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HUMAN RESEARCH UNIT NO. 1
OFFICE, CHIEF OF ARMY FIELD FORCES
Fort Benning, Georgia

Under the Technical Supervision of

The George Washington University
HUMAN RESOURCES RESEARCH OFFICE
operating under contract with
THE DEPARTMENT OF THE ARMY

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Human Research Unit No. 3, OCAFF, is established under the command of the Chief of Army Field Forces. The Human Resources Research Office, The George Washington University, operating under contract with the Department of the Army, employs the Director of Research and other civilian staff members who are assigned to the Unit with the approval of Office, Chief of Army Field Forces. The Human Resources Research Office provides the Unit with technical supervision in the planning and analysis of the research projects.

This report by the staff of Human Research Unit No. 3, OCAFF, is issued for the purpose of transmitting useful findings to the Army without delay. It has, therefore, not been subjected to extensive evaluation by the Director's Office of the Human Resources Research Office. Conclusions stated herein do not necessarily represent the official opinion or policy of Office, Chief of Army Field Forces, or the Department of the Army.

SUMMARY

Purpose: The purpose of the present study was to evaluate the effect of personalized stocks on rifle marksmanship in order to decide whether or not to include stock-size as a factor in Task TRAINFIRE.

Procedure: An Infantry School class of 169 advanced non-commissioned officers fired a record course with the standard M1 rifle (initial proficiency), following which they were issued new rifle stocks according to the lengths of their forearms as measured by a method developed by the Canadian Army. Thirty-two men received short stocks (12 in.), 23 men received long stocks (14 in.), and the remaining 114 men retained their standard stocks (13 in.). They then received 40 hours of marksmanship training with the personalized stocks, terminating by firing a second record course (final proficiency).

Results: (1) There was no significant difference between either the initial or final proficiencies of the short, medium and long groups.

(2) There was no significant difference between the marksmanship improvement of the three groups.

(3) The mean record score of the total class increased from bolo level to sharpshooter level, with the greatest improvement occurring in sustained fire.

(4) There was no significant difference in marksmanship improvement between men who received stocks of the length they

preferred, and men who did not receive stocks of the length they preferred.

Conclusion: It was concluded that personalized stocks are ineffective in significantly improving rifle marksmanship. It was decided that personalized stocks will not be used in Task TRAINFIRE.

(The most important results may be found on pages 9 - 12.
The reading time of this memorandum is approximately 15 minutes.)

BACKGROUND

In March, 1953, the Chief of Army Field Forces received a study on personalized rifle stocks from the Weapons Department of The Infantry School (see Reference 2). The primary concern of this study was the adaptation of the M1 rifle to individual users in order to make allowance for their varied statures, arm lengths, and finger lengths. Three Infantry School classes, comprising a total of 263 officers, were sized by a TIS modification of a method developed by the Canadian Army (see below) and each was then given M1 marksmanship instruction with a rifle fitted to his own size. About 25% of the men used the short stock, 53% the standard stock and 22% the long stock. At the end of this instruction, each student filled out a questionnaire designed to obtain his reaction to the study. About 91% of the men (including those men who used the standard stock) said they liked the fitted stock idea, and that the sizing method was adequate. About 79% thought that the supply problems attendant to fitted stocks were outweighed by such advantages as improved accuracy and higher morale. The improvement in marksmanship of the classes was not measured.

The reply of OCAFF to this study (see Reference 3), stated, in part:

"...the primary consideration for US Army use (of personalized stocks) must be battlefield utility, particularly as related to improved marksmanship. Other considerations will assist in arriving at a decision but are secondary to the marksmanship requirement. The concept of

personalized stocks and the limited tests conducted to date provide a basis for assuming that some improvement in marksmanship could reasonably be expected. However, the degree of improvement is not known. It is evident that the concept of personalized stocks can be implemented only if the improvement is more than marginal and outweighs the disadvantages of additional cost and logistic effort." (Underlining added.)

Of the alternative courses of action suggested by OCAFF, The Infantry School recommended a plan which would incorporate the study of personalized stocks into this Unit's Task TRAINFIRE (see Reference 5), with the objective of determining the degree of improvement in marksmanship resulting from the use of personalized stocks.

The following is a report of a pilot study which sought to provide an adequate basis for deciding whether or not personalized stocks should be included as a factor in the forthcoming phases of Task TRAINFIRE.

PROCEDURE

The subjects of this experiment were 169 non-commissioned officers who constituted Advanced Non-Commissioned Officer Class No. 2 of The Infantry School. On the first day of their marksmanship training, the class fired a record course with the standard-sized stock in order to obtain an indication of the base-level, initial proficiency of each man. During this initial day's firing, each man's arm length was measured in two ways: (a) with a rigid yardstick, which allowed the determination, to the nearest quarter-inch, of the length of his arm from armpit to fingertips; and (b) by an adaptation of a Canadian method, paraphrased by TIS from

"Shoot to Live," an official Canadian army handbook, as follows

(see p. 4, Reference 2, and Reference 6):

"Lay the butt of the rifle at the inside of the right elbow, bending the forearm at the elbow so the inside of the forearm from elbow to heel of the palm touches the stock wrist as straight as possible; grasp the small of the stock naturally and with the left hand lay a .30 cal. cartridge case against the right side of the stock just in rear of the trigger guard. Place the right index finger over the cartridge case and put the first joint of the index finger on the trigger. If the center of the 'pad' of the first joint is centered on the trigger the stock is correctly fitted. If the center of the 'pad' of the first joint extends past the trigger, the individual needs a longer stock. If the center of the 'pad' does not reach the trigger, the man needs a shorter stock."

