Technical Paper 358

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EFFECTIVE TRAINING FOR TARGET IDENTIFICATION UNDER DEGRADED CONDITIONS

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Research Institute for the Behavioral and Social Sciences

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This experiment explored the relevance of the psychological concept of overshadowing to military target identification training. The concept predicts that the most outstanding distinctive feature of a target will capture the attention of the trainee, who will pay little attention to other features. This prediction implies that soldiers will have a difficult time identifying degraded targets unless specifically trained on degraded targets. The experimental procedure was to force attention on more and more features of the

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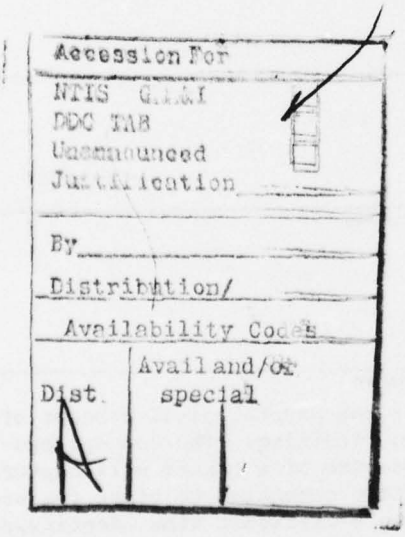
targets by progressively covering the outstanding features. Results confirmed the relevance of overshadowing and suggested that most training should concentrate on degraded views.

Psychologists interested in perception and in military target identification training are the intended audience for this report.



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EFFECTIVE TRAINING FOR TARGET IDENTIFICATION UNDER DEGRADED CONDITIONS

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Target
Identification

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FOREWORD

The Army Research Institute for the Behavioral and Social Sciences (ARI) conducts research on ways to provide effective training and also on gaining and processing reconnaissance and surveillance information. This report presents results of an in-house laboratory independent research (ILIR) project, funded under Army Project 2Q161101A91B, on target identification training. Previous research findings on vision and perceptual learning have been applied to military training in target identification, for instance as reported in ARI Technical Papers 209 and 301. This report explores the principles involved in using degraded views for training and the practical effects of different presentation methods. Work was done at the ARI Field Unit at Fort Knox, Ky.

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EFFECTIVE TRAINING FOR TARGET IDENTIFICATION UNDER DEGRADED CONDITIONS

BRIEF

Requirement:

To investigate the concept of overshadowing and the role it might play in target identification training. The concept of overshadowing holds that trainees pay attention to the most obvious distinctive feature of a particular target and pay little attention to less obvious features. The dominant feature is said to overshadow the less obvious features.

Procedure:

The concept was investigated by training four groups of subjects to identify targets. Each group was trained on a different view of the same targets, with more and more of the distinctive features being covered in order to force attention to the less obvious features. All groups were tested on the same 100%, 67%, and 35% views of the targets.

Findings:

Groups trained on partly concealed targets made the best final scores, and groups trained entirely on completely visible targets made the worst scores on 35% visible targets. Results agree with the overshadowing concept and indicate that the best way for trainees to learn to identify degraded (difficult to see) targets is to train on degraded targets. Training on wide-open targets may waste time or even be harmful; possibly all training should be concentrated on different views of degraded targets.

Utilization of Findings:

Many other basic research findings in vision and perceptual learning may be pertinent to target identification training, and transition research should investigate the application of these research findings.

EFFECTIVE TRAINING FOR TARGET IDENTIFICATION
UNDER DEGRADED CONDITIONS

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EFFECTIVE TRAINING FOR TARGET IDENTIFICATION UNDER DEGRADED CONDITIONS

INTRODUCTION

Leibowitz (1967) has suggested to the military that certain basic psychological research findings in vision and perception could be applied to military training in target identification. Based on his analysis of the target identification process, Leibowitz recommended the following changes in training procedure: (a) elimination of verbal descriptive materials, i.e., verbal descriptions of target features; (b) much greater emphasis on frequency of exposure; and (c) presentation of all possible degraded views of each target. Leibowitz argued that perceptual learning is accomplished by perceiving, not by listening, and that training on degraded views is necessary because many targets in combat are degraded.

Cockrell (1970) confirmed the usefulness of the recommendations in an experiment with photointerpreters: Verbal descriptions of target features proved to be a waste of valuable training time; and subjects who were exposed to the most identification trials on degraded views and who received prompt feedback learned the most.

The present study continues the above research. It seeks to explore some of the psychological principles involved in the use of degraded views in training and also to explore various training methods for presenting the degraded views.

One such psychological principle that may be pertinent is the concept of overshadowing. This concept has been explored by a number of investigators, including Mackintosh (1975), Wagner (1969), Lovejoy (1967), Dukes (1967), Sutherland (1963), and Anderson (1958). Pavlov (1927) gave the following definition of overshadowing: "The presence of an equally relevant, more salient stimulus may decrease or completely prevent conditioning to a less salient stimulus." In target identification terminology, this might be paraphrased as "an easily seen and outstanding distinctive feature on a particular target will capture the attention of the trainee, and little attention will be paid to the remaining features."

In other words, if identification training is given on wide-open, nondegraded targets, we can expect trainees to learn the identifications based on the outstanding feature of each target and to ignore the other features of the target. Mackintosh (1965) cites the "Law of Least Effort" as probably working in these situations. He says that the subjects will attend to whichever cue is correlated consistently with reward and provides the easiest predictor of reward.

The evidence seems to indicate that overshadowing does not produce an "all-or-none" effect, but rather produces a gradient effect similar to a one-sided stimulus generalization gradient. Depending upon experimental conditions the overshadowing gradient appears to be more or less steep. Bruner (1955), for example, offers evidence that indicates the overshadowing gradient is steeper with a high drive state; Sutherland's (1966) evidence indicates that the gradient is less steep under partial reinforcement.

