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### FOOD PREFERENCE, ACCEPTANCE AND CONSUMPTION IN A SIMULATED, ISOLATED-DUTY STATION

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May 1977

UNITED STATES ARMY NATICK RESEARCH and DEVELOPMENT COMMAND NATICK, MASSACHUSETTS 01760

**Food Sciences Laboratory** 

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#### SUMMARY

The effectiveness of isolated duty stations depends on unusually careful planning to compensate for storage and logistical limitations. This study was an attempt to provide information pertaining to food related planning for such stations. The food choice and consumption behaviors of the crew of a simulated isolation duty station were measured in detail during a nine-day experiment. The laboratory located in a university building provided isolation from the outside for two functionally separate crews. The four members of the Increw spent the nine days working on an academic task unrelated to food, and were unaware that food and food related behaviors were a primary concern of the experiment. The eight members of the Outcrew were occupied with the control and operation of the experiment and the preparation and recording of food and food related behavior. While the daily schedule of the Increw was very regular, with fixed work and leisure times and normal meal times, the schedule of the Outcrew was variable and irregular. All 12 crewmembers completed Food Preference Survey forms and kept daily Food Consumption Diaries, and complete measures of food selection and consumption were recorded for each of the 12. The food items for each meal or snack were individually selected by each crewmember from a large list of available items.

Overall caloric intake was higher than expected from available comparative data, with a consequent weight gain for many of the crewmembers. There was day-to-day variation of caloric intake for all crewmembers, but the only clear general trend was a decline in intake on the final two days. Increwmembers, with a relatively normal schedule of activities, displayed a fairly common pattern of intake during a day, with about 19% of their calories obtained from breakfast, 30% from lunch, 35% from dinner and 16% from snacks. For Outcrewmembers, with irregular schedules, the proportion of calories obtained from lunch and snacks was switched: 16% from lunch and 30% from snacks, while proportions for breakfast and dinner were the same as for Increwmembers.

There appeared to be no systematic shifts in probability of selection for either food classes or individual items as a function of the duration of the experiment. Selection of items for meals remained quite typical of the normal meal composition, even among Outcrewmembers with irregular schedules. The items which were ordered more than once by at least 25% of the 12 crewmembers were also generally from food classes with the highest overall probabilities of selection.

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In this experiment then the best general predictor of food item choice was the preferred frequency rating score from a Survey completed during habitation. The extent to which this superiority over hedonic preference scores would occur in a longer habitation, or with a more limited menu, simply cannot be determined from these data, although it is likely that the hedonic preference rating scores correlations were artifactually reduced by the design of this experiment. Even in this experiment, however, the correlations between food choice and hedonic preference scores from the second and third Surveys (during habitation) were higher than those from the first Survey (before habitation).

In comparing actual and recorded food consumption, errors were found both in reporting the consumption of a food item and in estimating the amount consumed. Several factors influence the occurrence of these errors. An error in reporting a food item was more often due to a failure to record that food item in the diary, and generally a structured and regular work schedule increased the accuracy with which food items were reported. Errors in estimating the amount consumed tended to be overestimations if the food item was a solid and tended to be underestimations if the food item was a liquid. The estimated amount of a liquid, which may have been determined by the volume of the container in which it was served, was generally more accurate than the estimated amount of a solid, but this varied according to the specific gravity of the liquid. The differences between the amount of calories actually consumed and the estimated amount of calories derived from the weight estimations, also depended largely upon the consistency of the food items. Solids, generally, had a higher caloric intensity and a larger estimation error than liquids, resulting in a greater difference between actual and estimated amount of calories for solids than for liquids. Furthermore, the amount of calories in solids were overestimations of actual consumption and underestimations for liquids.

Due to the very complex nature of the design of the experiment, there are data from several sub-experiments not included in this report. These data include the add and delete forms and test items determined prior to the beginning of the experiment, the food quality survey and debriefing questions at the end of the nine days, and the protocol of food related conversation by the four Increwmen. Analysis of these data was not included in the Contract under which this report was developed.

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#### FOOD PREFERENCE, ACCEPTANCE AND CONSUMPTION IN A SIMULATED, ISOLATED-DUTY STATION

#### INTRODUCTION

Isolated, small-crew, duty stations must provide a complete living environment for their inhabitants. The inhabitants are generally most productive when the isolated environment provides for a lifestyle very similar to the individuals' previous experience. Optimally, the isolated duty station would provide the full range of activities and choices available in ordinary life settings. Unfortunately, the logistic difficulties created by the remoteness of such stations dictate severe restrictions of the optimum living environment. These restrictions are most noticeable as reductions in the freedom of immediate choice by the inhabitants. While an acceptable spectrum of activities and provisions is included in most isolated stations, their use is rigidly preplanned and scheduled. The extent and rigidity of this preprogramming is the result of limited storage space and the difficulty or impossibility of replenishment from the outside. The effect of the extensive preprogramming is the curtailment of spontaneous choices by the inhabitants and the difficulty of compensating, on the spot, for deficiencies and errors in the preplanning. As a consequence, the process of preplanning is critical, and any information which will facilitate effective planning is significant.

The effect and importance of the process of preplanning is more obvious with regard to food than it is for any other aspect of the isolation environment. Factors which increase the difficulty of food related preplanning include the fact that much of it is perishable, menu planning is complex in that it involves several items at a time, individual preferences are very strong, good nutrition must be maintained, and the fact that isolation station inhabitants regard "good" meals as perhaps the most significant element of successful habitation.

This experiment, in the setting of a simulation of an isolated, small-crew, duty station, was directed toward obtaining information relevant to food planning. There were two primary goals. The first was to assess the effects of isolation on various food behaviors, including amount and pattern of food consumption, and patterns of choice and selection as related to stated preferences. The second goa. was the evaluation of some procedures for gathering food related data from crewmembers. These included food hedonic preference and preferred frequency rating scales, and the food consumption diary.

#### EXPERIMENTAL DESIGN

The experiment was conducted in a university laboratory designed to functionally simulate an isolated small crew duty station. It provided a self-contained or closed living environment for twelve people, with about seven square meters of space for each person. The laboratory was divided into two separate but adjoining areas, each containing several rooms, and each self-contained with a bath and facilities for leisure, sleeping and work. The smaller area, Inner Space, was adequate for four crewmen, and contained Closed Circuit Television cameras and microphones, but included no food storage or preparation facilities. The larger area, Outer Space, was the control and observation center, and contained food preparation facilities for the entire crew of twelve. The experiment which was run during August, 1974, was nine continuous days in duration, with none of the crewmembers leaving the laboratory during that period. The most significant differences between the simulation and an actual isolated station were the virtual absence of physical stress and danger, and the inclusion of the food experiments.

Of the total of twelve crewmembers, four were a select crew, the <u>Inner Crew</u>, inhabiting the smaller Inner Space and thus separated for the duration from the eight members of the <u>Outer Crew</u>. The Inner Crew, unaware that the primary purpose of the experiment was the study of food behavior, worked about eight hours per day to complete a college course for credit and a grade. The eight Outer crewmembers constantly monitored the activities of the Increwmen and prepared the food and maintained food related data collection for all 12 crewmembers.

Each of the 12 completed a food hedonic preference and preferred frequency rating scale, before, during and at the end of the experiment, and each kept a daily 24-hour diary of food consumption during the experiment. Each crewmember selected all food from one of three large lists, a snack list with 40 items, a breakfast list with 25 items, and a lunch-dinner list with 126 items. Each individual item was weighed as served, as was any unconsumed remainder.

The design thus provided for the examination of the following:

- o The temporal pattern, within and across days, of food consumption.
- o The temporal pattern, across days, of choice of types of food.

- Changes of expressed food hedonic preferences, as measured by the rating scales, during habitation.
- The relationship between hedonic preference, as measured by the rating scales, and actual food choice.
- The relationship between expressed food hedonic preference and the amount consumed.
- The accuracy of reporting on the food diary the specific items actually consumed.
- The accuracy of reporting on the food diary the amounts actually consumed.

#### METHOD

<u>SUBJECTS</u>. The total group of 12 subjects was composed of two unique subgroups, the Increw, a select group of four, and the Outcrew, a group of eight laboratory staff members.

The Increw were four male university students between the ages of 23 and 25. Of the pool of prospective subjects available, the four selected had mean hedonic preference scores most nearly approximating an Air Force mean food hedonic preference score. These scores were derived from ten of the foods on a 220-item food Preference Survey administered three weeks before the experiment. Each was in apparently excellent physical health and was within the normal weight range for his age and height. They were in apparently good mental health, and scored within normal ranges on the Minnesota Multiphasic Personality Inventory. Each had previous military service, one having served a tour in an isolated duty station. Each also had an expressed need for credit for a statistics course.

During extensive interviews and briefing sessions, the nature of the simulation, its duration, requirements and hazards, were fully explained to the Increwmen. The explanations stressed the idea that a primary goal of the experiment was to study and record their use or consumption of all the features and provisions of the habitat, including leisure provisions such as music, books and magazines, and living provisions such as hygiene materials and food. Throughout the experiments all the food related procedures had apparent counterparts relating to other types of consumables. Daily consumption diaries, for example, were kept for music, reading and TV as well as for food. The special emphasis on food was not revealed to the Increw until the post experi-

ment debriefing, at which time all four, even when questioned about the purpose of the experiment, stated that they had been unaware of any unique emphasis on food.

Each of the Increwmen was paid \$250.00 for participation, and successfully completed the statistics course for credit and a grade.

The eight members of the Outcrew included the Principal Investigator and seven undergraduate student assistants, all experienced in the design and execution of isolation studies. Since they participated in the set-up of the experiment, all were aware of the special emphasis on food procedures and data. The age of the P.I. was 41, the students between 21 and 31, and all body weights, shown in Table 1, were within normal ranges. Three of the Outcrew were females. All food related measures, procedures and data pertaining to the Increw were also applied to the Outcrew, who also prepared and weighed food for the entire crew. For participating in isolation, the students were paid \$250.00 in addition to their regular pay as staff members.

In addition to the twelve isolated crewmembers, there were other "non-isolated" personnel involved in the execution of the experiment. There were three student assistants whose task was to bring provisions and supplies, as needed during the experiment, to the door of the laboratory. Two members of the professional staff of the Natick Research and Development Command also participated extensively in the planning and execution of the experiment. At least one of them was working with the Outcrew during the entire experiment.

FACILITIES, INSTRUMENTS AND PROVISIONS. The laboratory included a large control and observation room immediately adjoining, but acoustically and visually separated from the inner confinement area. (See Appendix F for the plan of the isolation laboratory.) The control room (120 m<sup>2</sup>) included a fully equipped kitchen, and an observation and data area, adequate hygiene facilities and an adjoining leisure-living area.

The inner confinement space included: (a) a work room  $(9 \text{ m}^2)$ , containing a large table and secretary's chairs, book shelves, calculators, reference and work material for the statistics course, and music speakers; (b) two general purpose rooms  $(9 \text{ m}^2)$ , each containing a TV set, high quality stereo system, large and small chairs, and drapes and carpet; (c) a bathroom (2.5 m<sup>2</sup>), with shower, sink, small toilet, cabinet and shelves with linens and toiletry supplies; and (d) a hallway

 $(9 m^2)$  with additional storage shelves. The wall between the Inner Space and the Control Room contained an interlock for delivery of food, exchange of small items, and garbage ejection without exposure to the Control Room. An intercom system provided communication between each of the Inner areas and the Control Room. Closed Circuit Television cameras and multiple microphones provided for continuous monitoring of Increw activities in all areas except the bathroom. Dim lights remained on at all times.

Control of temperature, lights, water, music, TV, etc., were directly accessible to the Increw. Leisure provisions were located within Inner space, and included the following:

- Music: More than 1000 taped records distributed among all the major categories such as classical, folk, rock, show tunes, etc.
- Books: Approximately 500 books distributed among categories such as fiction, poetry, best sellers, hobby books, philosophy, etc.
- Magazines: A variety of current men's magazines, technical and business magazines, comics, etc.
- Games, Hobbies, and Crafts: Included group and solitary games, cards, wood carving, painting, fiber optics, puzzles, etc. Television: Included three local stations in black and white.

