Physiological Correlates of Optimal Performance

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I. Introduction

This research was directed toward defining the potential utility of psychological and physiological variables in predicting human performance during extended periods of stress. It was hoped that the information obtained would be of relevance to predicting human performance in space flight.

The project was divided into two phases. Phase I was directed toward defining baselines on the psychological, physiological and performance variables and to determine their stability over time. The first two experimental testings (runs) were ones in which the subjects came to the laboratory at approximately 10:00 P. M. and slept all night in the laboratory while the electroencephalogram, basal skin resistance, galvanic skin response, heart rate, finger blood volume, and respiration were continuously recorded. On the following morning, after a light breakfast, the subjects practiced performance on a vigilance-shock avoidance task consisting of monitoring three meters. The subjects (Ss) pressed buttons (interrogated) mounted in front of the three meters. When a meter deflection was observed, the subjects' task was to press another button corresponding to that meter as quickly as possible in order to avoid electric shock through the left calf. This task was divided into five conditions: 1. rest, 2. performance - 1.88 secs. reaction time - shock punishment, 3. performance - 1.88 secs. reaction time - no shock

punishment, 4. performance - 4.5 secs. reaction time - shock punishment, and 5. performance - 4.5 secs. reaction time - no shock punishment. Urine specimens were collected immediately after waking in the morning and following completion of the performance task approximately 2 hours later. Norepinephrine and epinephrine levels excreted in these urines were determined. The foregoing experimental testings provided an opportunity for the subjects to become acclimated to the laboratory, to become accustomed to sleeping all night in it and to reach asymptotic levels of performance on the vigilance task.

The third experimental testing (run 3) was identical to the first two except that the subjects were kept awake throughout the night performing various perceptual and motor tasks of a benign nature. The purpose of this experimental testing was to provide a baseline of total sleep deprivation of a non-stressful nature for comparison with what was expected to be partial sleep deprivation under the stress of Phase II of the experiment.

In the course of the Phase I research, an automated method for the classification of sleep stages was developed and this was published (Roessler, Collins & Ostman, 1970). In addition, as anticipated, performance was impaired following total sleep deprivation and this impairment was related to a psychological variable, ego strength, and to a physiological variable, skin conductance. These results

were reported in another publication (Strausbaugh & Roessler, 1970). Additional publications during the period of support from this grant are listed on page 24. The grant is credited with support in these publications because of the partial salary support provided the principal investigator under the grant and because these publications developed information relevant to the conduct of the psychophysiological aspects of this research.

The foregoing is a brief, general statement of the nature of the Phase I research and the results. Additional detail has been provided in previous semiannual status reports. In addition to the results reported earlier and those included in the publications already cited, additional analyses were made upon the data collected from Run 3 (the sleep deprivation run). Of particular interest were those variables correlated significantly with the total number of correct responses on the vigilance-shock avoidance task. These correlations are shown in Table 2. (These analyses were concluded after the last interim semiannual status report for the period January 1, 1970 through June 30, 1970. Because of the volume of data generated in Phase II of the experiment, a no-cost time extension was requested and granted until June 30, 1971.) Table 2 shows that the personality variables of ego strength, extraversion and impulsivity were all correlated at modest but significant levels with the total number of correct responses. The first variable, the score on the ego strength (Es) scale from the

Minnesota Multiphasic Personality Inventory, was positively correlated with the total correct number of responses and the extraversion variable from the Eysenck Personality Inventory and the Barratt Impulsivity Scale were negatively correlated. All these correlations were of similar magnitude and of moderate, but significant levels. Table 2 also shows the negative correlation of the embedded figures and of the rod and frame perceptual tasks with total number correct. These perceptual variables have been related to dependent personality characteristics in research by Silverman, et. al. (1961). In addition, the performance of the subjects upon the spatial organization task of the Guilford-Zimmerman Aptitude Survey also correlated significantly with the number correct. Among the norepinephrine variables, only the norepinephrine level following performance after all-night sleep deprivation was significantly correlated with number correct; no other norepinephrine or epinephrine correlations were significant. The rate at which the subjects interrogated (pressed buttons to light meters in order to observe whether a needle deflection was occurring) was also correlated with number correct, of course, as was reaction time.

The data summarized in Table 2 and that reported in the previously cited publication by Strausbaugh and Roessler, appeared to increase the likelihood that Phase II would be fruitful in developing information of value in predicting human performance under conditions

of sustained vigilance.

Phase II was a single experimental run for each subject remaining in the experiment after completion of the Phase I research. This consisted of three continuous days and nights in the laboratory. Those subjects who gave their informed consent were given the written instructions incorporated in Appendix A. In this phase of the experiment the subjects arrived at the laboratory at 6:30 A. M. and terminated the experiment (if they completed it) at 6:30 A. M. seventy-two hours later. In addition, they collected the urine specimen and followed the instructions regarding dietary intake, fluids, drugs and smoking given to them in the instructions in Appendix A. Prior to the first performance of the day the subjects were given the same light meal, consisting of 200 ml. of "Tang", which they had been given in Phase I. After the physiological transducers were attached, the instructions in Appendix B were read to the subjects. Before initiating performance on the vigilance task, the subjects also completed the questionnaire included as Appendix C. This inquired regarding any unusual life circumstances surrounding the time of this experimental testing, including the stress of intercurrent life events and physical illnesses, drug ingestion and previous night's sleep. Throughout the remainder of the experimental testing, the protocol summarized in Appendices D-1, D-2 and D-3 was followed by the technicians and the subjects. During the morning, afternoon and evening of each 24-hour

period, the subjects performed on the vigilance task on five different occasions, each lasting 110 minutes. In addition, there were two "rest-alert" periods, during which the subject was told that the red light on the performance module might light up at any time and, that if it did so, he was to begin monitoring the meters immediately or he would risk being shocked. During each 24-hour period, only the following performances were actually recorded: 7:30 - 9:20 A.M., 2:10 - 4:00 P.M. and 8:50 - 10:40 P.M. Following the last performance at 10:40 P.M., the subject was prepared for sleep and permitted to sleep uninterruptedly, if possible. The physiological variables previously recorded in Phase I of the experiment were also recorded during Phase II (run 4).

During Phase I of the experiment, every subject completed a sleep questionnaire relating to his usual sleep pattern. This is shown in Appendix E. Following each night of Phase II sleep in the laboratory, the subject completed Appendix F, relating to the quality of sleep during the experiment in the laboratory. In addition, the subjects also completed the Multiple Affect Adjective Check List (Appendix G) after each of the recorded performances. This check list provided a quantitative index of the subjects' anxiety, depression and hostility.

