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AMXFC REPORT NO. 40-62

FOOD CONSUMPTION AND PREFERENCES UNDER CONDITIONS OF RESTRICTED AND NON-RESTRICTED FEEDING

Interim Report

December 1962

ARMED FORCES FOOD AND CONTAINER INSTITUTE
U. S. ARMY QM RESEARCH AND ENGINEERING COMMAND
CHICAGO 9, ILLINOIS

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Primary Field: Food Acceptance

Secondary Field(s): Environmental Stress

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2. Food Preference

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QMASO Form 12-437
Rev 3 Jul 61

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PROJECT: Human Factors in Quartermaster Corps Operations

TASK: Attitude toward and acceptance of Quartermaster materiel

PHASE: Psychosocial aspects of undersupply

FOOD CONSUMPTION AND PREFERENCES UNDER CONDITIONS OF RESTRICTED AND NON-RESTRICTED FEEDING

Interim Report

by

David R. Peryam
Richard W. Seaton
Food Acceptance Branch, Food Division

December 1962

ARMED FORCES FOOD AND CONTAINER INSTITUTE

FOOD CONSUMPTION AND PREFERENCE UNDER CONDITIONS OF RESTRICTED AND NON-RESTRICTED FEEDING

In the summer of 1960 the Quartermaster Research and Engineering Command conducted the second of two studies on the problem of the foot-soldier operating in the Arctic. Both took place under the "winter-in-summer" conditions on the high icecap of interior Greenland in the vicinity of Camp Fistclench. The first, Crystal Key I, run in 1959, was an exploratory study of different equipment systems. Food was one major focus of that study. Three different rations, all supplied at the rate of 4800 calories/man/day, were used according to a planned pattern over a period of five weeks. Data were obtained on preferences and actual food consumption. The 1960 study, Crystal Key II, continued the testing of equipment systems, but it also focused on two special problems. First, there was the physiological cost of the strenuous effort that must be expended by soldiers in foot-movement across the snow fields. Equal in importance were the social-psychological effects that arose within the small groups of soldiers in the course of the interaction of people, tasks, and environment. Results of the psychological investigations have been published by Seaton (4).

The present report concentrates on just one aspect of those experiments -- food consumption and food preferences. Food deprivation was one of the independent variables in the study. All subjects subsisted on Meal, Combat, Individual; however, the men alternated between half-rations and full rations of 4800 calories. Again, complete data were obtained on food preferences and consumption. This study

afforded an opportunity for further examination of the relationship of food preferences and consumption and of how it varies in response to other conditions. The effects of controlled underfeeding were of particular interest. Such an analysis was made and the results are presented in this report.

Procedures

Experimental Plan

The complete design of the experiment and a full description of the operations are set forth in the Institute report, "Hunger in Groups"(4). Only those aspects of design and procedure necessary to the understanding of the present data will be repeated here.

The exercise involved two 10-day treks by 20 men across the snow fields of the high icecap. They traveled in four 5-man teams along a marked trail leading west from Camp Fistclench toward Camp Century. They were accompanied by a tractor-powered wanigan train in which the research team members and support personnel lived and worked and which carried reserve supplies. The experimental teams transported all of their supplies and equipment with the exception of gasoline and rations, which were issued on a one-day supply basis.

The teams traveled a fixed distance of eight miles each day. In the morning -- marked only by the clock in that land of constant summer sun -- they arose, cooked and ate breakfast, melted water, and performed various other house-keeping duties; struck camp, packed up, and took to the trail. For safety reasons the teams were required to keep pace so as to stay in sight of each other and of the wanigan train. At noon

they stopped to eat their cold ration lunches. Then they continued until they had made the required distance, which usually took six to eight hours of walking. Again they set up camp and entered into their round of housekeeping chores, equipment maintenance, etc. This was also the time when contact was made with the wanigan headquarters to draw rations and fuel for the next day.

The experimental plan called for isolation of each 5-man team throughout each 10-day trek. The teams were kept apart at all times and the men were isolated from the other personnel as much as possible, coming in to the wanigan only to pick up supplies, for sick call, or to permit the taking of physiological measures. Members of the research team contacted the men periodically during the day to take data.

At the start of the experiment the 20 men were allocated to the four teams (A, B, C, and D) so as to achieve comparability on a number of combined, subjectively weighted criteria, including such things as size, strength, experience, military rank, and personality variables. The teams were then randomly assigned to the "low" and "high" feeding conditions for the first 10-day cycle.

Following is a summary of the important events of the exercise:

1. Pre-operational: 14 days in training, all subjects on modified A ration.

2. Cycle I, Phase I: 5 days, 40-mile out-bound trek; Teams A and B on full rations; Teams C and D on half rations; preference questionnaires completed on the fifth day.

3. Cycle I, Phase 2: 5 days, 40-mile trek back to Camp Fistclench; team on same rations as in Phase 1; preference questionmaires completed on the last day.