Work materials provided for each Increwman consisted of a set of volumes entitled "Psychological Statistics" (published by Individual Learning Systems), a calculator, a spiral notebook, graph paper, and pencils. Also available were various additional statistics texts and a reference list to guide the Increwmen to other material and exercises. A unit test was provided for each unit in the programmed sequence and a comprehensive final exam was given on the last day of the experiment.

The kitchen, located in the Control room area, was approximately 3.5 m x 3.5 m, with one side open to the Control room. Equipment included a stove, oven, sink, three refrigerators, shelving and counters, a microwave oven, and a Mettler P 1200 top loading scale. All food was served on disposable containers of lightweight plasticware manufactured by Sweetheart Paper Company, Inc.

There were 158 food items available, all taken from the Armed Forces 42-Day Master Menu. Most entrees were obtained, as needed, freshly prepared from "franchise type" restaurants in the area. Entrees not available from area restaurants and all other foods such as breakfasts, vegetables, salads and snacks were prepared in the kitchen from "name brand" canned or frozen packages. Fresh fruits, vegetables and eggs were obtained from the local "farmers' market".

There were three types of menu/order forms, one each for breakfast, lunch/dinner, and snacks. Identical menu/order forms were available for all crewmembers for all days of the experiment. Each form provided space for the crewmember's name and the date and time. Each item available on that menu/order form was printed with space for the crewmember to indicate which items were desired, how many units of those items, and how they were to be prepared, (well done, over light, etc.). Space was provided beside each item for recording the weight of the container, the gross weight when served, the gross weight when returned and the weight of edible waste returned. Appendix A details, for each of the 158 items, the menu/order forms on which it was available, the total number of times it was actually served, and the average weight, in grams, of the servings of that item.

The consumption diaries were mimeographed forms divided into separate segments for food, music, reading, and TV. Each diary form covered a 24 hour day and was subdivided into four quadrants of the day, with quadrants beginning at 0300 hours, 0900 hours, 1500 hours and 2100 hours, respectively. These hours insured that, at least for Increwmen, meals fell within, rather than on, the boundaries of a quadrant. The diary form included four pages, one for each quadrant. The food portion of the diary contained space for recording the various items consumed during the four quadrants of the previous day, the number of units of that item consumed, and the estimated weight of the items consumed in ounces. (One of the Inner crewmen was, at his request, permitted to record estimates in grams.) The printed instructions for the diary are included as Appendix B.

The Preference Survey form included sections for food, music, reading, and TV, all in a similar format. The food part of the Survey form included 220 items, drawn primarily from the Armed Forces 42-Day Master Menu, including all of the 158 items available in the experiment. The items included on the form but not available in the experiment are listed in Appendix C. The form provided for rating each item on two different scales, a nine-point hedonic preference scale and a preferred frequency scale. The hedonic preference scale ranged from 1 (dislike extremely) to 9 (like extremely). The preferred frequency scale provided for a judgement (from 0 to 30) of the number of days per month that item was desired. Space was also provided for indicating that an item had never been tried.

PROCEDURE AND SCHEDULES. Three weeks before the experiment all twelve crewmembers completed the Preference Survey form for the first time and received their first extensive briefing about the schedule and procedures during the experiment. One week before the experiment each of the twelve, except the P.I. received a "tentative" menu drawn from the results of the initial Preference Survey. The food part of this menu omitted fifty items of high, medium, and low average hedonic preference values, and contained ten items of extremely low average hedonic preference value. Each of the eleven crewmembers was asked to list items they desired to have added to the menu and items they felt could be dropped. The final 158 item menu was then prepared by adding a previously selected high mean hedonic preference subset of ten of the omitted 50 items whether or not any crewmember suggested them, and any other item from the 220 item Preference Survey List which any crewmember suggested. Items suggested for dropping were left on the menu to determine whether they would, in fact, be chosen. Analogous procedures were also used for music and reading, in order to avoid calling the attention of Increwmen to the special importance of food in this experiment.

During the evening prior to the formal start of the experiment there were additional extensive briefings and instructions for all crewmembers, and Informed Consent Forms were signed by all. Following the signing of the forms, the crews were separated, the door between the two areas and the door to the outside were formally closed for the duration. The doors were never physically locked, permitting rapid egress in the case of an emergency. During the remainder of the evening all procedures to be used throughout the experiment were put into effect, providing enough practice to permit them to run smoothly when the experiment formally began the next morning.

The daily schedules and types of activities during the experiment were somewhat different for the Increw and Outcrew. The work task for the Increw was the statistics course, which required approximately eight hours per day, and their schedule was formal and regular, whereas the Outcrew was performing the diverse variety of work associated with running the experiment, preparing and handling all the food and maintaining continuous observation of the Increw. As a result, the daily schedule of the Outcrewmembers was much less regular. Work shifts began as early as 5:30 A.M. and ended as late as 1:00 A.M., with at least one person required for the all-night shift each day.

The daily schedule for the four Increwmen was built around a required 9 to 5 workday with a 30-minute lunch break. Their meal availability periods were 0700 to 0900, 1130 to 1300, and 0730 to 0900, with snacks, including beverages, available anytime, day or night. The workday began at 0900, with the task of filling out the daily Consumption Diary form, recording on it all items consumed during the 24 hours preceding 0300 that day. On the fourth day this requirement also included completing a Preference Survey Form, and on the ninth day, both a Preference Survey Form and a Food Quality Form. Use of leisure facilities and provisions was not permitted during working hours, except during the lunch break. Each crewman was required to record his body weight before breakfast.

For members of the Outcrew considerably more flexibility of schedule was required, since work schedules began at different hours on different days for each crewman. In general, breakfast was available within the first two hours after awakening, before 1230. Lunch and dinner windows were then set at approximately four and eight hours after breakfast, except that no dinner was served after 1130. Outcrew members were expected to weigh themselves soon after awakening, and to complete Consumption Diary forms within two hours, cr as soon thereafter as their work schedule permitted.

All crewmembers ordered their food and snacks via the printed menu/order forms. All items desired at that time were checked on the appropriate form which was relayed to the Outcrewmember in charge of orders. Snack orders were filled immediately, while breakfast orders were required to be placed at least 30 minutes before serving, and lunch/dinner orders at least 90 minutes early. If a meal order required a restaurant entree, the order was called to the appropriate restaurant, and one of the non-crew personnel stationed outside the laboratory was sent to get it. All the items on each order were served in individual containers on a single tray. Serving sizes were deliberately varied approximately 50% around a "normal" serving size, in order to reduce the predictability which might otherwise influence size estimates in the food Consumption Diaries. Each item was weighed before serving by an Outcrewmember, but no member weighed his own food. For every

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item the container weight and gross weight of item and container was recorded on the menu/order form. After reheating in the microwave if necessary, the order was delivered to the requesting crewman. The individual was expected to eat as soon as served, without removing foods from the tray, or sharing any food, and to return the tray as soon as the meal or snack was completed. Upon return, the gross weight of each remainder and container was recorded, any edible remainder was removed, and the gross weight of the inedible waste and container was recorded. (The edible remainder was consistently determined via operational procedures defined prior to the experiment.) This procedure provided for determining the exact amount of every food item consumed by each crewmember.

Beginning and ending times were also recorded for each individual's meal. Comments were solicited regarding any item which was largely uneaten, and a comprehensive log was kept of all food related conversational comments among the Increwmen throughout the experiment.

During the last day of the experiment each Outcrewmember underwent a debriefing interview, as did each Increwman on the evening of the same day. The interview included questions about major discrepancies between successive Preference Survey forms, about food changes that might be desirable for longer experiments, about the most pleasant and unpleasant eating experiences, about the extent to which their food behavior during the experiment differed from their usual food behavior, and about the desirability of more limited menus which changed from day to day, as compared to the large but constant menu used in this experiment.

#### RESULTS

#### FOOD CONSUMPTION

On the average, the rate of food consumption during the experiment exceeded 3000 calories per day. As shown in Table 1 the grand average daily rate was 50 cal/kg. As a point of comparison, the average daily pre-mission intake for the crews of Apollo 9, 12, 16 and 17 was 37 cal/kg, and this decreased to 27 cal/kg during the mission. As may be seen in Table 1, the high food consumption rate in the present experiment led to an average weight gain of 1 kg, or 1.5%, during the experiment. The Outcrew, whose level of activity was considerably greater,

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	Crewn	nembers	during the E	xperiment	•
			During	g First Eight	Days
Crewmember	Sex	Mean Weight	Weight Change	Calorie <b>s</b> Per Day	cal/kg Per Day
Inner I	М	73.5	+1.4	3191	43
Inner 2	М	60.3	+1.4	3123	52
Inner 3	М	70.3	+1.4	3580	51
Inner 4	М	74.8	-0.9	3094	41
Inner Avg		69.7	+1,3	3247	47
Outer 1	м	75.8	0.0	3631	48
Outer 2	М	72.1	+2.3	3850	53
Outer 3	F	49.4	+0.7	2302	47
Outer 4	F	48.1	0.0	3188	66
Outer 5	F	52.2	+1.8	2949	57
Outer 6	Μ	60.8	+2.3	3697	61
Outer 7	Μ	75.3	0.0	3593	48
Outer 8 (PI)	Μ	65.3	0.0	2781	43
Outer Avg		62.3	+0.9	3249	52
Grand Avg		64.8	+1.0	3248	50

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Weight and Caloric Intake of Individual Crewmembers during the Experiment

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also had a higher average rate of caloric intake with a smaller average weight gain than the four Increwmen.

That there was considerable day-to-day variation in the caloric intake for individuals can be seen from the curves for the four individual Increwmen in Figure 1. The variation was even greater for the Outcrew, whose work/sleep schedules, unlike the regimented schedules of the Increw, varied greatly from day to day. As seen in the grand mean curve, there was a general tendency to eat more than average during the first day, and all but one of the twelve ate less than their daily average mean on the eighth day. Although there were large individual differences in the day-to-day pattern, the composite grand mean curve suggests a cyclic pattern overall. The downward trend on the eighth day appears to have continued on the ninth day, which is not presented because complete data were not obtained on that day. Though the form of this general consumption cycle may generalize to other ten-day experiences, it is probably not safe to generalize it to habitation of different durations. Data from previous experiments in this laboratory suggest a strong influence of the beginning and ending days on the pattern of consumption of both food and nonfood resources. It is not impossible that the sharp decline toward the end was partially the result of the gain in weight, which was emphasized by the fact that each crewmember recorded his weight daily.

On the average, both crews consumed about 35% of their total daily calories at dinner, and about 20% at breakfast. As seen in Table 2, however, there was a very large difference between the crews in the distribution of the remaining 45% of calories. The Increw, living by a regular schedule, took 30% of their calories as lunch, and only 16% as snacks. The pattern was exactly reversed, 16% lunch and 30% snacks, for the Outcrew. This reversal probably is due to the unique schedule of the Outcrew, who, on days when their work schedule began late, tended to eat a late breakfast and skip lunch altogether, compensating with an increase in snacks.

As seen in Table 3, there was considerable day-to-day variation in the distribution of calories among meals. For individual crewmembers the effect is even greater, as illustrated in Figure 2, Figure 3 and Figure 4. These figures present cumulate curves of caloric intake as a function of time of day, for each day of the experiment. Figure 2 depicts the consumption pattern of Increwman #3. His pattern was typical of all the Increwmen. Figure 3 is for Outcrewmember #1, who had the least regular

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Fig. l

Day-to-day variations in caloric intake during isolation. The values shown are deviations from the mean caloric intake averaged over the entire eight days

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#### Table 2

#### Average Daily Caloric Intake as Distributed Among Meals and Snacks

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			م الفان مين المراجع مين المراجع المراج المراجع المراجع
	Inner 4	Outer 8	Total 12
Broaklast	18.6%	20.2%	19.6%
Lunch	30.4%	16.2%	21.1%
Dinner	34.7%	34.6%	34.7%
Snacks	16.3%	28.9%	24.7%

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Table 3

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Percent of Individual's Daily Caloric Intake as a Function of Meals and Snacks

				Day of Ex	periment			
	1	2	3	4	5	9	7	8
Inner 4								
Breakfast	18	16	16	18	21	24	15	20
Lunch	38	33	26	29	26	28	31	32
Dinner	29	37	38	31	37	32	39	35
Snacks	15	14	20	21	16	16	15	13
Outer 8								
Breakfast	26	22	22	25	19	12	22	12
Lunch	9	20	21	11	23	16	17	20
Dinner	36	32	31	37	36	36	30	41
Snacks	33	26	26	27	23	36	32	27
Total 12								
Breakfast	23	20	20	23	20	16	20	15
Lunch	16	24	23	17	24	20	21	24
Dinner	33	34	34	35	36	35	32	39
Snacks	27	22	24	25	21	29	26	22

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Temporal pattern of food consumption for Outcrewmember #1. Consumption is shown as a cumulative record across nine days of isolation, but the ninth day does not include the evening meal

Fig. 3

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Fig. 4

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Temporal pattern of food consumption for Outcrewmember #3. Consumption is shown as a cumulative record across nine days of isolation, but the ninth day does not include the evening meal



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pattern of consumption, while a pattern relatively typical for the Outcrew is seen in Figure 4, (Outcrewmember #3). Generally the variability was much greater for Outcrewmembers.

