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FINAL REPORT:

A BASELINE PROTOCOL
FOR PERSONAL HYGIENE

FRD 3989

31 August 1971



FAIRCHILD
REPUBLIC DIVISION

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31 August 1971

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SECTION I

INTRODUCTION

This document represents one facet of many involved in producing a "Baseline Personal Hygiene Protocol" under Contract NAS9-11509 for the Manned Spacecraft Center, National Aeronautics and Space Administration. Mr. R. L. Sauer, Preventative Medicine Branch Code DC7, NASA/Manned Spacecraft Center was the contract monitor for this program.

The NASA/MSC Medical Directorate has been in the forefront of programs dedicated to the well-being of space crewmen. As a corollary to these efforts many beneficial spin-offs have evolved and find their way into the field of practicing medicine. The area of personal hygiene has attracted considerable attention in the past few years; particularly, as regards space flight due in part to the realization that this function could be a source of infection or mental concern and, too, the imminence of long duration flights. In planning for the personal hygiene requisites it was determined that a baseline must be defined to allow the medical requirements and logistics to be satisfied.

Fairchild Republic Division has felt that, by virtue of its more than a decade involvement in space oriented personal hygiene, it could meaningfully interpret the responses and assorted comments that were to be obtained by its investigations and then evaluate the data therefrom. The need to formulate a day by day protocol to satisfy the contract has been paced by what is desired and what is able to cleanse the man in keeping with a level of personal hygiene yet to be determined.

The necessity to maintain liaison with the Medical Directorate was deemed critical to the program so as not to prejudice their priority in medical determinations. It was felt that an awareness of these needs could reduce incidents of our recommending either technique or intake, e.g., an ingestible mouthwash that would invalidate a key medical determinant.

This study offered the opportunity to hear valid individual concerns; to weigh them; and relate them to physiological, psychological, and hardware considerations. In this manner, an appreciation of the sophistication or acceptability level has been

recorded for the various subject groups, and what is common or unique to each has been made known. Based on the subjective comments and contingent on the mission limitations recommendations have been offered.

Realizing the pioneer nature of this work, Fairchild Republic Division, while not contractually obligated to do so, has produced a computer program to document and evaluate the data and to serve as the nucleus for additional personal hygiene data input. Interest in this study has been expressed by urban planning groups and a United States Navy team concerned with shipboard habitability. However, the major benefit to be realized must be in the realm of space flight since many of the more obvious conclusions obtained from space studies will have statistical validity to reinforce them and new thoughts unique to long-term flight will be voiced.

SECTION II

THE PERSONAL HYGIENE PROTOCOL: A RATIONALE

In defining the parameters that would be included in this study it became apparent that an in-depth survey of various precepts had to be initiated prior to any conclusions being formulated and adopted. The involvement of the astronaut with his environment in the personal hygiene sense must include cognizance of the cabin relative humidity, its temperature, and composition of the breathing gas. Recognition had to be extended to other factors such as the clothing worn, work-rest cycle, dermatological effects, and bacterial survival in an enriched oxygen environment. Since the intent of this protocol is to track the Skylab time period, some of our opinions are, understandably, extrapolations of lesser time intervals. The ultimate test of our theories must await the appropriate time span and test program.

This protocol was designed to utilize as much of the updated philosophies and opinions of experienced space crewmen as was feasible in light of physical constraints and the equipment state-of-the-art. The basic tenets of cleanliness have had to undergo scrutiny to see if they were applicable to the prolonged space missions contemplated. What, indeed, is clean? Is it something one sees, smells, or defines as so many bacteria per square inch?

We were desirous of equating the astronaut mode of living with other confined environments. To this end we promulgated the enclosed questionnaire to persons (both male and female) with undersea habitat experience such as Tektite, Sealab, Helgoland, AEGIR, Ben Franklin, and submarines. Additional inputs based on land experiences of cave dwellers, Antarctic, and chamber studies added to our data pool. Recognizing the need for control data to refer all of these confinement studies to, we accumulated data from lay persons and astronaut crewmen who are still to venture into space.

This agglomeration has given rise to this unique data bank on personal hygiene in confined spaces. The data evaluation is presented as derived from a computer program intended to statistically evaluate the many comparisons and opinions that the questionnaire evoked. The questionnaire design is explained and interpreted in the appendix.

The questionnaire formed one facet of the preparatory effort. Other areas investigated were the anatomy, physiology, and utility of the human integument and its extensions such as hair and nails. The bacteriology phase of the protocol was built to some extent on previous Republic experience and also includes procedures suggested by the Naval Biological Laboratory NAMRU I NSC Oakland.

Recognizing the need to equate hygiene procedures with accepted decontamination techniques, we have reviewed hardware and personnel decontamination wherever responsive to the protocol.

Dermatological manifestations such as a body rash were present on a few of the manned flights to date. The awareness of these events and the empirical philosophizing as to the cause need not be excluded from this rationale. Recognizing the potential for physical, microbiological, and/or psychosomatic exacerbation of skin or gum, we have concerned ourselves, too, with minimizing the causative force -- whatever the origin. In this regard, acting on the professional advice of recognized dermatologists and dentists, we have indicated skin care and oral hygiene procedures.

The physical phenomena required to achieve the desired realm of cleanliness have been studied and, where deemed feasible for space, have been included in the Latin square array of procedures.

In the course of interpreting the subjective comments, the desire for normalcy in ablutions was a frequently recorded response. A bar of soap, an adequacy of towels, and a means of rinsing the body would all seem to be common enough except that the space environment and logistics make them all uncommon.

Few ventures of personal hygiene definition have gone beyond the beneficial admonition to wash the hands and face, brush the teeth, and shower periodically. A measure of the efficacy of these and other related events forms the foundation for the protocol instructions indicated.

A. OBJECTIVE

Personal hygiene systems and logistics for space have heretofore been a function of available space and the current state of the art. In this study the desired inclusion of the crewman's updated comments has been accomplished to the extent of defining desired utensils, devices, and techniques for personal hygiene.

B. PURPOSE

The study had as its direction the need to accomplish the following goals:

- Review of cleansing techniques.
- Ascertain levels of medically acceptable bacterial populations.
- Recommend sampling techniques to verify the above.
- Describe odor effects and control procedures.
- Relate work/rest cycles to personal hygiene.
- Prepare, distribute, evaluate, and employ the results of an extensive psychological questionnaire.

C. MISSION MODEL PARAMETERS

While the baseline information could not derive solely from space flight due to the brevity of most personal hygiene time increments, it is felt a post-Apollo flight should set the overall tone. Therefore,

Gravity: Zero to one earth G

Radiation: Protected by spacecraft.

Atmosphere:

Pressure 10 - 14.7 psia

Composition O₂ always at 3.5 psi - other designated gases as stipulated to make up balance.

Temperature: Range 65°F - 75°F
Nominal: 72°F

Dew Point: Preferred Range: 41°F to 46°F
Nominal: 44°F
Maximum: 60°F
Minimum partial pressure H₂O, 4 mm Hg.

Crew: Number variable, all male on this go around.

Water System: 155°F and 50°F water available.

*Nominal Duty Cycle (Work/Rest)

Work	-	8 hours
Eat	-	3 hours
Sleep	-	8 hours
Off Duty	-	5 hours

*See Section III.c re other work/rest cycles studied.

Evaporation of water could influence the mode of wet wash procedures. Allowing for a reduced cabin pressure between 510-760 mm Hg the vapor pressure of water will vary between 89.2°C and 100°C. In this environment, dependent on the actual dew point and other factors such as air movement, a washcloth could conceivably require more or less water to feel or be "wet".

D. OVERALL TASK APPROACH

A study task flow diagram depicted in Figure 1 outlines the tasks performed within the phases of the study.

E. LITERATURE SURVEY

Fairchild Republic Division conducted an extensive continuing survey of industrial, governmental, university, and private foundations for sources able to contribute relevant data or who could participate in our study in any fashion. A number of personal meetings, visits with crewmen, interrogators, and investigators comprise additional sources of data.

The literature search, still in being, has been conducted at Fairchild Republic Division and locally, employing among other sources DDC, MEDLARS, and the NASA computerized literature search data tapes. References are to be found with the relevant volume bibliography.

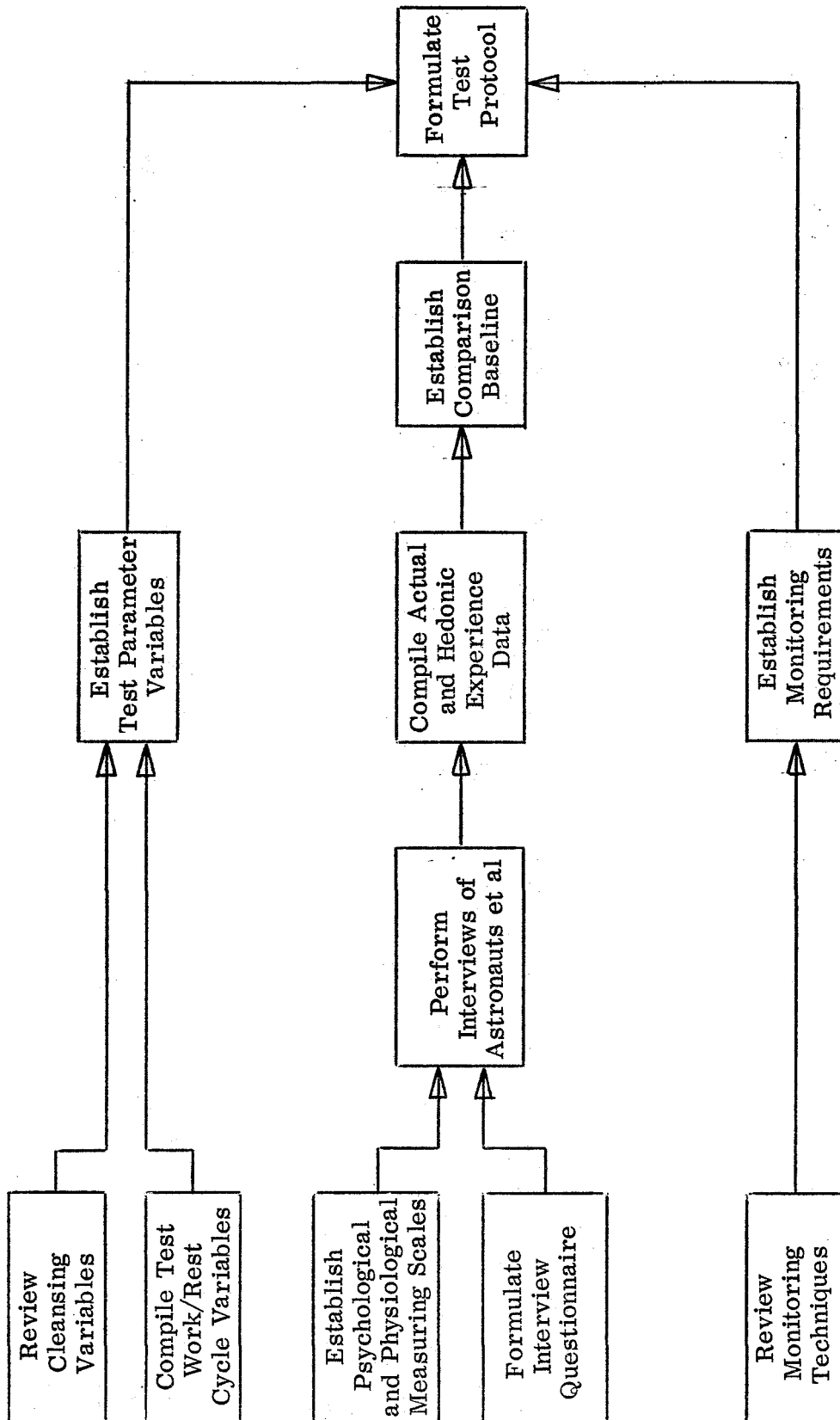


Figure 1. Study Task Flow Diagram

SECTION III

STUDY EVALUATION AND COMMENTS

A. THE ECOLOGICAL ARENA

The imminence of truly long-term space sojourns has placed an added emphasis on the requirements for personal hygiene. The elemental need for a clean body has been discussed at length by medical personnel, psychologists, and crewmen alike. While the need for sophistication on a 3-14 day journey can be minimized due to the pioneer or adventuresome aspects of the flight, by and large a repeated message has been voiced by participating crewmen. Plainly spoken it says, "How close can you get me to a normal bathroom situation?" This real concern for normalcy pervades many of the subjective comments in this study.

The Medical Directorate has been concerned with this for a number of years. It has recognized the limitations imposed on the solution by the state of the art, the uncertainty of the logistics absolutely required, and the uniqueness of the space environment. Even as a continuing effort is expended in the hardware area, this study was aimed at defining the baseline requirements critical to the goals of the previous paragraph. When, indeed, do we have an esthetically, psychologically, or medically clean skin? How much effort and paraphernalia is needed to reach this state? While we address ourselves to the extraneous sources of "dirt", we must additionally concern ourselves with the so-called body dirt. Extraneous "dirt" would result from gases, aerosols (bacterial and particulate), and dusts derived from equipment particles, clothing debris, furniture, residue of food, body waste products such as nasal or oral exudate, desquamated epithelium, urine, and feces. Body dirt derived from body functions would include glandular secretions such as sweat and sebum, and circulating fluids such as blood and lymph. Clothing would be expected to absorb some of these contributions but would not, depending on its physical traits, do so at a measurable level. Therefore, the extent of build-up of "dirt" with its accompanying array of bacteria, oils, soil, salts, hair, and skin would not be a truly measurable entity.

In the normal course of a space flight the astronaut would be subjected to many unusual physical and mental influences. Stresses devoid of the influence of gravity

would be present at sleep and at work. The impact of the circadian alteration in the endocrine system, coupled with the effect on the autonomic nervous system, would be expected to perhaps provide a somewhat different skin residue. This is an interesting assumption. Could it, perhaps, result in new skin flora, different forms of sebum, and different ratios of chlorides and organic materials? What is the stage that all of these points focus on? In the following paragraphs, we attempt to understand the ultimate sites of concern.

1. Skin/Hair

The function of the skin can be divided into the two main subfunctions of body protection and growth. As body protection, the skin provides a remarkably effective barrier for the muscular and skeletal body components against a wide range of potentially injurious chemical, physical, and biological factors. This integument serves to maintain body fluid balance, provide a mechanism for body temperature control, and protect the organism from bacterial invasion. Through the process of growth, the skin provides an undulating sea of 10 to 20 layers of flat, dead, dry, keratinized cells which adhere to one another tightly except nearest the surface where they are continually shed as microscopic flakes. These cells are replaced continuously from below the surface as new cells complete their growth and are exposed to the surface. Most substances are poorly absorbed through the intact skin except in the gaseous state.

This undulating surface of the skin is pierced at intervals by two types of orifice. One is the duct of the eccrine sweat gland and the other is the hair follicle. Both have their origins in the dermis layer located between the surface (epidermis) layer and the undermost (subcutaneous) layer. The eccrine sweat glands produce a weak saline solution containing nitrogenous and other nutrient substances. The hair follicle produces the hard keratinaceous hair and exudes a complex secretion of lipids and fatty substances called sebum from the sebaceous gland which ducts into the hair follicle. Together the sebum and sweat mix and spread over the epidermal surface near the hair follicle forming an oasis of nutrient solution suitable to support life of the microbial inhabitants of man's skin. The sweat glands and hair follicles are not evenly distributed over the entire skin surface, but vary in size and density. Examples of varying density are seen in the axilla, pubis, scalp, and hands. The axilla and pubis are dense with coarse hairs which receive secretions from eccrine and specialized

structures called apocrine sweat glands. The scalp and hands are without apocrine sweat glands, but make up the difference with high concentrations (300-400) of eccrine sweat glands per square centimeter and thus can provide vast quantities of nutrients in relation to the remainder of the skin surface. To appreciate more fully the problems encountered in maintaining a clean odor-free body, we would do well to consider the secretions of the eccrine, sebaceous, and apocrine glands.

2. Glands

The eccrine sweat glands occur throughout the skin of man in large numbers. Each gland is an independent, slender, blind tubule about 0.002 mm in diameter. The total number of sweat glands in man is over 2,000,000. The chief function of sweat secretion in man is the regulation of body temperature by means of providing fluid for evaporative cooling. Sweat also helps maintain normal hydration of the outer layers of the skin, and on the palms its moisture enhances the grip.

Sebaceous glands are multilobulated structures 0.2 to 2 mm in diameter with short ducts opening into the necks of the hair follicles. Their secretion of a highly complex mixture of lipids, called sebum, diffuses upward in the follicle and impregnates the hair and surrounding horny layers of the skin--thus a major contributor in forming the greasy skin surface film. This film helps maintain normal pliability of the skin by retarding loss of water. Additionally, it delays absorption of many foreign substances and contains substances that act as protective agents against exogenous infection.

Apocrine secretion is an opalescent fluid that under bacterial action gives rise to odorous substances partly responsible for offensive body odors. The apocrine ducts empty into the hair follicles located in the axilla, perineal and pubic regions, and about the nipples. Their mode of secretion differs from that of eccrine sweat glands in that part of the cytoplasm and cell residue of the secretory cells is pushed off in the secretion process. This is sometimes known as decapitation secretion and is what accounts for the fatty acid nature of the secretion. This substance tends to accumulate without removal by surfactant action.

3. Cutaneous Appendages

Description of the skin would not be complete without some attention to the nails. They are platelike translucent, keratinous structures that grow over the

ends of the fingers and toes to form specialized, proximal epidermal matrices called nail roots. These extend to the distal edge of the lunula, a moon-shaped white area often visible at the base of the nail plate. The nails consist of densely compacted, highly cornified, dead epithelial cells containing only remnants of degenerated nuclei. Their primary function is to provide firm backing for the fingertips and toes when they are subjected to pressures of grasping or walking. They grow continuously and tend to collect soil under their surfaces which mixes with sweat and clings tenaciously until scraped out.

The rates of epidermal skin desquamation (sloughing) and removal of sebum from hairy areas of the body are directly related to the bacterial populations and amount of soiling present on the skin surface at any time. The sebum and sweat are removed primarily by washing or rinsing the skin while desquamation takes place usually through the process of abrasion either by clothing or wiping during washing. Either of these processes will have the effect of reducing surface nutrients and surface bacteria, but this does not represent the complete picture. Other parts of the picture are pH, temperature, humidity, light, and sensitization.

4. Oral Cavity

Anatomically, the oral cavity is an orifice of the alimentary tract whose central area is nearly filled with teeth, tongue, and projections such as those extending from the maxilla and mandible. These structures represent a series of complex surfaces which are roughly symmetrical in three distinct planes. If we can include the ever present film of saliva on the mucous membranes and teeth the overall surface area may approach $4 \times 10^{28} \mu^2$. If cocci with diameters of 0.5μ were spread only one cell thick over the surface, approximately 16×10^{28} bacterial cells would be needed. The number, while huge, actually is less than the number of bacteria that do inhabit the oral cavity. Since the mouth is basically temperature stable and the secretions present there offer a fluid environment, the changing chemistry and physical conditions permit a variety of organisms to find loci. The oral secretions are primarily water, mineral salts, and mucin; the remainder being enzymes, blood-group substances, and sometimes substances streaming over from the blood. The sum total of this wealth of material is contradictory in that it will support few bacteria. Individual group contributions, e.g. parotid fluid do not support growth due to the lack of the specific nutrients required. Supplementing these fluids with nutrients such as glucose can

result in bacterial growth. The point to consider here is that left alone, the mouth is relatively sterile but once food or other nutrient sources are introduced a new enriched bacterial media is available. An additional source of nutrients for the large populations found in the mouth must result from synergistic and symbiotic relationships between microbes. Therefore, the breaking of the chain, as it were, would do much to foster good oral hygiene.

Little has been offered to this point to reveal the hazards of poor dental hygiene. An awareness of this potential concern is manifested by the knowledge of various chamber studies that provided minimal personal hygiene facilities. In some of these an experimental design provided various devices for oral hygiene. The ease of shattering the normal routine to the detriment of the subject was very obvious and gingivitis, caries, and halitosis were quick to occur. The soft tissues of the mouth deteriorated and provided sites for infection and inflammation. In those experiments able to sustain a dental regimen with either brush and dentifrice, brush and stimulator, or brush, water, and dental floss, the mouth was preserved.

Oral hygiene requires an acceptable procedure in order to make it work on long-term flights. Some displeasure has been voiced with the need to swallow some of the dentifrices provided. This kind of negativism would, undoubtedly, lead to infrequent use of the dentifrice with subsequent detriment to the mouth.

The many crevices and fissures of the region in the back of the mouth must be prime focal points in harboring microorganisms. Due to the imbedded nature of the tonsillar substances, it is almost impossible to obtain a throat sample that is truly representative using a swab. We are, therefore, recommending a combined swab and throat-nasal gargle.

NASA/MSC has previously promulgated a very thorough oral hygiene protocol in conjunction with another chamber study. Based on the essence of this, we are recommending that a total bacterial count be sought and an attempt made to identify only a few organisms such as Nocardium, Neisseriae, Streptococci sp., Fusobacteria and Veillonellae sp.

Oral hygiene techniques other than those called for by the participating dentist in any study should be considered if there is time and the assurance of no interference with other study phases. It may well be that the ability to cleanse

teeth to the satisfaction of the dental monitor may result from a combination of an acceptable procedure and a dictated protocol.

B. BACTERIA IN A SPACE ENVIRONMENT

There have been numerous studies to identify, locate sites, and depict the distribution of bacteria on the skin. The bulk of these are based on topical discovery and enumeration using bacterial removal from the skin.

Montes and Wilborn⁽¹⁾ in the belief that bacteria had not been identified as to their anatomical habitat proceeded to look for bacteria in situ. We were interested in this because to properly determine the personal hygiene regimen able to give us the desired skin condition, one must know where the soap or antiseptic must reach. The previous background on the more important studies are summed up in Table I.

Riely⁽²⁾ indicates that her results differ as to the predominant organisms reported by others. She reported Corynebacteria as dominant while most others indicate Staphylococci are most prevalent. The need to identify can only be disregarded if the personal hygiene approach can cope with all potential pathogens.

That bacteria indigenous to a particular area do not remain selective is an established space fact. Enteric organisms have been found in axillary areas and Candida was discovered in the mouth and groin. In a similar vein, submariners have displayed E. coli in the mouth. All this tends to point up is the ubiquitous nature of many microorganisms and their adaptability. Consequently, good personal hygiene is required even beyond the esthetic requirements.

Gram positive anaerobes appear to predominate and are found primarily in approximation to hair follicles and in greater number in comedones. Any roughage in the skin such as intertrigo tends to cause bacterial proliferation. Therefore, it would appear to be a good policy to avoid chafing even to the extent of using powder or creams in areas of contact.

The effectiveness of any material in sterilizing a site must rest with its ability to avoid dilution by skin by-products, e.g. oils, sebum, keratin and, ultimately, make physical contact with its target. Sweating will promote an increase in residual flora, but eccrine sweat glands seem to remain free of bacteria and so we are probably looking at a self-sterilizing region. Any garment that ventilates poorly or causes

TABLE I. NORMAL SKIN FLORA LOCATION AND DISTRIBUTION

Study	Site	Sampling Technique	Results
1 Price ⁽³⁾	Hands, Arms		Residual population of bacteria imbedded. Transient types easily removed.
2 Lovell ⁽⁴⁾	Breast	Section	Transient only topical. Bacteria in pilosebaceous glands. None in sweat glands.
3 Evans ⁽⁵⁾	Ear Concha, Palm of Hand	Culture Direct	Bacteria in sebaceous orifices. None in sweat glands.
4 Updegraff ⁽⁶⁾	Back	Culture	Clusters only; few individuals.
5 Davies and Noble ⁽⁷⁾	Skin Scales	Direct	Colonial growth in agar that was incubated.
6 Williamson ⁽⁸⁾	Forearm, Forehead	Histological Section	Aerobes on surface.
7 Kligman ⁽⁹⁾	Head	Histological Section	Some gram positive in hair follicles.
8 Marples ⁽¹⁰⁾	Forehead, Arm	Replica Technique	Bacteria in hair follicles.
9 Gall and Riely ⁽¹¹⁾	Numerous Body Areas	Culture After Swab	Expected organisms appeared.
10 Riely and Shorenstein ⁽²⁾	Numerous Body Areas	Culture After Swab	Corynebacteria predominated.
11 Montes and Wilborn ⁽¹⁾	Scalp, Forehead, Posterior Neck, Upper Back, Pubic Area, Leg, Forearm	Electron Microscope	Fewer surface bacteria. Many in comedones and in hair follicles.

chafing will, undoubtedly, cause a bacterial increase. The total occlusion of an area with an air-proof membrane can result in a massive increase. Therefore, care should be directed at any permanent skin covering such as a "permanent" EKG electrode. Proper disinfection prior to attachment should be routine.

The lack of understanding of bacterial behavior in a weightless and enriched environment is only offset by the inability to comprehend the mechanisms of host resistance in a similar situation with reduced oxygen tension. A literature survey has indicated no discernible trend or rationale for certain events. Influenza virus has been both effective and ineffective in producing disease. The same can be said of S. typhimurium and of K. pneumoniae where time at altitude influenced the pathogenicity. S. aureus produced an increased number of skin lesions in a mouse study, but lacked lethality if injected intraperitoneal. Venezuelan equine encephalomyelitis (VEE) proved to be indeterminate in action as did a study with mengovirus. All in all, this remains a poorly defined area and, therefore, requires close observation and planning to protect space crewmen from bacterial concerns.

In a tabulation of studies aimed at depicting skin flora accumulation as a function of body wash, the results were generally as expected. The more extensive the wash, the cleaner the skin. Table II enumerates some of the findings.

C. BIORHYTHM

The existence of rhythmicities in humans has been detected in many body functions. Past experimental efforts have placed great emphasis on the interrelatedness of body temperature and other body functions. Heat production is affected by ambient temperature, muscular activity, food intake, and sleep which are normally unequally distributed over a 24-hour period. With the alteration of these activities in a space environment, there is reason to expect changes in body thermal regulation and subsequent changes in performance. Peak performance has been found to correspond to increased body temperature; generally, being best when body temperature is highest, and poorest when temperature is lowest. It has been demonstrated⁽¹²⁾ that the diurnal body temperature rhythm in man is developed by adaptation and maintained through adherence to the socially prevalent routine of living and can be shifted or completely reversed by changes in the daily routine. The success in altering body temperature curves, however, is highly dependent upon individual variability⁽¹³⁾. The inversion of the body temperature curve can more easily be accomplished when the external conditions are such as not to be interfering influences.

TABLE II. CONFINEMENT AND WASHING: A COMPARISON

Study Reference	Number of Days	Technique Used	Wipes Daily	Results
Rack and London ⁽¹⁴⁾	42	Washed with Hexachloro-o-phene soap on one side of the body		Lesions on omitted area
Riely ⁽¹⁵⁾	28	Unwashed		Athlete's foot-type problem
Moyer ⁽¹⁶⁾	56	Full sponge bath		Normal bacterial level
Gall and Riely ⁽¹¹⁾	34	Unwashed		Bacteria increased
Prince ⁽¹⁷⁾	Varied	Recommended wipes	3	Claimed wipes were O. K.
Kellett ⁽¹⁸⁾	20	Unwashed		Flaking of skin, pustules
Borchardt ⁽¹⁹⁾	14	Unwashed		Bacteria increased
MDAC* ⁽²⁰⁾	60	Full sponge		Normal bacterial level
Lotter ⁽²¹⁾	42	Used body wipes	5	Normal bacterial level
Popov ⁽²²⁾	23-60	Unwashed except for hands and face		Bacteria and skin disorders increased

*McDonnell Douglas Astronautics Company

1. Work/Rest Cycle

The need to evaluate the time period required by a space crewman for any purpose within the so-called work/rest cycle causes us to delve deeper to attempt to understand which drumbeat he follows. Halberg⁽²³⁾ has indicated that the rhythm of man's performance is organized at three different levels: neural, endocrine, and cellular. Many physiological problems can arise during the adaptation phase required by weightless exposure. The interplay of all levels indicated, coupled with the hazard and critical nature of the crewman's performance, can add up to sleep deprivation or changes in food acquisition, waste elimination, and even sweat production. We have studied a series of far-ranging studies and noted their parameters and uniqueness. The results of Table III are self-explanatory except, perhaps, for the last one. This study has two phases to it that enabled the subject to establish his own day/night rhythm. In the first instance the subject was not given any temporal or other cues to establish his cycle. The subject indicated when it was A.M. or P.M. and when he would eat or sleep. No work was required of him. This phase averaged a 25-1/2 hour "day". The second phase provided the subject with the same environment and added eight tasks; actually, eight ergometer runs to a predetermined level. The subject was free to establish his "day" as before, but had to perform his eight tasks prior to going to sleep. On this basis the "day" was stretched to an average of 40 hours.

TABLE III. WORK/REST OR SLEEP STUDIES

Study Site	Hours				Reference	Remarks
	Basic Period	Work	Free	Sleep		
Simulator	4	2	(2)	(2)	24	Low work capacity Best suited for watches. Used in submarines.
Simulator	6	3	(3)	(3)	24-31	
Cabin Simulator	8	4	(4)	(4)	24-32-33	
Submarines	12	4	(8)	(8)	27	
Laboratory	12	6	(6)	(6)	24	
Laboratory	16	8	(8)	(8)	24	Most normal.
Chamber	17	8	5	4	29	
Chamber	24	8	8	8	27-28	
Chamber	24	12	(12)	(12)	25-26	Sets own schedule.
Laboratory	Ad lib	Variable			30	

() = Optional

2. Sweating

Work produces metabolic heat that must be dissipated through the skin. The mechanism of this process involves an increased blood flow from the tissues involved and an internal blood flow to the cutaneous region. This is followed by sweat, evaporation, and the deposition on the skin of glandular secretions and inorganic salts. The relationship between the cutaneous blood volume and rate determines the pattern of heat dissipation from the body core to the skin. Concomitant with this rate of dissipation must be the impact of the clothing that surrounds the body and, too, the external environment.

The work/rest cycle affects sweating both by the intensity of the work and the duration thereof. A study by Harris⁽³⁴⁾ et al has indicated that oral temperatures were more depressed during a 4/4 hours work/rest cycle than during a 16/16 hours cycle. Sweat secretion mirrors heat dissipation in that added skin blood flow simultaneously involves the sweat glands. However, the effective environmental temperature dictates the ultimate skin temperature⁽³⁵⁾.

The overall body sweat load is an indeterminate quantity and varies from individual to individual. The author was a subject in a series of heat studies that pointed up the variability of the onset and quantity of sweat production for different subjects in an identical heat environment during which the subjects were passive. As the body temperature increases the flora on the skin increase in number much as an incubator aids multiplication. Concern dictates the need for continuous screening for coagulase positive staph, beta hemolytic strep, and fungi as regards the potential for skin infection.

The body tends to lose heat with movement and the presence of air currents. Convection is best served by this combination and, in fact, it is recommended that a deliberate small degree of movement be initiated rather than remain motionless in a warm environment. The increased cooling would neutralize favorably the resulting small increase in metabolic heat.

The loss of heat by evaporation of moisture via the body surface can range from 24% of the metabolic heat under resting conditions in a moderate climate to 100% under extreme heat loads. That this is a real measurable determination can be shown by scanning the body weight loss due to the amount of moisture exhaled or evaporated via the skin and from the clothing.

Evaporation of liquid at the surface is dependent on the difference in vapor pressure between the liquid; i.e., sweat, and that of the air in contact with it. Air movement at the interface will also influence the rate. The actual phase change is nurtured by the body's own heat as the liquid changes to vapor and then cools to air temperature.

The ability of the body to compensate for variations in the relative humidity (R.H.) of the surrounding air and maintain adequate heat loss by evaporation is a function of evaporative heat loss, wet skin, air velocity and direction, air temperature, and body activity. Clothed persons at rest in surroundings at air temperature will start sweating under the following conditions: 83°F (28.5°C) with R.H. 12%-35%, and at 75°F (23.9°C) with R.H. 75%-88%. Sweating will occur with work at lower temperatures. It is the wetted skin area that increases with rising air temperature and at higher R.H. The onset of this usually occurs at most any R.H. if the temperature of the skin reaches 95°F (35°C).

The sum of all of this liquid evaporation is the enhancement of skin habitats for surface bacterial growth. The increased temperature is also a positive factor in selective growth rates. The clothed individual will, by being in contact with his clothing, transfer sweat and skin debris of all forms to the fibers of the garment. Therefore, we have a second site for odor production and bacterial colonization (see Section III. F - Clothing). A self-imposed limit on exercise was reported by one astronaut. This was done to minimize his sweat production and subsequent "dirty" feeling. The awareness of the various consequences of sweat production has led to sponge baths in various studies. Where sweat could be removed by a total body sponge bath, the flora either subsided or remained of no consequence. In studies or actual flights permitting only hands and face washing, bacterial increases were noted on unwashed areas.

As a rule of thumb, we can say one remains cleaner in bed. Conversely, out of bed one would expect the probability of increased body dirt to be borne out. There is no mandated work/rest cycle firmly dictated in the protocol study. We should like to invoke this possibility for a twofold purpose. We would like to relate work time to "dirt" accumulated and, at the same time, have the opportunity to investigate the possible adoption of an ad lib work/rest cycle by the crewman. As we have reported, there is some evidence to suggest that a subject's day, devoid of temporal cues, can

be extended by him to between 30-40 hours. What this could mean to (1) work performance and dirt production, (2) psychological and physiological well-being, and (3) the logistics of personal hygiene remains to be determined; particularly, as it may relate to a long-term space sojourn. The possible incorporation into a personal hygiene study of this type of adjunct study is to be encouraged since the anticipated approach to obtain data for both purposes will be similar to a great extent. The approach contemplated would be visual observation and questionnaire coupled with physical sampling. The need to tie in "dirt" production gives rise to work tasks which can simultaneously serve as the day-night discriminator and "dirt" producer. The time devoted to this phase would be 2-3 weeks.

D. AN APPRECIATION OF ODORS

1. Cause and Effect

Personal hygiene concern for odors finds two directions being traveled at the same time. The most obvious is in the effect produced by body odors derived from body functions in the normal sequences of metabolism. The other direction lies in the effect of the odors on producing untoward events leading to still other odors. For example, the odor of vomitus is offensive per se, but it can also possibly invoke nausea and vomiting from anyone subjected to the stress.

Odors of an offensive nature can be of concern in a space environment and this has been voiced by Berry⁽³⁶⁾ and the crews of Apollo-11 and Apollo-12, as well as others. With the advent of the walk-around capability in Apollo and future programs, the possibility of stomach awareness, nausea, and possible vomiting during the adaptation period becomes a real concern. The ability to keep the man clean, as distinguished from cleaning the habitat, are interrelated and should not be totally divorced. Man, however, remains a sensitive responsive entity and requires a rapid and acceptable solution to his possible frailty.

Offensive odors have been identified, additionally, with provoking poor respiration, functional malaise, insomnia, mental agitation, poor appetite for solid food, and a lowered water intake. Therefore, the need for good personal hygiene as regards mitigation of offensive odors is vital to good health.

The odors associated with the spacecraft should at all times be identifiable; viz, correction, if needed, and for safety reasons.

The correcting of an offensive odor can be accomplished by first determining the source so as to neutralize the input. One of the earliest areas of concern in this regard was the gas-out potential of many materials used in space vehicles. In a similar vein, the body gives off many odors; some are completely acceptable, and others are not. The latter group requires correction. The recognition of an odor is dictated by olfactory receptors located in the upper part of the nasal cavity. The pigmented olfactory membrane occupies 2.5 cm^2 in each nasal cavity. The cells involved are long and thin, ending in sensory hairs. The odor is first sensed in this region and, via neural excitation over fine nerve fibers to the olfactory bulb of the brain, finds proper recognition. Insensitivity to odor is thought to also occur in this region of the brain. So, it is possible for an individual to tune out an odor or, conversely, to become hypersensitive to still other odors. When we recall that odors are theorized as being substances that emit radiations of high frequency or gaseous entities able to excite pigment granules in the olfactory reception apparatus, the corrective approach must be multi-faceted. Since we are dealing with an anatomical collecting and sensing station, it is possible for the olfactory sensors to become inured to or insensitive to offensive odors produced by the self same individual. This argument, based on real life experiences in submarines, Antarctica, Tektite, and even in space, implores a prophylactic solution. The old saw about even his best friends not telling him is not true when it causes discomfort. The need for good personal hygiene habits should not be the sole responsibility of the individual. A required personal hygiene regimen is critical for sound health, psychological acceptance, and good logistical control of necessary components.

2. Control Measures

In order to be "smelled", a substance must be volatile enough for its molecules to be wafted on air currents. Certain elements, i.e. fluorine, chlorine, bromine, iodine, phosphorus, arsenic, in and of themselves, have odors. In fact, most odorants are organic compounds which, by virtue of molecular arrangements, structure, and chemical formulation, provide the distinct odors that identify each array.

The olfactory apparatus is extremely sensitive and can detect substances such as ethyl mercaptan at levels of $4 \times 10^{-8} \text{ mg/l}$ in air. The comparison is significant, too, with regard to other senses in that the olfactory buds are 1×10^4 more

sensitive than taste buds. Additionally, the physiological state of the individual, e.g. hunger, enhances the sensitivity.

In the physical realm, the temperature and humidity of the air influence the volatility and, therefore, the detectable strength.

The most common body odor arises from the incomplete oxidation of families of nitrogenous compounds such as the urea in perspiration and fatty compounds from the skin. The oral cavity, left to its own devices, becomes a focal point of many other odors ranging from the last meal to bacterial by-products. The ability to remove debris should at all times take precedence over an attempt to mask the odor. In this manner the end result is frequently longer lasting and, certainly, more esthetically acceptable.

Once an odor is established as being offensive or harmful, certain methods can be implemented to remove them. The ideal situation would be to arrange or subdivide the molecules. This implies a great deal of sophistication and versatility, apropos recognition and cure, whether we deal with a single compound or a combination of odors. More to our liking, however, is the ability to prevent the source from functioning. This would imply destruction of the odor producer and not of the product. When harmful or obnoxious material, as it relates to man, is produced as a metabolic by-product such as CO, CH₄, H₂S, NH₃, acetone, methanol, ethanol, ketones, acetates, acetaldehydes, or mercaptans, the chemical masking of the odors of some of these seems to be the only feasible method. If the odor is produced by bacterial involvement, then the element of antisepsis is invoked. If the antiseptic in use can simultaneously cause chemical destruction of the odor molecules, mask the odor by odor substitution, and also destroy the perhaps involved bacteria, all will be well in the realm of personal hygiene. One step more needs to be indicated. While there are antiseptics able to do all three, selection must include those that are not toxic to man or detrimental to his equipment.

Current thinking is directed at trying to minimize odor production, e.g. low residue diet, antiperspirants, minimize work so as not to sweat and, further, to employ odor removers. In this last regard, substances such as activated carbon are effective against certain odors, but they, in turn, are used up and require reactivation. Therefore, prophylaxis would still appear to be the most logical goal to pursue.

E. PSYCHOLOGY OF CLEANLINESS

1. Why

Much conjecture has surrounded the "need" for various personal hygiene implements. Why does man have the need to feel clean? The psychologist will explain the social considerations, viz, body odor elimination or concealment, visibly clean fingernails, or a clean shaven face. The military thinker will, undoubtedly, align spit and polish with discipline and morale. The medical community will properly describe it as a visible means of indicating an attempt to reduce infection; and all will be right, of course. The Tektite series rewarded its crewmen and women with a warm shower after work. Certain odors emanating from the unwashed wet suit in one instance were not acceptable and a thorough washing was mandatory. Weybrew⁽³⁷⁾ pointed out the difficulty with unwashed clothing aboard the nuclear submarine Triton on its maiden voyage. Corrective action was forthcoming. Various astronauts have been subjected to emissions of fecal gases. The only salvation was the oxygen mask. The odors described were all offensive and implied, among other things, a dirty environment.

A distinction has been made by some researchers between personal hygiene and sanitation on the following basis. Personal hygiene is regarded as the concern for all acts that provide for the cleanliness of the body and the clothing that envelopes it. Sanitation would then involve itself with the maintenance of an uncontaminated environment. It is recognized that the contaminated environment may contribute to the uncleanliness of the body and clothing; hence, the symbiotic relationship. We are concerned with all aspects of personal hygiene. Those which are as above and those which result from body contributions.

The study by Mattoni and Sullivan⁽³⁸⁾ gave rise to a rather extensive table of expected waste produced by all sources in a space cabin inhabited by man (see Table IV). These are, of course, only estimates and, in fact, are a bit idealized. The space environment, because of its uniqueness, is approached in a hesitant and somewhat apprehensive manner. Preparations are made to mitigate (to remove from the mind, as it were) the anticipated, potentially hazardous, uncomfortable, unpleasant, or even ill effects of events like bowel movements, vomiting, nausea, or even minor ailments such as the common cold. That this prophylactic approach warrants the effort is well documented by the infrequency of untoward events such as those that

TABLE IV. ESTIMATE OF WEIGHT, VOLUME, AND POTENTIAL DISTRIBUTION OF WASTE
PRODUCED IN A CONFINED FACILITY/MAN/DAY

Material	Mass (grams)	Volume (ml)	Body (Covered)	Under Garment	Outer Garment	Towelings	Bedding	Comments
Miscellaneous Cabin Compounds (80% particulate, 20% condensed vapor)	0.70	0.720	0%	14%	3/4%	0%	1%	Handled mostly by the ECS
Food Spillage (10% on man)	0.70	0.70	0%	1%	9%	90%	0%	Toweling used to control spillage.
Urine Spillage (50% on man)	0.025	0.025	0%	20%	30%	50%	0%	" "
Fecal Particles (100% on man)	0.025	0.023	79%	20%	1%	0%	0%	--
Desquamated Epithelium	3.00	2.80	10%	80%	5%	10%	5%	Toweling and body amount the same.
Hair - Depilation Loss	0.030	0.030	1%	43%	1%	5%	50%	50% from body; 50% from head
Hair - Facial, Shaving Loss	0.300	0.280	0	0	5%	0	0	90% captured by razor; 5% by ECS
Solids in Sweat	3.000	3.000	10%	80%	5%	10%	5%	
Insensible Water	1200.0	1200.0	-	5%	-	5%	(25%)	Momentary residue; otherwise 90% to ECS
Sebaceous Excretion (Residue)	4.000	4.20	10%	80%	5%	10%	5%	
Seminal Fluid - Residue	0.003	0.003	10%	90%	-	-	-	--
Mucus	0.40	0.40	-	-	-	80%	20%	--
Microorganisms	0.16	0.14	10%	80%	5%	10%	5%	

Based on Mattoni and Sullivan (38)

could occur in space. The ability to avoid these events wherever possible involves in no small measure the necessity for good personal hygiene mandates. The relative brevity of all our space flights to date has, undoubtedly, excused some errors in personal hygiene management. A dormant bacterial spore may not have found the appropriate environmental setting for growth in the short span of our recent space ventures. As forgiving as these factors may appear, it should be apparent that like many other systems an implementation routine should be initiated--even required--to assure a clean personal hygiene environment. The man is the weakest link in the sequence of transmission and infection.

2. Studies

We recognize the status implied by a statement indicating a positive act to clean one's self: "I've just bathed." "I had a close shave." "That was a refreshing sauna." etc. Therefore, one can openly defend cleanliness for its own self. It implies something good, clean, and wholesome. However, this can be, of course, a manifestation of nothing so explicit. The court of the French kings reeked with the perfume required to mask the hydrophobic attitudes of the nobility. The surgeon scrubs his apparently clean hands to further vindicate Lister. The visible dirt, e.g. under a fingernail, and the implied dirt, e.g. body odor, are not really of the same value when one attempts to qualify dirt. The correlation of dirtiness with extrusion through a body aperture is revealed by the acceptance of one's own saliva or nasal mucus. They are considered clean in one's own mouth or nasal passage, as the case may be. Yet, these same substances when expelled upon another person are considered dirty. The role played by education or sex in determining the dirtiness of body products is not to be overlooked. Table V, after Hirt⁽³⁹⁾, displays a number of body products ranked according to cleanliness by 273 individuals.

It is interesting to comment upon just a few of the results. Human's milk and blood are universally accepted as being "clean" and, at the other end of the scale, we find blackheads, vomitus, and pus. The population, by and large, rates feces 15th, while medical students, perhaps aware of the true nature of feces, consider it dirtier and rate it 21st. Females feel nose pickings are dirtiest (21), while the medical students are not as convinced and rate it 16th. While most people consider the menstrual discharge as almost neutral, females consider it basically clean; i.e., 8 of 21. Body sweat, by men in general, (10) and by medical students (8), in particular, is considered clean, while females consider it dirty (13).

TABLE V. RANKING VIZ CLEANLINESS

<u>Body Product</u>	<u>Total Individuals</u>	<u>Males</u>	<u>Females</u>	<u>Male Medical Students</u>
Human's Milk	1	1	1	1
Blood	2	2	3	3
Tears	3	3	4	2
Hair	4	4	2	6
Semen	5	5	5	4
Saliva	6	6	7	5
Pubic Hair	7	7	6	7
Nail Clippings	8	8	10	11
Face Sweat	9	9	11	9
Urine	10	11	9	10
Body Sweat	11	10	13	8
Menstrual Discharge	12	13	8	12
Ear Wax	13	12	12	13
Phlegm	14	14	14	15
Feces	15	15	15	21
Desquamated Toe Cells	16	16	18	18
Dandruff	17	17	16	14
Nose Pickings	18	18	21	16
Pus	19	20	17	20
Vomitus	20	19	20	17
Blackheads	21	21	19	19

As to whether or not these materials are clean in any of the ways we have indicated (sight, smell, or bacteriological content), one must include in the total concept the mental image each of these conjures up. Frequently, the mental image prevails as the major discriminator.

F. CLOTHING

The function of clothing in the personal hygiene sense lies in its ability to influence body temperature and skin surfaces via friction or protection. We may assume

that clothing is not just a passive cover for the integument, but that it interacts with and modifies the heat regulating function of the skin and has effects which are further modified by body movement. This would account in part for the abrasive effect that aids in desquamification of dried epithelia.

In the extreme case where no clothing is worn, we are still faced with a body layer of interface air in contact with the environment. This concept, if extended to clothing, would substitute the clothing for the skin. The skin by virtue of its hairiness or surface roughness influences the thickness of the air boundary. The true determiner of this air boundary is the wind speed or air movement. Each layer of clothing possesses its own air layer. The significance lies in the surface area contacted and the entrapment possibilities for odors and microorganisms, as well as organic debris. The average man possesses 1.8 square meters of surface skin. While not all this area is sweat functional, when we add it to a two-layer clothing system we provide over 5 square meters of involved surface.

Two major areas of interest are to be found in clothing tests as regards personal health. The first invites concern for physiological limits such as heat tolerance. Our study is not aimed at this, but directs itself at the other concern-- sanitation and personal hygiene. The two are related in our context because the measures required for the sanitation of all clothing employed directly affects the personal hygiene of the wearer. The converse is, of course, obvious, too. A dirty person would tend to soil the garments and render them unfit for use by another individual. If at any time an exchange of clothing is contemplated for logistical or test purposes, then adequate washing must be assured. Socks, for example, should be washed and then sterilized by a rinse in an antiseptic solution. Clothing that is not in contact with the skin may be more freely exchanged or utilized. The presence of an obvious skin infection should mandate rigid measures to keep the infection contained.

It may be possible to sterilize clothing and retain its sterility on a long-term basis. Russian studies have implied this capability using coatings. Other techniques impregnate the fibers with chemical agents and/or antibiotics. The toxicity and allergenicity of these approaches are not without concern.

The ideal garment would be lightweight, thin, smooth-fibered, and porous. It should be slightly hydrophilic so as to absorb sweat easily and eventually transport

it via wicking or capillary action to the air interface for evaporation. An awareness of the reactivity between layers of clothing is necessary. Underwear removes moisture from the skin and transmits the moisture via distillation over rough fibers to the outer garment. The residue of the distillate can represent topical body exudates and minerals.

One of the contemplated Skylab clothing inventories indicates the following:

- 60 Jackets
- 60 Pairs of pants
- 60 Shirts
- 210 Sets of underwear
- 15 Pairs of boots and gloves (15 each)
- 30 Constant wear garments

It is hoped that in pre-Skylab testing the approach suggested in this protocol could be employed to investigate the microorganism retention capabilities of the clothing enumerated. The intent is to investigate by this approach the moisture retaining properties since it is the moisture that fosters bacterial survival on clothing fibers. Corrective action could be initiated if required.

Linens and towels would be expected to act as collectors of "dirt" and all that it implies. Left unchecked for any period of time, we could expect an increase in bacterial populations. If we could establish a microbiological barrier on these materials by fixation of a chemical bond with antimicrobial substances, bacteriostasis may result. It is not sufficient to impart to a fiber a permanent chemical bond as described unless certain components of the bond can diffuse readily to the bacterial surface and perform its mission. The nature of the bond and its very tenacity form the key to this problem. Fibers can be bonded to substances of an antimicrobial nature by bonds of three types: coordination, ionic, and covalent. The strongest of these is the covalent bond.

The approaches to bonding are twofold. One is the equivalent of dipping in a solution after the cloth is formed, and the second is in the bonding acquired during fiber synthesis or manufacture. This last approach is more permanent.

In summation, clothing is equivalent to a second skin. The greater the number of layers the greater the evaporative surface and habitat surface that is made available.

Disinfection can be accomplished by washing or imparting antibacterial properties to cloth. The best way to achieve the last event is by covalent bonding during the manufacturing phase of the cloth production.

G. THE PRACTICALITIES OF CLEANLINESS

1. Previous Personal Hygiene Studies

In a review of previous chamber studies there did not appear to be that which could properly be described as a personal hygiene study. All of the few who so identified themselves were, in fact, limited to one small area of concern. Tables VI and VII indicate in summary fashion the main concern and, to a degree, the personal hygiene concern of twenty-one studies. This review of personal hygiene involvement is understandably limited and it is believed that any omissions would track in a similar fashion.

The manner in which they were conducted has been reviewed so as to take advantage of the many approaches and the results derived therefrom.

2. Hygiene Approaches - Preliminary Tradeoff

a. Body Hygiene

Studies conducted indicate that body hygiene must be attended to every day for psychological reasons and for optimization of skin health parameters. To provide efficient utilization of resources and effect a variety of cleaning modes similar to an earth environment, body hygiene has been further reduced to a combination of some form of (1) Full Body Wash, (2) Hand and Face Wash, and (3) Selected Body Area Cleansing.