The combat soldier must be able to identify targets under all degraded conditions, and therefore the training problem is how to produce a flat gradient. With stimulus generalization, flat gradients are produced by providing discrimination training all along the continuum. Such a procedure might be useful in target identification training.

METHOD

Overview

The many different types of target degradation in combat include range, obstructed views, camouflage, dust, smoke, heat waves, glare, harsh shadows, and inadequate illumination. For the present experiment, the degradation chosen was obstructed views simply because the experimental materials are easier to produce and the dimension can be manipulated precisely. The essence of the experiment was to try to force the trainees to pay attention to many different features on the target other than the outstanding features. The most direct way to accomplish this was to cover various parts of the target. Theoretically, each type of degradation should have much the same effect. However, it may be necessary to study several types in order to confirm this.

The subjects were 96 soldiers in various stages of initial training. They were trained by the usual method: Slides were projected on a screen; each subject was required to respond; and then the correct identification was projected under the target on the screen. All of the subjects in all groups learned to identify the same targets in the same sequence and with the same number of trials.

The only difference among the experimental groups was the amount of the target that could be seen. All of the targets were the same color and size and had the same orientation, so the primary cue dimension was shape of the various features. The amount of the target visible for each group was as follows:

Group A. 100% visible throughout.
Group B. 100% visible at first, then 67% visible.
Group C. 100% visible at first, then 67% visible, and then 33% visible.
Group D. 33% visible throughout.

After training, each group received three tests in a counterbalanced order. The tests were conducted in the same manner as the training, except that correct answers were not given. The targets were the same as those used in the training but faced the opposite direction. The visibility of the targets in the tests were as follows:

Test 1. 100% visible.
Test 2. 67% visible.
Test 3. 33% visible.

Prior to the main experiment, all subjects participated in a warm-up experiment. This consisted of a few trials in which subjects learned to identify a small number of targets differing in color and shape. All subjects received identical warm-up training and tests. After warm-up training, two warm-up tests were administered. The first test removed all color cues; the second test removed all color cues and 80% of the target area. The purposes of the warm-up experiment were (a) to check on the equality of ability of the various groups and (b) to familiarize the subjects with the procedure so they would know what to expect in the tests.

Subjects

The subjects were soldiers who had just completed basic training or who were in advanced individual training. They were assigned randomly to 4 groups of 24 each in batches of 3 to 5. Because of the nature of the procedure, all of the subjects in any one batch necessarily were in the same group. The experiment was designed to run five subjects at each session, but often the units requested to supply the personnel failed to send the required number. The subjects were not actually selected randomly by the units, but rather in a haphazard manner. Since each batch of subjects often came from two or three different units, and since different units sent men each day, there is no reason to believe that any selective bias was present. Analysis of the composition of the experimental groups revealed that all groups consisted of seven or eight batches, and all groups were represented approximately equally by all categories of personnel.

Identification Slides

The slides used in the experiment were photographs of small-scale model vehicles (1:87). These models were photographed one at a time in profile view with a brown kraft paper monochrome background. All of the slides were in color, although for the most part all of the vehicles were the same color. The size of the projected images was such that identification could be made comfortably at a distance of 5 to 20 feet. Enough duplicates of each slide were obtained that a prearranged carousel of slides could be constructed for each

experimental group and slides could be shown in a different sequence in each trial. Each slide was numbered to correspond to a number on the answer sheet (any particular vehicle had a different number each trial).

During the training phase, the correct answers were projected after a period of 8 seconds just beneath the remaining image of the vehicle on the screen by means of a separate carousel of answer slides and a separate projector. The same answer slides could be used for all experimental groups. It was necessary to place a blank opaque slide between each of the answer slides in order to remove each answer from the screen without turning off the projector. The answer slides themselves were opaque except for the lettering so that the projected answers did not produce any degradation of the image.

The variations in the slides for the different groups and procedures were as follows:

1. Warm-up Training Slides. Four military armored vehicles each painted a different color (tan, white, light gray, dark gray) were used for this procedure. These slides were wide-open views with no obstructions.

2. Warm-up Test 1 Slides. The same four armored vehicles were painted with camouflage stripes. Care was taken to get each camouflage stripe in the same relative position on the vehicle so that colorwise, all vehicles looked alike. These vehicles were also facing in the opposite direction from the training slides.

3. Warm-up Test 2 Slides. These slides were the same as for test 1 except that the rear 80% of each vehicle was covered from view (the nose of the vehicle plus the main gun could be seen).

4. Main Experiment Training Slides. Eight civilian vehicles were used for the main experiment. These vehicles were scale models of customized foreign and U.S. sports cars which are not seen on the street. All the vehicles were painted a dull red so that they all appeared the same. Color slides of a profile view were made of the vehicles in the same manner as for the warm-up training slides. The slides for each experimental group were prepared as follows:

- Group A (100%). The slides for this group were photographed so that 100% of each vehicle could be seen.
- Group B (67%). The slides for this group were photographed so that the front 67% could be seen. This group started training on Group A slides and then shifted to Group B slides.
- Group C (33%). The slides for this group were photographed so that the front 33% could be seen. This group started training

on Group A slides, shifted first to Group B slides, and then to Group C slides.

- Group D. This group trained throughout on Group C slides (33% visible).

5. Main Experiment Test Slides. The slides for the three tests given in the main experiment were as follows:

- Test 1 (100%). These slides were the same as those used for Group A but faced the opposite direction.

- Test 2 (67%). These slides were the same as those used for Group B but faced the opposite direction.

- Test 3 (33%). These slides were the same as those used for Groups C and D but faced the opposite direction.