In addition, at the end of the first day's firing, each man's preference for stock-length was obtained from his response to the following instructions:

"Give me your attention on the waiting line. As part of this experiment, we want to find out what size stock each of you prefers. We realize that you probably have never fired with any other size stock than the standard. Nevertheless, we are going to ask you to state whether you think you would prefer a longer stock, a smaller stock or the standard-sized stock. Those men who think they would prefer longer stocks, fall in here (point). Those men who think they would prefer a shorter stock, fall in here (point). Those men who think they would prefer the standard-size stock, remain where you are."

The men were divided into three groups, "short," "medium," and "long," according to the above-described Canadian method of arm-measurement. On the following morning, the 32 men in the short group were issued short stocks, the 23 men in the long group were issued long stocks, and the remaining 114 men (the medium group), retained their standard stocks. Neither the expressed preferences

of the men nor their arm-lengths by the yardstick measurement were considered in the assignment of new stocks.¹

This experiment employed the short and long stocks used by TIS in the previously mentioned survey. Short stocks were made by trimming 1 in. from the butt end of the standard 13-in. stock and long stocks made by adding the 1-in. fillers thus obtained to the butts of standard M1's. Thus the sizes of the short, standard and long stocks were 12 in., 13 in., and 14 in., respectively.

The training of class ANCO-2 then followed Change 1, Annex 1 of the Program of Instruction for Infantry ANCO classes (7-E-19), dated 1 July 1953, of The Infantry School, with the single exception, as stated above, that some of the men used M1's with stocks shorter or longer than the standard. A breakdown of this training by hour is as follows:

(8 hrs. "Initial Proficiency Record Firing")

- 4 hrs. Mechanical Training and Functioning
- 4 hrs. Sighting, Aiming, Positions
- 2 hrs. Sustained Fire Exercise
- 2 hrs. Trigger Squeeze
- 4 hrs. 1000" Zeroing and Practice Firing
- 8 hrs. KD Zeroing and Practice Firing
- 8 hrs. Practice Record Firing
- 8 hrs. Record Firing

¹One man, who originally was determined to have a "long" arm by the Canadian method, and who was issued a long stock, complained that his finger would not reach the trigger of the long-stocked piece. When remeasured by the Canadian method, this man was found to have a "medium" length arm, and was returned his original standard stock. In addition, this man had originally expressed a preference for a long stock. This incident, though the only such irregularity in the experiment, nevertheless reflects the possible unreliability of both the Canadian method and a man's own preference.

The pit scores of both the initial and final day's record-firing courses were obtained. Thus, to sum up, the following measures were obtained from each subject in this experiment:

1. His initial marksmanship proficiency, as measured by his record score fired with the standard stock prior to training.
2. His forearm length, as determined by the Canadian method (either short, medium, or long).
3. His total arm-length to the nearest quarter-inch, as measured with a rigid yardstick.
4. His own stock-length preference (either short, medium or long).
5. His marksmanship proficiency after 40 hrs. of training with a fitted stock, as measured by the final day's record firing score.

RESULTS

1. Arm Length.

The distribution of arm lengths as obtained by the Canadian and yardstick measures are shown in Table 1 and Figure 1.

TABLE 1

Arm Length

Length by Canadian Method	Number of Men	Per Cent of Total	Mean Arm Length (Ins.)
Short	32	18.9	27.89
Medium	114	67.5	29.40
Long	23	13.6	30.76
Total	169	100.0	29.30