II. Results (Phase II)

Before proceeding with a discussion of the results, it must be

noted that the conduct of the research was compromised by lapses in funding. This resulted in a loss of subjects from the research and in a loss of trained technicians. Because of this and because, as expected, some subjects terminated because they found the experiment too distressing and because still others were terminated by the experimenter because he felt that to continue would risk their health, only 30 of the original 53 subjects were potentially available for the final phase of the experiment. When efforts were made to contact these subjects, it was found that an additional 9 subjects had moved away during the period after the completion of the sleep deprivation testing, leaving a potential 21 participants. Of these, 2 additional subjects failed to make or keep appointments, leaving only 19. Of the 19 who began the experiment, 2 were terminated by the experimenter because of the development of hypertension and 4 terminated the experiment on their own initiative because they found it too distressing. The foregoing information is summarized in Table 1. Column 1 of the table contains the subject numbers, column 2, the ego strength and manifest anxiety scores from the Minnesota Multiphasic Personality Inventory, and columns 3, 4, 5 and 6, the dates the subjects were tested in each experimental run or were lost to the experiment in the ways previously described. The ego strength and manifest anxiety scores were those which were obtained at the time of the third experimental testing (sleep deprivation run).

The results will be presented under the following variables classes: A. Performance, B. Personality and Mood, C. Catecholamines, D. Sleep, and E. Skin conductance, heart rate, finger pulse volume, galvanic skin responses and respiration.

A. Performance Variables.

The term "stress" is often used without rigorously defining what is meant. In this research, stress was defined as objective evidence of a decrement in the level of performance. The emphasis was upon the performance variables because these were the ones about which we hoped to obtain information of predictive value. In Phase I of the research, three performance variables - reaction time, interrogation rate, and number of errors (or number correct) - were examined in relation to personality variables and physiological variables. In this Phase II of the research, both errors of commission and errors of omission were calculated, in addition to total errors. This decision was made because of the reports of Williams (1966) and the work of Wilkinson (1963), who reported that errors of omission are more sensitive to stress than are errors of commission. This is particularly true of the stress of sleep deprivation. Table 3 shows the mean values for 8 subjects (the other five subjects who completed the 3 days of the experiment had some missing data) for each day on each of the performance parameters. Th is table shows the afternoon performances only in order to reveal trends independent of diurnal and

other circadian rhythms. Although the total number of errors increases from the first to the last day of the three day performance period, analysis of variance of these differences reveals that they are not significant. The mean commission errors actually are fewer on the third day than on the first and second, while the errors of omission increase progressively from the first through the third day. The mean differences in total errors are therefore attributable entirely to the errors of omission Once again, however, analysis of variance fails to reject the hypothesis that these differences could be attributable to chance. The mean reaction time is actually shorter on the second and third day than on the first; however, once again, these differences are not significant. Similarly, the mean interrogation rate slows from the first to the third day, but once again these differences fail to reach significance.

Similar analysis conducted on the morning and evening performances reveal similar trends, but in no instance do the differences achieve statistical significance. Moreover, when the data is examined for the effect of possible fluctuations attributable to the time of day, no significant differences are found. A further analysis was performed on the data from four high ego strength subjects, four low ego strength subjects (all of whom completed the three days) and four drop-out subjects. A summary of these analyses of variance for all these performance parameters is shown in Table 4 where the

significant differences and the level of significant differences are also noted. The conditions referred to in the table summary are the levels of task difficulty described in the introduction. The hours term refers to the fact that each of the five conditions listed in the introduction was repeated in the second 50 minutes of each performance period. There were no significant differences between groups, between morning and afternoon performances and (ignoring groups and groups interactions) there were no differences between the two performance periods in any of the performance parameters. The highly significant conditions effect simply reflects the greater number of total errors, shorter reaction time and faster interrogation rate associated with the more difficult level of performance. Based upon the data of these 12 subjects, we are obliged to conclude that there are no differences of potential predictive value between groups constituted on the basis of this personality dimension or constituted on the basis of their completing or not completing the experiment. It must be added, however, that this generalization cannot apply to levels of task difficulty beyond those employed. In retrospect, it is evident that this task was not sufficiently demanding for performance decrement to occur once the subjects practiced to an asymptotic level. Indeed, some subjects reported that with the repeated performances of Phase II, they were actually able to memorize the pseudo-random schedule of meter deflections in the vigilance task.

B. Personality and Mood Variables

Although there was no evidence of performance decrement in the form of significant differences between groups, between performance periods or between time of performance, the fact that four subjects dropped out of the experiment may be viewed as a failure in performance. These four subjects all terminated despite strong efforts to encourage their continuation, including the promise of an additional $50.00 bonus if they completed the full 72 hours. Although all of them reported that the money was very meaningful to them, they nevertheless dropped out. Their reasons for doing so were interesting. No subject reported that the shock itself was too distressing. Instead, in one way or another, all reported that they felt that their performance was not measuring up to their own expectations and/or they feared that it was not living up the experimenter's expectation. This was true, despite the previously mentioned lack of objective evidence that their performance was actually poorer than those who remained for the full 72 hours.

These four subjects are indicated by the capital letter B in the "Run 4" column of Table 1. Inspection of that table reveals that all four of these subjects were low ego strength - high manifest anxiety subjects. Further inspection reveals that, of the 13 subjects who completed the full 72 hours of the experiment, four were also low ego strength - high manifest anxiety subjects, using the mean of this sample as a cut-off point. However, two of these four, subjects No.

15 and 17, were above the population mean (44) on their ego strength scores. The other nine subjects completing the full 72 hours were all high ego strength subjects. Although this differential drop-out rate in relation to ego strength and manifest anxiety is suggestive, a Chi-square of this distribution does not achieve significance.

Our criterion for the presence of stress was objective evidence of decrement in performance variables. However, data on the subjects' anxiety, depression and hostility (Appendix G) was collected because previous research had shown an association between such decrement and subjective distress. It was possible therefore that there would be objective evidence of subjective distress, in the absence of performance decrement. Table 5 shows the mean values for these mood variables for all 13 subjects who completed run 4. Once again, although there is suggestive evidence of a peak in all three mood variables after the evening performance of the first and second days, an analysis of variance on all of this data failed to reach an F ratio value of statistical significance. Furthermore, the scores of those subjects who dropped out did not differ significantly from those completing the 72 hours. Also, no mean value for any variable was greater than one standard deviation above the population mean except the hostility score (61) after the evening performance on the second day. Since this was only one score among 30, the most parsimonious explanation is that it was due to chance. We conclude that this subjective report also fails

to support the interpretation that Run 4 was stressful.

C. Sleep

Table 6 contains two types of data. In the top half of the page is data on 7 subjects who had complete all-night sleep data on run 2 and also on the first night of run 4. The table shows the percentage of time spent in each sleep stage for each of the two nights for each subject. The data is presented in this way because it is one way to examine the question of whether or not the first night of the 72 hour stay in the laboratory was characterized by more disturbed sleep than the base-line night of run 2. Except for the percent of time spent awake and the number of awakenings, the table fails to reveal any consistent trends in percent of time spent in various sleep stages. The number of awakenings is greater during the run 2 night in every instance but one. The percent time spent awake is greater on the run 2 night in every instance. Using this criterion of disturbed sleep, it would be concluded that the baseline run was actually more disturbing than the first night of the Phase II experiment.