6. Retest Slides. These slides were the same as those used for the warm-up and main experiment tests.

In preparing slides of this nature, it is important to insure that no background cues or other extraneous cues are correlated with one of the vehicles and not with the others. If background cues are present, subjects have a tendency to memorize them. To avoid background cues, several photographs were taken of each vehicle in a particular condition using a slightly different camera angle and slightly different positioning of the vehicle. All the slides were then mixed in a random manner so that background cues for a particular vehicle varied from trial to trial and could not be used for identification purposes.

This need to avoid background cues also prevented a more precise covering of the distinctive features of each vehicle, even if these distinctive features could have been ascertained. As Sutherland and Holgate (1966) have showed, the distinctive features for any one target vary from subject to subject. In the present study, the covering of various portions of the targets may not necessarily have eliminated the main distinctive features from all targets, but on a random basis it can be assumed that the method eliminated many distinctive features.

Experimental Room and Equipment

The experiment was run in a large, soundproofed room with air conditioning. Each subject was seated at a small table. Six tables were arranged in two rows about 6 feet apart, one row on each side of the screen. The front tables were about 8 feet from the screen, and the rear tables, about 14 feet. The projected targets were large enough to be seen comfortably by all subjects.

Procedure

The maximum number of subjects that could be tested in 1 day was 10. On the average, the actual number ranged from 3 to 10; about 5 was average. Depending on the number present, either one or two morning sessions would be scheduled. Each session required 1-1/2 hours, including a 10-minute session break. Each morning session consisted of warm-up training and testing followed by a main experiment training and testing. The subjects were allowed to watch television in a comfortable lounge area when not participating in the experiment. After 3 hours, the subjects were given the warm-up and main experiment retests.

The steps in the procedure were as follows:

1. Purpose and Instructions. The purpose of the experiment was explained, and specific instructions for the warm-up phase were given.

2. Warm-up Training. This training consisted of one preview trial (no responding) followed by four training trials. Each slide was presented for 8 seconds during which time the subjects responded by trying to pick the correct name from a list on the answer sheet. Only the actual names of the vehicles used were on the answer sheet. After all subjects responded to each slide, a second projector projected the correct identification underneath the vehicle on the screen. Using the process of elimination, the subjects should have been able to guess correctly a high percentage of the targets.

3. Warm-up Test 1. This test was presented immediately following the last training trial. The procedure was the same except that no correct identifications were given. Since the correct identifications were not given, the probability for guessing right may have been less than during the training.

4. Warm-up Test 2. This test immediately followed warm-up test 1 and used the same procedure.

5. Instructions for the Main Experiment.

6. Main Experiment Training. This training consisted of one preview trial (no responding) followed by nine training trials. The procedure was the same as for warm-up training. The specific number of trials for each experimental group was as follows:

- Group A. Nine training trials on Group B slides (100% visible).
- Group B. Three training trials on Group A slides and six training trials on Group B slides (67% visible).

- Group C. Three training trials on Group A slides, two training trials on Group B slides, and four training trials on Group C slides (33% visible).

- Group D. Nine training trials on Group C slides (33% visible).

The guessing probability for the main experiment training was much less than for the warm-up training because of the greater number of vehicles and because it was unlikely that the soldiers could retain in memory the vehicles already shown for any one trial.

7. Main Experiment Tests. All subjects received the same tests. Half the subjects in each group were given the tests in the 1, 2, 3 order and half in the 3, 2, 1 order. The procedure for giving the main experiment tests was the same as for the warm-up tests. During testing, the correct identification for each vehicle was not shown at any time. Each test took about 2 minutes to administer.

8. Retests. After a 3-hour interval, each group was administered the warm-up and main experiment tests once again. The content, procedure, and order of the retests were the same as for the tests.

RESULTS

The first analysis shows the scores made on the warm-up training trials and tests. The purpose of this analysis is to determine whether the experimental groups were equal in ability prior to the start of the main experiment. This analysis also shows some of the effects of overshadowing for all subjects combined.

Figure 1 shows the results for the warm-up learning trials, tests 1 and 2, and retests 1 and 2. The learning task for the warm-up phase was intended to be fairly simple and consisted of memorizing the names of four vehicles, all of which had many different features and were painted different colors. As shown in Figure 1, the task was simple. All groups made a high score on the first trial following the preview trial and then progressed to a near perfect score by the fourth trial. The results for warm-up test 1 show a large fall-off in scores for all groups, indicating that overshadowing was playing a role. In other words, the subjects had been memorizing the vehicles based on color during training. When this cue was removed for test 1, the scores dropped. The results for test 2 show that the subjects had also learned something about the shape of the vehicles, because when many of the shape cues were removed, the scores dropped even further.