(1) Full Body Wash

The Full Body Wash can be effected in three ways: Shower, Immersion Bath, and Sponge Bath.

The immersion bath concept consists of a plastic suit which may have pads of sponge material on the inner surface. The crewman steps into the suit and seals it around himself (the suit does not cover his head). Water is introduced through lines from the water management subsystem. Washing is obtained by either rubbing the sponge areas over the body, use of a washcloth, or direct hand washing.

TABLE VI. CHAMBER STUDIES

	REFERENCE	DATE	AUTHORS	AIM OF WORK	LENGTH	HYGIENE CONDITION	TESTS MADE WITH RESPECT TO HYGIENE	COMMENTS
40	Dayton Newspaper Unchanged underwear	3/67	Dr. Rene La Chapelle	Skin bacteria as a function of undergar- ments treated with anti- microbial compounds	80 days	Hygiene assumed to be normal (for dormitory students) except no changing of underwear	1) Bacteriological of the anal fold and public area 2) General health	1) No mention of washing 2) No mention of work rest 3) No mention of outer garments change
41 Vol. 1 and 42 Vol. 2	Feasibility Study of Personnel Shirtsleeve Clothing and Disposal NASA L-67, 067, MS138	6/68	Clothing and organic Materials Lab Natick Labs	1) Clothing design 2) Laundry feasibility 3) Heat stress effects of various clothing configurations	N.A.	Not mentioned	1) 5 laundry clothing exchange cycles compared 2) Heat stress versus activity level	Not a chamber test -- Concerned with short term (less than 1 day) physio- logical effects of clothing
43	Sanitation and Personal Hygiene during Aerospace Missions	6/22	R. H. Mattoni	1) General overview of problems 2) Generation rates of soiling agents 3) Physical and psycho- logical definitions of "dirty"	N.A.	N.A.	N.A.	Very General -- Subjective analysis of various washing modes
22	Hygienic Investigations of Cosmonaut Clothing designed for wear in small sized cabins under shirtsleeve microclimate conditions	65	I. G. Popov et al Problems of Space Biology NASA TTF 368	Function of clothing with respect to heat loading of wearer	N.A.	No mention of washing	1) Chemical tests of man's soil and clothing's soil 2) Heat stress 3) Absorption capacity of clothing	Absence of personal hygiene data
44	Some means of reducing bacterial propagation during prolonged space flights	? Circa 65-67	V. V. Borshchenko N 67 13426	Skin bacteria as a form of undergarments treated with antimicrobial compounds	N.A.	N.A.	1) Bacteriological anal fold and public area	1) Background on bacteria growth on astronauts 2) Analysis of clothing and its function
45	Integrated life support system study (20 day evaluation program) AFAMRL TR-66 185	12/66	Courtney A. Metzger Eugene Fritz	Study overall physical and psychological effects of the space environment as created by life support equipment	20 days	1) No bathing 2) No clothes changing 3) No personal hygiene (5 wipes/man day for after defecation cleanup and prior to eating	None	All evaluations of personal hygiene were of the subjective type complaint
46	Microbiological Sampling for Human Subjects AFAMRL TR-65-192	12/65	Arselus West	A graphic outline for the microbiological sampling of human subjects to de- termine the composition of indigenous microflora	N.A.	N.A.	N.A.	Methods were presented to minimize the destruction of a sites microbiological integrity
47	Determination of the indigenous microflora of men in controlled environments	4/66	Phyllis E. Rely et al	To obtain "baseline data in order to define the effects of space stimula- tion on microbiological flora	42 days	1) Washing with soap and water for controls No washing at all for remainder 2) No clothes changing	1) Bacteriological various locations	Washing technique was not discussed
48	Effects of diet and atmos- phere on intestinal and skin flora NASA CR-661	4/67	L. S. Gall Phyllis E. Rely	Establish skin flora variations as a function of atmosphere and food	4 days	Washed hands and face only - no other hygiene - no soap	Atmospheric environment and diet versus skin flora as indicated by bacterio- logical sampling	No mention of work rest cycles

TABLE VI. CHAMBER STUDIES (concluded)

REFERENCE	DATE	AUTHORS	AIM OF WORK	LENGTH	HYGIENE CONDITION	TESTS MADE WITH RESPECT TO HYGIENE	COMMENTS
49	?	I. G. Popov et al	Effect of limited work, limited food, and limited	23-60 days	Water and alcohol were used in various quantities	1) Chemical testing for chlorides on skin and clothing and organic compounds on skin and clothing 2) Ph determinations 3) Medical examination of skin	1) Subjects changed socks only every 20-22 days 2) Occasionally washed feet
50	6/68	T. M. Fraser	Background into various habitability experiments conducted to date	N. A.	N. A.	N. A.	All applicable references are covered in this chart
51	67	K. R. Coburn L. S. Gail P. E. Reilly NASA CR 708	See title	See title	1) No change of clothes 2) No soap or toothpaste 3) Unlimited hot or cold water	1) Bacteriological tests-general 2) Psychological	1) Washcloths were laundered regularly
52	66	A. R. Slonim	Comparative water purification	28 days 4 weeks	1) No personal hygiene at all 2) Wipes before meals and defecation 3) No clothes or linen change	1) Microbiological analysis	
53	60	J. H. Ebersole				Bacteriological	Long duration missions of submarines resulted in better skin health (than non-nuclear) because of the abundance of fresh water for bathing
54	9/67	L. P. Lotter B. S. Horstman	See title	28 days	1) No personal hygiene 2) Wipes only after defecation	1) Bacteriological tests general	
55	9/67	L. P. Lotter B. S. Horstman J. V. Rack	See title	28 days	1) No personal hygiene 2) Wipes only after defecation	Bacteriological tests general	
56	12/68	McDonnell Douglas Astronautics Co.	See title	60 days	Daily sponge baths	Bacteriological	No mention of clothing changes
57	5/71	McDonnell Douglas Astronautics Co.	Test of a Regenerative	90 days	Washcloths soap Basic H detergent only	Bacteriological-water potability	
58	1/70	D. C. Pauli H. A. Cole	Man's work and life at the bottom of the sea with existing technology	60 days	Shower	Bacteriological	
59	9/70	Conkle et al	See title	14 days	Damp Cloth Dry Toothbrush	N. A.	

TABLE VII. CHAMBER STUDIES SUMMARY

See Table VI	Was personal hygiene a primary independent variable?	Post defecation hand wipes?	Hands and face wash?	Feet wash?	Body fold wash?	General wash?	Technique of washing described? ie, amount water and soap, abrasion, etc.	Soap used?	Alcohol used	Underwear changed	Socks changed	Outer garments changed	Bed linens changed	Tests P Psychological M Medical B Bacteriological
40	No	?	?	?	?	No	?	No	No	?	?	?	B	?
45	Yes	Yes	No	No	No	No	No	No	No	No	No	No	P	?
47	Yes	?	C	C	C	No	C	No	No	No	No	No	B	?
48	No	?	Yes	No	No	No	No	No	No	No	No	No	B	?
49	Yes	?	Yes	Yes	Yes	No	No	V	?	Yes	?	?	C,M	?
51	?	?	Yes	Yes	Yes	No	No	No	No	No	No	No	B,P	?
52	Yes	Yes	No	No	No	No	No	No	No	No	No	No	B	?
53	No	?	Yes	Yes	Yes	Yes	?	No	?	?	?	?	?	?
54	No	Yes	No	No	No	No	No	No	No	No	No	No	B	?
56	No	No	Yes	Yes	Yes	No	Yes	No	?	?	?	?	P,M,B	?
57	No	No	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes	P,B	?
58	No	No	Yes	Yes	Yes	No	Yes	No	?	?	?	?	P,M	?
59	No	No	No	No	No	No	No	No	No	No	No	No	No	No

? = Not evident from reference

V = Indicates described parameter was an experimental variable

C = Controls only

A = Sponge bath

The tradeoff between these methods is shown in Figure 2. A full shower is recommended; the psychological advantages warrant this selection.

	Shower	Immersion Bath	Sponge Bath
Crew Acceptability	High	Good	Fair
Cleansing Time Requirement	5 minutes	5 minutes	8 minutes
Equipment Complexity	Complicated	Moderate	Simple
Operation Complexity	Simple	Moderate	Simple
Cleansing Action	Excellent	Good	Good
Water Consumption	2-3 gallons	.8 gallon	.03 gallon
Applicability to Zero- and Partial-G	Moderate Design Considerations Required	Simple Design Considerations Required	No Effect

Figure 2. Full Body Wash

(2) Hand and Face Wash

The hand and face wash can be effected in a variety of ways: a standard sink, disposable wipes, sponge, and cleansing cream.

The standard sink should consist of an easily cleaned surface. The controls for the flow rate of water are available to the crewman who adjusts them to suit conditions. He wets and soaps his hand and/or washcloth and cleanses his hands and/or face. Water is used for final rinse.

Disposable body wipes can be of two types: (a) towels pre-moistened with water or a mixture of propylene glycol and alcohol, or (b) dry towels moistened in the water system. Each type is utilized in the same obvious way.

The sponge is used in the manner described in the protocol section on Full Body Wash.

Cleansing cream would be a non-water base solvent on the order of women's cold cream or mechanic's solvent cream. It would be applied from a tube or container and wiped off with whatever form of wipes are utilized.

The tradeoffs between these methods are shown in Figure 3. A standard sink is recommended for the increased psychological value of washing with soap and water in an almost normal method. The lack of significant expendables and superior washing action also support this choice.

	Standard Sink	Disposable Wipes	Sponge	Cleansing Cream and Wipes
Crew Acceptability	Excellent	Good	High	Fair
Weight	20 lbs/sink	.3 lb/man day	10 pounds	.3 lb/man day
Water Consumption Per Wash	1 gallon	0	.01 gallons	0
Expendables Per Wash	2 ml (soap)/wash	.03 lb/wash	0	30 ml
Equipment Complexity	Moderate	Simple	Simple	Simple
Operation Complexity	Moderate	Simple	Simple	Simple
Time Requirements	2 minutes	.5 minutes	2 minutes	1 minute
Applicability to Zero- and Partial-G	Moderate Design Considerations Required	No Effect	Simple	No Effect
Cleansing Action	Excellent	Fair	Good	Fair

Figure 3. Hand and Face Wash

(3) Selected Body Area Cleansing

Selected body area cleaning can be accomplished in a variety of ways: disposable wipes, washable wipes, or a combination; i.e., disposable-washable.

The disposable wipes have been described in the section on hand and face wash (see III.G.2(2)). The washable wipes have wide application as they are compatible with the shower, sink, and laundry. The combination would consist of wipes which could be washed three to five times and then disposed of. These wipes would have to be compatible with washing machine, sink, and shower as well as the waste disposal system.

The tradeoffs between these methods are shown in Figure 4. Washable wipes are recommended as other methods become excessively heavy and volume consuming over long periods of time with large crews.

	Disposable	Washable	Combination of Rewash of Disposable Wipes For Specific Number of Washes
Crew Acceptability	Good	Excellent if very clean; poor if dingy.	Good if very clean; poor if dingy.

Figure 4. Body Wipes

b. Personal Grooming

(1) Head Hair Hygiene

Head hair hygiene can be achieved by any of the three considered methods: hand clippers, electric clippers, and razor comb. A preliminary tradeoff (Figure 5) is provided which indicates some of the differences between the methods; although, as before, final selection is made on a nonquantifiable weighing of the factors.

Electric clippers are recommended almost primarily due to ease of use, less crew time, and flexibility of operation. The clipper should have a vacuum collector for preventing loose hairs from entering the cabin atmosphere.

	Hand Clippers	Electric Clippers	Razor Comb
Crew Acceptability	Good	High	Fair
Crew Time	15-20 minutes	5-10 minutes	20-30 minutes
Equipment Complexity	Simple	Moderate	Simple
Operational Complexity	Moderate	Simple	Moderate

Figure 5. Hair Hygiene

(2) Facial Hair

Shaving can be accomplished in any of three methods: shaving cream and razor, electric razor, or wind-up razor. Although shaving cream and a safety razor has evidently been successfully used on Apollo flights, objections to this method are concerned with applicability for long flights. Critical factors include

continuous wiping or cleaning of blade surface during shaving, possible loss of cuttings handling problems (cuts or nicks causing bleeding), expendables for cleaning the blade, and disposal problems of the expendables. Electric razors and wind-up razors eliminate the above objections and are both considered suitable after recent use. The elementary tradeoff performed (Figure 6) reveals no obvious solution and, further, more extensive tradeoffs are required before selection of the final system can be made.

	Electric	Wind-Up	Shaving Cream and Razor
Crew Acceptability	High	Fair	Fair
Operational Complexity	Simple	Simple	Moderate
Equipment Complexity	Moderate	Moderate	Simple
Water Expended/Shave	0	0	50 ml
Expendables/Shave	0	0	10-15 ml
Time	4 minutes	4 minutes	8 minutes

Figure 6. Shaving Capability

(3) Nail Care

Nail care consists of removing long finger and toe nails. The equipment must be designed to collect the material before it can drift free in the cabin. This may be accomplished with an enclosed clipper. The alternate methods (clipper and file) are compared in Figure 7. A standard nail clipper is considered superior because of crew acceptability and because of the ease of handling the clippings by an integral containment device.

	Clipper	File
Crew Acceptability	High	Fair
Time	5 min/man (2 weeks)	15 min/man (2 weeks)
Ease of Handling Debris in Zero- or Partial-G	Simple	Moderate

Figure 7. Nail Care (Fingers and Toes)

(4) Oral Hygiene

Dental hygiene should be practiced after each meal to maintain the teeth free of cavities, reduce plaque build-up, and prevent gingivitis. It is recommended that the diet include a number of solid foods requiring chewing in order to prevent softening of the gums and loosening of the teeth. However, proper dental stimulation through brushing will assist in maintaining good tooth emplacement. The methods considered were toothbrush and toothpaste; electric brush, toothpaste, and interdental stimulator; toothbrush and edible toothpaste; toothbrush, H₂O, and dental floss; and Water Pik. Preliminary tradeoffs are presented in Figure 8. See also Oral Hygiene - Section V.A.4.e(1).

	Toothbrush and Toothpaste	Electric Brush Toothpaste, and Interdental Stimulator	Toothbrush and Edible Toothpaste	Toothbrush + H ₂ O and Dental Floss	Water Pik
Crew Acceptability	Excellent	Excellent	Fair	Good	Good
Time Requirements	2 minutes	2 minutes	2 minutes	2 minutes	2 minutes
Water Con- sumption Per Wash	25 cc	25 cc	25 cc	25 cc	125 cc
Expendables Per Wash	1 cc	None	1 cc	1 cc	None
Cleaning Action	Good	Excellent	Good	Excellent	Excellent
Equipment Complexity	Simple	Moderate	Simple	Simple	Complicated
Operation Complexity	Simple	Simple	Simple	Moderate	Moderate

Figure 8. Dental Care

Edible toothpaste (ingestible dentifrice) is not required for basic personal hygiene considerations. It is not favored because of the anticipated greater crew stress and possible medical problems relating to long-term ingestion.

The combination of toothbrush, H₂O (no paste), and dental floss, while possessing much in its favor, is eliminated because of the reduced feeling of cleanliness resulting from the lack of a dentifrice.

The Water Pik is retained as a possible candidate until more knowledge about its sole use for dental hygiene is obtained and evaluated for long-term use. Toothbrush and toothpaste versus electric brush, toothpaste, and interdental stimulator should be the subject of more extensive tradeoffs to be completed before a final selection can be made. The process for either should be such that the dentifrice is delivered directly from its storage container so as to avoid contamination. The crewman inserts the toothbrush into his mouth and either brushes or activates the electric motor. When brushing is completed, water should be used in the mouth for rinsing. To collect the expectorate, an adaption tube should be inserted into the waste water collection system. This tube (with possibly a mouthpiece) will provide for the transfer of the mixture of water, saliva, dentifrice, and dental debris for delivery to the water recovery system, if available.

(5) Ear Hygiene

Ears can be kept clean and free of wax with the use of cotton swabs. Reusable swabs were not considered as weight ratio of wax and debris to cotton material as a soiled swab necessitates large expenditures of water, detergent, and/or solvent. Disposable swabs (with paper stems) are recommended although they are volume consuming. However, their use should be restricted to remedial cleaning and not be a part of normal hygiene, as natural mechanisms limit the build-up of wax within the ear.

3. Personal Hygiene Management - Discussion of Tradeoff Studies

The efforts desired in the implementation of personal hygiene management are depicted in the following flow chart (Figure 9). The all-inclusive nature of the tasks involved must be coordinated with other activities and available hardware. It is conceivable that certain of these desired events can be substituted for and still others omitted due to other priorities. The scope of this program is enhanced by the interdependence of the events depicted.

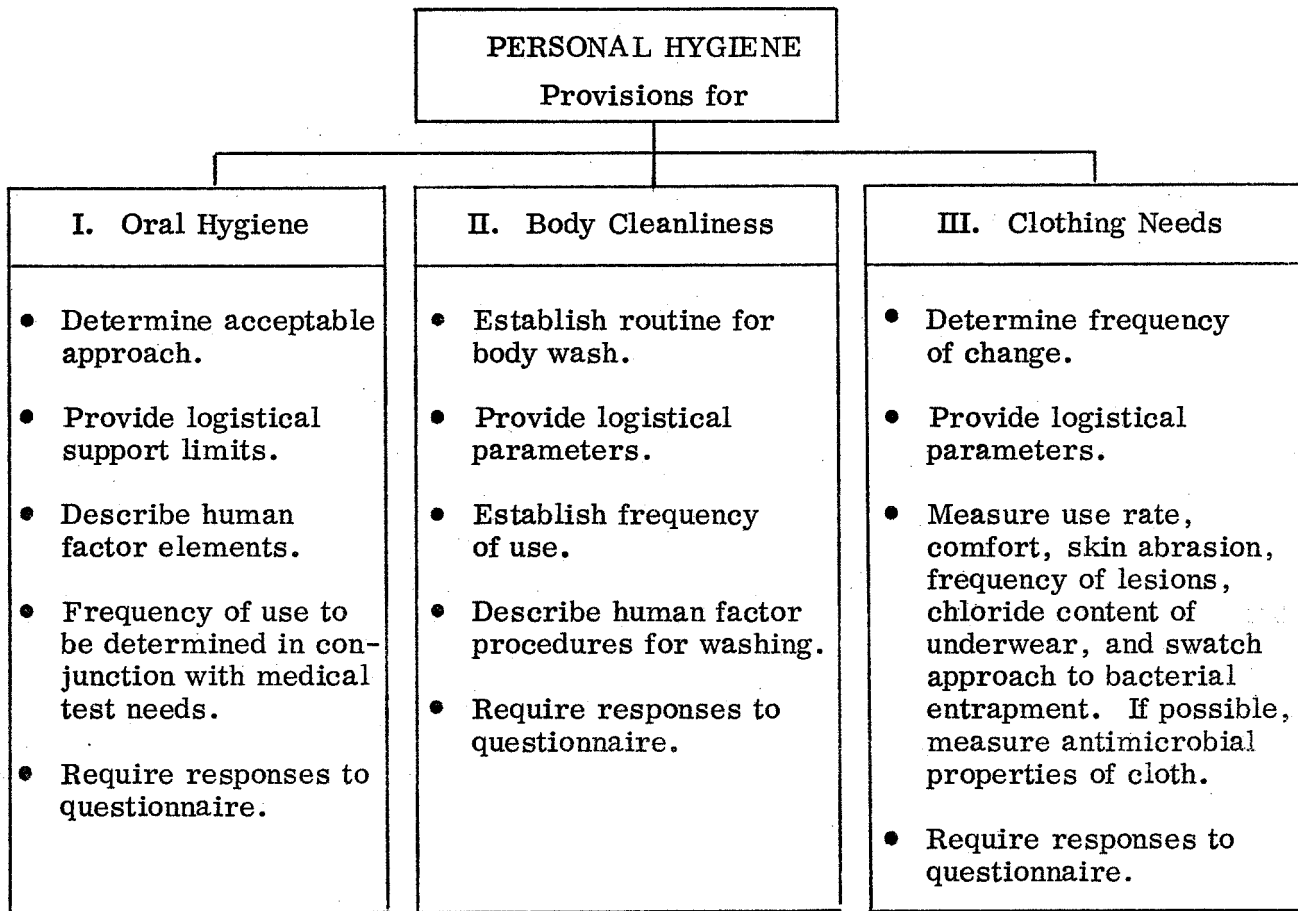


Figure 9. Personal Hygiene Management Flow Chart - Tasks

A discussion of each of these areas follows so as to depict in a general way the many factors that impinge on task performance.

I. ORAL HYGIENE

- A. Brush teeth as recommended by dental personnel.
- B. Provide variables for consideration by dentist; e.g. ingestible toothpaste, chewable toothpaste or brush, water and dental stimulator. Establish use rate.
- C. Have containment facility for oral discards.
- D. Assure health of mouth via frequent examinations.
- E. Implement oral sampling via swab and gargle.
(See Techniques Section - Page 66)

II. BODY CLEANLINESS

A. Hair Length and Cleaning

1. Use clippers to maintain desired length. Due to bacterial inhabitation of hair and the cost of frequent hair washings, the length of hair should be esthetically pleasing but as short as possible.
2. Utilize hair washes at prescribed intervals. An antiseptic rinse is recommended.

B. Wash Face

1. Face washing should occur at prescribed intervals.
2. Washcloth and bar soap which is pierced by neck string are used.
3. Follow by fresh water rinse.
4. Either air dry or use towel.

C. Wash Hands

1. The obvious time would be in conjunction with the washing of the face.
2. If required at other times due to dirtiness or other form of contamination, use authorized water quantity with hand brush and bar soap.
3. Proceed as prescribed.
4. Rinse with fresh water or, if directed, use moist wipe.
5. Either air dry or use towel.

D. Shaving

1. For reasons similar to the hair length discussion, beards should not be permitted. Bacterial infection is readily promulgated via beards⁽⁶⁰⁾.
2. Since both mechanical and conventional means have been used in outer space, a choice based on ease of hair removal and entrapment of hair particles is implied.
3. Mechanical means may result in skin abrasions. The lather approach requires much post-shave activity.
4. Frequency should be dictated by individuals' pre-determined growth rate.

E. Trim Nails

1. Trim nails using conventional clipper in a containment bag; i.e., clear plastic.
2. Required for safety as well as hygiene reasons.
3. Cut to establish length commensurate with finger dexterity (gloved or ungloved) and to minimize dirt accumulation.
4. Filing is not recommended.

F. Torso Washing

1. The approaches to torso washdown are indicated elsewhere and include whole body immersion, shower, and sponge bath.
2. Whole body immersion requires too many functions and too much in the way of supplies ranging from a containment device, provision for over 10 gallons of water, and a method to clean the system, etc.
3. Showering with a prewarmed discharge adequate to lather-up using conventional washcloth (sponge) and bar soap can be followed by a timed rinse.
4. Dry with air or towel.
5. Frequency to be varied according to plan.

III. CLOTHING LOGISTICS

A. Screen clothing for the following:

1. Wearability as regards linting and actual frequency of washing re wearability.
2. Possibility of being made antimicrobial.
3. Check comfort to prevent chafing.

B. Absorbability -- desired, but not suggested as part of this report.

1. Water and dirt retention.
2. Oils
3. Bacteria

C. Cleaning Methods

1. "Dry" (powder adsorbents)
2. Wet (Laundry)

D. Storage

1. To retain sterility or cleanliness.
2. To minimize odors and cross-contamination.

4. Soaps - Antiseptics

The need for a mediator to aid in soil removal from skin and clothing is well understood. This substance has assumed many shapes from powder to liquid to aerosol and many other intermediate forms. The material we are searching for must possess a host of required traits. Directing our perusal at a potentially space qualifiable material, we seek one able to function in zero-g as well as one-g, capable of remaining stable throughout 35-180°F temperature. It should also be effective in 100% O₂ at 3.5 to 5.0 psia, or 75% N₂, 25% O₂ at 5.0 to 14.0 psia. This material must cleanse well without irritation, reduce or inhibit bacterial growth, be easily removed after low sudsing, and not prejudice any other system it contacts. That it may not be corrosive, toxic, or flammable is, hopefully, understood.

The collective term surfactants has been applied to organic molecules or unformulated compounds that act on a surface. In general, they fall into four major chemical categories: anionics, non-ionics, cationics, and amphoterics. "Syndet" is a contraction for synthetic detergent. These substances, depending on their basic makeup, assume many guises. Certain syndets (e.g., Tide^(R)) would not be called surfactants, while sodium lauryl sulfate would classify as one. Syndets compete in the real world with soap detergents. When we consider the efficiency of these groups to perform, we find little difference except as regards biodegradability. A truly intense chemical synopsis was never intended to be a part of this study, yet certain basic considerations point up the desirability of soap detergents as opposed to syndets. Fatty acid soaps, rosin soaps, and tall oil soaps do not impose certain basic problems that do occur with some syndets. One of these is in the area of foaming. This effect would preclude easy water recovery prior to a preliminary treatment. The normal hardness of water is sufficient to precipitate soap. Thus, 20 ppm of hardness in water will precipitate effectively at least 40 ppm of soap. As little as 5 ppm of some syndets will promote high foaming. This foam is the forerunner of a residue that can accumulate on clothes and on the skin. Some of these, in turn, may also be hydrophobic and would, therefore, affect sweat absorption. In any attempt to reclaim wash water, particularly for drinking purposes, we must cope with the realization that as little as 2 ppm can cause a perceptible taste in water.

Depending on the task on hand, a surfactant is selected to do the work based on the level of emulsification, wetting, penetrability, solubilization, and

spreading potential in its formulation. The function to be fulfilled can be attacked from two directions: (1) tailor the job to the product, and (2) design a product for the job. There is no easy approach to properly evaluating any surfactant for personal hygiene considerations. At best, we can apply a semi-empirical procedure to its study.

As we attempt to utilize a surfactant, a consideration of its biological and toxicological properties come to the fore. Some surfactants such as cationics have a lethal effect on bacteria. C.A. Lawrence⁽⁶¹⁾, in his book, indicates the effectiveness of quaternary ammonium compounds on both gram-positive and gram-negative organisms. Anionic surfactants are more selective, killing predominantly gram-positive organisms. Additionally, they are more easily susceptible to pH changes and all in all act slower. The non-ionic surfactants are not truly germicidal.

It would appear that the effects on the skin by various surfactants impose still another hurdle in a selection process. The greater the complexity of the composition, the greater the possibility of an allergic dermatitis. Inasmuch as individuals vary so very much in sensitivity to surfactants, it would seem prudent to return to simple compositions. The desire to test various compounds should be tempered by the realization that there does not appear to be any common linear relationship among concentrations, time of exposure, and irritancy. There appears to be the need to single out the saturated fatty soaps as the most dermatologically acceptable surfactants based on the fact they are the best studied. For example, C₈ and C₁₀ are highly irritating; C₁₂ less so, and C₁₄ to C₁₈ the blandest of all. Oleic soap is also acceptable, but rosin soaps are irritants. While there really isn't any evidence that syndets are better or worse than soaps with regard to skin irritancy, it does appear that superfatted compounds protect the skin more.

The bactericidal activity of any surfactant is influenced by the presence of other substances. The cationics are not enhanced by other substances, but do react to inhibitors of many types. Consequently, the knowledge of the surface contaminant may dictate the agent to be used. Marples, in her book, The Ecology of the Human Skin, pointed out that just removing the surface dirt and temporarily cleansing the top layer of the skin invites reinhabitation and colonization from the bottom layers which Montes and Wilborn⁽¹⁾ confirmed earlier in this study.

Stoughton⁽⁶²⁾ raises an important point in stressing the need to have an agent penetrate whatever protective surface coat there may be. To this end, he points out the penetrability of various substances: 95% ethanol, cold cream (Eucerin Cream), cream base (hydrophilic petrolatum U.S. P.), and dimethylacetamide. The ranking showed the dimethylacetamide to be the most efficient vehicle for skin penetration. This approach to cleansing the skin deep down should be considered.

In a study by MacKenzie⁽⁶³⁾ it became apparent that antibacterial soaps (Hexachlorophene-Tricocarbon) had some effect on bacteriostasis, but the effect was not as significant as might have been wished for. The subjects changed clothes too often and showered much too frequently; as many as three showers a day. It would be very difficult to relate the efficacy of the soap to the washing frequency and/or method of scrubdown. Further, since the end point in the protected group appears to be the presence of 23 bacterial lesions (N = 602) versus 41 bacterial lesions (N = 599) in the unprotected group, it is difficult to read wherein the value of the antibacterial soap lies. In a further study comparing .6% undecoylium chloride-iodine, 24% hexachlorophene, and 3% hexachlorophene with detergent, by Ramsey et al⁽⁶⁴⁾, the first compound was far superior to either hexachlorophene dilution. In both studies it became apparent that the initial degerming by the hexachlorophene soap or agent was a temporary phenomenon. After varying periods of time the count of organisms increased. We might theorize as to the cause of this event: (1) The "potency" of the antibacterial agent perhaps became diluted by organic materials, (2) The range of activity did not encompass the emerging organism, (3) The action curve of the agent with reference to rapidity of action peaked too soon, and (4) The germicide was self-limiting.

The essence of this information underscores the need for an extensive soap and antiseptic study. Over a span of many years a variety of studies of limited scope have attempted to predict or determine a particular effect for perhaps a particular organism. In our review, we rarely encountered a study that challenged more than three or four types of organisms. The self-serving studies of individual soap companies and the general lack of cooperation in publishing their results can lead to any conclusion. Our's is that no soap or syndet can be a total surfactant. We must tailor the product to the task. At first glance this might apply also to the antiseptics explored. However, certain elemental compounds such as the undecoylium chloride-iodine have shown great effectiveness and so deserve further support.

In summation, surfactants encompass many forms of soil removers. We are interested in cleansers. A detergent is a cleanser. There are three major groups of detergents as follows:

- a. Anionic-Alkyl Sulfates and Soaps. Most household detergents are in this category either as syndets (alkyl sulfate) which clean well, but cause foam, or as soaps. Some syndets are bacteriostatic and can produce contact dermatitis. Soaps have limited microbial lethality. Even with known bactericides they are only initially effective.
- b. Cationic detergents are generally quaternary amines. They are good bacteriocides, but cause allergic reactions and other harmful events.
- c. Non-ionic detergents are poor germicides and are frequently toxic.

A pure soap appears to be the choice. Potassium or sodium oleate or palmitate would be able to dissolve readily and with a minimum of residual foam.

No soap appears qualified to keep skin bacteria at a completely acceptable level. Therefore, at this point in time, frequent bathing appears to be the best solution to this concern.

SECTION IV

HUMAN FACTORS BASELINE CONSIDERATIONS

The events envisioned in a personal hygiene study and the time and material cost to perform these can only be estimated. The time elements used are based on the enclosed report data. The events are as follows:

- a) Hand and/or Face Wash
- b) Hair Wash
- c) Oral Care
- d) Total Body Wash
 - Shower
 - Sponge, washcloth, or brush

The task times are the latest working calculations as distinct from earlier tradeoff studies. The skin variables to consider are depicted in the following. Not all are factors for our purpose. All, however, have been discussed previously or at this time.

A. SKIN VARIABLES

- 1. Skin Cleansing Variables
 - a. Cleaning Process Frequency
 - b. Water (Solvent)
 - (1) Temperature
 - (2) Quantity for washing (cc/cm² of skin) and rinsing (cc/cm² of skin)
 - c. Additive (Soap)
 - (1) Concentration
 - (2) Bactericidal Qualities
 - (3) Resultant pH
 - d. Technique
 - (1) Mechanical Action
 - Abrasion With Washcloths
 - Brushes
 - Water Jet
 - Hand Rubbing

- (2) Drying Action
 - Abrasion Drying With Towels
 - Blotter-Type Drying With Towels
 - Ambient Air Drying
 - Airflow
 - Temperature
 - Humidity

B. SKIN SOILING VARIABLES

- 1. Time Between Cleaning
 - a. Percent reductions of significant soiling agents as function of time due to washing.
 - b. Percent reductions of significant soiling agents as a function of time due to cleaning effect of clothes changing.
- 2. Environmental Conditions
 - a. Temperature of the air
 - b. Relative humidity
 - c. Suspended particles and/or bacteria
 - d. Gaseous makeup of the air
- 3. Activity Levels
 - a. Work/Rest Cycles
 - b. Metabolic Activity
 - (1) Average
 - (2) Maximum
- 4. Garments
 - a. Heat Conductivity Through (Insulative Properties)
 - b. Absorptive Qualities
 - (1) Moisture
 - (2) Salts/Oils
 - (3) Particles
 - c. Air Circulation Through
 - d. Abrasive Qualities
 - (1) Due to fabric
 - (2) Due to fit
 - (3) Due to motion between cloths and skin
 - e. Bactericidal Qualities

C. SKIN QUALITY DESCRIPTORS

1. Medical
2. Bacteriological
3. Chemical
4. Psychological

D. GENERAL DISCUSSION

1. Frequency

It is known that men have gone unbathed for more than 30 days with no adverse effects on the skin microflora. Except for esthetic reasons, bathing or whole body cleansing every 30 days would appear to satisfy minimum health requirements. However, we are baselining our study at two times per week.

2. Temperature

Surface touch temperature is generally limited to 105°F. Therefore, water temperature should be between 100 and 110°F for whole body washing, and 110 to 115°F for just the hands.

3. Quantity

a. Washing - Washcloth

Each application of a washcloth will absorb approximately one-third of a pint of solution. A body wash utilizing four applications would require 1-1/3 pints.

b. Washing - Shower

Wetting for 20 seconds requires approximately 2 pints of water.

c. Rinsing - Cloth

Four applications of the washcloth requires approximately 1-1/3 pints of rinse water.

d. Rinsing - Shower

Thirty seconds of rinse time will use approximately 3 pints of rinse water.

4. Techniques of Personal Hygiene

a. Whole Body

• Showering

Task requires the wetting of the body prior to soaping. It is also applicable for a rinse of any substances from the body.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time</u>
0.0	Preparation	5	5
0.1	Close door	5	10
1.0	Wetting body and cloth	-	-
1.1	Adjust shower height	5	15
1.2	Water flow - ON	3	18
1.3	Wet front of body from shoulders to feet.	10	28
1.4	Rotate body	3	31
1.5	Wet rear of body. Raise arms slowly. Shower underarms.	12	43
1.6	Wet hair	6	49
1.7	Water flow - OFF	3	52

• Soaping

Task requires the soaping of the implement (e.g. brush, sponge, or cloth, if appropriate) and then the transfer of the soap to the body. This is done in sections.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time (52)</u>
2.0	Soaping		
2.1	Grasp soap.	3	55
2.2	Apply soap to implement if used; if not, directly to body.	5	60
2.3	Soap one arm from shoulder to fingers, stroking outward and downward. Soap underarm.	10	70
2.4	Soap upper torso front.	10	80
2.5	Soap other arm.	10	90
2.6	Soap groin and pubic area.	10	100
2.7	Soap back of upper torso.	10	110
2.8	Apply new soap to implement if required.	3	113
2.9	Soap front of legs from hips to knees.	5	118
2.10	Soap rear of legs from hips to knees.	5	123
2.11	Soap legs from knees to ankles.	10	133
2.12	Soap feet and between toes.	10	143
2.13	If hair is to be washed, soap hair. Move application back from forehead and down- ward from eyes.	15	158
2.14	Soap anal region and intergluteal fold.	10	168*

If hair is not to be washed, soap anal region. (Head is soaped after the other parts of the body to minimize exposure of eyes and mouth to soap solution.) Anal region is last to be soaped by the applicator for esthetic reasons.

*Deduct 8 seconds if no implement is used.

- Washing

Obviously related to soaping; it is, however, an extension in that repeated movements are required to perform the act.

The scope is broader in that we may have (1) abrasion with washcloths, (2) abrasion with sponge, (3) abrasion with brush, and (4) possible combinations or no implement except the hand.

Washing, in turn, relates to rinsing and so a slight overlap is to be expected there.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time (168)</u>
3.0	Washing		
3.1	Water flow - ON	3	171
3.2	Rinse implement if appropriate. Repeat as required.	10	181
3.3	Wash head and hair first.	10	191
3.4	Wash body in same order as Steps 2.3 to 2.9 if scrubbing by hand. Omit 2.8	45	238
3.5	Wash anal region.	10	246
3.6	Wash legs and feet in same order as Steps 2.10 to 2.12	30	276
3.7	If implement is used, wash body in same order as Steps 2.3 to 2.12; then wash anal region.	43	319

- Rinsing

Task requires the removal of soap residue and extraneous material. Procedure appears to be best served if the rinse is unidirectional.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time (319)</u>
4.0	Rinsing		
4.1	Place head under water stream. Rinse.	5	324
4.2	Stand facing shower head. Rinse forward part of body.	10	334
4.3	Rotate body.	2	336
4.4	Rinse rear portion of body	10	346
4.5	When all traces of soap are removed and body feels clean, shut off water.	3	349

• Drying

This obvious task can be accomplished by toweling, passive air drying, or positive air drying. An increased humidity will neutralize to a degree the effectiveness of air drying. This should be considered in any power requirement. Drying with a towel in and of itself is an abrasive action and will add to debris acquired from the skin.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time (349)</u>
5.0	Drying		
5.1	If air drier is used, adjust temperature control.	5	354
5.2	Stand in air stream.	60	414
5.3	Wipe between toes and in body folds. Remain until dry feeling is obtained.	20	434

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time (349)</u>
5.0	Drying with towel		
5.1	Dry head and shoulders.	15	364
5.2	Dry one arm.	10	374
5.3	Dry upper torso front.	15	389
5.4	Dry other arm.	10	399
5.5	Dry upper torso rear.	20	419
5.6	Dry lower torso front.	15	434
5.7	Dry lower torso rear.	15	449
5.8	Dry both legs.	30	479
5.9	Dry anal and pubic areas.	30	509

b. Hand Washing

Task requires soaping of hands, washing, rinsing, and drying.

Techniques here may include liquid soap or bar soap. Bar soap will require a wetting period in advance of all other tasks.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time</u>
6.0	Wash hands.		
6.1	Wet hands and soap if required.	6	6
6.2	Scrub with brush or with other hand.	10	16
6.3	Repeat Step 6.2.	10	26
6.4	Press water discharge.	3	29
6.5	Rinse	5	34
6.6	Remove excess water.	5	39
6.7	Air dry or towel dry.	15 or 10	54 or 49

c. Face Washing

Task requires wetting of hands and/or implement, soaping, washing, rinsing, and drying.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time</u>
7.0	Wash face		
7.1	Press water discharge.	3	3
7.2	Soap hands or implement.	7	10
7.3	Wash face.	10	20
7.4	Rinse face.	10	30
7.5	Dry face; air dry or towel.	10 or 5	40 or 35

d. Wet Wipe Use*

Task: Open envelope, remove wipe, unfold, use, and discard.

<u>Task Number</u>	<u>Task</u>	<u>Estimated Time (Seconds)</u>	
		<u>Task Time</u>	<u>Elapsed Time</u>
8.0	Use wet wipe for hands or face.		
8.1	Open packet.	3	13
8.2	Remove wipe.	7	10
8.3	Unfold	3	13
8.4	Apply to surface.	2	15
8.5	Wipe	10	25
8.6	Air dry	5	30

*Note: Wet wipe is not recommended for total body wash due to the inherent inability to soak through and wash beneath the uppermost skin layer.

e. Dental Procedures

As prescribed.

5. Activity Levels Per Medical Protocol

a. Work/Rest Cycles

4 hours on/4 hours off versus 8 hours straight work period.
Lunar work period was 6+ hours.

b. Metabolic Activity Assumed

Food Energy = 2300-2500 K cal/day

Oxygen Consumption = 2.0-2.5 lbs/day

Work Rate = ? Btu/hr maximum (600)
= ? Btu/day average (5000)

1 K cal = 4 Btu

25,000 K cal = 10,000 Btu work energy available (maximum)

c. Ambient Air Drying

See Task 5 of Task Analysis.

Approximate Drying Time ~ 90 seconds.

Dependent upon airflow rate, temperature, and humidity.

d. Airflow

Drying is more dependent upon air velocity than upon mass flow. A velocity across the skin area of 10 knots would be comfortable and effective in carrying the moisture from the skin. Hence, a nozzle of 0.1 ft² cross-sectional area (approximately 4 inches in diameter) would require a flow rate of 1.7 cubic feet of air per second or 100 cfm (arbitrary values).

e. Temperature

Must be above skin temperature, but not uncomfortably hot. Range of 100°F - 120°F (120°F is equivalent to ambient desert air temperature).

f. Humidity

The lower the better. Preferably below 50% relative humidity of circulating air

AIR DRYING		
Volume (fps)	Nozzle Area (sq. ft.)	Airflow Volume (cfm)
8	0.1	48
10	0.1	60
17	0.1	100

SECTION V

TECHNIQUES

A. SAMPLING TECHNOLOGY

1. Introduction

The key to successful microbiological analysis lies in ability of the investigators to harvest a representative sample of the microbial population and, after appropriate inoculations and subcultures, to correctly identify the organisms in question. Although, as stated above, the problem seems straightforward enough, in reality, microbiological sampling and the various techniques involved can be so complicated and time-consuming as to make some procedures prohibitive. In choosing applicable techniques for given situations, therefore, certain tradeoffs must be made in order to obtain optimum sampling efficiency combined with rapidity and repeatability.

This present review is concerned with body microbiological sampling techniques and is limited to surface and subsurface skin microflora, hair and scalp sampling, and sputum and throat sampling. The report also indicates which procedures and sampling instruments will be the most suitable for use on subjects in a personal hygiene study and, eventually, which of these techniques and their modifications along with newly conceived methods will be the most useful in a zero-gravity space cabin environment.

There are two main classes of body sampling techniques that will be considered. The first are the conventional methods, usually appropriate for large scale sampling, and which are cited in numerous texts on diagnostic or clinical microbiology. After a discussion of several types of swabs, a common microorganism collection or sampling technique will be given which is considered applicable for the study. The second class consists of new or relatively little used methods (usually because they are not adaptable for large scale sampling or because they have been lost in the literature after use for one specialized task) such as various types of tape or impression plate procedures. A comparison of these methods with each other and with the swab sampling techniques will then be discussed.

2. Conventional Methods of Sampling

Before embarking upon a discussion of the various known methods of microbiological sampling, the ultimate goal of the programs involved should be considered. In a study as is anticipated, emphasis should be placed on the personal hygiene aspects of microbial analysis. Obviously, screening will also be performed to assure the safety of the participants and thus some medical techniques must be employed. Although a study of microbial ecology will be the more salient undertaking, it cannot be divorced from the clinical point of view.

The following are various techniques and modifications of sampling methods which are to be considered:

a. Swab Techniques and Skin Flora Sampling

Any method for the microbial sampling, including swab sampling, depends mainly on three criteria⁽⁶⁵⁾:

- Swabbing techniques must involve the removal of as many bacteria as possible from the skin.
- The method employed must attain reproducibility by relating bacterial counts to constant area or weight of sample.
- The method should keep the organisms removed in a non-aggregated condition so that the individual viable cells can be counted rather than the large aggregates normally found on the skin.

Obviously, these criteria are not all met by the swab techniques. These also apply to other sampling techniques and they will be discussed in greater detail in the next section.

The usual sampling procedure for various skin areas had involved the use of a cotton swab. Since it has long been known that unsaturated fatty acids in cotton swabs inhibit a number of species of bacteria, various ways of overcoming the inhibitory effects of the cotton (such as coating the swab with serum or boiling the swabs in phosphate buffer, followed by charcoal treatment) has been tried. The standard practice now, however, is to substitute the cotton swab with a calcium alginate swab⁽⁶⁶⁾. Besides reducing the inhibitory action toward bacteria, the calcium alginate swab readily dissolves in a variety of solutions which are not injurious to the bacteria, thus permitting the quantitative estimation of micro-organisms⁽⁶⁷⁾.

In the study conducted by Ellner et al ⁽⁶⁶⁾, it was shown that a fortrel (polyester filter) swab had the best survival rate in a dry state (over cotton, dacron, calcium alginate, polyvinyl alcohol treated cotton) for the organisms tested (Hemophilus influenzae, Streptococcus, Corynebacterium diphtheriae, Neisseria gonorrhoea). But due to the fact that the survival rate increase of fortrel swabs as opposed to calcium alginate swabs is small and, furthermore, that calcium alginate swabs dissolve in certain transport or growth medias, it will be more practical to remain with calcium alginate as the swab material when this type of sampling is to be done.

A further consideration in the ability of swabs to retain viable bacteria during transport is the process of sterilization⁽⁶⁸⁾, handling, and packaging⁽⁶⁹⁾. It is advisable not to touch the swabs during sterilization or packaging (inhibitory skin oils may be left on swabs after sterilization), but since it is not yet known what are the best sterilization or packaging techniques and materials for these considerations, the preparation of swabs for this study will be left to the manufacturers of sterile disposable items.

In this review, virus sampling is not included. For future studies, however, in which viral sampling might be carried out, it should be noted that cotton swabs are preferred due to the fact that calcium alginate swabs may favor the recovery of undesirable bacteria contaminants⁽⁷¹⁾.

The swab technique is conventionally used for most medical sampling. Swab sampling techniques will apply for the following areas: axilla, groin, scalp, fingertips, interdigital area, throat and nasopharyngeal areas. Wherever noted, procedures will follow techniques as outlined.

3. New and Little Used Methods of Sampling

The methods discussed in this section will also not take into account every known sampling method because many of them are either redundant or do not apply to this protocol study. However, certain techniques are discussed which would be very useful, but which might have to be discounted because of their tediousness or because of the prohibitive amount of materials needed.

The most comprehensive methods which essentially satisfy the three criteria set forth in the previous section for skin sampling; that is, (1) the technique must include a method for removing all the bacteria from the skin, (2) the method must be able to attain reproducibility by relating bacterial counts to constant area or weight of the sample, and (3) the method to be used must keep the organisms removed in a non-aggregated condition, are those reviewed and refined by Williamson⁽⁶⁵⁾. He considers the last point the most important for studying the total microflora of the skin since individual viable cells should be counted rather than enumerating the large aggregates normally found on the skin. Most sampling methods which try to isolate skin microflora quantitatively have produced widely divergent results. This is because one is uncertain as to whether or not all the bacteria are removed from the skin and the inability to distinguish by the usual plate count method whether a bacterial colony arises from a single organism or from an aggregate of organisms.

The recovery of truly isolated microorganisms is also very important to any study since, although the major bacterial inhabitants of the skin should be known, those bacteria and fungi which are present in small numbers and are masked by the more predominant forms may be of equal or greater importance. These unobtrusive organisms might very well be future pathogens and survive on the skin just long enough to be passed from one crewmember to another. These potentially pathogenic microbes might be a minor part of the entire flora that could, under the conditions present in the chamber study, eventually become predominant over the normal skin microflora.

a. Surface Active Agent Sampling Techniques

According to Williamson⁽⁶⁵⁾, the requirements for adequate sampling are best satisfied by the use of surface active agents (surfactants) which are materials capable of simultaneously detaching organisms and dispersing them as single organisms, rather than in clumps; i.e., detergents or soaps). When the surfactants are added to a cell suspension and mechanically shaken, it was shown that these dispersing agents increased a cell count (plate count) by 1.5 to 2.2 times a water control where water instead of surfactant was added to the cell suspension. There are three broad categories of surfactants (see also Section III.G - soaps): (1) cationics, (2) anionics, and (3) non-ionics.

The cationics will not be discussed because they are usually quaternary ammonium compounds which are bacteriostatic or bactericidal. The anionic detergents, like alkyl sulfates, alkyl benzene sulfonates, and long chain fatty acids (soaps), are the best detergent or dispersing agents known, but most of these also have an antibacterial effect.

The third group of detergents, the nonionics, although not quite as good for detergent action as the above, still give a good dispersing effect for bacteria. Their advantages also include non-irritancy to the skin, low bacterial toxicity (especially in the dilute solutions in which they are used), high stability (whereas soaps, although non-bactericidal in dilute solutions, are unstable), and relative purity of commercial products (when compared to most anionic and cationic detergents). Of the many non-ionic detergents available such as polyoxyethylene aliphatic ethers, polyoxyalkylene block copolymers, polyoxyethylene sorbitan fatty acids esters, and polyethenoxyalkyl-phenols, three of the latter (Triton X-100 [p-tert octyl-phenoxy polyethoxyethanol], Poly-Tergent B-300 and Surfonic N-95) are among the best due to excellent in vitro dispersion obtained with these chemicals. The Triton X-100 is the most studied of this grouping and was also found to be the most satisfactory agent in regard to reproducibility and maximal removal of microorganisms of the above chemicals.

The actual methodology of surfactant sampling incorporates the glass cup method of Patchman et al due to its simplicity. One ml of the 0.1 percent detergent solution, Triton X-100, in a 0.075 M phosphate buffer is pipetted into a sterile glass cylinder of 3.8 cm² area held firmly against the skin by two attached handles. The skin is then rubbed as evenly as possible with a sterile, blunted teflon policeman for two minutes. The wash solution is aspirated and diluted and pour plates can then be prepared⁽⁶⁵⁾.

b. Impression Sampling Techniques

Impression sampling techniques started with the work of Axelrad and only the more successful of the many methods will be reviewed here.

(1) Tape Sampling Methods

The cellophane tape sampling method⁽⁷¹⁾ involved the pressing of transparent acetate tape against the area to be examined, removing the tape, and then pressing it on a sterile glass slide for staining and examination. The tape could

also be used for placement on an agar plate for culturing (which would show the growth pattern on the skin) or could be dropped in a tube of broth. This method has been refined and a paper published by Endo⁽⁷²⁾ gives a method in which a cellophane tape, Scotch double-stick tape No. 136, is placed on a cover glass, the excess tape is stripped, and after an impression from the skin is made it is stained and observed.

Another method similar to the tape strip method is the sticky disc method proposed by Kooyman and Simons⁽⁷³⁾. According to the author:

"Representative samples of the established microflora of the skin are difficult to obtain by swabbing, flushing, or touch-plate procedures. This is because the organisms are apparently firmly attached to, or are trapped among, the superficial layers of cornified cells. A procedure which strips these cells and associated microorganisms from the skin surface has many advantages over other popular sampling methods.