Another way of examining the data is to ask the question, "Do those subjects reporting distressing life events show a sleep pattern different from those who do not?" The double asterisks in the run 2 number of awakenings column indicates those subjects who did report such events on the sleep questionnaire. The mean number of awakenings and the percentage time spent in each stage of sleep does

not differ in any consistent way between those subjects reporting such stressful life events and those who did not.

On the bottom half of Table 6, the percent time spent in each stage of sleep on each of the three successive nights of Run 4 is shown. Here, a consistent trend is evident. There is a progressive increase in the percent time spent awake and a progressive decrease in the percent time spent in stages 3 and 4 (slow wave) sleep. If one assumes apriori that less slow wave sleep and more waking time is less restful sleep than the opposite pattern, this data suggests that the subjects were becoming progressively more distressed as the experiment proceeded. However, this interpretation is not supported by the subjective report data, either that from the adjective check list already reviewed or from the questionnaire reports.

D. Catecholamines

Catecholamine determinations on the urines collected in this experiment were carried out by Roy Mefferd, Jr., Ph. D., without cost to the grantor, because of the interest of Dr. Mefferd and the principal investigator. Mason, et. al. (1968) had shown an increased excretion of both norepinephrine and epinephrine by monkeys performing in a somewhat similar experimental design. Each of five monkeys was followed through at least three successive 72 hours of continuous shock avoidance. Urine samples were pooled for each of the three 24 hour periods in each 72 hour avoidance session. These

values were compared to the levels of catecholamines excreted during three recovery days and one control day. The greatest epinephrine excretion occurred during the avoidance days and the greatest norepinephrine excretion occurred during the three recovery days. Most monkeys showed greater excretion of epinephrine and norepinephrine on the avoidance days and the recovery days as compared to a control day. The experimenters concluded that, "the physiological or metabolic significance of the delayed and prolonged norepinephrine response during recovery is not at all clear." (page 662, op. cit.) In discussing the possible explanations, they suggest that the norepinephrine rise during recovery "is possibly an alteration in the metabolic fate of secreted norepinephrine which results in a higher percentage being excreted as the parent compound."

Table 7 contains the norepinephrine values for all of the subjects who completed the 72 hours run (the missing samples were either lost or contained too small a volume for analysis). The norepinephrine values before and after the vigilance performance on run 3 are also shown for comparison purposes.

It is evident, first of all, that the norepinephrine values are higher for most subjects during the 72 hour experiment than during the sleep deprivation experiment. There are also many values which are greater than the mean excretion rate during run 1 (5.1 micrograms/hr., pre-performance, and 6.7 micrograms/hr. post

performance) and run 2 (5.0 micrograms/hr., pre-performance, and 6.0 micrograms/hr. post performance). However, it is also clear that there is a great deal of intra-subject variability within run 4. For example, subject 26 excreted 19.4 micrograms/hr. on the evening before coming to the laboratory and only 1.3 micrograms/hr. during first evening performance in the laboratory. Similarly, there is a great deal of between subjects variability in norepinephrine excretion. For example, subject 49 never excreted more than 5.7 micrograms/hr. while subject 23 not only showed great variability within his own values but also excreted 20 or more micrograms/hr. on three different occasions throughout the 72 hr. experimental run. An analysis of variance of the values shown in Table 7 fails to reveal any significant differences, probably because of the variability already mentioned. When the means are examined at the bottom of the table, there is a trend toward higher norepinephrine values to occur after the evening performance but the differences are small and not significant. Further inspection and analysis fails to reveal any consistent diurnal trend.

It is of interest that the highest all-night value is the third night in the laboratory, possibly because the amount of norepinephrine excreted increases with anabolic processes, as Mason, et. al. suggested. At this point in the experiment, the subjects knew that the experiment was over except for sleeping in the laboratory on the third

night. Such an interpretation would also be congruent with the finding mentioned in earlier reports on this experiment, that the run 3 norepinephrine values were significantly lower than the run 1 and run 2 values. These lower values could be associated with catabolic processes. However, such an interpretation is not congruent with the generally higher values throughout run 4.

Table 8 shows the corresponding epinephrine values for the same subjects for run 4 and, in the last two columns, for run 3. Inspection of the mean values at the bottom of the page reveals a trend toward lower values during the sleeping hours but, once again, this difference does not reach significant statistical difference when all the data is subjected to analysis of variance. More careful inspection of individual values reveals the same intra-subject and between subjects variability characteristic of the norepinephrine values.

This variability raises a question as to the error of measurement in the catecholamine values. Aliquots of the same urine samples were used for independent determinations. The correlation between the two (N= 15 for both norepinephrine and epinephrine) was .85. Further data bearing on the reliability of catecholamine determinations is contained in Table 11, where the correlations between the pre-performance and post performance values are shown for all four experimental runs. In every instance, the correlations are significant and, in general, the greater the number of subjects, the higher the correlation. The data

on Table 11 also indicates that, despite the intra-subject variability subjects showed a significant tendency to maintain their rank in catecholamine excretion in relation to other subjects suggesting that these values, while perhaps not exact, do not contain a large error of measurement.

Table 9 shows the norepinephrine/epinephrine ratio. Some investigators have hypothesized that subjects in whom a fearful response predominates will show a smaller ratio and subjects in whom an aggressive response predominates will show a larger ratio. Comparison of these values with the mood data does not provide any support for this hypothesis. Moreover, analysis of variance for repeated measures again fails to reveal a significant F value for this data.

In Table 10, the catecholamine data for the four drop-out subjects is shown, again, along with the data on the same subjects for the sleep deprivation run. These subjects do not differ in their norepinephrine and epinephrine excretion nor in the ratio of one to the other from the same parameters in those subjects who completed the experiment.

Although the analyses of the performance parameters themselves failed to reveal any evidence of performance decrement, as already noted, the correlations between the catecholamines and the performance parameters are of intrinsic interest because of the widely held impression that increased catecholamine excretion is associated with

"stress". Table 12 shows the correlation of the epinephrine values with total errors and with reaction time for run 4. Correlations are shown for the performance levels on the first performance of day 1, (N = 13). None of the correlations are significant or approach significance. Table 13 shows the corresponding norepinephrine values. One correlation is significant, that between reaction time and the pre-norepinephrine value; the higher the norepinephrine value, the faster the reaction time. None of the other correlations are significant, and the most parsimonious explanation is that this correlation achieved significance by chance.

