FINAL REPORT - Part III

Contract NAS 9-13870 (Including Modification 3S)

with

The Methodist Hospital
Houston, Texas

AUTOMATED ELECTROENCEPHALOGRAPHY SYSTEM

AND

ELECTROENCEPHALOGRAPHIC CORRELATES OF SPACE MOTION SICKNESS

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SECTION 3

QUANTIFICATION AND SIGNIFICANCE OF ELECTROENCEPHALOGRAPHIC CHANGES ASSOCIATED WITH SPACE FLIGHT

3.1. SUMMARY

The Skylab EEG data has been analyzed in a quantitative manner, using a computer methodology that provides both amplitude and frequency information. For comparison purposes, a similar analysis of the Skylab Medical Experiments Altitude Test (SMEAT) data was also accomplished. The results indicate that the unique environment associated with space flight does influence the electroencephalogram (EEG), and several inflight changes were common to all three astronauts studied. The awake state was characterized by increases of beta and delta activity and elevation of the average alpha frequency. During stages 2 and 3 of sleep, the delta amplitude tended to be higher than preflight. In addition, certain other significant alterations were found to occur in individual cases. In spite of these clear-cut changes inflight, the EEG characteristics were never found to be abnormal.

A number of potential etiological factors have been identified and their various possible influences discussed. The occasional use of drugs inflight was considered to be one conceivable explanation for increases in beta-range activity and for elevation of the alpha frequency. The pattern of medication use, however, seems to preclude this factor as the sole cause, although it probably exerted some effect. Changes in metabolic rate and psychological aspects might also play a role. The presence of the zero-g state was thought to be an important factor, possibly influencing EEG through alteration of vestibular function and/or by producing fluid shifts secondary to loss of hydrostatic pressure.

The results indicate that the EEG may eventually be of value in determining the etiology of the "space motion sickness" syndrome. In particular, the possibility that increased intracranial pressure may result from fluid shifts associated with prolonged weightlessness should be considered in future studies.

3.2. INTRODUCTION

The goal of this project was to analyze in detail, using computer quantification methods, the Skylab electroencephalographic data obtained during the course of the M133 series of experiments (1-5). This undertaking was prompted by initial observations made during visual analysis of the tape-recorded sleep records. It was noted that there appeared to be an increase of the alpha-rhythm frequency during some inflight recording sessions, as compared to preflight baseline observations. Subsequently, this was investigated in a more systematic manner, using visual-analysis techniques.

The results of this preliminary study (5) indicated that in all three Skylab missions there was at least a tendency toward an increased alpha frequency. This phenomenon was most clear-cut in the 84-day flight, with an average increase of approximately 0.8 Hz, compared to baseline. A similar, but less pronounced, result was determined for the 59-day mission, and, although only two inflight monitoring sessions were obtained during the 28-day flight, a slight elevation was observed.

A more extensive and quantitative analysis of this data was consequently proposed in order to extract as much information as possible from the Skylab results. It was postulated that such information could be of value in identifying possible neurological factors involved in production of the space motion sickness syndrome, which has been a recurrent problem in past manned space flights.

3.3. METHODS

3.3.1. Data-Base Considerations

As a part of the sleep monitoring experiment (M133), the EEG was recorded during selected all-night sessions from three Skylab astronauts. Signals were obtained from the scalp by means of a recording cap, containing built-in sponge electrodes. After suitable amplification, the EEG, in addition to EOG (electro-oculogram) and head-movement signals, was recorded on an onboard analog tape recorder. At the termination of each mission, the tapes were returned and subsequently played back to produce graphic records suitable for visual analysis of sleep characteristics. These analog tapes were utilized in the present study and served as the basic data base.

Only one EEG channel was recorded during Skylab, and it was derived from four scalp electrode positions: left central (C_1), right central (C_2), left occipital (O_1), and right occipital (O_2). The two central electrode positions were electrically paired, as were the two occipitals, and each pair served as one input to the EEG amplification system. This paired central-to-paired occipital derivation provided a highly reliable channel for determination of sleep characteristics, but, in terms of the present study, it prevented consideration of any left-right differences (asymmetries) that might have been present. Similarly, the limited montage did not permit a comprehensive examination of EEG characteristics in the clinical sense, which would have required more complete coverage of the frontal and temporal areas.

In addition to the Skylab data, computer analyses were also performed on the tape-recorded EEG data obtained from the Scientist Pilot (SPT) of the SMEAT. This study (6) duplicated, under 1-g conditions, the features of a typical Skylab mission and thus provided a control for some of the variables associated with actual space flight.

3.3.2. Selection of Data for Analysis

The following table summarizes the basic data available for analysis.

Flight	Subject	Number of Nights Preflight	Inflight	Postflight
28-day Skylab	J.K.	3	2	3
59-day Skylab	O.G.	3	12	3
84-day Skylab	E.G.	3	18	3
56-day SMEAT	W.T.	2	16	3

The graphic records corresponding to these recordings, each comprising an all-night monitoring session, were examined visually in order to select clear-cut, typical, and artifact-free samples for detailed computer analysis. From each record, an attempt was made to select one 60-sec sample during each of the following states of consciousness:

(1) Awake. This sample was identified from the presleep period of each recording session, i.e., between the time the subject donned the recording cap and began the recording session and the first appearance of drowsiness. The awake state is typically characterized by 8-12 Hz alpha activity and/or low-amplitude, mixed-frequency activity. Some low-voltage 18-22 Hz rhythmic activity may be present as well. Care was taken to avoid taking samples from sections showing signs of drowsiness (e.g., increased amounts of theta activity {4-7 Hz}, decreased voltage of alpha, or slow, rolling movements of the eyes {as noted in the EOG channel}).

(2) Stage 2 Sleep. This stage of light sleep is characterized by a somewhat random frequency, low-amplitude, background activity, upon which bursts (spindles) of 12-14 Hz rhythmic activity and/or relatively high voltage transient forms exceeding 0.5 sec in duration (K-complexes) are superimposed. Because this stage tends to vary somewhat in its appearance in the early morning (after several hours of sleep), an attempt was made to select this sample from the first half of the monitoring session.

(3) Stage 3 Sleep. This stage is usually considered to be a form of deep sleep and is characterized by the occurrence of fairly high amplitude (>75 μV) activity of 2 Hz or slower, which is present between 20 and 50% of the time, superimposed upon a background otherwise basically similar to that of stage 2.

(4) Stage REM Sleep. This stage is highly correlated with dreaming and is characterized by relatively low amplitude EEG signals of a somewhat lower frequency (5-7 Hz) than the awake state. It is accompanied by rapid and sporadic bursts of eye movements, as detected in the EOG.

Stages 1 and 4 were not included in the sampling scheme after initial attempts showed that because of their transient nature, reliable selection of samples of adequate length was not always possible.

In a few instances it was not possible to find a suitable 60-sec sample of a particular stage on a particular night. In such cases, a shorter sample

(30 sec) was located, if possible, and the results were subsequently normalized.

3.3.3. Data-Analysis Techniques

3.3.3.1. Analog Tape Recordings. As a part of the Skylab M133 experiment, the original analog tapes from each flight and from the SMEAT simulation had been reproduced in graphic form, on a conventional EEG machine, to facilitate human evaluation of sleep characteristics. Each tape contained data in the following format:

EEG (C_1C_2-O_1O_2), 2 redundant channels
EOG (eye motion), 1 channel
Head movement (accelerometer), 1 channel
10-Hz tape-speed reference signal, 1 channel

At the time these tapes were reproduced, dubbed copies were made on standard IRIG-compatible magnetic tape recorders in order to facilitate later analysis. In addition to the original data channels, an arbitrary time-code signal (hours, minutes, seconds) was simultaneously recorded on an additional channel of the dubbed tape and on the graphic recording. This provided a means whereby the samples selected visually could be precisely located on tape for computer processing. These dubbed copies of the original flight tapes were utilized in the current study. The data quality was double-checked at the time of analysis by the production of a second graphic recording, which was then compared visually to the original tracing made earlier during playback of the actual flight tapes.

3.3.3.2. EEG Quantification. The general methodology utilized for EEG quantification is based upon a system (wavelength-amplitude profile analysis) developed in this laboratory (7-10). The technique considers both frequency (wavelength) and amplitude (peak-to-peak) and is designed to automate a number of the steps used in conventional visual analysis of EEGs. Evaluation of this system has shown a high degree of correlation with certain aspects of human EEG analysis, but it has also permitted more precise quantification of several aspects of the EEG wave-form.