"The procedure generally entails using Goldschmidt and Klingman's special adhesive or a plastic disc with a handle. The disc strips off a monolayer of cornified cells and attendant microbes from the skin. Where these are placed on the surface of nutrient agar medium and incubated, the organisms grow in situ. Repeated strippings from the same area show how deeply the organisms are situated."

According to Hartman⁽⁷⁴⁾ no one has yet thought of using sterile, pressure sensitive tape (it only becomes sticky when pressure is applied, thus storage and handling problems would be greatly alleviated as compared to normal tape) to serve as a pick-up surface for the enumeration of microorganisms on the skin.

(2) Direct Media Contact Methods

Several direct media contact methods have been used for skin flora sampling. Direct agar plate sampling of the skin does not work due to the porosity of the skin. A direct contact agar-paper strip method using paper strips impregnated with a moist agar medium has been used by Förg⁽⁷⁵⁾. A plastic-paper strip is removed from a sterile envelope, pressed on a surface and then lifted up. The contaminated plastic backing is removed and the strip can then be placed in the original envelope for incubation. Tetrazolium (2,3,5-triphenyl tetrazolium chloride) can be included in the media so that colonies appear as red spots on the paper. Another contact method is to use an agar media impregnated muslin fabric⁽⁷⁶⁾. The agar-impregnated muslin is flexible and the surface examined does not have to be flat, thus this method would be applicable to non-flat skin areas.

According to Hartman⁽⁷⁴⁾ the tape method is more suitable for skin sampling than is the direct media contact method because the latter fails to affect adequate recovery of microorganisms from the surface being examined.

c. Comparisons of Various Skin Sampling Techniques

To determine the relative effectiveness of several of the aforementioned skin sampling techniques, Williamson⁽⁶⁵⁾ conducted the following study:

"An important question to be considered when sampling the skin surface is whether or not the mechanical method employed reaches all the organisms present. It is a common and traditional view that skin bacteria are largely situated well within the follicles. Vigorous scraping has often been utilized, presumably to collect organisms deeply lodged in the stratum corneum. If the organisms do exist in follicles or in the deeper portions of the horny layer, simple surface sampling of the sort described here is grossly inadequate. However, there is more recent evidence of a superficial localization, at least of the aerobic population. The tape stripping methods of Röckl and Muller and of Updegraff, although not quantitative studies, indicate that the greatest number of bacteria are present in the outer layers of the stratum corneum.

"To resolve the question of localization, four different quantitative methods were used:

- "1. A Comparison of Scrubbing to Soaking. Two minutes of normal manual scrubbing was compared on adjacent sites to gentle agitation of the wash fluid without touching the skin surface. The average of ten such studies showed that 30% to 40% of the bacterial population removable by scrubbing is suspended by simple soaking. These organisms are not only superficial, but also rather weakly adherent.
- "2. Cellophane Tape Stripping. Two-minute scrubs were made on adjacent areas before and after firm serial stripping with Scotch(R) brand adhesive cellophane tape. Strikingly, as many organisms were removed by four strippings as by ten. More than 95% of the organisms recoverable by the Triton scrub technique were removed by either four or ten strippings. This is true whether a normal area having 1,000 bacteria per cm² is used or an experimentally hydrated one having 50 x 10⁶ organisms per cm². These results are in accord with recent findings which indicate that the major portion of the horny layer is a coherent membrane which does not provide crevices for the enlodgement of bacteria. The sloughing of the horny layer is a surface phenomenon restricted to the outer three to four layers.

- "3. Normal Cleansing. Subjects washed their own forearms and foreheads with soap and tap water for approximately 15 seconds following a control sample and then were resampled. This simple cleansing of the skin removed 60% to 80% of the organisms from the arm and 65% to 95% from the forehead.
- "4. Serial Scrubbing. Successive one-minute washes were taken at the same site on the forearm of five individuals, three with high counts and two with low counts. It was found that regardless of the number of organisms originally present, an average of 85% were removed in the first wash, 12% in the second, 3% in the third. This pattern of greater than 95% removal by two successive one-minute washes was observed in other areas as well, including those areas of large bacterial populations such as the scalp and axilla.

"From the four types of evidence presented here, then, it can be stated that the major portion of the aerobic skin flora is situated very superficially on the non-hairy skin, and hence is removable by surface sampling. Furthermore, even in areas where coarse, terminal hairs are present, as on the scalp, histological studies in this laboratory have never revealed organisms below the infundibulum of normal follicles."

This study shows that the bacteria are not lodged within the horny layers of the skin as several investigators have indicated such as Kooyman in 1965⁽⁷³⁾, but the bacteria is, in fact, attached loosely to the outer skin layers. Because of this the advantages of the tape-sampling methods (can remove the top layers of the skin, and, therefore, the bacteria within these layers) are negated and other methods become just as suitable, or more so. Due to this, and the pain and skin loss of the subject to be sampled, the tape-sampling method will be ruled out for sampling. The direct media contact sampling method has been shown to be unable to pick up even some of the loosely adhering microorganisms and its use results in the deposition of nutrient substances on the skin surface thus providing growth medium for the remaining bacteria. For these reasons this method will also be ruled out.

Another type of sampling, the application of Millipore filter technology for use has been considered. The main advantages of the Millipore filter methods in clinical microbiology over conventional methods are when:

- (1) Organisms of specific interest are of low concentration in large volumes of fluid.
- (2) The suspending fluid is bacteriostatic, as in the case of spinal fluids and urine from antibiotic-treated patients.

- (3) The more rapid growth rates on the Millipore filter will reveal a pathological condition significantly earlier than by conventional methods.
- (4) The use of Millipore filters, as in total counts of urine, avoids time-consuming dilutions.

This leaves two general methods (for skin flora): the conventional calcium alginate swab sampling technique, and the detergent-scrub sampling technique. It is recommended that the skin sampling should be done with the calcium alginate swab (as directed in the first section) and that the surfactant sampling technique should also be used as an adjunct study. In this way, the sampling should be relatively easy and no organisms will be overlooked.

4. Study Protocol For Microbiological Tests

Microbiological monitoring of surfaces and the air of any facility properly fall in the overall sanitation area and thus are not covered in detail here. We would like to recommend weekly Rodac sampling of surfaces and a biweekly Anderson sampler analysis of the air.

The human involvement would be directed at personnel, clothing, and water used for personal hygiene.

An extensive survey of recent chamber and submarine studies of various types has been conducted for microbiological impact. The sampling techniques have been studied and the previous review allows us to recommend the following protocol as an efficient way to evaluate this area of concern.

In order to obtain significant microbiological data in any proposed study, a technical protocol and method of sampling has been devised which will emphasize the salient results of closed ecology, man-machine relationships within a space cabin configuration. The isolation, enumeration, and species identification of saprophytic organisms that past Republic Aviation Division studies have shown to pose no threat to human health⁽⁷⁶⁾ can only serve to cloud more important data. Although these organisms should be noted in a complete cabin ecology study, it is of the utmost importance to thoroughly screen for those potential pathogens which appear in the environment as a result of selective overgrowth and subsequent shedding, food contamination, and carrier states.

In a previous study by Republic Aviation Division⁽⁷⁶⁾, the appearance of Acinetobacter anitratus (a pathogen of increasing importance) during the middle of a "controlled activity facility" study, demonstrated the present inability to fully control man's microbiological environment in a closed system.

Still an important problem is the apparent ease with which virulent indigenous organisms transfer from one crewmember to another and to the surrounding areas. In the study mentioned above, Republic Aviation Division found conclusive evidence of transfer of Staphylococcus aureus 52/52A/80/81, a strain associated with hospital-acquired infections. This same phenomenon was subsequently noted by the USAF in the research mentioned above.

a. Microbiological Monitoring

Microbiological monitoring will encompass the following areas:

(1) personnel, (2) water, and (3) clothing.

b. Preparation

In order to create optimum conditions for a valid sampling procedure and accumulation of baseline data, the following protocol will be observed:

Before the crewmembers enter the chamber all environmental areas and surfaces should be cleaned with Zephiran^(R) solution. This procedure is not an attempt to enforce rigid disinfection, but to remove larger aggregates of particles and organisms so as to establish a reasonable starting point. It has been determined that in the course of events prior to a launch, an appreciable number of microorganisms can be deposited within the vehicle and, although a sterile cabin is not desirable, it is still a matter of conjecture whether or not the number and kinds of bacteria should be limited.

The crewmembers will shower using a mild bath soap (or will follow the showering protocol recommended) the day before the baseline study, before and after the chamber study, and the day before the onset of the actual chamber experiment. This serves to establish a relatively common starting point.

Before both periods the wearing apparel of the subjects will be sterilized. Flexibility in the sampling procedure will exist in order to test for the

use of specialized clothing such as constant wear undergarments designed for the control of body surface microbial populations, if so directed.

All initial sampling procedures during the baseline experiments and the chamber experiment will be performed by the crewmembers trained in this specialty.

c. Areas To Be Sampled

A complete list of areas to be sampled will be found in Figure 10 (Body Sampling Chart).

d. Personnel

Although the use of swabs in isolating and enumerating skin microorganisms may result in variable findings unless methodology is rigidly controlled, it is considered the most appropriate technique for this study. Since the use of roll-plates or liquid scrubs introduces such variables as media or moisture left on the skin with a resultant growth or inhibition of indigenous flora, a dry calcium alginate swab will be used to sample all body areas except as noted elsewhere. Performance of correct microbiological technique in taking such samples is assured since the crewmembers assigned to this task will have previous training in the simple approaches.

e. Body Areas (Method of Sampling and Isolation of Organisms - Qualitative

(1) Throat

Utilizing a sterile tongue depressor a swab will be used to sample the tonsillar area. Due to the variables involved in taking swab throat cultures (excess saliva, irregular sampling area, and differences in sampling technique), no enumeration techniques will be attempted. In an area such as the throat in which organisms are in a state of constant flux, such a procedure would be, at best, of questionable significance.

Using the gargle technique, each subject will rinse and gargle with 25 ml sterile normal saline for 30 seconds and then expectorate into 225 ml saline in a wide mouth bottle. This provides 250 ml of a 10% solution. Care should be taken to include any nasal discharge that can be extracted by vigorous inhalation to the back of the throat⁽⁷⁷⁾. A comparison of techniques is indicated in Table VIII.

<u>Body Areas To Be Sampled</u>	<u>Recommended Primary Method (To be performed every sampling day.)</u>	<u>Recommended Secondary Method (To be performed as an adjunct method.)</u>
Axilla	Calcium Alginate Swab Technique	Surfactant-Wash Technique
Groin	Calcium Alginate Swab Technique	Surfactant-Wash Technique
Scalp	Calcium Alginate Swab Technique	Surfactant-Wash Technique
Fingertips	Calcium Alginate Swab Technique	Surfactant-Wash Technique (on palm of hand rather than fingertips)
Interdigital Area	Calcium Alginate Swab Technique	
Throat	Calcium Alginate Swab Contained in Sterile Throat Culture Outfit and Gargle	
Sputum	Gargle	

*For a description of the advantages and disadvantages of these methods, see the text.

Figure 10. Body Sampling Chart*

TABLE VIII. COMPARISON OF 4 SAMPLING TECHNIQUES FOR DETECTION
OF *SERRATIA MARCESCENS* IN UPPER RESPIRATORY TRACT

Exposure range organisms cu ft	Method of expression of result*	Posterior pharyngeal swab					Tongue dorsum swab					Nasal pha- ryngeal wash	Mouth wash sample		No. of trials
		direct	dilute	either	MF	any method	direct	dilute	either	MF	any method		from 100 ml 1%	from 50 ml 10%	
< 5,000	a	2	1	3	0	3	0	0	0	4	4	4	150c	110	17
	b	2	1	3	0	3	0	0	0	2	2	2	4	6(8d)	17
5,000- 9,999	a	27	11	38	47	85	10	8	18	69	87	74	1,400	1,175	19
	b	8	6	9	8	11	2	5	5	10	12	10	11	14(15)	19
10,000	a	137	7	144	116	260	7	2	9	170	179	94	4,445	3,285	20
	b	16	3	17	12	18	5	2	7	13	15	12	15	19(19)	20
< 5,000- <10,000	a	166	19	185	163	348	17	10	27	243	270	172	5,995	4,570	56
	b	26	10	29	20	32	7	7	12	25	29	24	30	39(42)	56

- * a - Total number of cells recovered.
 b - Number of times indicator organism recovered.
 c - Number of cells calculated to be in entire MW sample.
 d - Positive from either dilution given in parentheses.

(2) Axilla

Sampling of the underarm areas (right and left) will be aided by the crewmember to be tested raising his arms directly overhead. The microbiologist crewmember will swab the axilla as follows. Using a separate swab for each side, sampling will be done by running the swab around the hairy area twice (while rotating the swab) and then carefully drawing it across the hairy area five times.

(3) Groin

The groin areas (right and left) will be treated as one area and sampled by running separate swabs down the line of the ligamentum Poupartii. The media used will be the same as that for the axillary region.

(4) Scalp

The crewmembers will swab from the forehead to the base of the occipital region down the midline of the scalp with enough pressure to remain in contact with the skin in spite of the hair mass. Primary isolation media will be the same as above.

(5) Fingertips

It has been found that the tips of the fingers carry approximately one-third the total bacterial population of the hand and forearm. Since it is obvious that the fingertips play a major role in the transfer of microbes, it is considered essential that they be regularly monitored.

The right and left digits of each hand will be considered separate specimens. One swab will be used to sample each hand by rotating the swab over and around the tips of the fingers up to the first knuckle.

(6) Interdigital Area

Each foot will be treated as a separate specimen. One swab will be passed between the digits in a rolling motion.

f. Water

Stored (bottled) water will be tested for the following: (1) Total count, (2) yeast and mold count, (3) total E. coli and enterococci count, and (4) identification of organisms. Results will be expressed in number of organisms per ml of water.

The methods to be used for these procedures are described at great length by the American Public Health Association. In order to simplify sampling techniques and retain accuracy in the counts obtained, the Millipore filter methods developed specifically for the above procedures will be used. These membrane filter tests are in conjunction with standards set by the APHA. Isolated coliforms and enterococci will be identified by the methods described by Edwards and Ewing⁽⁷⁸⁾, and Bailey and Scott⁽⁷⁹⁾, respectively. An elevated temperature confirmatory test described in Standard Methods (APHA, 1965) will also be performed on coliform-like organisms isolated from water in order to confirm their fecal origin.

g. Identification of Microorganisms

- (1) Aerobic Organisms. Methods for the identification of aerobic bacteria and fungi should be based on currently accepted methods for the differentiation of clinically significant organisms.
- (2) Anaerobes
- (3) Spore formers (notably Clostridium sp.). Anaerobic spore forming bacteria will be identified according to the methods of Willis⁽⁸⁰⁾.
- (4) Nonspore Formers. Many of the nonsporeforming anaerobic bacteria found in human feces have, until recently, thwarted attempts at definitive classification. The importance of being able to identify the organisms which are intimately associated with human nutrition cannot be denied. In studies conducted by Republic⁽⁸¹⁾, nonsporeforming anaerobes were isolated and grouped morphologically and biochemically into arbitrary FA and GD types.

In any proposed study, the nonsporeforming fecal anaerobes should be identified according to the original criteria outlined in Bergey's⁽⁸²⁾ manual and Skerman's, "A Guide to the Identification of the Genera of Bacteria"⁽⁸³⁾. Differentiating characteristics can be determined by the utilization of tests which have been shown to classify anaerobes in their respective genera. Wherever feasible, speciation of these organisms should be attempted. Essentially, the methods will consist of those standardized in the "Manual For Microbiological Methods"⁽⁸⁴⁾ and listed in Skerman's book.

The areas to be sampled and frequency are indicated in Table IX. This frequency is subject to change with the degree of contamination.

B. CLOTH SAMPLING

All clothing that is worn should be tested for biological relevancy as regards bacterial survival time on garments worn by any of the subjects. This can best be accomplished by removable swatches of cloth each containing the same surface area. Relevant to this is the need to equate surface area of each test fiber to adsorption of bacteria. These swatches should be attached at predetermined points on underwear, constant wear garments and socks. Additionally, any second use item such as a towel or sheet should be similarly examined. The entire object (swatch attached) should be sterilized prior to use. The swatch removed at the appropriate time is immersed in a beaker of 20 ml of sterile saline. The need to stimulate bacterial release is met by placing the covered beaker on a shaker for 30 minutes. Plating out is followed by incubation, quantification, and qualification of pathogenic or odor-producing bacteria. Control samples of cloth are run concurrently.

Another recommended approach previously noted would be to measure the chloride deposit on the skin and in the clothing. The skin is sampled using a Fairchild technique wherein a 1 ml quantity of sterile distilled H₂O is pipetted into a sterile glass cylinder of 3.8 cm² area held tightly against predetermined skin areas. The skin is then rubbed with a teflon wand for two minutes. The solution is aspirated and analyzed for chloride using Mohr's titration. Swatches can be soaked in sterile distilled water for two hours and the residue similarly examined for chloride. Oxidizability of these solutions (in mg. of O₂) would indicate the presence of organic material.

C. WATER REQUIREMENTS FOR PERSONAL HYGIENE

Minimal requirements for body cleanliness have ranged in actual practice from 2 gallons of water in the most recent long-term chamber study (NASA CR11181, McDonnell Douglas Astronautics Company) to an estimate of 5 pints of water in a space design shower (Martin-Marietta).

The space acceptability of any level of water usage is contingent on a host of variables, not the least of which is the routine acceptance of a predetermined manner of washing at a particular frequency and for a given time period.

TABLE IX. MICROBIOLOGICAL SAMPLING SCHEDULE

	Baseline	Experiment Day	Follow-Up
Personnel	Throat Axilla Groin	2, 5, 8, 11, 14, 16, 19, 22, 25, 28 30, 33, 36, 39, 42, 44, 47, 50, 53, 56	1, 4, 10 Days After
	Scalp Gingiva Feet Fingertips Ear	4, 8, 14, 18, 22, 28, 32, 36, 42, 46, 50, 56	1 and 10 Days After
Clothing	Swatches	Clothing Sterile	
Water	As Specified	D-1 3, 6, 9, 12, 15, 18, 21, 24, 27, 31, 34, 37, 40, 43, 47, 51, 54, 56	

Irrespective of the method of water usage available, the goals of this protocol study can only be satisfied when we reach "a quantity of water able to make you feel clean and not necessarily relaxed." Our study indicated this to be a wholly valid point and this then becomes the goal to be sought. This does not neutralize the concern for cleanliness adequate for health. The study of bacteriological quality of the water per se is covered under Microbiological Techniques. The skin is to be examined at large in the manner previously described. We are left, therefore, with the water itself, quantity, and temperature.

Testing as to temperature has been accomplished and 105°F appears to be a good median temperature able to "open" the pores rapidly and aid in cleaning the skin. The section on Hygiene Approaches (III.G.2) indicates a minimum of .03 of a gallon for a sponge bath, .8 gallon for an immersion type bath, and 2-3 gallons for a shower. Crew acceptability is indicated as fair, good, and high (in that order) for each approach. We feel a "good" acceptance should be minimum for any approach.

Recognizing the need to conserve water, we have suggested a pulsed shower using 5 pints increasing to 24 pints. An immersion or sponge bath approach may not truly be able to wet the body with the quantities of water indicated above. This is based on the realization that an artificial cellulose sponge will gain 1300% in weight. A sponge weighing 1 ounce will occupy 38.5 cubic inches of volume. A sponge volume able to supply .8 of a gallon of water would be about 295 cubic inches. A 50% reserve factor would increase this to 450 cubic inches. Therefore, to get the water to cover the area indicated by a measure of skin surface will necessitate large sponges replete with drying and/or odor problems. Nevertheless, we recommend a study with scaled measurements to see if a sponge bath can be developed able to satisfy the aforementioned goals.

D. QUESTIONNAIRE

The preliminary or tentative design of this questionnaire is not to be construed as a working document. It is only for format purposes and does not have any testing validity built into it.

The design of this basic questionnaire is intended to be simple to answer, be quantifiable, and cover both the psychology of cleanliness and the logistics thereof. The inherent flexibility allows selection of relevant questions in keeping with the time

involved, hardware available, and number of subjects. The questions when a valid design is implemented will indicate basic emotions and indicate acceptable logistic parameters. Any input in this direction will supplement our stored data. The actual working questionnaire will be evolved after the subject crew has been selected. This will be done so as to incorporate such variables as motivation, work/rest schedule, sex, and available personal hygiene paraphernalia such as soaps, sponges (washcloths), sheets, underwear, and socks (among others) into the design.

Instructions

On the following pages is a list of items for you to answer. By answering them honestly, you are telling us many things about the adequacy of the personal hygiene equipment and procedures. Each question is unique within itself. Treat it as a separate item. Any apparent similarity of questions is actually posing a different thought.

1. Read each question thoroughly.
 2. Think of the event and your feelings.
 3. Select one of the following to answer each statement:
A B C D E.
- A You disagree most strongly.
 B You disagree but not as strongly.
 C You are undecided.
 D You agree quite well with it.
 E You agree very strongly with it.

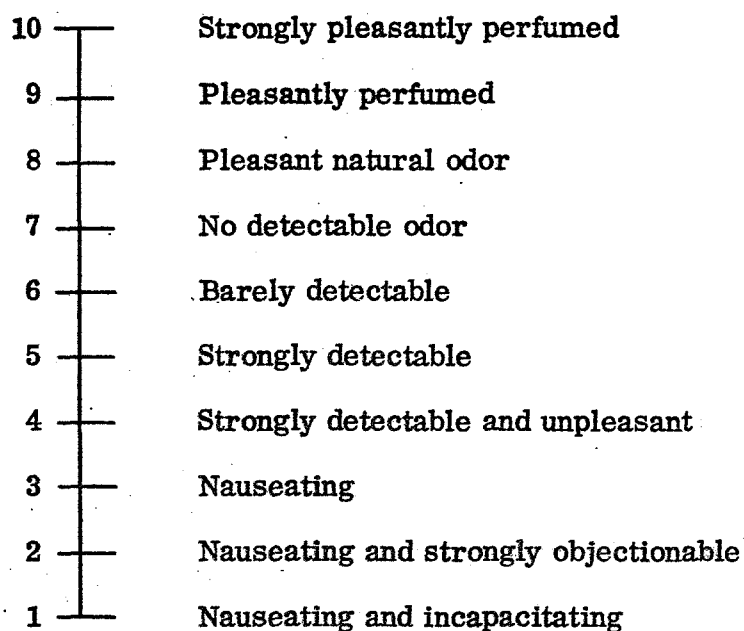
Circle only one letter. That is your answer.

- | | Circle |
|---|-----------|
| 1. I didn't think much of the "chemical" wipes. | A B C D E |
| 2. I like the aroma of a strong after-shave lotion. | A B C D E |
| 3. Dandruff repulses me. | A B C D E |
| 4. I would rather have long clean nails than short clean nails. | A B C D E |
| 5. I would have preferred more rinse water. | A B C D E |
| 6. I preferred the liquid soap to the bar soap. | A B C D E |
| 7. That dentifrice I used today left a film in my mouth. | A B C D E |
| 8. My clothes smelled when I took them off. | A B C D E |
| 9. I didn't have bad breath today. | A B C D E |
| 10. I normally brush my hair rather than comb it. | A B C D E |

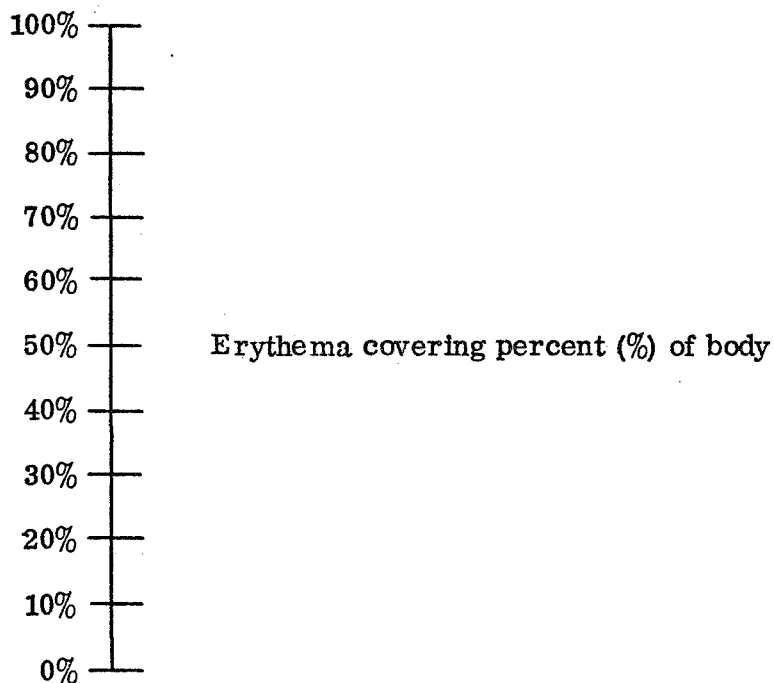
- | | |
|---|-----------|
| 11. I felt dirty before washing. | A B C D E |
| 12. Odors today were noticeable. | A B C D E |
| 13. I object to being told to wash. | A B C D E |
| 14. I need more privacy. | A B C D E |
| 15. I normally wash more frequently. | A B C D E |
| 16. The wash technique was too foreign. | A B C D E |
| 17. My hair feels clean. | A B C D E |
| 18. The razor performed well. | A B C D E |
| 19. My clothes felt okay unpressed. | A B C D E |
| 20. My underwear lets me know when I am really dirty. | A B C D E |
| 21. My colleagues are truly clean people. | A B C D E |
| 22. My beard length is my business. | A B C D E |
| 23. I found the amount of wash water more than sufficient. | A B C D E |
| 24. The temperature of the wash water was good. | A B C D E |
| 25. The soap provided was excellent. | A B C D E |
| 26. I felt clean after washing. | A B C D E |
| 27. My clothes were clean enough to wear again. | A B C D E |
| 28. I didn't mind scrubbing with the sponge as directed. | A B C D E |
| 29. Air temperature was too cool. | A B C D E |
| 30. We had enough time to wash. | A B C D E |
| 31. The drying procedure was good. | A B C D E |
| 32. Nail care procedure was familiar. | A B C D E |
| 33. Dental procedure and sampling were not objectionable. | A B C D E |
| 34. When my hands are dirty I must wash them immediately. | A B C D E |
| 35. Somehow the liquid soap feels gooey. | A B C D E |
| 36. I see nothing wrong in sleeping in my shorts. | A B C D E |
| 37. Dirt under my fingernails means I've been working. | A B C D E |
| 38. If a man looks neat you can bet he recently showered. | A B C D E |
| 39. Knowing this bar soap prevents B.O. is important to me. | A B C D E |
| 40. Somehow unkempt hair looks dirty. | A B C D E |
| 41. If I had to do physical work to obtain shower water I believe I'd prefer a sponge bath. | A B C D E |
| 42. So what if he smells, no one's perfect. | A B C D E |
| 43. Just wetting my body with water is satisfying. | A B C D E |
| 44. I can tell when my skin is dirty. | A B C D E |

- | | |
|---|-----------|
| 45. Sweat is dirty. | A B C D E |
| 46. I wish the guy ahead of me had not left such a mess. | A B C D E |
| 47. I don't mind wearing the same unwashed socks for 3 days. | A B C D E |
| 48. I actually feel cleaner than I thought I would. | A B C D E |
| 49. I actually prefer cleaning my teeth after each meal as I do
at home. | A B C D E |
| 50. I should shave more often because I understand a beard harbors
dirt and germs. | A B C D E |

SCALE FOR BODY ODOR (HEDONIC TYPE)



SCALE FOR ERYTHEMA (DERMATOLOGIC TYPE)



Examples of Rating Scales

SECTION VI
PROTOCOL

Title: A Protocol to Establish Baseline Values for Personal Hygiene.

Technical Objectives: The need to establish baseline information on body cleanliness, techniques of cleaning and logistics for cleaning the skin surfaces, and required paraphernalia. It is hoped that the test program will provide a fix on the degree of skin cleanliness that is medically, psychologically, and esthetically sound. As a corollary to this it is expected that logistical requirements will be determined within reasonable levels. The Latin Square array of test items will permit selection of parameters commensurate with time allocated to this study.

Background: At the present time no definition of the technical objectives outlined above has been presented in any manner that properly encompasses a space environment. Fairchild has concluded that persons confined in a space limited, isolated, sometimes hazardous environment require the same personal hygiene accouterments as do others. These observations take into consideration the host of subjective comments voiced by our subject pool and by medical notes on illnesses, skin disturbances, and other manifestations related to personal hygiene. Few studies have had as even a study item any aspect of personal hygiene. It has almost always been taken for granted. The most significant personal hygiene comment on the Ben Franklin drift was the lack of warm bathing water. The diaper rash appearing in space was, at the very least, uncomfortable; but, fortunately, the duration of the voyage was not overly long. There is sufficient evidence present to dictate a realm of personal hygiene involvement aimed at prescribing items like water volume, temperature, frequency, and use technique. The ad lib water usage common to some Tektite series and nuclear submarines was more than offset by the work entailed in the Antarctic by the melting of snow to obtain water and the limited measured quantities of available wash water on many of our space flights. As we attempt to put together a pattern that will be acceptable, we are influenced to a degree by statements decrying the liquid soap, dentifrice, wet wipes, towel size, shaving approach, and preparatory cleansing. These and other inferences have been extracted from this study.

Many studies have utilized clothed subjects, but few touched on the clothing data so readily available. Clothing does serve a cleansing function. In fact, underwear can contain 75% of the probable body soil.

The studies that did involve an evaluation of soap effectiveness were either single blind or non-directional as to the desired study intent. In effect, an all or none argument. We have stated in our comment on detergents that it is our belief that no one soap will be all things to all tasks.

The degree of "dirt" production by man has only been estimated. In order to placate the logistics of cleanliness, the dirt produced must be calculated for a variety of environments and times. A work regimen of a measurable level must be determined so as to baseline a work effort that will be the standard.

Hazards: No hazards are expected from this protocol implementation except possibly allergenic reactions to soaps and/or antiseptics. Clothing and other cloths, if of a unique material, might evoke a contact dermatitis. Proper pre-screening via patch tests should rule out this concern. The presence of a bacterial or viral cross-infection is always possible, but will certainly be minimized by the pre-confinement baseline examinations.

Requirements For Subjects: Four subjects are required to cover the scope of the test program. Recognizing the need to implement this protocol within the framework of other on-going studies, this study will require 28 to 56 working days. This schedule is flexible and can decrease in both time and subjects as well as increase in both areas.

Schedule of Study: All events and time increments are depicted in Figure 11. Each subject will comply with his designated program. All subjects will follow the to be established activity level; e.g., 25-minute ergometer run, wash pattern, and skin examination. Psychological testing and questionnaire responses will be conducted at the appropriate times. The required body sampling will be one of the few events of a joint effort. It is expected that monitors will cue the various events if time critical and permit those not time critical to occur at leisure. The time critical events will be indicated prior to the study commencing.

Duties and Procedures Required of Subjects: The subjects are required to proceed in this study as directed. The entire design is to find a median in many heretofore undefined areas. The subjects, therefore, may be required to curtail or continue a particular hygiene procedure beyond their normal stopping point. The evaluation of the individual events will be performed by an outside observer and the subject after the event as stipulated.

Subject Selection: Subjects will not be required to possess any unusual physical traits so as to favor any phase of the study. Our preliminary study indicates hirsuteness to be an undesirable trait insofar as hair retains bacteria. This characteristic, whether present as body hair or on the head (i.e., long hair), will be the only stipulated disqualifier, along with a marked allergic sensitivity to items to be used.

Pre-Confinement Training: All subjects will be required to undergo a period of allergenic testing with all items of use in the study to be placed in contact with his skin, e.g., wet swabs, soaps, toweling, sheets, wet wipes, and other materials. Subjects will be trained in data reporting, bacteriological sampling techniques, exercise techniques, washing tasks, and related dermatological events. Background psychological, physiological, and bacteriological baseline data will be obtained during this phase which should be at least four days.

Confinement: The subjects will participate in all scheduled events and perform the actions prescribed for that time period. Reporting follows each indicated event. Non-scheduled events will be noted and any personal hygiene involvement discussed.

Post-Confinement: Post-confinement evaluation and critique will follow skin sampling and examination. All involved personnel such as monitors, subjects, dental and medical collaborators will participate in a personal hygiene debriefing. A limited follow-up plan of perhaps 10 days should be invoked to rule out delayed skin eruptions or dermatitis attributable to the study.

The personal hygiene protocol is derived from an analysis of all study data and is a legitimate attempt to bracket the involved variables. The study indicated that a shower was a most desirable item because it could clean in a short period of time and, if used at leisure, it could be very relaxing. Bar soap and regular

toothpaste are also favored. The frequency of washing and the clothing worn added to the psychological well-being of those queried. Certain foreign personal hygiene methods of cleaning one's person, e.g., wipes, were questioned and remain as do other areas barely tolerable. The protocol endeavors to move the subjects through a paced variety of tasks, work effort levels, water availability, drying techniques, and clothing and bedding changes. Each subject will experience the same regimens. An evaluation sheet will be designed to complement the available paraphernalia and will be employed to record daily comments on matters such as water availability, soap, shaving, etc. These will be quantifiable and will be evaluated in a manner similar to the basic study. The logistics involved in a 56-day study are enumerated in Table X. These quantities are meant to be basic takeoff points and not frozen values. Events like shaving or toothbrushing are not called out in the protocol since they are dictated by this table.

Protocol variables are indicated in Table XI which also provides a code that identifies each variable. This code is to be found throughout the protocol schedule (Figure 11) and is explained below.

Implementation of the protocol is based on the selection of a given battery of variables for the desired data point. For example, the following prevails.

AL - A
WR - A
TA - 3
SO - 2
WI - 3
CL - 2
BE - 2
SA - B - S - C - E

The activity level (AL-A) prior to the task should be at about 100 Kcal/hour and the water required (WR-A) will be a total of 0.5 pints performing task (TA-3). The subject will have used bar soap (SO-2) employing no wipes (WI-3) (see Tasks - Section IV.D). He will dress (CL-2) in soiled underwear, soiled socks, and soiled outerwear garment and sleep on soiled sheets and pillow case (BE-2). Where mentioned,

TABLE X. PERSONAL HYGIENE BASIC LOGISTICS FOR A 56-DAY STUDY

Item/Per Man	Quantity/Basic	Expected Usage Rate Frequency or Range	Resupply Method
Liquid soap	32 oz.	.5 oz. daily	N/A
Bar soap	3 each	1 per man per 20 days	N/A
Windup razor	.5 (1 for 2 men)	1 x every 2 days	Pass through
Razor-electric	.5	1 x every 2 days	Pass through
Hair trimmer	.5	1 x weekly	Pass through
Nail clipper	.5	Every 2 weeks	Pass through
Towels	3 each	3 x daily	Wash
Wash cloth	3 each	2 x daily	Wash
Hand brush	1 each	3 x daily	N/A
Sponge	1 each	1 x daily	N/A
Underwear	6 sets	1-3 days	Wash
Outer garments	3 sets	1 per 4 days	Clean
Bed sheets	4 each	2 per week	Wash
Pillow cases	4 each	2 per week	Wash
Water	224 gallons	Daily usage 4 gallons	Recycle
Toothpaste	4 oz.	2 x daily (.06 oz. daily)	N/A
Toothbrush	2	2 x daily	N/A
Wipes, wet	120	2 per day	Pass through

TABLE XI. PROTOCOL VARIABLES

Activity Level (AL)			
Code	K cal/hr	Temperature and Humidity	Time
A	50	Mission Model	As Required
B	100	 	 
C	200		
D	300		
E	400	Mission Model	As Required

Water Required (WR)		
Code	Pints	Temperature *
A	0.5	100°F
B	2.0	 
C	6.0	
D	12.0	
E	24.0	110°F
F	N/A	
*Cooler water may be required for mouth rinse.		

Task (TA)	
Code	
1	1,2,3,4,5 (Air Dry)
2	1,2,3,4,5 (Towel Dry)
3	6
4	7
5	8
6	N/A

TABLE XI. PROTOCOL VARIABLES (cont'd)

Soap (SO)		
Code	Type	Specifics
1	Liquid	As Required
2	Bar	As Required
3	None	As Required

Wipes (WI)	
Code	
1	Wet
2	Dry
3	N/A

Clothing (CL)			
Code	Underwear (U)	Outerwear (O)	Socks (S)
1	Clean	Clean	Clean
2	Soiled	Soiled	Soiled
3	N/A	N/A	N/A

Bedding (BE)	
Code	Sheets and Pillowcases
1	Clean
2	Soiled
3	N/A

SA is the symbol for a sample to be taken after the conclusion of the task (see Techniques - Section V.A and B). SA-B is the bacteriological sample to include the axilla, groin, and throat; SA-S is the scalp, gingiva, feet and fingers; and SA-C is the sampling of cloth swatches. E would be an examination of the skin for dermatological concerns.

CREWMAN	DAY		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	VARIABLE															
1	AL	A	A	A	A	A	D	D	D	D	B	B	B	B	B	B
	WR	A	A	A	A	A	A	A	A	A	C	C	C	C	C	C
	TA	3	3	3	3	3	4	4	4	4	2	2	2	2	2	2
	SO	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	BE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AL	B	B	B	B	B	B	E	E	E	C	C	C	C	C	C
	WR	A	A	A	A	A	B	B	B	B	D	D	D	D	D	D
2	TA	3	3	3	3	3	4	4	4	4	2	2	2	2	2	2
	SO	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	BE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AL	C	C	C	C	C	B	B	B	B	D	D	D	D	D	D
	WR	A	A	A	A	A	C	C	C	C	E	E	E	E	E	E
	TA	3	3	3	3	3	1	1	1	1	2	2	2	2	2	2
	SO	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
3	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	BE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AL	C	C	C	C	C	B	B	B	B	D	D	D	D	D	D
	WR	A	A	A	A	A	C	C	C	C	E	E	E	E	E	E
	TA	3	3	3	3	3	1	1	1	1	2	2	2	2	2	2
	SO	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
4	BE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	AL	D	D	D	D	D	C	C	C	C	E	E	E	E	E	E
	WR	A	A	A	A	A	D	D	D	D	F	F	F	F	F	F
	TA	3	3	3	3	3	1	1	1	1	5	5	5	5	5	5
	SO	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
	WI	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1
	CL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	BE	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	SA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Figure 11. Protocol Schedule

CREWMAN	DAY		15	16	17	18	19	20	21	22	23	24	25	26	27	28
	VARIABLE															
2	AL	A	A	A	A	A	D	D	D	D	B	B	B	B	B	
	WR	A	A	A	A	A	A	A	A	A	C	C	C	C	C	B
	TA	3	3	3	3	3	4	4	4	4	2	2	2	2	2	C
	SO	2	2	2	2	2	2	2	2	2	1	1	1	1	1	2
	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	1
	CL	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3
	BE	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1
3	SA						C+S			B+S						B+S+C
	AL	B	B	B	B	B	E	E	E	E	C	C	C	C	C	C
	WR	A	A	A	A	A	B	B	B	B	D	D	D	D	D	D
	TA	3	3	3	3	3	4	4	4	4	2	2	2	2	2	2
	SO	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1
	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1
4	BE	2	2	2	2	2	2	2	2	1	2	2	2	2	2	1
	SA						C+S			B+S						B+S+C
	AL	C	C	C	C	C	B	B	B	B	D	D	D	D	D	D
	WR	A	A	A	A	A	C	C	C	C	E	E	E	E	E	E
	TA	3	3	3	3	3	1	1	1	1	2	2	2	2	2	2
	SO	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	WI	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
1	CL	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2
	BE	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2
	SA						G+S			B+S						B+S+C
	AL	D	D	D	D	D	C	C	C	C	E	E	E	E	E	E
	WR	A	A	A	A	A	D	D	D	D	F	F	F	F	F	F
	TA	3	3	3	3	3	1	1	1	1	5	5	5	5	5	5
	SO	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
	WI	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1
	CL	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2
	BE	2	2	2	2	2	2	2	2	1	2	2	2	2	2	2
	SA						C+S			B+S						B+S+C
	AL	B	B	B	B	B	E	E	E	E	C	C	C	C	C	C
	WR	A	A	A	A	A	B	B	B	B	D	D	D	D	D	D
	TA	3	3	3	3	3	4	4	4	4	2	2	2	2	2	2

Figure 11. Protocol Schedule (cont'd)

CREWMAN	DAY		29	30	31	32	33	34	35	36	37	38	39	40	41	42
	VARIABLE															
3	AL	A		A	A	A	D	D	D	D	B	B	B	B	B	B
	WR	A		A	A	A	A	A	A	A	C	C	C	C	C	C
	TA	3		3	3	3	4	4	4	4	2	2	2	2	2	2
	SO	2		2	2	2	2	2	2	2	1	1	1	1	1	1
	WI	3		3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2		2	2	1	2	2	2	1	2	2	2	2	2	1
	BE	2		2	2	1	2	2	2	1	2	2	2	2	2	1
	SA	B		B	B	C+S	B	B	B	B+S						B+S+C
	AL	B		B	B	B	E	E	E	E	C	C	C	C	C	C
	WR	A		A	A	A	B	B	B	B	D	D	D	D	D	D
4	TA	3		3	3	3	4	4	4	4	2	2	2	2	2	2
	SO	2		2	2	2	2	2	2	2	1	1	1	1	1	1
	WI	3		3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2		2	2	1	2	2	2	1	2	2	2	2	2	1
	BE	2		2	2	1	2	2	2	1	2	2	2	2	2	1
	SA	B		B	B	C+S	B	B	B	B+S						B+S+C
	AL	C		C	C	C	B	B	B	B	D	D	D	D	D	D
	WR	A		A	A	A	C	C	C	C	E	E	E	E	E	E
	TA	3		3	3	3	1	1	1	1	2	2	2	2	2	2
	SO	2		2	2	2	2	2	2	2	2	2	2	2	2	2
1	WI	3		3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2		2	2	1	2	2	2	1	2	2	2	2	2	2
	BE	2		2	2	1	2	2	2	1	2	2	2	2	2	2
	SA	B		B	B	C+S	B	B	B	B+S						B+S+C
	AL	C		C	C	C	B	B	B	B	D	D	D	D	D	D
	WR	A		A	A	A	C	C	C	C	E	E	E	E	E	E
	TA	3		3	3	3	1	1	1	1	2	2	2	2	2	2
	SO	2		2	2	2	2	2	2	2	2	2	2	2	2	2
	WI	3		3	3	3	3	3	3	3	3	3	3	3	3	3
	CL	2		2	2	1	2	2	2	1	2	2	2	2	2	2
2	BE	2		2	2	1	2	2	2	1	2	2	2	2	2	2
	SA	B		B	B	C+S	B	B	B	B+S						B+S+C
	AL	D		D	D	D	C	C	C	C	E	E	E	E	E	E
	WR	A		A	A	A	D	D	D	D	F	F	F	F	F	F
	TA	3		3	3	3	1	1	1	1	5	5	5	5	5	5
	SO	2		2	2	2	2	2	2	2	3	3	3	3	3	3
	WI	3		3	3	3	3	3	3	3	1	1	1	1	1	1
	CL	2		2	2	1	2	2	2	1	2	2	2	2	2	2
	BE	2		2	2	1	2	2	2	1	2	2	2	2	2	2
	SA	B		B	B	C+S	B	B	B	B+S						B+S+C

Figure 11. Protocol Schedule (cont'd)

CREWMAN	DAY		43	44	45	46	47	48	49	50	51	52	53	54	55	56
	VARIABLE															
4	AL		A	A	A	A	D	D	D	D	B	B	B	B	B	B
	WR		A	A	A	A	A	A	A	A	C	C	C	C	C	C
	TA		3	3	3	3	4	4	4	4	2	2	2	2	2	2
	SO		2	2	2	2	2	2	2	2	1	1	1	1	1	1
	WI		3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL		2	2	2	1	2	2	2	1	2	2	2	2	2	1
	BE		2	2	2	1	2	2	2	1	2	2	2	2	2	1
	SA		B	B	B	C+S	B	B	B	B+S			B			B+S+C
1	AL		B	B	B	B	E	E	E	E	C	C	C	C	C	C
	WR		A	A	A	A	B	B	B	B	D	D	D	D	D	D
	TA		3	3	3	3	4	4	4	4	2	2	2	2	2	2
	SO		2	2	2	2	2	2	2	2	1	1	1	1	1	1
	WI		3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL		2	2	2	1	2	2	2	1	2	2	2	2	2	1
	BE		2	2	2	1	2	2	2	1	2	2	2	2	2	1
	SA		B	B	B	C+S	B	B	B	B+S			B			B+S+C
2	AL		C	C	C	C	B	B	B	B	D	D	D	D	D	D
	WR		A	A	A	A	C	C	C	C	E	E	E	E	E	E
	TA		3	3	3	3	1	1	1	1	2	2	2	2	2	2
	SO		2	2	2	2	2	2	2	2	2	2	2	2	2	2
	WI		3	3	3	3	3	3	3	3	3	3	3	3	3	3
	CL		2	2	2	1	2	2	2	1	2	2	2	2	2	2
	BE		2	2	2	1	2	2	2	1	2	2	2	2	2	2
	SA		B	B	B	C+S	B	B	B	B+S			B			B+S+C
3	AL		D	D	D	D	C	C	C	C	E	E	E	E	E	E
	WR		A	A	A	A	D	D	D	D	F	F	F	F	F	F
	TA		3	3	3	3	1	1	1	1	5	5	5	5	5	5
	SO		2	2	2	2	2	2	2	2	3	3	3	3	3	3
	WI		3	3	3	3	3	3	3	3	1	1	1	1	1	1
	CL		2	2	2	1	2	2	2	1	2	2	2	2	2	2
	BE		2	2	2	1	2	2	2	1	2	2	2	2	2	2
	SA		B	B	B	C+S	B	B	B	B+S			B			B+S+C

Figure 11. Protocol Schedule (concluded)

SECTION VII

SUMMARY

A personal hygiene protocol has been promulgated to encompass the needs, desires, and realities of keeping man clean in a confined space. Based on an in depth review of previous personal hygiene involvements, an analysis of cleansing agents, clothing interactions, water requirements and desirable skin conditions, a day-by-day schedule has evolved. It is hoped that by employing bacteriological sampling, psychological questionnaires, and various subject or observer rating schemes, a pattern of acceptable limits and techniques can emerge. Approximately 80 respondees with confinement experience replied to a questionnaire concerned with their confinement. Their responses have formed the basic data pool for this protocol. Baseline conditions will be obtained from a combination of previous inputs and refined by virtue of data contributions to be obtained from upcoming flights and chamber studies.

SECTION VIII

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1. INTRODUCTION

Various aspects of astronaut behavior have been investigated by numerous organizations. Fairchild employed Concept Applications, Limited (CAL), Hempstead, New York to aid in developing a questionnaire that might sample the attitudes of persons to various aspects of personal hygiene. The selection of CAL was based on a previous history of NASA studies relevant to habitability.

Since the attitudes of the user will, undoubtedly, affect the acceptance and utilization rate of any hygiene material or technique, the general aspects of hygiene were investigated. These included

- Hair cleaning/hair cleanliness
- Body cleaning/body cleanliness
- Oral hygiene
- Facial/body hair
- Care of nails
- Care of clothing
- General appearance

This was accomplished via the development of a three part questionnaire. Part I sampled all seven hygiene areas. There were ten questions for each of the hair, body, and oral hygiene areas. The other areas were sampled by five questions per area (hair, nails, clothing, and general appearance). Part II consisted of a semantic differential of each of the general topic areas. There were at least two semantic items for each of the hygiene areas. Part III consisted of anecdotal reporting to specific questions. The information contained in this report is the analysis of Parts I and II of the preliminary (initial) version of the test and is followed by the subjective commentary.

The rationale underlying the testing program reported herein has been explained by Horrocks⁽¹⁾. He noted that:

"An important determining aspect of any person's behavior involves the interests and attitudes he has developed, either through the experiences of every-day life or as a result of formal schooling. Any really comprehensive analysis of

(1) Horrocks, G., Assessment of Behavior, The Methodology and Content of Psychological Measurement, C.E. Merrill Book Company, Columbus, Ohio, (1964).

an individual's present status or estimation of the nature and direction of his future behavior should include an assessment of his interests and attitudes."

Clearly, Horrocks considers a knowledge of interests and attitudes as basic to any understanding of current behaviors and as an important source of predictive material. Nunnally⁽²⁾ and Freeman⁽³⁾ have suggested that opinions and values are also prominent influences upon social adjustment and social behavior. Although the majority of the material which follows will be concerned with techniques of attitude evaluation, some attention must be given to the relationships among attitudes, interests, values, and opinions. Figure 1A depicts the general relationship among these characteristics, from a motivational point of view.

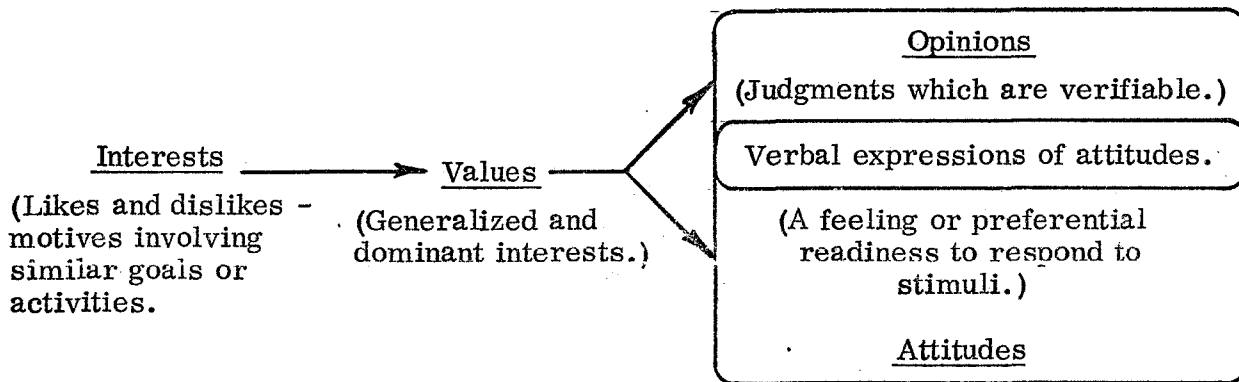


Figure 1A. Interrelationship Between Interests,
Values, Opinions, and Attitudes

A definition of the major terms found in Figure 1 include:

Interests: Those aspects of a person's environment which give him pleasure or satisfaction, challenge him, or compel and hold his attention.