E. Autonomic Nervous System Variables.

Heart rate, finger pulse volume, respiratory rate and respiratory amplitude, number of galvanic skin responses, the mean amplitude of galvanic skin responses per minute, the sum amplitude of galvanic skin responses per minute and the basal skin conductance were recorded and analyzed for all of the performances noted as having been recorded in the introductory section. Each of these variables showed a change in the direction of increased sympathetic activation (increased heart rate, decreased finger pulse volume, increased respiratory rate, decreased respiratory amplitude, increased number, mean amplitude and sum amplitude of galvanic skin responses and increased basal skin conductance levels) under the more difficult performance conditions (1.88 secs. reaction time). However, as is true of the catecholamines,

there was no difference between days, performances, or between those subjects who completed the experiment and those who failed to do so. In general, the levels tended to be higher during the first day (though not significantly so) than during the second and third days. This paralleled the subjective reports of the subjects who reported that it seemed to them that once they completed 24 hours they experienced a "second wind" and that thereafter they completed the experiment without any question in their own minds whether they could succeed in doing so. Because of these completely negative findings, the detailed data is not included in this report.

However, because of the relationship between skin conductance and performance on the third experimental run (sleep deprivation), correlations were calculated between this variable and number of errors, omission errors, commission errors and reaction time. These correlations are shown in Table 14. None are significant but all are negative - the higher the skin conductance, the lower the number of errors in general and the shorter the reaction time. Although not significant, this direction of relationship corresponds to that reported for the run 3 data.

Although the relationship between skin conductance and performance parameters is similar to that demonstrated in the third experimental run, there is no relationship between the data in the fourth experimental run to the personality dimension of ego strength. The

latter did correlate with performance in the sleep deprivation run. Neither is there any correlation between skin conductance and other personality variables.

The relationship between the catecholamines and skin conductance is of interest. Table 15 shows the correlations between skin conductance and the norepinephrine and epinephrine values for the first performance of run 4. Both the pre-performance and post-performance epinephrines are correlated with skin conductance positively, beyond the .50 level. Because of the small N, the post-performance epinephrine value of +.54 only approaches significance; however, the pre-performance level is significant beyond the 99.9% level of confidence. The correlation of skin conductance with pre-performance and post-performance norepinephrine are of opposite sign and not significant. If any weight can be placed upon these correlations (because of the small N) it would seem that both skin conductance and epinephrine perhaps reflect generalized physiological activation. Norepinephrine, on the other hand, may be associated instead with anabolic processes, as previously suggested.

III. Conclusions

Although there is some suggestion in the drop-out and sleep data from this experiment that it was distressing, the weight of the data can only support the interpretation that, if it was stressful at all, it was minimally so. Most important is the absence of any significant decre-

ment in the level of performance throughout the 3 days, the criterion which was adopted as the operational indicator of stress. The mood variables and all of the physiological data apart from sleep are in keeping with the interpretation that the subjects were not highly activated - i.e., were not stressed. It must be concluded therefore that only the sleep data and the possible relationship of personality to dropping out are of potential relevance to the problem of predicting human vigilance performance in space flight. The data suggests that well-trained men can continue to perform well for extended periods (of at least 3 days) if the schedule is one permitting time for sleep and the tasks themselves are ones which can be performed with few, if any, errors. This interpretation, for the most part, fits with actual space flight experience.

On the other hand, the Phase I sleep deprivation results suggest the likelihood that more prolonged sleep deprivation would be associated with performance decrement. Since such situations have occurred in space flight previously and likely will again, this possibility is being pursued presently in a new experiment in which subjects will be kept awake and performing almost continuously for forty-eight hours.

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TABLE 1

NASA Sleep and Performance

S No.	Es-MAS	Run 1	Run 2	Run 3	Run 4
1	54-06	1-15-68	8-29-68	(A)	
2	60-07	1-19-68	7-19-68	(D)	
3	55-03	1-22-68	9-09-68	2-07-69	(D)
4	56-09	1-24-68	6-28-68	2-14-69	(A)
5	55-05	1-26-68	5-31-68	12-13-68	5-15-69
6	54-05	1-29-68	5-27-68	3-21-69	(C)
7	49-05	2-01-68	7-22-68	(B)	
8	59-03	2-02-68	(C)		
9	58-14	2-05-68	5-06-68	1-06-69	(C)
10	56-03	2-08-68	6-12-68	1-20-69	8-21-70
11	57-25	2-09-68	(D)		
12	53-06	2-12-68	4-26-68	4-12-69	4-24-70
13	45-13	2-15-68	5-01-68	(A)	
14	53-22	2-16-68	5-10-68	(A)	
15	45-19	2-19-68	5-20-68	4-16-69	9-12-70
16	46-26	2-21-68	(B)		
17	47-17	2-23-68	5-17-68	12-06-68	5-15-70
18	55-24	2-27-68	(B)		
19	47-08	2-28-68	7-17-68	(D)	
20	45-19	3-04-68	7-13-68	12-11-68	(B)
21	61-04	3-06-68	9-20-68	2-10-69	(C)
22	32-41	3-08-68	6-05-68	2-03-69	(B)
23	41-25	3-11-68	9-16-68	12-10-68	6-06-70
24	45-20	3-13-68	(C)		
25	43-14	3-15-68	6-10-68	(D)	
26	40-29	3-20-68	10-04-68	3-28-69	6-19-70
27	50-05	3-22-68	6-20-68	1-30-69	(C)
28	56-12	3-25-68	6-26-68	2-13-69	4-11-70
29	55-12	3-27-68	7-01-68	2-26-69	
30	51-23	3-29-68	5-08-68	1-20-69	5-08-69
31	50-17	4-01-68	5-22-68	3-17-69	(C)
32	55-07	4-03-68	7-09-68	3-12-69	5-09-70
33	47-13	4-05-68	(B)		
34	47-14	4-08-69	(D)		
35	47-07	4-10-68	6-14-68	(C)	
36	44-21	4-12-68	5-29-68	4-07-69	(C)
37	45-07	4-24-68	(C)		
38	57-09	6-07-68	7-15-68	2-24-69	(D)
39	58-10	7-23-68	(B)		
40	28-34	7-26-68	(D)		
41	53-08	7-29-68	9-06-68	3-19-69	(C)
42	57-16	7-31-68	(D)		
43	50-21	8-02-68	9-27-68	3-07-69	(A)
44	59-03	8-28-68	(B)		
45	58-10	9-12-68	(B)		
46	47-17	9-23-68	10-24-68	1-24-69	(C)
47	41-32	9-25-68	10-25-68	12-19-68	(B)
48	58-05	9-30-68	11-04-68	1-14-69	5-12-69
49	55-12	10-02-68	11-06-68	3-05-69	5-22-69
50	40-31	10-07-68	11-13-68	12-17-68	(B)
51	55-03	10-09-68	11-14-68	3-14-69	8-28-70
52	55-20	10-14-68	11-22-68	1-28-69	(C)
53	45-20	10-18-68	12-14-68	(C)	

(A) S terminated by E (B) S terminated self- too distressing (C) S moved away
(D) S failed to make and/or keep appointments

TABLE 2

Correlations of Personality, Perceptual, Catecholamine, and Performance Variables with Total Number Correct, Run 3 (N = 22)