FORE-ARM LENGTH AS DETERMINED BY

THE CANADIAN METHOD

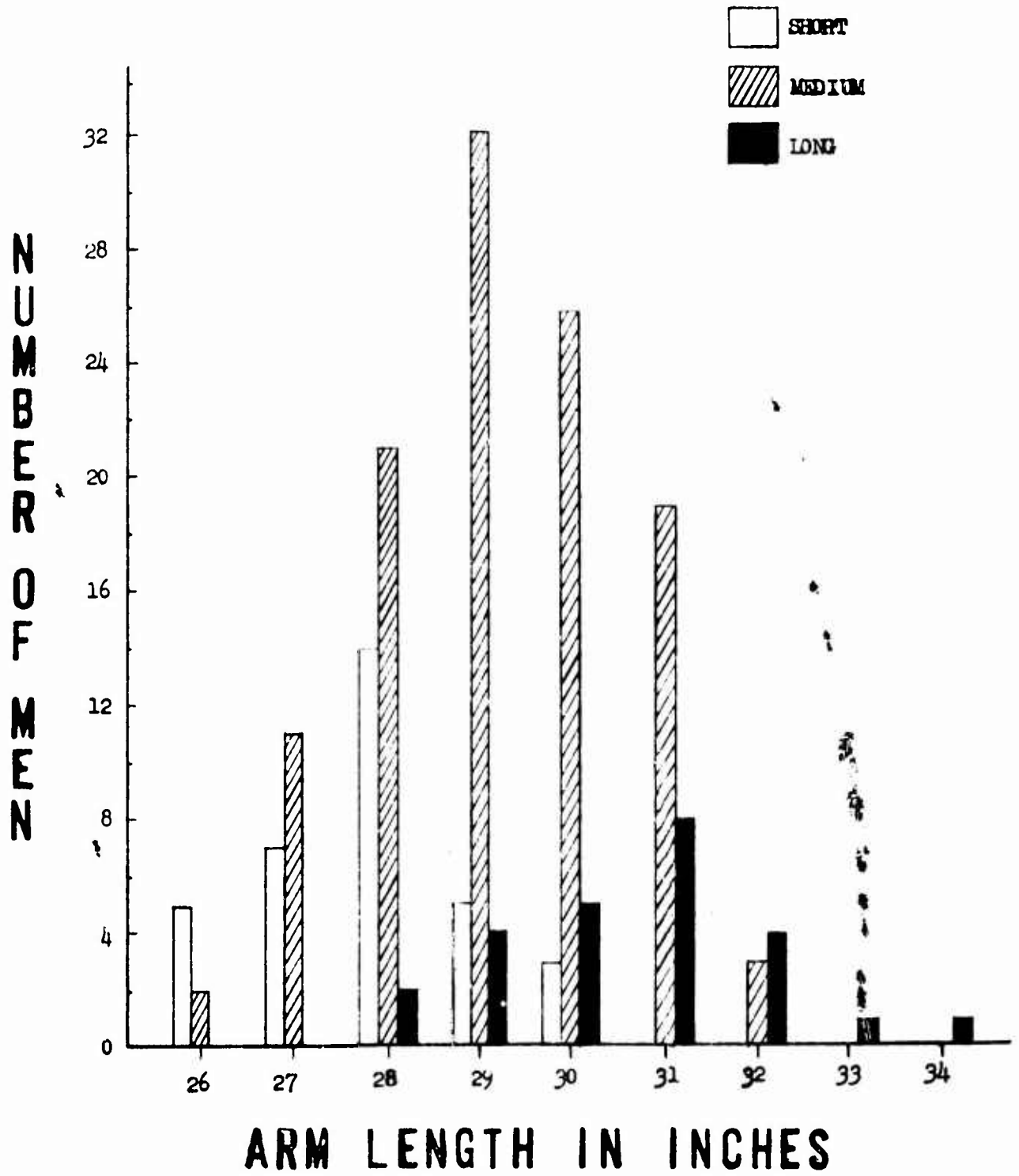


FIGURE 1

In assigning men to arm-length groups by the Canadian method, the doubtful "short-mediums" were assigned to the short group and the doubtful "long-mediums" to the long group. By this procedure, however, only about a third of the men required shorter or longer stocks. This was a smaller percentage than that obtained in the TIS study, in which 48% of the subjects required shorter or longer stocks.

There was a good deal of overlap between the Canadian categories with respect to total arm length measured with a yardstick, as will be seen in Figure 1. This was not unexpected, since the Canadian method does not take upper-arm length into account.

2. Marksmanship Improvement of the Short, Medium, and Long Groups.

The primary purpose of the present study was to measure the effect of personalized stocks on marksmanship by comparing the improvement in accuracy, after training, of the three arm-length groups. Prior to the experiment, an attempt was made to predict the outcome from what was already known. If personalized stocks do have a significant effect on rifle marksmanship, it was reasoned, then the following results may be predicted:

(a) On the initial day's record firing with the standard stock, the medium group should fire significantly better than the short and long groups, since the latter are, in a sense, "maladjusted" to the standard stock.

(b) When the initially poorer short and long groups fire the record course again--with properly sized stocks and after receiv-

ing training with properly sized stocks--their improvement should be significantly greater than that of the medium group.

Neither of these predictions was borne out. Although, as shown in Figure 2, the medium group scored higher on the initial day's firing, this superiority was not statistically significant, i.e., the likelihood was very high that this difference could have resulted by chance.² Similarly, although the short and long groups improved slightly more than did the medium group, this superior improvement was very small (see Fig. 2) and again, not statistically significant.

The following conclusions may be drawn from these results:

1. There is no practically important difference between the initial, standard-stock proficiencies of short-, medium-, and long-armed men.

2. There is no practically important difference between the improvement in marksmanship proficiencies of short-, medium-, and long-armed men trained on fitted stocks.