Values: Interests generalized through conditioning experiences to become dominant values. Values then provide the basis for two types of reactions by an individual to the people, institutions, and ideas in the world about him.

⁽²⁾Nunnally, J. C., Tests and Measurements; Assessments and Prediction, McGraw Hill, 1959.

⁽³⁾Freeman, F. S., Theory and Practice of Psychological Testing, 3rd Ed., Holt Rinehart, Inc., New York, 1964.

Opinion: If the reaction is a judgment which is capable of being verified, it is an opinion.

Attitude: If the reaction is a feeling, a preference, or a dispositional readiness to respond in a particular and consistent way, it is termed an attitude.

Both opinions and attitudes are usually assessed by having a person indicate his agreement or disagreement with a statement or series of statements constituting a scale. While in extreme cases, such statements may be clearly distinguished as representing opinion: "There are more bacteria on the body before washing, than after washing with soap and warm water." Or, as representing an attitude, "I dislike washing with a chemical wipe." Others may reflect both: "Women are less suited to being astronauts than men." The latter statement is open to study and verification and, as such, is an opinion; but it also indicates how an individual feels about women and is, therefore, a statement of attitude as well.

In addition to the potentially mixed nature of item design to assess attitudes, there are other problems inherent in the area of attitude measurement. Since attitudes fall within the psychological domain of behavior, they cannot be measured directly, but must be approached through behavior considered as a representative index of the attitude underlying it. Thus, whatever method is employed in the quantification of an attitude, the resultant index number stands only as a symbol of that attitude. It must also be appreciated that any verbal or overt expression of an attitude is not an infallible indication of the presence of that attitude in the person being assessed. Defensiveness, social desirability, and situational demands are factors that can influence verbal expressions of attitudes in ways that will distort or misrepresent the underlying trait. To the extent that the formation of attitudes is a learned process, a potential for relearning, extinction, or radical change over time is present. A reasonable and cautious interpretation of any attitude measure is that it yields information about a presumed feeling at the time of the measurement operation, and may not necessarily be predictive of actual behavior.

Because it is simpler to have subjects react to a list of statements in a questionnaire than to observe their actual behavior, attitude measurement essentially has developed into the construction of scales that locate the individual through his verbal reactions, in an intensity continuum. Scales are derived from collections of statements all of which concern different degrees of positive or negative reaction to

the object, person, or concept being studied. There are a number of techniques employed to obtain attitude scales. A brief description of the major ones follow.

An early, still widely used method of generating attitude scales is the Thurstone technique of equal-appearing intervals. Judges are asked to rate a collection of positive and negative statements about the class of persons, objects, ideas on an eleven-point continuum ranging from "extremely favorable" through "neutral" to "extremely unfavorable". The judges do not express their agreement or disagreement of the intensity of each statement. Statements having low interjudge variability are retained for the attitude scale. From this pool, a group of statements are selected that spreads evenly over the intensity range. A median intensity score is used for determining the scale position of a statement. In final form, the selected items are randomly ordered, and the subjects are instructed to mark those items with which he agrees. His score is the median intensity of the statement he has marked. The use of judges gives scale positions a rational meaning and is helpful in locating the neutral point in the attitude scale. Since attitudes tend toward bipolarity, the latter feature of this method is useful in determining direction of change following campaigns to modify particular attitudes. The Thurstone method assumes judge's intensity ratings are independent of their own attitude. If this assumption is not correct, scale positions would change as a function of the judges who are chosen. Data are available that suggest that while the relative positive statements can be determined without consideration of judges attitudes, significant differences in absolute intensity are often found. This type of dependence of scale values upon the particular group of judges used causes imprecise determination of the scale's neutral point.

The Likert method of test construction also begins with a large pool of positive and negative statements about an object, institution, or class of persons. However, item analyses techniques, rather than judges are used to derive the scale. This is done by administering the collection of items to a group of subjects who rate each item on a five-point continuum ranging from "strongly approve" to "strongly disapprove". An item-total score correlation is obtained, indicating the extent to which each item measures the general attitude underlying the total set of items. Only items found to have high correlations with the total score are retained for the attitude scale. Tested groups then indicate their agreement or disagreement on the same scale and are given a score based upon the sum of the item scores. The

Likert method is more empirical than the Thurstone technique. It ensures that the final scale is concerned with only one general attitude, and provides more confirmation that the simple dichotomy of "agree" or "disagree". However, no direct meaning can be given to the scale scores or absolute meaning given to the points on the Likert scale, unless large scale general norms are available.

A more recent approach to attitude scaling has been developed by Guttman. His procedure has as its objective to test directly whether a collection of items can be scaled in one continuum (attitude). The response pattern of a group of subjects to items is analyzed according to Guttman's scalability criterion which is that if an individual endorses a more extreme item, he should also endorse all less extreme items. Unfortunately, the Guttman method, while an elegant notion, has practical drawbacks. Almost no collection of items will meet the strict lawfulness of the scalability criterion. Thus, his contribution to the area of attitude scale construction is the concept of defining scalability criterion entirely in terms of rank ordering of persons and items and not a procedure suitable for practical work.

Statistically, the most direct approach to determining the number and kinds of scales contained in a collection of items is factor analysis. The major factors obtained from the analysis would define the separate attitude scales. With the increasing use of high speed computation equipment, large scale factor analysis of attitude items is much more feasible, and newer scales will probably take advantage of this method.

The semantic differential is an experimental technique used to measure the connotative meanings of words representing persons, concepts, organizations, institutions, events, and objects. The word is rated on a number of seven-point polar scales which generally reveal the person's attitude toward what the word represents in three dimensions. These are evaluative, potency, and activity dimensions. Some examples of how a semantic differential might appear is found below:

Shaving							
Good	_____	_____	_____	_____	_____	_____	Bad
Strong	_____	_____	_____	_____	_____	_____	Weak
Fast	_____	_____	_____	_____	_____	_____	Slow
Fair	_____	_____	_____	_____	_____	_____	Unfair
Wise	_____	_____	_____	_____	_____	_____	Foolish
Active	_____	_____	_____	_____	_____	_____	Passive

Other approaches to attitude assessment include observation, specific performances, pictorial and projective techniques, personal document analyses, and interviewing. Observation is defined as the systematic gathering of standard reports from trained recorders, operating within an explicitly stated frame of reference. Attitudes evolving in certain group atmospheres have typically been studied through the use of this method. Specific performances refer to those real life behaviors that are concrete manifestations of underlying attitudes. Financial contributions or contributions of time and effort to political parties are instances of specific performances that have been employed as measures of political attitudes. Pictorial and projective techniques obtain attitude information by having subjects react to various kinds of visual stimuli; i.e., photographs may be ranked or paired with statements, captions selected for political cartoons. Analysis of personal documents utilize the writings and other personal productions of individuals as a method of ascertaining their attitudes. Diaries, letters, public documents all have been employed in this manner in various studies of attitudes. The interview situation can range from the presentation of a list of simple "yes" or "no" questions to a series of more complex open-ended inquiries or some combination thereof. Interviewing is a fairly flexible format which allows for some in-depth probing when necessary, yet can be sufficiently structured to obtain the same data from all individuals. However, the desire to please the interviewer, or a failure for rapport to be established can influence the quality of the attitudinal material obtained during an interview.

Figure 52A is the first phase development of a personal hygiene questionnaire. It is presented in this section of the report.

2. APPROACH

The questionnaire must be considered the first phase in the development of a more sophisticated measurement instrument for the assessment of personal attitudes toward hygiene. At present, the validity of the instrument is primarily of the content variety known as sampling validity. This was achieved by designing items to assess feelings toward behaviors involved in a number of personal hygiene areas. Here the intent is to adequately sample a specifically defined universe of behaviors. The instrument views hygiene in terms of potential problem areas in a restricted environment. Any grooming or personal care procedure requiring an other than normal approach was conceived of as a potential problem area. Seven areas have been selected for

study by this questionnaire. They consist of hair cleaning, body cleaning, oral hygiene, shaving, hand and nail care, clothing care, and general appearance.

To test the degree to which these content areas in hygiene were sampled, it was decided to factor analyze the data obtained from the first groups of subjects tested. The technique was utilized in two ways. The first was to determine if the items designed to measure a particular area "loaded" on the same factor or factors. Thus, if all hair care items clustered together, i.e., had significant loadings on the same factor, evidence for the instruments factorial validity in that area would be present. The second use of factor analysis was to empirically determine the factors yielded and interpret them according to the items they contain. When factor analysis is employed in this manner, a taxonomy of traits which may be useful in further theoretical or applied work is suggested.

It must be pointed out that factor analysis techniques cannot get any more out of the data than was put in. However, it can reveal content lacks and provide information as to the fewest number of underlying attitudes that account for the inter-relationships among all the items. Because factor analysis relies upon correlational procedures, sample size is an important variable.

Table 1A presents the factor analysis of the largest size group, the non-astronaut male population. This data was used rather than any other group due to the larger size of the population ($N = 39$). Even with this size population, the N is considered small for the analytic technique used. Table 1A presents the significant factor loadings of the various items grouped according to the area the items are purported to measure. From this table it can be seen that 16 factors are needed to account for 85% of the variance in the item scores using a principal axis analysis with a varmax rotation. This table enables one to see the extent to which the items in each content area tapped the same dimension, and also to see what items seemed to measure a similar characteristic in the sample, independent of its original content area.

Table 1A indicates that while 16 factors are needed to account for 85% of the variance, this is due to a number of multi-content areas. Factors 2, 3, 8, 9, 11, 12, 15 and 16 belong in this category. Factor 1, however, seems to relate predominantly to body cleaning items, while Factors 4 and 10 relate to care of the hair. Factors 5 and 13 are concerned with shaving, while Factor 6 deals with oral hygiene.

TABLE 1A. FACTOR ANALYSIS OF THE 50 ITEM HYGIENE TEST FOR ALL NON-ASTRONAUT MALES

Content Area	Test Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Hair	1																
	6			.78		-.42			.34		.44						
	11												.80				
	16																
	21																
	26																
	31																
Nails	36																
	41																
	46																
	8																
	18																
Shaving	20																
	25																
	30																
	35																
	40																
Appearance	45																
	5																
	15																
	25																
	35																
Clothing	42																
	2																
	12																
	22																
	32																
Body Cleaning	37																
	47																
	3																
	7																
	13																
Oral Hygiene	17																
	23																
	27																
	33																
	37																
	43																
	47																
	4																
	9																
	14																
	19																
	24																
	29																
	34																
	39																
	44																
	49																

Factor 7 deals mainly with the attitude toward appearance; however, it has a component relating to clothing. The attitude relating to clothing is specifically seen in Factor 14.

While the factor analysis was performed with a small number of subjects (non-astronaut males - 39 subjects) it generally indicated some factor validity for the item categories present in the general questionnaire. The only item for which no factor cluster could be found were those items relating to the care of the hands/nails. Since the intent of this analysis was to see if there was some factor validity for the initial portion of the testing situation, there was no attempt made to distinguish by name, specific factors uncovered in the analysis.

An analysis of the data (means and standard deviations) indicated great similarity in the response patterns of all male subjects. For this reason a second factor analysis was performed after all of the data for the male subjects had been pooled. This allowed for a subject pool of 71 persons which, while marginal for the factor analysis technique, is more desirable than the subject size of the initial analysis. The results of this analysis can be seen in Table 2A.

In this analysis, 15 factors accounted for 75% of the variance. The content areas of hair clothing, body cleaning, and oral hygiene have primarily individual factors. The content areas of nail, shaving, and physical appearance, on the other hand, are found in split factors. There are internal consistencies in these factors however. Shaving and physical appearance appear as a split factor. A second split factor appears to relate to body cleaning and oral hygiene, while a third split factor relates to body cleaning and physical appearance.

The primary factor that resulted from both of these analyses relates to body cleaning. As such, it accounts for the greatest proportion of the variance, and might be considered of prime importance to the participants who were included in the analysis.

The reliability of the questionnaire has yet to be determined. While a test-retest determination of the coefficient of stability might seem appropriate for estimating this instruments ability to measure consistently, one important difficulty is encountered. Many traits of personality, interest, and attitude are conceived of as being in a state of flux rather than as being static. As a result, changes in scores over time may not be

TABLE 2A. FACTOR ANALYSIS OF THE 50 ITEM HYGIENE TEST FOR ALL MALE SUBJECTS

Content Area	Test Item no.	17%	26%	33%	38%	43%	47%	51%	55%	59%	62%	65%	68%	70%	73%	75%
Hair	1															
	6					.33							.80	.27		
	11	.34				.65										
	16				.61											.42
	21							.75					.85			
	26												.28			
Nail	31							.75					.26			.70
	36												.48	.30		.27
	41															
	46															
	8															
	18															
Shaving	28															
	38															
	48															
	10															
	20															
	30															
Appearance	40															
	50															
	15															
	25															
	35															
	45															
Clothing	2															
	12															
	22															
	32															
	42															
	3															
Body Cleaning	7															
	13															
	17															
	23															
	27															
	33															
Oral Hygiene	37															
	43															
	47															
	9															
	14															
	19															
	24															
	29															
	34															
	39															
	44															
	49															

due to measurement error inherent in the instrument, but attributable to real change. This would lead to an underestimation of reliability.

An alternative approach would be to develop a second instrument designed to measure exactly the same attitudes in the same way using different items from the same content area. To obtain two parallel tests, one must sample the same content universe in the same way and obtain scores (when both are given to the same group of persons) such that the means, variances, and inter-item covariances are equal. At the initial test construction phase, it appeared premature to go through this procedure (development of another instrument) in order to obtain a measure of the coefficient of stability-equivalence.

An alternative would be to divide the present test into two equivalent halves and score each part separately. The part scores can then be correlated to obtain a measure of form to form fluctuation known as the coefficient of equivalence. Split half reliability methods still face the same problem of parallel test reliability of getting the two parts to be approximately equal. Since the scale is designed to measure a number of areas, rather than a single unitary dimension, each area would have to be equally represented in the split versions. Failure to achieve this would affect the reliability estimate. Assuming equivalent halves could be devised, the reliability of the full scale would be estimated by applying either the Spearman-Brown prophecy formula or the Guttman formula.

Because the scale is likely to measure a trait that is not a unifactor one, measures of reliability based on test homogeneity or internal consistency should be ruled out. Thus, it does not appear appropriate to approach the determination of the questionnaires reliability through the use of Kuder-Richardson or Hoyt reliability formulas.

From the foregoing discussion, it appears that although in its initial phases this test has no determined reliability quotient; it does appear to have some factor validity, as well as content validity. This then provided the basic requirement for initial test construction.

3. METHOD

After the initial version of the test was constructed, and test forms were printed, they were distributed to several groups of persons. These included astronauts

who had participated in actual space flights; non-flying astronauts (astronauts who had not participated in any actual space flights); males who had participated in confinement studies or activities such as tours of duty on submarines, in the Antarctic, in space simulators or tank studies, Tektite II, the Benjamin Franklin drift, and other studies that required habitating confined or restricted environments. Included in the subject population were the females who participated in the female Tektite II work program.

After the subjects had responded to the questions, they mailed their completed forms to Fairchild Republic Division at Farmingdale, New York. Here, the questionnaires were scored, and the individual item scores tabulated on IBM coding sheets for keypunching. This was performed for all subjects. The data was keypunched and analyzed at the Fairchild facility on an IBM-360, Model 40. Scientific programs were utilized in the analysis.

The programming allowed for the data to be analyzed according to the specific population tested. There were four such groupings: Flying Astronauts, Non-Flying Astronauts, Non-Astronaut Males and Females. Means, standard deviations, and a factor analysis was performed for the data for these groups. The results of this analysis follows.

4. RESULTS

The results of the data analysis will be presented according to the findings for each specific content area. The initial analysis is based on the findings for the first fifty items in the test form. For each item, frequency distributions were computed. The potential range of scores for each item was from 1 to 5. The data presented in the tables represents the pooled data for all male subjects. This "pooling" was performed after tests of significance indicated great similarity in the male responses. Females were excluded from the analysis since the sex difference apparently yielded a greater number of significant differences.

a. Data Analysis

- Oral Hygiene

Table 3A indicates that the subjects feel that dental hygiene is important (item 9) because mouth odor is unpleasant (item 4). Brushing at least once

a day (item 49), and preferably twice a day (item 44) rather than after every meal (item 29), is the desired brushing frequency pattern of most of the subjects. Mouth feeling (item 39) rather than the feeling of a film (item 19) appears to be the rule for "bad breath" and, presumably, the reason for brushing. Brushing is seen as the most effective cleaning method (items 14 and 24), and it gives the subjects a "clean mouth feeling" (item 34).

TABLE 3A. ANALYSIS OF ORAL HYGIENE DATA
FOR ALL MALE SUBJECTS IN THE TESTING

Score	Test Item									
	4	9	14	19	24	29	34	39	44	49
5	24	34	5	2	1	6	42	9	35	42
4	27	29	4	15	13	23	29	33	28	25
3	13	6	4	15	8	30	0	15	5	0
2	6	2	33	29	30	18	0	10	4	5
1	1	0	24	10	18	4	0	5	0	1

• Hair

The subjects indicated a dislike for dirty hair (item 1), and felt that a proper amount of washing is necessary to avoid discomfort (item 31), and possible offense (item 41). Once a week (item 26) is seen as the most desirable frequency for washing the hair rather than twice (item 46) a week or every other day (item 16). The subjects are aware of the need to wash their hair before visible cues such as dandruff (item 11). They believe that a dry wash is not as desirable (item 21), or as adequate (item 36) as the standard "wet" wash. They appear to be neutral as to the relaxation value of hair washing (item 6). The frequency data for the items comprising this sub-item grouping can be seen in Table 4A.

TABLE 4A. ANALYSIS OF HAIR RELATED DATA FOR ALL MALE SUBJECTS

Score	Test Item									
	1	6	11	16	21	26	31	36	41	46
5	10	3	0	4	1	20	22	3	9	14
4	36	18	15	14	2	33	31	6	22	23
3	18	27	16	12	27	5	14	28	24	13
2	5	17	21	27	25	12	3	27	11	21
1	2	6	19	14	16	1	1	7	5	0

QUESTION: 4-Mouth odor is one of the most unpleasant aspects of many persons.

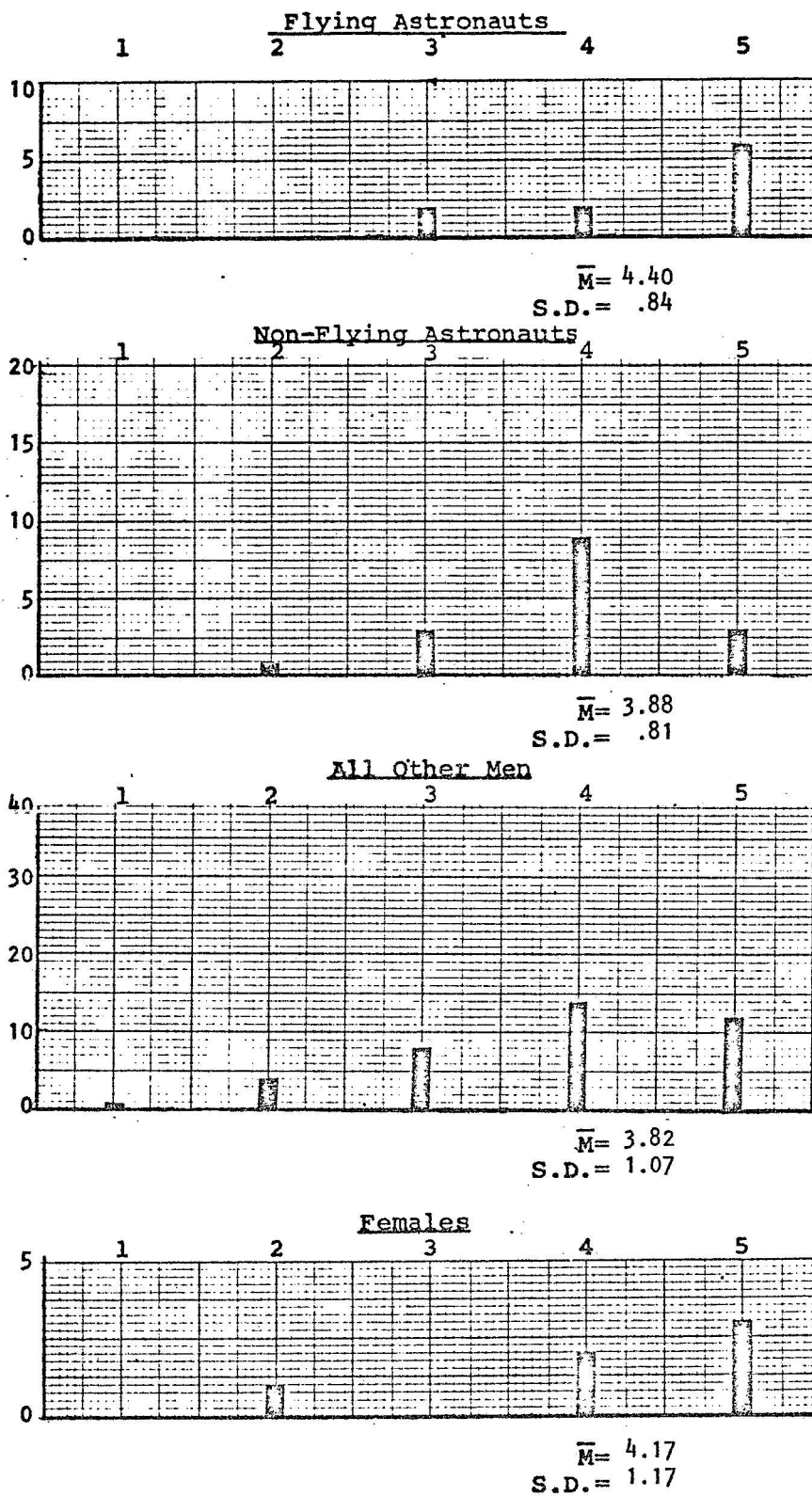
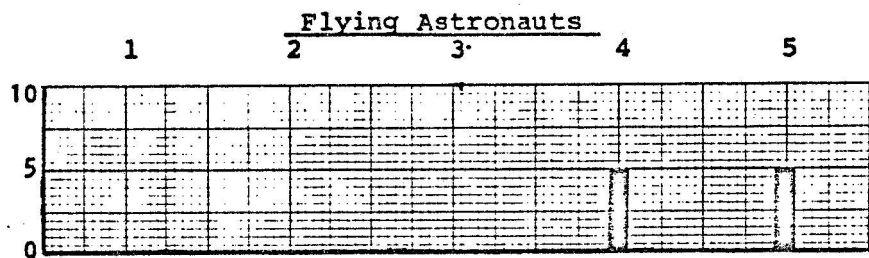
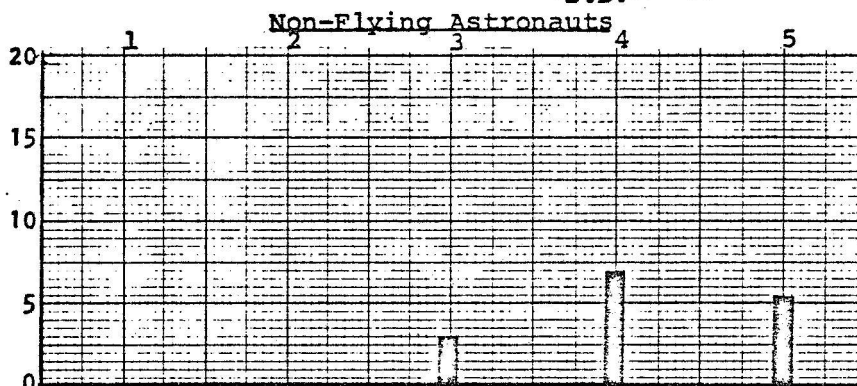


Figure 2A. Oral Hygiene: Response to Question 4

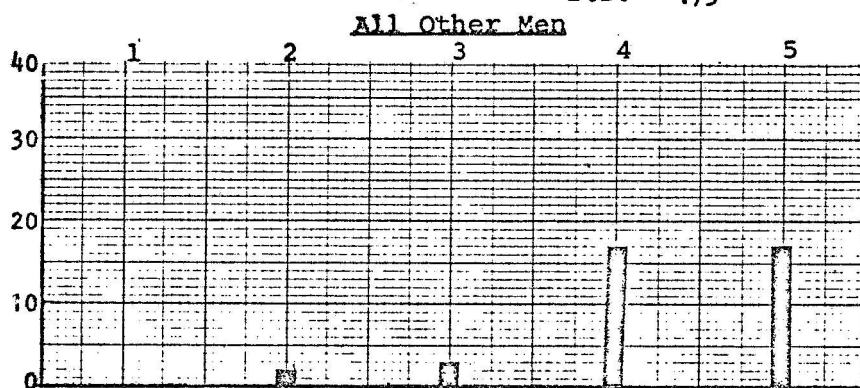
QUESTION: 9-Dental hygiene is important to me.



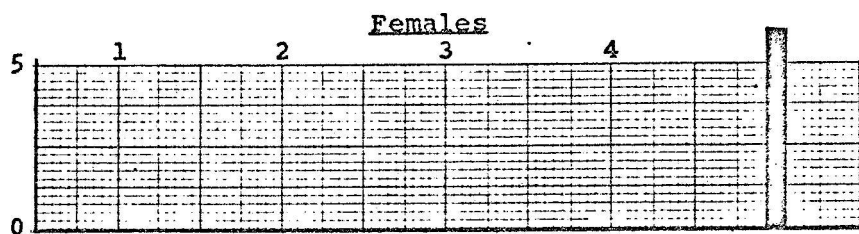
$\bar{M} = 4.50$
S.D. = .53



$\bar{M} = 4.19$
S.D. = .75



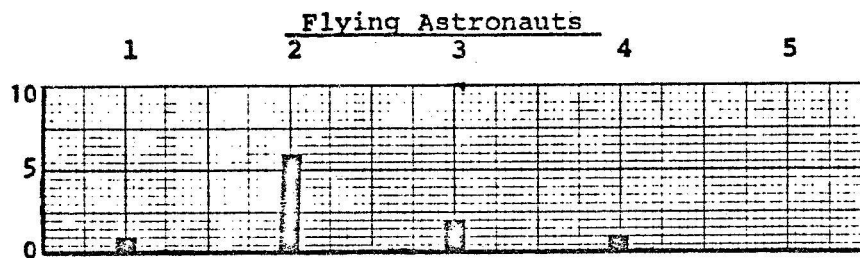
$\bar{M} = 4.26$
S.D. = .82



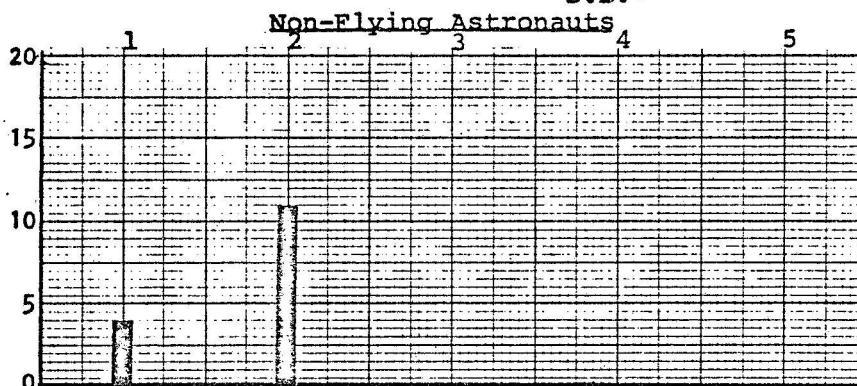
$\bar{M} = 5.00$
S.D. = .00

Figure 3A. Oral Hygiene: Response to Question 9

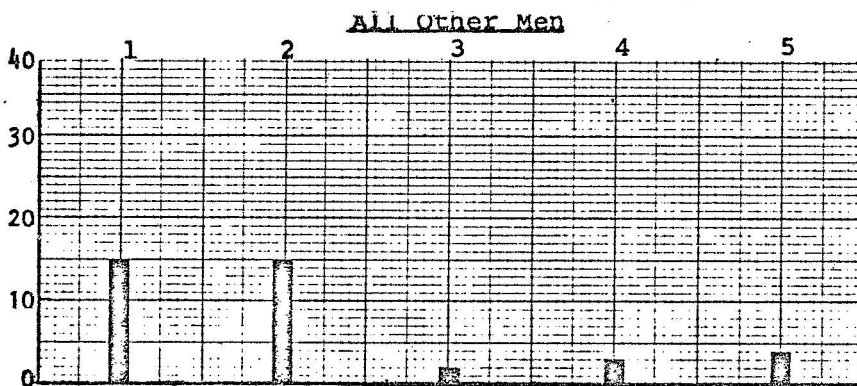
QUESTION: 14-Mouthwash is as effective as brushing, in keeping the mouth clean.



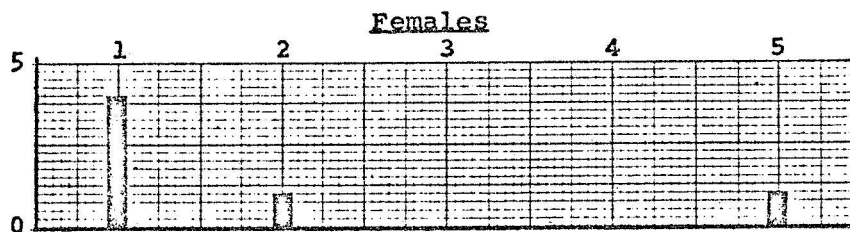
$\bar{M} = 2.30$
S.D. = .82



$\bar{M} = 1.88$
S.D. = .72



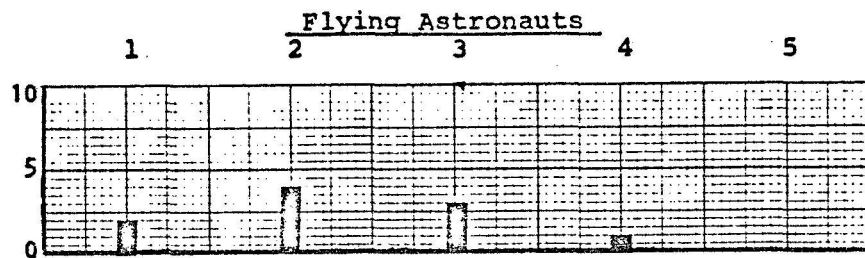
$\bar{M} = 2.13$
S.D. = 1.30



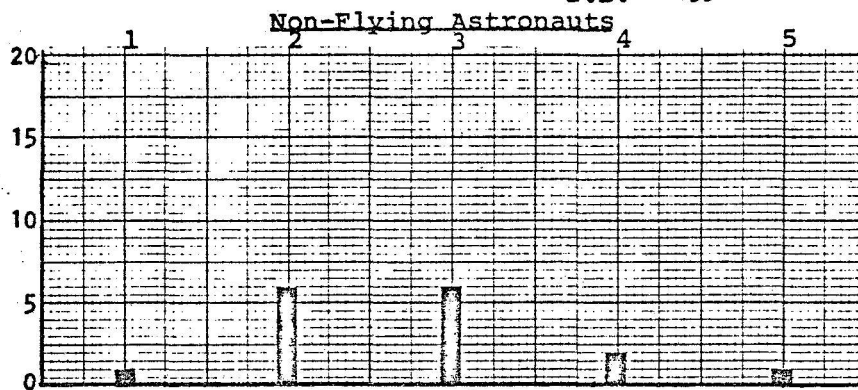
$\bar{M} = 1.83$
S.D. = 1.60

Figure 4A. Oral Hygiene: Response to Question 14

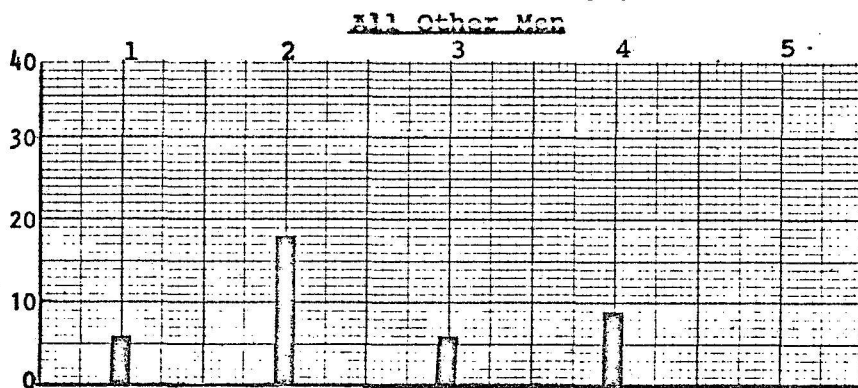
QUESTION: 19- I often feel there is a "film" in my mouth.



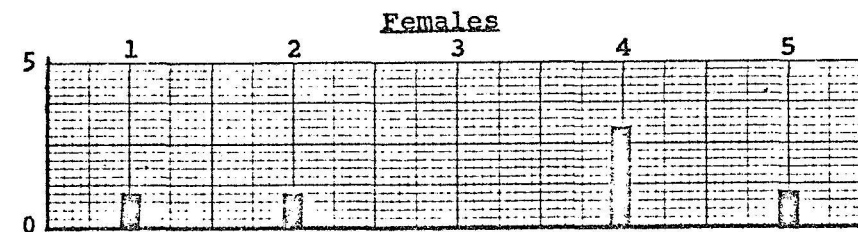
$\bar{M} = 2.30$
S.D. = .95



$\bar{M} = 2.75$
S.D. = 1.00



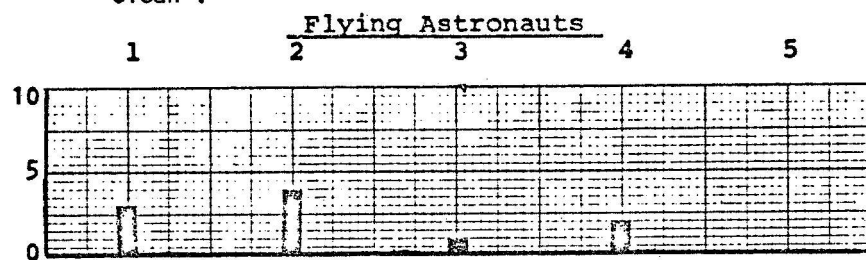
$\bar{M} = 2.46$
S.D. = 1.02



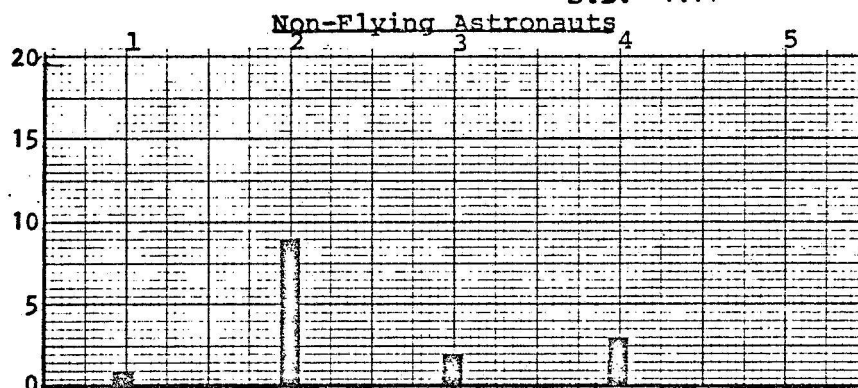
$\bar{M} = 3.33$
S.D. = 1.51

Figure 5A. Oral Hygiene: Response to Question 19

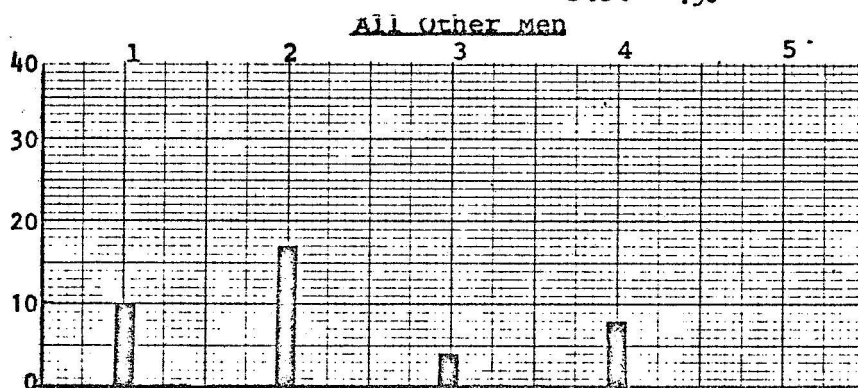
QUESTION: 24-Methods other than brushing are as effective in keeping the mouth "clean".



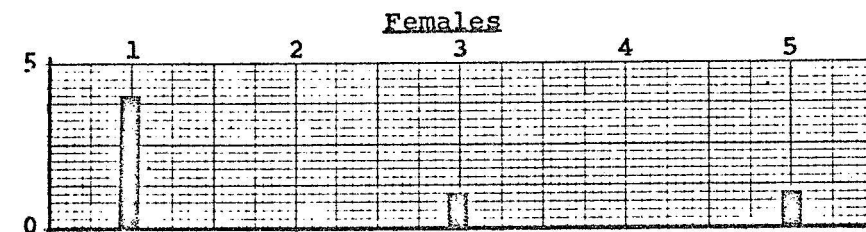
$\bar{M} = 2.20$
S.D. = 1.14



$\bar{M} = 2.38$
S.D. = .96



$\bar{M} = 2.26$
S.D. = 1.07



$\bar{M} = 2.00$
S.D. = 1.67

Figure 6A. Oral Hygiene: Response to Question 24

QUESTION: 29-I feel I should brush my teeth after every meal.

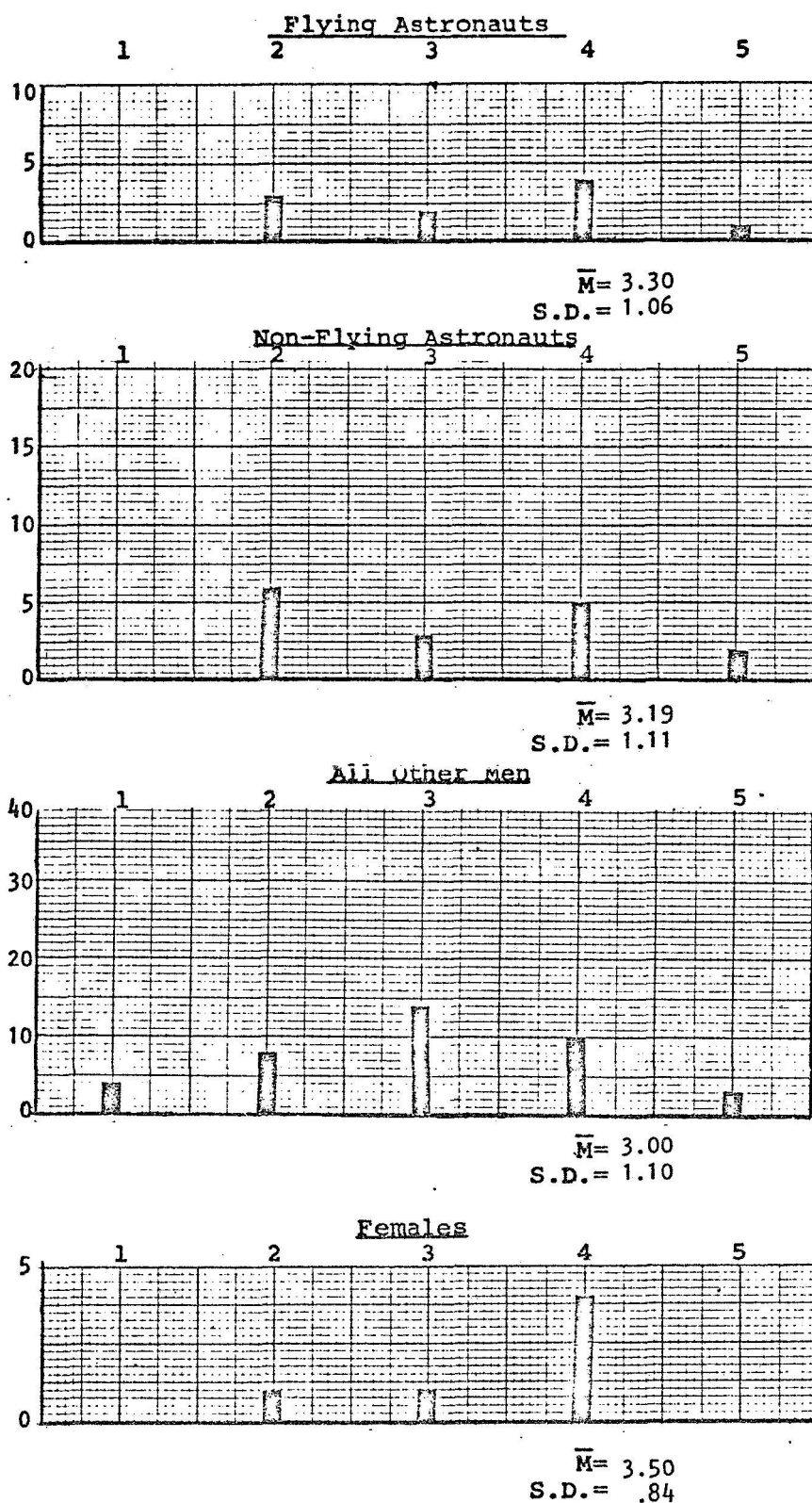
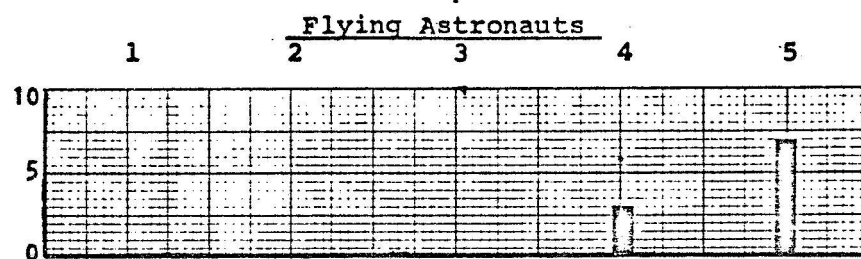
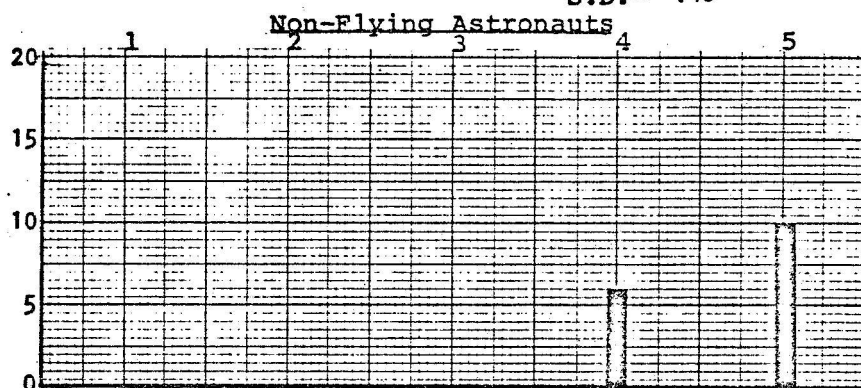


Figure 7A. Oral Hygiene: Response to Question 29

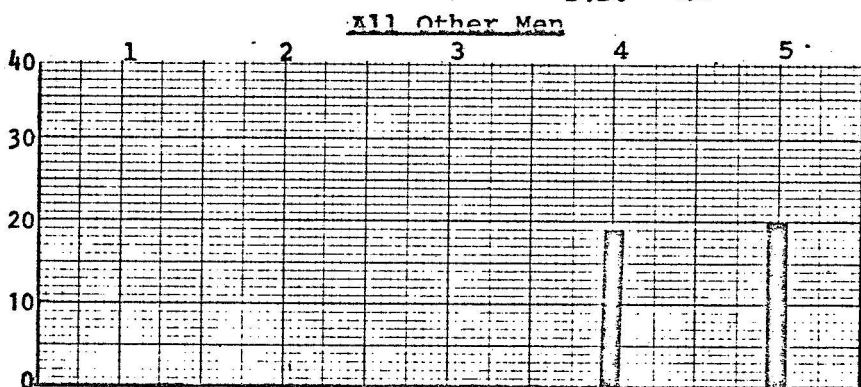
QUESTION: 34-Brushing my teeth gives my mouth a "clean" feeling.



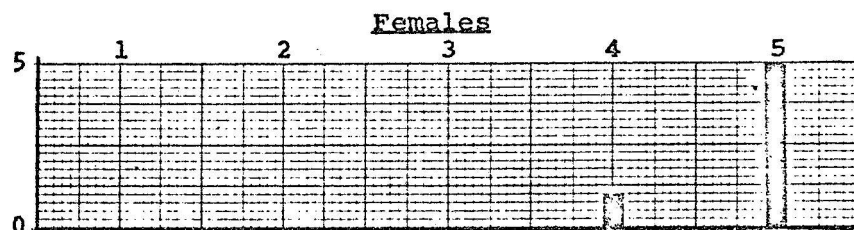
$\bar{M} = 4.70$
S.D. = .48



$\bar{M} = 4.63$
S.D. = .50



$\bar{M} = 4.51$
S.D. = .51



$\bar{M} = 4.83$
S.D. = .41

Figure 8A. Oral Hygiene: Response to Question 34

QUESTION: 39-I know when I have "bad breath" by how my mouth feels.

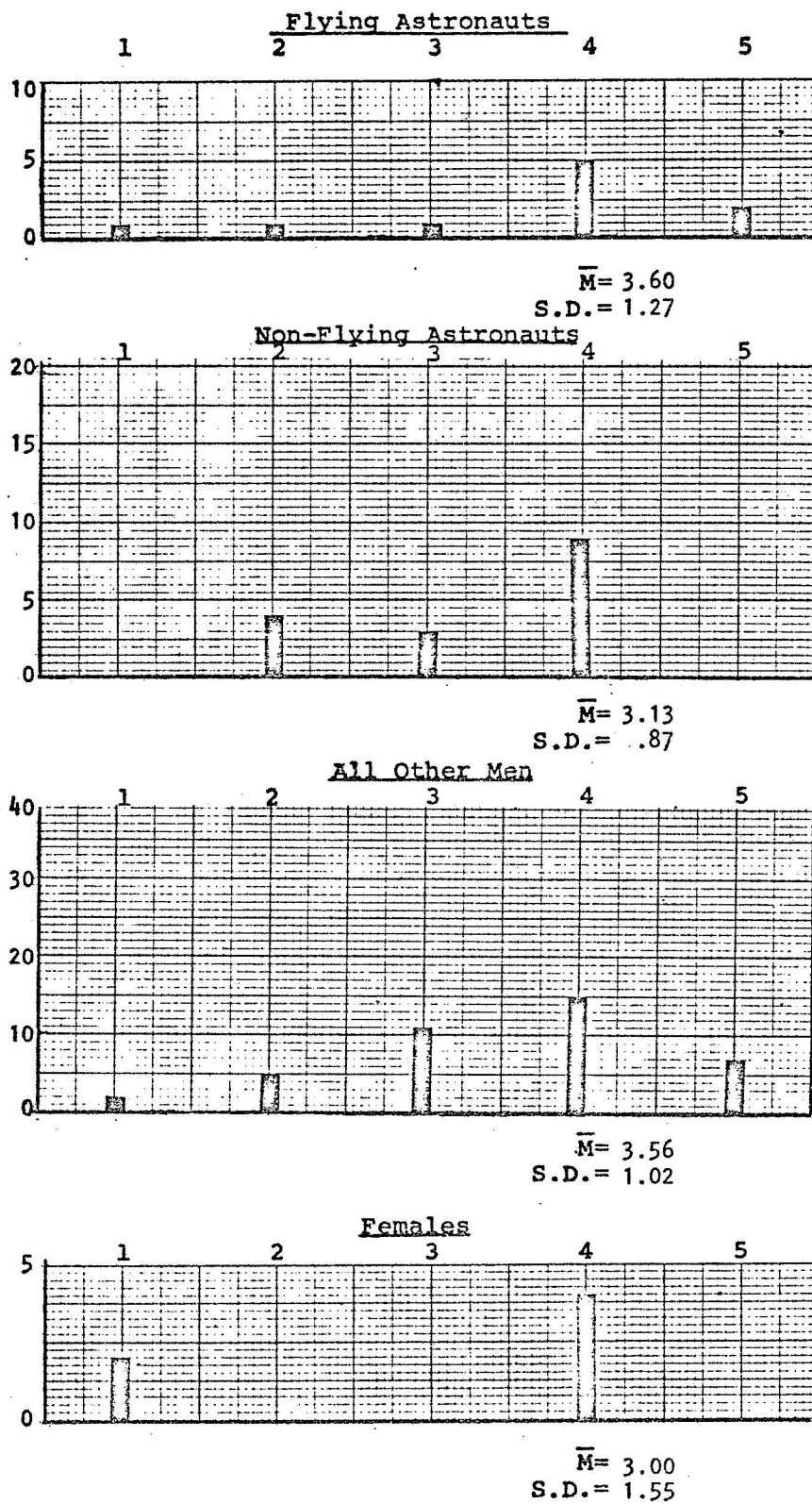


Figure 9A. Oral Hygiene: Response to Question 39

QUESTION: 44-1 feel I should brush my teeth at least every morning and every evening.