In general, there does not appear to be any consistent trend, over days of inhabitation, toward a systematic change in the allocation of caloric intake among meals and snacks. The variations from dayto-day are large, particularly for the Outcrew, but the variation between individuals is also large enough to mask any systematic trends.

Food consumption as a function of food classes is shown in Tables 4-6. Each of these tables, one each for breakfast, lunch and dinner, indicates the average amount, in both grams and calories consumed by a crewmember from each food class. The Inner 4 and Outer 8 were remarkably similar for both breakfast and dinner, with some difference apparent for lunch. At breakfast Outcrewmembers consumed less fruit juice and hot beverage, which were in fact frequently obtained as snacks before breakfast was served. Outcrewmembers also ate some grits (Class 16) while Increwmen did not. At dinner, Outcrewmembers consumed less milk and more beer than Increwmen, and consumed more meat from the extended meats class than did Increwmen. Both crews tended to eat a relatively typical meat and vegetables dinner. At lunch, the distributions for In and Out crewmembers are similar except for sandwiches and colas. This is again consistent with the tendency of the erratically scheduled Outcrew, to omit, or at least minimize lunch on the days when they ate a late breakfast, whereas Increwmen tended to eat a relatively stereotyped sandwich and cola lunch. In general, then, the food class composition of the various meals appears quite similar for the two crews.

Inspection of daily meal by class distributions revealed large day-to-day variations, but no trace of any consistent trend over days toward a change in the distribution of consumption among food classes.

Examination of calorie figures in Tables 4-6 reveals that caloric intake at breakfast was largely drawn from eggs, pancakes and waffles; and biscuits, toast and donuts. At lunch the greatest caloric input is drawn from sandwiches and short orders, and colas. At dinner, caloric intake is greatest for meats, desserts and hot breads. Table 4

### Breakfast

Food Consumption as a Function of Food Class

			Grams			Calories	
В М	d Class	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
10	Soups						
02	Juices, Fruit and Vegetable	183	127	146	82	52	62
03	Drinks, Iced Coffee, Iced Tea						
04	Hot Beverages	66	57	71	1	7	ŝ
05	Milk Products	104	113	110	69	74	72
90	Beverages, Carbonated						
07	Beer						
08	Hot Breads, Donuts	37	34	35	135	125	129
60	Breakfast Cereals, Griddle	27	45	39	69	169	136
10	Eggs	73	75	74	141	145	144
11	Breakfast Meats	23	14	17	97	58	71
12	Fish and Seafoods				_		
13	Meats						
14	Stews & Extended Meats						
15	Short Orders, Sandwiches						

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Table 4 (Continued)

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Breakfast

Food Consumption as a Function of Food Class

		Grams			Calories	
Food Class	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
ló Potato and Potato Substitutes 17 Green Vegetables		14	თ		2	S
18 Yellow and other Vegetables						
17 Jaiaus, vegetable and Green 20 Salad Dressing						
21 Fruit	21	29	27	σ	17	15
22 Cookies, Brownies, Cakes			-	•	i	) 4
23 Pies						
24 Ice Cream, Pudding			,			
<b>25 Sna</b> cks, Candy						

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Table 5

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Lunch

# Food Consumption as a Function of Food Class

		Grams			Calories	
Food Class	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
01 Soups	6	80	8	9	9	9
02 Juices, Fruit and Vegetable		6	9		2	2
03 Drinks, Iced Coffee, Iced T	ea 58	40	46	1	1	1
04 Hot Beverages	22	7	12	0	0	0
05 Milk Products	42	68	59	28	45	39
06 Beverages, Carbonated	191	52	96	74	21	39
07 Beer	_	30	20		13	80
08 Hot Breads, Donuts	12	2	6	37	20	26
09 Breakfast Cereals, Griddle	,•					
10 Eggs						
11 Breakfast Meats	<u></u>					
12 Fish and Seafoods	80		e	18		9
13 Meats	21	9	11	63	12	29
14 Stews & Extended Meats	27	47	41	36	68	58
15 Short Orders, Sandwiches	158	61	93	419	167	251

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Table 5 (Continued)

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Lunch

# Food Consumption as a Function of Food Class

		Grams			Calories	
Food Class	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
16 Potato and Potato Substitutes	23	13	16	60	28	39
17 Green Vegetables	m	2	2	7	1	1
18 Yellow and other Vegetables	24	8	13	21	8	13
19 Salads, Vegetable and Green	35	38	37	10	15	13
20 Salad Dressing	б —	7	80	48	33	38
21 Fruit			2		1	1
22 Cookies, Brownies, Cakes	2	18	15	24	47	40
23 Pies	25	7	13	65	21	35
24 Ice Cream, Pudding	44	14	24	77	25	42
25 Snacks, Candy						
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Table 6

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### Dinner

# Food Consumption as a Function of Food Class

			Grams			Calories	
Po	d Class	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
10	Soups		16	11		13	80
02	Juices, Fruit and Vegetable		12	80		e	2
03	Drinks, Iced Coffee, Iced Tea	117	164	148	2	ę	r
04	Hot Beverages	39	2	15	0	0	0
05	Milk Products	133	66	88	88	43	58
90	Beverages, Carbonated	37	32	33	14	13	13
07	Beer	11	65	47	S	27	20
08	Hot Breads, Donuts	32	36	35	97	107	103
60	<b>Breakíast Cereals, Gr</b> iddle	-	* .				
10	Eggs						
11	Breakfast Meats						
12	Fish and Seafoods	39	27	31	87	60	69
13	Meats	104	72	82	294	202	233
14	Stews & Extended Meats	25	66	53	32	108	83
15	Short Orders, Sandwiches	10	7	8	24	18	20

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Table 6 (Continued)

Dinner

Food Consumption as a Function of Food Class

Foc	d Class	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
16	Potato and Potato Substitutes	72	. 09	64	80	67	71
21	Green Vegetables	45	27	33	21	15	17
18	Yellow and other Vegetables	41	35	37	28	31	30
0	Salads Vegetable and Green	54	68	66	13	15	14
20	Salad Dressing	12	15	14	60	73	31
2 2	Fruit	7	58	41	7	31	23
:22	Cookies. Brownies, Cakes	48	60	56	134	151	145
23	Pies	39	31	34	105	89	94
24	Ice Cream, Pudding	23	29	27	38	57	51
25	Snacks, Candy						

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FOOD CONSUMPTION: SUMMARY. Overall caloric intake was higher than expected from available comparative data, with a consequent weight gain for many of the crewmembers. There was day-to-day variation of caloric intake for all crewmembers, but the only clear general trend was a decline in intake on the final two days. Increwmembers, with a relatively normal schedule of activities, displayed a fairly common pattern of intake during a day, with about 19% of their calories obtained from breakfast, 30% from lunch, 35% from dinner and 16% from snacks. For Outcrewmembers, with irregular schedules, the proportion of calories obtained from lunch and snacks was switched: 16% from lunch and 30% from snacks, while proportions for breakfast and dinner were the same as for Increwmembers.

#### FOOD CHOICE

In order to examine the patterns of food choice during the experiment, the actual selections of meal items were transformed into probability scores. These scores were derived by dividing the actual number of selections by the number of opportunities for selection of that item. Inspection of distributions of these scores by day and by crewmember revealed little difference from the analogous distributions for consumption. There was large variability among individuals and the means of all 12 crewmembers combined varied noticeably from day to day. There were no detectable systematic shifts in probability for either food classes or individual items as a function of the duration of the experiment. The general pattern of choice of meal items as a function of food classes was obtained by calculating the probability, for each class, that at least one item from that class was selected at each meal by the average crewmember. These figures are shown in Table 7, and represent the average of all 12 crewmembers. (Differences between the two crews with respect to the distribution of choice among classes are identical to the differences relating to distribution of consumption, discussed previously.) The classes which had the highest probability of selection for each meal are shown in Table 8. The fact that the probabilities are numerically higher for the breakfast selections is at least partially due to the fact that the individual breakfast items were contained in a smaller number of classes than were the items available for lunch and dinner.

Another dimension of choice behavior is the repeated selection of the same item. Table 9 lists those items which were chosen more than

Table 7

## Probability That at Least One Item of a Class was Selected by the Average Crewmember at a Meal

		Breakfast	Lunch	Dinner
10	Soups	00.00	ŋ.05	0.04
02	Juices, Fruit and Vegetable	0.73	0.04	0.03
03	Drinks, Iced Coffee, Iced Tea	0.00	0.20	0.49
04	Hot Beverages	0.57	0.12	0.12
03	Milk Products	0.38	0.21	0.28
90	Beverages, Carbonated	00.0	0.46	0.10
07	Beer	0.00	0.07	0.12
08	Hot Breads, Donuts	0.74	0.17	0.61
60	Breakfast Cereals, Griddle	0.34	00.0	0.00
10	Eggs	0.58	00.0	0.00
11	Breakiast Meats	0.53	00.0	0.00
12	Fish and Seafoods	0.00	0.02	0.16
13	Meats	00.0	0.11	09.0
<b>1</b> 4	Stews & Extended Meats	0.00	0.21	0.17
<b>1</b> 5	Short Orders, Sandwiches	0.00	0,60	0.04

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Table 7 (Continued)

### Probability That at Least One Item of a Class was Selected by the Average Crewmember at a Meal

		Breakfast	Lunch	Dinner
16	Potato and Potato Substitutes	0.07	0.28	0.48
17	Green Vegetables	C. 00	0.04	0.28
18	Yellow and other Vegetables	0.00	0.15	0.29
19	Salads, Vegetable and Green	00.0	0.30	0.53
20	Salad Dressing	0.00	0.25	0.46
21	Fruit	ŋ. 19	0.02	9.16
22	Cookies, Brownies, Cakes	0.00	0.15	0.25
23	Pies	0.00	0.11	9.26
24	Ice Cream, Pudding	0.00	9.23	0.19
<b>2</b> 3	Snacks. Candy	0.00	0.00	0.00

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### Food Classes with the Highest Probability of Having an Item Selected for a Meal

	Р
BREAKFAST	
Hot Breads, Donuts	0.74
Juices, Fruit and Vegetable	0.73
Eggs	0.58
Hot Beverages	0.57
Breakfast Meats	0.53
LUNCH	
Short Orders, Sandwiches	0.60
Beverages, Carbonated	0.46
Salads, Vegetable & Green	0.30
Potato and Potato Substitutes	0.28
DINNER	
Hot Breads	9.61
Meats	0.60
Salads, Vegetable and Green	0.53
Drinks, Iced Tea	0.49
Potato and Potato Substitutes	0.48

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Class		Food Item	N. of Reneaters	Maximum No. Of Repetitions
.ov	Class Name	Foud Itell	vehearers	OI Nepermons
02	Juices, Fruit and Vegetable	Orange Juice	11	6
03	Drinks, Iced Coffee, Iced Tea	Iced Tea	6	10
04	Hot Beverages	Hot Coffee	2	10
05	Milk Products	Milk	6	10
90	Beverages, Carbonated	Cola	7	10
07	Beer	Beer	4	9
08	Hot Breads, Donuts	Hot Rolls	S	9
		French Bread	2	7
		Biscuits	S	9
		Buttered Toast	<u>б</u>	6
<b>6</b> 0	Breakfast Cereals, Griddle	Griddle Cakes	4	ъ
10	Eggs	Eggs to Order	10	7
11	Breakfast Meats	Breakfast Ham	9	5
		Bacon	9	7
12	Fish and Seafoods	Fried Shrimp	S	e
13	Meats	Sirloin Steak	S	ſ
15	Short Orders, Sandwiches	Barbequed Pork Sandwich	4	e C
16	Potato and Potato Substitutes	Baked Potato	4	6
18	Yellow and other Vegetables	Buttered Corn	4	2
19	Salads, Vegetable and Green	Tossed Green Salad	10	10
21	Fruit	Fresh Peaches	4	<b>بلہ</b>
22	Cookies, Brownies, Cakes	Strawberry Shortcake	4	5

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Food Items Often Chosen More Than Once by an Individual as Part of a Meal

once by at least 25% of the crew of 12. The number of individuals selecting an item twice or more is indicated, as is the largest number of repetitions by any crewmember. It may be noticed that this list includes items from the classes shown in Table 8 as having the highest probability of selection. This list does include one item each from three classes of lower probability; the corn from Yellow Vegetables, the peaches from Fresh Fruits, and strawberry shortcake from Cookies, Brownies and Cakes.