The EEG sample was initially subjected to analog band-pass filtering in order to restrict the range of frequencies considered by each subsequent stage of computer analysis. Four ranges were utilized in this study, and the characteristics are as follows:

Band	Low Cutoff -3 dB	High Cutoff -3 dB
Beta	13.0 Hz	40.0 Hz
Alpha	6.0 Hz	14.0 Hz
Theta	3.0 Hz	7.0 Hz
Delta	0.5 Hz	4.0 Hz

These ranges correspond, in an approximate manner, with ranges commonly used in clinical electroencephalography.

The output of each frequency band was next processed by a PDP-12 computer, programmed to provide a wavelength-amplitude profile analysis (10). Consecutive EEG waves are initially defined by a baseline-cross method, then sorted into 60 discrete wavelength categories within the particular frequency band. The approximate passband limits for each band are as follows:

Band	Digital Range
Beta	25-77 msec
Alpha	56-173 msec
Theta	136-370 msec
Delta	250-2000 msec

The PDP-12 program determines the number of waves that fall into each of the 60 wavelength categories for each analysis run (beta, alpha, theta, and delta). Thus, 60 categories exist for beta, 60 for alpha, etc. Similarly, the summated peak-to-peak amplitudes of all of the waves falling into each of the 60 wavelength categories of each analysis range are calculated and accumulated. Consequently, for each frequency band of the EEG sample, two distributions are generated: one showing the number of waves falling into various wavelength categories (wavelength versus number of waves), the other showing total peak-to-peak amplitude in each wavelength category (wavelength versus peak-to-peak amplitude). This latter distribution is then normalized by dividing the values in each wavelength category by the total number of waves in that same category. The normalized distribution thus shows the wavelength versus mean (average) peak-to-peak amplitude.

After the above basic analysis has been performed on a selected EEG sample, additional PDP-12 programs automatically generate the following parameters from the two distributions.

(1) Wavelength versus number of waves distribution
- *(a) Modal wavelength value
- (b) Median wavelength value
- *(c) Mean wavelength value
- *(d) Variance and standard deviation of the distribution
- (e) Interquartile range of the distribution
- *(f) Number of waves detected at modal wavelength (wave count at mode)
- *(g) Total number of waves detected per minute

(2) Mean peak-to-peak amplitude versus wavelength distribution
- (a) Summated peak-to-peak amplitude (over all 60 wavelengths)
- *(b) Average wave amplitude (across all wavelengths)
- *(c) Wavelength of waves with largest mean amplitude
- (d) Largest mean amplitude value in any wavelength category
- (e) Wavelength at mean amplitude value
- (f) Interquartile range of distribution
- (g) Variance and standard deviation of distribution

*Utilized in this study

Although all of the above parameters were automatically computed for each sample in all four frequency bands, and thus were available for consideration, seven parameters were selected for use in this study (marked by an asterisk in above list). These measures have proved to be the most useful in prior evaluations of the analysis system and appear to offer a comprehensive and quantitative profile of the EEG background activity characteristics. These seven parameters are described in more detail below.

3.3.3.2.1. Modal wavelength value (modal frequency). This measure was converted to its reciprocal, the modal frequency, since most conventional EEG terminology is based upon frequency rather than wavelength. As the modal value of the wavelength versus number of waves distribution, it indicates which specific frequency component of the range under consideration predominated during the sample time interval.

3.3.3.2.2. Mean wavelength value (mean frequency). The mean wavelength (or its reciprocal, the mean frequency) is the best overall indicator of the frequency characteristics of the sample. It is simply the average of all the individual wavelengths (or their reciprocals), compiled over the observation time.

3.3.3.2.3. Variance or standard deviation of the wavelength versus number of waves distribution (wavelength standard deviation). This measure provides a convenient assessment of the amount of dispersion, or spread, of individual wavelength values. A high value indicates a relatively poorly sustained or irregular type of EEG activity, while a low value usually signifies a well-developed, rhythmic tracing. When used together with the mean and modal values, above, an overall estimation of the distribution is obtained.

3.3.3.2.4. Number of waves detected at modal wavelength (wave count at mode). This value indicates the actual number of times the modal frequency value occurred during the sample interval.

3.3.3.2.5. Total number of waves detected per minute (number of waves per 60 sec). This measure is a tally of the total number of waves whose wavelengths fall within the frequency band under consideration. It thus provides another measure of the constancy of activity and, together with the wave count at mode parameter, provides an indication of the distribution of the activity across the frequency spectrum.

3.3.3.2.6. Average wave amplitude. This parameter is computed by summing all individual peak-to-peak amplitude values for all waves detected in the frequency band and dividing this number by the total number of waves detected. It is the best overall indication of the EEG amplitude within a particular frequency band.

3.3.3.2.7. Wavelength (frequency) of waves with largest mean amplitude (frequency with LMA). The program first determines which of the wavelength categories contains the greatest mean amplitude value by scanning across the mean peak-to-peak amplitude versus wavelength distribution. This category is then converted to frequency by calculation of the reciprocal. This measure provides a quick indication of the presence of sporadic bursts of activity of relatively high amplitude which might not be reflected in the average value.

3.3.4. Time Error Correction

It was recognized, prior to Skylab, that certain errors in analysis could be produced by variations in tape speed of the onboard analog recorders utilized for preservation of the EEG signals. Thus, for example, a recorder operating too slowly would lead to erroneously elevated estimates of EEG frequency when the tape was replayed at normal speed, while increased speed of the onboard recorder would lead to lowering of the apparent EEG frequency. Consequently, a stable, 10-Hz reference frequency was built into the M133 apparatus, and this signal was constantly recorded on the onboard recorder, along with the EEG signal (see Section 3.3.3.1.). This 10-Hz signal was subsequently processed by the PDP-12 computer program, which detected deviations caused by speed variations and provided a correction factor to be applied to the corresponding EEG sample. This compensation process was carried out during processing of each of the samples selected for analysis, and all of the data presented in this report has been so corrected.

3.3.5. Statistical Treatment of the Data

In the initial statistical evaluation of the results, each subject was considered individually. This approach was taken because there was no reason to believe, a priori, that all individuals would respond in the same way to the weightless environment and because EEG characteristics tend to be somewhat individualized and are best considered as changes from pre-existing levels rather than as absolute values. Consequently, for each subject, the various parameters (Section 3.3.2.) were grouped into preflight (baseline), inflight, and postflight categories. Between-group comparisons were then performed (e.g., preflight versus inflight, preflight versus postflight), using a nonparametric statistical test (the Mann-Whitney U). This procedure provided an indication, for each subject, of whether a particular parameter showed a significant change during the inflight and postflight periods, compared to the individual's preflight baseline studies. In order to establish trends and to facilitate across-subject comparisons, inflight or postflight average values that differed by more than 5% from the preflight mean were also identified and considered in the discussions, even though they did not necessarily achieve statistical significance (such results are labeled ">5%, n.s."; see Section 3.4.).

Five of the computer-output parameters (mean frequency, modal frequency, wavelength standard deviation, average amplitude, and number of waves per minute) were also plotted graphically versus time for each of the four conditions (awake and stages 2, 3, and REM) in each of the four frequency bands (alpha, beta, theta, and delta).

Finally, across-subject comparisons were made, using the basic statistical results obtained in the individual comparisons. In this way, certain alterations common to all or several of the Skylab crew members could be identified and compared with the results of the SMEAT study.

3.4. RESULTS

3.4.1. The Awake State

Awake samples were obtained from the presleep period of each recording session. In selecting the periods for computer analysis, care was taken to exclude sections showing obvious artifact (e.g., caused by movement) or signs of drowsiness (loss of alpha rhythm; slow, rolling eye movements). Preference was given to times showing relatively high amplitude and continuous alpha activity and lack of rapid eye movements. Such samples are usually associated with the eyes-closed, alert (but relaxed) state.

An overall summary of selected average values for each subject during each of the test conditions (preflight, inflight, and postflight) is shown in Table I. Inflight and postflight values which differed significantly from the preflight mean, based on application of the Mann-Whitney U nonparametric statistical test, are identified by asterisks (* = $\underline{p}<0.10$; ** = $\underline{p}<0.05$; *** = $\underline{p}<0.01$). The individual daily values for all seven computer-output parameters are listed in Appendix A, Tables A1 through A16. Individual daily values for selected parameters (mean frequency, modal frequency, wavelength standard deviation, average amplitude, and number of waves per minute) are also plotted graphically in Figs. 1 through 16.

3.4.1.1. Beta Frequency Range, Awake State (Table I)

3.4.1.1.1. 28-day flight, subject J.K. (Fig. 1; Table A1). Because of mechanical problems associated with the onboard analog tape recorder (5), only two inflight days were available for analysis (days 5 and 6). As indicated in Table I, two parameters were altered significantly inflight ($\underline{p}<0.10$): The mean frequency of the beta activity decreased slightly (0.7 Hz), and the number of waves detected per minute increased (by 94 waves/min, or a 27.5% increase). The Table I values also indicate an inflight and postflight increase of average amplitude and a postflight increase of modal frequency. Although these differences exceeded 5% of the preflight values, they did not achieve statistical significance.