In addition to an evaluation of personalized stocks, the present study also afforded a quantitative estimate of the amount of marksmanship improvement which results from 40 hours of training. The average improvement of all 169 men was over 44 points, from 156.52 to 190.78, or from bolo to sharpshooter. One aspect of this

²For a discussion of statistical significance and a summary of all analyses, see Statistical Appendix, p. 20.

IMPROVEMENT AFTER TRAINING WITH FITTED STOCKS

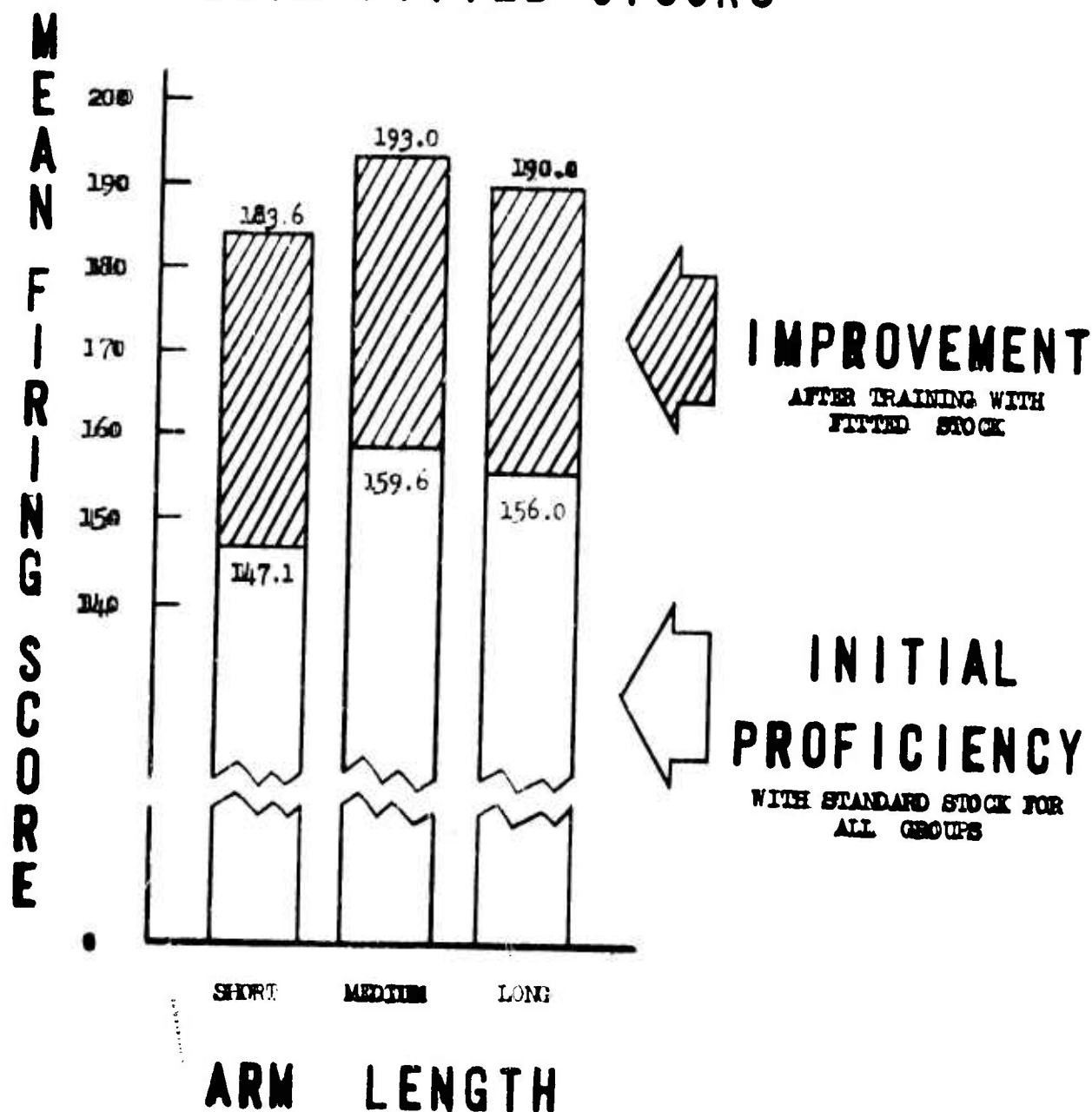


FIGURE 2

improvement is shown in Figure 3, which graphs the reduction in per cent bolos as a result of training. This graph shows that, as predicted, there were relatively more initial bolos in the "maladjusted" small and long groups, and that this per cent of small and long bolos decreased after training to approximately the same final per cent as that of the medium group. Again, however, neither this initial per cent difference nor the difference in bolo reduction was statistically significant. The beneficial overall effect of training was, of course, highly significant (see Figs. 2 and 3). (For a complete breakdown of marksmanship ratings before and after training, see Table 2, p. 17.)

