IMPROVING DISTANCE ESTIMATION UNDER WATER: LONG-TERM EFFECTIVENESS OF TRAINING

by

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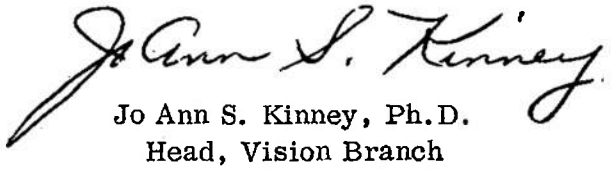

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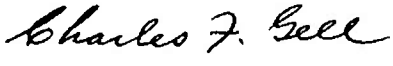

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SUMMARY PAGE

PROBLEM

To determine whether the improvement in distance estimation produced by training diminishes in the weeks following the training session.

FINDINGS

Although trained subjects were considerably more accurate than untrained subjects three weeks after training, only a small difference between groups remained after nine weeks. Thus a single training session was not sufficient to produce long-term improvement.

APPLICATION

A more extensive training program, including "refresher" sessions, is recommended for SCUBA divers involved in tasks in which distance estimation is important.

ADMINISTRATIVE INFORMATION

The investigation was conducted as a part of Bureau of Medicine and Surgery Research Work Unit M4306.03-2050DXC5 - Evaluation of Sensory Aids and Training Procedures on Navy Divers' Visual Efficiency. The present report is No. 11 on that Work Unit. It was approved for publication on 10 July 1972 and designated as Naval Submarine Medical Research Laboratory Report No. 718.

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ABSTRACT

Due to both optical distortion and water turbidity, divers are usually inaccurate when they estimate distances under water. Previous studies have demonstrated that training with feedback improves judgment accuracy. The present study showed that the effect of training diminishes considerably during the nine weeks following training. A more extensive training program is recommended for diving tasks in which distance estimation is important.

IMPROVING DISTANCE ESTIMATION UNDER WATER: LONG-TERM EFFECTIVENESS OF TRAINING

INTRODUCTION

Distance perception under water is usually quite inaccurate.[1,2] Divers either under- or overestimate distance, depending on whether the water is clear or turbid.[3,4] In clear water the optical distortion due to wearing a facemask causes objects to look closer than they really are. In turbid water there is a loss of brightness and contrast which has the opposite effect of increasing apparent distance. It has been shown that divers can be trained to compensate for their errors by informing them of the correct distance after each of a series of distance judgments. One problem with this method is that training in one body of water will not transfer to another body of water if there is a large difference in turbidity. However, it has recently been demonstrated that by training divers in several bodies of water, they learn to tailor their corrections to the prevailing turbidity conditions.[5] One question which remains to be answered, however, concerns the long-term effectiveness of training: Does the improvement diminish over time if there is no additional training? The present experiment was designed to answer this question.

METHOD

Subjects

Nine subjects volunteered for the experiment, six sailors and three female laboratory personnel. Most of the subjects had little or no previous diving experience, and only one had SCUBA experience. None had any experience with the experimental situation.

Apparatus

Distance estimates were obtained in a large, indoor swimming pool which was 35 ft. wide and 82 ft. long. A long rope was attached above the surface between the shallow and deep ends of the pool, between and parallel to two racing-lane lines painted along the bottom. The target was a metal cylinder (actually a soft-drink can, 2 3/4 in. in diameter and 4 3/4 in. high) which was painted fluorescent orange. One subject at a time knelt at a chin rest below the surface at the shallow end (about 4 ft. deep). The rope was not visible to the submerged observer. The target was suspended from the rope 8 in. below the surface, approximately at eye level. Since the target was visible up to a distance of about 60 ft., the water was quite clear.

Procedure

The subjects wore facemasks, snorkels, weightbelts, and sometimes rubber wet-suit jackets. They were instructed to judge the distance of the target to the nearest foot or half-foot. Since they remained submerged during the entire series of judgments, they indicated each judgment by raising an appropriate number of fingers above the surface. The basic test distances were 2, 3, 4, 5, 7, 9, 12, 15, 20, and

30 ft. The subject's view of the target was blocked between judgments.

The subjects were assigned to either a Trained or a Control Group. On the first day of testing, the five members of the Trained Group were tested, trained, and retested. The training session consisted of 20 presentations of various target distances between 1 and 35 ft. The subject was verbally informed of the correct distance after each judgment. The four members of the Control Group received no training, only the initial test on the first day of testing. Both groups were subsequently retested 1, 3, 6, and 9 weeks later. For each test, the two judgments of each subject at each distance were averaged, and group medians were obtained.