3.4.1.1.2. 59-day flight, subject O.G. (Fig. 2; Table A2). There was a significant elevation of the number of waves per 60 seconds during the inflight period (27.3% increase; $\underline{p}<0.05$) and then a significant decrease to below preflight levels in the postflight period (33.5% decrease; $\underline{p}<0.05$). Although not significant, the averages also reflect an increase in amplitude, both inflight and postflight, which exceeded 5% of the preflight value.

3.4.1.1.3. 84-day flight, subject E.G. (Fig. 3; Table A3). There was a significant increase of average amplitude inflight (40% increase; $\underline{p}<0.01$), with a continued elevation postflight (21%, but not significant). The number of waves per minute was significantly elevated, both inflight (188% increase; $\underline{p}<0.01$) and postflight (143% increase; $\underline{p}<0.10$). The modal frequency was low inflight (>5%), but the difference was not significant.

3.4.1.1.4. SMEAT, subject W.T. (Fig. 4; Table A4). The mean frequency was decreased both inflight (0.8 Hz decrease; $\underline{p}<0.05$) and postflight (0.5 Hz decrease; $p<0.10$). The number of waves per minute was decreased postflight (58% decrease; $p<0.10$), with a similar tendency inflight (>5%, n.s.)that was not, however, statistically significant. The average amplitude also showed a decrease both inflight and postflight (>5%, n.s.). Similar, nonsignificant changes were observed in the modal frequency, which was elevated inflight and postflight.

3.4.1.2. Alpha Frequency Range, Awake State (Table I)

3.4.1.2.1. 28-day flight, subject J.K. (Fig. 5; Table A5). Although no parameters exhibited statistically significant changes either inflight or postflight, several of the measures indicated in Table I showed alterations exceeding 5% of the preflight mean: Inflight, the modal frequency increased, while the average amplitude and number of waves per minute decreased; postflight, the average amplitude and number of waves per minute increased, while the modal frequency decreased.

3.4.1.2.2. 59-day flight, subject O.G. (Fig. 6; Table A6). The mean frequency increased significantly inflight, rising 0.3 Hz (from 7.3 Hz preflight to 7.6 Hz inflight) ($p<0.05$). The average amplitude was elevated inflight (>5%, n.s.) and postflight (38% increase; $p<0.10$).

3.4.1.2.3. 84-day flight, subject E.G. (Fig. 7; Table A7). There was a clear-cut and significant increase in the mean frequency (0.6 Hz increase; $p<0.05$) and in the modal frequency (0.8 Hz increase; $p<0.10$). Several parameters deviated from the preflight mean by more than 5% but were not statistically significant: The number of waves per minute increased slightly inflight and postflight, as did the modal frequency postflight. In addition, postflight, there was a small reduction in the average amplitude.

3.4.1.2.4. SMEAT, subject W.T. (Fig. 8; Table A8). The modal frequency was increased significantly inflight (0.3 Hz increase; $p<0.05$). Other changes (>5%, n.s.) included an inflight and postflight decrease of average amplitude and a postflight increase in number of waves per minute.

3.4.1.3. Theta Frequency Range, Awake State (Table I)

3.4.1.3.1. 28-day flight, subject J.K. (Fig. 9; Table A9). The mean frequency decreased by 0.2 Hz inflight ($p<0.10$), while the modal frequency decreased postflight by 0.2 Hz ($p<0.10$). The number of waves per minute was increased both inflight (>5%, n.s.) and postflight ($p<0.10$). There was a slight increase of average amplitude (>5%, n.s.), inflight and postflight.

3.4.1.3.2. 59-day flight, subject O.G. (Fig. 10; Table A10). There were no statistically significant changes, inflight or postflight. Several parameters varied more than 5% from the preflight averages but were not significant: The average amplitude and modal frequency values were decreased inflight and postflight, while the number of waves per minute showed a slight increase inflight.

3.4.1.3.3. 84-day flight, subject E.G. (Fig. 11; Table A11). The number of waves per minute increased significantly inflight (20.6% increase; $p<0.10$) and showed a similar, but nonsignificant, trend postflight. The modal frequency decreased slightly inflight (0.4 Hz decrease; >5%, n.s.) and more so postflight (1.3 Hz decrease; $p<0.05$). The average amplitude decreased somewhat (>5%, n.s.), both inflight and postflight.

3.4.1.3.4. SMEAT, subject W.T. (Fig. 12; Table A12). None of the parameters were altered significantly, inflight or postflight. There was a nonsignificant (but >5%) increase in the number of waves per minute detected inflight, and the average amplitude decreased somewhat both inflight and postflight (>5%, n.s.).

3.4.1.4. Delta Frequency Range, Awake State (Table I)

3.4.1.4.1. 28-day flight, subject J.K. (Fig. 13; Table A13). The number of waves per minute was significantly increased inflight (42.5% increase; $p<0.10$) and slowly declined postflight (>5%, n.s.). Although not significant, the average amplitude increased inflight and remained slightly elevated postflight. The mean frequency was decreased both inflight and postflight (>5%, n.s.), as was the modal frequency inflight.

3.4.1.4.2. 59-day flight, subject O.G. (Fig. 14; Table A14). The mean frequency was slightly increased inflight (>5%, n.s.) and significantly so postflight (0.2 Hz change; $p<0.10$). The number of waves per minute tended to increase inflight (>5%, n.s.) and was consistently elevated postflight (25.8% increase; $p<0.10$). There was also a small drop in average amplitude postflight (>5%, n.s.).

3.4.1.4.3. 84-day flight, subject E.G. (Fig. 15; Table A15). Inflight, there was an increase in the number of waves per minute detected (38.9% increase; $p<0.10$), while postflight this parameter was slightly below the preflight value (>5%, n.s.). The modal frequency was increased somewhat both inflight and postflight (>5%, n.s.). There was a small (>5%, n.s.) decrease of the average amplitude during the inflight period.

3.4.1.4.4. SMEAT, subject W.T. (Fig. 16; Table A16). There were significant decreases in both the mean frequency (0.3 Hz decrease; $p<0.05$) and the modal frequency (1.3 Hz decrease; $p<0.05$) inflight. Postflight, the mean frequency continued to be significantly decreased (0.3 Hz decrease; $p<0.10$) and the modal frequency slightly so (>5%, n.s.). There were slight (>5%, n.s.) decreases in average amplitude and increases in the number of waves per minute, both inflight and postflight.

3.4.2. Stage REM Sleep

Samples showing unambiguous EEG characteristics of stage REM were selected visually for computer analysis from each sleeping record. Table II provides a summary of the average preflight, inflight, and postflight results for each of the subjects in each frequency range. The format of Table II is identical to that of Table I with respect to the statistical treatment. Individual daily values for each parameter are listed in Appendix A, Tables A17 through A32. Selected measurements are plotted graphically in Figs. 17 through 32.

3.4.2.1. Beta Frequency Range, Stage REM Sleep (Table II)

3.4.2.1.1. 28-day flight, subject J.K. (Fig. 17; Table A17). A suitable sample could be obtained on only one of the two inflight days available. The mean frequency was relatively low inflight (>5%, n.s.) and significantly so postflight (0.8 Hz decrease; $p<0.10$). The number of waves detected per minute was also quite low inflight (>5%, n.s.) and remained so postflight (41.4% decrease; $p<0.05$). Nonsignificant (>5%, n.s.) lowering of the modal frequency was also noted both inflight and postflight.

3.4.2.1.2. 59-day flight, subject O.G. (Fig. 18; Table A18). The modal frequency showed a significant increase inflight (3.2 Hz increase; $p<0.05$), and the average remained elevated postflight (>5%, n.s.). There was also a slight decrease in the number of waves per minute in the postflight period (>5%, n.s.).

3.4.2.1.3. 84-day flight, subject E.G. (Fig. 19; Table A19). The average amplitude was significantly elevated inflight (47.4% increase; $p<0.01$) and continued to be elevated postflight (23.0% increase; $p<0.05$). The mean frequency increased by 0.6 Hz inflight ($p<0.05$) and returned to baseline postflight. A similar trend was seen in the modal frequency, with some elevation inflight (>5%, n.s.) and a significant increase postflight (6.5 Hz increase; $p<0.05$). There was a marked increase in the number of waves per minute inflight (147% increase; $p<0.01$), which continued postflight (77.8% increase; $p<0.05$) but with a downward trend.