Ego strength (MMPI)	.47*
Manifest anxiety (MMPI)	n.s.
Extroversion (Eysenck)	.43*
Neuroticism (Eysenck)	n.s.
Impulsivity (Barratt)	-.46*
Perceptual speed	n.s.
Spatial visualization	n.s.
Spatial organization	.48*
Embedded figures	-.58**
Rod and Frame	-.58**
Rod and Frame time	n.s.
Norepinephrine (pre-performance)	n.s.
Norepinephrine (post-performance)	.44*
Norepinephrine (Post - pre)	n.s.
Epinephrine (pre-performance)	n.s.
Epinephrine (post-performance)	n.s.
Epinephrine (post - pre)	n.s.
Interrogation rate	.55**
Reaction time	-.81***

*p < .05
**p < .01
***p < .001

TABLE 3

Performance Parameters, Afternoon Performances
(N = 8)

First Day	Second Day	Third Day
Total Errors		
1.42	1.86	2.27
Commission Errors		
.28	.28	.19
Omission Errors		
1.14	1.58	2.08
Reaction Time		
1.24	1.15	1.15
Interrogation Rate		
148.13	91.03	96.72

TABLE 4

Summary of Analyses of Variance (Significant F Values) of Performance Parameters for High vs Low Ego Strength vs Drop-out Subjects, First Morning and Afternoon Performances, Run 4

	Interrogation Rate	Reaction Time	Errors Σ	Errors Omission	Errors Commission
A (Groups)					
B (Performances)					
AB					
C					
AC (Groups x Hours)		*			
D (Conditions)	***	***	**		
AD (Groups x Conditions)		*			
BC					
ABC (Groups x performance x Hours)					
BD		*			
ABD					
CD		*			
ACD					
BCD					
ABCD					

* $p < .05$
** $p < .01$
*** $p < .001$

TABLE 5

Mean Values (T-scores) for Anxiety,
Depression and Hostility for Subjects Who Completed Run 4

Day 1			Day 2			Day 3			
A. M. Pre Perform.	A. M. Post Perform.	P.M. Post Perform.	A. M. Pre Perform.	A. M. Post Perform.	P. M. Post Perform.	A. M. Pre Perform.	A. M. Post Perform.	P. M Post Perform.	A. M. Post Experiment
Anxiety									
52	52	58	56	54	57	54	53	53	56
Depression									
49	49	57	57	52	58	54	52	52	53
Hostility									
52	51	64	59	55	61	48	55	54	56

TABLE 6

Distribution of % Time in Each Sleep Stage,
Subjects Common to Run 2 and Run 4, Night 1

S#	W %		Stage 1%		Stage 2 %		Stage 3 %		Stage 4 %		# Awakenings	
	Run 2	Run 4	Run 2	Run 4	Run 2	Run 4	Run 2	Run 4	Run 2	Run 4	Run 2	Run 4
10	8.11	.34	24.33	28.95	49.49	30.04	15.76	31.90	2.30	8.78	14	0
17	12.10	.61	21.81	19.88	47.32	60.24	17.37	18.86	1.40	.41	15**	0
20	2.92	1.88	9.44	18.89	47.94	55.98	28.24	16.32	11.46	6.92	5	4
28	12.70	5.06	31.67	28.86	33.41	37.22	18.57	25.23	3.65	3.63	6**	9
32	2.45	.42	12.34	10.08	40.31	44.50	25.21	25.00	19.69	20.00	4**	0
48	11.69	5.93*	20.52	28.44	28.48	37.04	26.25	21.93	13.05	6.67	11**	5
49	29.12	6.27	23.75	30.90	44.37	54.59	2.07	4.49	.69	3.75	28	9
$\bar{X}$	11.30	2.93	20.55	23.71	41.62	45.66	19.07	20.53	7.46	7.17	12	4

Percent Time in Each Sleep Stage, Run 4

Night 1 (N=12)	2	18	44	26	10
Night 2 (N=10)	5	25	39	23	8
Night 3 (N=8)	13	28	31	21	7

*Short night (3 hrs. 45 min.)
** Subjects reporting intercurrent life stress at time of Run 2

TABLE 7

NOREPINEPHRINE VALUES -- RUNS 3 & 4 (μg/hr.)

	0	1	2	3	4	5	6	7	8	9	10	Run 3	
					Run 4								
	Pre Expermt P.M.	Home Night	A.M. Perform	P.M. Perform	1st Night	2nd A.M Perform	2nd P.M. Perform	2nd Night	3rd A.M. Perform	3rd P.M. Perform	3rd Night	Pre Perform.	Post Perform.
10	6.6	10.8	4.0	7.5	9.2	16.6	17.6	2.0	6.1	6.4	9.8	2.6	1.8
12	20.0	10.5	4.1	3.0	7.2	6.7	9.2	9.9	13.4	9.1	8.1	3.6	7.1
15	16.9	16.8	4.2	15.4	4.6	10.0	6.1	4.0	15.2	20.0	18.0	2.8	3.3
17	6.7	15.8	15.7	20.1	2.5	1.3	6.3	6.9	20.0	2.9	20.0	2.5	1.4
23	1.7	5.8	3.1	5.0	1.3	20.0	21.0	13.8	9.2	35.0	19.3	2.7	1.2
26	19.4	13.4	20.0	1.3	15.0	14.3	18.7	16.4	17.0	22.1	17.0	2.4	8.0
28	1.0	13.6	9.0	5.6	3.8	7.0	8.3	5.1	6.7	10.4	5.8	3.1	3.4
32	12.0	14.1	17.5	22.3	25.0	25.0	20.6	18.4	19.6	12.0	14.0	3.9	2.1
51	10.0	1.8	1.1	1.1	9.1	2.8	9.7	7.7	16.0	1.0	7.9	1.6	2.0
5	- -	2.5	2.8	5.0	1.8	4.2	2.4	3.4	6.1	11.8	-	1.6	3.0
30	-	2.6	2.9	7.8	2.6	3.7	8.1	2.1	2.7	8.6	2.2	2.6	4.0
48	-	1.9	2.5	1.9	1.7	5.1	4.2	2.3	4.9	9.5	-	2.1	5.8
49	-	1.3	7.5	2.1	2.3	5.7	3.9	2.0	4.2	4.1	4.2	5.4	3.5
$\overline{X}$	10.5	8.5	7.2	7.5	6.6	9.4	10.5	7.2	10.9	11.8	11.5	2.8	3.6

TABLE 8

EPINEPHRINE VALUES - RUNS 3 & 4 ($\mu g/hr.$)