3. Marksmanship Improvement by Exercise.

The nature of this improvement due to training may be seen in Fig. 4, which shows the marksmanship improvement of the whole class in terms of firing exercise. (For a more complete analysis, see Table 3, p. 18.) This breakdown illustrates quantitatively a fact which many experienced rifle instructors have long known, namely that the greatest amount of improvement in training occurs in sustained fire. A further fact shown by this breakdown is that improvement is greatest when the range is neither very short nor very long. Such a finding exemplifies the common observation that the effect of training must necessarily be small when the task is very easy or very difficult: if too easy, it can be done well without training; if too difficult, no amount of training can cause improvement.

TRAINING REDUCES BOLOS

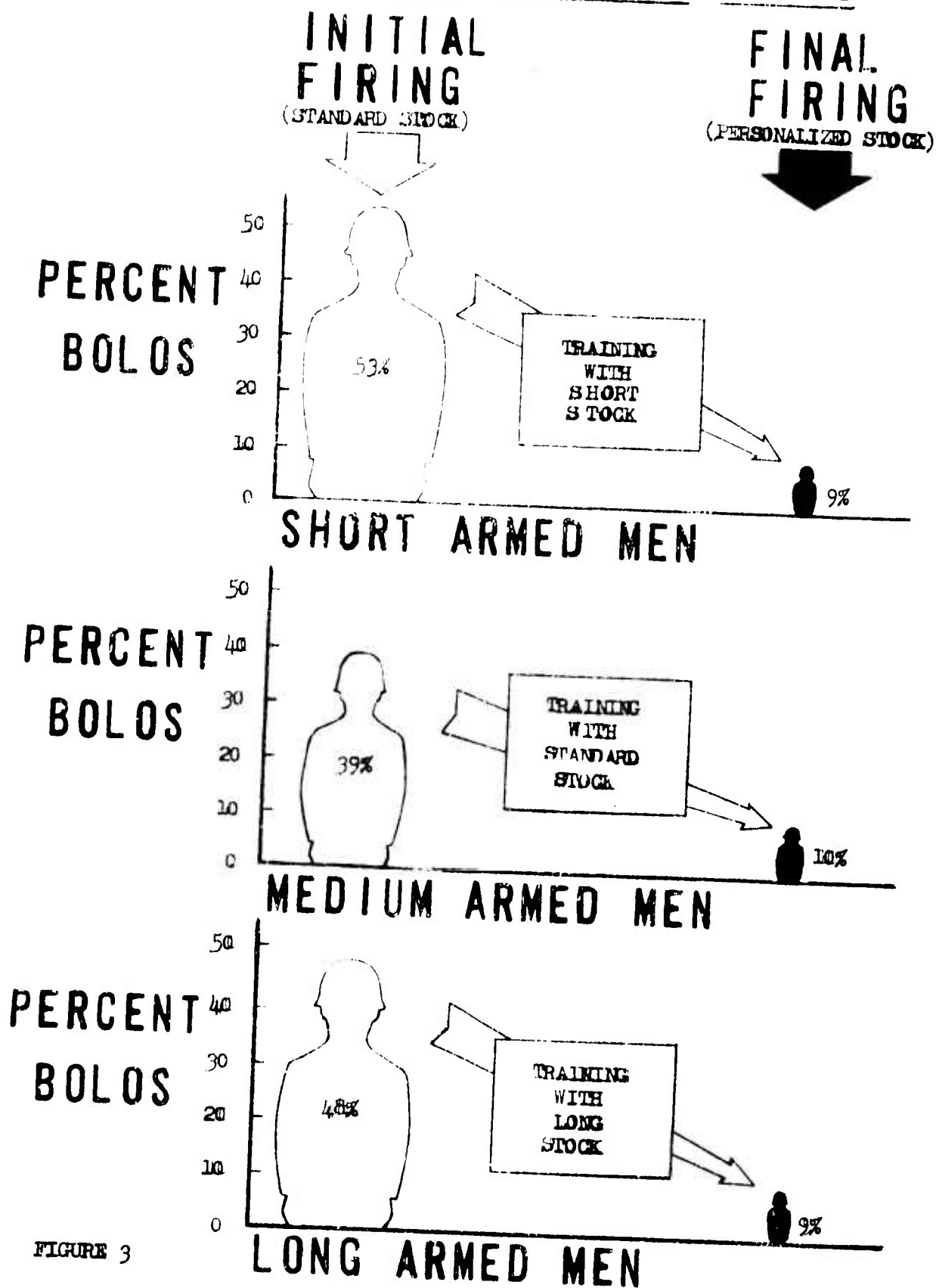


FIGURE 3

IMPROVEMENT AFTER TRAINING (PER EXERCISE)