3.4.2.1.4. SMEAT, subject W.T. (Fig. 20; Table A20). Inflight, the modal frequency was 3.8 Hz lower than the preflight average ($p<0.10$), and it continued to be low in the postflight period (1.4 Hz decrease; $p<0.10$). The number of waves per minute was decreased both inflight (32.6% decrease; $p<0.10$) and postflight (52.0% decrease; $p<0.10$). The average amplitude was somewhat decreased inflight and postflight (>5%, n.s.), compared to the preflight average.

3.4.2.2. Alpha Frequency Range, Stage REM Sleep (Table II)

3.4.2.2.1. 28-day flight, subject J.K. (Fig. 21; Table A21). There were no statistically significant inflight or postflight changes in any parameter. The modal frequency average value was slightly higher postflight than preflight (>5%, n.s.), but all values were within the preflight range.

3.4.2.2.2. 59-day flight, subject O.G. (Fig. 22, Table A22). There were no significant changes in this category. The average amplitude showed a slight (>5%, n.s.), but nonsignificant, increase inflight.

3.4.2.2.3. 84-day flight, subject E.G. (Fig. 23, Table A23). The average amplitude increased by 18.3% inflight ($p<0.05$), then became slightly decreased below preflight average in the postflight period (>5%, n.s.). The modal frequency was elevated inflight (1.5 Hz increase; $p<0.05$) and continued to be increased postflight (1.6 Hz increase; $p<0.10$). The mean frequency was 0.1 Hz lower postflight ($p<0.10$). There was a clear-cut increase in the number of waves per minute inflight (33.2% increase; $p<0.01$), followed by a slight decrease below preflight values in the recovery period (>5%, n.s.).

3.4.2.2.4. SMEAT, subject W.T. (Fig. 24; Table A24). The mean frequency decreased inflight by 0.3 Hz ($p<0.05$) and remained low postflight (0.5 Hz decrease; $p<0.10$). The modal frequency showed a similar trend (inflight >5%, n.s.; postflight, 1.7 Hz decrease; $p<0.10$). There were nonsignificant decreases (>5%, n.s.) in average amplitude and number of waves per minute in both the inflight and postflight periods.

3.4.2.3. Theta Frequency Range, Stage REM Sleep (Table II)

3.4.2.3.1. 28-day flight, subject J.K. (Fig. 25; Table A25). Average amplitude was increased inflight (>5%, n.s.) and postflight (1.0 Hz increase; $p<0.05$). The modal frequency showed an increase inflight (>5%, n.s.), while the number of waves per minute increased postflight (>5%, n.s.).

3.4.2.3.2. 59-day flight, subject O.G. (Fig. 26; Table A26). There was a significant drop in modal frequency both inflight (0.9 Hz decrease; $p<0.05$) and postflight (0.8 Hz decrease; $p<0.05$). Average amplitude decreased slightly postflight (>5%, n.s.).

3.4.2.3.3. 84-day flight, subject E.G. (Fig. 27; Table A27). An increase of average amplitude was seen inflight (15.3% increase; $p<0.05$), while postflight a drop to below baseline occurred (19.5% decrease; $p<0.10$). There was a 0.3 Hz decrease of mean frequency in the postflight period ($p<0.05$), while modal frequency increased slightly inflight (>5%, n.s.) and decreased postflight (>5%, n.s.). The number of waves per minute was slightly elevated inflight (>5%, n.s.) and significantly decreased postflight (22.6% decrease; $p<0.10$).

3.4.2.3.4. SMEAT, subject W.T. (Fig. 28; Table A28). There were no statistically significant changes in this category. Average amplitude and modal frequency were slightly decreased in the inflight and postflight periods (>5%, n.s.). The number of waves per minute dropped in the postflight period (>5%, n.s.).

3.4.2.4. Delta Frequency Range, Stage REM Sleep (Table II)

3.4.2.4.1. 28-day flight, subject J.K. (Fig. 29; Table A29). Compared to the preflight average, the mean frequency was elevated by 0.1 Hz postflight ($p<0.10$). The average amplitude value was high inflight and postflight (>5%, n.s.). Modal frequency was slightly decreased inflight and postflight (>5%, n.s.), while the number of waves per minute was increased inflight (>5%, n.s.). Postflight, the number of waves decreased to somewhat below baseline (>5%, n.s.).

3.4.2.4.2. 59-day flight, subject O.G. (Fig. 30; Table A30). The average amplitude was significantly decreased in the postflight period (16.2% decrease; $p<0.10$). The modal frequency was slightly increased inflight (>5%, n.s.), while the mean frequency was decreased postflight (>5%, n.s.).

3.4.2.4.3. 84-day flight, subject E.G. (Fig. 31; Table A31). Average amplitude increased inflight (>5%, n.s.), then dropped significantly postflight (17.6% decrease; $p<0.10$). The modal frequency was slightly decreased inflight and postflight (>5%, n.s.), as was the number of waves per minute postflight (>5%, n.s.).

3.4.2.4.4. SMEAT, subject W.T. (Fig. 32; Table A32). There were no significant changes associated with the inflight or postflight period. The average amplitude, mean frequency, and number of waves per minute all showed slight decreases postflight (>5%, n.s.).

3.4.3. Stage 2 Sleep

Samples of stage 2 sleep were selected from each all-night recording. Table III is a summary of the computer-analysis results obtained from all subjects and is similar in format to Table I. Individual daily values of each measurement are listed in Appendix A, Tables A33 through A48. Graphic plots of selected parameters are presented in Figs. 33 through 48.

3.4.3.1. Beta Frequency Range, Stage 2 Sleep (Table III)

3.4.3.1.1. 28-day flight, subject J.K. (Fig. 33; Table A33). The single modal frequency value inflight was relatively low (>5%, n.s.), while the number of waves per minute was decreased both inflight and postflight (>5%, n.s.).

3.4.3.1.2. 59-day flight, subject O.G. (Fig. 34; Table A34). The mean frequency was decreased postflight (0.6 Hz decrease; $p<0.10$), as was the modal frequency (2.2 Hz decrease; $p<0.10$). There was an elevation of the number of waves per minute inflight (>5%, n.s.) and postflight (>5%, n.s.).

3.4.3.1.3. 84-day flight, subject E.G. (Fig. 35; Table A35). There was a clear increase of average amplitude inflight (34.9% increase; $p<0.01$), which persisted postflight to a lesser extent (19.8% increase; $p<0.05$). There was an inflight increase of mean frequency (0.9 Hz increase; $p<0.05$) and a similar trend (nonsignificant) in the modal frequency in the early inflight period, although this was not reflected in the average values. The number of waves per minute increased markedly inflight (134% increase; $p<0.01$) and remained elevated postflight (50.3% increase; $p<0.10$), although there was a rapid decline evident in the plot of this parameter (Fig. 35) in the recovery period.

3.4.3.1.4. SMEAT, subject W.T. (Fig. 36; Table A36). Postflight, there was a significant decrease of the mean frequency (1.2 Hz decrease; $p<0.10$). There was also an inflight and postflight reduction of average amplitude (>5%, n.s.) and a similar, nonsignificant, decrease in the number of waves per minute (>5%, n.s.).

3.4.3.2. Alpha Frequency Range, Stage 2 Sleep (Table III)

3.4.3.2.1. 28-day flight, subject J.K. (Fig. 37; Table A37). Although there were no significant changes in this category, the averages reflect a slight increase of average amplitude inflight (>5%, n.s.) and an increase in the number of waves per minute postflight (>5%, n.s.).

3.4.3.2.2. 59-day flight, subject O.G. (Fig. 38; Table A38). The mean frequency showed a significant drop postflight (0.2 Hz decrease; $p<0.10$). The average amplitude decreased slightly inflight and postflight (>5%, n.s.), while the number of waves per minute declined inflight (>5%, n.s.).

3.4.3.2.3. 84-day flight, subject E.G. (Fig. 39; Table A39). A fairly marked increase of the average amplitude was seen inflight (23.5% increase; $p<0.05$) and, to a lesser extent, postflight (8.4% increase; $p<0.05$). A parallel increase in the number of waves per minute occurred (inflight, 33% increase, $p<0.05$; postflight, 20.9% increase, $p<0.10$). A less obvious increase of the modal frequency was noted inflight (>5%, n.s.) and postflight (0.9 Hz increase, $p<0.10$).

3.4.3.2.4. SMEAT, subject W.T. (Fig. 40; Table A40). The mean frequency decreased inflight by 0.4 Hz ($p<0.05$), while the modal frequency decreased both inflight (>5%, n.s.) and postflight (>5%, n.s.). Average amplitude and number of waves per minute both decreased (>5%, n.s.), inflight and postflight.

3.4.3.3. Theta Frequency Range, Stage 2 Sleep (Table III)

3.4.3.3.1. 28-day flight, subject J.K. (Fig. 41; Table A41). The average values reflect an increase in the modal frequency inflight (>5%, n.s.) and postflight (0.5 Hz increase; $p<0.10$) and a postflight increase of 0.2 Hz ($p<0.05$) in the mean frequency. The average amplitude was somewhat elevated inflight (>5%, n.s.), as was the number of waves per minute both inflight and postflight (>5%, n.s.).