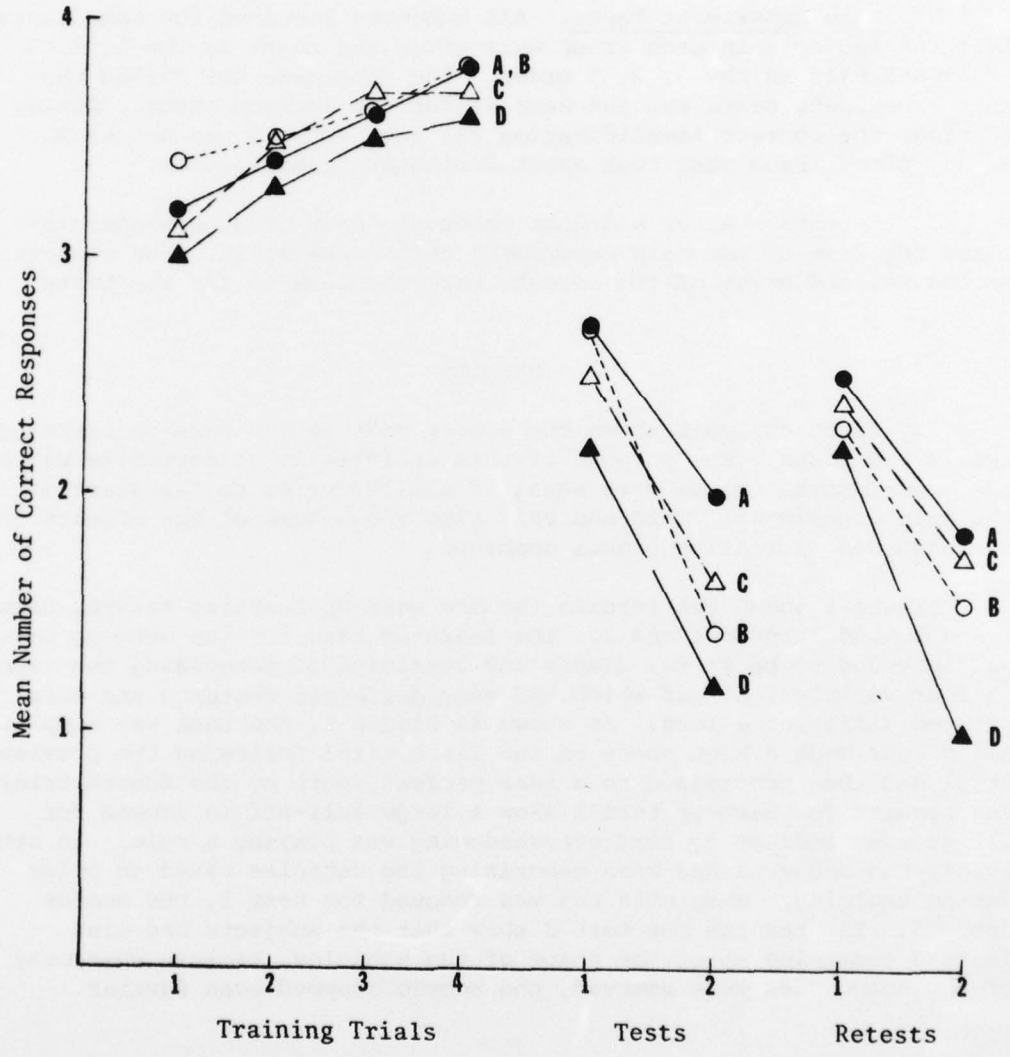

Figure 1. Mean number of correct responses for each group during the warm-up phase. (Smoothed curve.)

From the curves, it appears that all of the groups are equal in ability, both in terms of learning and of reacting to the reduction in cues. A Kruskal-Wallis[1] test for test 2 indicated no significant difference ($p < .22$). Retest scores were essentially the same as test scores. As expected, since only 3 hours intervened between test and retest, only a slight decrease appears in retest scores.

Figure 2 shows the curves for the learning phase of the main experiment. It should be remembered that each of the groups memorized the same vehicles, but each group had a different view of the vehicles. For Groups A, B, and C, the vehicles for the first three trials were identical (100% visible). The dip in the curve at trial 3 for Groups B and C was an artifact of the smoothing procedure and the dip actually occurred on trial 4 where it would be expected (shift from 100% visible to 67% visible). It can be seen that shifting from 100% visible to 67% visible depresses the learning curve for several trials. Group A appears to have the easiest task, and Group D appears to have the most difficult task, at least in the first few trials. There did not seem to be any reason to make an extensive analysis of the learning curves. Kruskal-Wallis tests for trials 1 and 9 revealed no significant differences among the groups.

Figure 3 shows the results for the testing phase of the main experiment. The results are given in terms of percentage of subjects making a perfect score, because this score appears to be highly sensitive to the procedure. The results appear to be very close to those predicted according to the concept of overshadowing. The score made by Group B on test 1 is badly misplaced, but it is interesting to note in Figure 4, which shows the retest results, that the score made by Group B on test 1 is now in the predicted place.

Figure 5 shows the results of the testing phase for the main experiment using the more conventional score of mean number correct. Here the results are essentially the same as in Figure 3, but are much less dramatic. Kruskal-Wallis tests were run for tests 1, 2, and 3 with nonsignificant results for test 1 and significant results for tests 2 and 3 at the .02 and .01 levels respectively. Table 1 shows results of Mann-Whitney U tests run for the individual scores in tests 2 and 3. Group A clearly scores less than all other groups in tests 2 and 3, and Group D is marginally superior to Groups B and C on test 3.

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[1]Kruskal-Wallis tests were used throughout the various analyses because some phases of the data were on the borderline of acceptability for the analysis of variance or covariance. In all cases where the analysis of variance or covariance was appropriate, the significance level was the same as that obtained with the Kruskal-Wallis test.