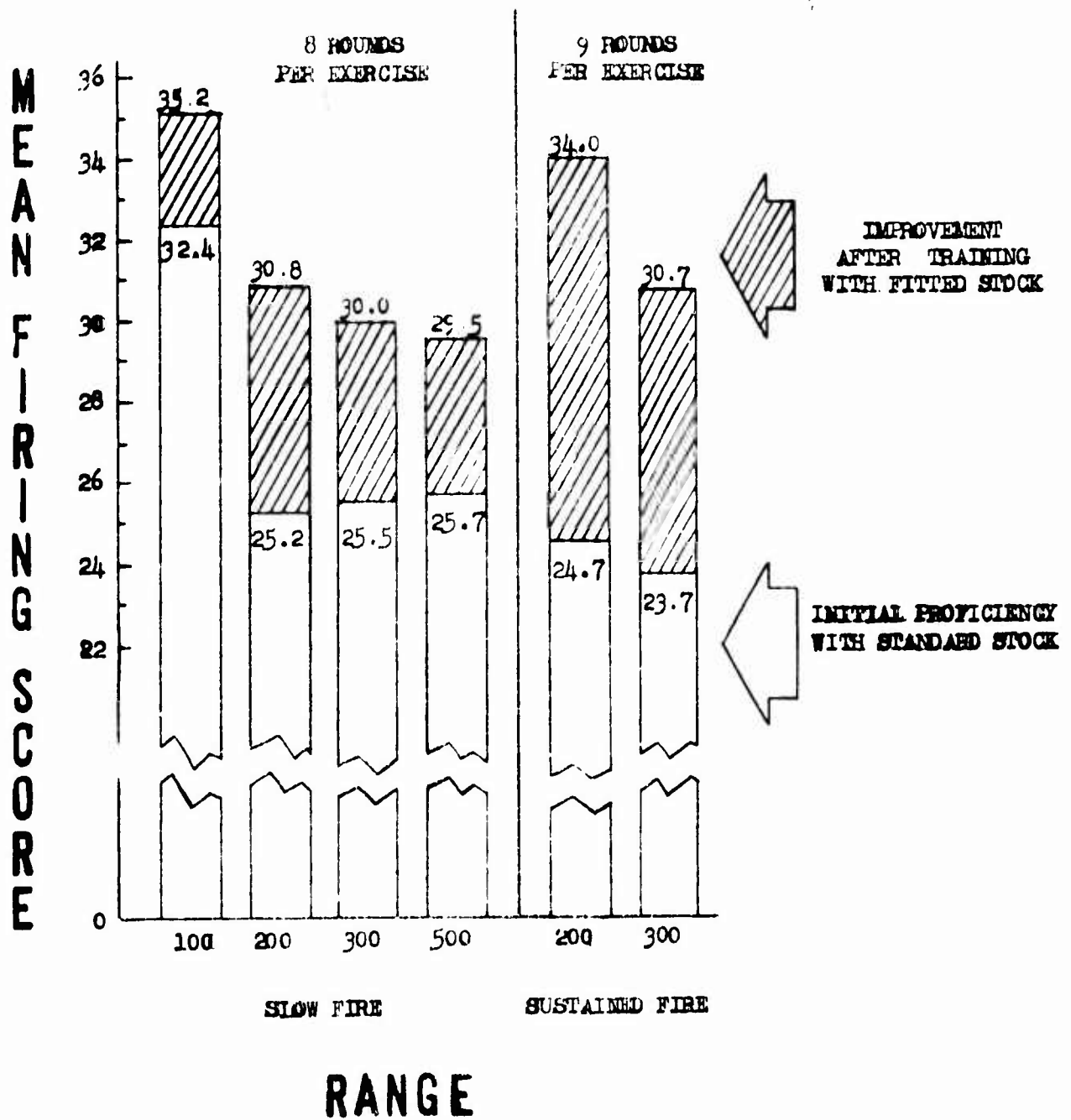


FIGURE 4

4. Marksmanship Improvement and Preference.

Does the firer himself know the size stock he needs? The answer seems to be "no." A comparison was made of the marksmanship improvement of two groups: 102 men who were issued the stock they preferred, and 67 men who received a non-preferred stock. It was found that the "preferred-stock group" did improve slightly more than did the "non-preferred-stock group" (see Fig. 5), but as before this difference was statistically non-significant. The small differential improvement which occurred may be explained by the hypothesis that those men whose preferences were satisfied either gained confidence or were more highly motivated as a result of the personal interest seemingly taken in them by this satisfaction of their preference.

IMPROVEMENT AFTER TRAINING

(WITH PREFERRED OR NON-PREFERRED STOCKS)