3.4.3.3.2. 59-day flight, subject O.G. (Fig. 42; Table A42). A significant drop in the number of waves per minute parameter was seen inflight (13.4% decrease; $p<0.05$) and postflight (14.5% decrease; $p<0.10$). The modal frequency increased slightly inflight (>5%, n.s.), then decreased below the preflight value, postflight (>5%, n.s.).

3.4.3.3.3. 84-day flight, subject E.G. (Fig. 43; Table A43). No statistically significant changes were noted. There was an increase in the average amplitude inflight (>5%, n.s.), and the modal frequency and number of waves per minute measures declined postflight (>5%, n.s.).

3.4.3.3.4. SMEAT, subject W.T. (Fig. 44; Table A44). The mean and modal frequencies were low in the postflight period (mean, 0.1 Hz decrease, $p<0.10$; mode, 0.9 Hz decrease, $p<0.10$). The average amplitude showed a slight rise inflight (>5%, n.s.), then fell below the preflight average, postflight (>5%, n.s.). The number of waves per minute fell inflight (>5%, n.s.) and postflight (11.6% decline, $p<0.10$).

3.4.3.4. Delta Frequency Range, Stage 2 Sleep (Table III)

3.4.3.4.1. 28-day flight, subject J.K. (Fig. 45; Table A45). The mean frequency increased slightly postflight (0.1 Hz increase; $p<0.10$), while the modal frequency was increased both inflight (>5%, n.s.) and postflight (>5%, n.s.). The number of waves per minute also showed an inflight and postflight increase (>5%, n.s.), and the average amplitude increased inflight (>5%, n.s.) and decreased postflight (>5%, n.s.).

3.4.3.4.2. 59-day flight, subject O.G. (Fig. 46; Table A46). Inflight, the average amplitude was elevated by 13.8% ($p<0.05$). Postflight, there was an increase in the number of waves per minute (9.2% increase; $p<0.10$).

3.4.3.4.3. 84-day flight, Subject E.G. (Fig. 47; Table A47). There were no statistically significant alterations in this category. The average amplitude was increased slightly inflight and postflight (>5%, n.s.). The modal frequency and number of waves per minute were increased inflight (>5%, n.s.) and decreased postflight (>5%, n.s.). The mean frequency was slightly increased inflight (>5%, n.s.).

3.4.3.4.4. SMEAT, subject W.T. (Fig. 48; Table A48). The number of waves per minute was elevated somewhat inflight (24.1% increase; $p<0.10$) and remained high postflight (>5%, n.s.). There was a small increase of average amplitude inflight (>5%, n.s.) and a postflight decrease of mean frequency (>5%, n.s.).

3.4.4. Stage 3 Sleep

As before, samples of stage 3 sleep were visually selected from the all-night tracings. The computer-analysis results are summarized in Table IV, which is similar in construction to Table I. The individual daily values are listed in Appendix A, Tables A49 through A64. The graphic plots of selected parameters are contained in Figs. 49 through 64.

3.4.4.1. Beta Frequency Range, Stage 3 Sleep (Table IV)

3.4.4.1.1. 28-day flight, subject J.K. (Fig. 49; Table A49). The number of waves per minute was slightly elevated inflight (>5%, n.s.), then dropped to below baseline levels, postflight (60.4% decrease; $p<0.10$). The average amplitude was also increased inflight (>5%, n.s.) and decreased postflight (>5%, n.s.). The mean frequency was slightly decreased postflight (>5%, n.s.).

3.4.4.1.2. 59-day flight, subject O.G. (Fig. 50; Table A50). Average amplitude decreased inflight (>5%, n.s.) and continued to be low postflight (20% decrease; $p<0.10$). There was a similar pattern in the number of waves per minute parameter, with a small inflight reduction (>5%, n.s.) and a more pronounced postflight decrease (35.8% decrease; $p<0.10$). The modal frequency increased somewhat postflight (1.0 Hz increase; $p<0.10$).

3.4.4.1.3. 84-day flight, subject E.G. (Fig. 51; Table A51). There were marked inflight increases of both average amplitude (40.7% increase; $p<0.01$) and number of waves per minute (211.2% increase; $p<0.01$), which remained elevated postflight (average amplitude, 19.8% increase, $p<0.05$; number of waves per minute, 150% increase, $p<0.05$), although a downward trend was evident. The mean frequency was also significantly elevated inflight (0.9 Hz increase; $p<0.05$).

3.4.4.1.4. SMEAT, subject W.T. (Fig. 52; Table A52). Inflight, the mean frequency declined (1.1 Hz decrease; $p<0.05$), and it remained depressed in the postflight period (1.6 Hz decrease; $p<0.10$). Modal frequency and number of waves per minute likewise showed a slight decrease, both inflight and postflight (>5%, n.s.). The average amplitude parameter declined inflight (>5%, n.s.) and dropped still further postflight (30.4% decrease; $p<0.10$).

3.4.4.2. Alpha Frequency Range, Stage 3 Sleep (Table IV)

3.4.4.2.1. 28-day flight, subject J.K. (Fig. 53; Table A53). The average amplitude showed a significant increase during the inflight period (36.9% increase; $p<0.10$).

3.4.4.2.2. 59-day flight, subject O.G. (Fig. 54; Table A54). The average amplitude showed a decline inflight (7.6% decrease; $p<0.10$), while the number of waves per minute increased postflight (8.6% increase; $p<0.10$). In addition, there was a nonsignificant decrease of modal frequency postflight (>5%, n.s.).

3.4.4.2.3. 84-day flight, subject E.G. (Fig. 55; Table A55). Several measures were elevated inflight: The average amplitude increased 29.3% ($p<0.01$) and remained elevated postflight (>5%, n.s.). The mean frequency increased 0.5 Hz ($p<0.01$) and was 0.2 Hz above the preflight value in the postflight period ($p<0.05$). The number of waves per minute was elevated by 75.7% ($p<0.01$) and continued high postflight (54.3% increase; $p<0.05$). The modal frequency also showed a slight increase, both inflight and postflight (>5%, n.s.).

3.4.4.2.4. SMEAT, subject W.T. (Fig. 56; Table A56). The mean frequency was decreased inflight by 0.5 Hz ($p<0.05$), while the modal frequency was elevated by 1.2 Hz ($p<0.10$) postflight. The average amplitude and number of waves per minute were decreased (>5%, n.s.), both inflight and postflight.

3.4.4.3. Theta Frequency Range, Stage 3 Sleep (Table IV)

3.4.4.3.1. 28-day flight, subject J.K. (Fig. 57; Table A57). Inflight, the modal frequency increased by 1.3 Hz ($p<0.10$) and continued to be elevated postflight (0.9 Hz increase; $p<0.10$). The average amplitude was also higher inflight than preflight (52.9% increase; $p<0.10$) and was slightly increased postflight (>5%, n.s.). The number of waves per minute increased inflight (>5%, n.s.), then dropped to below baseline in the postflight period (>5%, n.s.).

3.4.4.3.2. 59-day flight, subject O.G. (Fig. 58; Table A58). The average amplitude decreased inflight (8.4% decrease; $p<0.10$) and remained depressed postflight (>5%, n.s.). The modal frequency and the number of waves per minute were also somewhat decreased postflight (>5%, n.s.).

3.4.4.3.3. 84-day flight, subject E.G. (Fig. 59; Table A59). Inflight, the average amplitude increased by 14.8% ($p<0.05$), while the number of waves per minute increased by 21.4% ($p<0.05$). The latter measure remained increased postflight (>5%, n.s.).

3.4.4.3.4. SMEAT, subject W.T. (Fig. 60; Table A60). There were no statistically significant alterations in this group of measurements. There was a small decrease in the modal frequency, both inflight and postflight (>5%, n.s.), and in the mean frequency postflight (>5%, n.s.). In addition, the average amplitude declined postflight (>5%, n.s.).

3.4.4.4. Delta Frequency Range, Stage 3 Sleep (Table IV)

3.4.4.4.1. 28-day flight, subject J.K. (Fig. 61; Table A61). The average amplitude increased inflight by 71.4% ($p<0.10$) and remained somewhat high postflight (>5%, n.s.). There was a slight increase in the mean frequency inflight (>5%, n.s.) and then a decrease to below baseline in the postflight period (>5%, n.s.). The modal frequency was minimally decreased, both inflight and postflight (>5%, n.s.). The number of waves per minute increased inflight (>5%, n.s.), then declined postflight (>5%, n.s.).