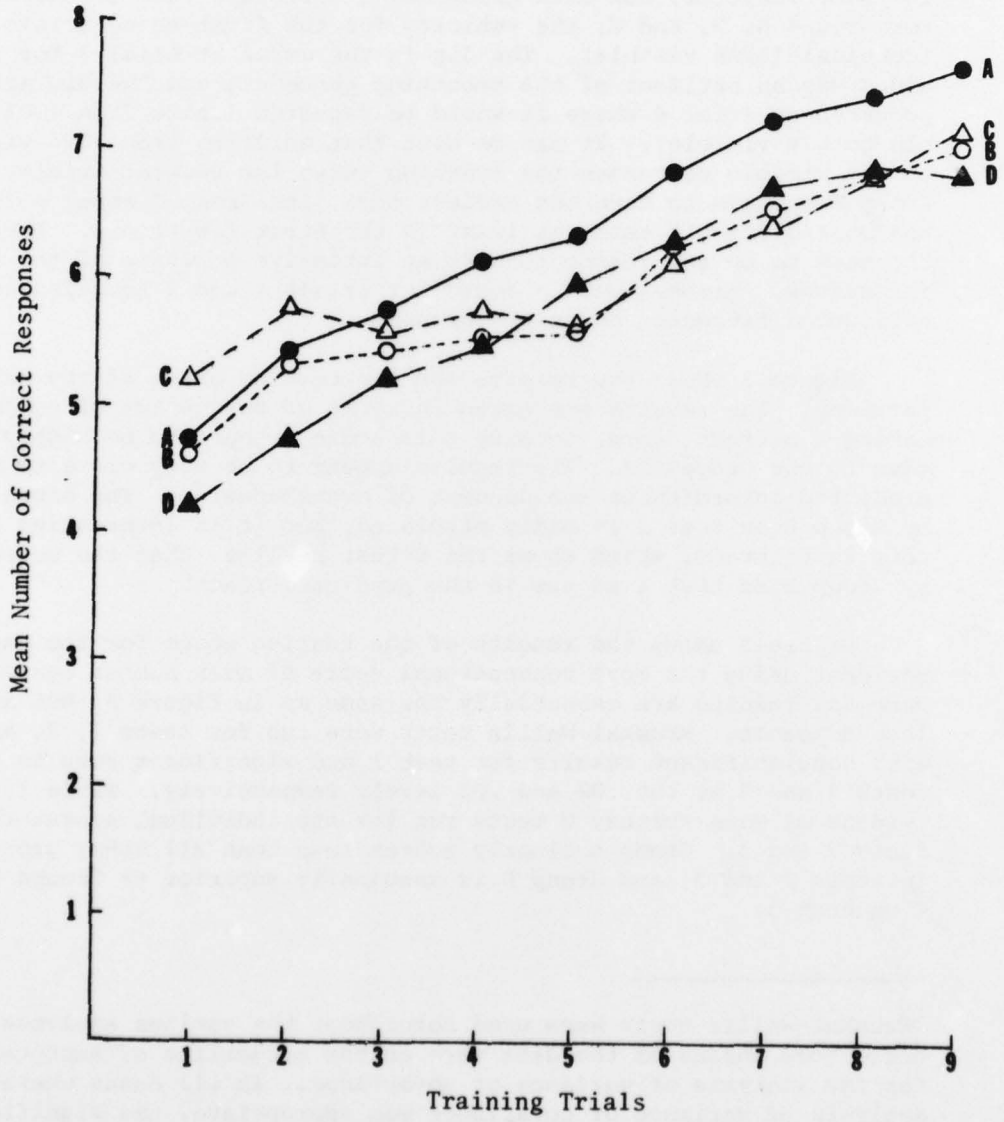

Figure 2. Mean number of correct responses on main experiment training trials. (Smoothed curve.)