4. Between cycles: 10 days of rest and testing at Camp Fistclench; all subjects on a modified A-ration; test subjects regrouped within Teams A and B; also within Teams C and D.

5. Cycle II, Phase 1: 5 days, 40 mile outboard trek; Teams C and D on full rations; Teams A and B on half rations; preference questionnaires completed on fifth day.

6. Cycle II, Phase 2: 5 days, 40-mile trek back to Camp Fistclench; teams on same rations as in Phase 1; preference questionnaires completed on last day.

Feeding

The rations used were a 1957 pack of the Meal, Combat, Individual. The basic plan of the 12 menus was the same as in more recent packs, although a number of substitutions of individual items have since been made. All the water the men used was melted from snow. Each team had Yukon stoves for this purpose, and to heat their food if desired. Rations were issued and accounted for on an individual basis. Everybody in a test team was given the same menus for each day; however, each person planned his own usage of the food. At the time of issue, unused portions of the previous day's food were returned. Despite the controls that were applied, it was not completely assured that food usage was on an individual basis. Swapping of items, mixing of individual portions, or throwing away unused portions were prohibited; however, there could have been undetected swapping within groups, and odds and ends of items were probably discarded to some extent. The foregoing would have tended to produce records that overstated actual consumption. Also, swapping and mixing would have tended to invalidate individual records, although having no effect on the group averages.

There were occasional instances of men obtaining unauthorized additional food. This applied particularly to one of the groups on the restricted diet in Cycle II.

Variation in level of feeding was effected by providing each man in two of the teams with four individual meals which closely approximated a total of 4800 calories. Each man in the other teams received only two of the meals. No compensating adjustments were made in workload, speed of travel, or in any other way. The two teams which were fed at the high level during the first 10-day period became the "lows" for the second 10-day period, and vice versa.

Data Analysis

The daily records of ration issue and returns were kept separately for each man and each food item. Thus, it was possible to compute "percent consumption," i.e., the percentage of the amount of each item issued that was actually eaten. This was done for each group of men for each cycle. Also, amounts consumed were converted to calories using conversion tables prepared by the Institute, and the daily total was accumulated for each subject.

For most of the analyses the two teams that were on the same feeding regimen have been considered together as one group. Physically, Team A and Team B were operating separately; however, they were on the same feeding schedule throughout. The same was true for Teams C and D. Average consumption figures are given for each team, but for other analyses the data were combined. The two combined groups are referred to in the tables and in the discussion as "Team AB" and "Team CD."

Average preference ratings on the hedonic scale were obtained for each item for each group of men at the end of each phase. The usual method was followed of assigning the values one to nine to the scale points beginning with "dislike extremely," so that higher average ratings reflect higher preference.

To investigate the relationship between preference and consumption, product-moment correlations were computed between percentage consumed and average preference across the 29 items of the rations for which both preference and consumption data were obtained. This was done separately for each cycle and for the "high" and "low" feeding groups. Correlations were also computed separately for the sub-set of the 11 meat items of the ration.

An analysis of variance was made on the individual daily consumption data. It was concerned with the variables of Team (Team AB vs. Team CD); Level of feeding (high vs. low); Cycle (I vs. II); Days (averages across cycles of the 10 successive days) and interactions among these factors. The design was a partial replicate; hence, there was confounding of some of the main effects as well as the interactions. Since the two different groups were fed at different levels in different cycles, Team was completely confounded with the Cycle x Level interaction, and Cycle was completely confounded with the Team x Level interaction.

Results and Discussion

Some of the social-psychological data and observations made during the course of the exercise provide relevant background for understanding the results on preference and consumption. This information is presented and fully discussed in Seaton's report (4) and is only summarized here.

Weather and Snow Surfaces

The weather during the period of the study, although still cold by comparison with temperate climates, was somewhat milder than usual for the Greenland icecap. The mean noontime temperature for each phase of each cycle was 16 to 17°F. On a few occasions the temperature dropped below 0°F.; also, it occasionally rose above 32°F., although never for more than a few hours. Generally the weather was milder in Cycle II, which was contrary to expectation. Temperatures were about the same, but in Cycle I the wind, which blows almost constantly from an easterly direction, averaged twice as strong -- 18 miles per hour as compared to nine miles per hour -- for Cycle II. The wind would have tended to make walking easier in Phase 1, when movement was to the West, but would have hindered walking in Phase 2. The snow surface was another important difference between cycles. Snowfall on two occasions early in Cycle I deposited shallow drifts and generally reduced the hardness of the snow surface, both of which conditions tended to make walking more difficult. No more precipitation occurred and the snow crust became progressively harder during the rest of the exercise.

Daily observations were made of the speed, in terms of time for 100 steps, at which the teams moved. There was little variation in pace between teams since they were required to stay together.

The average was significantly faster for Cycle II than for Cycle I and was significantly faster for Phase 1 than for Phase 2 where the men had to walk into the wind; however, respirometer data showed that energy expenditure tended to be lower in Phase 2 of both cycles (4).