3.4.4.4.2. 59-day flight, subject O.G. (Fig. 62; Table A62). The only significant finding was an increase of the average amplitude postflight (5.4% increase; $p<0.10$). This parameter was also elevated inflight (>5%, n.s.). The mean frequency and the number of waves per minute were decreased inflight and postflight (>5%, n.s.).

3.4.4.4.3. 84-day flight, subject E.G. (Fig. 63; Table A63). Inflight, the average amplitude increased significantly (11.9% increase; $p<0.05$), and there were nonsignificant increases of number of waves per minute and modal frequency (>5%, n.s.). This latter measure was significantly elevated postflight (1.0 Hz increase; $p<0.05$).

3.4.4.4.4. SMEAT, subject W.T. (Fig. 64; Table A64). No findings in this category were statistically significant. There was an inflight decrease in both the mean and the modal frequency measures (>5%, n.s.), and both remained low postflight (>5%, n.s.). The average amplitude increased inflight (>5%, n.s.), and the number of waves per minute parameter was elevated inflight and postflight (>5%, n.s.).

3.5. DISCUSSION

3.5.1. Interindividual Comparisons

The incidence of the various alterations in EEG characteristics seen inflight and postflight is shown in Tables V, VII, IX, and XI for those changes that were statistically significant ($p<0.10$) on an individual basis. A similar comparison, in which all changes exceeding 5% of the preflight average are included with the statistically significant values, is provided in Tables VI, VIII, X, and XII.

3.5.1.1. The Awake State. In the awake state (Tables V and VI), only one significant change was seen in all three Skylab astronauts: an inflight increase in the number of beta frequency waves. This finding was most pronounced in the case of subject E.G. (84-day flight, Fig. 3), where the inflight value rose to an average of 481 waves per minute, from a preflight mean of 167 waves per minute (188% increase). This increase in number of beta frequency waves was accompanied by a tendency toward an increased average amplitude in all three subjects (Table VI), although this measure was significant in only one flight (84-day, subject E.G.). Postflight, the number of waves was back to baseline, or below, in two subjects and showed a continued elevation, but with a distinct downward trend, in the third (E.G.). This phenomenon was not present during the SMEAT study, and, in fact, this subject showed a reverse tendency, with a nonsignificant inflight reduction of both number of waves per minute and average amplitude parameters.

Two astronauts showed significant increases in the mean alpha frequency inflight. The third (J.K.), while showing no increase in the mean frequency, did have a nonsignificant elevation of the modal frequency parameter. Thus, at least one measure of average alpha frequency tended to increase in all Skylab subjects. These measures returned to baseline postflight in all three subjects. This pattern is best typified in Fig. 7 (E.G., 84-day flight), where inflight increases are clear-cut for both the mean and the modal frequency parameters. It is possibly of significance that the highest individual values tended to occur in the early inflight period, with a secondary increase just before the end of the missions. A somewhat similar trend was evident in SMEAT, where the modal alpha frequency was significantly elevated inflight and returned to baseline postflight.

In the delta frequency range, two of the Skylab subjects showed small, but significant, increases in the number of waves per minute measure, while the third exhibited a similar, but nonsignificant, tendency. In two subjects, this measure remained elevated postflight. The SMEAT crew member also had a slight increase in the number of waves per minute, both inflight and postflight.

In the postflight period, there was a small, but significant, decrease in the theta range modal frequency measure in two of the Skylab subjects and a similar, but nonsignificant, decrease in the third. This alteration was not present in SMEAT.

The awake state during Skylab was thus typified by inflight increases of beta and delta activity (number of waves per minute) and elevation of the average alpha frequency. While these measures tended to return to normal postflight, a decline of theta frequency was seen at this time. SMEAT was similar only with respect to the inflight increase of alpha frequency and delta amount (number of waves per minute).

3.5.1.2. Stage REM Sleep. Although fairly clear-cut alterations were seen during stage REM in several individual categories (e.g., see Sections 3.4.2.1.3. and 3.4.2.2.3., above), there were no changes common to all three Skylab subjects, even when nonsignificant trends were included (Tables VII and VIII). Two subjects (O.G. and E.G.) showed a significant decrease in the average delta range amplitude during the postflight period, while the third (J.K.) showed a small increase in this measure. A nonsignificant decrease was also seen in the SMEAT subject postflight.

3.5.1.3. Stage 2 Sleep. Although several parameters were markedly changed on an individual basis (e.g., subject E.G., Table III), there were no significant alterations common to two or more of the Skylab subjects (Table IX). If nonsignificant deviations from the preflight averages are included (Table X), then one parameter shows a similar trend in all subjects (including the SMEAT subject): There was an inflight increase of average amplitude in the delta frequency range. This measure was statistically significant only in the case of subject O.G. (59-day flight). Two subjects (J.K. and E.G.) showed significant increases in the average theta amplitude inflight, while subject O.G. had a slight decrease.

3.5.1.4. Stage 3 Sleep. Delta activity increased in average amplitude during the inflight period in all three Skylab astronauts, although this change was statistically significant in only two cases (Tables XI and XII). A similar, but nonsignificant, trend was also seen during SMEAT.

Significant inflight increases in average amplitude were also noted in the alpha and theta frequency ranges in two Skylab subjects (J.K. and E.G.), while the third subject (O.G.) showed a significant decrease in these parameters.

In the postflight period, two Skylab subjects (J.K. and O.G.) had significant decreases in the number of beta frequency waves per minute, while the other crewman (E.G.) showed a significant increase. The SMEAT subject had a nonsignificant decrease in this measure. In addition, two subjects (O.G. and E.G.) had postflight increases in the number of alpha frequency waves per minute, while the SMEAT participant had a nonsignificant decrease.

3.5.1.5. Individual Considerations. It is clear that some of the individuals showed a great number of changes inflight and postflight, while others showed much less variability. Table XIII shows the total number of altered parameters for each subject, inflight, postflight, and overall. This Table considers a total of 128 measurements for each subject (four EEG parameters x four frequency ranges x four sleep/wakefulness categories x two conditions (inflight and postflight)). Subject E.G. (84-day flight) showed statistically significant changes in 47 of the 128 categories (36.7%), a level that is approximately twice that seen in any other subject. When nonsignificant changes or trends are included, there is less variation among subjects; however, subject O.G. continues to show relatively little variation, compared to the others.

The most common inflight alterations are summarized in Table XIV, which also indicates the way in which these particular individual parameters varied during other sleep/wakefulness conditions. Thus, for example, while the number of beta waves per minute was significantly elevated inflight in all three Skylab subjects when they were awake, during sleep only subject E.G. continued to exhibit this finding. The other subjects either showed no significant elevation of this parameter or occasionally demonstrated a decrease. A very similar pattern was seen for the average amplitude of the beta activity, for the alpha frequency measures, and for the number of waves per minute in the delta range. The SMEAT subject, on the other hand, had a significant decrease of alpha frequency inflight in all stages of sleep but showed no alteration of this measure in the awake state. A somewhat opposite variability across sleep stages is evident in the average amplitude measurements in the alpha, theta, and delta frequency ranges, with increases most common during sleep - especially during stages 2 and 3.

3.5.2. General Discussion

The results of this study have confirmed the initial observation, based upon visual analysis of the Skylab sleep records, that a change in alpha rhythm frequency occurred during exposure to the inflight environment. The computer analysis has quantified these changes and has, in addition, revealed several other effects that were not apparent to the eye. Since several of these findings were seen in all three subjects, the possibility of explaining these results by random variation of individual EEG characteristics over time seems remote. Consequently, it seems reasonable to conclude that the conditions imposed by long-term space flight have a definite influence upon the central nervous system factors responsible for the generation and maintenance of the electroencephalogram.

Although changes were often statistically significant, in no instance were they considered to be abnormal in the clinical sense. Thus, all of the inflight and postflight values were within the range of variation to be expected among members of a normal population. In considering the real significance of these findings, the major problem is thus determining which of the multitude of environmental factors was responsible for which EEG alteration and whether or not the relationship can be used in further studies of man's ability to perform adequately during space flight. It was hoped, for example, that such information might suggest new approaches to the space motion sickness syndrome, in terms of its etiology and prevention. Consequently, in the discussion below, the various EEG alterations seen in Skylab are considered separately, within the scope of the present state of our knowledge. While truly definitive answers will require further observation of subjects during exposure to the environment, the data now in hand suggests some logical directions for future experimental design.

3.5.2.1. Stability of the EEG. Since the data to be considered consists of relative shifts of certain EEG parameters within a total range considered to be clinically "normal," an overall consideration is the stability of the EEG under control (i.e., non-space flight) conditions. In order to assess the meaning of the experimentally observed changes, we need to know how consistent and invariable these same measures are in a normal individual over time.