RESULTS

The results are shown in Fig. 1. Before training, the two groups were quite similar. After training, the Trained

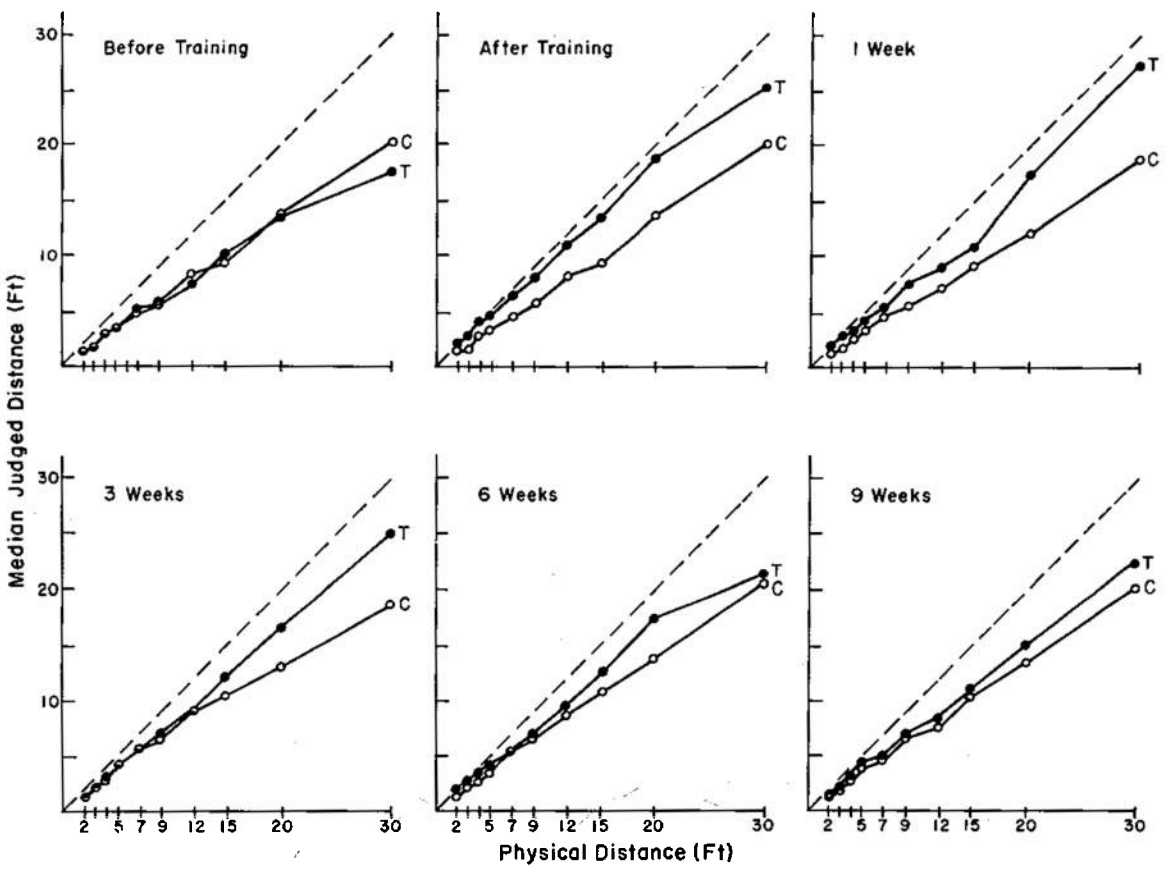

Fig. 1. Median distance estimates of the Trained (T) and Control (C) Groups before and after training, and after 1, 3, 6, and 9 weeks had elapsed. The "before" and "after" curves for the Control Group are actually the same, the "after" curve being shown for comparison purposes.

Group (T) showed considerable improvement in judgment accuracy (closeness to physical distance). The "after" curve for the Control Group (C) is actually the "before" curve, replotted for comparison purposes. Based on the results of a previous study,[4] it is assumed that the Control subjects would not have shown any improvement had they been immediately retested. One week later, the Trained Group was still considerably more accurate than the Control Group. After three weeks the improvement diminished, and the groups differed primarily at the larger distances. By nine weeks, there remained only a small, but consistent difference. These changes in the group differences over time are reflected in a statistically significant Group x Test x Distance interaction, $F(45,315) = 2.15$, $p < .001$, as revealed by an analysis of variance. The changes over the six tests, averaged across the ten test-distances, are summarized in Fig. 2.