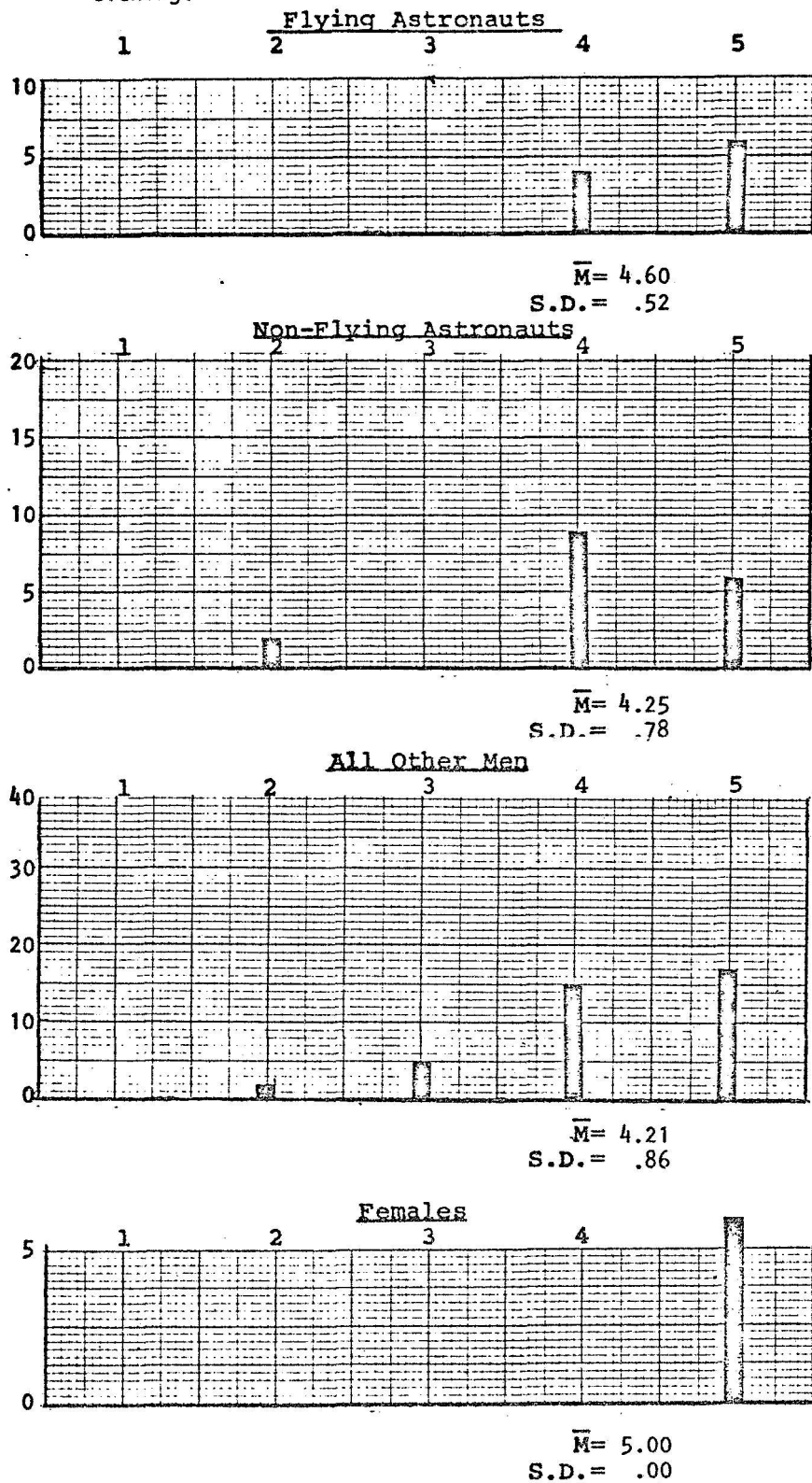
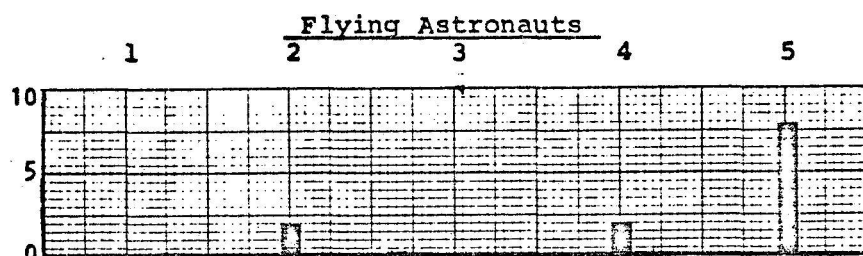
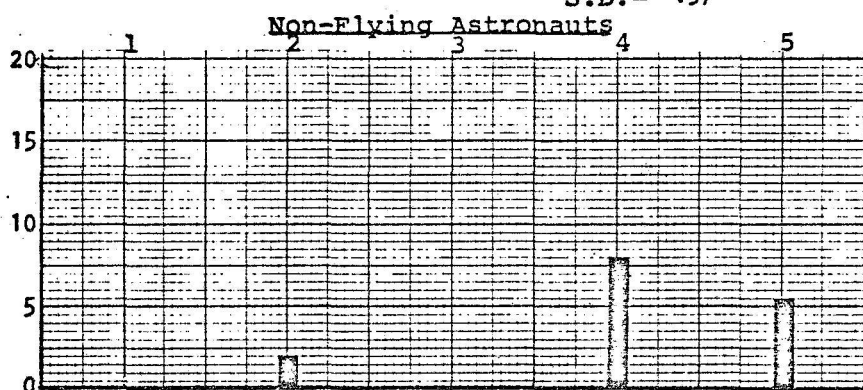


Figure 10A. Oral Hygiene: Response to Question 44

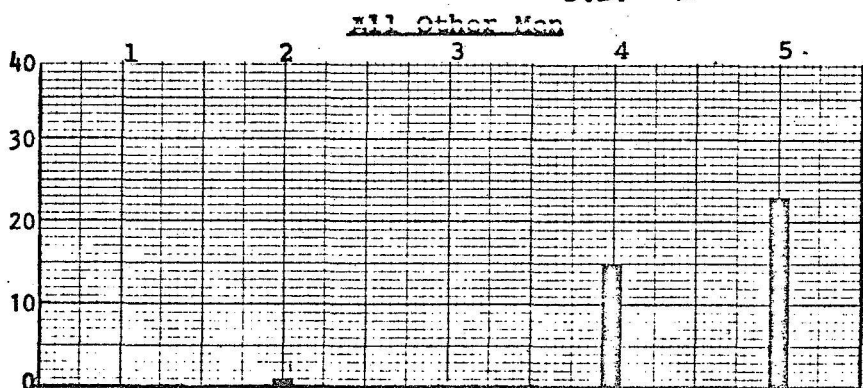
QUESTION: 49-I feel I should brush my teeth at least once a day.



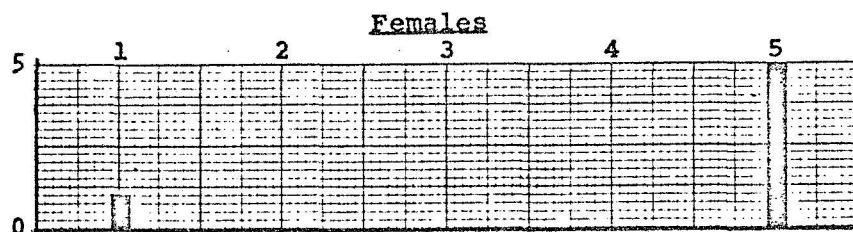
$\bar{M} = 4.60$
S.D. = .97



$\bar{M} = 4.13$
S.D. = .96



$\bar{M} = 4.54$
S.D. = .64



$\bar{M} = 4.33$
S.D. = 1.63

Figure 11A. Oral Hygiene: Response to Question 49

QUESTION: 1-The odor from "dirty" hair is offensive to me.

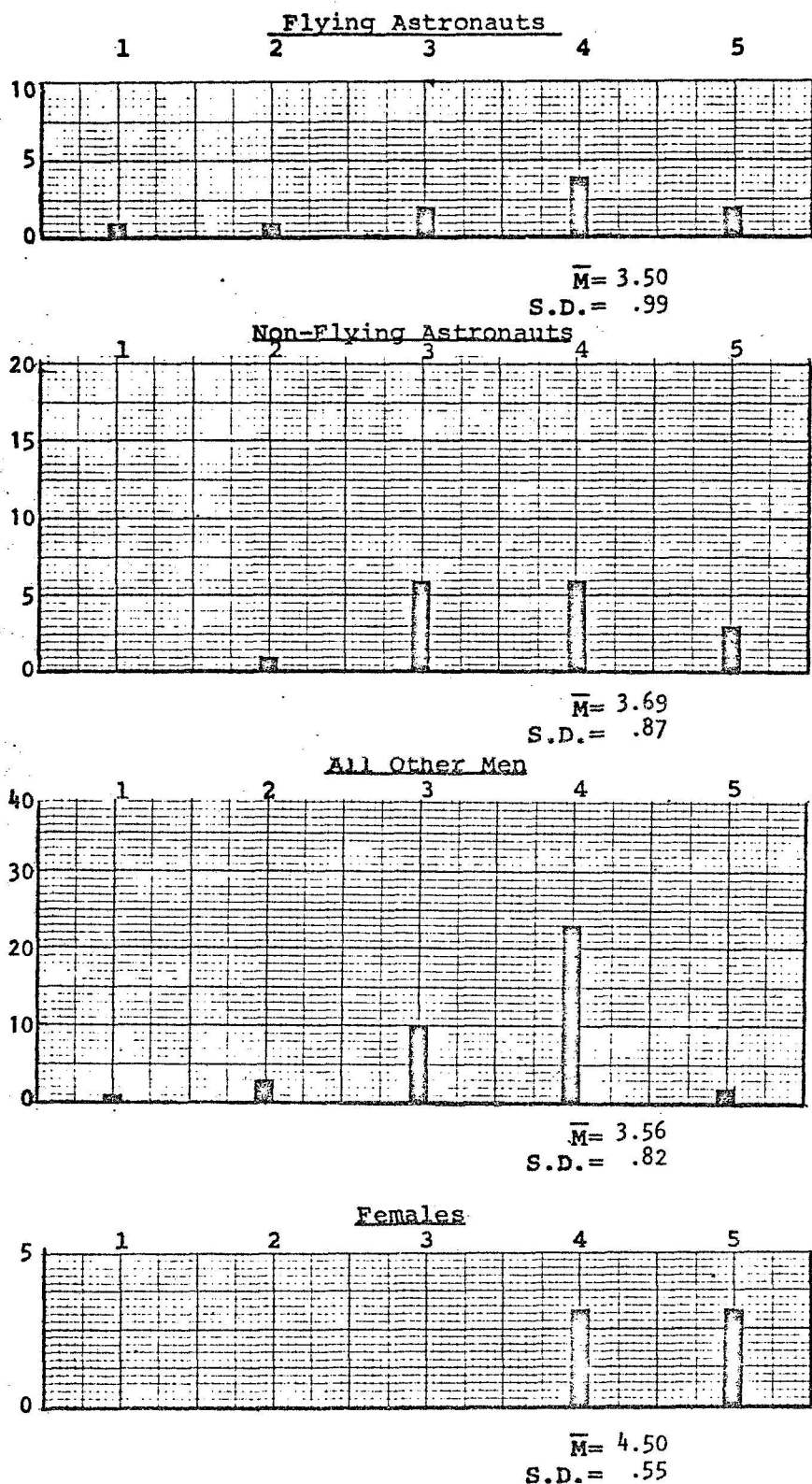
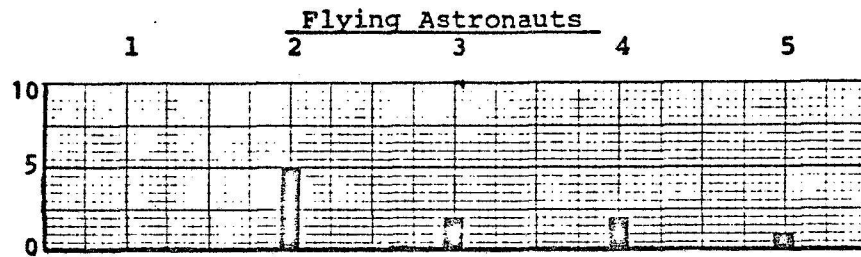
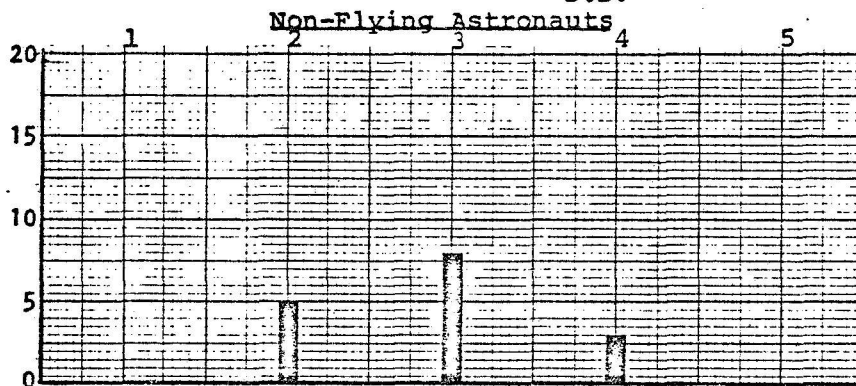


Figure 12A. Hair Cleaning: Response to Question 1

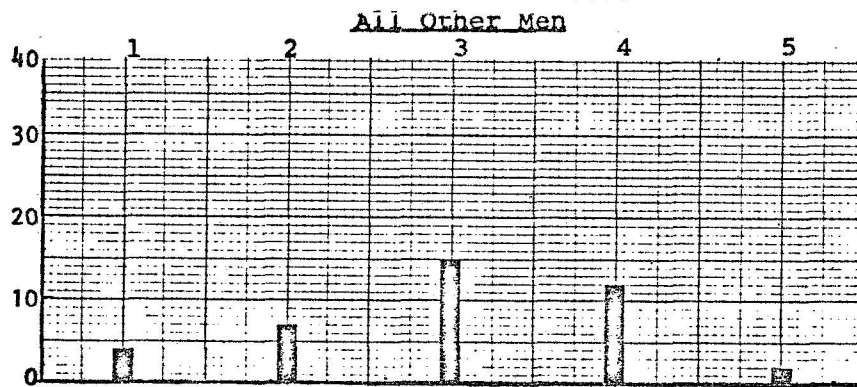
QUESTION: 6-Washing my hair relaxes me.



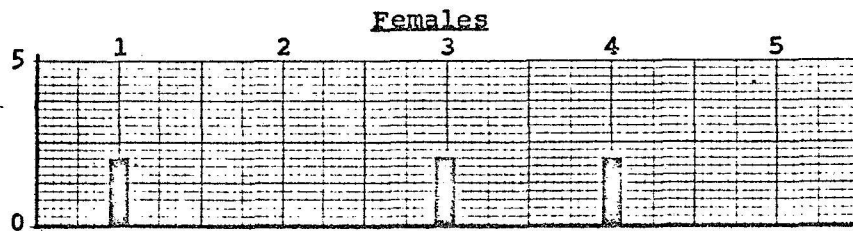
$\bar{M} = 2.90$
S.D. = 1.10



$\bar{M} = 2.88$
S.D. = .72



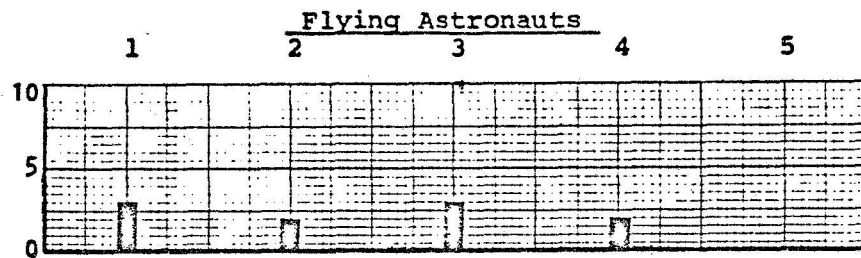
$\bar{M} = 2.97$
S.D. = 1.01



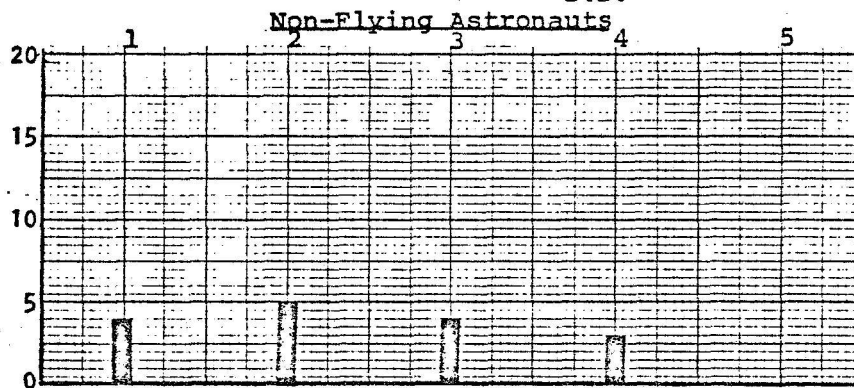
$\bar{M} = 3.33$
S.D. = 1.86

Figure 13A. Hair Cleaning: Response to Question 6

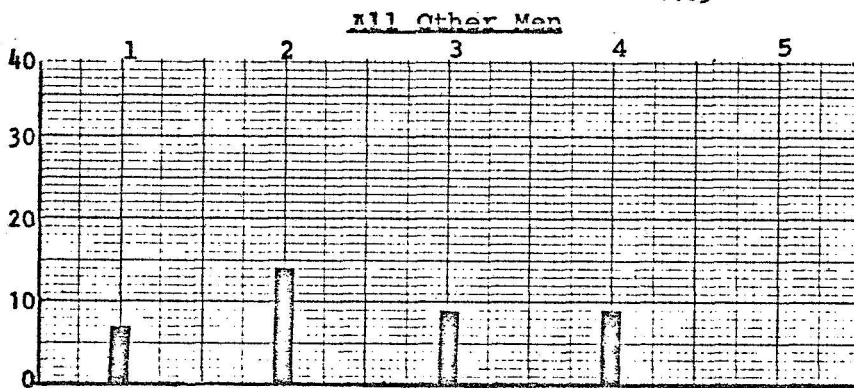
QUESTION: 11-1 am not aware of "dirty" hair until I have dandruff.



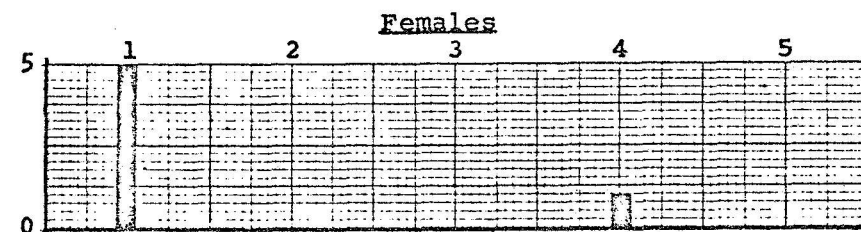
$\bar{M} = 2.40$
S.D. = 1.17



$\bar{M} = 2.38$
S.D. = 1.09



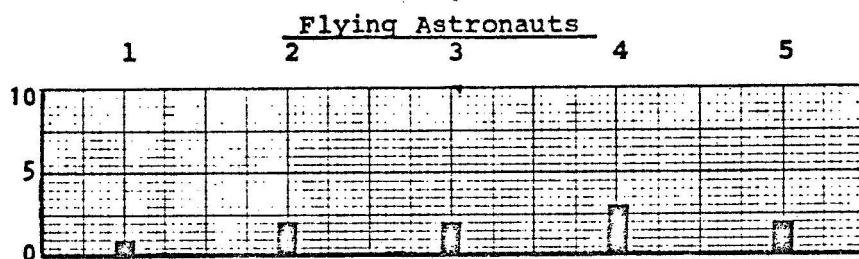
$\bar{M} = 2.51$
S.D. = 1.05



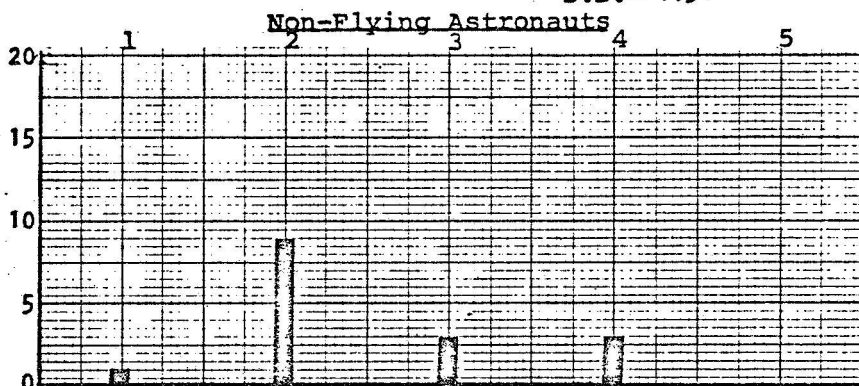
$\bar{M} = 1.50$
S.D. = 1.23

Figure 14A. Hair Cleaning: Response to Question 11

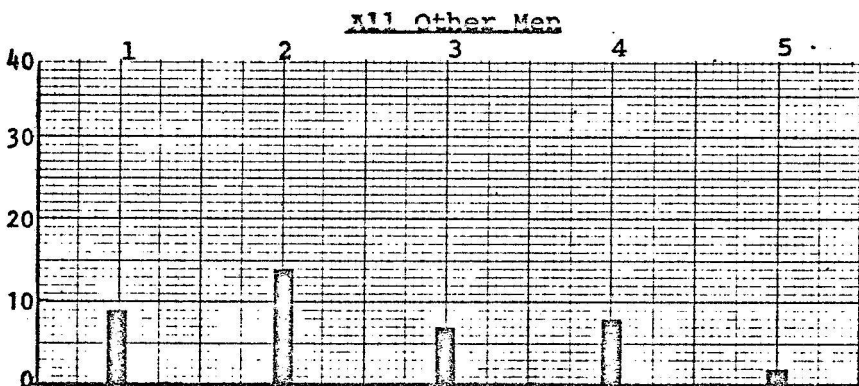
QUESTION: 16-1 feel I should wash my hair approximately every other day.



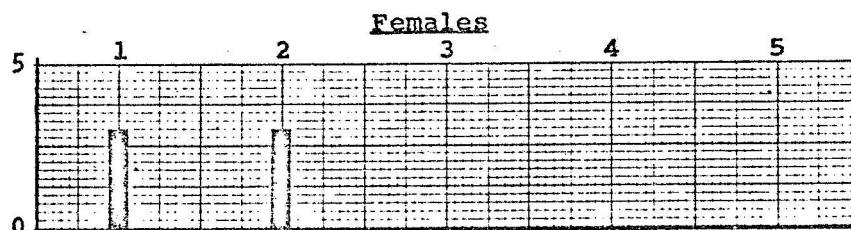
$\bar{M} = 3.30$
S.D. = 1.34



$\bar{M} = 2.50$
S.D. = .89



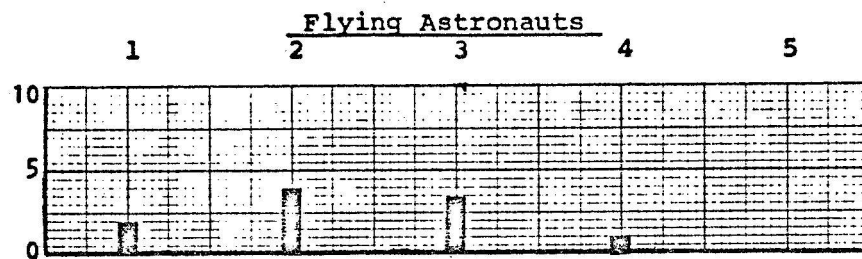
$\bar{M} = 2.44$
S.D. = 1.14



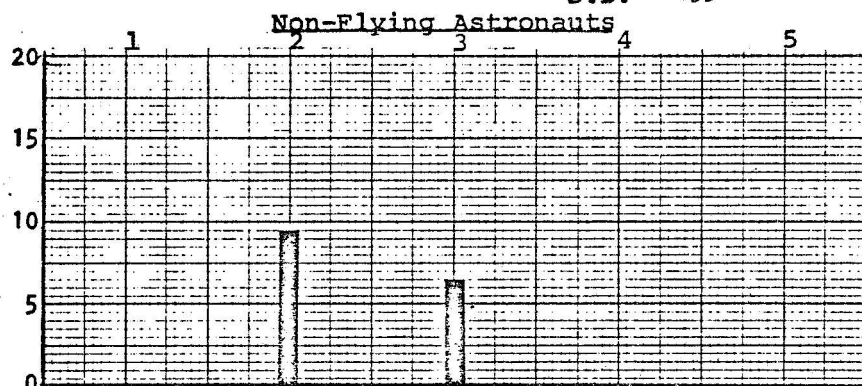
$\bar{M} = 1.50$
S.D. = .55

Figure 15A. Hair Cleaning: Response to Question 16

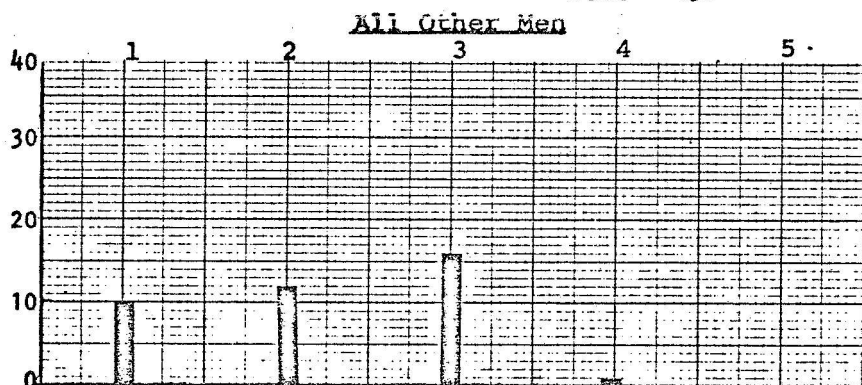
QUESTION: 21-A dry hair wash (chemical) is as desirable as a "wet" one.



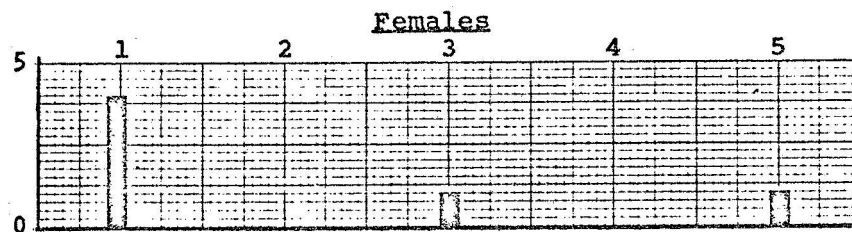
$\bar{M} = 2.30$
S.D. = .95



$\bar{M} = 2.44$
S.D. = .51



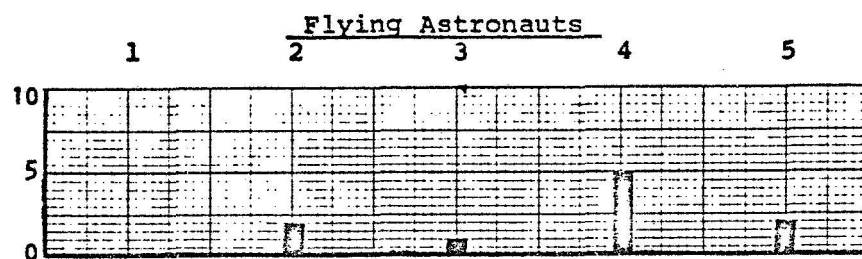
$\bar{M} = 2.21$
S.D. = .86



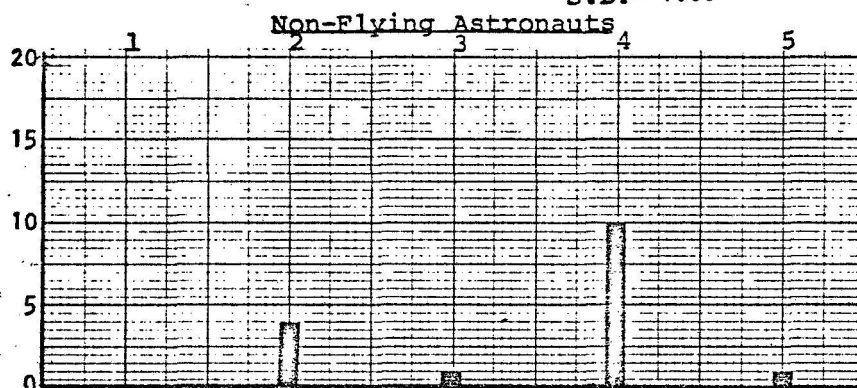
$\bar{M} = 2.00$
S.D. = 1.67

Figure 16A. Hair Cleaning: Response to Question 21

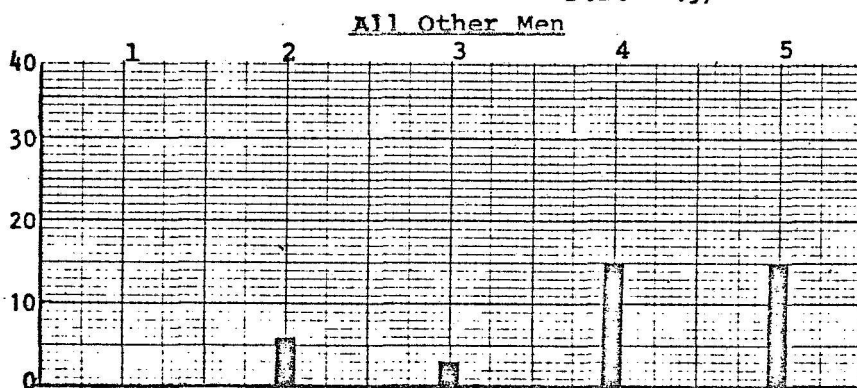
QUESTION: 26-I feel I should wash my hair approximately once a week.



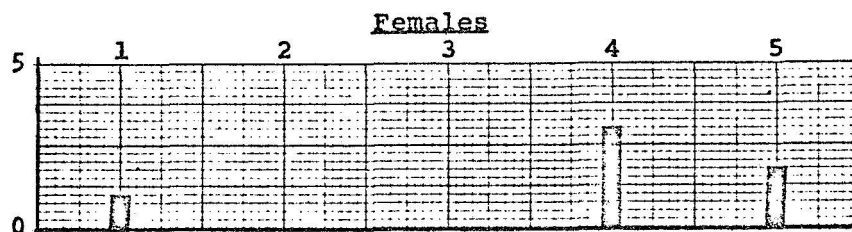
$\bar{M} = 3.70$
S.D. = 1.06



$\bar{M} = 3.50$
S.D. = .97



$\bar{M} = 4.00$
S.D. = 1.05



$\bar{M} = 3.83$
S.D. = 1.47

Figure 17A. Hair Cleaning: Response to Question 26

QUESTION: 31-If I do not wash my hair often enough, it becomes oily and uncomfortable.

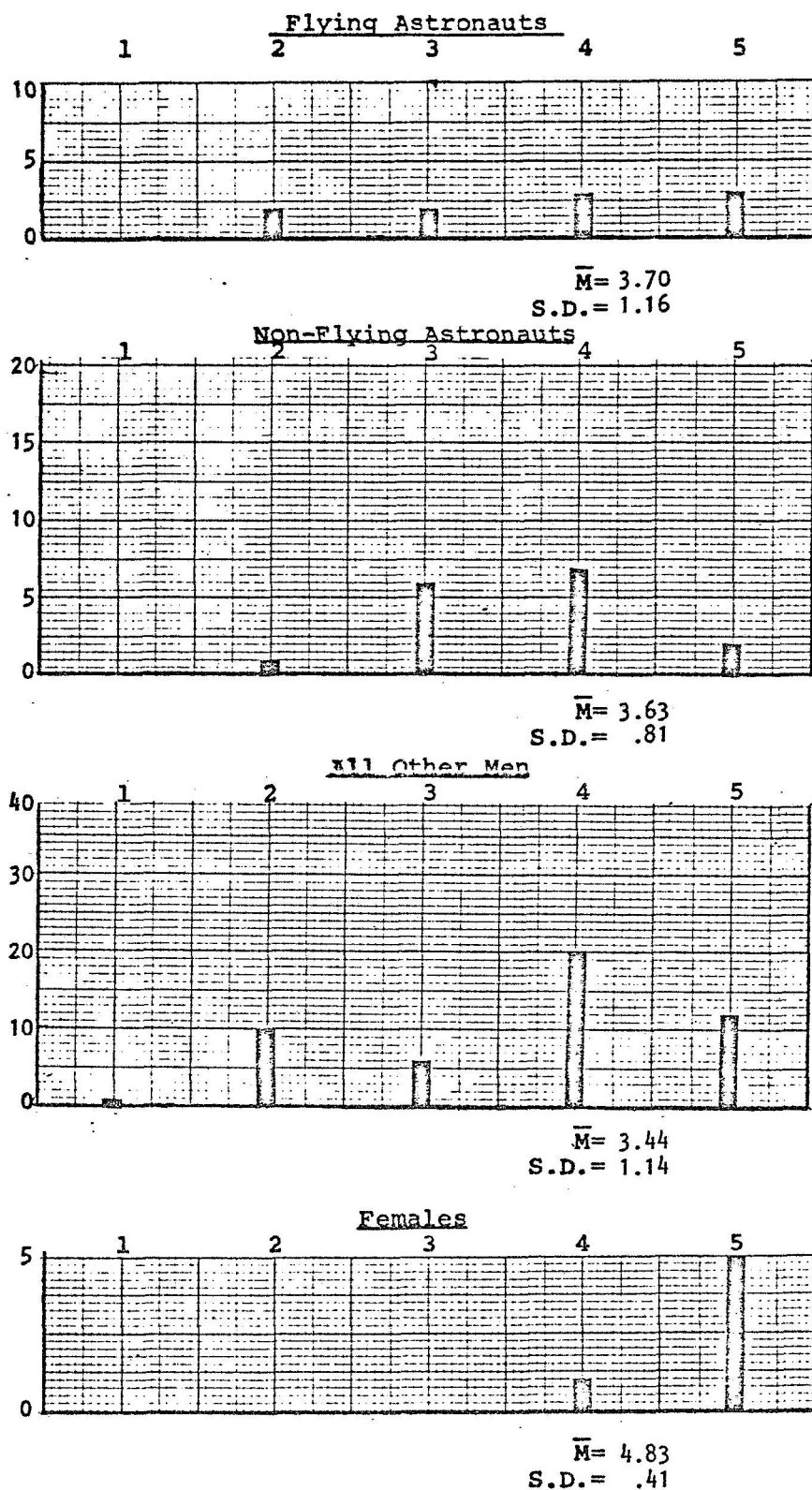
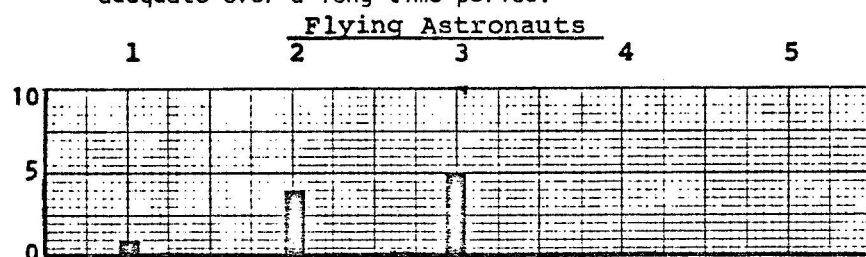
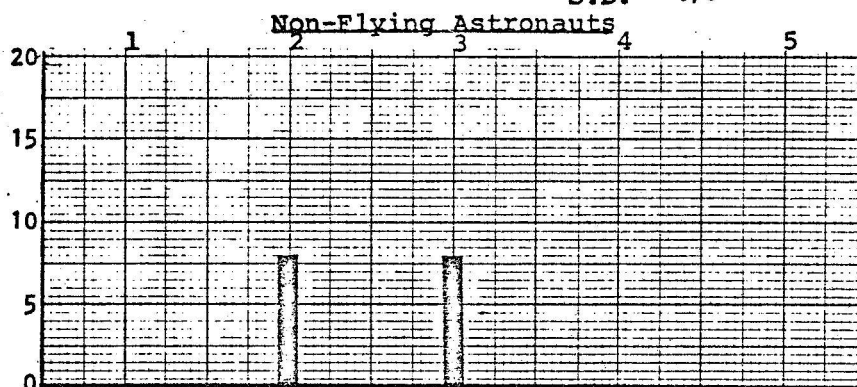


Figure 18A. Hair Cleaning: Response to Question 31

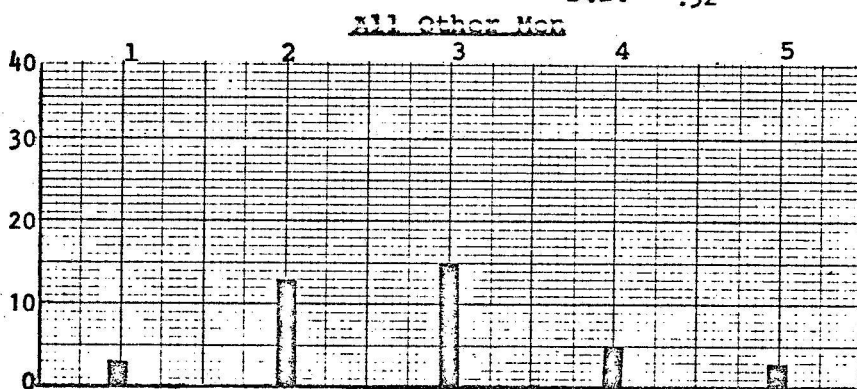
QUESTION: 36-1 would find a "wet" or "dry" (chemical) wash for my hair, equally adequate over a long time period.



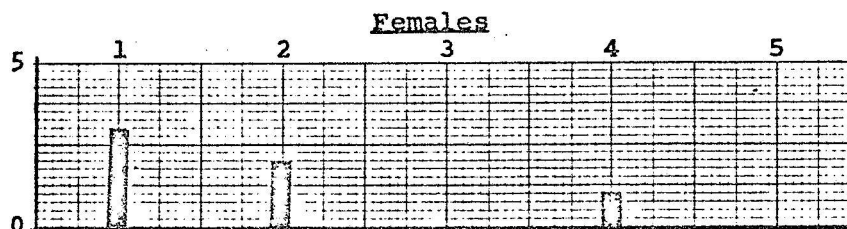
$\bar{M} = 2.40$
S.D. = .70



$\bar{M} = 2.50$
S.D. = .52



$\bar{M} = 2.80$
S.D. = 1.03



$\bar{M} = 1.83$
S.D. = 1.17

Figure 19A. Hair Cleaning: Response to Question 36

QUESTION: 41-If I do not wash my hair often enough, it begins to have an odor.

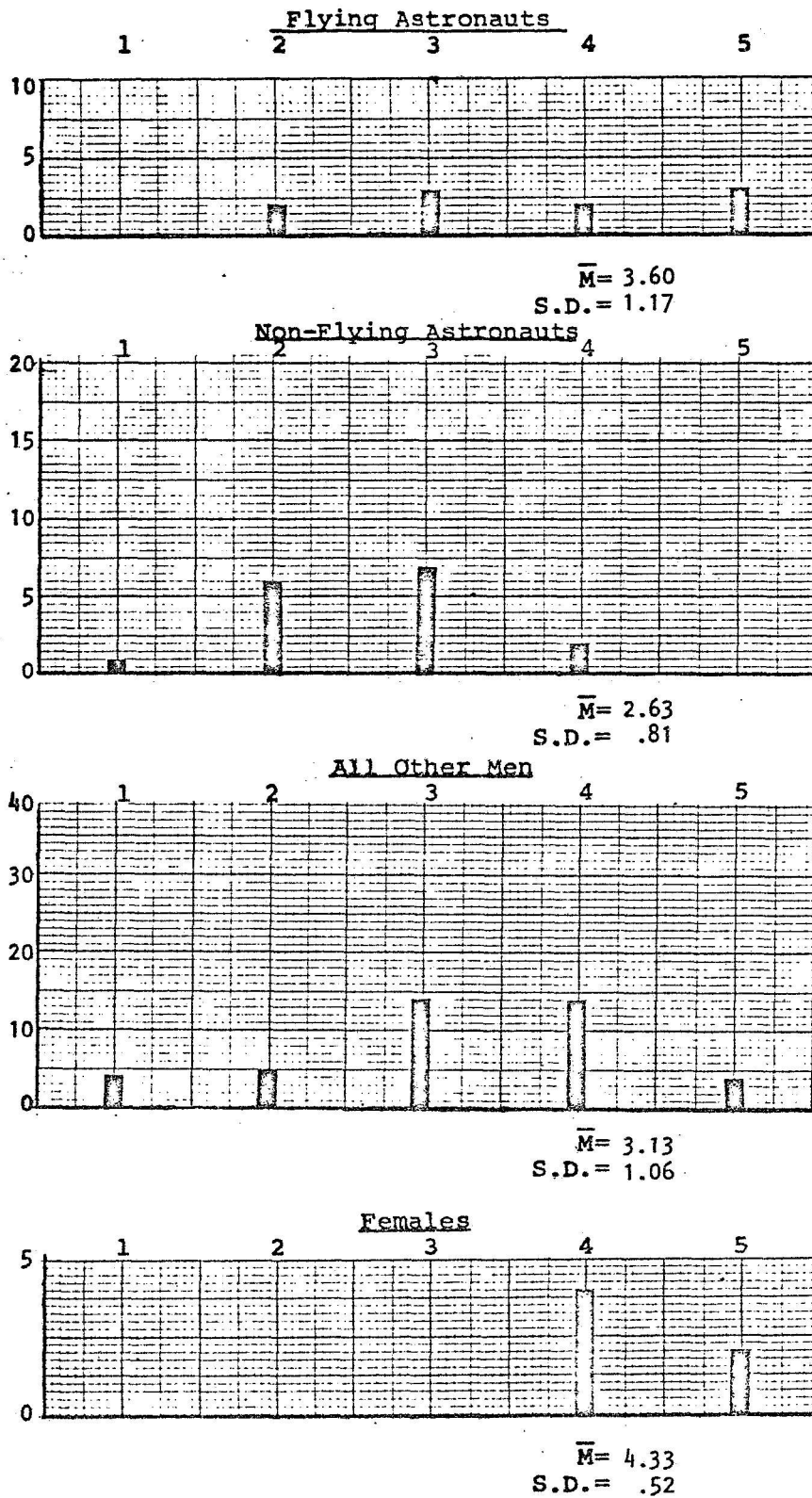


Figure 20A. Hair Cleaning: Response to Question 41

QUESTION: 46-I feel I should wash my hair approximately twice a week.

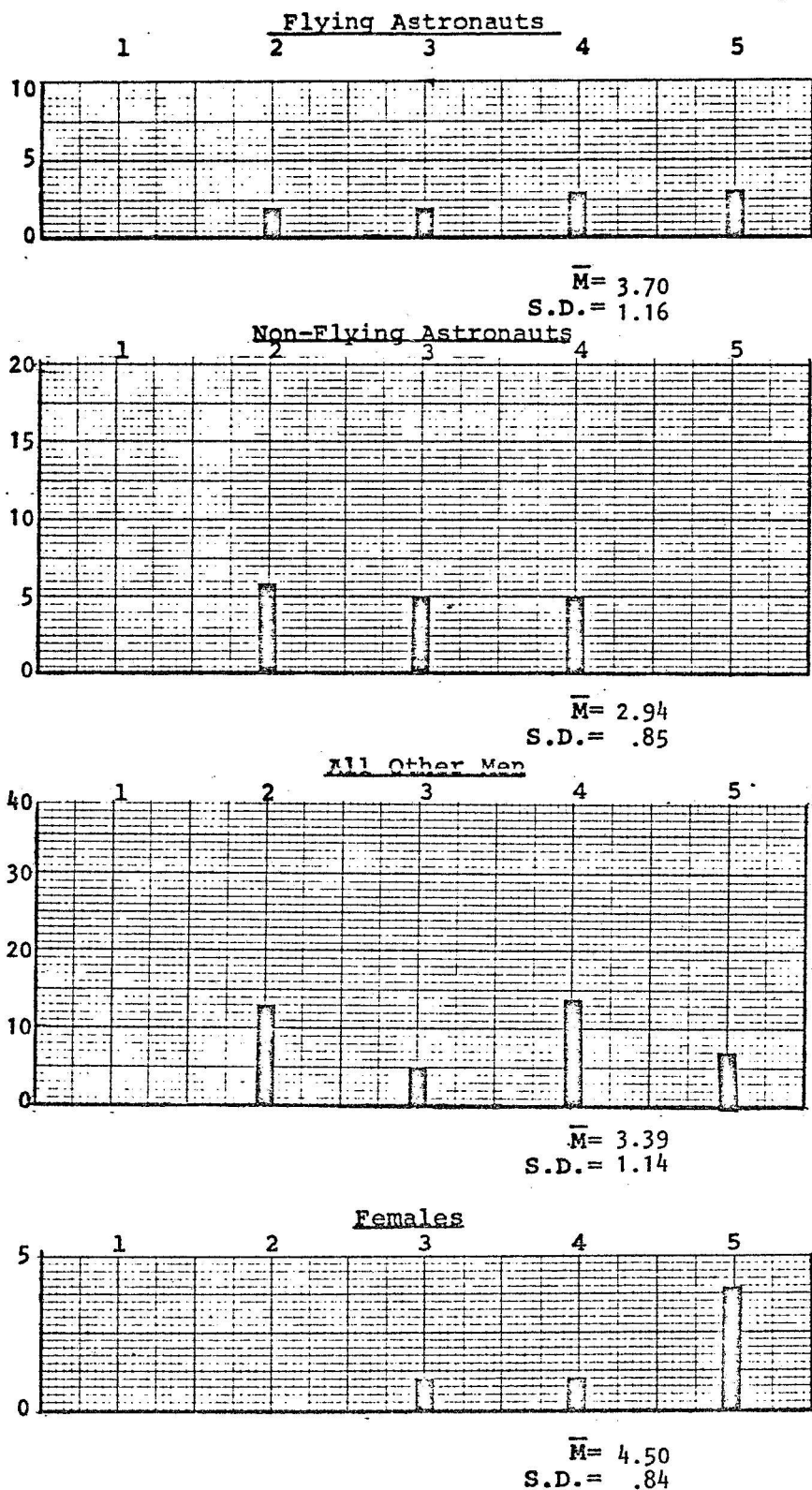


Figure 21A. Hair Cleaning: Response to Question 46

- Clothing Care

Table 5A indicates that the subjects generally desire variety in their clothing (item 2). While they don't feel that unironed clothes are necessarily uncomfortable (item 12), they appear to enjoy wearing ironed clothes (item 32). They believe that their clothing must be cleaned after they wear it for several days (item 22), even though they can generally wear used or soiled clothes (item 42).

TABLE 5A. ANALYSIS OF CLOTHING CARE DATA
FOR ALL MALE SUBJECTS

Score	Test Item				
	2	12	22	32	42
5	7	2	17	9	3
4	26	4	33	32	20
3	25	11	3	21	7
2	5	25	16	8	32
1	3	29	2	4	9

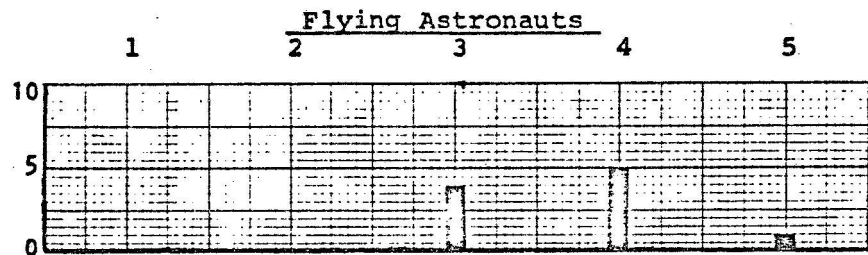
- Physical Appearance

The subjects are concerned with their own physical appearance both as a personal (item 35) and general (item 45) need, and as it effects their feelings of well-being (item 15). They tend to judge others to some extent by their appearance (item 25), but are evenly divided, or are neutral, in equating cleanliness with religious or moral virtues (item 5). This data appears in Table 6A.

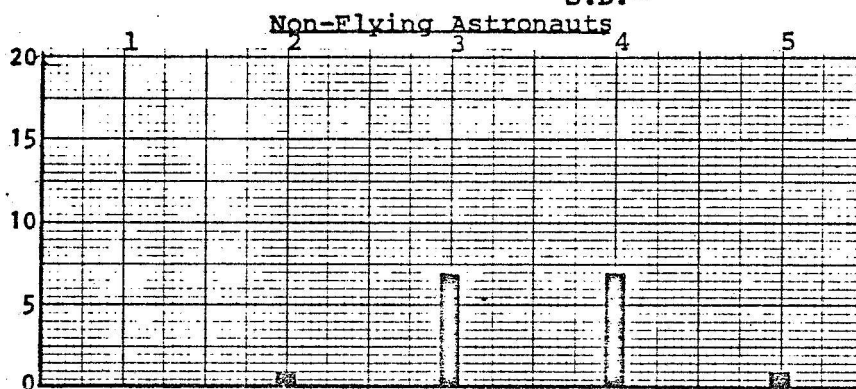
TABLE 6A. ANALYSIS OF PHYSICAL APPEARANCE DATA
FOR ALL MALE SUBJECTS

Score	Test Item				
	5	15	25	35	45
5	10	30	13	24	11
4	14	35	26	40	22
3	23	6	12	5	22
2	14	0	16	1	14
1	10	0	4	1	2

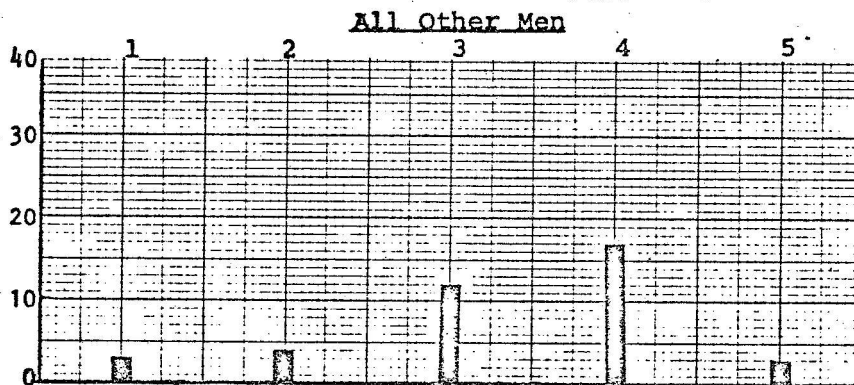
QUESTION: 2-I enjoy variety in my clothing styles.