Physical Stress

What the test subjects were undergoing could properly be called "rough duty." There was high output of physical energy. A daily eight-mile hike might be easy on dry, firm earth, but when it has to be made on snowshoes over a variable snow surface, while wearing heavy clothing and carrying or dragging a full complement of equipment, the task takes on formidable dimensions. To this was added the circumstance of living -- sleeping, eating, resting -- constantly on, or in, the dry snow with the temperature almost never above freezing. Despite the general cold, during the daily stint on the trail cold was a lesser problem than the over-heating which resulted from exercising while wearing heavy outer clothing. These men had been preselected for physical fitness and also had undergone two weeks of preliminary toughening in the icecap environment. Even so, when the planned experiment began the initial responses showed physical and emotional distress. This was clearly demonstrated in the psychological data (4).

Psychological Effects

A variety of psychological measures were employed to investigate the men's attitudes and feelings about themselves, about each other, and about the experiment and the tasks it imposed. Particular emphasis was placed on the degree of social interaction within groups.

These data, taken as a whole, show a trend toward improvement as the experiment progressed. Generally, in Cycle II as compared to Cycle I, feelings toward the experiment were more favorable and there was better social integration and organization. This was verified by such objective evidence as the fact that fewer men reported on sick call in Cycle II.

Between-cycle improvement occurred for both full-fed and underfed groups; however, there were also many effects related to level of feeding. For example, the "lows" showed more complaining, less humor, greater sick call frequency, and less talking. Clearly, there was less mutual good feeling and more friction within underfed groups. One of the periodic questions which was related to hunger established the expected clear-cut difference between the "highs" and "lows." All groups were at least "moderately hungry," but the "lows" consistently rated their hunger at a "very high level." The degree of hunger tended to decrease between cycles and there was a trend toward an increase from Phase 1 to Phase 2 within both cycles.

Weight Losses

Independent evidence of the rigors of the experiment is provided by comparison of "before and after" weights of the men. Table 1 gives each subject's weight loss in kilograms for each cycle. Also, the starting weights for Cycle II are shown in relation to the starting weights for Cycle I. On the average both teams had more than recovered their Cycle I losses prior to Cycle II. Every subject lost weight in both cycles, although this loss varied from a low of .02 kilograms for

Table 1

Weight Losses (Kilograms) and Average Calories Eaten for Each Subject at Each Level of Feeding

		Cycle I High Level			Cycle II Low Level	
Team	Subject	Weight Loss	Average Calories	Starting Weight*	Weight Loss	Average Calories
AB	1	.02	4116	1.63	2.76	2408
AB	2	5.46	3018	-2.36	6.27	2278
AB	3	1.71	3719	1.06	3.89	2381
AB	4	2.04	3663	-.43	2.87	2360
AB	5	1.13	3522	1.52	3.97	2348
AB	6	.43	4019	-.06	3.21	2383
AB	7	1.81	3058	.22	2.46	2310
AB	8	2.97	3108	.31	6.04	2257
AB	9	1.20	3619	1.64	4.00	2386
AB	10	2.66	3656	-.52	4.95	2398
AB Average		1.94	3550	.30	4.04	2350
		Low Level			High Level	
CD	1	2.34	2280	1.00	1.41	4212
CD	2	2.77	2388	-.29	2.15	3854
CD	3	3.32	2318	.80	2.36	4180
CD	4	2.86	2289	2.20	.86	4625
CD	5	2.40	2337	-.93	1.27	4241
CD	6	3.48	2270	-1.01	1.87	3817
CD	7	2.49	2399	2.23	2.08	4137
CD	8	2.35	2283	1.25	2.68	3880
CD	9	2.18	2329	1.12	.64	3844
CD	10	2.77	2385	-.93	1.27	4671
CD Average		2.70	2328	.54	1.66	4156

*Weight in relation to starting weight for Cycle I. A positive figure means that the subject had more than recovered his Cycle I weight loss during the one week rest period.

Subject 1, Team AB (Cycle I, high level) to a high of 6.27 kilograms (13.8 pounds) for Subject 2, Team AB (Cycle II, low level). As expected, the low level of feeding produced the greatest weight losses, which were somewhat higher for Team AB in Cycle II (4.40 kilograms) than for Team CD in Cycle I (2.70 kilograms). Average weight losses were about the same for both teams on the high level of feeding.

Food Consumption

Table 2 presents the data on food consumption in terms of average calories per man per day; also in terms of percentage of available calories. Averages are given for various combinations of times, subject groups, and level of feeding.