FOOD CHOICE: SUMMARY. There appeared to be no systematic shifts in probability of selection for either food classes or individual items as a function of the duration of the experiment. Selection of items for meals remained quite typical of normal meal composition, even among Outcrewmembers with irregular schedules. The items which were ordered more than once by at least 25% of the 12 crewmembers were also generally from food classes with highest overall probabilities of selection.

### FOOD PREFERENCE SURVEY

Analysis of the hedonic preference and preferred frequency scores from the Preference Survey completed before the experiment reveals, as shown in Table 10, variation in means and standard deviations among the individual crewmembers. The variation is smallest for the hedonic preference scores for the Inner 4, since these scores were part of the selection criteria for these four crewmen. Interestingly, however, the variation among preferred frequency scores (number of times an item is desired per month) is higher for that group. The overall correlation between hedonic preference and preferred frequency scores was 9.60, (0.64 for the Increw, and 0.58 for the Outcrew). The general pattern of scores was somewhat unusual for two of the Outcrew; Outcrewmember #2 rated almost every food as seven on the hedonic preference scale and ten days per month, and Outcrewmember #3 rated most foods as eight. Informal observations of their food behavior during the experiment indicated that this pattern actually did reflect their attitude toward food, they liked almost everything. Their general pattern of responding did not change appreciably on successive administrations of the survey form.

As can be seen in Table 11, there was a notable and consistent change in both hedonic preference and preferred frequency scores between the first and second administrations of the Survey, but little difference

Individual Mean Hedonic Preference and Preferred Frequency Scores from the Pre-Experiment Survey

Crowmombor	Hedonic P	reference	Preferred 1	Frequency
	Mean	Sigma	Mean	Sigma
Inner 1	6.64	1.47	7.32	5.32
Inner 2	6.39	1.45	14.32	11.87
Inner 3	6.14	1.78	2.73	4.22
Inner 4	6.90	1.05	7.66	4.24
Inner Avg.	6.52	1.44	8.01	6.41
Outer 1	6.71	1.40	9.22	7.18
Outer 2	6.85	.91	10.00	3.82
Outer 3	7.85	.63	4.14	4.59
Outer 4	6.58	1.60	7.41	8.58
Outer 5	7.00	1.21	5.85	6.89
Outer 6	6.33	2.20	4.89	5.73
Outer 7	6.55	1.28	8.39	5.71
Outer 8	5,86	2.33	3.19	4.97
Outer Avg.	6.72	1.45	6.64	5.93
Grand Avg.	6.65	1.44	7.09	6.09

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### Food Preference Survey

### Mean Hedonic Preference and Preferred Frequency Scores

	Before Experiment	Mid Experiment	End of Experiment
Hedonic Preference Inner 4 Outer 8 Total 12	6.5 6.7 6.7	6.2 6.5 6.4	6.3 6.5 6.4
Preferred Frequency Inner 4 Outer 8 Total 12	7.3 6.1 6.6	5.0 4.1 4.5	$6.0 \\ 3.9 \\ 4.4$

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between the second and third administrations, both of which occurred during the experiment. As shown, both the mean hedonic preference and mean preferred frequency were lower on the second Survey. This decrease, which occurred in all crewmembers except the older P.I. was accompanied by a decrease in the variability of both scores. There was also a marked decrease in the correlation between hedonic preference and preferred frequency scores, from 0.60 on the first, to 0.51 on the third administration. As discussed below, the scores from the Surveys administered during the experiment are better predictors of food choice. There are no data available to indicate the reason for this shift, although two explanations seem more likely than others. The shift may reflect a "practice effect" independent of any of the characteristics of habitation, or it may reflect an "anchor" or "point of reference" effect. At the initial administration of the Survey, individuals had no consistent quality standards to base their judgements on, whereas by the fourth day of the experiment they may have referred most judgments to the average guality of the food being served in the habitat.

A number of correlations between Survey scores and probability of food item selection were calculated. They are, however, all based on skewed distributions, and in most cases their numeric values are lowered as an artifact of one of the major characteristics of the experiment. There was a large number of food items available, and a limited number of meals in which to choose these items. As a consequence, there were not enough opportunities for an individual to select all his high preference items, even once. Thus the scattergrams, particularly hedonic preference scores reveal a very curvilinear relationship. A typical plot for hedonic preference scores is shown in Figure 5, and for preferred frequency scores in Figure 6. The preferred frequency scores form a more statistically adequate distribution, and as a direct consequence, the correlation coefficients between preferred frequency scores and probability of selection are numerically higher.

Table 12 shows that preferred frequency scores from all three Surveys were more highly correlated with choice than were any of the hedonic preference scores. Preferred frequency scores from the second and third Surveys are also better correlated with choice than those from the first Survey. The fact that the mean preferred frequency score has the highest correlation is mostly due to the contribution of the second and third surveys.

number of zero probability items numerically reduces the correlation coefficient Correlation scatter diagram for probability of food item selection as related to the Hedonic Preference value of that item for one Crewmember. The large

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## Correlation scatter diagram for the probability of food item selection as related to the Preferred Frequency of that item



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### Correlations Between Hedonic Preference and Preferred Frequency Scores and Overall Probability of Item Selection

	Inner 4	Outer 8	Total 12
Pre-Exp. Hedonic Preference	0.35	0.30	0.31
Mid-Exp. Hedonic Preference	0.40	0.35	0.37
End-Exp. Hedonic Preference	0.41	0.32	0.35
Pre-Exp. Preferred Frequency	0.55	0.49	0.51
Mid-Exp. Preferred Frequency	0.68	2.58	0.61
End-Exp. Preferred Frequency	0.65	0.58	0.60
Mean Hedonic Preference	0.40	0.35	0.36
Mean Preferred Frequency	0.66	0.59	0.62
Zend P. + Zend F.	0.60	0.54	0.56

Table 13 shows that, for some individuals, the mid-experiment preferred frequency score was the better predictor of choice, while for others it was the end-experiment score, and for one individual, Outcrewman #2 whose unusual pattern of judgements was described earlier, the pre-experiment preferred frequency was the best predictor.

When the pattern of correlations is examined for food classes, Table 14, the picture is not quite so clear. In 21 of the 25 classes, the end-experiment preferred frequency score is most highly correlated with choice, although in two classes the correlation is no higher than with the pre-experiment preferred frequency scores. In four classes; Beer, Breakfast Cereals and Griddle Cakes, Breakfast Meats, and Cookies, Brownies and Cakes, hedonic preference scores are more highly correlated with choice than are preferred frequency scores. In the case of beer, there was only one item in the class, and in the other three cases there were a limited number of items, some of which were of near universal low hedonic preference value. As a consequence, for each of these classes there were ample opportunities to select all the high hedonic preference items, allowing the correlation to reflect the unrestricted discrimination among items.

FOOD PREFERENCE SURVEY: SUMMARY. In this experiment then the best general predictor of food item choice was the preferred frequency rating score from a Survey completed during habitation. The extent to which this superiority over hedonic preference scores would occur in a longer habitation, or with a more limited menu simply cannot be determined from these data, although it is likely that the hedonic preference rating scores correlations were artifactually reduced by the design of this experiment. Even in this experiment, however, the correlations between food choice and hedonic preference scores from the second and third Surveys (during habitation) were higher than those from the first Survey (before habitation).

### FOOD CONSUMPTION DIARY

Differences were found between the general composition of the daily food consumption diaries recorded by the Inner 4 crewmen and the composition of the diaries recorded by the Outer 8. One cause for these differences may have been the dissimilarity of the schedules of the two crews. The Inner 4 were working within a strict regimen including regular working hours, specific meal time windows at intervals which

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Correlations Between Preferred Frequency Scores and Probability

Crewmember	Pre-Experiment Preferred Freg.	Mid-Experiment Preferred Freg.	End of Experiment Preferred Freq.	Mean Preferred Freg.
Inner 1	0.65	0.72	9.76	0.76
Inner 2	0.41	0.67	9.51	9.56
Inner 3	9.48	0.60	3.68	0.62
Inner 4	0.65	0.73	0.64	0.72
Outer 1	0.52	0.78	0.77	ŋ.73
Outer 2	0.31	0.21	0.24	0.30
Outer 3	0.57	0.60	9.59	0.60
Outer 4	0.40	0.54	0.59	0.55
Outer 5	0.53	0.59	0.63	0.62
Outer 6	0.52	0.72	η.61	0.71
Outer 7	0.54	0.61	0.60	0.64
Outer 8	0.57	9.56	0.62	<b>ں.</b> 60
Inner Mean	0.55	0.68	0.65	0.66
Outer Mean	0.49	0.58	0.58	0.59
Grand Mean	0.51	0.61	0.60	0.62

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# Correlations Between Hedonic Preference and Preferred Frequency Scores

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		Pre-Exp	eriment	End-Ex	beriment
		Hedonic	Preferred	Hedonic	Preferred
F00	d Class	Preference	Frequency	Preference	Frequency
01	Soups	0.25	0.25	0.27	0.28*
02	Juices, Fruit and Vegetable	0.63	0.68*	0.63	0.68*
03	Drinks, Iced Coffee. Iced Tea	0.71	0.63	0.73	• 5.0
40	Hot Beverages	0.43	0.58	0.45	0.65*
05	Milk Products	0.41	0.68	0.52	0.86*
06	Beverages, Carbonated	0.37	0.68	0.43	n.69*
07	Beer	0.17	0.12	0.39*	0.34
08	Hot Breads, Donuts	0.21	0.22	0.29	0.33*
60	Breakfast Cereals, Griddle	0.32	0.40	0.49*	0.37
2	Eggs	0.60	0.80	0.56	0.83*
11	Breakfast Meats	0.25	0.40	0.60*	9.58
12	Fish and Seafoods	0.39	0.45	0.47	0.48*
13	Meats	0.34	0.44*	0.35	0.44*
14	Stews & Extended Meats	0.21	0.20	0.34	0.60*
15	Short Orders, Sandwiches	0.30	0.28	0.29	0.34*

\*Highest correlation within food class

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Table 14 (Continued)

# Correlations Between Hedonic Preference and Preferred Frequency Scores

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		Pre-Exi	periment	End-Ext	beriment
Foo I	d Class	Hedonic Preference	Preferred Frequency	Hedonic Preference	Preferred Frequency
16	Potato and Potato Substitutes	0.34	0.24	0.32	0.38*
17	Green Vegetables	0.32	0.29	0.35	0.38*
18	Yellow and other Vegetables	0.37	0.39	0.34	0.40*
19	Salads, Vegetable and Green	0.28	0.50	0.42	0.60*
20	Salad Dressing	0.43	0.46	0.51	0.60*
21	Fruit	0.30	0.25	0.32	0.33*
22	Cookies. Brownies, Cakes	0.58*	0.28	0.56	0.44
23	Pies	0.54	0.58	0.58	0.73*
54	Ice Cream, Pudding	0.36	0.36	0.38	0.65*
<b>2</b> 5	Snacks. Candv				
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\*Highest correlation within food class.

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matched those of the quadrants in which the diary was divided, and a record keeping period scheduled for nine o'clock each morning. Their diaries reflect the orderly structure within which they worked. The Outer 8, on the other hand, worked within a far less regimented schedule. Their diverse duties prevented a regular record keeping period and though they conformed to meal time windows as closely as possible, occasionally meal times were postponed, or completely missed. Their diaries are much less organized and duplications of food items were found when meals and snacks were eaten at odd hours. These duplications were eliminated from the diary data.