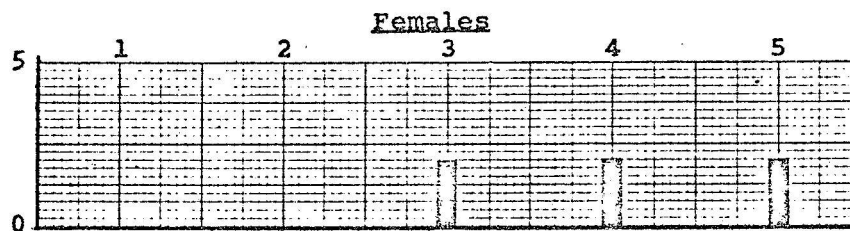
$\bar{M} = 3.70$
S.D. = .68



$\bar{M} = 4.25$
S.D. = 1.13



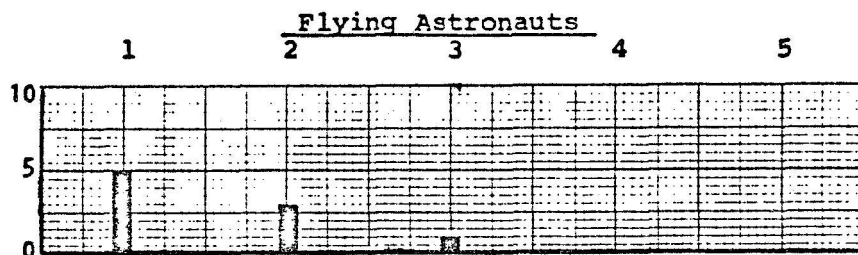
$\bar{M} = 3.33$
S.D. = 1.03



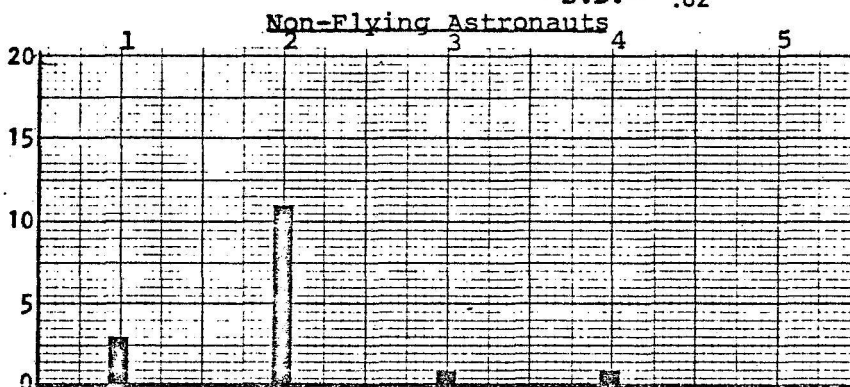
$\bar{M} = 4.00$
S.D. = .89

Figure 22A. Clothing Care: Response to Question 2

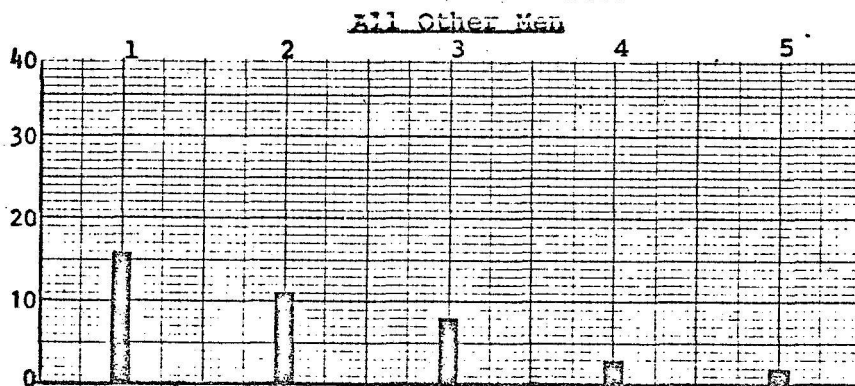
QUESTION: 12-Wearing unironed clothing is uncomfortable.



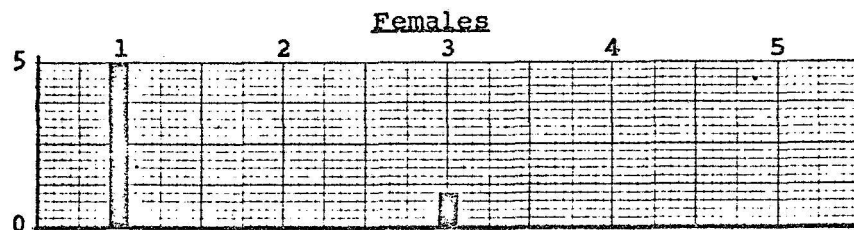
$\bar{M} = 1.70$
S.D. = .82



$\bar{M} = 2.00$
S.D. = .73



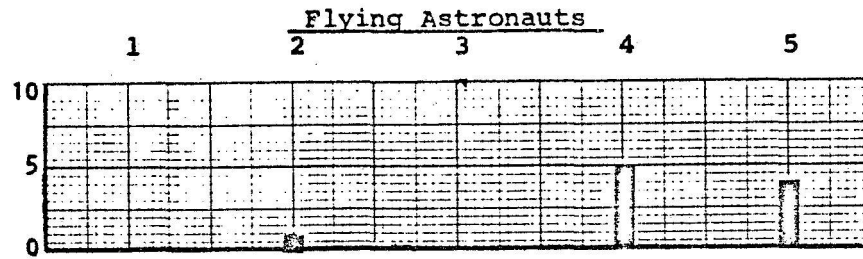
$\bar{M} = 2.03$
S.D. = 1.09



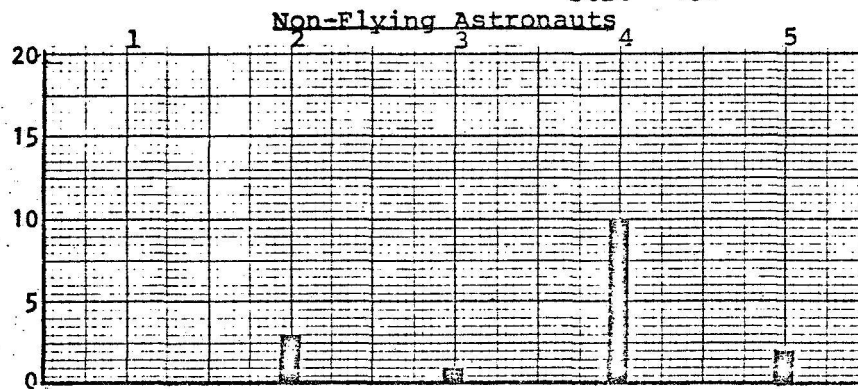
$\bar{M} = 1.33$
S.D. = .82

Figure 23A. Clothing Care: Response to Question 12

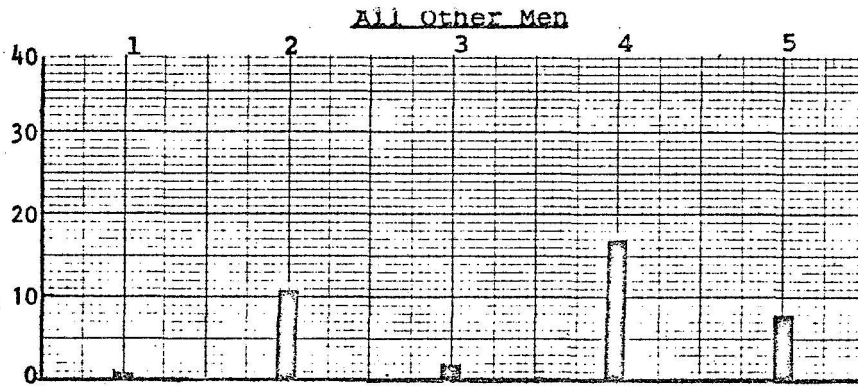
QUESTION: 22-After several days of wear, my clothing must be cleaned.



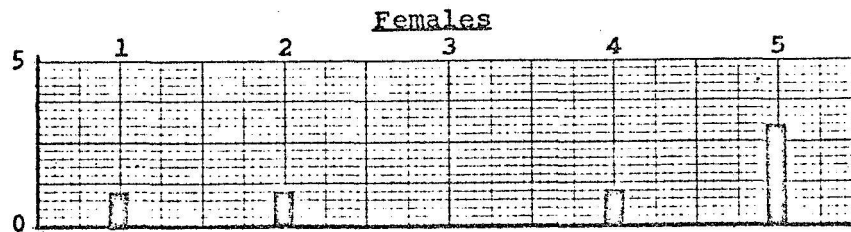
$\bar{M} = 4.20$
S.D. = .92



$\bar{M} = 3.69$
S.D. = .95



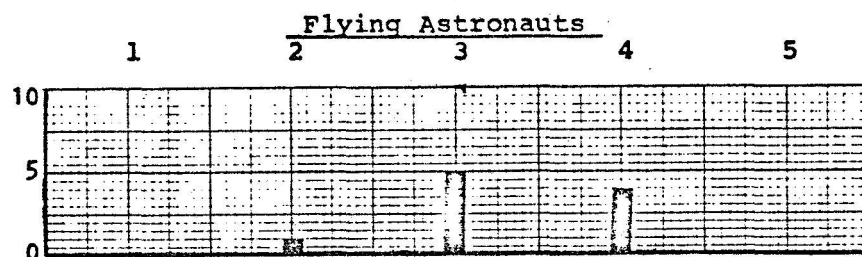
$\bar{M} = 3.51$
S.D. = 1.19



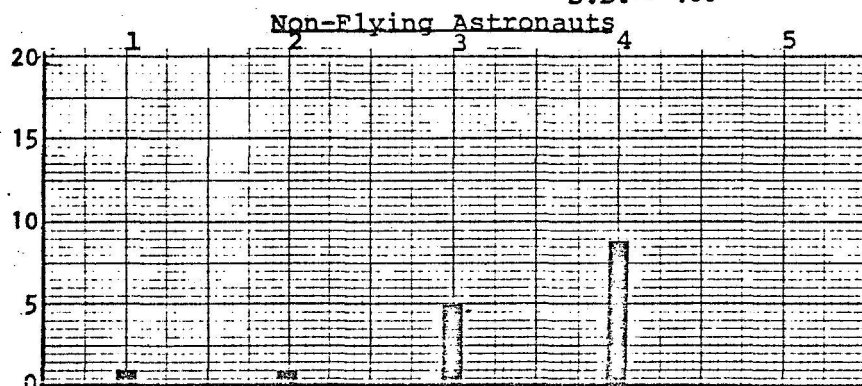
$\bar{M} = 3.67$
S.D. = 1.75

Figure 24A. Clothing Care: Response to Question 22

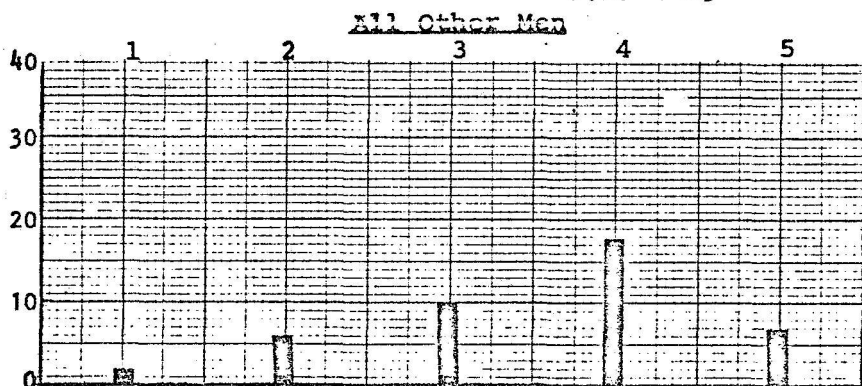
QUESTION: 32-1 enjoy wearing clothing that has been ironed.



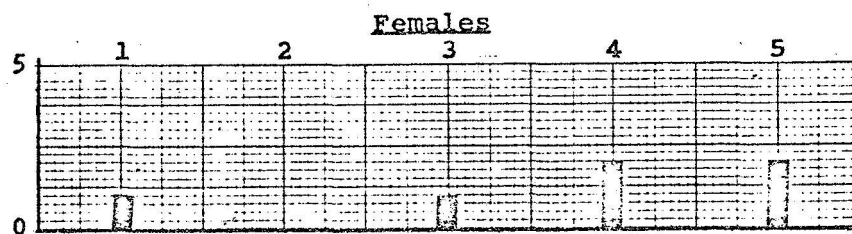
$\bar{M} = 3.30$
S.D. = .68



$\bar{M} = 3.38$
S.D. = .89



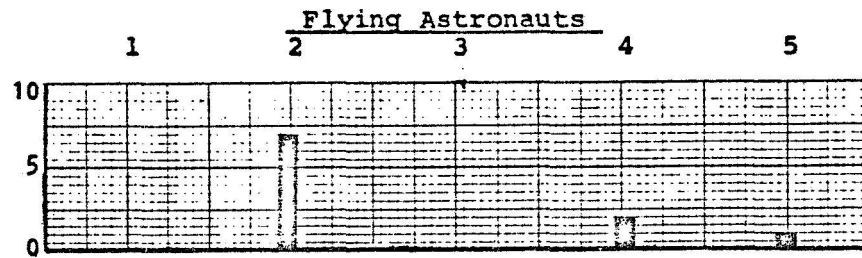
$\bar{M} = 3.69$
S.D. = .95



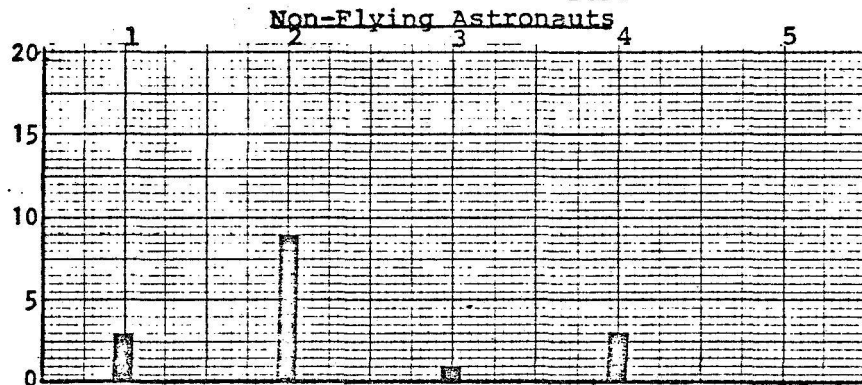
$\bar{M} = 3.67$
S.D. = 1.51

Figure 25A. Clothing Care: Response to Question 32

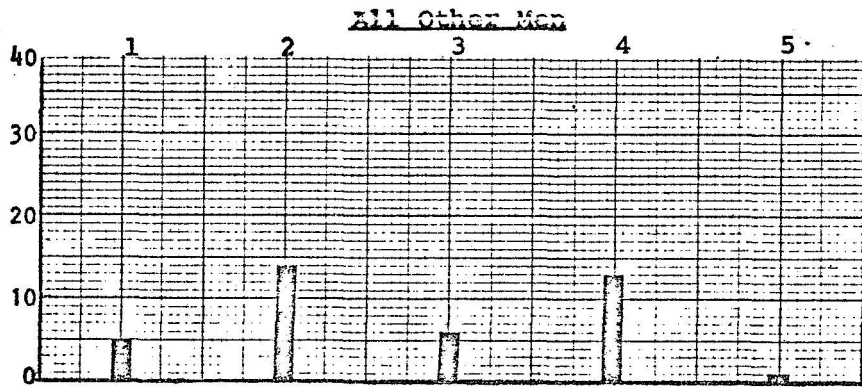
QUESTION: 42-1 can not wear clothes that I believe are "dirty".



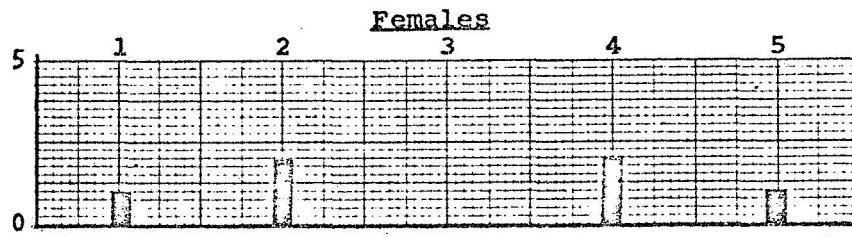
$\bar{M} = 2.70$
S.D. = 1.16



$\bar{M} = 2.25$
S.D. = 1.00



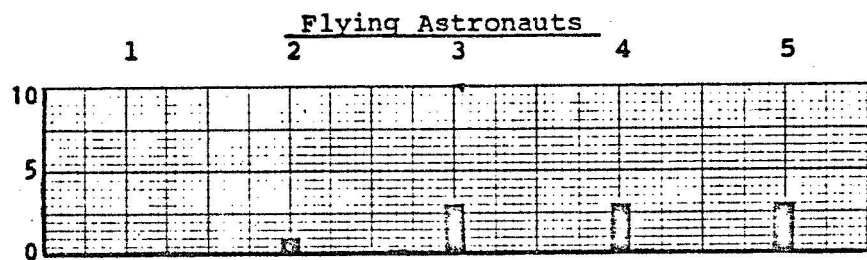
$\bar{M} = 2.77$
S.D. = 1.14



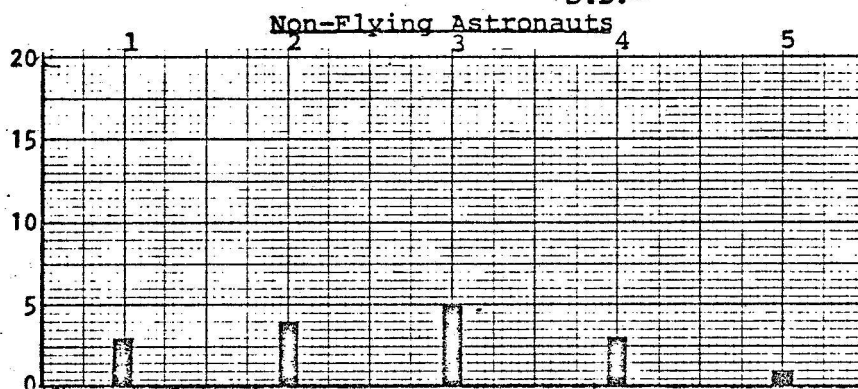
$\bar{M} = 3.00$
S.D. = 1.55

Figure 26A. Clothing Care: Response to Question 42

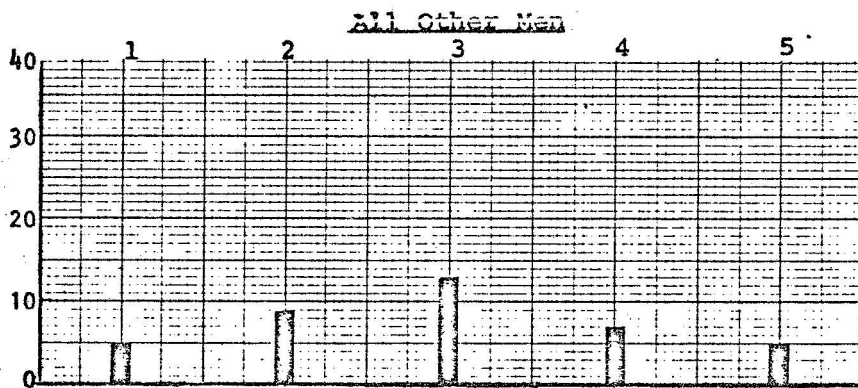
QUESTION: 5-The old saying: "Cleanliness is next to Godliness" is true.



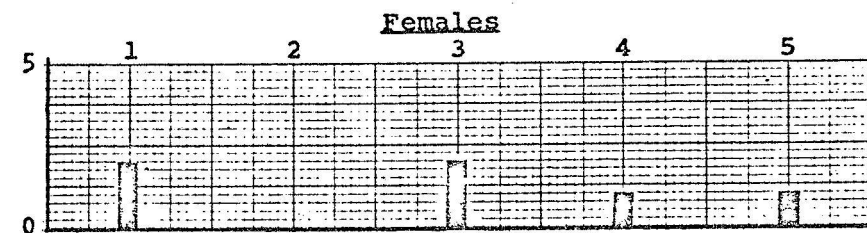
$\bar{M} = 3.80$
S.D. = 1.03



$\bar{M} = 2.69$
S.D. = 1.20



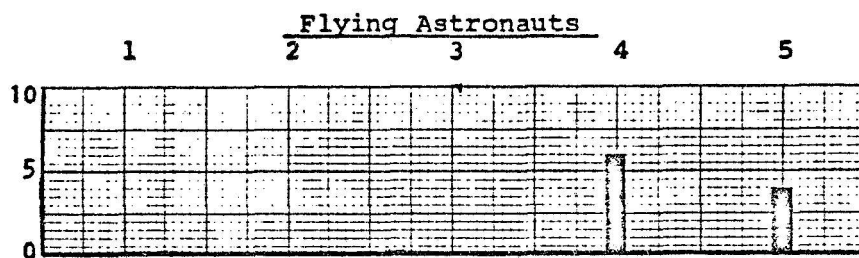
$\bar{M} = 2.95$
S.D. = 1.21



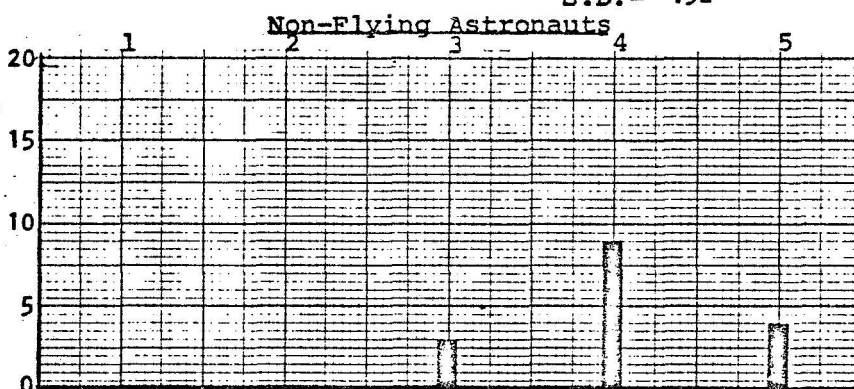
$\bar{M} = 2.83$
S.D. = 1.60

Figure 27A. Physical Appearance: Response to Question 5

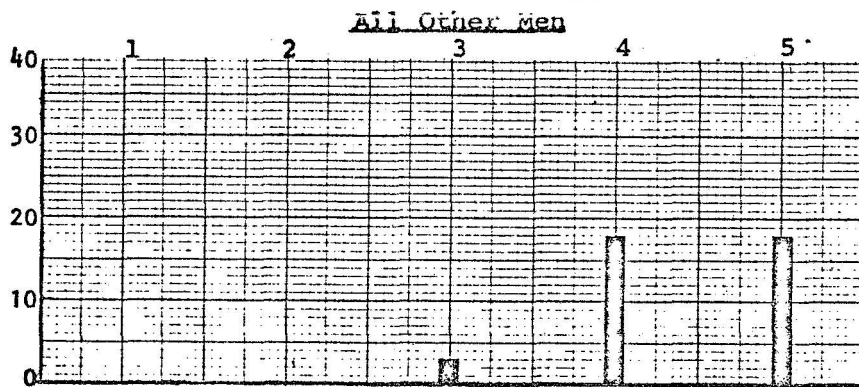
QUESTION: 15-I feel better when I present a good physical appearance.



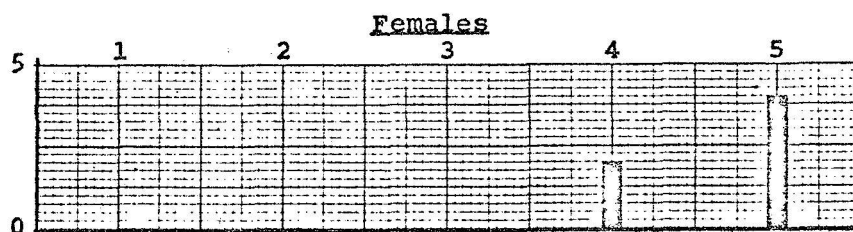
$\bar{M} = 4.40$
S.D. = .52



$\bar{M} = 4.06$
S.D. = .68



$\bar{M} = 4.39$
S.D. = .63



$\bar{M} = 4.67$
S.D. = .52

Figure 28A. Physical Appearance: Response to Question 15

QUESTION: 25-You can tell a lot about a person by his physical appearance.

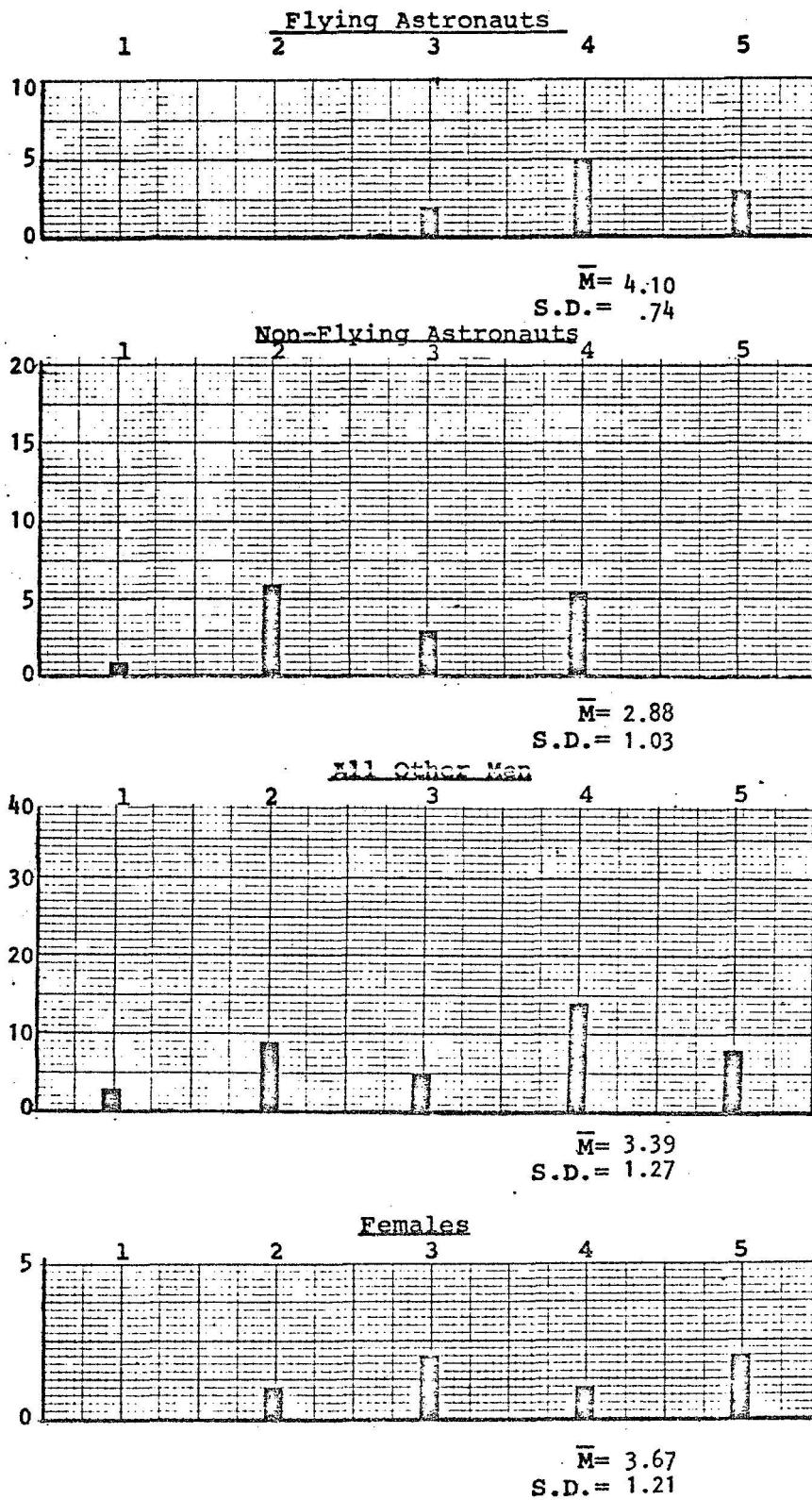


Figure 29A. Physical Appearance: Response to Question 25

QUESTION: 35-My physical appearance is important to me.

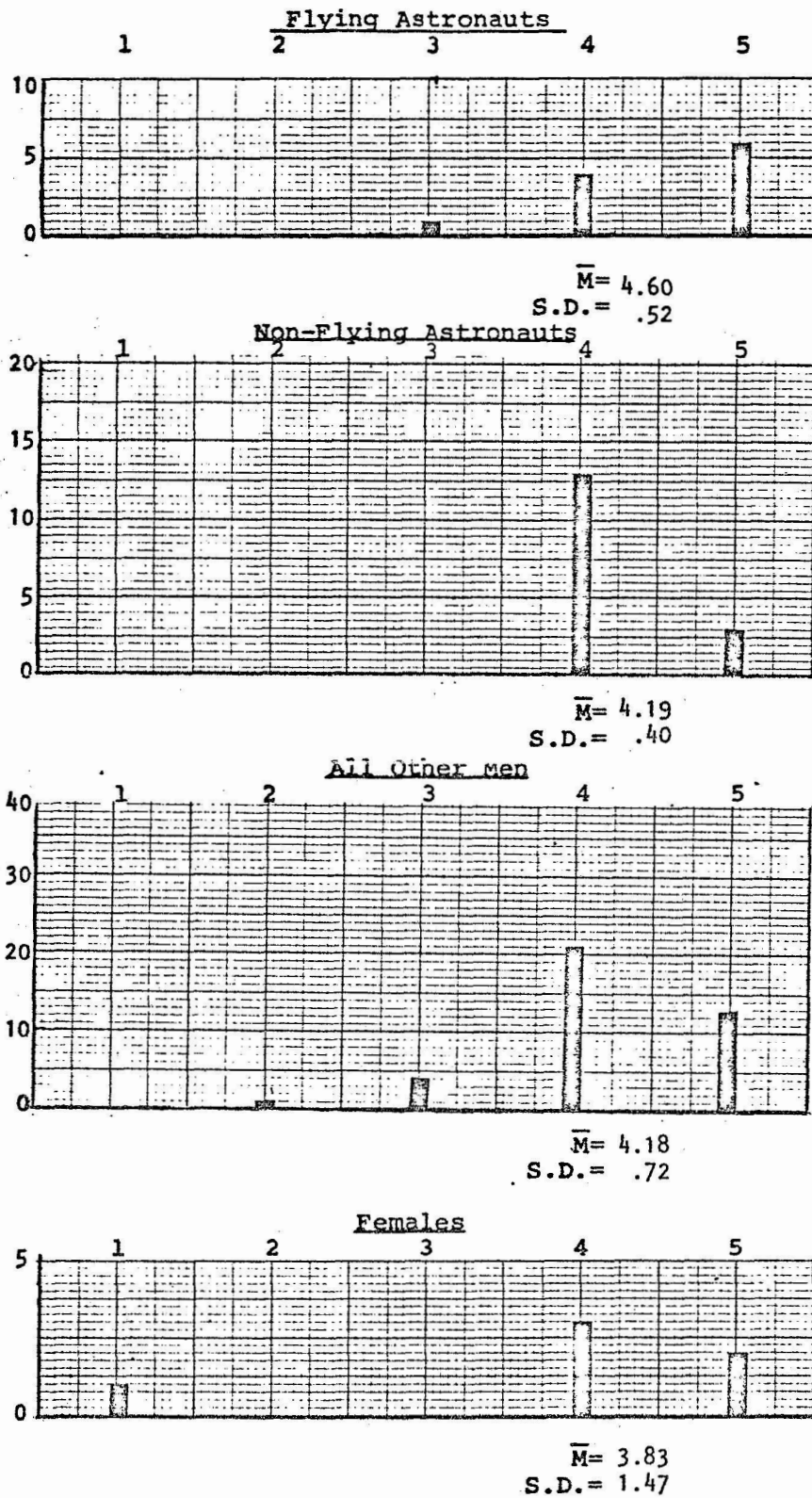
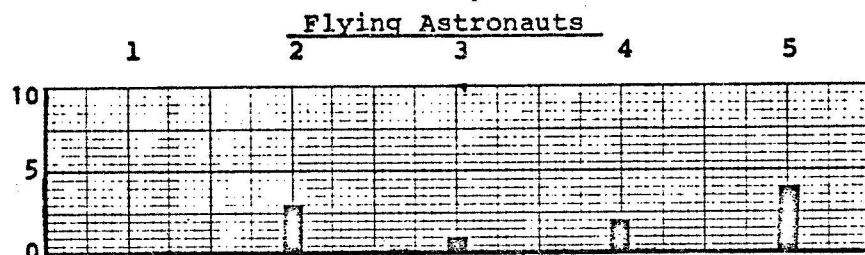
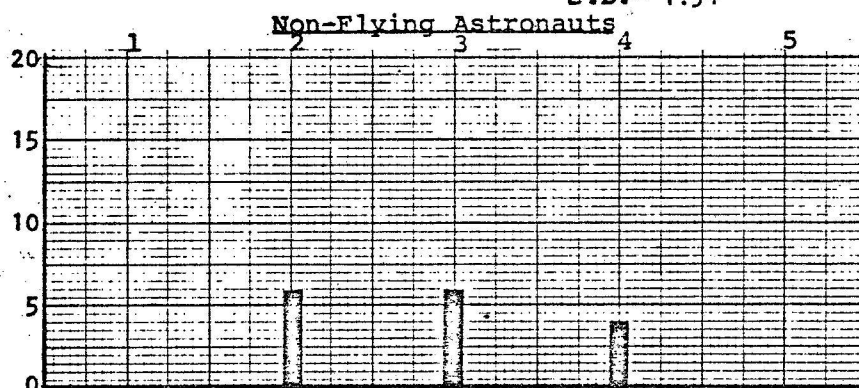


Figure 30A. Physical Appearance: Response to Question 35

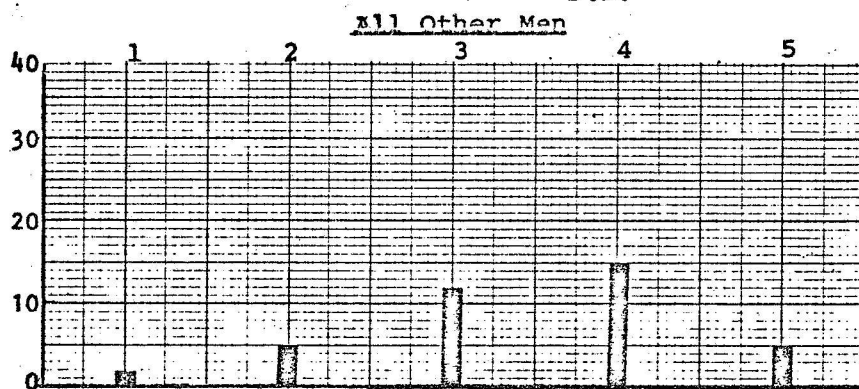
QUESTION: 45-An individual's physical appearance is extremely important.



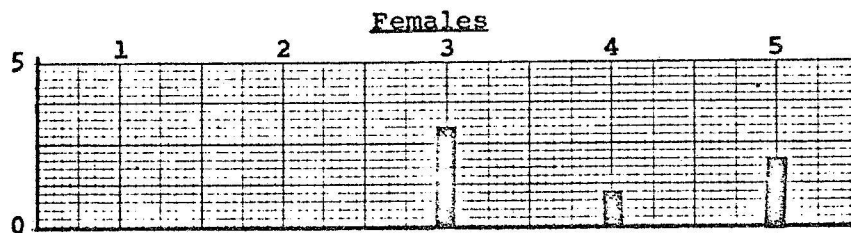
$\bar{M} = 3.70$
S.D. = 1.34



$\bar{M} = 2.88$
S.D. = .81



$\bar{M} = 3.41$
S.D. = 1.04



$\bar{M} = 3.83$
S.D. = .98

Figure 31A. Physical Appearance: Response to Question 45

• Facial Hair and Shaving .

Table 7A indicates that while the subject group enjoys feeling clean shaven (item 3), and tends to consider it necessary (item 50), they do not feel compelled to shave every day (item 20). They do not equate being unshaven with dirtiness (item 40). About as many subjects feel that stubble and beards are uncomfortable as do not (item 10).

TABLE 7A. ANALYSIS OF FACIAL HAIR AND SHAVING DATA
FOR ALL MALE SUBJECTS

Score	Test Item				
	10	20	30	40	50
5	6	5	13	2	11
4	18	12	28	19	24
3	18	15	24	19	10
2	16	26	4	23	17
1	13	13	2	9	9

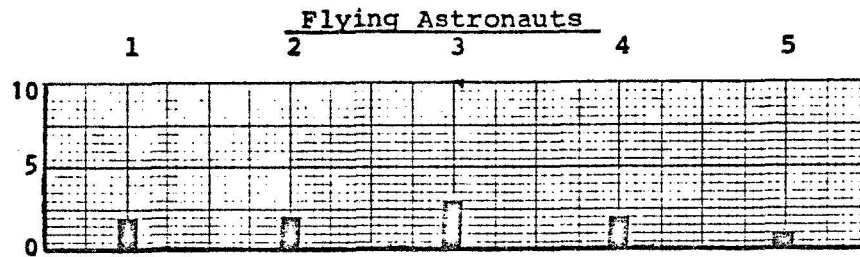
• Finger and Nail Care

The subjects tested dislike dirty nails (item 8) and find that dirty or ragged nails are uncomfortable (items 38 and 48). The subjects feel that once every two weeks is adequate for a manicure, although other alternatives were not presented (item 28). The subjects do not tend to use the appearance of someone else's hands and nails as a cue to how he feels about himself. This data is presented in Table 8A.

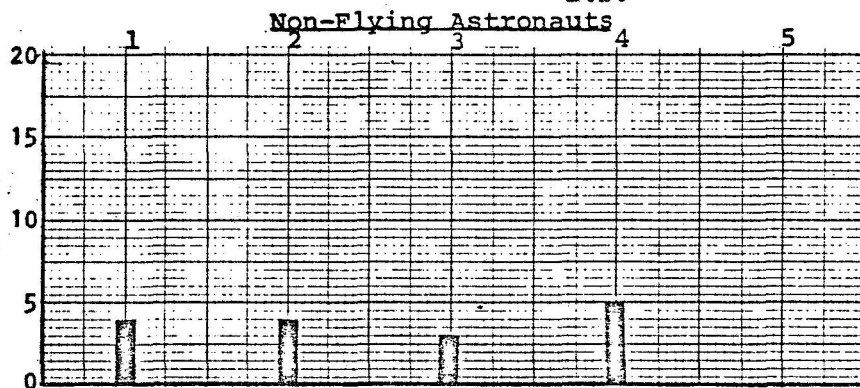
TABLE 8A. ANALYSIS OF FINGER AND NAIL CARE DATA
FOR ALL MALE SUBJECTS

Score	Test Item				
	8	18	28	38	48
5	11	2	7	26	15
4	34	14	22	25	29
3	13	29	21	11	15
2	11	17	14	7	9
1	2	9	7	2	3

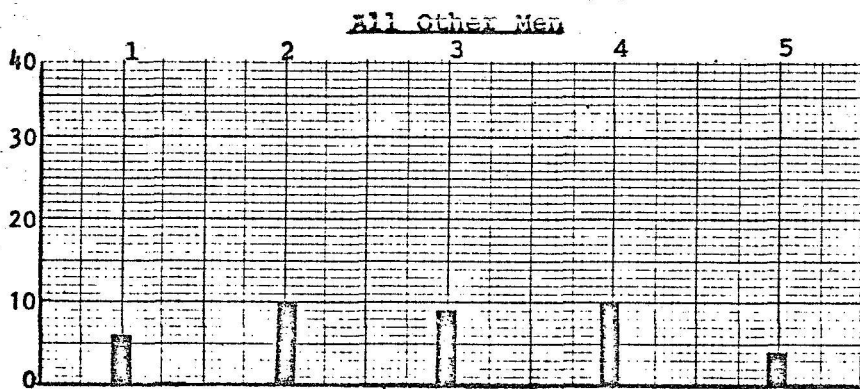
QUESTION: 10-Stubble or beards are uncomfortable to me.



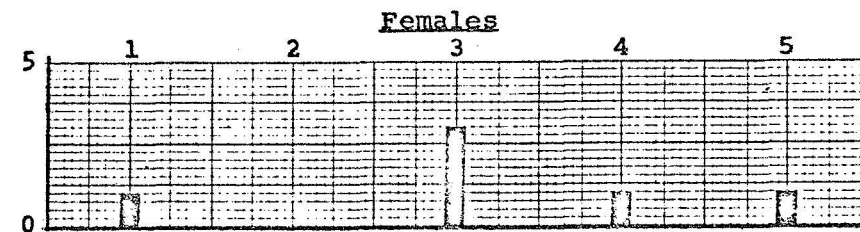
$\bar{M} = 2.80$
S.D. = 1.32



$\bar{M} = 2.56$
S.D. = 1.21



$\bar{M} = 2.90$
S.D. = 1.25



$\bar{M} = 3.17$
S.D. = 1.33

Figure 32A. Facial Hair and Shaving: Response to Question 10

QUESTION: 20-I feel I must shave at least once a day.

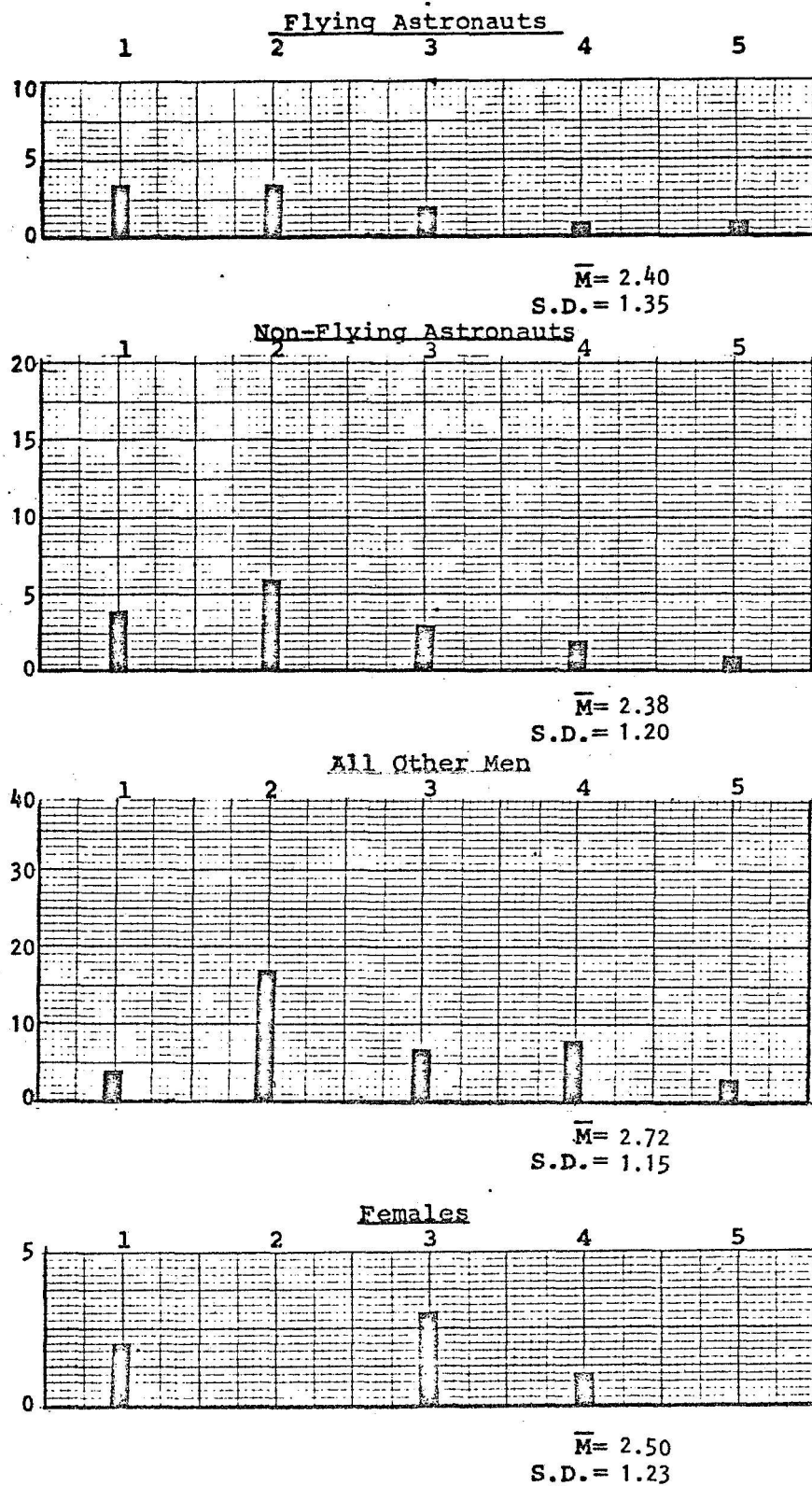
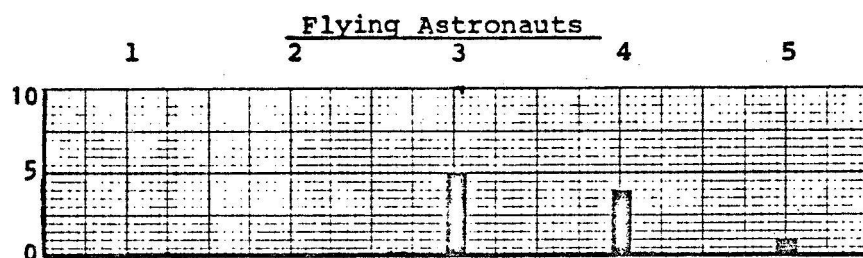
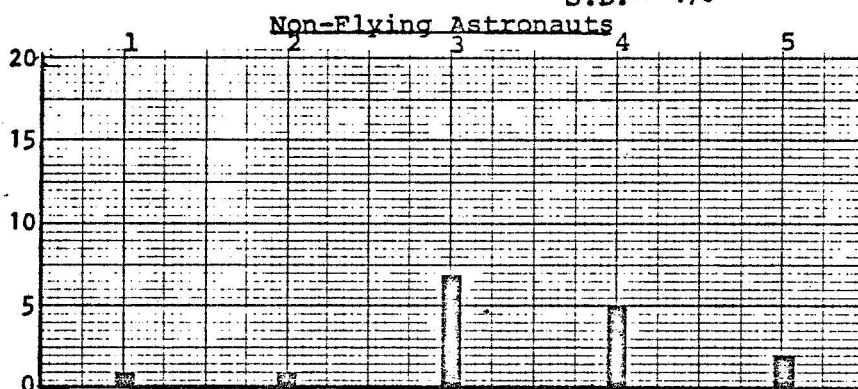


Figure 33A. Facial Hair and Shaving: Response to Question 20

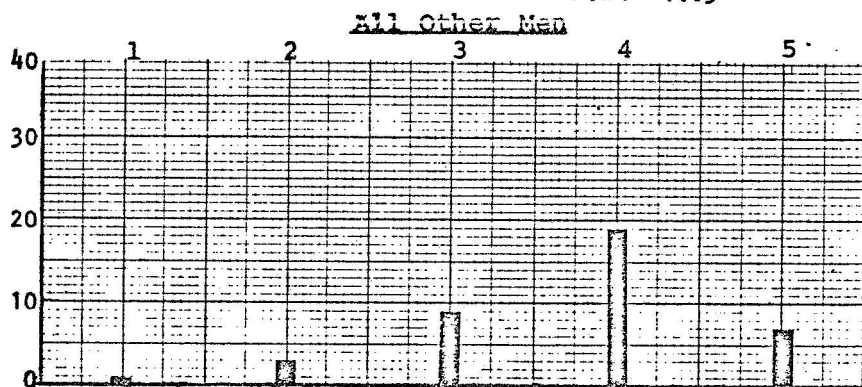
QUESTION: 30-1 enjoy being "clean" shaven.



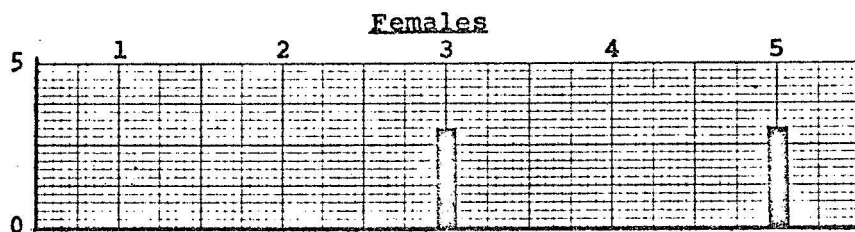
$\bar{M} = 3.60$
S.D. = .70



$\bar{M} = 3.38$
S.D. = 1.03



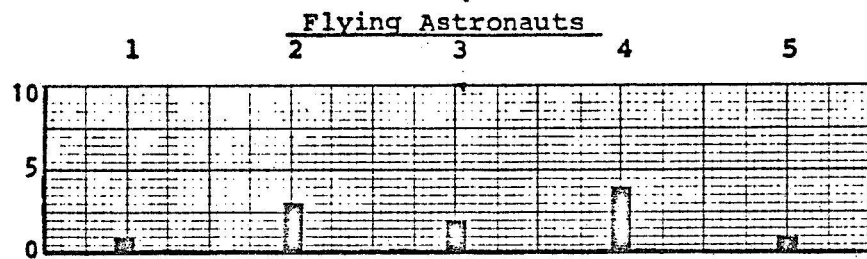
$\bar{M} = 3.72$
S.D. = .94



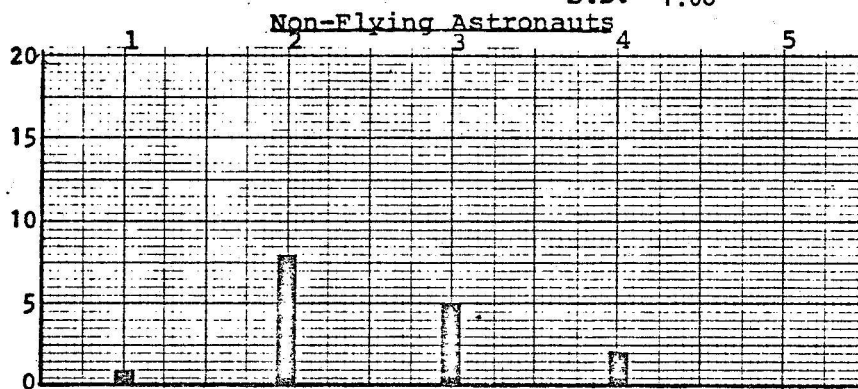
$\bar{M} = 4.00$
S.D. = 1.10

Figure 34A. Facial Hair and Shaving: Response to Question 30

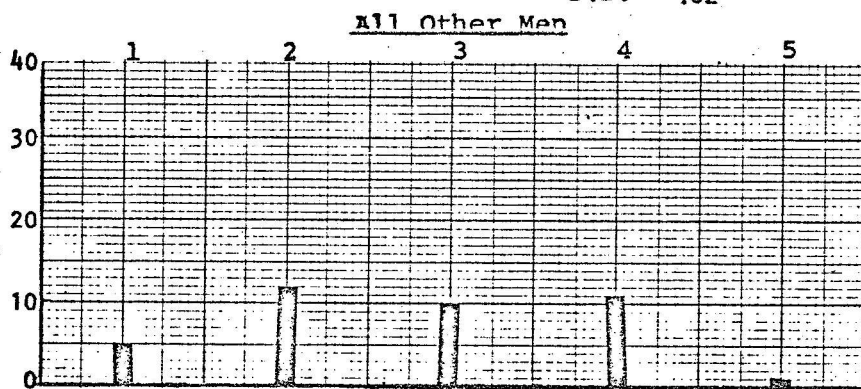
QUESTION: 40-Stubble or a beard makes a person look "dirty".



