different stages of processing. Griffith and Johnston (1973) have suggested that whereas the instructional manipulation affects the initial processing of information during the study stage, the normative manipulation has its primary effect on information accessibility during the retrieval stage. In any case, it is likely that the manipulations of instructional set and item imagery are not equivalent and that they are affecting different underlying processes.

Finally, attention should be given to the precipitous loss of information across lists. This loss occurred even in the high GT imagery group, i.e., the group that was able to implement successfully the mnemonic technique. Practically speaking, this finding does not augur well for situations where it is desirable to remember several lists of words linked to the same pegs. The present study indicates a mean recall loss of considerable magnitude, although a number of individual subjects indicated high recall across lists. The conditions under which the same pegwords can be reused without retroactive effects need to be identified.

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APPENDIX A

IMAGERY SUBJECT INSTRUCTIONS

Hello, my name is _____ and I am from the Army Research Institute. According to my information you are _____. Your ability to remember information is key to your performance of many tasks. As a result the Army is interested in basic research on memory. This is an experiment in the Army's ongoing research on the topic of memory. After this session has been completed, I'll be happy to answer any questions you might have and provide a brief explanation of this study, should you so desire. For the time being, however, I want you to follow instructions completely. Of course, should you have any questions about what you are supposed to do, don't hesitate to ask.

Let's warm up by memorizing this simple rhyme scheme.

1 - Bun

2 - Shoe

3 - Tree

4 - Door

5 - Hive

6 - Sticks

7 - Heaven

8 - Gate

9 - Wine

10 - Hen

The words associated with the numbers are called pegwords. Now, whenever I give you a number from 1-10, you give me the rhyme pegword. (Prompt, if he doesn't answer. Repeat each iteration until all ten are correctly supplied three times in succession.)

1.		Again.	7.	And Again.	2.
2.			5.		7.
3.			1.		10.
4.			3.		5.
5.			9.		8.
6.			2.		3.
7.			4.		6.
8.			10.		9.
9.			8.		1.
10.			6.		4.

Now I'm going to show you how to use these rhyme pegwords to help you remember. The key technique is to use visual imagery, mental pictures, to help you remember. Say, for example you want to learn the following associations: 1 - Helicopter

2 - Rifle

3 - Jeep

4 - Desk

5 - House

Learn these pairs so that whenever I give you the number you can give me the word that was paired with it. You can use the rhyme pegword you associated to the number to form an interacting image (a mental picture containing the word you want to remember). That is, when you hear 1, you would think of Bun and then form an image of, say, a helicopter in an enormous hamburger bun. For the pair 2 - Rifle, you could think of the rhyme word, Shoe, with a rifle sticking through the toe. Later, when the number 1 is presented, you will think of the rhyme pegword Bun which will make you think of the mental picture you formed of the helicopter in the bun. You can then recall the word, Helicopter. Likewise, when the number 2 is presented you will think of the rhyme pegword Shoe which will remind you of the image you formed of the rifle sticking through the toe of the shoe. You can then recall Rifle from this image.

Now, I'll give you three more # - word pairs. After you have formed an image for each pair, describe it.

(Present Singly)

3 - Jeep

4 - Desk

5 - House

Any questions?

So far, all the words you have used have been relatively concrete. That is, the words refer to concrete objects. It is also possible, however, to use imagery when words are abstract and refer to no concrete objects. Consider the following # - word pairs.

6 - Religion

7 - Poverty

8 - Bravery

9 - Law

10 - Wealth

The trick here is to use concrete objects to refer to the abstract concepts. You could handle the pair 6 - Religion in the following way. For the number 6 you remember the rhyme "Sticks." Next, you translate the word Religion into a picture of a group of people having a prayer meeting. Then you can form a mental image of a group of people having a prayer meeting on a pile of sticks. Later, when the number 6 is presented, you will think of the rhyme Sticks which will remind you of the mental picture you formed of the prayer meeting on top of a pile of sticks. This mental picture, then, should remind you of the word Religion.

Sound complicated? It becomes easier after you've had a little practice. Consider the pair 7 - Poverty. Here you might simply translate the word poverty into a picture of a group of poor people. Since the rhyme pegword for 7 is heaven, you can form an image of a group of poor people in heaven. Later when you hear 7, you will think of heaven which will remind you of the mental picture of the poor people in heaven which will, in turn, remind you of the word Poverty.

Any questions? Now I'll give you several # - noun pairs and have you describe to me the images you have formed for them.