	0	1	2	3	4	5	6	7	8	9	10	Pre	Post
10	1.3	.6	.5	.4	1.1	1.9	.9	1.1	2.5	1.5	1.3	1.9	.8
12	5.3	1.5	2.1	1.8	1.4	1.7	3.9	1.8	2.2	1.6	1.5	1.1	2.1
15	1.6	1.3	1.9	1.5	.7	1.1	1.4	1.8	.8	2.7	2.5	2.0	2.4
17	1.0	.9	.7	2.6	1.8	3.4	1.2	2.4	3.6	2.2	1.5	.7	2.2
23	.9	1.5	2.0	1.3	.5	1.9	3.1	1.8	1.9	3.2	3.6	1.3	4.2
26	1.6	1.1	1.9	4.4	2.3	2.9	4.0	4.1	3.4	.7	4.1	2.6	3.8
28	.9	1.1	1.3	1.4	1.2	1.0	2.4	1.0	1.6	2.8	1.3	1.7	.7
32	1.7	1.3	2.0	1.7	1.0	1.6	1.3	.7	1.3	1.0	1.8	.5	1.0
51	2.3	1.0	1.4	5.0	.4	.7	1.0	1.5	2.7	1.1	1.1	1.1	1.2
5	-	.9	2.1	2.4	.8	2.2	.5	.3	1.0	1.3	-	.7	.9
30	-	.9	.5	1.3	.2	.9	1.8	.2	.3	2.5	.5	1.5	2.1
48	-	.5	.6	.4	.4	.9	.6	1.0	1.4	1.0	-	1.1	.4
49	-	1.0	1.1	1.3	.3	.4	1.6	.3	1.3	1.3	.9	1.3	1.1
$\bar{X}$		1.0	1.4	2.0	.9	1.6	1.8	1.4	1.8	1.8	1.8	1.3	1.8

TABLE 9

NOREPINEPHRINE/EPINEPHRINE RATIO - RUNS 3 & 4

S#	0	1	2	3	4	5	6	7	8	9	10	Run 3 Pre	Run 3 Post
10	5.1	18.0	8.0	18.7	8.4	8.7	19.6	1.8	2.4	4.3	7.5	1.4	2.2
12	3.7	7.0	1.9	1.7	5.1	3.9	2.4	5.5	6.1	5.7	5.4	3.3	3.4
15	10.6	12.9	2.2	10.3	6.6	9.1	4.4	2.2	19.0	7.4	7.2	1.4	1.4
17	6.7	17.6	22.4	7.7	1.4	.4	5.2	2.9	5.6	1.3	13.3	3.6	.6
23	1.9	3.9	1.6	3.8	2.6	10.5	6.7	7.7	4.8	10.9	5.4	2.1	.3
26	12.1	12.2	10.5	.3	6.5	4.9	4.7	4.0	5.0	31.6	4.1	.9	2.1
28	1.1	12.4	6.9	4.0	3.2	7.0	3.5	5.1	4.2	3.7	4.5	1.8	4.9
32	7.1	10.8	8.7	13.1	25.0	15.6	15.8	26.3	15.1	12.0	7.8	7.8	2.1
51	4.3	1.2	.8	.2	22.7	4.0	9.7	5.1	5.9	.9	7.2	1.5	1.7
5	-	3.0	1.3	2.0	2.2	1.9	5.3	12.2	6.4	9.1	-	2.3	3.3
30	-	3.0	5.7	5.8	11.9	4.3	4.5	9.7	9.2	3.4	5.0	1.7	1.9
48	-	3.8	3.9	4.3	3.8	5.8	6.8	2.2	3.4	9.5	-	1.9	14.5
49	-	1.2	6.6	1.6	7.0	15.3	2.5	6.0	3.3	3.2	4.5	4.2	3.2
$\bar{X}$	5.8	8.3	6.2	5.7	8.2	7.0	7.0	7.0	6.9	6.5	6.5	2.6	3.2

TABLE 10

DROPOUTS

Norepinephrine

S#	0	1	2	3	4	5	Run 3 Pre	Run 3 Post
20	13.7	2.0	8.5	4.9	3.4	13.9	1.5	4.8
22	16.6	1.4	11.8	21.2	10.3	-	4.4	3.2
47	1.0	4.9	9.9	-	-	-	6.1	13.6
50	10.0	3.4	2.1	-	-	-	.9	1.1
$\bar{X}$	10.3	2.9	8.1	13.0	6.8	13.9	3.2	5.7

Epinephrine

20	3.1	.5	.6	-	-	1.5	.4	.5
22	3.8	.4	1.9	1.6	1.4	-	1.6	1.4
47	.3	.6	1.9	-	-	-	1.0	2.1
50	1.7	.2	.8	-	-	-	.5	.5
$\bar{X}$	2.2	.4	1.3	1.6	1.4	1.5	.9	1.1

Norepinephrine/Epinephrine Ratio

20	4.4	4.0	14.2	-	-	9.3	3.8	9.6
22	4.4	3.5	6.2	13.2	7.4	-	2.8	2.3
47	3.3	8.2	5.2	-	-	-	6.1	6.5
50	5.9	17.0	2.6	-	-	-	1.8	2.2
$\bar{X}$	4.5	8.2	7.0	13.2	7.4	9.3	3.6	5.2

TABLE 11

Reliability of Catecholamine Pre-performance with Post-performance Values, Runs 1, 2 and 3, 4

	47 Ss 1	22 Ss 2	30 Ss 3	19 Ss 4 (1st perform.)
Norepinephrine	.39**	.44*	.63***	.48*
Epinephrine	.59***	.49*	.63***	.66**

TABLE 12

Correlations of Epinephrine Values with
Total Errors and Reaction Time, Run 4

Errors Pre Epinephrine	-.27
Errors Post Epinephrine	-.15
Errors Diff. Epinephrine	.02
Reaction Time Pre Epinephrine	-.09
Reaction Time Post Epinephrine	-.01
Reaction Time Diff. Epinephrine	.04

TABLE 13

Correlations of Norepinephrine Values
with Total Errors and Reaction Time, Run 4

Errors Pre Norepinephrine	-.03
Errors Post Norepinephrine	-.27
Errors Diff. Norepinephrine	-.22
Reaction Time Pre Norepinephrine	-.74 **
Reaction Time Post Norepinephrine	-.12
Reaction Time Diff. Norepinephrine	.01

** $p < .01$

TABLE 14

Correlations of Skin Conductance with Total Errors, Errors of Commission, Errors of Omission and Reaction Time

Skin Conductance Σ Errors	-.35
Skin Conductance Omission Errors	-.33
Skin Conductance Commission Errors	-.33
Skin Conductance - Reaction Time	-.10

TABLE 15

Correlation of Skin Conductance with
Catecholamine Values for First Performance
(N = 12)

SC with (difference) Post - Pre Performance Noradrenaline	-.51+
SC with Pre - Performance Noradrenaline	+.44
SC with Post - Performance Noradrenaline	-.08
SC with (difference) Post - Pre Adrenaline	-.05
SC with Pre - Performance Epinephrine	+.87 ***
SC with Post - Performance Epinephrine	+.54+

+ p .10

***p < .001

Appendix A

Instructions to Subjects
Run 4

I would like you to follow these instructions as far as possible during the day, prior to coming to Room 07-D, Baylor, at 6:30 AM in the morning.