Unfortunately, truly quantitative information on this subject is sparse. Much of what is known is based upon visual analysis, and results of various other studies may not be comparable because of numerous unspecified criteria utilized by the investigators. A recent review of this topic (11) makes it clear that new quantitative studies are needed.

With respect to the alpha rhythm, subject E.G. (84-day flight) showed the greatest inflight increase of mean frequency (Fig. 7, Table A7). The preflight average was 9.2 Hz, with a range of from 8.9 to 9.7 Hz (-0.3 to +0.5 Hz). In clinical EEG practice, it is common to consider the alpha rhythm of an individual subject, under normal conditions, as a relatively constant phenomenon. Thus, variations of more than ±0.5 Hz would be unexpected. Using this criterion, the preflight variability for subject E.G. is not unusual. Inflight, however, the first value (day 3) is 10.3 Hz, an increase of 1.1 Hz above the preflight average and 1.2 Hz greater than the last previous value obtained on baseline day 3 (B3). This difference is readily apparent to the eye in samples selected from these two days, as illustrated in Fig. 65. Thus, while neither record is "abnormal" by clinical criteria, the increase of alpha frequency is clinically significant and would lead to the suspicion that some change in the metabolic status of the individual had occurred between the two test dates (see below).

The stability of EEG characteristics in the theta, delta, and beta frequency bands has not been studied as comprehensively as has the alpha range. In general, however, in clinical practice, these components are assumed to be stable over fairly long periods of time, with approximately the same degree of variability as is accepted for the alpha rhythm. With respect to the Skylab findings, the alterations in beta frequency components would certainly be considered clinically significant in certain instances. Subject E.G., for example, had, in the preflight period, an average value of 167 beta waves per minute, with a range of 152 to 194 per minute. Inflight, the mean was 481 waves per minute, with a range of 249 to 703 per minute. This measure is well outside the limits of day-to-day variability typically seen with this activity, and, as discussed below, raises the question of possible drug effects on the EEG during the inflight period.

In summary, then, from a clinical point of view, several of the quantitative alterations in EEG characteristics identified in this study would be considered significant when viewed in terms of change with respect to time, even though none, taken in isolation, would be considered abnormal.

3.5.2.2. Metabolic and Drug-Induced EEG Changes. The EEG is believed to arise as a result of synaptically induced electrical activity in neuronal populations of the cerebral cortex (12). Maintenance of the stability of the various EEG rhythms, with respect to both amplitude and frequency, is apparently dependent upon a complex interplay between the neurons of the cerebral cortex that originate the activity and more deeply placed neurons located within the thalamic projection nuclei. Relatively random activity from more peripheral areas is transmitted to the cortex via the thalamus in discrete bursts, gated by an interplay of excitatory and inhibitory groups of interneurons. The frequency of a given cortical rhythm, and its apparent amplitude, is consequently dependent upon the biochemical (metabolic) factors at the level of the excitatory and inhibitory synaptic junctions within the thalamocortical neuronal network. It is not surprising, then, that in addition to alterations in metabolic status that occur spontaneously, many drugs are known to produce alterations in the human EEG.

With respect to the alpha rhythm, most pathological states (and most drugs) either lower the frequency or leave it unchanged. Conditions causing an absolute increase in the alpha frequency, such as were observed during Skylab, are relatively rare.

Elevated alpha frequencies have been reported to occur in some deep-sea divers during exposure to elevated atmospheric pressures of inspired air (13-15). These studies demonstrated that the partial pressure of nitrogen was the crucial factor, and its elevation produced the syndrome commonly known as nitrogen narcosis (euphoria, mental impairment, incoordination), along with the EEG changes. When the partial pressure of oxygen was increased independently, the phenomenon did not occur (although other adverse effects were seen). Increased alpha frequencies have also been reported to occur in individuals who move to high altitudes, where the atmospheric pressure of all components of the inspired air is reduced (16). Skylab was associated with a low atmospheric pressure (5 p.s.i.) and a pure oxygen environment, in which the partial pressure of O_2 was essentially identical to normal sea-level conditions. Nitrogen was certainly not elevated, and, unlike the high-altitude situation, there was no tendency toward an anoxic state. Thus, it seems unlikely that the alpha alterations seen during Skylab were related to the breathing mixture used. The SMEAT results, unfortunately, do not provide a conclusive answer to this problem, since the alpha changes here were quite similar to those of one of the Skylab subjects (J.K.).

Elevations of alpha frequency are known to accompany states of increased metabolic activity. Hyperthyroidism, for example, is associated with an increase of alpha frequency (e.g., 17, 18), with the increases roughly proportional to blood levels of the thyroid hormone. Although there is no direct evidence of an increased metabolic state during Skylab, tests made in the immediate postflight period did show significant elevations of thyroxine and TSH and, sometimes, nonsignificant elevations of the T3 test (19). Thus, there is a good possibility that such elevations did occur inflight and therefore may have been contributing factors with respect to the EEG changes seen. In the study by Olsen et al. (18), the alpha frequencies of hyperthyroid patients (thyroxine average level 21.7, s.d. ±6.5) were increased by 1 to 2 Hz above their euthyroid levels. This increase is similar in magnitude to the inflight increase of average frequency seen in subject E.G. of the 84-day flight (Fig. 7). Olsen et al. also reported a concomitant increase of amplitude and abundance of fast (beta) activity during times of elevated thyroxine levels. Their measure corresponds approximately to our indexes of average amplitude and number of waves per minute in the beta frequency range, parameters which were also increased inflight during the awake state in all three Skylab subjects (see Table XIV). Thus, an inflight increase of thyroid activity remains one possible explanation for some of the EEG alterations associated with Skylab.

Another major factor to be considered is the influence of the various drugs administered during Skylab. A number of medications are known to produce alterations in the electroencephalogram, and some of these were utilized inflight. A summary of inflight medication usage for the three Skylab subjects is presented in Table XV.

Some stimulant-type drugs, particularly dextroamphetamine (and possibly others used in Skylab, such as ephedrine, pseudoephedrine, and oxymetazoline), are known to influence the alpha rhythm. Such effects include an increase in the number of waves per epoch (20) and an increase in the mean frequency (21, 22). These studies also suggest that there may be an increase in the amount of beta frequency activity as well in subjects receiving amphetamine-type drugs.

The elevation of alpha frequency in subject E.G. (Fig. 7) showed two peaks: one near the initial portion of the flight (days 3-5) and the other just before its termination (days 77-82). Since dextroamphetamine was taken on days 1-4, there is a good possibility that this drug may have contributed to the alpha frequency elevation at this time. The final elevation, however, does not appear to be closely related to the times of administration of the other sympathomimetic compounds. Although oxymetazoline was taken on days 75 and 80, and ephedrine on day 82, the alpha elevation was also evident on days 77 and 81, when no medication was taken. The presence of similar peaks in the case of subject O.G. could not be determined, since no data was available for analysis prior to day 7 or subsequent to day 35. Consequently, it seems reasonable to conclude that some increase of the alpha frequency measure in subjects

E.G. and O.G. may be attributable to drug effects, especially in the case of E.G. early in the flight. But it is also clear that this factor cannot explain the total elevation seen inflight, particularly the elevation seen near the termination of the 84-day mission.

Two of the drugs used inflight, secobarbital and flurazepam, are known to produce EEG changes in the beta frequency range - primarily an increase in the amplitude and the number of waves per unit of time (9, 23). Since these two parameters were elevated inflight in all three Skylab subjects, a drug effect must again be considered.

Examination of the data indicates that in the case of subject E.G. (Fig. 3), the marked inflight increase of the number of beta waves per minute measure is characterized by two plateaus: The number of waves rises rapidly early in the flight to a level of approximately 350-400 per minute, and it remains at this level until day 40, when there is a second abrupt rise to a level of approximately 500-650 waves per minute that persists until day 81. This latter period coincides very well with the time of intermittent usage of flurazepam (Dalmane) (Table XV) between days 37 and 75. The moderate decrease at day 55 coincides with a prior 5-day period during which this drug was not taken. The early rise in the number of waves per minute does not appear to be drug-related, since it continued to increase beyond the time during which dextroamphetime was utilized (days 1-4).

Subject O.G. (59-day flight) also showed an inflight increase in the number of beta waves per minute parameter, and it appears to be unrelated to drug usage. In magnitude, it is quite similar to the initial elevation seen in subject E.G. The presence of a late peak associated with the time this subject received secobarbital cannot be determined, since no EEG data was available after day 36. The two days available for analysis from the 28-day flight show a similar elevation - again apparently not drug-related. Thus, these results appear to rule out drug effects as the sole cause of the inflight increase in beta activity, although it does seem likely that this factor was a contributing one in the 84-day mission.