Table 3 summarizes the analysis of variance on these data, using individual daily consumption as the basic unit. The instances of confounding are indicated. Team (AB vs. CD) is confounded with the Cycle x Level interaction and Cycle is confounded with the Team x Level interaction. This further means that the Team x Days and Cycle x Days interactions are confounded with higher order interactions. All effects, with the exception of the higher order effects of Days, are highly significant. It is only the effect of Team that fails to reach the 0.1 percent level and this is significant at the one percent level. Thus, the mere fact of significance does not tell much about the relative magnitude of the effects. For this purpose one must look at the mean squares and F ratios. As expected, the most important effect was level of feeding, with a mean square 100 times larger than any other. Cycle is second in order of importance, followed by Days and

Table 2

Average Caloric Consumption and Percent of Available Calories by Phase for Various Teams, Cycles, and Levels of Feeding

Team	Cycle & Level	Phase 1 Calories	Phase 1 Percent Available	Phase 2 Calories	Phase 2 Percent Available	Total Calories	Total Percent Available
AB	Cycle I High	3311	69	3788	79	3550	74
CD	Cycle II High	4115	86	4197	87	4156	87
AB	Cycle II Low	2346	98	2355	98	2350	98
CD	Cycle I Low	2282	95	2374	99	2328	97
	Average High	3704	77	3992	83	3848	80
	Average Low	2317	97	2364	99	2339	97
	Average Cycle I	2689	75	3080	86	2939	82
	Average Cycle II	3221	89	3296	92	3284	91
	Average Team AB	2829	79	3072	85	2950	82
	Average Team CD	3189	89	3285	71	3237	89

Table 3

Analysis of Variance of Food Consumption Data*

Source of Variation	d.f.	M.S.	F.	Significance
Team = Cycle x Level	1	82,140	11.37	.01
Level	1	2.275,874	2,998.00	.001
Days - linear	1	25,777	33.96	.001
Days - quadratic	1	1,063	1.40	not sig.
Days - cubic	1	1,260	1.66	not sig.
Days - remainder	6	791	1.04	not sig.
Cycle = Team x Level	1	95,915	126.37	.001
Team x Day = C x L x D	9	2,690	3.54	.001
Level x Days	9	2,737	3.61	.001
Cycle x Day = T x L x D	9	3,312	4.36	.001
Within Teams:				
Subjects	18	7,236	9.53	.001
Subjects x Levels	18	5,208	6.68	.001
Residual	324	759		

*Based on three-digit consumption figures for ease of computation.

Team. The other effects, even though significant, are of relatively minor importance as judged by the mean squares.

Table 2 gives the mean values related to the analysis of variance. The average for the high level of feeding is 1500 calories higher than that for the low level. Perhaps the most notable thing here is that the consumption of the "highs" fell about 1000 calories below the 4800 calories available to them. The "lows" performed as expected; on the average they ate about 97 percent of the food available.

Consumption in Cycle II was higher than in Cycle I by about 350 calories; however, this occurred because Team CD averaged about 600 calories higher in Cycle II than did Team AB in Cycle I. Of course, an increase in consumption was possible only at the high level, since the "lows" ate almost all of their food in both cycles. The increase in Cycle II may have been due to differences between the two groups, e.g., Team CD may have contained a number of chow hounds or it may have been due to differences in the conditions maintaining in the two cycles. The confounding of the Team and Cycle effects with the interactions involving Level means that the analysis of variance is not clear-cut. Here the interpretation is made that the difference was due to Cycles for several reasons. First, the groups were matched on a number of relevant factors before the test began. Second, examination of the individual consumption figures (Table 1) shows that the higher average consumption was not caused by large increases by just a few men, but that nearly all of the subjects contributed. The best explanation for this between-cycle difference is that it was due to the men's generally better adjustment as the exercise

progressed. Early in the experiment the men tended to be unhappy, irritable, more conscious of the physical stress, and not well adjusted to each other. Decreased desire for food was the result. Later on, as these conditions ameliorated, appetites improved and those who could, i.e., those on the high level of feeding, increased their intake.

The analysis of variance shows that the linear effects of Days was a major one. The extent of this effect may be seen in Table 2 by comparing the averages for Phase 1 with those for Phase 2. Phase 2 always shows the higher consumption whether the data are grouped by level, by cycle, or by teams. However, the interactions are also clearly evident, the higher Phase 2 consumption occurred primarily with Team AB at the high level of feeding in Cycle I. They ate about 500 calories/man/day more in Phase 2 than during Phase 1. There were minor increases in consumption for Team CD on the high level in Cycle II, and for the same team on the low level in Cycle I. These inter-phase differences are probably related to the trend toward improved general adjustment, as were the between-cycle differences. This is supported not only by the marked increase for the high level team (AB) in Cycle I, but perhaps more by the much smaller increase for the low level team (CD); who rejected five percent of their available calories during the first phase of Cycle I, but rejected only one percent during the second phase. In Cycle II, both "highs" and "lows" ate about as much in the first as in the second phase.

Food Preferences

Table 4 gives information on food preferences comparable to that shown in Table 3 for food consumption. Average preference is given for each team and each phase, in each cycle. Every subject rated each of the 29 different items at the end of each phase. The figures shown in the table are the simple averages of the 290 ratings (29 items x 10 men). This provides a general index of preference. No further analysis of these data was made; hence the significance of the trends in the data were only estimated.