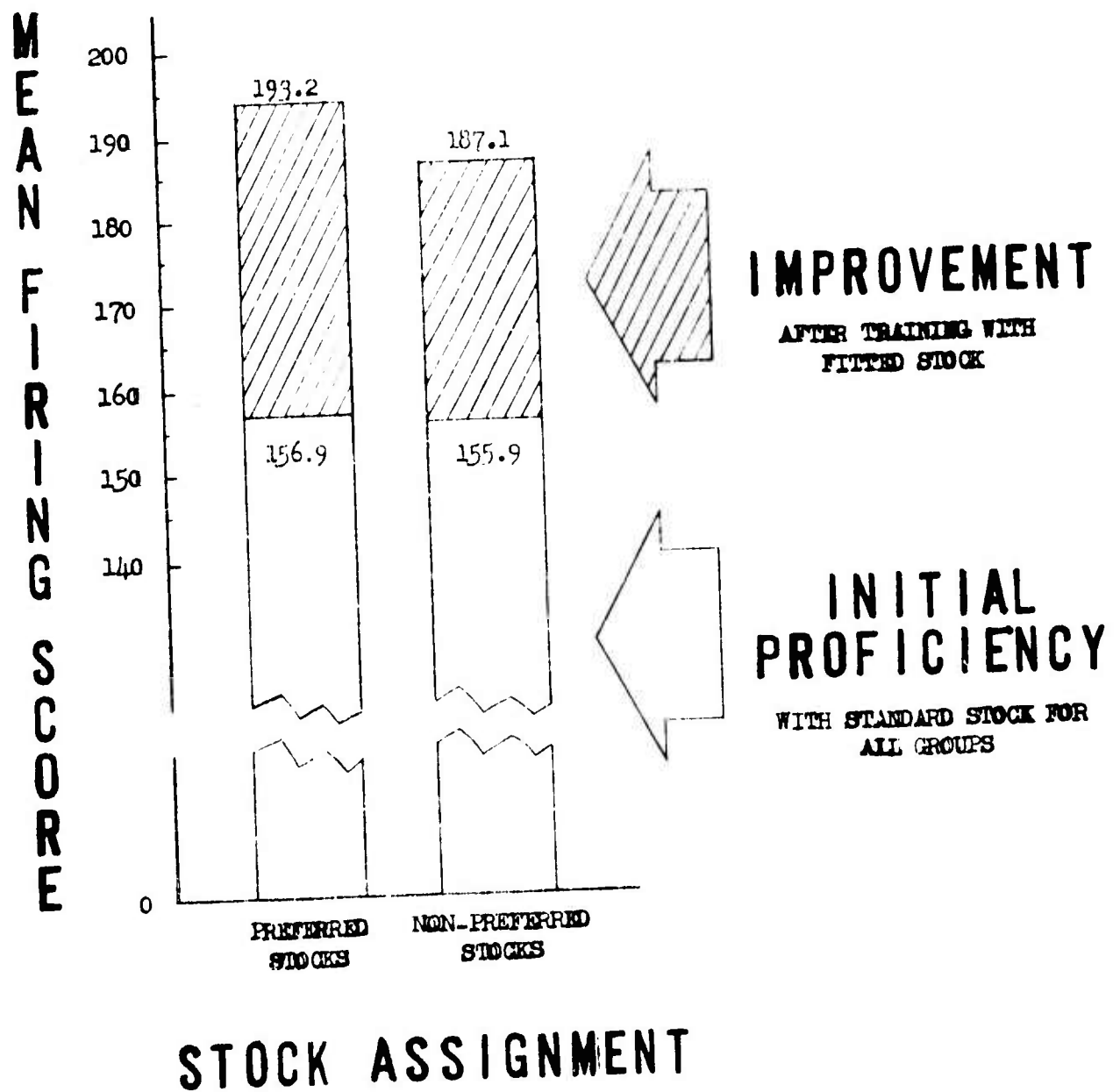


FIGURE 5

TABLE 2
Number and Per Cent of Men in Each Marksmanship Rating
Before and After Training

I. Initial Proficiency (before training)

Rating	Short		Medium		Long		Total	
	#	%	#	%	#	%	#	%
Expert (212-)	0	00	1	01	0	00	1	01
Sharpshooter (187-211)	4	12	18	16	3	13	25	15
Marksman (160-186)	11	34	50	44	9	39	70	41
Bolo (-159)	17	53	45	39	11	48	73	43
Total	32	100	114	100	23	100	169	100

II. Final Proficiency (after training)

Rating	Short		Medium		Long		Total	
	#	%	#	%	#	%	#	%
Expert (212-)	2	06	17	15	1	04	20	12
Sharpshooter (187-211)	15	47	64	56	15	65	94	56
Marksman (160-186)	12	38	22	19	5	22	39	23
Bolo (-159)	3	09	11	10	2	09	16	09
Total	32	100	114	100	23	100	169	100

TABLE 3

Group Means and Standard Deviations, Record Firing Scores

Range in Yards	Short		Medium		Long		Total	
	M	SD	M	SD	M	SD	M	SD
100	31.47	3.708	32.50	5.029	32.08	4.555	32.42	4.763
200	23.97	8.153	25.33	7.095	25.04	6.649	25.20	7.641
300	22.47	9.263	26.17	7.100	25.04	9.213	25.51	7.984
500	23.69	8.110	26.13	7.885	25.33	6.799	25.71	7.843
Slow Total	101.60	22.256	110.69	18.340	107.50	19.881	108.61	19.655
200	22.41	9.750	24.70	9.638	26.25	7.137	24.49	9.420
300	23.06	9.621	24.23	8.628	22.25	8.156	23.74	8.789
Sust. Total	45.46	16.589	48.93	14.313	48.50	13.058	48.23	14.658
Total	147.06	36.448	159.62	27.260	156.00	29.624	156.79	31.529
100	34.78	3.370	35.97	3.056	34.83	5.001	35.17	3.487
200	29.72	5.501	32.00	4.531	29.52	5.508	30.83	4.993
300	28.94	6.923	30.52	4.208	29.26	4.561	30.04	4.931
500	28.81	4.633	29.56	5.114	30.09	7.162	29.49	5.369
Slow Total	122.24	14.250	128.04	11.090	123.72	17.442	126.51	12.949
200	33.50	7.968	33.85	6.754	34.09	6.121	33.99	6.923
300	27.81	8.409	31.05	7.529	32.22	6.345	30.60	7.686
Sust. Total	61.31	12.310	64.90	11.579	66.30	9.512	64.41	11.572
Total	183.56	22.765	192.96	19.616	190.00	22.914	190.78	21.031