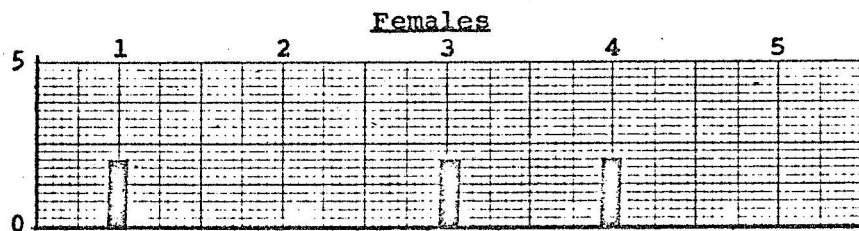
$\bar{M} = 3.30$
S.D. = 1.06



$\bar{M} = 2.50$
S.D. = .82



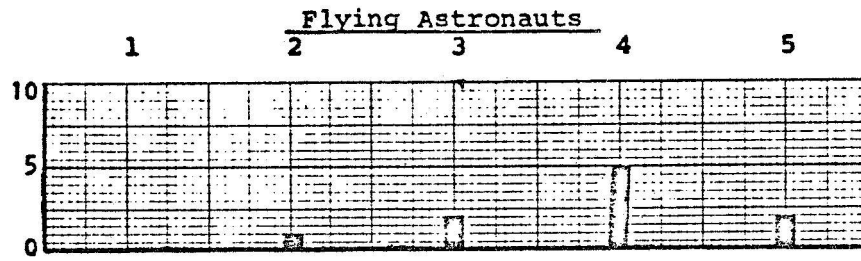
$\bar{M} = 2.77$
S.D. = 1.09



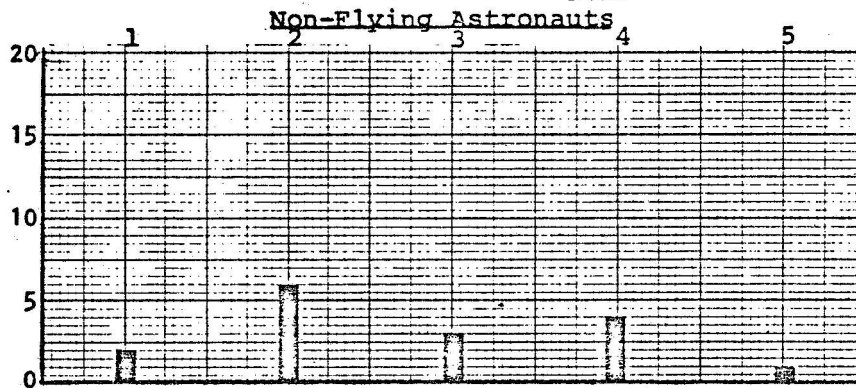
$\bar{M} = 2.67$
S.D. = 1.37

Figure 35A. Facial Hair and Shaving: Response to Question 40

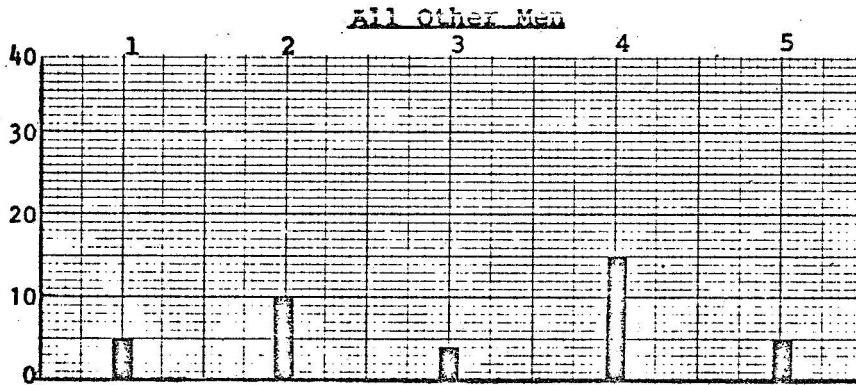
QUESTION: 50-1 find shaving necessary.



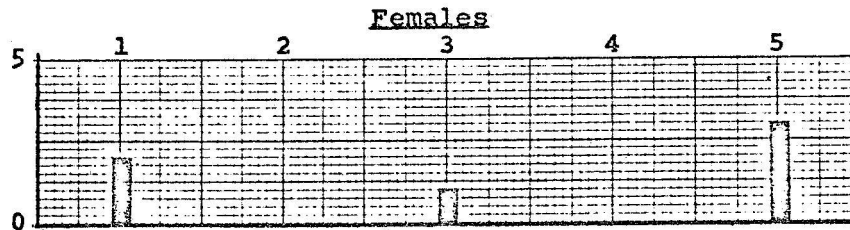
$\bar{M} = 3.80$
S.D. = .92



$\bar{M} = 2.75$
S.D. = 1.18



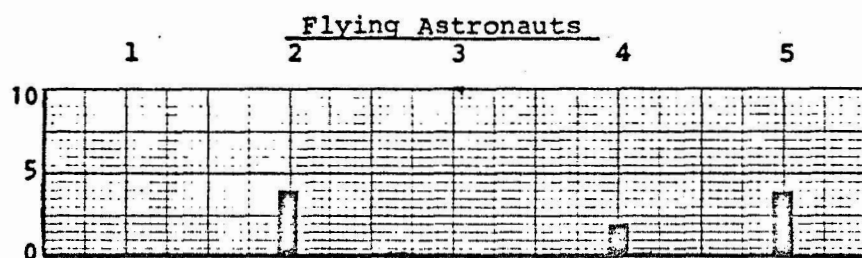
$\bar{M} = 3.13$
S.D. = 1.30



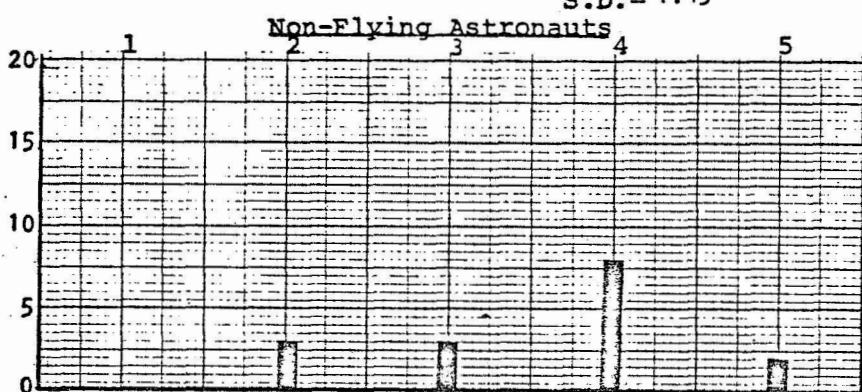
$\bar{M} = 3.33$
S.D. = 1.97

Figure 36A. Facial Hair and Shaving: Response to Question 50

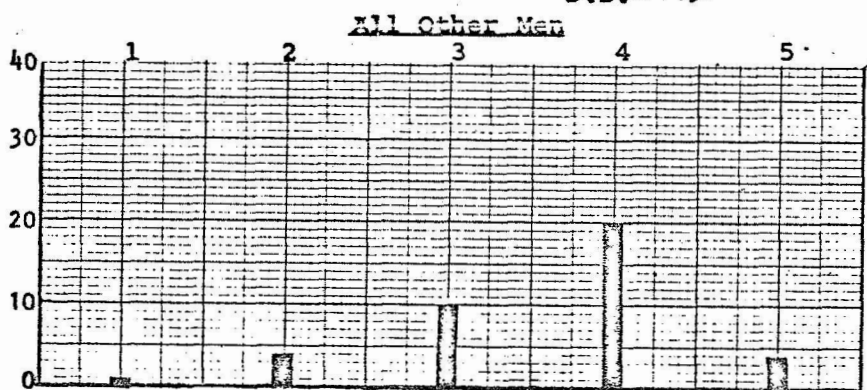
QUESTION: 8-Dirty nails "bother" me.



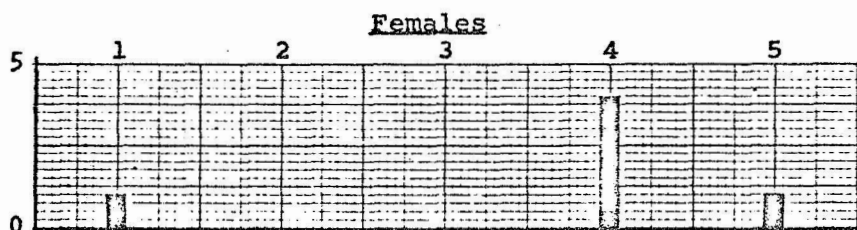
$\bar{M} = 3.60$
S.D. = 1.43



$\bar{M} = 3.56$
S.D. = .96



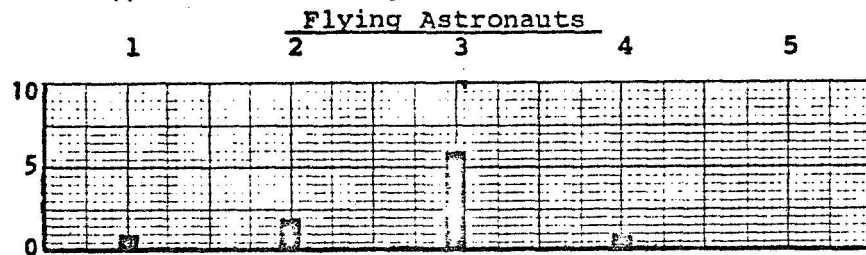
$\bar{M} = 3.56$
S.D. = .91



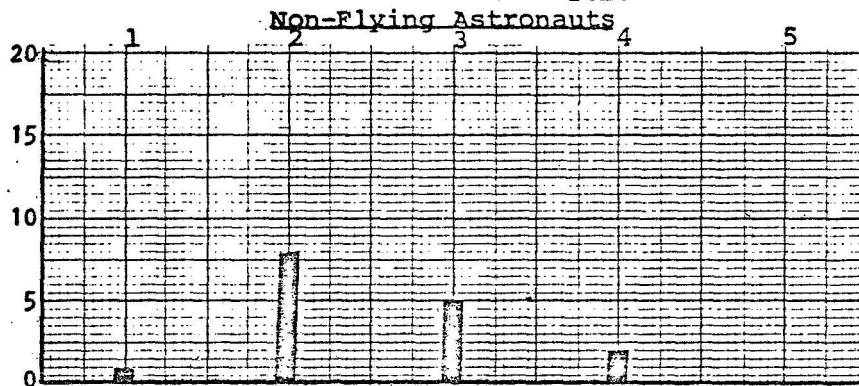
$\bar{M} = 3.67$
S.D. = 1.37

Figure 37A. Finger and Nail Care: Response to Question 8

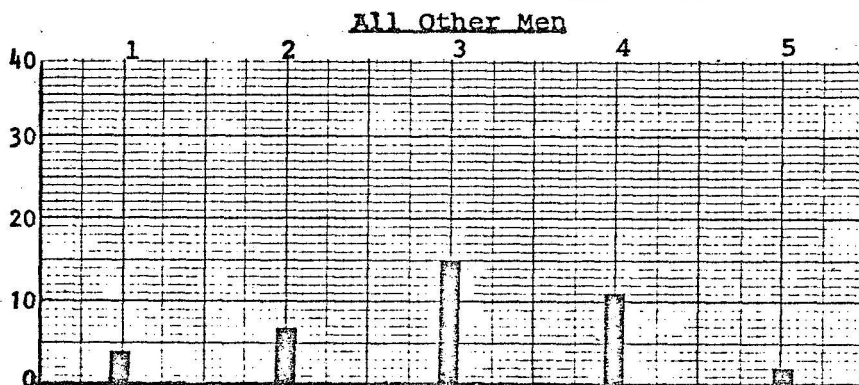
QUESTION: 18-1 can tell how a person feels about himself by how he cares for the appearance of his finger nails and hands.



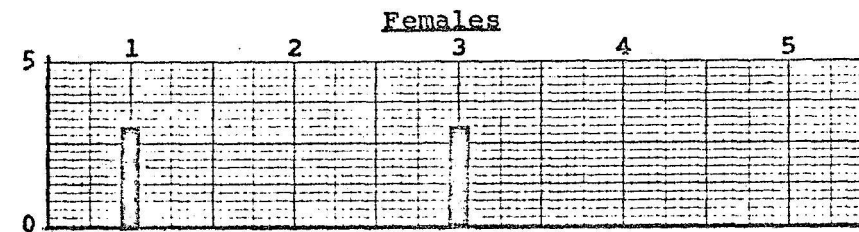
$\bar{M} = 2.70$
S.D. = .82



$\bar{M} = 2.50$
S.D. = .82



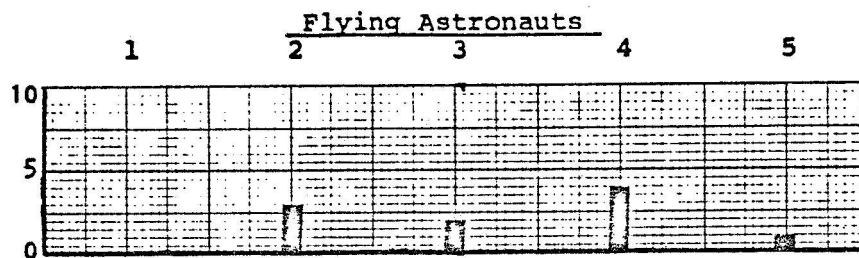
$\bar{M} = 3.00$
S.D. = 1.05



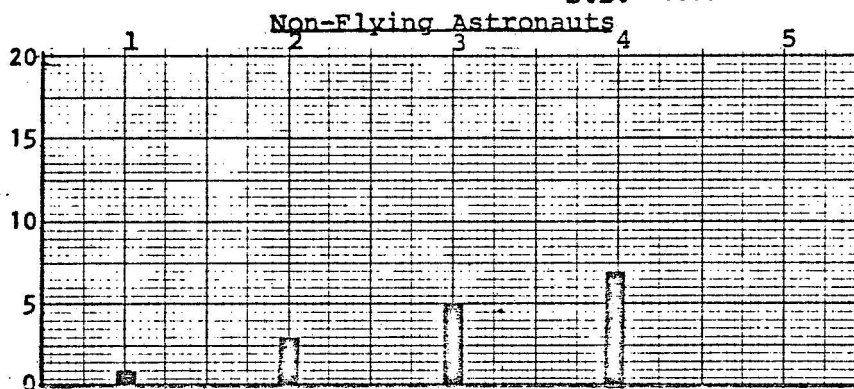
$\bar{M} = 2.00$
S.D. = 1.10

Figure 38A. Finger and Nail Care: Response to Question 18

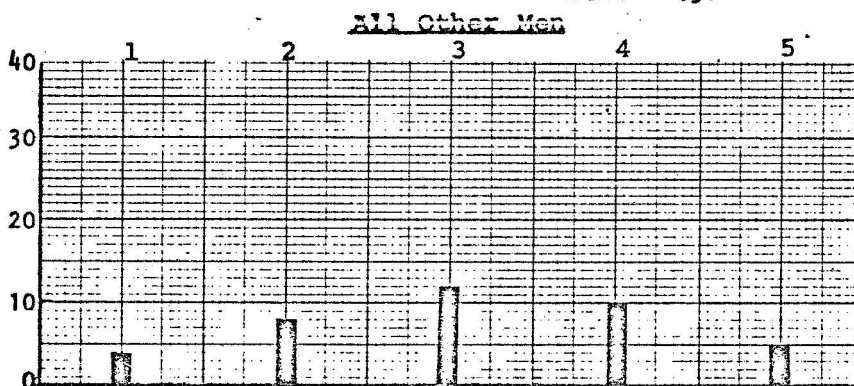
QUESTION: 28-I feel I should manicure my finger nails about once every two weeks.



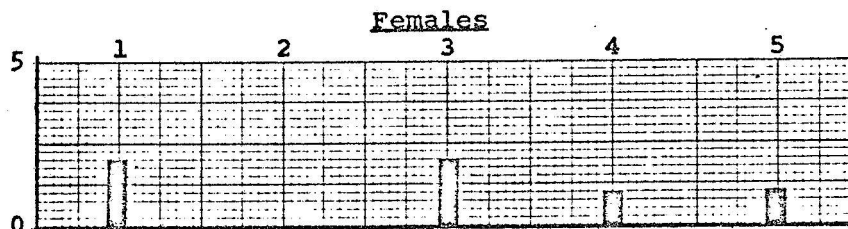
$\bar{M} = 3.30$
S.D. = 1.06



$\bar{M} = 3.13$
S.D. = .96



$\bar{M} = 3.10$
S.D. = 1.19



$\bar{M} = 2.83$
S.D. = 1.60

Figure 39A. Finger and Nail Care: Response to Question 28

QUESTION: 38-Ragged fingernails are "uncomfortable".

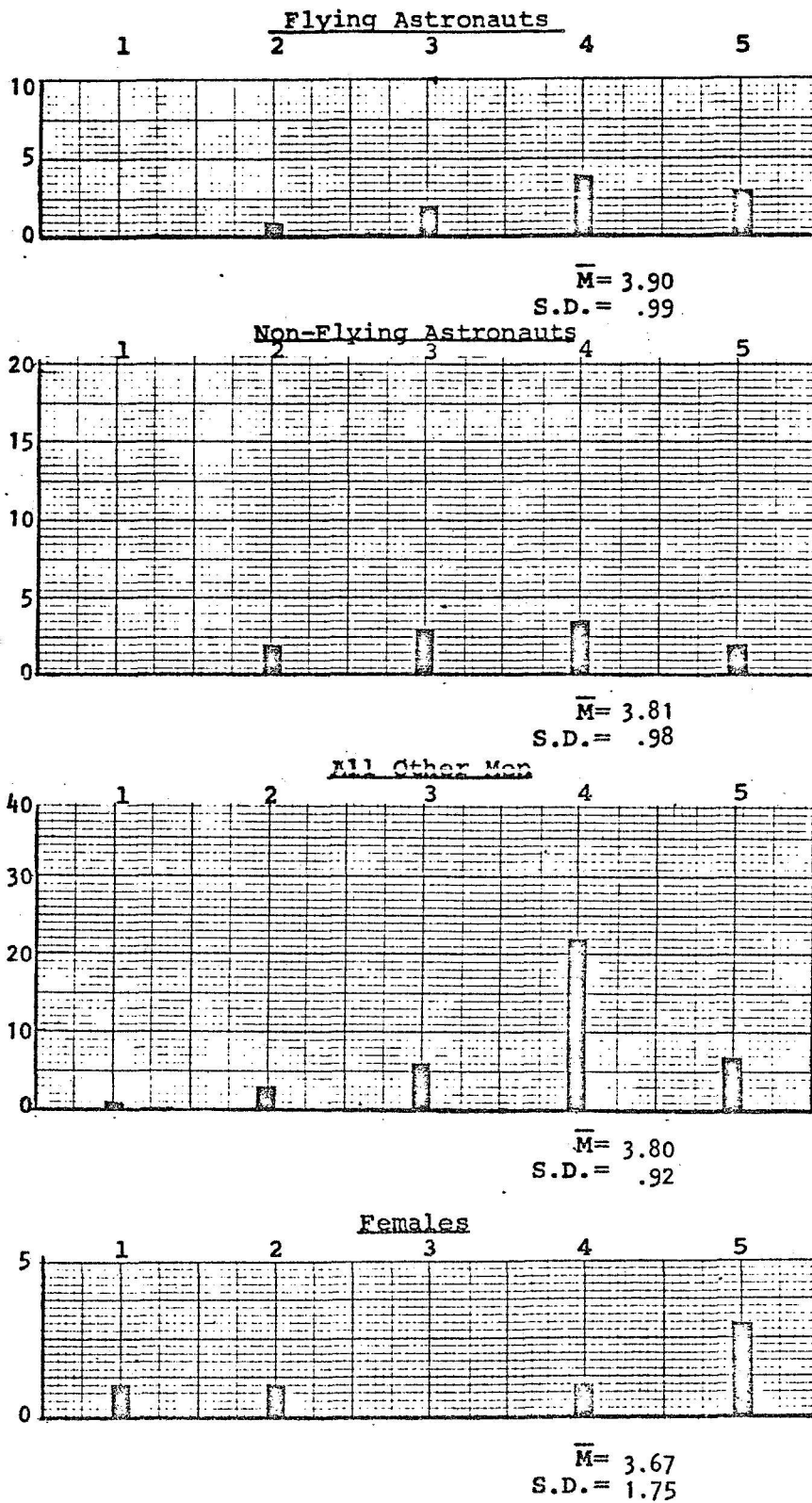


Figure 40A. Finger and Nail Care: Response to Question 38

QUESTION: 48-I am uncomfortable by the feel of dirt under my finger nails.

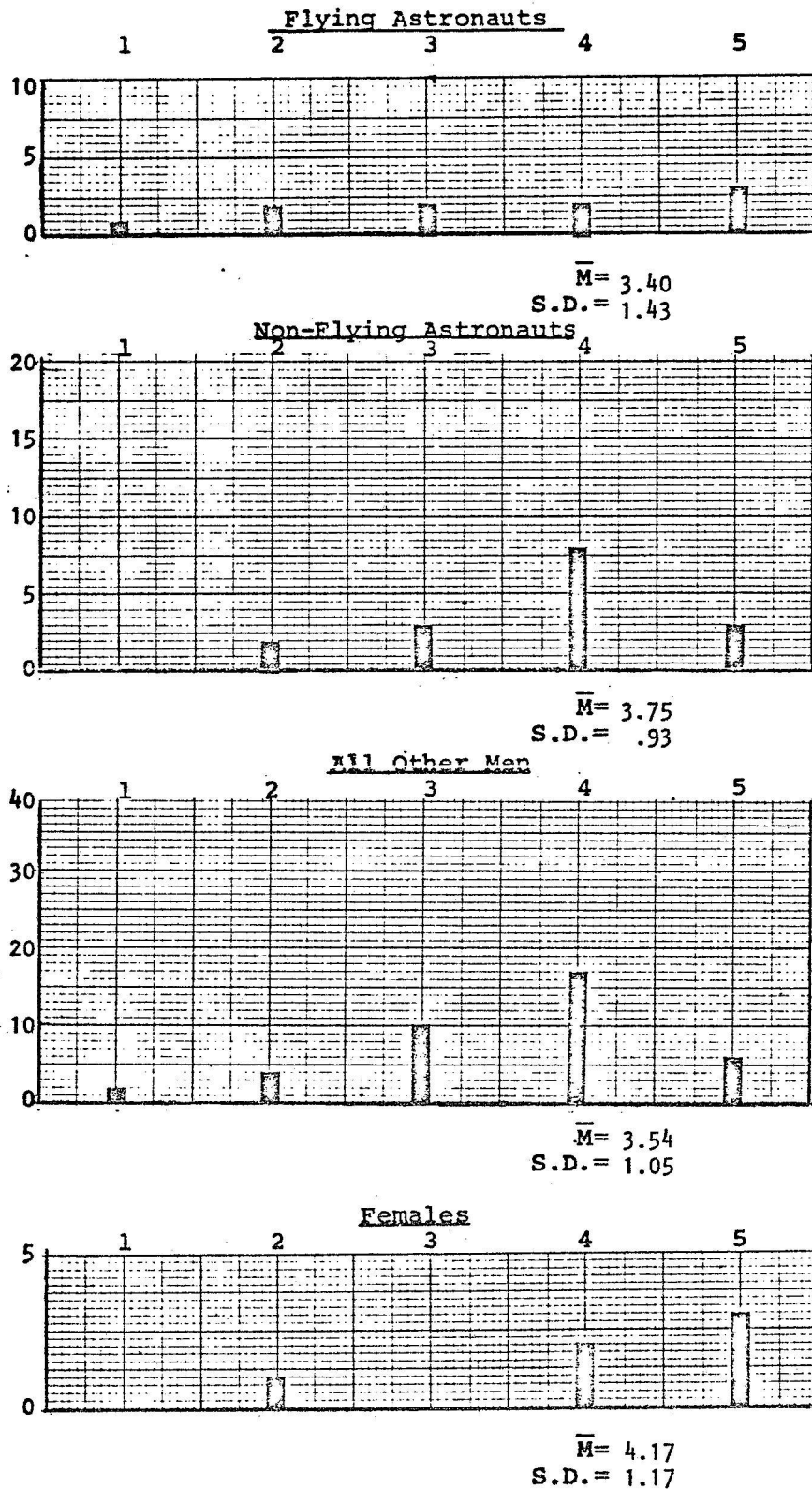


Figure 41A. Finger and Nail Care: Response to Question 48

- Showering

Table 9A indicates that the subjects feel the need for frequent showers (items 3, 23, 33) so as not to feel dirty (item 7) and because they believe that body odors are offensive (item 27). Looking at skin pores is not seen as a cue for when to shower (item 43), nor are chemical wipes seen as being satisfying (item 13), or as effective as wet showers (item 17). The subjects do not feel that they get any cleaner by taking long showers (item 37), but they find that long showers are relaxing (item 47).

TABLE 9A. ANALYSIS OF SHOWERING DATA
FOR ALL MALE SUBJECTS

Score	Test Item									
	3	7	13	17	23	27	33	37	43	47
5	39	23	4	3	42	15	15	3	2	23
4	16	34	3	12	19	35	31	8	10	32
3	9	5	7	14	3	9	7	13	17	5
2	4	7	34	21	2	10	10	33	34	4
1	3	3	23	21	5	2	8	14	8	2

b. Semantic Differential

Much of the data presented in the previous section of the testing situation indicated that the subject population had a preference for the more common or familiar forms of hygiene maintenance. The results of the semantic differential yielded similar results that are considered supportive in nature.

Initially, the data for all males were pooled and evaluated in terms of means, standard deviations, and factor analyses. The results of these analyses will be discussed on the following pages.

In earlier studies, using the semantic differential, it was noted that three factors appeared fairly consistently. These are evaluative, potency, and an activity dimension. In the present study, all three factors were sampled. The predominance of semantic pairing used, however, were related to the evaluative factor scales determined in previous studies. Eleven of the fourteen pairs were evaluative in

QUESTION: 3-I feel I must shower at least twice a week.

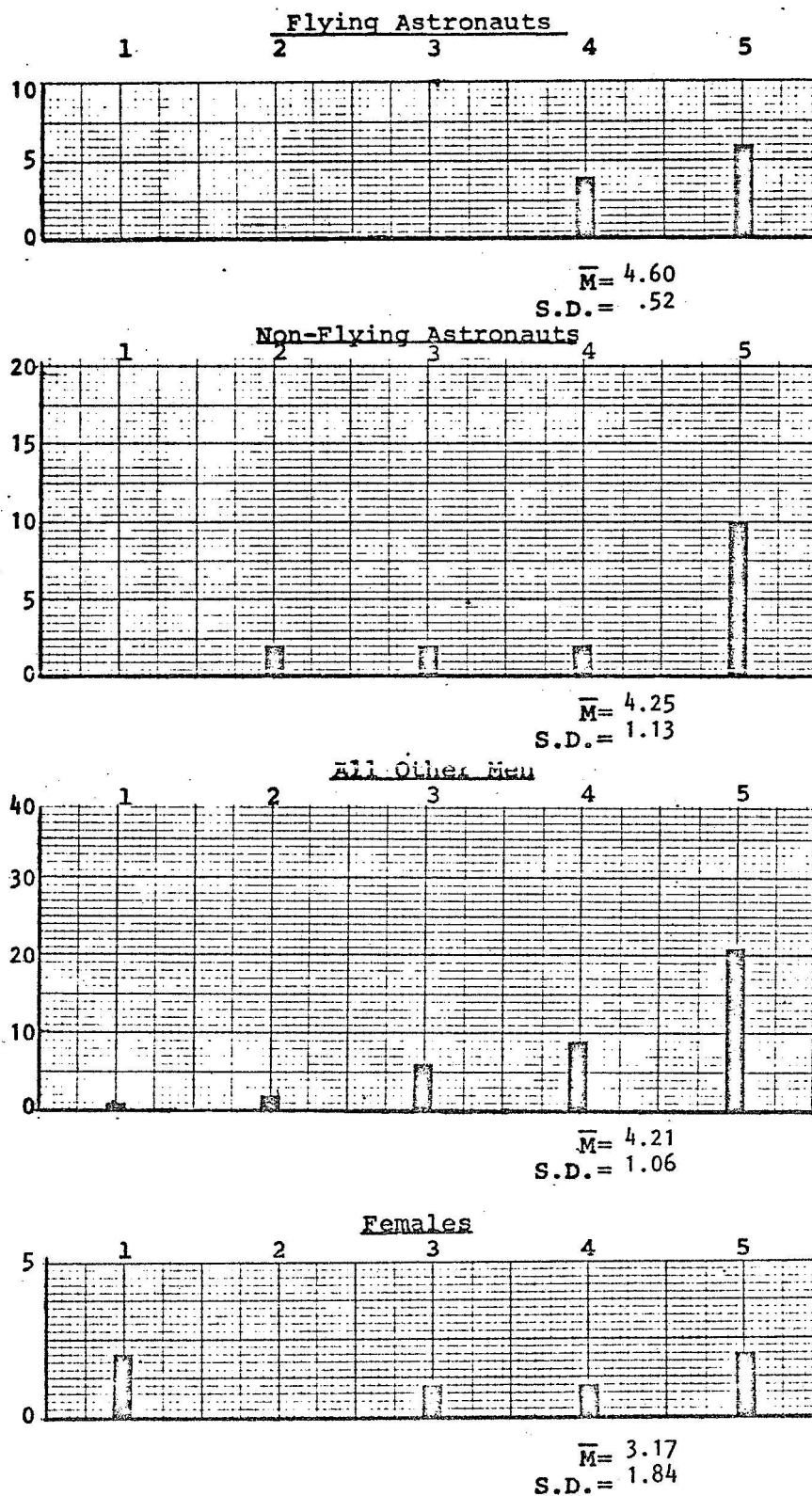
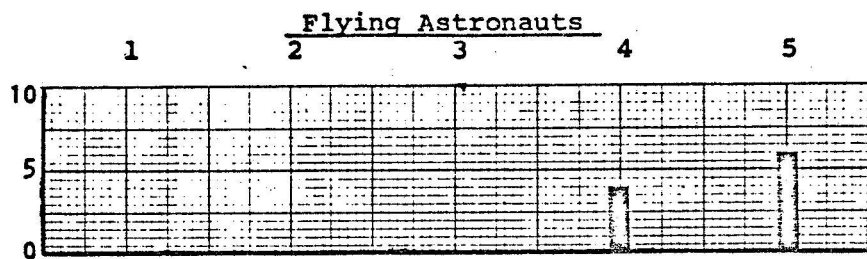
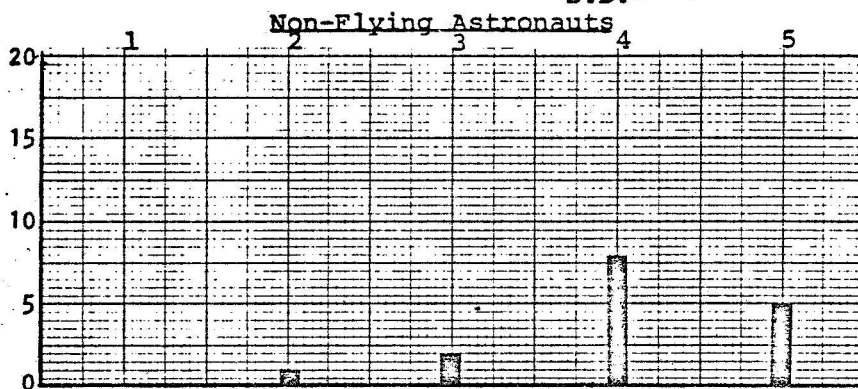


Figure 42A. Showering: Response to Question 3

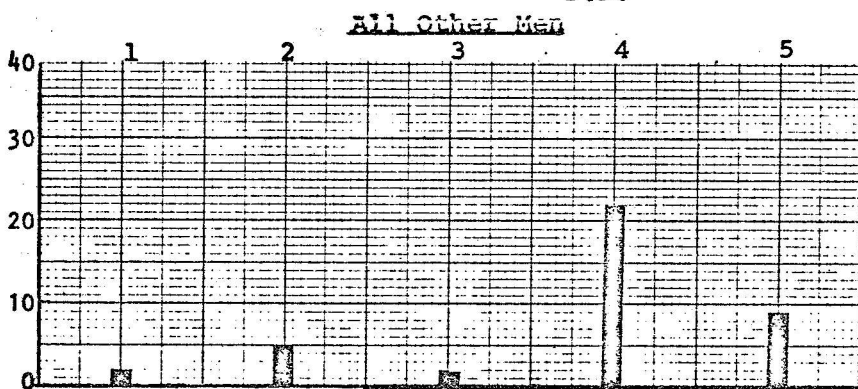
QUESTION: 7-If I do not shower often, I feel dirty.



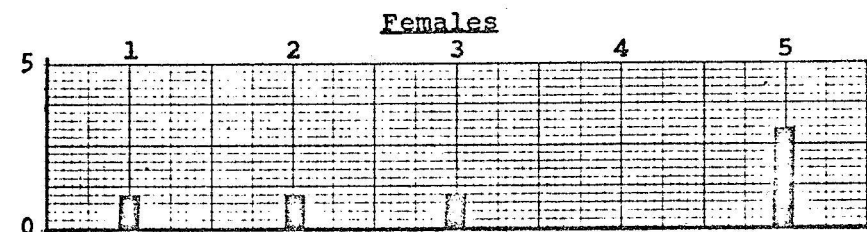
$\bar{M} = 4.60$
S.D. = .52



$\bar{M} = 4.06$
S.D. = .85



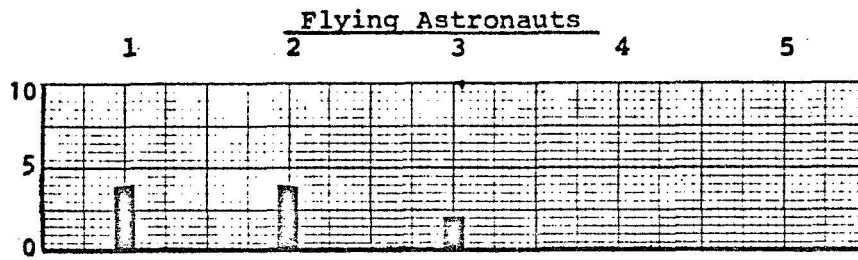
$\bar{M} = 3.80$
S.D. = 1.11



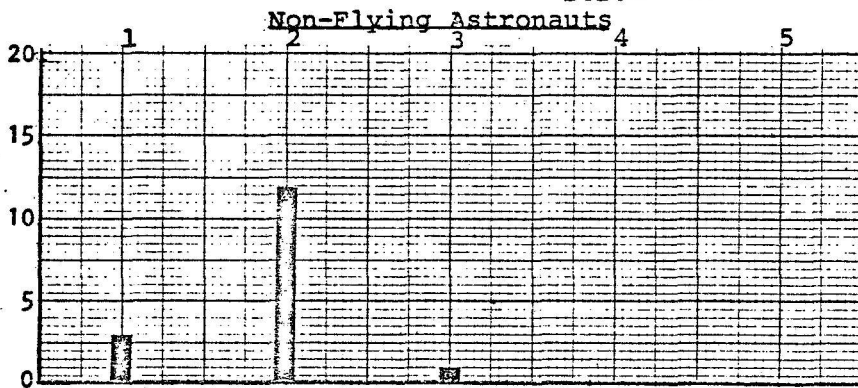
$\bar{M} = 3.50$
S.D. = 1.76

Figure 43A. Showering: Response to Question 7

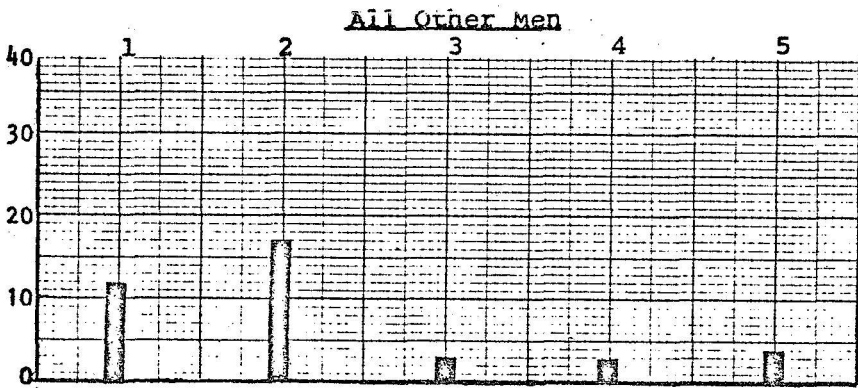
QUESTION: 13-Washing with a "chemical wipes" would satisfy me as much as a "wet" shower.



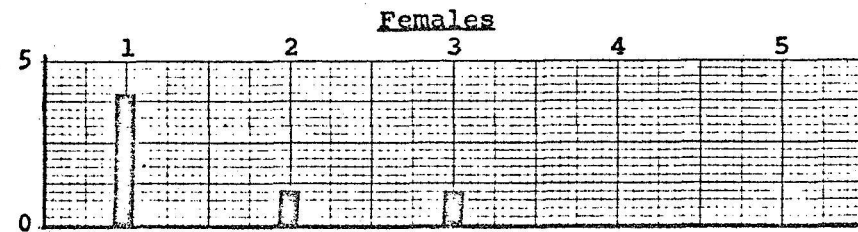
$\bar{M} = 1.80$
S.D. = .79



$\bar{M} = 1.88$
S.D. = .50



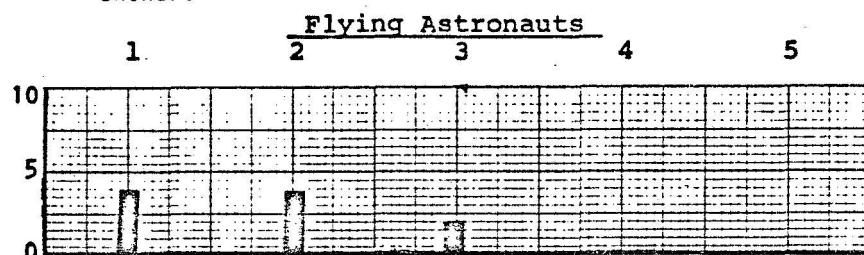
$\bar{M} = 2.23$
S.D. = 1.27



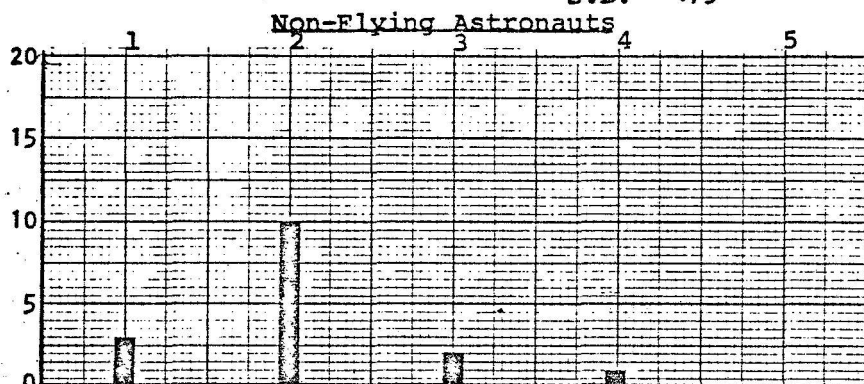
$\bar{M} = 1.50$
S.D. = .84

Figure 44A. Showering: Response to Question 13

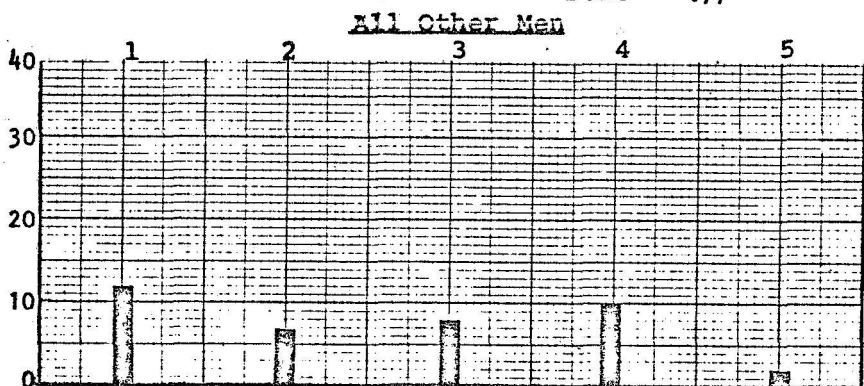
QUESTION: 17-A "chemical wipe" is as effective a cleaning method as a "wet" shower.



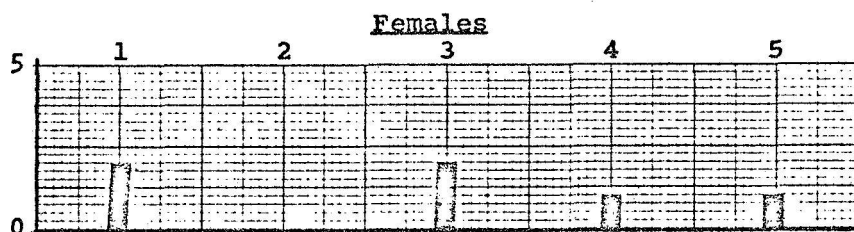
$\bar{M} = 1.80$
S.D. = .79



$\bar{M} = 2.06$
S.D. = .77



$\bar{M} = 2.56$
S.D. = 1.31



$\bar{M} = 2.83$
S.D. = 1.60

Figure 45A. Showering: Response to Question 17

QUESTION: 23-I feel I must shower at least once a week.

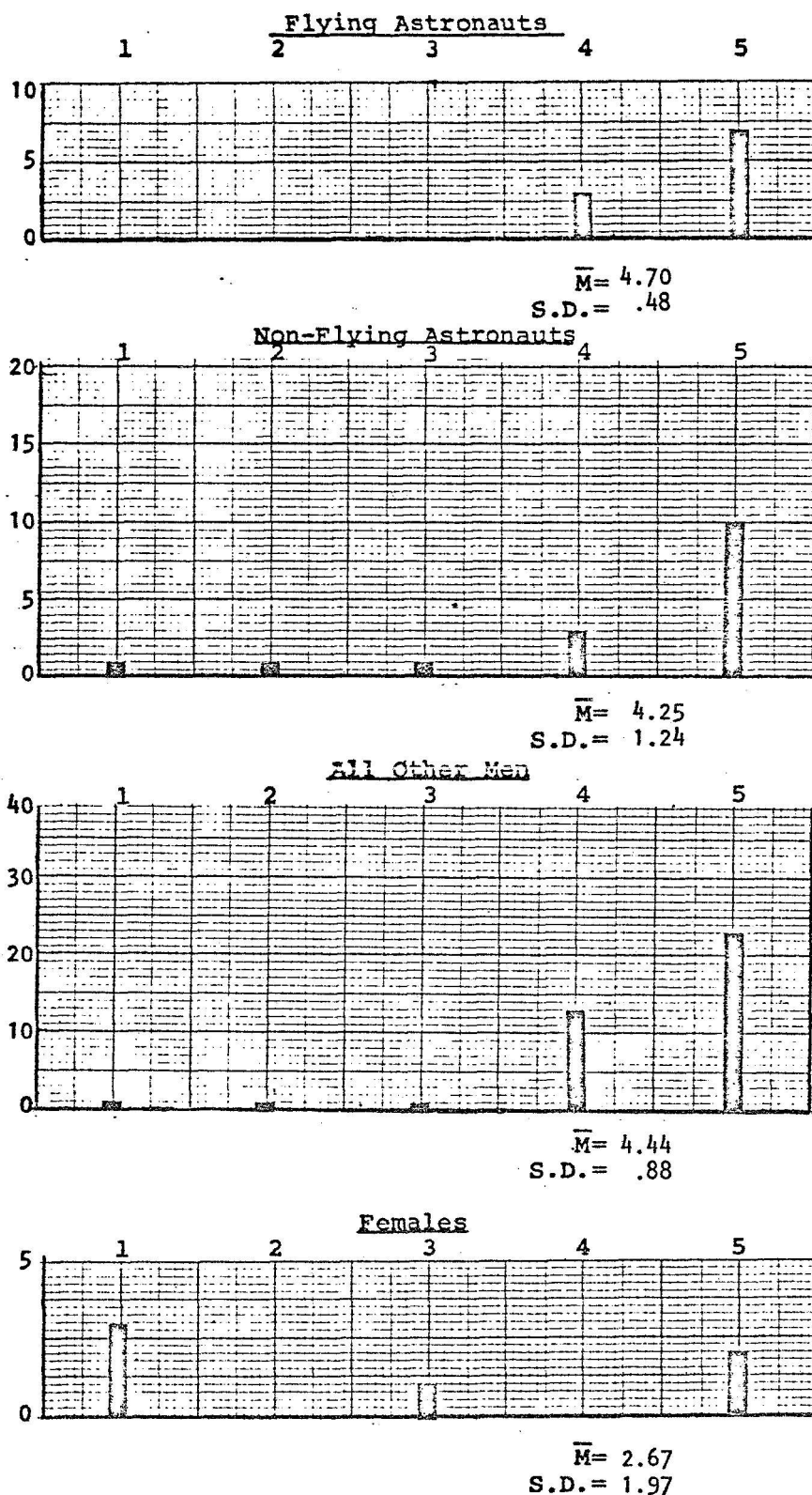
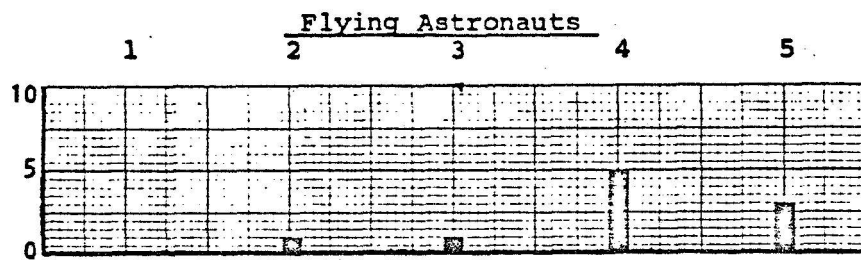
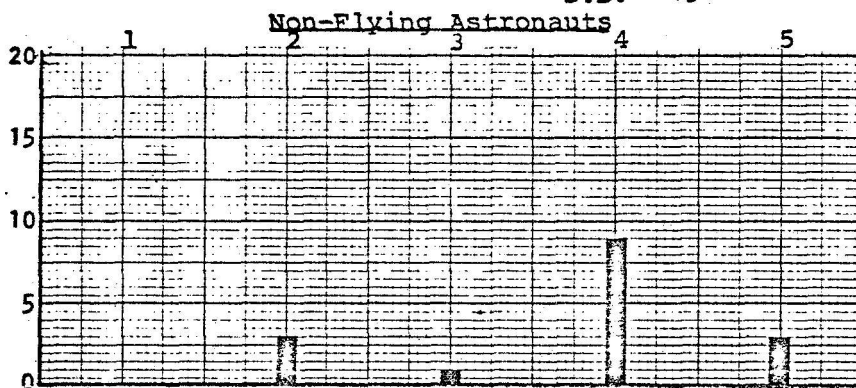


Figure 46A. Showering: Response to Question 23

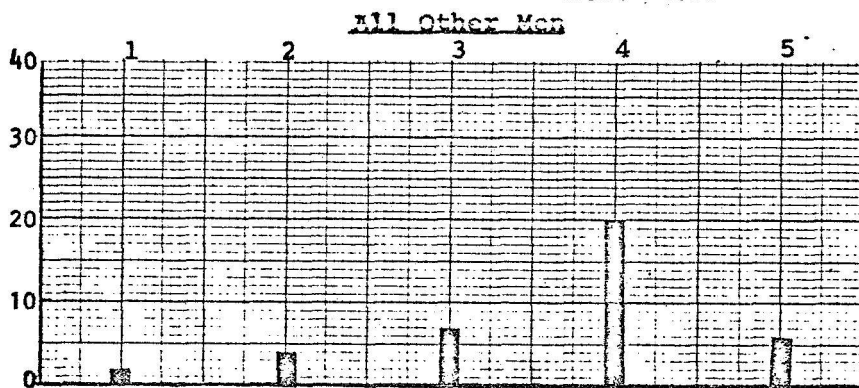
QUESTION: 27-Most body odor is offensive to me.



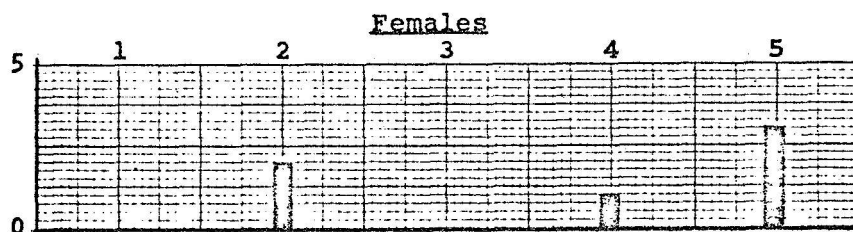
$\bar{M} = 4.00$
S.D. = .94



$\bar{M} = 3.75$
S.D. = 1.00



$\bar{M} = 3.62$
S.D. = 1.04



$\bar{M} = 3.83$
S.D. = 1.47

Figure 47A. Showering: Response to Question 27

QUESTION: 33-I feel I must shower every day to be clean.