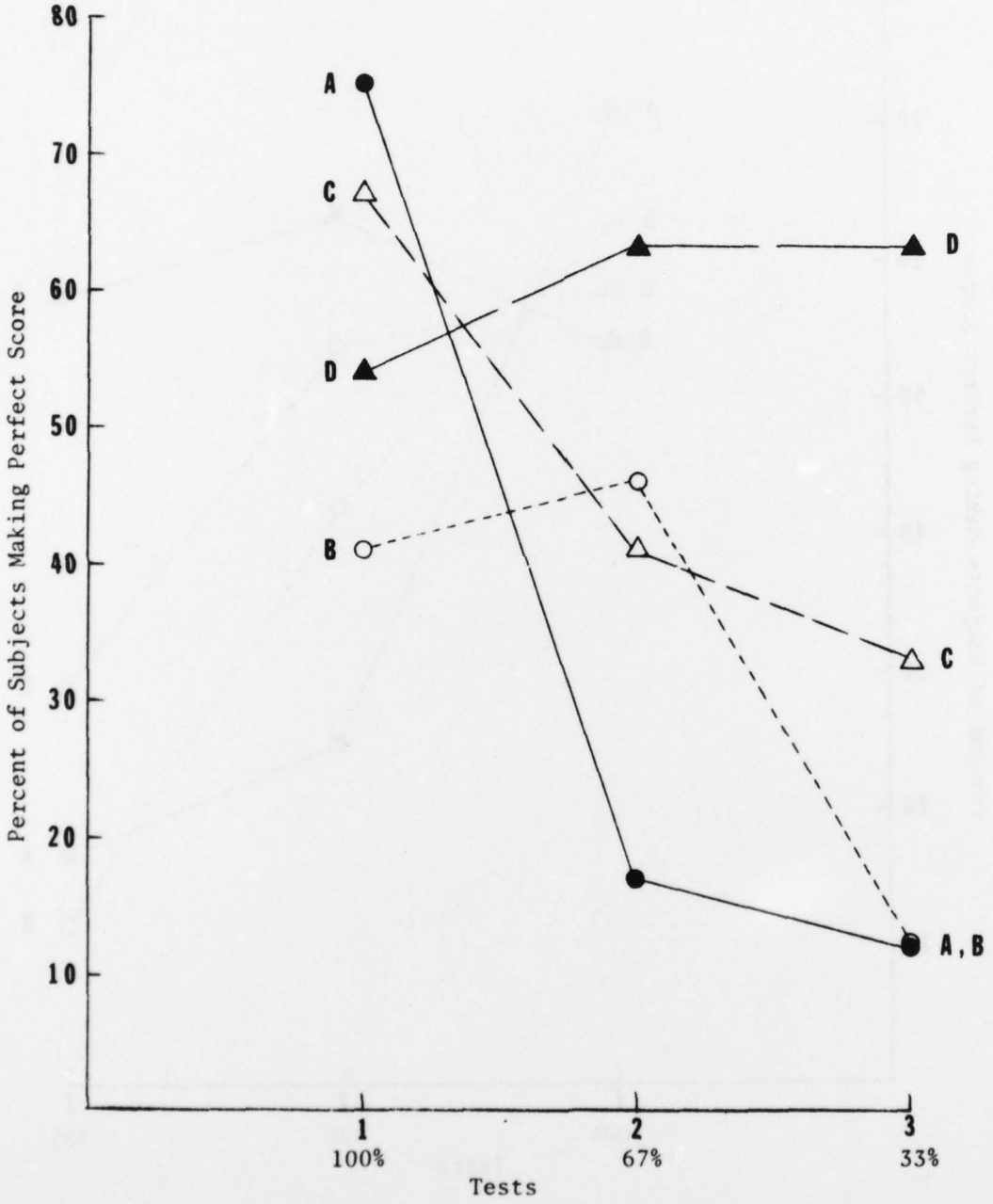

Figure 3. Percent of subjects making perfect score on main experiment tests.

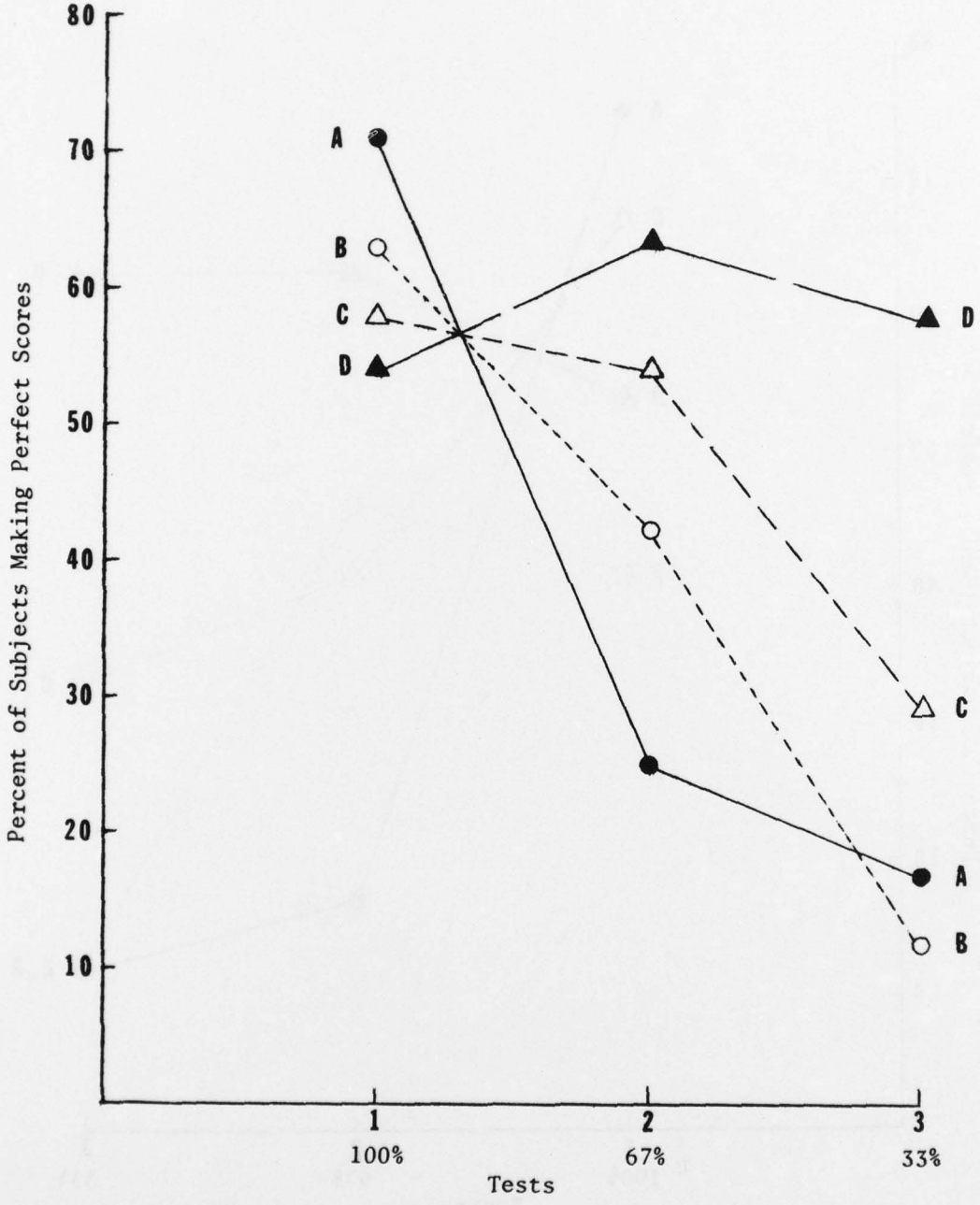

Figure 4. Percent of subjects making perfect score on main experiment retests.