REFERENCES

1. Letter GNKEAD-P, Headquarters, The Infantry School to Chief,
Army Field Forces, dated 11 March 1953, subject: "Personal-
ized Rifles."
2. 1st Inclosure, above letter ("A Study - Personalized Rifles").
3. 3rd Indorsement, above letter (Office, Chief of Army Field
Forces, to Commandant, The Infantry School, subject:
"Personalized Rifles").
4. 4th Indorsement, above letter (Headquarters, The Infantry School,
to Chief, Army Field Forces, subject: "Personalized Rifles").
5. "Experimental Development of Proficiency Tests and Training
Methods for Improving the Effectiveness of Combat Riflemen,"
Technical Research Proposal submitted by Human Research
Unit No. 3 to Chief, Army Field Forces.
6. "Shoot to Live," official Canadian Army Handbook, Ottawa:
Edmond Cloutier, 1945.

STATISTICAL APPENDIX

A common method of testing the influence of any experimental factor (e.g., arm-length) or, in other words, of testing the significance of a difference between the effects of different levels of a factor (e.g., proficiency differences between arm-length groups) involves the computation of a statistic and then the ascertainment of the probability of occurrence (p) of that statistic. This probability states the proportion of times that results such as those obtained (or differences as large as those obtained) would occur by chance alone if the experiment were repeated a very large number of times. Thus the smaller the p -value, the less is the likelihood that the obtained results are mere happenstance, and the greater is the significance of the factor being tested. Standard practice demands the selection, before the experiment, of a particular criterion probability level (also called "level of confidence" or "coefficient of risk") beyond which the chance-explanation of the results is rejected. The criterion probability level selected for the present experiment was .01. Thus a result whose probability of chance occurrence was less than one in a hundred was regarded as "statistically significant" in this experiment. Differences whose probability of chance occurrence was greater than .01 were called "statistically non-significant."

The most important statistics computed in this experiment and their probabilities, are presented on the following pages.

1. Summary Table of a Simple Randomized Design which Tested
the Effect of Canadian Arm-Length on Initial Proficiency

Source	df	ms	F	p
Arm Length	2	1988.5	2.246	>.10
Within subjects	170	885.4		
Total	172			

2. t-test to Determine the Significance of the Difference
Between the Initial Proficiency of the Short and Medium Groups

$$t = 2.116 \quad .05 > p > .02$$

3. Summary Table of a Simple Randomized Design Which Tested
the Effect of Arm Length on Final Proficiency

Source	df	ms	F	p
Arm Length	2	1069.5	2.445	>.05
Within subjects	166	437.4		
Total	168			

4. Summary Table of a Type I Design Which Tested the Overall Main Effects of Training and Arm Length, and the Interaction Between These Factors

Source	df	ms	F	p
Between subjects	168			
Arm Length	2	2,996.5	3.095	> .01
error (b)	156	968.1		
Within subjects	169			
Training	1	99,150.0	266.9	< .001
AL x Tr	2	58.0	.16	> .50
error (w)	156	371.5		
Total	337			

5. Summary Table of a Type I Design which Tested the Overall Main Effects of Training and Stock Assignment (Preferred vs. Non-Preferred) and the Interaction Between These Factors

Source	df	ms	F	p
Between subjects	168			
Pref. - Non-pref.	1	1,021.0	1.03	> .20
error (b)	167	992.1		
Within subjects	169			
Training	1	99,150.0	270.77	< .001
P x T	1	518.0	1.41	> .20
error (w)	167	366.9		
Total	337			

6. Chi-Square Test of the Significance of the Relationship
Between Initial Marksmanship Ratings and Arm-Length

	Short	Medium	Long	Total
Qualified	15	69	12	96
Bolo	17	45	11	73
Total	32	114	23	169

Chi-square = 2.12

$p > .30$

7. Critical Ratio Test of the Significance of the Difference
in Proportion Qualifying Initially Between the Short and Medium
Groups

	Short	Medium	Total
Qualified	15	69	85
Bolo	17	45	62
Total	32	114	146

$z = 1.412$

$p = .16$

8. Critical Ratio Test of the Significance of the Difference
in Proportion Qualifying Initially Between the Medium and Long
Groups

	Medium	Long	Total
Qualified	69	12	81
Bolo	45	11	56
Total	114	23	137

$$z = .8007$$

$$p = .42$$