Table 4

Average of Item Preference Ratings by Phase for Teams, Cycles, and Levels of Feeding

Team	Cycle	Level of Feeding	Average Preference Phase 1	Phase 2	Rating Average
AB	1	High	6.5	6.5	6.5
CD	II	High	6.8	6.6	6.7
AB	II	Low	7.0	7.3	7.2
CD	I	Low	6.8	7.2	6.9
Average High			6.7	6.6	6.6
Average Low			6.9	7.3	7.1
Average Cycle I			6.6	6.8	6.7
Average Cycle II			6.9	6.9	6.9
Average (AB)			6.7	6.9	6.8
Average (CD)			6.8	6.8	6.8

The over-all variation in these data is much less than in the consumption data, suggesting that a man's feeling about a food tends to remain reasonably constant even though many conditions may influence its actual consumption. Certain trends should be noted. The main one is the 0.5 scale points difference between the high and low levels of feeding. This reflects the men's higher level of hunger. The two teams did not contribute equally to this average difference; Team CD shows only a 0.2 scale points difference while Team AB shows 0.7 scale points. Averaged over both levels of feeding (and cycles) the teams rated foods the same (6.8), but Team AB rated slightly lower than Team CD at the high level, and rated slightly higher at the low level of feeding. At the high level of feeding, both teams rated the foods about the same in the two phases, but at the low level of feeding, they rated foods higher at the end of Phase 2. Averaged over both teams the difference amounted to 0.4 scale points. The increase in average rating was due primarily to higher ratings for meat and candy items. Again, this is probably related to the increasing hunger that was experienced by the "lows."

Food Consumption and Preferences by Item

Table 5 gives the data on food preferences and consumption for each item of the ration for each team in each cycle. Consumption is given as the percentage of the amount available that was eaten. The preference figures are the averages of the ratings obtained at the end of each cycle. Thus, each mean is based on 20 ratings, but from only 10 men. Items have been grouped by type, and averages are given for each type. The consumption figures are the unweighted averages of the percentages of consumption for the individual items, with no account taken of the differences in caloric value of the items.

Table 5

Percent Consumption and Average Preference for Items of the Meal, Combat, Individual for Each Team, Cycle, and Level of Feeding

	% Consumption				Preference			
	Cycle I		Cycle II		Cycle I		Cycle II	
Team	AB	CD	CD	AB	AB	CD	CD	AB
Level of Feeding	High	Low	High	Low	High	Low	High	Low
Meats								
Beans w/Franks	60	99	80	100	6.8	7.3	7.7	7.8
Ham & Eggs	46	98	48	98	5.8	6.6	6.7	7.2
Ham & Potatoes	38	94	52	87	5.1	5.1	4.4	5.9
Pork Steak	58	96	71	95	4.3	6.3	5.8	5.0
Turkey Loaf	32	96	31	88	5.1	6.3	6.5	6.1
Beef & Peas	44	86	62	98	5.1	5.8	4.5	6.3
Spiced Beef	81	98	87	100	5.7	6.4	5.8	6.6
Fried Ham	67	86	65	97	5.9	6.0	5.7	6.3
Tuna & Noodles	18	89	24	94	4.2	4.1	3.3	4.5
Chicken	71	95	82	96	5.7	7.4	7.4	6.6
Beef Steaks	32	92	57	93	4.7	5.8	5.7	5.4
Average	50	94	60	95	5.3	6.1	5.8	6.2
Baked Goods								
Pound Cake	97	100	98	100	7.8	8.1	8.0	8.0
Crackers	77	100	86	100	6.7	6.9	6.7	7.3
Pecan roll	93	100	96	100	7.2	7.3	7.3	8.1
Bread	92	99	96	100	6.8	7.5	7.5	7.6
Vanilla cookie	95	100	98	100	7.6	7.7	7.6	8.0
Chocolate cookie	97	99	98	100	7.1	8.2	7.8	7.8
Average	92	100	95	100	7.2	7.6	7.5	7.8
Fruit								
Apricots	100	100	100	100	8.1	8.2	7.9	7.9
Pears	98	95	99	100	8.4	8.2	8.2	8.4
Pineapple	100	100	100	100	7.8	8.0	7.7	7.9
Peaches	100	100	100	100	8.6	8.3	8.3	8.6
Average	99	99	100	100	8.2	8.2	8.0	8.2
Candy								
Coconut disc	81	100	87	100	6.8	7.2	6.6	7.6
Chocolate fudge disc	97	100	99	100	6.9	7.1	7.0	7.5
Vanilla cream disc	87	96	92	100	6.3	6.8	6.7	7.6
Sweet chocolate disc	87	100	93	100	6.5	6.7	6.6	7.8
Average	88	99	90	100	6.6	6.9	6.7	7.6
Beverages								
Cream & Sugar	53	91	83	94	-	-	-	-
Coffee	39	85	52	61	5.3	6.4	5.6	5.7
Cocoa	81	99	85	92	7.7	8.1	7.9	8.4
Average	58	92	70	82	6.5	7.2	6.7	7.0
Spreads								
Peanut Butter	73	89	78	100	7.1	6.7	6.7	8.1
Jam	70	95	80	100	7.1	7.3	7.3	7.7
Average	71	92	79	100	7.1	7.0	7.0	7.9

The contribution of the different types of items to the over-all caloric value of the ration differs widely. Table 6 gives the number of different items in the class, the number of menus in which the class is represented, and the percent of total ration calories it contributes. The average percent consumed at high and low levels of feeding is also shown.