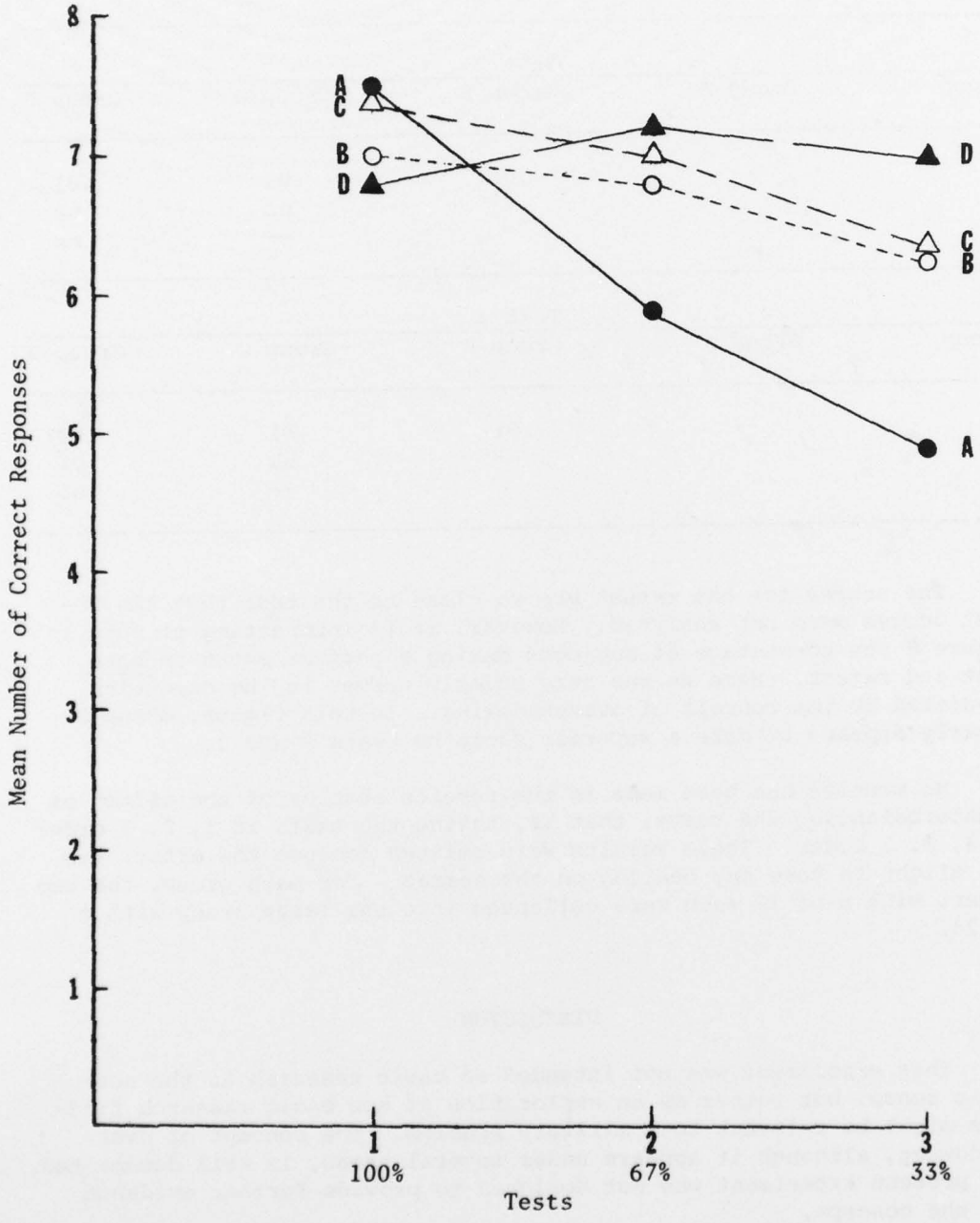

Figure 5. Mean number of correct responses on main experiment tests.

Table 1

Significance Levels for Mann-Whitney U Tests,
Main Experiment, Tests 2 and 3

	Test 2			
Group	Group A	Group B	Group C	Group D
A	--	.02	.01	.01
B		--	ns	ns
C			--	ns

	Test 3			
Group	Group A	Group B	Group C	Group D
A	--	.01	.01	.001
B		--	ns	.01
C			--	.05

The scores for the retest are so close to the test that the retest scores were not analyzed. However, it is interesting to note in Figure 6 the percentage of subjects making a perfect score on both test and retest. Here we see very orderly curves in the direction predicted by the concept of overshadowing. In this figure, Group D clearly appears to make a superior score on tests 2 and 3.

No mention has been made in the results section of the effect of counterbalancing the tests; that is, taking the tests in 1, 2, 3 order or 3, 2, 1 order. These results were omitted because the effect was too slight to have any bearing on the scores. For each group, the two orders with n of 12 each were collapsed into one large group with n of 24.

DISCUSSION

This experiment was not intended as basic research in the academic sense, but rather as an exploration of how basic research findings might be relevant to a military problem. The concept of overshadowing, although it appears under several names, is well documented. The present experiment was not designed to provide further evidence for the concept.