(Present singly)

8 - Bravery

9 - Law

10 - Wealth

Any questions? Remember it is important that you translate any words which do not already refer to a concrete object into words which refer to something concrete and form vivid mental images combining the words with the rhyme pegwords.

You will learn three lists of # - word associations. Each list will consist of two phases: a study phase and a test phase. In the study phase # - word pairs will be projected singly on the screen for eight seconds each. After ten pairs have been presented the test phase will begin. In the test phase the digits will be presented individually in a random order. When the digit is presented you are to try to recall

the word that was paired with it. You'll have four seconds to remember the word. When you think you know the word, say your answer aloud. After four seconds have elapsed, another digit will be presented and you'll try to remember the word that was paired with it. You'll be tested on all the pairs. Do you have any questions?

Now we'll try another list. Once again the digits will be 1-10, but now you are to associate new words to them.

Now we'll try a third list. Once again the digits will be 1-10, and once again you are to associate new words to them.

APPENDIX B

CONTROL SUBJECTS INSTRUCTIONS

Hello, my name is _____ and I am from the Army Research Institute. According to my information, you are _____. Your ability to remember information is key to your performance of many tasks. As a result the Army is interested in basic research on memory. This is an experiment in the Army's ongoing research on the topic of memory. After this session has been completed, I'll be happy to answer any questions you might have and provide a brief explanation of this study, should you so desire. For the time being, however, I just want you to follow instructions exactly. Of course, should you have any questions about what you are supposed to do, don't hesitate to ask.

Let's warm up by memorizing this simple rhyme scheme.

Pun - Bun

Clue - Shoe

Fee - Tree

Bore - Door

Jive - Hive

Hicks - Sticks

Leaven - Heaven

Hate - Gate

Fine - Wine

Men - Hen

Now, whenever I give you a word, you give me the word I gave you which rhymes with it. (Prompt if he doesn't answer. Repeat each iteration until all ten are correctly supplied three times in succession).

Pun	Leaven	Clue
Clue	Jive	Leaven
Fee	Pun	Men
Bore	Fee	Jive

Jive	Fine	Hate
Hicks	Clue	Fee
Leaven	Bore	Hicks
Hate	Men	Fine
Fine	Hate	Pun
Men	Hicks	Bore

You will learn three lists of # - word associations. Each list will consist of two phases: a study phase and a test phase. Here is a sample list:

1 - Helicopter

2 - Rifle

3 - Jeep

4 - Desk

5 - House

6 - Religion

7 - Poverty

8 - Bravery

9 - Law

10 - Wealth

In the study phase the # - word pairs will be projected singly on the screen for eight seconds each. After the ten pairs have been presented, the test phase will begin. In the test phase the digits will be presented individually in a random order. When the digit is presented, you are to try to recall the word that was paired with it. For example, the number "4" will be presented and you will try to remember "Desk." Then the number 10 might be presented and you would try to remember Wealth. You'll have eight seconds to remember the word. When you think you know the word, say your answer aloud. After eight seconds have elapsed, another digit will be presented and you'll try to remember the word that was paired with it. You'll be tested on all the pairs. Do you have any questions?

Now we'll try another list. Once again the digits will be 1-10, but now you are to associate new words to them.

Now we'll try a third list. Once again the digits will be 1-10, and once again you are to associate new words to them.

APPENDIX C

LIST OF EXPERIMENTAL WORDS AND ASSOCIATED DIGITS

High Imagery	Intermediate Imagery	Low Imagery
(1) Money	(1) Month	(1) Opportunity
(2) Newspaper	(2) Owner	(2) Situation
(3) Flower	(3) Trouble	(3) Fault
(4) Arm	(4) Author	(4) Answer
(5) Iron	(5) Journal	(5) Moment
(6) University	(6) Vegetable	(6) Truth
(7) Star	(7) Charm	(7) Soul
(8) Ambulance	(8) Convention	(8) Advantage
(9) Fire	(9) Expression	(9) Event
(10) Flag	(10) Passion	(10) Occasion