Table 6

Contribution of the Different Classes of Items to the Over-all Caloric Value of the Meal, Combat, Individual and Percent Consumption of Each at High and Low Levels of Feeding

	Over-all Contribution to Ration			% Consumption	
Class	No. of Items	No. of Menus*	Percent of Total Calories**	High	Low
Meats	11	12	31	55	94
Baked Goods	6	12	34	93	100
Spreads	2	12	14	75	96
Beverages	2	12	10	64	87
Candy	4	4	7	89	99
Fruit	4	4	4	99	99

*Numer of menus in which the item is used.
**Averaged over all 12 menus.

Meat items represent the most serious acceptance problem. The "highs" consumed only 55 percent of this important class which appears in every menu and represents about 30 percent of the over-all caloric value. Even the "lows" rejected six percent in spite of their caloric need. Meats also rated lower on preference than any other type. Certain "bad actors," which were low on both consumption and preference, may be noted, e.g., tuna and noodles, turkey loaf, beef steaks, and ham and potatoes. On such items consumption and preference were higher for

the "lows," but the items kept their same low position relative to other items of the r ation.

Baked Goods are represented by six items. The class appears in all 12 menus, and provides 34 percent of the total calories. These items represent no acceptance problem, with 100 percent consumption by the "lows" and 93 percent by the "highs." Crackers rated consistently lower than the other items, and were most often rejected by the "highs."

Fruits, represented by only four items and a low contributor to the over-all ration, is clearly the best class. Ratings were very high and rejection was almost zero.

Candy, represented by only four items in four menus and again a low contributor, was almost completely eaten by the "lows" and had a low rate of rejection by the "highs." The average preference ratings for the class were in the middle range.

Beverages are represented by two items from the standpoint of ration design -- cocoa and instant coffee with its accompanying cream and sugar. As a class beverages had the lowest consumption for the "lows" (87 percent) and next lowest for the "highs" (64 percent). However, it was the instant coffee, which provides few calories, that was rejected and not high-rating cocoa nor even cream and sugar. It is apparent that the men used the cream and sugar packets with other foods as well as with the coffee.

Spreads, represented by two items but appearing in all 12 menus and contributing 14 percent of the over-all calories, ranked next above Beverages from the standpoint of rejection with the "highs" (25 percent), although there was only four percent rejection with the "lows." Both of the items rated in the middle range.

Correlation Between Preference and Consumption

Table 7 gives the correlations across items between preference rating and percent consumption for each cycle and level of feeding. Correlations are shown both for the complete list of 29 items and for the 11 meat items separately.

Table 7

Correlation Between Percent Consumption and Average Preference for Meal, Combat, Individual Items Under High and Low Feeding Conditions

	N	Low Level (2400 cal.)	High Level (4800 cal.)
All items			
Cycle I	29	.64	.86
Cycle II	29	.51	.77
Meat Items Only			
Cycle I	11	.29	.60
Cycle II	11	.49	.52

These correlations are of about the same order as those found in other studies. In Operation Crystal Key I in 1959, correlations between preference and consumption were .57 for the Meal, Combat, Individual; .79 for the 5-in-1; and .69 for the Quick-Serve Meal.

Note that the correlations are higher for the high level of feeding. This result was to be expected because it is only when excess food is available that it is possible to do much choosing. For example, a man might have a strong dislike for tuna and noodles; but when it represents a major part of his meal, he eats it anyway. On the other hand, with

twice as much food available, he can reject it and fill up on items he likes better. This has also been found in other studies of restricted feeding (2).

The all-item correlations are higher for both "highs" and "lows" in Cycle I than in Cycle II, probably for the same reason as cited above. In Cycle I consumption was lower than in Cycle II. Both "highs" and "lows" rejected more of their food, and it is evident that they tended to reject the disliked items.

The intent in analyzing the 11 meat items separately was to test the hypothesis that the correlations would be lower because these items provide such a high proportion of the diet that they were not likely to be rejected. Most of the correlations are, in fact, lower than those for all items under comparable conditions; however, other evidence suggests a qualification. With the "lows" the average rate of food rejection was low, but the meat items accounted for most of it. It seems likely that the lower correlations arise in part because of the relatively restricted range of preference among the meat items as compared to the range among all items.