Another large difference was discovered in the diaries between the Inner and Outer crews in their accuracy in recording the number and amount of food items consumed. The Outer 8 made a greater number of misrecordings (food items consumed but not recorded in the diaries, or food items recorded but not actually consumed), than did the Inner 4, possibly because the Outer crewmembers handled large quantities of food other than their own. Interestingly, they made smaller errors in estimating the amount in ounces of their servings. This is perhaps due to the fact that they weighed other crewmembers food, even though it was weighed in grams. They also were familiar with the size (in ounces) of the containers in which the food was served.

In addition, a "revised diary" was produced by making a few changes in the diary data. On the menu there were several items which were very similar to other items but had different names. Some examples are hot rolls and biscuits, frozen peas and canned peas, spinach and turnip greens. The item name in the diary was changed to match the name of the item actually consumed, if the items were within the same class and the difference was trivial and semantic. (See Appendix D for list of all changes in item name.) Also, servings of milk were omitted when recorded in a diary as a supplement with cereal or fruit when the actual data did not show milk as a separate item.

The value of the "revised diary" is that it provides data on the items misrecorded which are not trivial in their difference from the actual data. A clearer estimation is given of the discrepancies which can be expected from food consumption diaries.

The 158 food items which were used in this experiment were drawn from 25 different food classes. (24 food classes were used, salad dressing being excluded because it was reported in a procedurally different manner.) To facilitate the presentation and comprehension of the diary related results, these classes were further divided into five Food Groups based on the nutritional composition of the items in each class. In Table 15, the five Food Groups are listed along with the classes in each Group. These Groups are represented in Figure 7 by the number of calories consumed in each Food Group as a percentage of the total number of calories consumed in all Groups. The Milk and Meat Group comprised 41% of all calories consumed; the Starch Group, 19%; the Beverage Group, 19%; the Sweets Group, 13%; and the Vegetable and Fruit Group, 8%.

In analyzing the data from the food consumption diaries many formulae and technical terms are used. Appendix E contains descriptions of these terms and the formulae.

ERROR IN RECORDING THE NUMBER OF SERVINGS. A comparison of the gross or total number of servings actually consumed and those recorded in the diaries is shown in Table 16. The <u>Gross Percentage of</u> <u>the Difference</u> in each Food Group is also given. In all Food Groups, for the Total 12 crewmembers, the recorded number of servings is lower than the actual number consumed. The <u>Gross Percentages of the</u> <u>Differences</u> range from -4.13% in the Beverage Group to -32.20% in the Sweets Group.

The Inner 4 have a smaller <u>Gross Percentage of the Difference</u> in every Food Group than the Outer 8, except in the Beverage Group where more than half of the error for the Inner 4 is in the carbonated beverage class. The Milk and Meat Group, for the Inner 4, shows a <u>Gross Percentage of the Difference</u> of zero, but within this group the milk products and ice cream classes each have a small number of errors which cancel each other. In the Vegetable and Fruit Group no error is found for the green vegetables and salads classes, and in the Starch Group there is no error for the breakfast cereals, griddle cake class. The number of errors in the snacks class within the Sweets Group largely contributes to the <u>Gross Percentage of the Difference</u> for the Inner 4 crewmen.

The Outer 8 are less accurate in recording the number of servings but the differences tend to occur within the same Groups and classes. Within the Milk and Meat Group, the greatest number of errors occur in the milk products and ice cream classes as they did for the Inner 4.

Food Groups and the Classes Within Each Group

### I. MILK AND MEATS

- 05 Milk Products
- 24 Ice Cream, Pudding
- 10 Eggs
- 11 Breakfast Meats
- 12 Fish and Seafoods
- 13 Meats
- 14 Stews and Extended Meats
- 15 Short Order, Sandwiches

### **II. VEGETABLES AND FRUITS**

- 01 Soupe
- 02 Juices, Fruit and Vegetable
- 17 Green Vegetables
- 18 Yellow and other Vegetables
- 19 Salads, Veg. and Green
- 21 Fruits

### III. STARCHES

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- 08 Hot Breads, Donuts
- 09 Breakfast Cereals, Griddle
- 16 Potato and Potato Substitutes

### IV. SWEETS

- 22 Cookies, Brownies, Cakes
- 23 Pies
- 25 Snacks, Candy

### V. BEVERAGES

- 03 Drinks, Iced Coffee, Iced Tea
- 04 Hot Beverages
- 06 Beverage, Carbonated
- 07 Beer



Percentage of total calories in each food group

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Gross Number of Servings (Actual and Recorded) and the <u>Gross Percentage of the Difference</u> for Diary Data

Food Groups	Act	Inner Dia	<b>4</b> %	Act	Outer ( Dia	8 %	Act	Total 1 Dia	12
Milk and Meats	161	161	0	262	233	-10.38	421	394	- 6.41
Vegetables and Truit <b>s</b>	101	95	- 5.94	222	180	-18.92	323	275	-14.86
Starches	109	103	- 5.50	180	151	-16.11	289	254	-12.11
Sweets	48	33	-31.25	70	47	-32.89	118	80	-32.20
Beverages	277	255	- 7.94	497	487	- 2.01	774	742	- 4.13

In the Vegetable and Fruit Group, less error is found in the green vegetables and salads classes, and within the Starches Group, there is no error for the breakfast cereals, griddle cakes class. However, in the Sweets Group, though the <u>Gross Percentage of the Difference</u> is approximately the same as for the Inner 4, the error is more evenly distributed among the classes. In the Beverage Group, the only Group in which the Outer 8 were more accurate, their error is greatest for the iced tea class.

The <u>Gross Percentages of the Difference</u> for the "revised diary", shown in Table 17, are very nearly the same as for the diary. Furthermore, the pattern of error is retained throughout Groups and classes. The trivial errors corrected to produce the "revised diary" seem to have little effect on the overall number and pattern of errors.

Table 18 shows the <u>Algebraic</u> and <u>Arithmetic Sums</u> of the number of individual misrecordings, both understatements (food items actually consumed but not recorded in the diaries) and overstatements (food items recorded but not actually consumed).

The <u>Algebraic Sum</u> takes into account whether the misrecording is an overstatement or an understatement, giving the residual number of misrecordings. The <u>Arithmetic Sum</u> disregards the direction of the misrecordings, merely counting their number, giving the total number of errors. For both crews, in every Food Group, there was a greater number of understatements made except in the Milks and Meats Group for the Inner 4. In fact, within this Group, in all meat classes, the Inner 4 made no misrecordings at all. All errors were made in the milk products and ice cream classes. It is within these same classes plus the short order sandwiches class that the Outer 8 made most of their errors.

The total number of errors always exceeds the residual (algebraic) number of errors (except in the Sweets Group where they are equal), and is noticeably greater in the Beverage Group for the Outer 8.

Table 19 lists the average number of individual misrecordings of a food item within a Food Group as a proportion of the average number of servings of a food item actually consumed in that Group.

The <u>Algebraic Average Proportions</u> indicate once again that misrecordings are more frequently understatements. The <u>Arithmetic Average</u>

### Gross Percentage of the Difference

Food Groups	Inner 4	Revised Diary % Outer 8	Total 12
Milk and Meats	0	-12.31	- 7.60
Vegetables and Fruits	- 5.94	-18.47	-14.55
Starches	- 5.50	-16.67	-12.46
Sweets	-31.25	-32.86	-32.20
Beverages	- 7.94	- 2.21	- 4.26

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Food Groups	Inno Alg.	er 4 Arith.	Oute Alg.	er 8 Arith.	Total Alg.	12 Arith.
Milk and Meats	0	14	-27	53	-27	67
Vegetables and Fruits	- 6	14	-42	66	48	80
Starches	- 6	22	-29	57	-35	79
Sweets	-15	15	-23	27	-38	42
Beverages	-22	46	-10	172	-32	218

### Algebraic and Arithmetic Sum of Misrecordings

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Algebraic and Arithmetic Average Proportion of Misrecordings

			Diary						levised	Diary		ļ
Food Groups	A	lgebraic		A	rithmet	ic	A	lgebraic		Ar	ithmeti	U
	4	8	12	4	8	12	4	8	12	4	8	12
Milk and Meats	01	14	09	•06	.18	.13	01	14	- 00	.03	.17	.12
Vegetables and Fruits	12	18	16	.14	.26	.23	08	15	11	.10	.20	.17
Starches	02	11	13	.14	.26	.26	02	13	12	.08	.20	.17
Sweets	÷.30	40	34	.30	.44	.37	30	35	29	.30	.37	.30
Beverages	12	20	20	.16	.36	.32	13	21	22	.15	.35	.31

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<u>Proportions</u> are average probabilities of misrecordings of averaged items within each Food Group, and are generally larger than the <u>Gross Percentages</u> of the <u>Difference</u> because they more closely represent the occurrence of each isolated misrecording. These probabilities vary for the total 12 crewmembers froma 0.13 chance of error for the Milks and Meats Group to a 0.37 chance of error for the Sweets Group. They indicate the same pattern of errors among Groups as the <u>Gross Percentages of the Difference</u>, as well as similar differences between Inner and Outer crews. The only exception is the Beverage Group in which the Outer 8 made a smaller <u>Gross Percentage of the Difference</u> than the Inner 4. The <u>Arithmetic Average Proportion</u> of misrecordings for this group is greater for the Outer 8 than for the Inner 4 which is explained by the large <u>Arithmetic Sum</u> of misrecordings that was shown in Table 18.

The <u>Arithmetic Average Proportions</u> are less in the "revised diary" because the total number of errors (the <u>Arithmetic Sum</u> of misrecordings) decreased due to the item name changes which erased trivial discrepancies.

ERROR IN WEIGHT ESTIMATION. In the diaries, the amount by weight consumed for each serving was estimated in ounces (except for Increwman #1). These estimations were translated into grams and in Table 20 the gross recorded amounts are compared to the gross amounts actually consumed. For the Total 12 in each Food Group, except the Starch Group, the amount recorded in the diaries is less than the amount actually consumed. To some extent this is because the gross recorded number of servings is less than the gross actual number of servings consumed. Since the number of servings recorded for the Starch Group was also understated, the overestimation of amount must indeed be great.

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The <u>Gross Percentages of the Difference</u> in amount are shown in Table 21. For the Total 12 they range from -12.99% for the Sweets Group to +16.99% for the Starch Group for the diary estimations. Only slight differences are seen in the "revised diary" figures for the <u>Gross</u> Percentage of the Difference in amount.

The smallest <u>Gross Percentage of the Difference</u> occurs in the Milk and Meat Group, but within this group there are errors which cancel each other, the recorded amount being greater than the actual for the meat classes and less than the actual for the milk classes. The result of cancellation occurs also in the Vegetable and Fruit Group

### Gross Amount Consumed in Grams (Actual and Recorded)

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Food	Inn	er 4	- Out	er-9	Tota	1 12
Groups	Actual	Diary	Actual	Diary	Actual	Diary
Milk and Meats	28770	28468	47002	47175	75772	75643
Vegetables and Fruits	16211	15901	37441	32480	53652	48381
Starches	6837	10534	15023	15039	21860	25573
Sweets	4316	3570	9077	8083	13393	11653
Beverages	59237	48296	135697	129821	194934	178117

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### Gross Percentage of the Difference

in Amount (Diary and Revised Diary)

Food		Diary		F	evised Dia	ry
Groups	Inner 4	Outer 8	Total 12	Inner 4	Outer 8	Total 12
Milk and Meats	- 1.05	0.37	- 0.17	- 1.05	- 1.07	- 1.06
Vegetables and Fruits	- 1.91	-13.25	- 9.82	- 1.91	-12.72	- 9.46
Starches	+54.07	.11	+16.99	+54.07	- 1.21	+16.08
Sweets	-17.28	-10.95	-12.99	-17.28	-10.95	-12.99
Beverages	-18.47	- 4.33	- 8.63	-18.47	- 4.52	- 8.76

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where the recorded amounts are greater than the actual for the vegetable classes and less than the actual for the fruit, juice and soup classes. Looking across all Groups and classes, a pattern of underestimation for liquid items and overestimation for solid items appears. This explains why the classes within the Starch, Sweets, and Beverage Groups are consistent with their Group <u>Gross Percentage of the Difference</u>. The main reason Sweets, although they are solids, show a large underestimation is the fact that their number of servings were understated in the diaries. A look at the weight estimations isolated from the number of misrecordings will make this apparent.