ARI Distribution List

4 OASD (M&RA)
2 HQDA (DAMI-CSZ)
1 HQDA (DAPE-PBR
1 HQDA (DAMA-AR)
1 HQDA (DAPE-HRE-PO)
1 HQDA (SGRD-ID)
1 HQDA (DAMI-DOT-C)
1 HQDA (DAPC-PMZ-A)
1 HQDA (DACH-PPZ-A)
1 HQDA (DAPE-HRE)
1 HQDA (DAPE-MPO-C)
1 HQDA (DAPE-DW)
1 HQDA (DAPE-HRL)
1 HQDA (DAPE-CPS)
1 HQDA (DAFD-MFA)
1 HQDA (DARD-ARS-P)
1 HQDA (DAPC-PAS-A)
1 HQDA (DUSA-OR)
1 HQDA (DAMO-RQR)
1 HQDA (DASG)
1 HQDA (DA10-PI)
1 Chief, Consult Div (DA-OTSG), Adelphi, MD
1 Mil Asst. Hum Res, ODDR&E, OAD (E&LS)
1 HQ USARAL, APO Seattle, ATTN: ARAGP-R
1 HQ First Army, ATTN: AFKA-OI-TI
2 HQ Fifth Army, Ft Sam Houston
1 Dir, Army Stf Studies Ofc, ATTN: OAVCSA (DSP)
1 Ofc Chief of Stf, Studies Ofc
1 DCSPER, ATTN: CPS/OCP
1 The Army Lib, Pentagon, ATTN: RSB Chief
1 The Army Lib, Pentagon, ATTN: ANRAL
1 Ofc, Asst Sect of the Army (R&D)
1 Tech Support Ofc, OJCS
1 USASA, Arlington, ATTN: IARD-T
1 USA Rsch Ofc, Durham, ATTN: Life Sciences Dir
2 USARIEM, Natick, ATTN: SGRD-UE-CA
1 USATTC, Ft Clayton, ATTN: STETC-MO-A
1 USAIMA, Ft Bragg, ATTN: ATSU-CTD-OM
1 USAIMA, Ft Bragg, ATTN: Marquat Lib
1 US WAC Ctr & Sch, Ft McClellan, ATTN: Lib
1 US WAC Ctr & Sch, Ft McClellan, ATTN: Tng Dir
1 USA Quartermaster Sch, Ft Lee, ATTN: ATSM-TE
1 Intelligence Material Dev Ofc, EWL, Ft Holabird
1 USA SE Signal Sch, Ft Gordon, ATTN: ATSO-EA
1 USA Chaplain Ctr & Sch, Ft Hamilton, ATTN: ATSC-TE-RD
1 USATSCH, Ft Eustis, ATTN: Educ Advisor
1 USA War College, Carlisle Barracks, ATTN: Lib
2 WRAIR, Neuropsychiatry Div
1 DLI, SDA, Monterey
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-WGC
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-MR
1 USA Concept Anal Agcy, Bethesda, ATTN: MOCA-JF
1 USA Artic Test Ctr, APO Seattle, ATTN: STEAC-MO-ASL
1 USA Artic Test Ctr, APO Seattle, ATTN: AMSTE-PL-TS
1 USA Armament Cmd, Redstone Arsenal, ATTN: ATSK-TEM
1 USA Armament Cmd, Rock Island, ATTN: AMSAR-TDC
1 FAA-NAFEC, Atlantic City, ATTN: Library
1 FAA-NAFEC, Atlantic City, ATTN: Hum Engr Br
1 FAA Aeronautical Ctr, Oklahoma City, ATTN: AAC-44D
2 USA Fld Arty Sch, Ft Sill, ATTN: Library
1 USA Armor Sch, Ft Knox, ATTN: Library
1 USA Armor Sch, Ft Knox, ATTN: ATSB-DI-E
1 USA Armor Sch, Ft Knox, ATTN: ATSB-DT-TP
1 USA Armor Sch, Ft Knox, ATTN: ATSB-CD-AD
2 HQUSACDEC, Ft Ord, ATTN: Library
1 HQUSACDEC, Ft Ord, ATTN: ATEC-EX-E-Hum Factors
2 USAEEC, Ft Benjamin Harrison, ATTN: Library
1 USAPACDC, Ft Benjamin Harrison, ATTN: ATCP-HR
1 USA Comm-Elect Sch, Ft Monmouth, ATTN: ATSN-EA
1 USAEC, Ft Monmouth, ATTN: AMSEL-CT-HDP
1 USAEC, Ft Monmouth, ATTN: AMSEL-PA-P
1 USAEC, Ft Monmouth, ATTN: AMSEL-SI-CB
1 USAEC, Ft Monmouth, ATTN: C, Facl Dev Br
1 USA Materials Sys Anal Agcy, Aberdeen, ATTN: AMXSY-P
1 Edgewood Arsenal, Aberdeen, ATTN: SAREA-BL-H