1. Follow your usual diet but avoid candy, cheese and bananas.
2. Eat a light meal between 6:00 - 7:00 PM. Please eat nothing between 7:00 PM and the time you arrive in the evening.
3. Do not drink any caffeine-containing beverages such as coffee, tea and coke. Other soft drinks are o.k.
4. Do not drink alcohol in any form.
5. If you smoke, try to reduce the number of times you smoke during the day.
6. Do not drink anything after your evening meal. (We will give you a measured amount of fluid before the experiment begins)
7. Do not take drugs of any kind, including such ordinary ones as aspirin and antihistamines. (If you are ill on the day of the experiment, please call and we will re-schedule it.)

Remember, your appointment is for _____ at 6:30 A.M.

Robert Roessler, M. D.

P.S. In addition to the urine metabolite specimens to be collected during your 180-hr. stay in the laboratory, we will need a specimen from the day prior to your coming to the lab. Please follow the instructions below:

1. At approximately 8:50 P.M., void and record the exact time. Do not save this specimen and do not void again for 2 hours.
2. At 10:40 P.M., void again, and save this specimen, recording exact time. Refrigerate specimen and bring it with you when you come to the lab tomorrow morning.

APPENDIX B

PERFORMANCE, NASA IV TECHNICIAN'S INSTRUCTIONS

* Read these instructions before 1st performance session of NASA IV.

The performance for this experiment is the same as it has been for the other three.

Please rest the arm with the electrodes on it comfortably on the arm of the chair and try to move it as little as possible.

Remember, pressing the green buttons activates the lights behind the corresponding meters. ~~and~~ Your task is to press the red button corresponding to the meter in which you detect a needle deflection. If you do not press it quickly enough or if you press the wrong button, or if you fail to observe a needle deflection, you will receive an electric shock through the calf of your leg after we have begun this portion of the experiment. It is impossible to cheat because if you press the red button when there is not a meter deflection you will receive a shock. The needle deflections are scheduled in such a way that there are different intervals between them and they occur randomly among the three meters. It is therefore necessary for you to press the green buttons rapidly to make sure that you do not miss a needle deflection.

Press the green buttons in the one - two - three order, from left to right.

The experiment will be divided into several segments. You will have rest periods, periods of performance without shock and periods during which you will be shocked if you make mistakes. Try to press the buttons as rapidly as possible, even when the shock unit is not activated. Your reaction time and your errors will be recorded even though you will not be shocked. Remember, your reaction time and total number of errors during both shock-activated and deactivated performances will be used to determine who receives the bonus of $100.00. Before each phase we will tell you over the intercom what your task is to be. When the instruction is "Performance", you will press the green buttons in the 1-2-3 left-to right order, then press the corresponding red button each time you see a needle deflect in one of the 3 meters. When the instruction is "Performance, Shock", a red light will come on, indicating that you are to perform in the same manner but will be shocked for errors. When the instruction is "Rest, Eyes Closed", you should make yourself comfortable, relax your jaw, and try to move as little as possible.

If you have any questions about the performance task, please ask them now. No questions will be answered once the experiment has begun.

TECHNICIAN: Instructions in 2nd paragraph are to be given before each performance session.

APPENDIX C

SUBJECT QUESTIONNAIRE

Run no. _____
Record no. _____
Time _____

1. NAME: _____ Social Security No. _____

2. DATE: _____

3. Are you now suffering, or have you suffered from any acute illness today or during the past week? (Include minor illnesses such as "flu", colds, allergies - no matter how minor.) _____

4. Have you taken any medication in the past 48 hours? If yes, list the drug(s) and dosage (include such ordinary drugs as aspirin, antihistamines, vitamins, etc.)

5. How many cups of coffee, if any, did you drink today? _____

6. Do you use alcohol in any form? _____ Have you had any in the past 24 hours? _____. If yes, how much? _____

7. Did you smoke today? If yes, what and how much? _____

8. Have any unusual events occurred in your life during the past week and/or are you anticipating anything unusual? (Pleasant, unpleasant or neutral - e.g., financial problems, unexpected good fortune, difficulty in one of your courses, a fight with your girl friend, etc.) If yes, briefly describe. _____

9. Has anything upset you today (usual or unusual)? If yes, describe briefly how you felt and what it was that disturbed you. _____

10. Have you ever had any serious illness? If so, what and when? _____

11. When did you last see a doctor? For what reason did you see him? _____

12. Did you sleep well last night? _____
How many hours? _____

DAY 1 2 3 Shift 1
Date _____
Tape _____
File _____

Appendix D-1

PROTOCOL

NASA IV

Subject _____
Technician _____

**Dr. Roessler will be available and on call during this entire run. Should a technician feel concern for the medical welfare of a subject, Dr. Roessler should be notified immediately. Call 667-8154, day or night.

6:30 - 7:30 AM:

____ Calibrate equipment.
____ Have subject void. Save and label D____. Record exact time here _____.
____ Have subject sign Permission Form and complete health questionnaire. (This applies to first day only)
____ Give subject 200 ccs. Tang and breakfast (corn flakes, milk, 1 Tbls. sugar)
*____ Prep subject. Take and record blood pressure here: _____
____ Have subject complete Sleep Questionnaire II (Days 2 and 3 only)

7:30 - 9:20 AM:

____ Take and record blood pressure here: _____ (1)
____ Have subject complete Zuckerman, No. _____.
____ Begin Performance. Record.
Comments on Performance: _____

_____

Take and record blood pressure here: _____

____ Have subject void. Save and label D____. Record exact time here _____
____ Have subject complete Zuckerman No. _____.
____ Have subject complete ES - MAS Scale (First day only)

9:20 - 10:20 AM:

**____ Rest period. Subject may shave, brush teeth, etc. at this time.
____ Give subject 200 ccs. water.
____ Have subject complete Sleep Questionnaire I (1st day only)

10:20 - 12:10

____ Check electrodes for loose connections, bad contact, etc.
____ Performance. Do not record. (2)

12:10 - 1:10 PM

____ Lunch. (Roast beef sandwich and milk)
____ Have subject void. Do not save specimen. Record time here _____

1:10 - 2:10 PM

____ Check electrodes.
____ Rest-alert. Do not record. (Reinforce, 1:45, 3rd day)
____ Give subject 200 ccs. water.

** IF RUNNING LATE, REST AND REST-ALERT PERIODS MAY BE SHORTENED
* B/P of <150/<90 should be reported to Dr. Roessler

NASA IV

**Dr. Roessler will be available and on call during this entire run. Should a technician feel concern for the medical welfare of a subject, Dr. Roessler should be notified immediately. Call 667-8154, day or night.

2:10 - 4:00 PM

____ Blood Pressure Reading: _____ (3)

____ Performance. Record.

Comments on Performance: _____

_____

Blood pressure reading:

____ Have subject void. Do not save specimen. Record time here: _____

4:00 - 5:00 PM

____ Rest-alert. Do not record. (Reinforce at 4:20, 1st & 3rd days)

____ Give subject 200 ccs. water.

5:00 - 6:00 PM

____ Supper. (Ham sandwich, salad & italian dressing, milk, choc. cake.)

COMMENTS: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Technician

DAY 1 2 3 Shift 2 APPENDIX D-3 Subject _____
Date _____ Technician _____
Tape _____
File _____

NASA IV

**Dr. Roessler will be available and on call during this entire run. Should a technician feel concern for the medical welfare of a subject, Dr. Roessler should be notified immediately. Call 667-8154, day or night.