Table 22 lists the <u>Algebraic</u> and <u>Arithmetic Sums</u> of the differences between the average amount of a serving per day actually consumed and the average amount of a serving per day estimated in the diaries for items in each Food Group. These sums of estimation error disregard those items which were misrecorded, referring only to the cases in which both recorded estimation and actual consumption occurs.

The <u>Algebraic Sums</u> for the Total 12, which take into account whether the amount of weight is overestimated or underestimated, indicate that the weight of the average item in all Food Groups, except the Beverage Group, is overestimated more often than underestimated. Of course, the total number of grams in error, the <u>Arithmetic Sums</u>, are substantially larger than the <u>Algebraic Sums</u>.

The <u>Algebraic</u> and <u>Arithmetic Sum</u> of estimation error for each food item written as a proportion of the average amount of a serving actually consumed and averaged for a day gives the <u>Algebraic</u> and <u>Arithmetic Average Proportion</u> of estimation error for each food item. These proportions, totaled and averaged for each Food Group are shown in Table 23.

An example of the calculations used to produce Tables 22 and 23, is shown in Appendix F. This example also clarifies the apparent discrepancy between these tables with respect to the Sweets Group for the Inner 4.

The <u>Arithmetic Average Proportions</u> indicate the proportion of error in estimating the amount of a daily average serving of an average item within a Food Group. The <u>Algebraic Average Proportion</u> gives the proportion of overestimation or underestimation when many servings of

Food Groups	Inne Alg.	er 4 Arith	Out Alg.	er 8 Arith	Tota Alg.	l 12 Arith
Milk and Meats	2263	15099	5813	16393	8076	31490
Vegetables and Fruits	-707	7776	1811	9932	1104	17709
<b>Sta</b> rche <b>s</b>	3959	5448	1573	5776	5531	11223
Sweets	-111	2735	1070	2166	959	4901
Beverages	-3707	7268	-1309	6117	-5016	13385

### Algebraic and Arithmetic Sum of Estimation Error

Table 22

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Algebraic and Arithmetic Average Proportion of Estimation Error

			Diai	<u>ح</u>					Revised	Diary		Ì
Food Groups		Algebra	ic	A	rithmet	lic		Algebra	ic	, A	rithmet	ic
	4	8	12	4	8	12	4	8	12	4	<b>∞</b>	12
Milk and Meats	.47	.39	.35	.81	.56	.61	.47	.40	.35	.82	.57	. 62
Vegetables and Fruits	.00	•06	.04	.47	.27	.34	.07	.07	.08	.55	.30	.38
Starches	.50	.19	.26	.90	.39	.52	.50	.19	.26	. 93	.42	.52
Sweets	.31	.18	.32	.70	.26	.51	.31	.24	.37	.70	.32	.56
Beverages	24	08	10	.34	.11	.20	24	08	10	.34	.13	.20

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the average item in that Group are considered.

For the Total 12, on the average, estimations of the amount consumed of single items in the Milk and Meat Group are 0.61 in error and the effect of these errors on many servings results in a0.35 overestimation. The classes within this Group vary from the Group <u>Average Algebraic</u> and <u>Arithmetic Proportions</u>, with less error occurring in the milk products class, and these errors being underestimations since milk is a liquid. Juices, within the Vegetable and Fruit Group, vary similarly. However, the soups class within this Group, although underestimated, show a large amount of error. Possibly the weight of the liquids are generally estimated by the volume of the container in which they are served. For water this is a very accurate estimation, but as the specific gravity of the liquid increases above that of water, the estimation becomes less accurate. Soups, then, have a relatively large <u>Algebraic</u> and <u>Arithmetic</u> Average Proportion of error.

The <u>Algebraic</u> and <u>Arithmetic Average Proportions</u> for the Sweets and Starch Groups also show relatively large overestimations and total number of errors, especially compared to the Beverage Group which has an <u>Algebraic Average Proportion</u> of -0.10 and an <u>Arithmetic Average</u> <u>Proportion of 0.20</u>.

A second pattern of error is seen, in that generally the estimated weights of liquids consumed have a smaller proportion of error than estimated weights of solids. This varies according to the specific gravity of the liquid.

Both patterns of error are consistent throughout Inner and Outer crews, though the average proportion of error in estimating amounts are smaller for the Outer 8 than for the Inner 4. The difference in estimation errors between the two crews is greatest for the Beverage Group where the Outer 8 proportion is three times smaller than the Inner 4 proportion. The Outer 8 were perhaps more familiar than the Inner 4 with the size in ounces of the containers in which the beverages were served.

The average proportions of error in the "revised diary" are universally equal to or larger than those in the diary. This is apparently due to the decrease in the number of misrecordings which allows more weight estimations to be compared to the actual amounts consumed. ESTIMATION ERROR IN TERMS OF CALORIES. To gain a perspective on the number of calories involved in the errors made in estimating the weight of food items consumed, the amount in grams for each food item was calorated. That is, the amount in grams, consumed and recorded, was translated into the number of calories by using the caloric intensity per gram for each food item in the data.

Table 24 lists the gross calorated amounts actually consumed and recorded in the diaries for each Food Group. When these calorated amounts are compared to the amounts in grams listed in Table 20, it can be seen that the pattern of the differences between the actual and recorded calorated amounts is not the same as the pattern of the differences for the amounts in grams. For the Milk and Meats Group this is especially apparent because the estimated amount in grams is smaller than the actual amount consumed while the calorated estimated amount is greater than the actual calorated amount consumed.

In Figure 8 the <u>Gross Percentages</u> of the Difference for amount in grams and calorated amounts are compared for each Food Group. It is obvious that these percentages are not the same, due to the varying caloric intensity of the food items in each Food Group. The differences between the percentages indicate that there is a definite relationship between weight estimation and caloric intensity. Since solids tend to have higher caloric intensities than liquids and solids are generally overestimated while liquids are generally underestimated, then overestimated items tend to have high caloric intensities and underestimated items tend to have low caloric intensities. Therefore, the relatively large overestimation indicated by the Gross Percentage of the Difference for the calorated amount for the Milk and Meats Group is understandable. The meat classes which are overestimated in weight have a high average caloric intensity and the milk classes which are underestimated in weight (which causes the cancellation resulting in such small weight estimation error for the group) have a low average caloric intensity.

This relationship appears to be consistent throughout the calorated data with the exception of vegetables. Though they are solids, vegetables have a relatively low caloric intensity. All classes within the Vegetable and Fruit Group, whether solids or liquids, have approximately the same average caloric intensity. Since the soup class has a large weight underestimation, and the greatest amount of grams was consumed in the juice class, which is underestimated, the Gross Percentage of the

### Gross Calorated Amounts

### (Actual and Recorded)

Food Groups	Inne Actual	er 4 Diary	Out Actual	er 8 Diary	Tota Actual	l 12 Diary
Milk and Meats	49638	63272	73005	88219	122643	151490
Vegetables and Fruits	7616	6579	17879	14650	25495	21229
Starches	17007	26467	40443	42498	57450	68965
Sweets	12419	10492	26265	23668	38684	34160
Beverages	14073	9931	42696	41261	56770	51192



Fig. 8



TOTAL 12	DIARY	FOOD	TOTAL 12	REVISED DIARY
GROSS %	DIFF	GROUPS	GROSS %	DIFF
-30 -20 -10 0 10 20	80 40 80 80	MILK AND MEATS VEGETABLES AND FRUITS STARCHES SWEETS BEVERAGES	-30-20-10 0	10 20 30 40 50 60

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<u>Difference</u> for the calorated amounts show a larger underestimation than the <u>Gross Percentage of the Difference</u> for the amounts in grams.

The <u>Gross Percentages of the Difference</u> for calorated amounts in the other food groups are more nearly the same as the <u>Gross Percent-</u> <u>ages of the Differences</u> for the amounts in grams, their estimation errors and caloric intensities being consistent throughout the classes because they are either all solids or all liquids.

In comparing the <u>Gross Percentages of the Difference</u> for the Inner and Outer crew, the same relationship between weight estimation and caloric intensity is evident. However, for the Beverage Group for the Inner 4, the <u>Gross Percentage of the Difference</u> for calorated amounts is greater than the <u>Gross Percentage of the Difference</u> for the amounts in grams, while the <u>Gross Percentage of the Difference</u> for the calorated amounts for the Outer 8 is less than the percentage for the amounts in grams. This is due to the large estimation error for the Inner 4 in the carbonated beverage class within the Beverage Group. This class has a relatively high average caloric intensity as compared to other beverages which causes a greater <u>Gross Percentage of the</u> Difference for the calorated amounts in that Food Group.

The <u>Gross Percentages of the Difference</u> for the "revised diary" vary slightly from those for the diary but due to the item name changes which allow correct caloric intensities to be used, they reflect more closely the relationship between weight estimation and caloric intensity.

The <u>Algebraic</u> and <u>Arithmetic Average Proportions</u> of estimation error, which account for the individual discrepancies, are identical for both weight estimation and calorated estimation.

AVERAGE RATIOS OF ERROR. The average ratios of error for all food items are shown in Table 25 for misrecordings, estimation errors, and calorated errors. The <u>Gross Percentage of the Difference</u> is a grand sum average in which the data for all food items recorded in the diaries are summed up and compared to the data for the total actual items consumed. The <u>Algebraic</u> and <u>Arithmetic Average Proportions</u> are individual average errors for each food item which have been summed up and averaged again for all food items recorded in the diaries compared to the items, amounts, and calorated amounts actually consumed.

Selected Ratios		Diary		Revised
	Inner 4	Outer 8	Total 12	Total 12
<u>Gross % Diff</u> Mis-Recordings Estimation Err Calorated Err	- 7.04 - 7.46 +15.87	-10.66 - 4.77 + 5.00	-9.35 -5.63 +8.63	-9.66 -5.89 +8.64
Alg. Avg. Proportion Mis-Recordings Estimation Err	- 0.09 0.29	- 0.18 0.22	- 0. 14 0. 23	-0.13 0.25
Arith. Avg. Proportion Mis-Recordings Estimation Err	0.13 0.70	0.26 0.40	0.21 0.49	0.17 0.52

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### Average Ratios of Error for Total Food Items

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The Inner 4 crewmen have smaller ratios of error than the Outer 8 for misrecordings but larger ratios of errors than the Outer 8 for estimation errors and calorated errors. This indicates that the Inner 4 show greater accuracy at recording food items than the Outer 8, and the Outer 8 show greater accuracy at estimating amounts than the Inner 4. The reasons for this occurrence may well be the difference in schedules for the Outer 8 and their familiarity with weights gained from handling others' food.

The calorated error expressed in the <u>Gross Percentage of Difference</u> indicates a larger divergence from estimation error for the Inner 4 than for the Outer 8. This is caused chiefly by the large weight overestimation for the Inner 4 for the Starch Group which has a high average caloric intensity.

The results of the "revised diary" show a greater <u>Gross Percent-age of the Difference</u> for misrecordings and estimation error, caused by the omissions of milk; smaller <u>Algebraic</u> and <u>Arithmetic Average Proportions</u> for misrecordings due to item name changes; and greater <u>Algebraic</u> and <u>Arithmetic Average Proportions</u> for estimation errors because more grams were available for comparison, also due to item name changes.

These ratios, though they differ only slightly from those for the recorded diary, represent, more nearly, the fundamental errors found in food consumption diaries.

FOOD CONSUMPTION DIARY: SUMMARY. In comparing actual and recorded food consumption, errors were found both in reporting the consumption of a food item and in estimating the amount consumed. Several factors influence the occurrence of these errors. An error in reporting a food item was more often due to a failure to record that food item in the diary, and generally a structured and regular work schedule increased the accuracy with which food items were reported. Errors in estimating the amount consumed tended to be overestimations if the food item was a solid and tended to be underestimations if the food item was a liquid. The estimated amount of a liquid, which may have been determined by the volume of the container in which it was served, was generally more accurate than the estimated amount of a solid, but this varied according to the specific gravity of the liquid. The differences between the amount of calories actually consumed and the estimated amount of calories derived from the weight estimations, also, depended

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largely upon the consistency of the food items. Solids, generally, had a higher caloric intensity and a larger estimation error than liquids resulting in a greater difference between actual and estimated amount of calories for solids than for liquids. Furthermore, the amount of calories in solids were overestimations of actual consumption and underestimations for liquids.