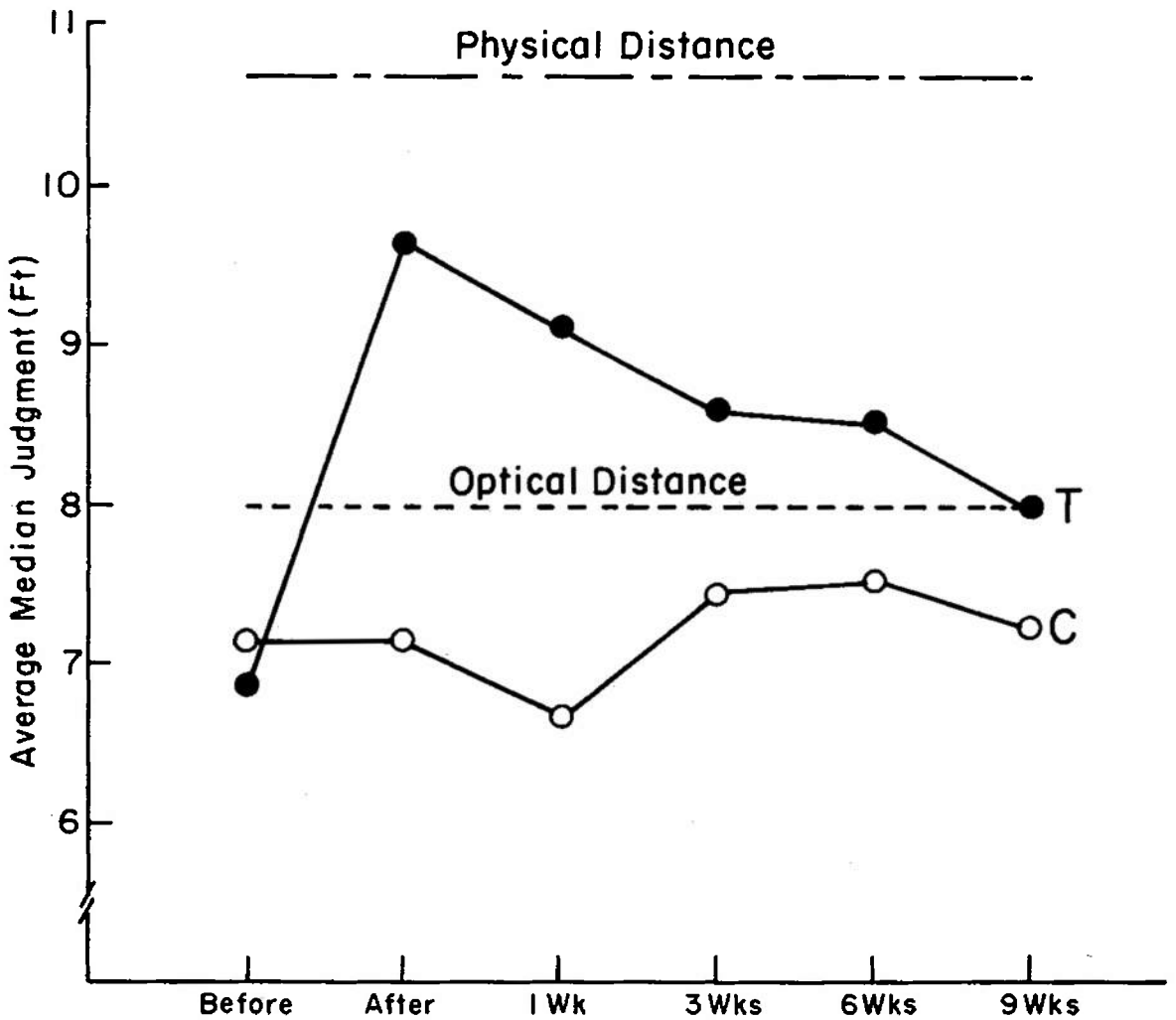

Fig. 2. Average median judgments of the Trained (T) and Control (C) Groups. These curves summarize the results shown in Fig. 1, averaging across distance.

DISCUSSION

The results indicate that a single training session is not sufficient to produce long-term improvement in distance estimation. Before training, estimates were less than the theoretical optical distance. This underestimation was due to the combined effect of the optical distortion produced by wearing a facemask and a general tendency to underestimate distance, even in air.[4] Training produced substantial improvement, as has been previously reported.[4,5] However, since the effect of training diminished significantly during the next nine weeks, more extensive training is necessary if the improvement is to be permanent. The best strategy would probably be to space several training sessions over a period of days or weeks, with "refresher" sessions either every few months or prior to a task involving distance estimation. Since the turbidity of the water is an additional critical factor affecting judgment accuracy, these training sessions should be carried out under a variety of turbidity conditions.[5] This type of training program is recommended primarily for divers engaged in activities in which the estimation of distances is important.

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