1 USA Ord Ctr & Sch, Aberdeen, ATTN: ATSL-TEM-C
2 USA Hum Engr Lab, Aberdeen, ATTN: Library/Dir
1 USA Combat Arms Tng Bd, Ft Benning, ATTN: Ad Supervisor
1 USA Infantry Hum Rsch Unit, Ft Benning, ATTN: Chief
1 USA Infantry Bd, Ft Benning, ATTN: STEBC-TE-T
1 USASMA, Ft Bliss, ATTN: ATSS-LRC
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA-CTD-ME
1 USA Air Def Sch, Ft Bliss, ATTN: Tech Lib
1 USA Air Def Bd, Ft Bliss, ATTN: FILES
1 USA Air Def Bd, Ft Bliss, ATTN: STEBD-PO
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Lib
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: ATSW-SE-L
1 USA Cmd & General Stf College, Ft Leavenworth, ATTN: Ed Advisor
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: DepCdr
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: CCS
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCASA
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACO-E
1 USA Combined Arms Cmbt Dev Act, Ft Leavenworth, ATTN: ATCACC-CI
1 USAECOM, Night Vision Lab, Ft Belvoir, ATTN: AMSEL-NV-SD
3 USA Computer Sys Cmd, Ft Belvoir, ATTN: Tech Library
1 USAMERDC, Ft Belvoir, ATTN: STSFB-DQ
1 USA Eng Sch, Ft Belvoir, ATTN: Library
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL-TD-S
1 USA Topographic Lab, Ft Belvoir, ATTN: STINFO Center
1 USA Topographic Lab, Ft Belvoir, ATTN: ETL-GSL
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: CTD-MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATS-CTD-MS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TE
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TEX-GS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTS-OR
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTD-DT
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-CTD-CS
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: DAS/SRD
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: ATSI-TEM
1 USA Intelligence Ctr & Sch, Ft Huachuca, ATTN: Library
1 CDR, HQ Ft Huachuca, ATTN: Tech Ref Div
2 CDR, USA Electronic Prvg Grd, ATTN: STEEP-MT-S
1 CDR, Project MASSTER, ATTN: Tech Info Center
1 Hq MASSTER, USATRADOC, LNO
1 Research Institute, HQ MASSTER, Ft Hood
1 USA Recruiting Cmd, Ft Sherdian, ATTN: USARCPM-P
1 Senior Army Adv., USAFAGOD/TAC, Elgin AF Aux Fld No. 9
1 HQ USARPAC, DCSPER, APO SF 96558, ATTN: GPPE-SE
1 Stimson Lib, Academy of Health Sciences, Ft Sam Houston
1 Marine Corps Inst., ATTN: Dean-MCI
1 HQUSMC, Commandant, ATTN: Code MTMT 51
1 HQUSMC, Commandant, ATTN: Code MPI-20
2 USCG Academy, New London, ATTN: Admission
2 USCG Academy, New London, ATTN: Library
1 USCG Training Ctr, NY, ATTN: CO
1 USCG Training Ctr, NY, ATTN: Educ Svc Ofc
1 USCG, Psychol Res Br, DC, ATTN: GP 1/62
1 HQ Mid-Range Br, MC Det, Quantico, ATTN: P&S Div