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Appendix A

Availability and Serving Size of Foods

Food			Availab	le for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
01	Soups						
	Tomato Soup		Ц	D		264	4
	Onion Soup		Ц	D		1	0
	Split Pea Soup		Ч	D		   	0
02	Juices, Fruit and Vegetable						
	Tomato Juice	В	Ц	р	S	327	7
	Orange Juice	В	Ч	D	S	331	77
	Prune Juice	В				 	0
03	Drinks, Iced Coffee and Iced Tea						
	Iced Coffee		Ч	Д	ა	   	0
	Iced Tea		Ч	D	S	428	36
04	Hot Beverages						
	Hot Chocolate	В	ц	Д	ა	312	4
	Hot Tea	В	Ч	Д	S	176	9
	Hot Coffee	В	ц	D	S	182	214
05	Milk Products						
	Milk	В	ц	D	S	415	66
	Fruit Flavored Yogurt				S	225	ŝ
	Swiss Cheese	•			S	1	0
	Cheddar Cheese				S	70	e
06	Beverages, Carbonated						
	Cola		Ч	D	S	423	71
	Seven-Up Soda		Ч	D	S	437	7
	Root Beer		Ч	D	S	421	9
	Lo Cal Soda		ы	D	S	1	0

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Food			Availab	ole for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
07	Beer						
	Beer		Ч	Δ	S	407	156
08	Hot Breads, Donuts						
	Hot Rolls		Ч	р		44	18
	Sweet Rolls	ß				72	6
	French Bread		ы	р		163	19
	Rye Bread		ц	Д		35	l
	Dark Bread		ч	р		50	æ
	White Bread		Ч	D	<u> </u>	30	ŕ
	Baking Powder Biscuits	ß	Ч	D		68	6
	Buttered Toast	æ				45	28
	Donuts				S	68	13
60	Breakfast Cereals, Griddle Cakes						
	Griddle Cakes	а				111	8
	Waffles	щ	·			129	8
	Heartland Natural Cereal	В				247	പ
	Grape Nuts Cereal	В				321	-1
10	Eggs						
	Ham Omelette	В		_		233	e
	Cheese Omelette	ш				1	0
	Eggs to Order	В				119	32
11	Breakfast Meats						
	Ham (Breakfast)	В				70	12
	Bacon	щ				23	17
	Sausage Links	В				46	6
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Food			Availabl	e for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
12	Fish and Seafoods						
	Fried Clams		L	Д		   	0
	Seafood Platter		Ц	Д		177	Ч
	Fried Shrimp		ц	Д		228	12
	Fried Fish		Ч	Д		1	0
	Fried Oysters		Ч	A		   	0
13	Meats						
	Veal Parmesean		ц.	Д		219	4
	Sirloin Steak		Ч	Д		152	11
	Roast Beef		Ч	Д		135	r
	Roast Turkey		ц	Д		196	ო
	Grilled Lamb Chops		ц	Д		259	Ч
	Braised Liver and Onions		Г	۵		151	1
	Fried Chicken		Ц	D		292	ε
	Barbequed Chicken		ц	Д		251	ŝ
	Salisbury Steak		Ч	۵		178	ნ
	Grilled Ham Steak		ы	D		114	
	Chopped Round Steak		Г	D		144	2
14	Stews and Extended Meats		-				
	Macaroni and Beef Casserole		Ч	Ω		     	0
	Lasagna		Ц	р		285	2
	Chili Con Carne		Ч	D		288	e
	Pork Chop Suey		Ч	р		727	ε
	Corned Beef Hash		Ц	Д		348	г

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Food			Availabl	e for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
14	Stews and Extended Meats						
	Spaghetti with Meat Sauce		ы	D		1	0
	Beef Pot Pie		ы	۵		8	0
	Chinese Egg Roll		Ч	۵		144	ო
	Beef Straganoff		ы	Δ		243	-1
	Enchiladas		ч	ŋ		255	ო
	Baked Beans and Franks		ц	۵		1	0
	Shrimp Creole		Ч	D		123	1
15	Short Orders, Sandwiches						
	Roast Beef Sandwich (cold)		ц	D		170	e S
	Tacos		Г	Д		227	S
	Onion Pizza		ы	D		1	0
	Tamale		ц	D		75	
	Ham Sandwich		ы	D		140	-1
	Cheeseburger		ц	D		278	ę
	Hamburger	•	ц	D		1	0
	Hot Dog	·	Ц	Д		102	I
	Hot Pastrami Sandwich		Ч	D		-	0
	Peanut Butter & Jelly Sand.		Ц	D		126	4
	B.L.T. Sandwich		Ц	D		189	ę
	Mushroom Pizza		Ц	Д		352	2
	Balogna Sandwich		ы	D		1	0
	Barbequed Pork Sandwich		Ч	D		158	8
	Hot Reuben Sandwich		Ļì	р		180	9

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Food			Availab]	e for		Average	Time s
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
15	Short Orders, Sandwiches						
	Baked Bean Sandwich		ы 	D		1	0
	Turkey Club Sandwich		Ц	D		373	2
	Tuna Fish Salad Sandwich		Ч	Д		172	2
16	<b>Potato and Potato Substitutes</b>						
	Crackers				S	1	0
	French Fried Potatoes		Ч	Д		127	4
	Potato Salad (cold)		Ч	D		116	e
	Buttered Noodles		Ч	D		133	9
	<b>Mashed Potatoes</b>		Ч	Ω		199	4
	Refried Beans		Ч	D		139	1
	Pork Fried Rice		L	Ω		1	0
	Baked Potato		Ц	D		184	20
	Pop Corn				ა	35	2
	Baked B <b>e</b> ans		н —	Ω		217	Г
	Potato Chips		Ч	Ω	ა	43	15
	Sweet Potatoes		Ч	D		189	2
	Pretzels				ა	48	9
	Steamed Rice		Ц	D		160	e
	Grits	В			•	183	4
17	Green Vegetables						
	Turnip Greens		Ч	Ω		1 2 1	0
	Frozen Peas		Ч	D		1	0
	Brussel Sprouts		ц	D		145	S
	Frozen Lima Beans		ы 	D		152	-
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Food			Available	e for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
17	Green Vegetables						
	Frozen Green Beans		Ч	D		129	S
	Buttered Zucchini Squash		Ч	Д			0
	Broccoli		Ч	Д		129	1
	Spinach		Ļ	Д		174	1
	Canned Peas		<u>ا</u> ا	ı ۲		105	l LC
18	Yellow and Other Vegetables		1	)		) ) †	)
	Corn on the Cob		Ц	Д		274	e
	Buttered Corn		Г	D		137	14
	Baked Yellow Squash		Г	Δ		127	2
	Beets		Ч	Д		95	1
	Fried On' on Rings		Ц	D		146	9
	Stewed 7 natoes		Ц	D		230	1
	Black Eyed Peas		Ч	Д		182	ę
	Buttered Carrots	-	Ц	D		86	7
19	Salads, Vegetable and Green	•		•			
	Chef Salad		Ц	D		565	4
	Cole Slaw		Ч	Д		162	Ч
	Sliced Tomato and Lettuce		ч	Д		147	9
	<b>Tossed</b> Green Salad		Ч	A		150	33
20	Salad Dressings						
	Sour Cream Dressing		Ч	Д		32	1
	Blue Cheese Dressing		ц	Д		30	12
	Italian Salad Dressing		Ч	Д			ſ
	Thousand Island Dressing		Ч	Д		к <b>т</b> М	18

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Food			Available	e for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
20	Salad Dressings						
	French Salad Dressing		IJ	D		32	4
21	Fruit						
	Stewed Prunes		Ц	D	S	1	0
	Cantalope Melon	В	Г	Д	S	377	4
	Canned Apricots		Ц	D	S	296	l
	Cottage Cheese		Ч	Д		256	2
	Fresh Oranges	В	Ц	D	S	1	0
	Half Grapefruit (fresh)	В	Ц	Д	ა	223	2
	Fresh Bananas	В	L	D	S	193	10
	Fresh Peaches		Ц	Д	S	185	7
	Fresh Apples		Ч	D	S	143	S
22	Cookies, Brownies, Cakes						
	Chocolate Chip Cookies				S	108	9
	Molasses Cookies				S	41	e
	Devils Food Cake		Ч	Д		100	e
	Cheese Cake		Ц	D		111	6
	Chocolate Cookies				S	151	
	Strawberry Shortcake		ы	D		325	8
23	Pies						
	Coconut Custard Pie		ц.	D		138	თ
	Blueberry Pie		Ц	D		101	8
	Apple Pie		Ц	; Д		204	9
	Pecan Pie		Ч	Д		167	m
24	Ice Cream, Pudding, Other						
	Desserts						
	Orange Sherbet		н <b>і</b>	D		144	S

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Food			Available	e for		Average	Times
Class	Food Items	Breakfast	Lunch	Dinner	Snack	Serving	Selected
24	Ice Cream, Pudding, Other Desserts Butterscotch Pudding Vanilla Ice Cream Chocolate Pudding Chocolate Ice Cream Snacks, Candy Lifesavers M & M Candy Lifesavers M & M Candy Peanut Butter Cup Candy Sugarless Gum Chewing Gum Snickers Candy Bar Three Muskateers Candy Milk Chocolate Bar		ЧЧЧЧ		ο ο ο ο ο ο ο ο	136 136 168 133 157 40 49 11 24 50	00-13-560 9228

#### APPENDIX B

### INSTRUCTIONS FOR CONSUMPTION DIARY

The purpose of this diary is to keep track of what you "consum e' during each day of isolation. Specifically, we are interested in your consumption of reading materials (things you read), media (things you watch or listen to), and food (things you eat). Your performance on this task will be used to judge the possibility of a more detailed and complete consumption diary.

The diary for each day is quite simple. It contains four pages. One page will cover 3 AM to 9 PM of that day, the second will cover 9 AM to 3 PM, the third 3 PM to 9 PM and the fourth 9 PM to 3 AM. Each page will be divided into three sections, one section for reading materials, one for media, and the other for food.

You should fill out your diary the first thing each day. At this time, you should write down all the consumption of reading materials, media, and foods of the previous day. Do this by first taking the page with "3 AM to 9 AM" typed on top. In the first section of that page, the one marked "READING MATERIALS," write down the name of <u>any</u> book (including your statistics book), magazine, newspaper, or other reading material you read between the hours of 3 AM and 9 AM of the previous day. Beside each name write down the approximate amount of time (in minutes) you spent reading it.

Next, move down to the section marked "MEDIA." In this section, write: (a) the name of any television show you watched between 3 AM and 9 AM of the previous day; (b) the name of any radio program you listened to during that part of the day; and (c) the title of any record album or single you listened to during the same part of the previous day. Beside each name or title, again, write the approximate amount of time (in minutes) you spent watching or listening.

In the third section of that page, marked "FOOD," write the name of any food or beverage you consumed during 3 AM and 9 AM of the previous day. You should give specific names (examples: "fried chicken," not just "chicken"; "Spanish rice," not just "rice"; or "iced tea," not just "tea.") Make sure to record all the foods and beverages you consumed, even such things as gum or water. The <u>only</u> things you do not have to record are condiments, that is, salt, pepper, mustard, ketchup, and the like. You should also indicate in this section the amount of the foods eaten. Do this by making an estimate of the total weight (in ounces) of each food and beverage you consumed and write it down beside the appropriate food or drink. If it makes sense, you should also record how many of a particular food item you ate. For example, it would make sense to do this for eggs, baked potatoes, and the like, but it would not make sense for such things as peas, mashed potatoes, or french fries.

When you have completed this section, take the next page. It has "9 AM to 3 PM" typed on top. In filling out it and the last two pages, follow the same procedure that was just described for the first page.

In filling out your diary, try to be as accurate as possible. When you are not sure about any particular entry, give whatever information you can. For example, if you cannot recall the name of a particular radio program, record the type of program it was. Or if you cannot remember the name of a food, give the type of food it was, such as meat, vegetable, or fruit.

To give you a picture of how the diary is to be completed examine the attached example of one page from a diary.