6:00 - 7:50 PM

_____ Check electrodes
_____ Performance. Do not record. (4)

7:50 - 8:50 PM

_____ Rest-alert. Do not record. (Reinforce at 8:10, 2nd day

8:50 - 10:40 PM (5)

_____ Blood Pressure reading: _____
_____ Have subject void. Do not save specimen. Record time here _____
_____ Check electrodes.
_____ Performance. Record.
Comments on Performance: _____

_____

Blood Pressure reading: _____

_____ Have subject void. Save and label D_____. Record exact time _____
_____ Have subject complete Zuckerman No. _____

10:40 - 11:00 PM

_____ Prep for sleep.
_____ Give subject 200 ccs. water.

11:00 PM - 6:30 AM

_____ Sleep. Record EEG and EOG on Grass Recorder.
*On last morning have subject void. Save and label D-10. Time _____
*On last morning, give Zuckerman, Sleep Questionnaire II and reaction form.

COMMENTS: _____

APPENDIX E

Subject # _____ Sleep Questionnaire I (Pre) NASA Run _____

Name: _____ Date: _____

1. How long does it generally take for you to go to sleep? (Minutes) _____

2. How many times per week do you fall asleep within 5 minutes? _____

3. How many times per week does it take more than 30 minutes? _____

4. How many nights per week do you awaken during the night? _____

5. How many times per night do you wake up? _____

6. How many times per month do you wake up and are unable to go back to sleep?

_____

7. When you awake how difficult is it to go back to sleep? (Check one).
   No Difficulty ( )
   Considerable difficulty ( )
   Usually not able to ( )
   Never able to ( )

8. How much difficulty do you have in falling asleep? (Check one)
   No difficulty ( )
   Very little difficulty ( )
   Quite a bit of difficulty ( )
   Much difficulty ( )

9. How rested do you feel in A. M. ? (Check one)
   Very rested ( )
   Moderately rested ( )
   Not very rested ( )
   Not rested at all ( )

10. How much do you enjoy sleep? (Check one)
    Much enjoyment ( )
    Moderate enjoyment ( )
    Little enjoyment ( )
    No enjoyment ( )

APPENDIX F

Subject No. _____ Sleep Questionnaire II (Post) NASA Run _____

Name: _____ Date: _____

1. Describe the quality of your night's sleep during the experiment. If poor or unusual, tell why it was so. _____

2. How long did it take for you to go to sleep? (minutes) _____

3. Did you awaken during the night? _____

4. How many times did you awaken? How long were you awake and approximately what part of the night did the awakening(s) occur? _____

5. Were you ever awake and unable to return to sleep for a considerable period of time? How long was the period? _____

6. If you awakened, how difficult was it to go back to sleep? (Check one)
   No difficulty ( ) Very little difficulty ( )
   Considerable difficulty ( )
   Not able to ( )

7. How much difficulty did you have in falling asleep initially?
   No difficulty ( )
   Very little difficulty ( )
   Quite a bit of difficulty ( )
   Much difficulty ( )

8. How rested do you feel this A. M. ?
   Very rested ( )
   Moderately rested ( )
   Not very rested ( )
   Not rested at all ( )

9. How much did you enjoy your sleep?
   Much enjoyment ( )
   Moderate enjoyment ( )
   Little enjoyment ( )
   No enjoyment ( )

10. Do you remember dreaming? If so, tell how many dreams you had and briefly describe the content of the dreams. _____

APPENDIX G
Multiple Affect Adjective Check List

1 ☐ active
2 ☐ adventurous
3 ☐ affectionate
4 ☐ afraid
5 ☐ agitated
6 ☐ agreeable
7 ☐ aggressive
8 ☐ alive
9 ☐ alone
10 ☐ amiable
11 ☐ amused
12 ☐ angry
13 ☐ annoyed
14 ☐ awful
15 ☐ bashful
16 ☐ bitter
17 ☐ blue
18 ☐ bored
19 ☐ calm
20 ☐ cautious
21 ☐ cheerful
22 ☐ clean
23 ☐ complaining
24 ☐ contented
25 ☐ contrary
26 ☐ cool
27 ☐ cooperative
28 ☐ critical
29 ☐ cross
30 ☐ cruel
31 ☐ daring
32 ☐ desperate
33 ☐ destroyed
34 ☐ devoted
35 ☐ disagreeable
36 ☐ discontented
37 ☐ discouraged
38 ☐ disgusted
39 ☐ displeased
40 ☐ energetic
41 ☐ enraged
42 ☐ enthusiastic
43 ☐ fearful
44 ☐ fine
45 ☐ fit
46 ☐ forlorn
47 ☐ frank
48 ☐ free
49 ☐ friendly
50 ☐ frightened
51 ☐ furious
52 ☐ gay
53 ☐ gentle
54 ☐ glad
55 ☐ gloomy
56 ☐ good
57 ☐ good-natured
58 ☐ grim
59 ☐ happy
60 ☐ healthy
61 ☐ hopeless
62 ☐ hostile
63 ☐ impatient
64 ☐ incensed
65 ☐ indignant
66 ☐ inspired
67 ☐ interested
68 ☐ irritated
69 ☐ jealous
70 ☐ joyful
71 ☐ kindly
72 ☐ lonely
73 ☐ lost
74 ☐ loving
75 ☐ low
76 ☐ lucky
77 ☐ mad
78 ☐ mean
79 ☐ meek
80 ☐ merry
81 ☐ mild
82 ☐ miserable
83 ☐ nervous
84 ☐ obliging
85 ☐ offended
86 ☐ outraged
87 ☐ panicky
88 ☐ patient
89 ☐ peaceful
90 ☐ pleased
91 ☐ pleasant
92 ☐ polite
93 ☐ powerful
94 ☐ quiet
95 ☐ reckless
96 ☐ rejected
97 ☐ rough
98 ☐ sad
99 ☐ safe
100 ☐ satisfied
101 ☐ secure
102 ☐ shaky
103 ☐ shy
104 ☐ soothed
105 ☐ steady
106 ☐ stubborn
107 ☐ stormy
108 ☐ strong
109 ☐ suffering
110 ☐ sullen
111 ☐ sunk
112 ☐ sympathetic
113 ☐ tame
114 ☐ tender
115 ☐ tense
116 ☐ terrible
117 ☐ terrified
118 ☐ thoughtful
119 ☐ timid
120 ☐ tormented
121 ☐ understanding
122 ☐ unhappy
123 ☐ unsociable
124 ☐ upset
125 ☐ vexed
126 ☐ warm
127 ☐ whole
128 ☐ wild
129 ☐ willful
130 ☐ wilted
131 ☐ worrying
132 ☐ young