1 US Marine Corps Liaision Ofc, AMC, Alexandria, ATTN: AMCGS–F
1 USATRADOC, Ft Monroe, ATTN: ATRO–ED
6 USATRADOC, Ft Monroe, ATTN: ATPR–AD
1 USATRADOC, Ft Monroe, ATTN: ATTS–EA
1 USA Forces Cmd, Ft McPherson, ATTN: Library
2 USA Aviation Test Bd, Ft Rucker, ATTN: STEBG–PO
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Library
1 USA Agcy for Aviation Safety, Ft Rucker, ATTN: Educ Advisor
1 USA Aviation Sch, Ft Rucker, ATTN: PO Drawer O
1 HQUSA Aviation Sys Cmd, St Louis, ATTN: AMSAV–ZDR
2 USA Aviation Sys Test Act., Edwards AFB, ATTN: SAVTE–T
1 USA Air Def Sch, Ft Bliss, ATTN: ATSA TEM
1 USA Air Mobility Rsch & Dev Lab, Moffett Fld, ATTN: SAVDL–AS
1 USA Aviation Sch, Res Tng Mgt, Ft Rucker, ATTN: ATST–T–RTM
1 USA Aviation Sch, CO, Ft Rucker, ATTN: ATST–D–A
1 HQ, DARCOM, Alexandria, ATTN: AMXCD–TL
1 HQ, DARCOM, Alexandria, ATTN: CDR
1 US Military Academy, West Point, ATTN: Serials Unit
1 US Military Academy, West Point, ATTN: Ofc of Milt Ldrshp
1 US Military Academy, West Point, ATTN: MAOR
1 USA Standardization Gp, UK, FPO NY, ATTN: MASE–GC
1 Ofc of Naval Rsch, Arlington, ATTN: Code 452
3 Ofc of Naval Rsch, Arlington, ATTN: Code 458
1 Ofc of Naval Rsch, Arlington, ATTN: Code 450
1 Ofc of Naval Rsch, Arlington, ATTN: Code 441
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Acous Sch Div
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L51
1 Naval Aerospc Med Res Lab, Pensacola, ATTN: Code L5
1 Chief of NavPers, ATTN: Pers-OR
1 NAVAIRSTA, Norfolk, ATTN: Safety Ctr
1 Nav Oceanographic, DC, ATTN: Code 6251, Charts & Tech
1 Center of Naval Anal, ATTN: Doc Ctr
1 NavAirSysCom, ATTN: AIR–5313C
1 Nav BuMed, ATTN: 713
1 NavHelicopterSubSqua 2, FPO SF 96601
1 AFHRL (FT) William AFB
1 AFHRL (TT) Lowry AFB
1 AFHRL (AS) WPAFB, OH
2 AFHRL (DOJZ) Brooks AFB
1 AFHRL (DOJN) Lackland AFB
1 HQUSAF (INYSD)
1 HQUSAF (DPXXA)
1 AFVTG (RD) Randolph AFB
3 AMRL (HE) WPAFB, OH
2 AF Inst of Tech, WPAFB, OH, ATTN: ENE/SL
1 ATC (XPTD) Randolph AFB
1 USAF AeroMed Lib, Brooks AFB (SUL–4), ATTN: DOC SEC
1 AFOSR (NL), Arlington
1 AF Log Cmd, McClellan AFB, ATTN: ALC/DPCRB
1 Air Force Academy, CO, ATTN: Dept of Bel Scn
5 NavPers & Dev Ctr, San Diego
2 Navy Med Neuropsychiatric Rsch Unit, San Diego
1 Nav Electronic Lab, San Diego, ATTN: Res Lab
1 Nav TrngCen, San Diego, ATTN: Code 9000–Lib
1 NavPostGraSch, Monterey, ATTN: Code 55Aa
1 NavPostGraSch, Monterey, ATTN: Code 2124
1 NavTrngEquipCtr, Orlando, ATTN: Tech Lib
1 US Dept of Labor, DC, ATTN: Manpower Admin
1 US Dept of Justice, DC, ATTN: Drug Enforce Admin
1 Nat Bur of Standards, DC, ATTN: Computer Info Section
1 Nat Clearing House for MH–Info, Rockville
1 Denver Federal Ctr, Lakewood, ATTN: BLM
12 Defense Documentation Center
4 Dir Psych, Army Hq, Russell Ofcs, Canberra
1 Scientific Advsr, Mil Bd, Army Hq, Russell Ofcs, Canberra
1 Mil and Air Attache, Austrian Embassy
1 Centre de Recherche Des Facteurs, Humaine de la Defense Nationale, Brussels
2 Canadian Joint Staff Washington
1 C/Air Staff, Royal Canadian AF, ATTN: Pers Std Anal Br
3 Chief, Canadian Def Rsch Staff, ATTN: C/CRDS(W)
4 British Def Staff, British Embassy, Washington
1 Def & Civil Inst of Enviro Medicine, Canada
1 AIR CRESS, Kensington, ATTN: Info Sys Br
1 Militaerpsykologisk Tjeneste, Copehagen
1 Military Attache, French Embassy, ATTN: Doc Sec
1 Medecin Chef, C.E.R.P.A.–Arsenal, Toulon/Naval France
1 Prin Scientific Off, Appl Hum Engr Rsch Div, Ministry of Defense, New Delhi
1 Pers Rsch Ofc Library, AKA, Israel Defense Forces
1 Ministeris van Defensie, DOOP/KL Afd Sociaal Psychologische Zaken, The Hague, Netherlands