Consistency of Preference and Consumption

How consistent are the data on percent consumption and on average preference? To put it another way, how much do they tend to vary as a function of the experimental conditions? The correlations shown in Table 8 were obtained to answer this question. Correlations were computed across the set of 29 items for both percent consumption and average preference for different pairs of experimental conditions. These pairs

of conditions, as shown in the left hand column, were selected so that subjects, feeding level, and time (in terms of Cycle) would be successively held constant.

Table 8

Correlation of Percent Consumption and of Average Preference Ratings for Ration Items Between Various Situations where Subjects, Time, or Feeding Level is Held Constant.

	Time	Feeding Level	Subjects	Correlation Consumption	Correlation Preference
Cycle I High vs. Cycle II Low	Diff.	Diff.	Same	.78	.94
Cycle II High vs. Cycle I Low	Diff.	Diff.	Same	.76	.97
Cycle I Low vs. Cycle II Low	Diff.	Same	Diff.	.68	.84
Cycle I High vs. Cycle I Cycle II High	Diff.	Same	Diff.	.98	.90
Cycle I Low vs. Cycle I High	Same	Diff.	Diff.	.74	.91
Cycle II Low vs. Cycle II High	Same	Diff.	Diff.	.78	.85

The correlations are all positive and fairly high. Those for preference indicate a somewhat closer relationship than for consumption. The lowest preference correlation is .84, and when the factor of subjects is held constant, the relationship is almost perfect. This indicates that relative preferences of individuals for the various items changed very little as the experimental conditions varied, that relative

preferences were very much alike among groups of people, and that relative preferences did not change over time. Four of the consumption correlations fell into the range .74 to .78, which may be considered as a fairly strong positive relationship. The same items tended to be accepted or rejected by the same men at different times under different conditions; also when time was controlled but the men and conditions were different. Note what happens when feeding level is controlled. The "high" levels are almost perfectly correlated (.98), but the "low" correlation drops to .68. This effect is probably related to degree of restriction of consumption. At the low level most items were completely eaten and the range of percentage rejection of the remainder was not large. When a man under the "low" condition was forced by hunger to eat some of the disliked foods, what he actually rejected was probably determined by change to a considerable extent. The correlation of two of these compressed and partly chance determined distributions could be expected to be low. That even under these conditions the correlations were significant and positive is an indicator of the constancy of the forces that determine food acceptance and rejection. When excess food was available, as it was for the "highs" in this experiment, these constant forces could exert their full effect in both cycles. The result was the nearly perfect correlation between the two distributions.

Another measure of consistency was the degree of correspondence of the distributions of preference and consumption with those from an independent study. Such distributions were available from the 1959 Greenland exercise, where the Meal, Combat, Individual was one of the rations used. Correlations across items were obtained between the 1959 distri-

butions and the 1960 distributions for "highs" and "lows" (Table 9). Preference correlated .83 with the 1960 "highs" and .81 with the "lows", which is at nearly the same level as for the different experimental conditions of the 1960 experiment. The correlation between the 1959 consumption figures and the 1960 "high" averages was .73, which is comparable to the central tendency of the correlations among various conditions in the 1960 experiment, although definitely lower than the .98 correlation between the two 1960 highs. The correlation of the 1959 distribution with the 1960 "lows" distribution, at .47, was somewhat lower, although it is still significant at the one percent level.

Table 9

Correlation of Percent Consumption and of Average Preference Ratings for Items Between 1959 and 1960 Greenland Exercises

	Correlation
Consumption	
1959 Average vs. 1960 High Average	.73
1959 Average vs. 1960 Low Average	.47
Preference	
1959 Average vs. 1960 High Average	.83
1959 Average vs. 1960 Low Average	.81

Level of Food Consumption

Table 1 provides information on another point, namely, the amount of food actually required. It is both the popular, and official, belief that food requirements are substantially higher for men operating in cold climates than for those in temperate or tropic regions. For this

reason the Northeast Air Command Master Menu allows for 4800 calories/man/day. Greenland, because of the special rigor of its climate, is allowed an additional 50 percent, making a total allowance of 7200 calories/man/day. The data of Table 1 indicate that this allowance exceeds actual requirements. The subjects in this exercise were performing hard physical labor and were living under much more rigorous conditions than the usual camp-based soldier. Moreover they did not have access to other, "non-official" food sources such as the Post Exchange. Hence, their food consumption should have been maximal. However, of the 20 "high level" 10-day averages, only eight are over 4000 calories. Examination of the individual data shows that of the 200 cases (10 men x 20 days) there were only eight cases where a man used the full 4800 calories (all in Team CD during Cycle II) and only 30 cases where the intake was 4500 calories or over.

Average intake for those on the high level of feeding over the entire experiment was 3848. Nor did these men sustain serious weight losses during the 10-day experimental periods. Similar findings came from the 1959 Greenland exercise (1). Average daily intakes were 4267 for the Meal, Combat, Individual; 4114 for the Quick-Serve Meal; and 4519 for the 5-in-1. Again, there were no serious individual weight losses, and there was an average gain in weight. This shows that the 4800 calorie allowance, since it is fully adequate for men under difficult bivouac conditions, should be more than ample for camp based troops. Obviously, 7200 calories is far in excess of requirements.