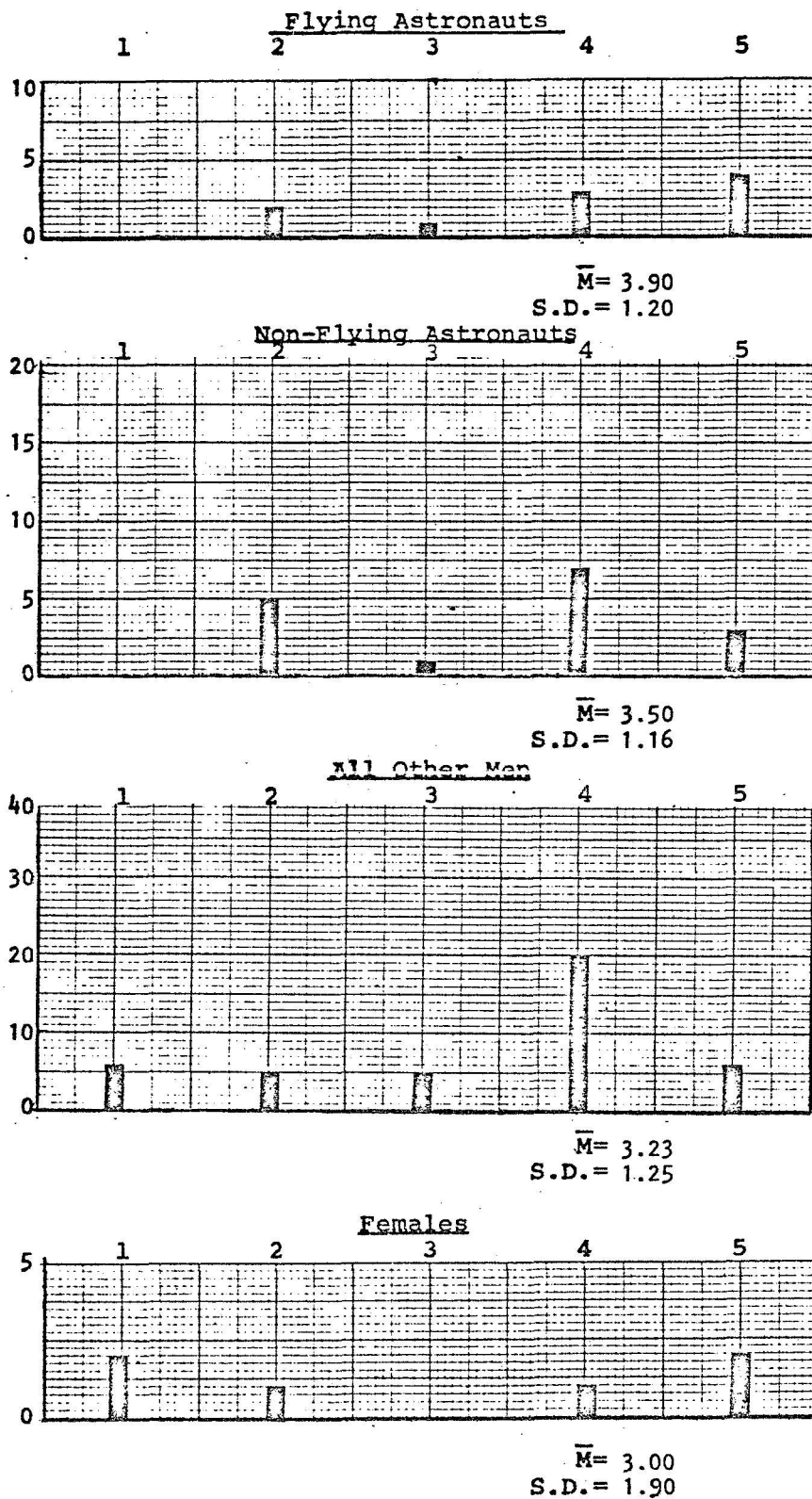
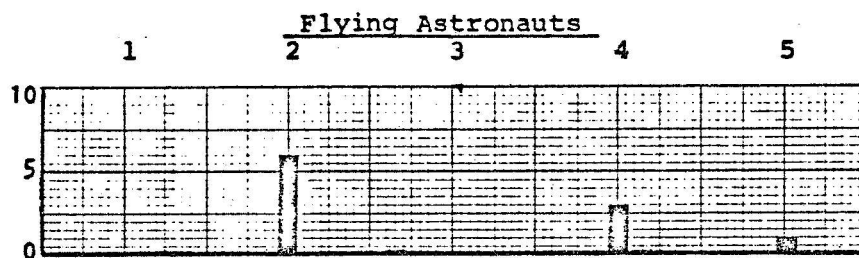
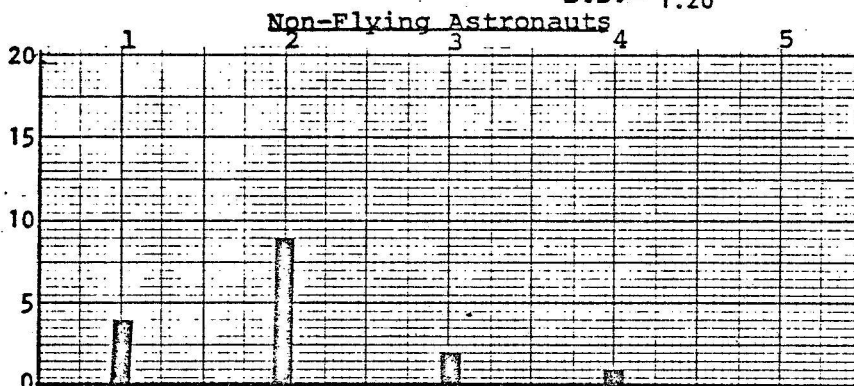


Figure 48A. Showering: Response to Question 33

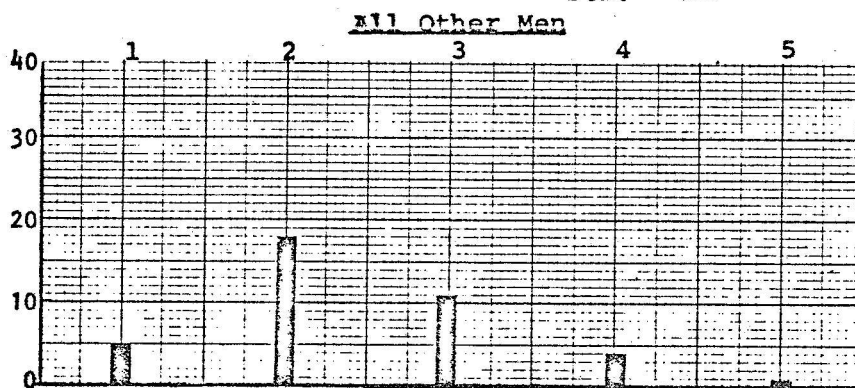
QUESTION: 37-I get cleaner when I take long showers.



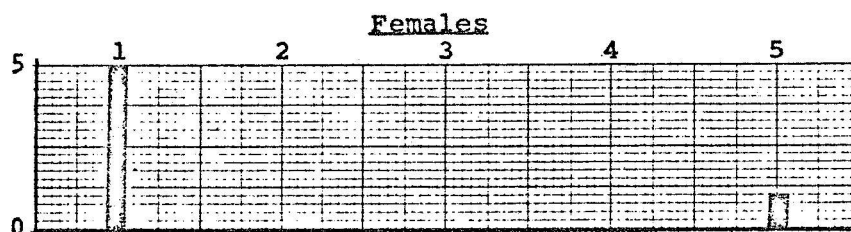
$\bar{M} = 2.90$
S.D. = 1.20



$\bar{M} = 2.00$
S.D. = .82



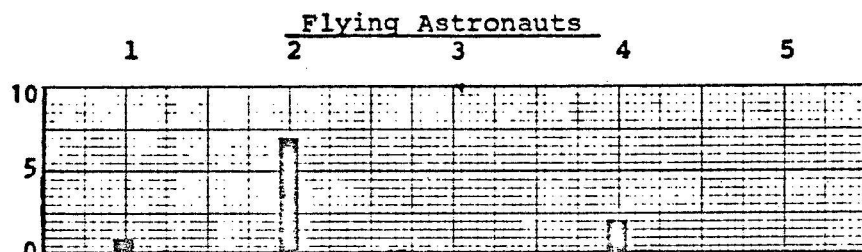
$\bar{M} = 2.44$
S.D. = .94



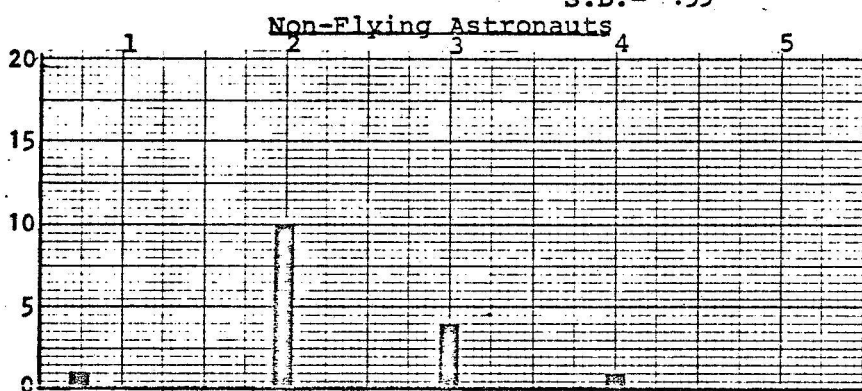
$\bar{M} = 1.67$
S.D. = 1.63

Figure 49A. Showering: Response to Question 37

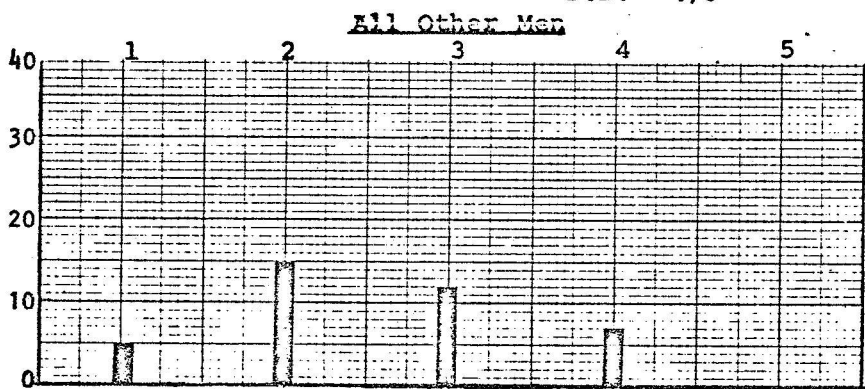
QUESTION: 43-I know when I am dirty just by looking at the pores in my skin.



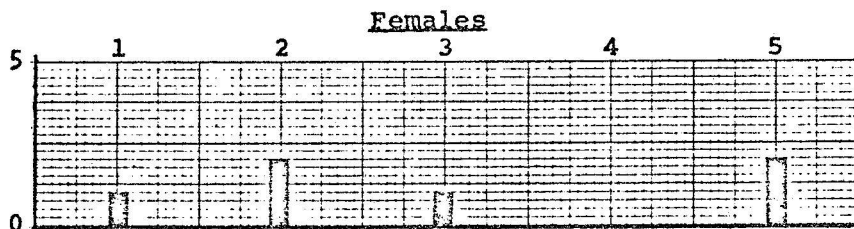
$\bar{M} = 2.30$
S.D. = .95



$\bar{M} = 2.31$
S.D. = .70



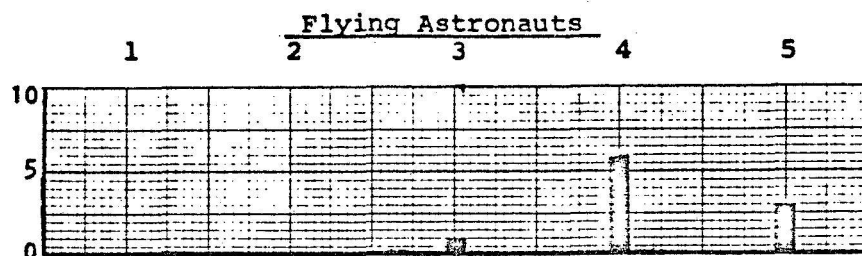
$\bar{M} = 2.54$
S.D. = .94



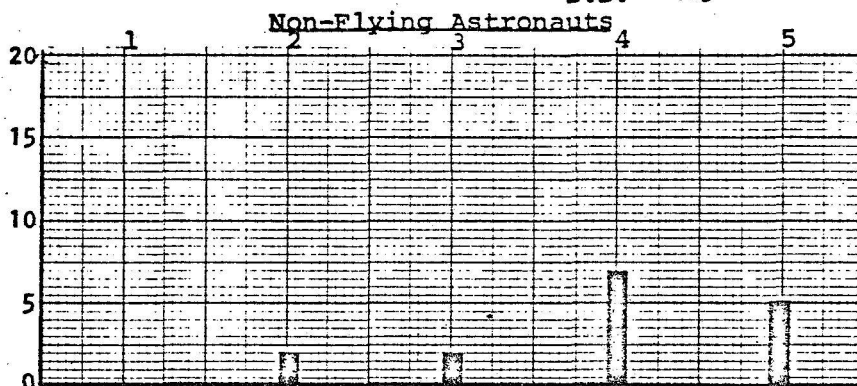
$\bar{M} = 3.00$
S.D. = 1.67

Figure 50A. Showering: Response to Question 43

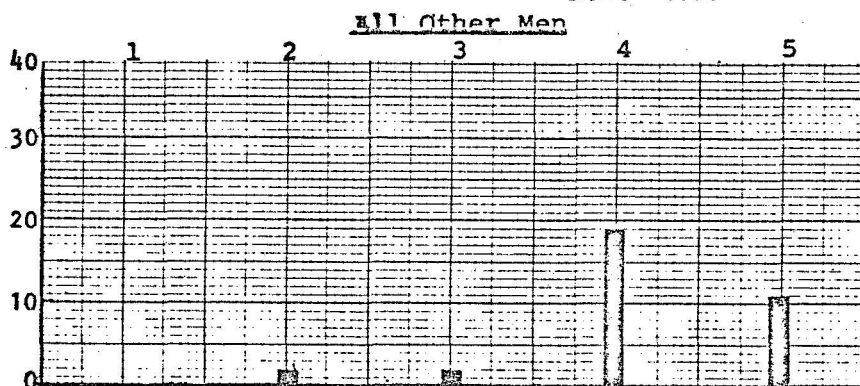
QUESTION: 47-Long hot showers relax me.



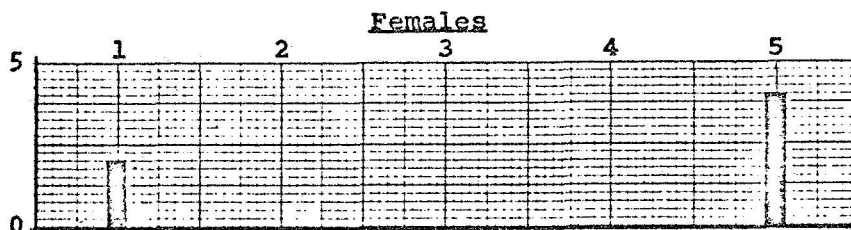
$\bar{M} = 4.20$
S.D. = .63



$\bar{M} = 3.94$
S.D. = 1.00



$\bar{M} = 4.26$
S.D. = .79



$\bar{M} = 3.67$
S.D. = 2.07

Figure 51A. Showering: Response to Question 47

nature. This appears to be justified by the preponderance of variance typically accounted by this factor. The results of the factor analyses indicated that two factors are present for two of the concepts, while three factors and four factors were present for nine and five concepts, respectively. This is consistent with previous factor analytic studies of the semantic differential.

The means for each scale for the sixteen concepts were plotted graphically for visualization. The range of scores anticipated for this testing methodology did not materialize. A pattern of responses was noticeable, however, Those concepts considered more desirable had higher mean scale patterns than the less desirable concepts. This apparent hierarchy of preference can be seen in Table 10A.

TABLE 10A. HIERARCHIAL PREFERENCE OF CONCEPTS

Area of Hygiene	Rank Preference	Item Number and Concept	
Body Cleaning	1	12	Body cleaning via a shower.
	2	4	Washcloth
	3	3	Body cleaning via sauna and toweling.
	4	1	Body cleaning using towel only.
	5	5	Body cleaning via a chemical wipe.
Oral	1	9	Washing teeth with brush and toothpaste.
	2	2	Cleaning teeth with brush only.
	3	11	Cleaning teeth with "chemical" ingestible paste.
Clothing	1	16	Clothing washed and ironed.
	2	6	Clothing washed, but not ironed.
Shaving	1	15	Shaving with an electrical or manual razor.
	2	7	Shaving with a depilatory.
Hair	1	13	Hair wash with soap and water.
	2	8	Hair wash with chemical spray.
Nails	1	14	Manicured nails.
	2	10	Unmanicured nails.

An importance of interpretation for any semantic differential was noted in the Measurement of Meaning⁽⁴⁾. The authors state that:

"What is required to express semantic similarity is some measure of relation that takes into account both the profile covariation and the discrepancies between the means of the profiles, thereby reflecting more fully the information available in the data."

The present researchers attempted such an analysis. Since the scale values were interpreted on a scale from 1 to 7 in all cases, the mid or neutral value was selected at being 4. Additionally, the scales were alternated to counter the effects of subject "set". In this way, the 14 of the 15 scales used in the present study included: hot - cold, pleasant - unpleasant, tense - relaxed, hard - soft, fresh - stale, dirty - clean, sweet - sour, sick - healthy, bitter - sweet, nice - awful, calming - exciting, bad - good, pleasing - annoying, and strange - familiar.

Several distance evaluations were completed. In general, they support the findings presented in Table 10A. An analysis of scale means per concept to form general concept means is presented in Table 11A. The only difference in the results of this analysis is in the hierarchal positioning of items 4 and 3 in the body cleaning area of hygiene. The difference between these two items (.02) is so slight as to be negligible. All other data supports the preferential rankings presented in Table 10A.

A distance score was determined in the following manner. The scales were conceptualized as being polarized in terms of desired and undesired aspects. Each concept was judged to fall somewhere along a desirability continuum. The specific scale scores were considered from the midpoint value of 4, and weighted for directionality from this value. If the responses were in an anticipated direction, they were given a positive value, while unexpected directionality was negatively valued. This was performed for all "evaluative" scales for each concept. The positive and negative weightings were summed to yield a total deviance/distance score for each concept. The results of this analysis can be seen in Table 11A. In general, it can be observed that the original hierarchial listing is supported by this form of analysis.

⁽⁴⁾Osgood, C.E., G. J. Suci, and P.H. Tannenbaum, The Measurement of Meaning, University of Illinois Press, Urbana, Illinois, 1957.

TABLE 11A. MEANS AND DISTANCE SCORES FOR SEMANTIC DIFFERENTIAL CONCEPTS

Area of Hygiene	Number	Concept	Means	Differential Distance Score
Body Cleaning	12	Body cleaning via a shower.	6.04	+2.36
	4	Washcloth	5.17	+ .89
	3	Body cleaning via sauna and toweling.	5.19	+2.87
	1	Body cleaning using towel only.	4.34	+ .76
	5	Body cleaning via a chemical wipe.	4.26	+ .82
Oral	9	Cleaning teeth with brush and toothpaste.	5.45	+ .47
	2	Cleaning teeth with brush only.	4.33	- .25
	11	Cleaning teeth with "chemical" ingestible paste.	3.92	+ .01
Clothing	16	Clothing washed and ironed.	5.31	+1.06
	6	Clothing washed, but not ironed.	4.98	+ .74
Shaving	15	Shaving with an electrical or manual razor.	5.08	- .11
	7	Shaving with a depilatory.	3.67	+ .46
Hair	13	Hair wash with soap and water.	5.77	+1.78
	8	Hair wash with chemical spray.	3.84	+ .27
Nails	14	Manicured nails.	4.93	+ .62
	10	Unmanicured nails.	3.37	-2.79

In summary, the results of the semantic differential support the findings of the initial 50 item test. This suggests that the male population prefers to use the more familiar methods available for maintaining personal hygiene.

c. Subjective Commentary Discussion

A review of subjective comments provided a substantiation of some points indicated earlier. The data presented in this section represents voluntary comments from subjects within the total pool. Where a subject felt he had no input, he properly withheld any comment.

The questions posed were quite general so as to elicit broad comment rather than a narrow limited response. This section was comprised of responses based on 1,944 man days of varied confinement periods in many forms of seclusion. The average confinement period of these respondents was 32.95 days per man.

Question 1: The longest period of close confinement I have shared with
(59 responses) others was

Answer: Range from 1/2 day to 365 days
 Mean: 32.95 days

Question 2: Describe the most disconcerting personal hygiene problem
(55 responses) that you or others with you encountered.

Answer: See Table 12A.

 As indicated, a total of 55 problems were presented. The major problem centered around body odor (27.2%) as distinguished from defecation odors (9.1%). The lack of shower water (12.7%) was equaled in concern by the defecation process (12.7%).

Question 3: Did the event cause you to miss a meal, perform work poorly,
(38 responses) or just plain irritate you?

Answer: 7.9% missed a meal
 7.9% had their work impaired
 84.2% were irritated

Question 4: What item of normal living did you, or do you think you
(65 responses) might, miss most with reference to personal hygiene?

Answer: Left to their own thought processes, the subjects indicated the following:

(1)	Shower	52.3%
(2)	Wash Water	13.8%
(3)	Oral Hygiene Capability	13.8%
(4)	Toilet	12.3%
(5)	Large Towel	7.7%

In a tracking question (10) where a choice was offered, the toilet and a hand sink assumed a greater popularity.

Question 5: Were you satisfied with the arrangements for

1. Shaving (62 responses)
77.4% Yes
22.6% No

The ability to view the shaving process influenced some answers. Some women didn't shave at all; hence, the difference in number of responses with B - Body Wash.

2. Body Wash (64 responses)
65.6% Yes
34.4% No

This area is not as favorable as the percentages imply. Tektite and submarine type respondees had all the shower water (hot) they desired. Almost all space crew replies are in the 34% NO category.

3. Care of Teeth (64 responses)
89% Yes
11% No

The most frequent NO reason was the requirement to swallow the dentifrice on space flights.

4. Disposal of Soiled Clothing (59 responses)
74.6% Yes
25.5% No

Unless sealed lockers were provided, the clothes soon had that dirty clothes odor.

Question 6: Did you feel you were in a "dirty" environment?
(62 responses)

Answer: 72.6% No 27.4% Yes

Most of the YES votes were quick to admit they made it dirty by tracking in moon dust or poor housekeeping. The NO majority felt the ECS did a fine job.

Question 7: Did you realize you were probably breathing and rebreathing another person's expired air? (51 responses)

Answer: 80.4% knew it; 19.6 didn't realize it.

Did this annoy you in any way? (54 responses)

Answer: 14.8% were annoyed; 85.2% were not.

Question 8: Given the opportunity would you prefer a bunk with clean sheets for every sleep period or could you manage with a change once a week? Would you feel the same if you couldn't shower? (69 responses)

Answer: 82.6% thought one change a week was fine
11.6% would have liked two changes per week
4.3% representing three individuals said every two weeks
1.5% representing one fastidious soul would have liked a daily change

All of the respondents indicated that they preferred a shower to precede a clean sheet. Lacking a shower, at least a clean sheet. The feeling prevailed that if the sheets were dirty they might be reluctant to shower and then use the sheets. On the other hand, if the person was dirty, a dirty sheet was fine.

Question 9: Recognizing that we can all ignore a bad personal situation, would you hesitate to call a poor hygiene situation to the offender's attention? (68 responses)

Answer: 55.9% No
44.1% Yes

The rationales expressed for the responses included the following generalizations:

- 1) I wouldn't want to offend him.
- 2) I might cause a conflict greater than the problem.
- 3) I believe the crew commander should do it.
- 4) I can't imagine being that sensitive.
- 5) I would know him well enough by that time to tell him.
- 6) The crew comes first.
- 7) The mission and its harmony need to be preserved.
- 8) He would know it and correct it.

Each of these generalizations are plausible and because 44% of the respondents would keep quiet, perhaps a routine

prescribed self-evaluation should be considered. Certainly, the crew commander should be responsive to this situation should it arise--as it has in some situations.

Question 10:
(211 responses)

If you were responsible for the best possible personal hygiene facility which of these would you regard as absolutely critical?

Answer:

(1)	Shower	26.1%
(2)	Flush Toilet	24.6%
(3)	Hand Sink	21.8%
(4)	Oral Hygiene Facility	16.6%
(5)	Electric Razor	6.1%
(6)	Sun Lamps	2.0%
(7)	Makeup Mirror	2.0%
(8)	Sauna	0.5%
(9)	Electric Hair Dryer	0.5%

In this battery of responses, unlike Question 4, there is no single dominant element. A cursory appraisal would still rate the shower first; followed by the toilet, hand sink, and oral hygiene facility. This list, however, is based on availability and so precludes any spartan attitude.

TABLE 12A. PERSONAL HYGIENE PROBLEMS

Rank	Problem	Percent	Number of Responses
1	Body odor	27.2	15
2	No shower water	12.7	7
2	Defecation process	12.7	7
3	Defecation odors	9.1	5
4	Odor from urine	5.4	3
5	Dirty feet	3.6	2
5	Vomitus	3.6	2
5	No oral hygiene facility	3.6	2
5	Excessive clamminess	3.6	2
6	Crowding	1.8	1
6	Grimy hands	1.8	1
6	No hair washing capability	1.8	1
6	No fresh clothing	1.8	1
6	Water had a chemical taste	1.8	1
6	Others unclean	1.8	1
6	Skin rash	1.8	1
6	Lack of real soap	1.8	1
6	Bad breath	1.8	1
6	Body dirt (general)	1.8	1

TABLE 13A. TABULATION OF SUBJECTIVE COMMENTARIES

Question	Part	Total Responses	Responses		Percent	
			Favorable	Unfavorable	Positive	Negative
1	1	1,944	59			
2			55			
3	1 2 3	38	3 3 32		7.9 7.9 84.2	
4	1 2 3 4 5	65	9 34 5 8 9		13.8 52.3 7.7 12.3 13.8	
5	1 2 3 4	62 64 64 59	48 42 57 44	14 22 7 15	77.4 65.6 89.0 74.6	22.6 34.4 11.0 25.4
6		62	17	45	27.4	72.6
7	1 2	51 54	41 8	10 46	80.4 14.8	19.6 85.2
8	1 week 2 weeks 2 weeks 1 day	57 8 3 1			82.6 11.6 4.3 1.5	
9		68	30	38	44.1	55.9
10	Toilet Shower Hand Sink Sauna Oral Hygiene Mirror Sun Lamps Electric Razor	211	52 55 46 0 35 5 5 13		24.6 26.1 21.8 0 16.6 2.3 2.3 6.1	

This questionnaire is part of a contract study with NASA/MSC, Houston, Texas (NAS9-11509).

Your cooperation is solicited to enable us to derive data pertinent to personal hygiene requirements. We are asking your cooperation because you have been or will be concerned with personal hygiene during some degree of confinement and/or communal living. If you can recollect your impressions of the items discussed, so much the better. If time has dimmed your memory, or you have still to experience this environment, answer spontaneously.

Your prompt response, returned in the stamped envelope (enclosed), is most important to the study's progress.

Check site of experience (actual or contemplated):

Chamber
Submarine
Sealab
Tektite
Ben Franklin
Mercury
Gemini
Apollo
Aegir
Helgoland
Antarctic
Caves
Other

GENERAL INFORMATION (Reply to all pertinent questions 1-6):

1. Job title: _____
2. Length of time with organization? Years _____ Months _____
3. Length of time with the military? Years _____ Months _____
4. Branch of service? _____
5. Age? _____
6. Area of educational/professional specialization? _____

Figure 52A. Personal Hygiene Questionnaire

INSTRUCTIONS:

On the following pages is a list of items that may be used to describe some of your attitudes toward various aspects of hygiene. Each item describes a specific kind of attitude or behavior pattern. Although some items appear or may appear to be similar, they express or examine differences that are important in the maintenance of personal hygiene. Each question should be considered as a separate entity. This is not a test of ability or consistency in making answers. Its only purpose is to make it possible for you to describe, as accurately as you can, your behavioral patterns/ attitudes toward the specific items presented. Please answer these items as honestly as you can.

In responding to the following items, follow the instructions presented below:

1. Read each item carefully.
2. Think about how you feel or would feel about the item.
3. Decide whether you:
 - A. Disagree with the item strongly.
 - B. Disagree with the item moderately.
 - C. Are indifferent or undecided about the item.
 - D. Agree with the item moderately.
 - E. Agree with the item strongly.

Draw a circle around one of the five letters (A B C D E) following the item to show the answer you have selected. Remember:

- | | | |
|---|---|--------------------------|
| A | = | Disagree with strongly |
| B | = | Disagree with moderately |
| C | = | Undecided or indifferent |
| D | = | Agree with moderately |
| E | = | Agree with strongly |

- | | |
|--|-----------|
| 1. The odor from "dirty" hair is offensive to me. | A B C D E |
| 2. I enjoy variety in my clothing styles. | A B C D E |
| 3. I feel I must shower at least twice a week. | A B C D E |
| 4. Mouth odor is one of the most unpleasant aspects of many persons. | A B C D E |
| 5. The old saying: "Cleanliness is next to Godliness" is true. | A B C D E |
| 6. Washing my hair relaxes me. | A B C D E |

Figure 52A. Personal Hygiene Questionnaire (cont'd)

- | | |
|--|-----------|
| 7. If I do not shower often, I feel dirty. | A B C D E |
| 8. Dirty nails "bother" me. | A B C D E |
| 9. Dental hygiene is important to me. | A B C D E |
| 10. Stubble or beards are uncomfortable to me. | A B C D E |
| 11. I am not aware of "dirty" hair until I have dandruff. | A B C D E |
| 12. Wearing unironed clothing is uncomfortable. | A B C D E |
| 13. Washing with a "chemical wipe" would satisfy me as much as a "wet" shower. | A B C D E |
| 14. Mouthwash is as effective as brushing in keeping the mouth clean. | A B C D E |
| 15. A feel better when I present a good physical appearance. | A B C D E |
| 16. I feel I should wash my hair approximately every other day. | A B C D E |
| 17. A "chemical wipe" is as effective a cleaning method as a "wet" shower. | A B C D E |
| 18. I can tell how a person feels about himself by how he cares for the appearance of his fingernails and hands. | A B C D E |
| 19. I often feel there is a "film" in my mouth. | A B C D E |
| 20. I feel I must shave at least once a day. | A B C D E |
| 21. A dry hair wash (chemical) is as desirable as a "wet" one. | A B C D E |
| 22. After several days of wear, my clothing must be cleaned. | A B C D E |
| 23. I feel I must shower at least once a week. | A B C D E |
| 24. Methods other than brushing are as effective in keeping the mouth "clean". | A B C D E |
| 25. You can tell a lot about a person by his physical appearance. | A B C D E |
| 26. I feel I should wash my hair approximately once a week. | A B C D E |
| 27. Most body odor is offensive to me. | A B C D E |
| 28. I feel I should manicure my fingernails about once every two weeks. | A B C D E |

Figure 52A. Personal Hygiene Questionnaire (cont'd)

- | | |
|---|-----------|
| 29. I feel I should brush my teeth after every meal. | A B C D E |
| 30. I enjoy being "clean" shaven. | A B C D E |
| 31. If I do not wash my hair often enough, it becomes oily and uncomfortable. | A B C D E |
| 32. I enjoy wearing clothing that has been ironed. | A B C D E |
| 33. I feel I must shower every day to be clean. | A B C D E |
| 34. Brushing my teeth gives my mouth a "clean" feeling. | A B C D E |
| 35. My physical appearance is important to me. | A B C D E |
| 36. I would find a "wet" or "dry" (chemical) wash for my hair equally adequate over a long time period. | A B C D E |
| 37. I get cleaner when I take long showers. | A B C D E |
| 38. Ragged fingernails are "uncomfortable". | A B C D E |
| 39. I know when I have "bad breath" by how my mouth feels. | A B C D E |
| 40. Stubble or a beard makes a person look "dirty". | A B C D E |
| 41. If I do not wash my hair often enough, it begins to have an odor. | A B C D E |
| 42. I cannot wear clothes that I believe are "dirty". | A B C D E |
| 43. I know when I am dirty just by looking at the pores of my skin. | A B C D E |
| 44. I feel I should brush my teeth at least every morning and every evening. | A B C D E |
| 45. An individual's physical appearance is extremely important. | A B C D E |
| 46. I feel I should wash my hair approximately twice a week. | A B C D E |
| 47. Long hot showers relax me. | A B C D E |
| 48. I am uncomfortable by the feel of dirt under my fingernails. | A B C D E |
| 49. I feel I should brush my teeth at least once a day. | A B C D E |
| 50. I find shaving necessary. | A B C D E |

Figure 52A. Personal Hygiene Questionnaire (cont'd)

IMPORTANT:

- 1) Place your check-marks in the middle of spaces, not on the boundaries:

 This Not This
____: ____: ____: X : ____: ____ X ____

- 2) Be sure you check every scale for every concept; do not omit any.
3) Never put more than one check-mark on a single scale.

Sometimes you may feel as though you've had the same item before on the test. This will not be the case, so do not look back and forth through the items. Do not try to remember how you checked similar items earlier. Make each item a separate and independent judgment. Work at fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, the immediate "feelings" about the items that we want. On the other hand, please do not be careless because we want your true impressions.

Figure 52A. Personal Hygiene Questionnaire (cont'd)

BODY CLEANING USING TOWEL ONLY

hot	_____	cold
pleasant	_____	unpleasant
tense	_____	relaxed
hard	_____	soft
fresh	_____	stale
dirty	_____	clean
sweet	_____	sour
sick	_____	healthy
bitter	_____	sweet
pungent	_____	bland
nice	_____	awful
calming	_____	exciting
bad	_____	good
pleasing	_____	annoying
strange	_____	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

CLEANING TEETH WITH BRUSH ONLY

hot	_____:	_____:	_____:	_____:	_____:	cold
pleasant	_____:	_____:	_____:	_____:	_____:	unpleasant
tense	_____:	_____:	_____:	_____:	_____:	relaxed
hard	_____:	_____:	_____:	_____:	_____:	soft
fresh	_____:	_____:	_____:	_____:	_____:	stale
dirty	_____:	_____:	_____:	_____:	_____:	clean
sweet	_____:	_____:	_____:	_____:	_____:	sour
sick	_____:	_____:	_____:	_____:	_____:	healthy
bitter	_____:	_____:	_____:	_____:	_____:	sweet
pungent	_____:	_____:	_____:	_____:	_____:	bland
nice	_____:	_____:	_____:	_____:	_____:	awful
calming	_____:	_____:	_____:	_____:	_____:	exciting
bad	_____:	_____:	_____:	_____:	_____:	good
pleasing	_____:	_____:	_____:	_____:	_____:	annoying
strange	_____:	_____:	_____:	_____:	_____:	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

BODY CLEANING VIA SAUNA AND TOWELING

hot	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	cold
pleasant	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	unpleasant
tense	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	relaxed
hard	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	soft
fresh	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	stale
dirty	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	clean
sweet	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	sour
sick	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	healthy
bitter	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	sweet
pungent	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	bland
nice	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	awful
calming	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	exciting
bad	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	good
pleasing	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	annoying
strange	_____	:	_____	:	_____	:	_____	:	_____	:	_____	:	_____	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

WASH CLOTH

hot	_____	_____	_____	_____	_____	_____	_____	cold
pleasant	_____	_____	_____	_____	_____	_____	_____	unpleasant
tense	_____	_____	_____	_____	_____	_____	_____	relaxed
hard	_____	_____	_____	_____	_____	_____	_____	soft
fresh	_____	_____	_____	_____	_____	_____	_____	stale
dirty	_____	_____	_____	_____	_____	_____	_____	clean
sweet	_____	_____	_____	_____	_____	_____	_____	sour
sick	_____	_____	_____	_____	_____	_____	_____	healthy
bitter	_____	_____	_____	_____	_____	_____	_____	sweet
pungent	_____	_____	_____	_____	_____	_____	_____	bland
nice	_____	_____	_____	_____	_____	_____	_____	awful
calming	_____	_____	_____	_____	_____	_____	_____	exciting
bad	_____	_____	_____	_____	_____	_____	_____	good
pleasing	_____	_____	_____	_____	_____	_____	_____	annoying
strange	_____	_____	_____	_____	_____	_____	_____	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

hot	:	:	:	:	:	:	cold
pleasant	:	:	:	:	:	:	unpleasant
tense	:	:	:	:	:	:	relaxed
hard	:	:	:	:	:	:	soft
fresh	:	:	:	:	:	:	stale
dirty	:	:	:	:	:	:	clean
sweet	:	:	:	:	:	:	sour
sick	:	:	:	:	:	:	healthy
bitter	:	:	:	:	:	:	sweet
pungent	:	:	:	:	:	:	bland
nice	:	:	:	:	:	:	awful
calming	:	:	:	:	:	:	exciting
bad	:	:	:	:	:	:	good
pleasing	:	:	:	:	:	:	annoying
strange	:	:	:	:	:	:	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

hot	:	:	:	:	:	:	cold
pleasant	:	:	:	:	:	:	unpleasant
tense	:	:	:	:	:	:	relaxed
hard	:	:	:	:	:	:	soft
fresh	:	:	:	:	:	:	stale
dirty	:	:	:	:	:	:	clean
sweet	:	:	:	:	:	:	sour
sick	:	:	:	:	:	:	healthy
bitter	:	:	:	:	:	:	sweet
pungent	:	:	:	:	:	:	bland
nice	:	:	:	:	:	:	awful
calming	:	:	:	:	:	:	exciting
bad	:	:	:	:	:	:	good
pleasing	:	:	:	:	:	:	annoying
strange	:	:	:	:	:	:	familiar

A-88

WASHING TEETH WITH BRUSH AND TOOTHPASTE

hot	_____	_____	_____	_____	_____	_____	cold
pleasant	_____	_____	_____	_____	_____	_____	unpleasant
tense	_____	_____	_____	_____	_____	_____	relaxed
hard	_____	_____	_____	_____	_____	_____	soft
fresh	_____	_____	_____	_____	_____	_____	stale
dirty	_____	_____	_____	_____	_____	_____	clean
sweet	_____	_____	_____	_____	_____	_____	sour
sick	_____	_____	_____	_____	_____	_____	healthy
bitter	_____	_____	_____	_____	_____	_____	sweet
pungent	_____	_____	_____	_____	_____	_____	bland
nice	_____	_____	_____	_____	_____	_____	awful
calming	_____	_____	_____	_____	_____	_____	exciting
bad	_____	_____	_____	_____	_____	_____	good
pleasing	_____	_____	_____	_____	_____	_____	annoying
strange	_____	_____	_____	_____	_____	_____	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

hot	:	:	:	:	:	:	cold
pleasant	:	:	:	:	:	:	unpleasant
tense	:	:	:	:	:	:	relaxed
hard	:	:	:	:	:	:	soft
fresh	:	:	:	:	:	:	stale
dirty	:	:	:	:	:	:	clean
sweet	:	:	:	:	:	:	sour
sick	:	:	:	:	:	:	healthy
bitter	:	:	:	:	:	:	sweet
pungent	:	:	:	:	:	:	bland
nice	:	:	:	:	:	:	awful
calming	:	:	:	:	:	:	exciting
bad	:	:	:	:	:	:	good
pleasing	:	:	:	:	:	:	annoying
strange	:	:	:	:	:	:	familiar

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CLEANING TEETH WITH "CHEMICAL" INGESTIBLE PASTE

hot	_____	_____	_____	_____	_____	_____	cold
pleasant	_____	_____	_____	_____	_____	_____	unpleasant
tense	_____	_____	_____	_____	_____	_____	relaxed
hard	_____	_____	_____	_____	_____	_____	soft
fresh	_____	_____	_____	_____	_____	_____	stale
dirty	_____	_____	_____	_____	_____	_____	clean
sweet	_____	_____	_____	_____	_____	_____	sour
sick	_____	_____	_____	_____	_____	_____	healthy
bitter	_____	_____	_____	_____	_____	_____	sweet
pungent	_____	_____	_____	_____	_____	_____	bland
nice	_____	_____	_____	_____	_____	_____	awful
calming	_____	_____	_____	_____	_____	_____	exciting
bad	_____	_____	_____	_____	_____	_____	good
pleasing	_____	_____	_____	_____	_____	_____	annoying
strange	_____	_____	_____	_____	_____	_____	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

BODY CLEANING VIA A SHOWER

hot	_____	_____	_____	_____	_____	_____	cold
pleasant	_____	_____	_____	_____	_____	_____	unpleasant
tense	_____	_____	_____	_____	_____	_____	relaxed
hard	_____	_____	_____	_____	_____	_____	soft
fresh	_____	_____	_____	_____	_____	_____	stale
dirty	_____	_____	_____	_____	_____	_____	clean
sweet	_____	_____	_____	_____	_____	_____	sour
sick	_____	_____	_____	_____	_____	_____	healthy
bitter	_____	_____	_____	_____	_____	_____	sweet
pungent	_____	_____	_____	_____	_____	_____	bland
nice	_____	_____	_____	_____	_____	_____	awful
calming	_____	_____	_____	_____	_____	_____	exciting
bad	_____	_____	_____	_____	_____	_____	good
pleasing	_____	_____	_____	_____	_____	_____	annoying
strange	_____	_____	_____	_____	_____	_____	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

HAIR WASH WITH SOAP AND WATER

hot	:	:	:	:	:	:	cold
pleasant	:	:	:	:	:	:	unpleasant
tense	:	:	:	:	:	:	relaxed
hard	:	:	:	:	:	:	soft
fresh	:	:	:	:	:	:	stale
dirty	:	:	:	:	:	:	clean
sweet	:	:	:	:	:	:	sour
sick	:	:	:	:	:	:	healthy
bitter	:	:	:	:	:	:	sweet
pungent	:	:	:	:	:	:	bland
nice	:	:	:	:	:	:	awful
calming	:	:	:	:	:	:	exciting
bad	:	:	:	:	:	:	good
pleasing	:	:	:	:	:	:	annoying
strange	:	:	:	:	:	:	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

hot	:	:	:	:	:	:	cold
pleasant	:	:	:	:	:	:	unpleasant
tense	:	:	:	:	:	:	relaxed
hard	:	:	:	:	:	:	soft
fresh	:	:	:	:	:	:	stale
dirty	:	:	:	:	:	:	clean
sweet	:	:	:	:	:	:	sour
sick	:	:	:	:	:	:	healthy
bitter	:	:	:	:	:	:	sweet
pungent	:	:	:	:	:	:	bland
nice	:	:	:	:	:	:	awful
calming	:	:	:	:	:	:	exciting
bad	:	:	:	:	:	:	good
pleasing	:	:	:	:	:	:	annoying
strange	:	:	:	:	:	:	familiar

Figure 52A. Personal Hygiene Questionnaire (cont'd)

hot	:	:	:	:	:	:	cold
pleasant	:	:	:	:	:	:	unpleasant
tense	:	:	:	:	:	:	relaxed
hard	:	:	:	:	:	:	soft
fresh	:	:	:	:	:	:	stale
dirty	:	:	:	:	:	:	clean
sweet	:	:	:	:	:	:	sour
sick	:	:	:	:	:	:	healthy
bitter	:	:	:	:	:	:	sweet
pungent	:	:	:	:	:	:	bland
nice	:	:	:	:	:	:	awful
calming	:	:	:	:	:	:	exciting
bad	:	:	:	:	:	:	good
pleasing	:	:	:	:	:	:	annoying
strange	:	:	:	:	:	:	familiar

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Subjective Commentary

Respond to the following questions in your own words. All replies are confidential and will be treated as such.

1. The longest period of close confinement I have shared with others was _____
2. Describe the most disconcerting personal hygiene problem that you or others with you encountered. _____
3. Did the event cause you to miss a meal, perform work poorly, or just plain irritate you? _____
4. What item of normal living did you, or do you think you might, miss most with reference to personal hygiene? _____
5. Were you satisfied with the arrangements for
A. Shaving _____ Why?
B. Body Wash _____ Why?
C. Care of Teeth _____ Why?
D. Disposal of Soiled Clothing? _____ Why?
6. Did you feel you were in a "dirty" environment? _____
What made it so? _____
7. Did you realize you were probably breathing and rebreathing another person's expired air? _____ Did this annoy you in any way? _____
Explain. _____

Figure 52A. Personal Hygiene Questionnaire (cont'd)

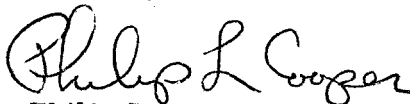
8. Given the opportunity would you prefer a bunk with clean sheets for every sleep period or could you manage with a change once a week? Would you feel the same if you couldn't shower?
9. Recognizing that we can all ignore a bad personal situation, would you hesitate to call a poor hygiene situation to the offender's attention? If so, why?
10. If you were responsible for the best possible personal hygiene facility which of these would you regard as absolutely critical?

Circle Selected Items

- A. Flush Toilet
- B. Shower
- C. Hand Sink
- D. Sauna
- E. Oral Hygiene Facility
- F. Makeup Mirror
- G. Sun Lamps
- H. Electric Hair Dryer
- I. Electric Razor
- J. Massage Instruments

Thank you for your prompt reply on behalf of NASA and Fairchild.

Sincerely,



Philip L. Cooper
Major USAF (Retired)
Program Manager

Address any inquiries to the above at
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Farmingdale, L.I., New York 11735
or telephone (collect) (516) 531-3197

Figure 52A. Personal Hygiene Questionnaire (concluded)

5. RECOMMENDATIONS

Since the initial intent of this study was to provide a baseline protocol, it follows that the proof of the theories implied must be tested. NASA/MSR is soon to embark on a valuable chamber program involving man in a simulated Skylab time frame. The employment of this hygiene protocol in such a study based on its design intent would enhance many areas of vital interest. The invocation of the personal hygiene program would relate to medical concerns, certain basic hardware involvements, and provide still further data for personal hygiene logistics, utility, and desirability. We have outlined in the accompanying flow sheet a logical sequence of events that considers many facets and attempts to integrate them. Based on the outcome of the protocol implementation, definite Skylab generation recommendations can be forthcoming. By stressing the need for interface involvement the suggestions would, undoubtedly, be timely and realistic. In essence, the knowledge of the operational plan with a review of its tasks can lead to an understanding of the personal hygiene limitations. Dependent on the tasks would be the levels of subject activity, work-rest cycle, and skin contamination. The appropriate level of effort with the tailored protocol can then be defined and mounted.

With reference to this study, we should like to suggest the following for consideration:

- 1) A comparison of soaps.
- 2) A comparison of dentifrices.
- 3) Use of creams to minimize chafing.
- 4) Use of a wet wipe for anal wash after defecation.
- 5) A study on various ways to wet a sponge with soap prior to washing.
- 6) New techniques for cleaning hair.

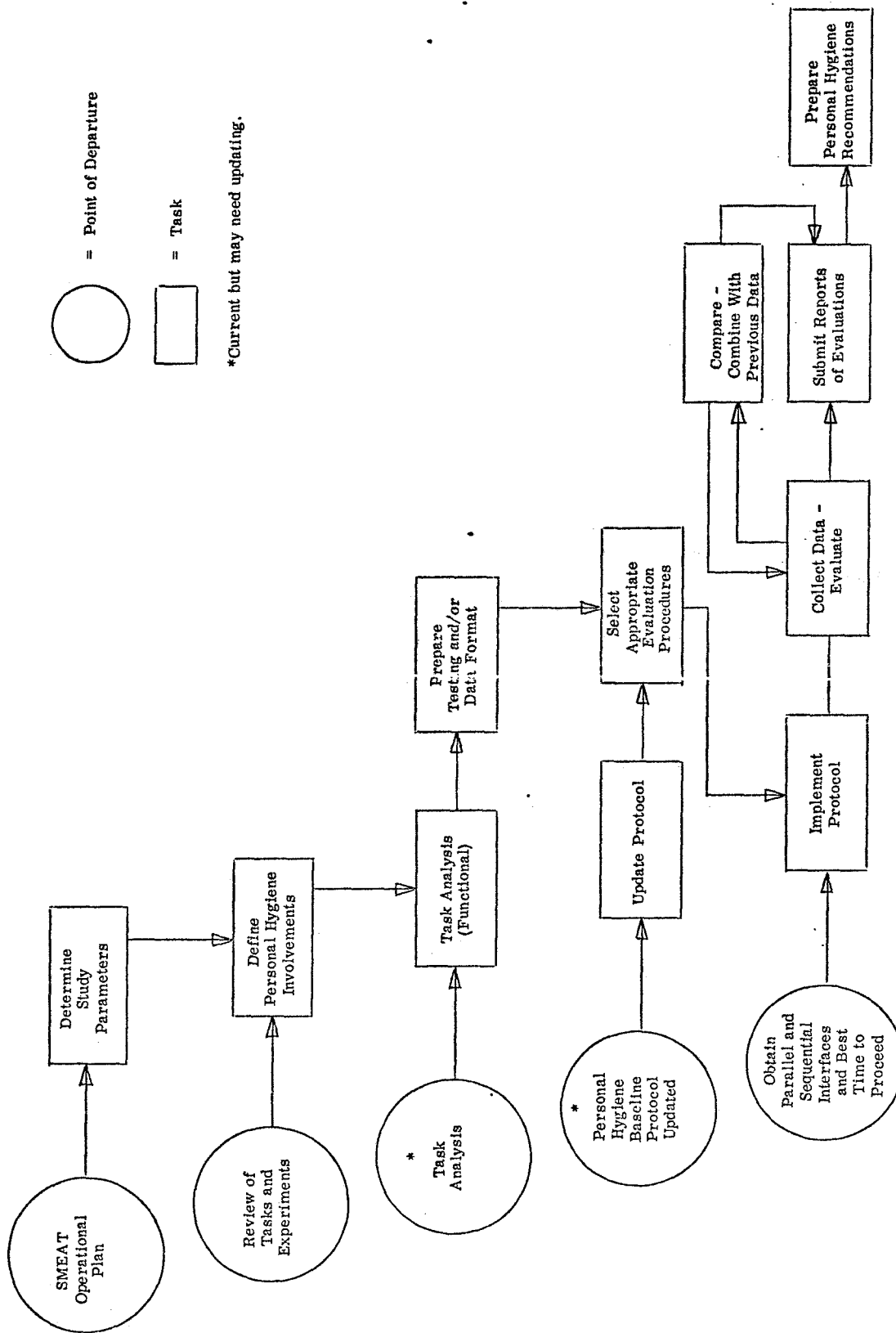


Figure 53A. SMEAT Personal Hygiene Evaluations



FAIRCHILD

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