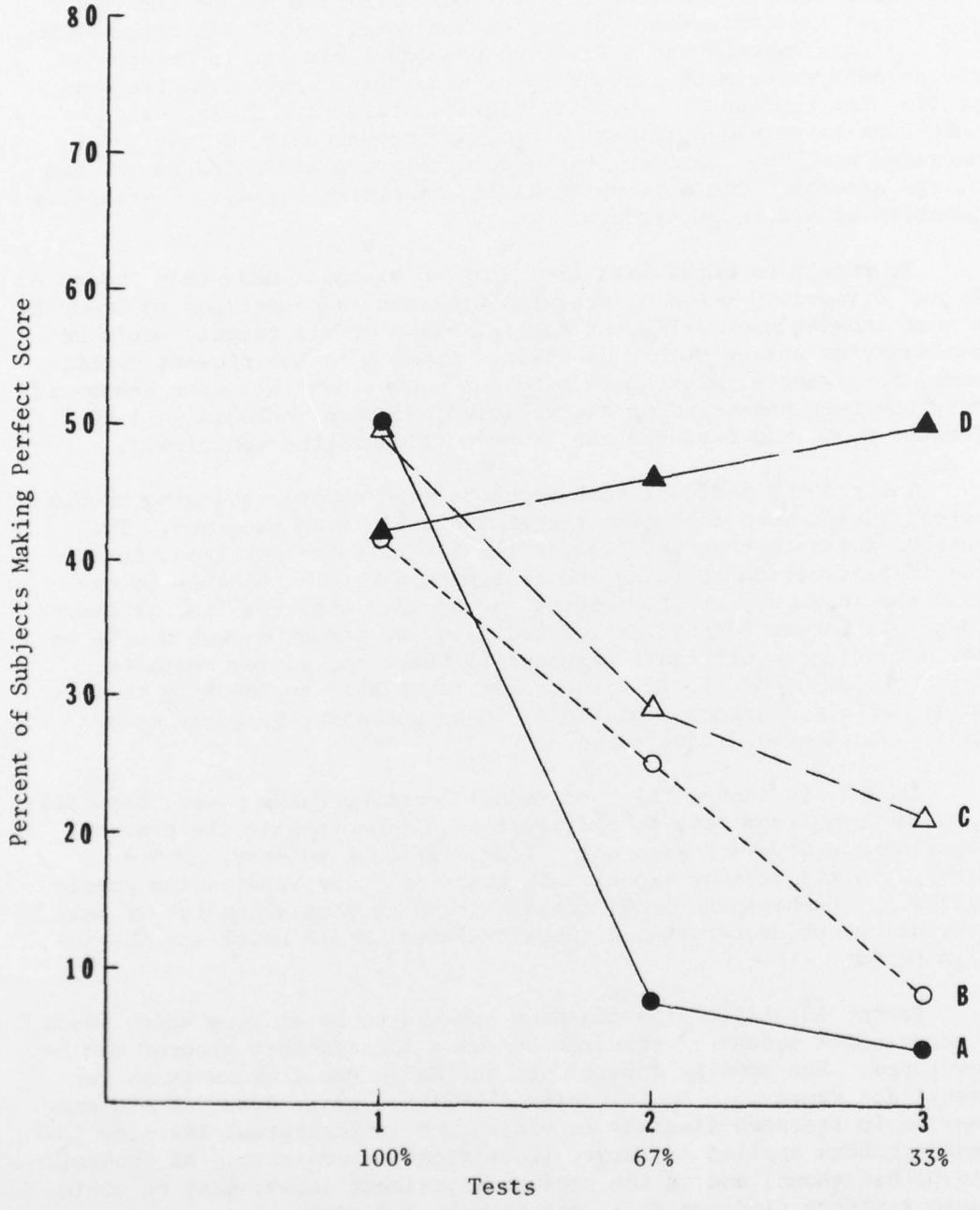

Figure 6. Percent of subjects making perfect score on both main experiment test and retest.

In fact, the methodology for the experiment perhaps could be criticized for using tests that are practically the same as the training. However, it should be kept in mind that the long-range focus of the research is to help solve the military problem: "Given a certain amount of training time, what is the best training method for teaching target identification for all combat conditions?" In other words, the military already has a training procedure similar to Group A in the present experiment: training on wide-open targets and then expecting the trainees to identify degraded targets. It is realized that some target identification programs occasionally do use a few degraded targets. However, these generally are added toward the end of the program. The primary focus is describing verbally distinctive features of wide-open targets.

It should be emphasized also that no claim is made that Groups B, C, and D received superior training programs in comparison to Group A. A test showing many different partial views of all targets would be necessary to answer such a question. Group A in the present experiment, for example, might make a better score than the other groups if only the rear one-third of the vehicles had been included in a test. (Groups B, C, and D viewed the front portion of the vehicles.)

The results indicate that concepts such as overshadowing should be considered when designing target identification programs. The results indicate that the "Law of Least Effort" is pertinent to target identification training and that people have a tendency to expend the least amount of energy to accomplish whatever task is facing them. In target identification training, we cannot expect people to pay attention to difficult features if there are easier features which can be used. If we wish people to be able to identify targets under certain degraded conditions, it is necessary to train under these same degraded conditions.

It appears that little incidental learning takes place, especially when going from easy to difficult as did Group A in the present experiment. However, when going from difficult to easy, as did Group D in the present experiment, there are some interesting possibilities. Perhaps the ideal training program should consist of only degraded views of targets, and the trainees should never see the entire target.

Target identification training appears to be an area which needs a substantial amount of research before a satisfactory program can be developed. The need is not so much for basic research as it is for transition research. As Leibowitz (1967) has pointed out, there are many basic research findings in vision and in perceptual learning that have not been applied to target identification training. As Cockrell (1970) has shown, and as the present experiment shows, many of these basic research findings do appear to make a difference.

SUMMARY AND CONCLUSIONS

The purpose of this experiment was to investigate the concept of overshadowing and the role it might play in target identification training. In target identification terminology, the concept of overshadowing says that trainees will give most of their attention to the most obvious distinctive feature of a particular target and pay little attention to less obvious features. The dominant feature is said to overshadow the remaining features.

The concept was investigated by training four groups of subjects to identify targets. Each group was trained on a different view of the targets with more and more of the distinctive features being covered for some of the groups. The purpose of covering the dominant features was to force attention to the less obvious features.

The results of the experiment agree with the overshadowing concept and indicate that the best way for trainees to learn to identify degraded targets is to train on degraded targets. In fact, there is some evidence to indicate that training on wide-open targets wastes time at best and may even be harmful, and that all training should be concentrated on different views of degraded targets.

The results were discussed in relation to the adequacy of the research base for target identification training. The conclusion is that there is good evidence to indicate that many research findings in the areas of vision and perceptual learning are pertinent to target identification training, and that additional transition research is needed to investigate the application of these research findings.

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