Prediction of Food Acceptance

Preference is concerned with feelings about food; acceptance with actual behavior. These two aspects are positively related, yet they are not the same nor are they perfectly correlated. People tend to eat the foods they like, yet there are also many motives other than pleasure for eating. One eats what is available, he eats because of social pressures, and he eats in response to hunger to replace the energy he has used.

Preference is easier to measure than is actual acceptance, since it may be accomplished by a verbal stimulus presented in a questionnaire. To get a valid measure of acceptance requires careful records of food intake over a period of time. Actual acceptance is more variable than preference, and is more closely dependent on elements of the particular situation, such as the degree of physiological need and the amount and variety of foods available. The question of the validity of predicting acceptance from preference measurements is important to the military because of the extensive use that is made of preference data in support of food research and development and in the planning of ration systems and menus. Validity is often assumed, usually with the awareness that there are limitations but without specific knowledge of the degree of limitation.

What are the limits? How good are the predictions of actual behavior? How is the relationship affected by environmental conditions? The present study provides useful insights in this problem area to add to the results of a number of careful studies which have been done previously.

Pilgrim (3) correlated soldiers' hedonic scale ratings for 66 foods with the percentage of men taking the foods from the serving line in Army messes. The correlation between preference and consumption was .55; however, use of additional variables, such as judged satiety value and the percent of calories in the food from fat and protein, gave a multiple correlation of .88. This supports the view that preference is important but is only one of several factors.

The publication, "Food Preferences of Men in the U. S. Armed Forces," (2) summarizes a series of studies conducted with populations of soldiers in different military situations. Two indices of acceptance were used: (a) percent of men taking a food on the serving line, and (b) actual consumption of foods. Consumption was measured under conditions ranging from severe restriction on types and amounts available to complete ad libitum, where a man could have as much as he wanted of a wide variety of foods. The preference measure was hedonic scale ratings obtained either directly from the men participating in the studies or from the National surveys.

Three main conclusions were derived: (a) there was always a positive and fairly good correlation -- ranging from .59 to .77; (b) correlations were lower for conditions where the amount or variety of food was restricted than for non-restrictive conditions; and (c) correlations were lower within classes of foods which may be considered central to the diet, such as meats and breads.

Results of the present study generally corroborate these earlier findings and, in addition, provide some new information which may be capable of generalization beyond the particular experimental situation. All correlations between preference and consumption were significant and positive, and were higher when the conditions were less restrictive, i.e., for the full-fed groups. The previous finding of a lower correlation for "central" types of food was confirmed, although the evidence was not strong. The most important new evidence lies in the fact that the special conditions of this experiment -- high energy demand and planned underfeeding -- caused little change in the relationship between preference and consumption. Despite the high energy expenditure, with its correlated higher need for food, the men still ate the foods they liked and tended to reject those they disliked. When the additional stress was imposed of restriction in the amount of food available, there was little change in the preference-consumption relationship.

An important implication of these findings is that preference measurements made under other conditions will be valid for predicting relative acceptance under stress conditions. A possible qualification is that the men's preferences, as well as their actual acceptance, were altered by the special conditions; however, food preferences are usually quite stable, since they carry a large component of general attitude.

Conclusions

1. Under conditions of dietary restriction soldiers' average preference ratings of foods increased significantly, and nearly all (97 percent) of available food was eaten.

2. There was a positive and high (.51 to .86) correlation between food preferences and actual food consumption for subjects subsisting on the Meal, Combat, Individual and living under conditions of high physical demand.

3. The correlation was higher (.77 to .86) for men eating a full 4800 calories ration than for those eating only 2400 calories (.51 to .84).

4. Relative preferences among ration items were highly intercorrelated (.84 to .97) among different groups of men whether at the same or at different feeding levels.

5. Relative percent consumption for various ration items was significantly correlated among the different groups of men, although the correlations were generally lower than for preferences.

6. Relative preferences among items were closely similar to those established for the Meal, Combat, Individual in the 1959 Greenland study (.81 to .83).

7. Relative percent consumption among items in the 1959 study was significantly and positively correlated with percent consumption in the present study, although the relationship with those on the high level of feeding was stronger (.73) than for those on the low level of feeding (.47).

8. Average caloric intake for men on the high level of feeding was 3848 calories/man/day, 80 percent of the 4800 avilable calories; the average intake for those on the low level was 2339 calories, or 97 percent of the 2400 available calories. Average weight losses were not excessive.

9. Subjects on the low level of feeding tended to reject the same food items as those on the high level.

10. The "meat" items of the Meal, Combat, Individual represented the most serious acceptance problem, being rejected to the extent of 45 percent by the "highs" and six percent by the "lows." Beverages, (principally coffee) were rejected to the extent of 36 percent by the "highs" and 13 percent by the "lows"; however this class represents only ten percent of the ration calories.

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