### Appendix C

Food Items on Preference Survey List which were not on Menu

Meat loaf Pepperoni pizza Milk shake Cabbage Grilled cheese sandwich Buttered Cauliflower Ham submarine sandwich Applesauce Lemonade Italian cold cut sub. sandwich Beef stew Milky Way candy bar Chocolate milk T-bone steak Breaded veal patty Baked stuffed chicken Sliced turkey sandwich Carrot and celery sticks Barbequed beef sandwich Bubble gum Strawberry ice cream Orange soda Grilled pork chops Pinto beans Canned peaches American cheese Scrapple Turnips Watermelon Potatoes au gratin Spaghetti and meat balls Brownies Sugar cookies

Spanish rice Peas and carrots Chicken noodle soup Hash brown potatoes Clark candy bar Fried scallops Chili dog Sugarless gum Chicken pot pie Turkey pot pie Dr. Pepper soda Lo Cal soda Rasberry Sherbert Chocolate cream pie Baked ham Fresh plums Vanilla wafers Broiled chicken Apricot pie French toast Chocolate bar with almonds Corn flakes cereal Frozen mixed vegetables Chicken chow mein Vegetable soup Chicken salad sandwich English muffins Canned green peas Cheese pizzą Mr. Goodbar candy

## Appendix D

## Item Name Changes Made to Produce

### The "Revised Diary"

## Diary

## Changed to

# "Revised Diary"

- 2 Ice Cream 4 Bread 1 White Bread 2 Bread 1 Bread 1 Hot Rolls 2 Tea 1 Salad 2 Peas 1 Cookies 1 Orange 1 Orange
- 1 Spinach
- 1 Sausage
- l Baked Beans

2 Chocolate Ice Cream 4 Dark Bread 1 Dark Bread 2 Hot Rolls 1 French Bread 1 Baking Powder Biscuits 2 Cola 1 Cole Slaw 2 Canned Peas 1 Chocolate Cookies 1 Orange Juice 1 Fresh Peach 1 Turnip Greens 1 Bacon 1 Lima Beans

#### Appendix E

### Definitions and Formulae used in Analysis of Diary Data

#### I. DATA SOURCES

- A. ACTUAL OR CONSUMED the data collected at the time of consumption on food items actually consumed during experiment by each of the Inner 4 crewmen and the Outer 8 crewmembers for 8 days.
- B. RECORDED OR DIARY the data collected on food items recorded in the daily food consumption diary by each of the Inner 4 crewmen and the Outer 8 crewmembers for 8 days.
- C. REVISED DIARY the data produced after the experiment by making trivial changes in the diary data in order to analyse the more important differences between consumption and recorded consumption.

#### II. DATA POINTS SELECTED FOR ANALYSIS

- A. NUMBER OF SERVINGS the number of reportings made of each food item in a data source.
- B. AMOUNT IN GRAMS the weight of each food item reported in a data source. In the diaries the weight was estimated in ounces (except Inner crewman 1) and translated into grams for comparison with the actual data.
- C. CALORATED AMOUNT the amount in grams of each reported food item translated into the number of calories for each data source. (Further descriptions for amount in grams are the same for calorated amount).

### III. DATA UNITS

- A. <u>GROSS UNITS</u> raw data points summed across days and subjects before comparison between data sources.
  - 1. NUMBER OF SERVINGS the number of servings of a food item in a data source summed across days and subjects.
  - 2. AMOUNT IN GRAMS the amount in grams of each food item in a data source summed across days and subjects.

- B. <u>MOLECULAR UNITS</u> raw data points for each day, for each subject compared between data sources before summing across days and subjects.
  - 1. NUMBER OF SERVINGS the number of servings of a food item in a data source for each day, for each subject.
  - 2. AMOUNT IN GRAMS the amount in grams of each food item in a data source averaged for each day, for each subject. If the average for a day is zero in either data source the error for that day is disregarded when summing across days. In this way estimation error is determined, isolated from misrecordings.
- IV. FORMULAE DESCRIPTIONS These data were analyzed for each food item, food class, Food Group, and grand total of all food items. The descriptions below apply to the formulae used for the Food Group Analyses.
  - A. FORMULAE USING <u>GROSS UNITS</u> OF DATA (See III Above)
    - 1. GROSS OR TOTAL ACTUAL NUMBER OF SERVINGS the number of servings in the actual data summed across days and subjects for all food items in all classes within a Food Group.
    - 2. GROSS OR TOTAL RECORDED NUMBER OF SERVINGS the number of servings in the diary data summed across days and subjects for all food items in a Food Group.
    - 3. GROSS OR TOTAL ACTUAL AMOUNT IN GRAMS the amount in grams in the actual data summed across days and subjects for all food items in all classes within a Food Group.
    - 4. GROSS OR TOTAL RECORDED AMOUNT IN GRAMS the amount in grams in the diary data summed across days and subjects for all food items in all classes within a Food Group.
    - 5. <u>GROSS PERCENTAGE OF THE DIFFERENCE</u> FOR NUMBER OF SERVINGS - the gross recorded number of servings for a Food Group minus the gross actual number of servings for the Food Group, divided by the gross actual number of servings for that Food Group multiplied by 100.
    - 6. <u>GROSS PERCENTAGE OF THE DIFFERENCE</u> FOR AMOUNT IN GRAMS the gross recorded amount in grams for a Food Group minus the gross actual amount in grams for a Food Group divided by the gross actual amount in grams for the Food Group multiplied by 100.
  - B. FORMULAE USING MOLECULAR UNITS OF DATA (See III Above).
    - 1. <u>ALGEBRAIC SUM</u> OF MISRECORDINGS the molecular recorded number of servings minus the molecular actual number of servings, summed across days and subjects for all food items in all classes within a Food Group. This sum takes into account whether the micrecording is an understatement (food item in actual data but

not in diary data) or an overstatement (food item in diary data but not in actual data.

- 2. <u>ARITHMETIC SUM</u> OF MISRECORDINGS the absolute value of the molecular recorded number of servings minus the molecular actual number of servings, summed across days and subjects for all food items in all classes within a Food Group. This sum, which does not take into account whether the misrecording is an understatement or overstatement, gives the total number of errors in recording food items.
- 3. <u>ALGEBRAIC SUM</u> OF ESTIMATION ERROR the molecular (average per day) recorded amount in grams minus the molecular actual amount in grams summed across days and subjects for all food items in all classes within a Food Group. This sum takes into account whether the estimation error is an overestimation or an underestimation.
- 4. <u>ARITHMETIC SUM</u> OF ESTIMATION ERROR the absolute value of, the molecular recorded amount in grams minus the molecular actual amount in grams, summed across days and subjects for all food items in all classes within a Food Group. This sum, which does not take into account whether the estimation error is an overestimation or an underestimation, gives the total number of grams in error.
- 5. <u>ALGEBRAIC AVERAGE PROPORTION</u> OF MISRECORDINGS the <u>Algebraic Sum</u> of misrecordings for a food item summed across days and subjects, divided by the total number of servings of that food item (actual or recorded, whichever is greater) summed across days and subjects. This proportion is then summed for all food items in all classes within a Food Group and divided by the number of different food items in the Food Group. This proportion is an abstract number which when related to the <u>Arithmetic Average Proportion</u> of misrecordings expresses the imbalance of understatements and overstatements which together make up the total proportion of misrecordings.
- 6. <u>ARITHMETIC AVERAGE PROPORTION</u> OF MISRECORDINGS the <u>Arithmetic Sum</u> of misrecordings for a food item summed across days and subjects, divided by the total number of servings of that food item (actual or recorded, whichever is greater) summed across days and subjects. This proportion is then summed for all food items in all classes within a Food Group and divided by the number of different food items in the Food Group. This gives the probability that an individual average food item in the Food Group, appearing in either data source, is in fact misrecorded in the diary.

- 7. <u>ALGEBRAIC AVERAGE PROPORTION</u> OF ESTIMATION ERROR the <u>Algebraic Sum</u> of estimation error for a food item summed across days and subjects, divided by the average actual amount in grams of a food item divided by the total number of servings of the food item. This proportion is then divided by the number of days in which the food item was reported in both data sources for a daily average proportion of error per serving. The average proportion is summed for all food items in all classes within the Food Group and divided by the number of different food items in the Food Groups. This gives the proportion of overestimation or underestimation of an average food item in a Food Group when many servings of that food item are considered.
- 8. <u>ARITHMETIC AVERAGE PROPORTION</u> OF ESTIMATION ERROR the <u>Arithmetic Sum</u> of estimation error for a food item summed across days and subjects, divided by the average amount in grams per serving obtained by the total actual amount in grams of a food item, divided by the total number of servings of the food item. This proportion is then divided by the number of days in which the food item was reported in both data sources for a daily average proportion of error per serving. The average proportion is summed for all food items in all classes within the Food Group and divided by the number of different food items in the Food Group. This gives the proportion of estimation error in a daily average serving of an average food item in the Food Group.

Example 1 - Algebraic and Arithmetic Sum of estimation error for a single food item.

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Note: If either the recorded or actual number of servings for a day is zero, that day

a day

day

is disregarded in calculations.

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Data on food item, Devil's Food Cake, in Sweets Food Group for Inner 4 crewmen.

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Crewmember	Day	Actua #servings	l GMs	Diary #servings	GMs
I	4	1	76	l	20
4	7	1	103	l	141
4	ω	1	102	0	0
Algebraic	c Sum		_	Arithmeti	c Sum

-56 n <u>76</u> 1 <u>1</u> \_

ABSVAL

56  $\left(\frac{20}{1} - \frac{76}{1}\right) =$ 

= 38 103

₄, |  $\frac{141}{1}$ 

ABSVAL

94

1

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-18 +38 11

<u>103</u> I 141

Example 2 - Algebraic and Arithmetic Sum of estimation error for a Food Group.

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<u>Arithmetic Sum</u> of estimation error error	0 0 147 147 -18 94 -145 153 -535 535	157 357 -123 357 173 603 -55 145	0 0 222 222 -28 28 94 94	-111 2735 (Algebraic) (Arithmetic)
Food items in Sweets Food Group	Chocolate Chip Cook. Molasses Cookies Devil's Food Cake Cheese Cake Strawberry Shortcake	Coconut Custard Pie Blueberry Pie Apple Pie Pecan Pie	M&M Candies Peanut Butter Cup Chewing Gum Snicker's Candy Bar	<u>Algebraic</u> and <u>Arithmetic</u> <u>Sum</u> of estimation error for Sweets Food Group
Class	22 Cookies Brownies Cakes	23 Pies	25 Snacks Candy	

Data on food items in Sweets Food Group for Inner 4 crewmen.

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Example 3 - <u>Algebraic</u> and <u>Arithmetic Average</u> <u>Proportion</u> of estimation error for a single food item.



number of days item is reported in both actual

and diary

Data on food item, Devil's Food Cake, in Sweets Food Group for Inner 4 crewmen

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# of Days	З
imation error Arithmetic	94
Sum of est. Algebraic	-18
Gross Actual Amount in grams	281
Gross Actual # of servings	m
1 <b> </b>	91

Algebraic Average Proportion



Arithmetic Average Proportion



- Algebraic and Arithmetic Average Proportion for a Food Group Example 4

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Data on food items in Sweets Food Group for Inner 4 crewmen.

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13 Different Food Items in Sweets Group

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	000T)	Sweers Lood Group	Proportion	Proportion
22	Cookies	Chocolate Chip Cook.	0.0	0.00
	Brownies	<b>Molasses</b> Cookies	1.40	1.40
	Cakes	Devil's Food Cake	-0.10	0.30
		Cheese Cake	-0.30	0.30
		Strawberry Shortcake	-0.50	0.50
23	Pies	Coconut Custard Pie	0.30	0.60
		Blueberry Pie	-0.30	0.80
		Apple Pie	0.30	0.90
		Pecan Pie	-0.20	0.50
25	Snacks	M&M Candies	0.00	0.00
	Candy	Peanut Butter Cup	1.60	1.60
		Chewing Gum	-0.20	0.20
		Snickers Candy Bar	2.00	2.00
		<u>Algebraic</u> and <u>Arithmetic</u> <u>Average</u> Proportions =	$\frac{+4.00}{13} = 0.31$	$\frac{9.10}{13} = 0.70$

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