3.5.2.3. Psychological State. The possible role of mental or psychological factors is very difficult to assess for several reasons: (1) the scientific literature is confusing and contradictory, and most experiments have not been well controlled; (2) the quantitative-analysis techniques used in other studies often were insufficient to permit unambiguous interpretation of the results; and (3) the Skylab situation did not permit a direct and independent assessment of psychological state, and the recording sessions were not controlled for such factors.

Relatively transient increases of alpha frequency have been reported to be associated with various alterations of mental state. Several investigators have noted an augmentation of alpha frequency when subjects engaged in mental activity (24). Becker-Carus (25) found the greatest increase to be associated with tasks of relative difficulty, while others (26-29) saw comparable changes in alpha when subjects engaged in a variety of mental tasks as compared to the resting or relaxed state. More recently, biofeedback techniques (e.g., 30) have reportedly been used successfully to increase, or produce other changes in, the alpha frequency (see overall review of this subject in Chatrian and Lairy, 11).

It seems unlikely that such influences could produce the sustained and persistent alterations seen during Skylab, although the possibility of some effect cannot be ruled out. It is, of course, conceivable that longer-term effects could be indirectly mediated via altered metabolic state, secondary to prolonged stress. The answers to these questions cannot be provided by the presently available data and must await further inflight experimentation under suitably controlled conditions.

3.5.2.4. Effects of Weightlessness. The most unique physiological factor inherent to space flight is the existence of the zero-g state and its effects upon biological function. Because it is a major alteration of the environment, and since other considerations (discussed above) cannot entirely explain the EEG changes observed, it obviously must be considered a causal factor.

One of the most obvious effects of the weightless state is upon the vestibular system (31). The vestibular organs comprise an important source of neural input to the central nervous system, and it is conceivable that alterations of this input by the loss of gravity could, in turn, produce changes in other parts of the nervous system and result in EEG modifications. There have been very few studies of this possible link between vestibular function and EEG. While there is good evidence that transient EEG responses occur following discrete stimulation of the labyrinthine system in humans (32, 33), the evidence for long-lasting alterations of the type seen in Skylab is sparse. In a few early EEG studies of patients with disorders of the vestibular system, there was some evidence presented for electrographic signs of labyrinthine dysfunction. Schwab and Carter (34), for example, reported an abnormal unilateral increase in the amount of fast (beta range) activity in patients with Meniere's disease. In a more recent study, though, Niedermeyer and Hinchcliffe (35) found that the vast majority of EEGs in patients afflicted with this disorder were normal, and no characteristic finding was described.

In a few studies, specific attempts have been made to detect changes in the ongoing EEG in association with induced vestibular alterations. Liske et al. (36) used unilateral caloric stimulation in a group of normal subjects and found no associated EEG changes by visual inspection or computer analysis, even though the stimulation often produced noticeable nystagmus. In studies involving cats, however, Costin et al. (37), using a computer technique (spectral analysis), were able to demonstrate consistent increases of low-frequency activity immediately following abrupt changes in posture. These responses were abolished by section of the vestibular nerves but were unaffected by bilateral section of the dorsal columns of the spinal cord.

Consequently, there is no basis for definitely attributing any of the changes seen in Skylab EEG characteristics to vestibular influences. On the other hand, since vestibular function certainly can influence the EEG under some experimental conditions, we cannot rule out the possibility of some similar mechanism being active during weightlessness. This question is currently being investigated experimentally in another phase of this contract, and quantitative EEG analyses of the type performed on the Skylab data will be applied in control situations associated with altered vestibular function (e.g., parabolic flight). The results of these studies hopefully will permit further assessment of the Skylab findings.

The other major factor associated with long-term exposure to the zero-g environment is the occurrence of fluid shifts among the various body compartments, resulting primarily from the loss of hydrostatic pressure (38). This phenomenon is not yet fully understood, but the major effect seems to be a significant loss of fluid from the lower extremities that is not accounted for by total body-fluid loss; in other words, there is a significant redistribution of fluid within the body. It is not clear where the excess fluid lost from the legs goes, but center-of-mass determinations confirm a cephalad shift. In addition, conventional photographs of crew members show a puffiness of the face and suggest increased fluid in the head and neck regions, while infrared studies show distension of the jugular veins and other veins of the temple and forehead areas. In view of these facts, the possibility of intracranial edema must also be considered. If present, it could conceivably result in alterations of brain function which might be reflected in the EEG. This factor must also be considered as one possible cause of the "space motion sickness syndrome," which is accompanied by several symptoms compatible with a neurological origin (e.g., headache, nausea, vomiting, etc.).

Acute (abrupt) and transient (less than 5 minutes) increases of cerebrospinal fluid pressure, per se, do not result in noticeable EEG changes (39). EEG changes commonly attributed to increased intracranial pressure of longer duration are often secondary and actually reflect underlying tissue damage produced by the primary disease process (e.g., tumor, hematoma, ventricular dilitation, etc.). However, patients are occasionally seen who present with symptoms and signs of raised intracranial pressure but without other evidence of intracranial pathology or ventricular dilitation. This disorder is commonly known as benign intracranial hypertension, and these cases provide an ideal means for studying the EEG signs of increased intracranial pressure in the absence of physical distortion. In a comparative study of 14 patients, Mani and Townsend (40) found a number of EEG alterations, including both transient or burst-type abnormalities (≈75%) and long-term alterations of the background activity (≈36%). With respect to the background alterations, two major types were seen: In one category (≈14%), there was a definite increase in the amount and amplitude of beta frequency range activity; in the other (≈14%), the theta and delta frequency range components were increased in amplitude and amount. An important point, also emphasized by this and other studies of benign intracranial hypertension (e.g., 41, 42), is that the background EEG is often entirely within the range of normal variation (≈64% of Mani and Townsend's patients). Unfortunately, no quantitative data comparing individual values in the normal and hypertensive states is available. Thus, within the normal range, it is certainly possible and even likely that significant increases or decreases of various frequency components occur at times of increased intracranial pressure, as compared to times of normal pressure.

In view of the above findings, a "typical" case of benign intracranial hypertension might be expected to show relatively minor changes in background activity and perhaps also exhibit transient or burst-type abnormalities. During Skylab, no transient abnormalities were detected, but definite changes in background activity, within the normal range, did occur. The most notable Skylab alteration - an increase of the alpha range average frequency - is not reported as occurring in benign intracranial hypertension, although its presence cannot be ruled out in those cases that were simply reported as "normal" at one point in time. One very consistent Skylab finding was an increase in the number of beta range waves occurring per minute in the awake stage (Tables I and XIV). This observation is compatible with the qualitative study of Mani and Townsend (40), in which 14% of their patients showed a similar increase of beta activity. Other Skylab changes, such as the increase in number of delta waves per minute in the awake state and during stages 2 and 3 of sleep, might also be compared to analogous findings in some benign intracranial hypertension patients (40). Thus, as with the vestibular effects, the data now available does not permit a conclusion to be drawn regarding the possible presence of increased intracranial pressure, secondary to body-fluid shifts. This possibility is certainly not ruled out by the EEG findings, however, and it should be seriously considered in the design of future experiments.

3.5.3. Conclusions

In spite of considerable individual variation, several EEG characteristics showed similar changes in all three Skylab subjects. In particular, compared to preflight studies, the amount of beta and delta activity tended to increase inflight in the awake state, as did the alpha frequency. During sleep, inflight amplitudes in the delta range were found to be increased. Although these intra-individual changes were statistically significant, the absolute values were never outside the range of normal variation.

The Skylab EEG changes are difficult to evaluate because of the multiplicity of potentially influential factors present in the inflight environment. Drugs used occasionally for medical purposes must be regarded as one very likely etiological factor. These could explain part, but not all, of the increase in beta range activity and possibly also a portion of the alpha frequency elevation. Increased metabolic activity must also be considered, in view of elevated thyroid-function tests in the immediate postflight period. Psychological factors (e.g., induced by stress) are considered to be unlikely candidates for causing the long-term alterations observed but could conceivably be contributing elements. Weightlessness, itself, is considered to be a very likely common denominator underlying some of the EEG changes observed. While the vestibular disturbances associated with the zero-g state may contribute by altering patterns of neuronal input, a more likely mechanism involves fluid-shift factors (secondary to loss of hydrostatic pressure), which may lead to an increase of intracranial pressure and concomitant EEG modifications.

The results suggest that the EEG, if applied in the proper context and with suitable controls for internal and external environmental influences, could provide more definitive information regarding the etiology of the "space motion sickness syndrome." Other work currently in progress (supported by Contract NAS 9-13870), including analysis of long-term bed-rest EEG data and EEG recordings during parabolic flight, will provide further information on vestibular and fluid-shift mechanisms and hopefully will narrow the range of etiological possibilities identified in this study.

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FIGURES AND TABLES

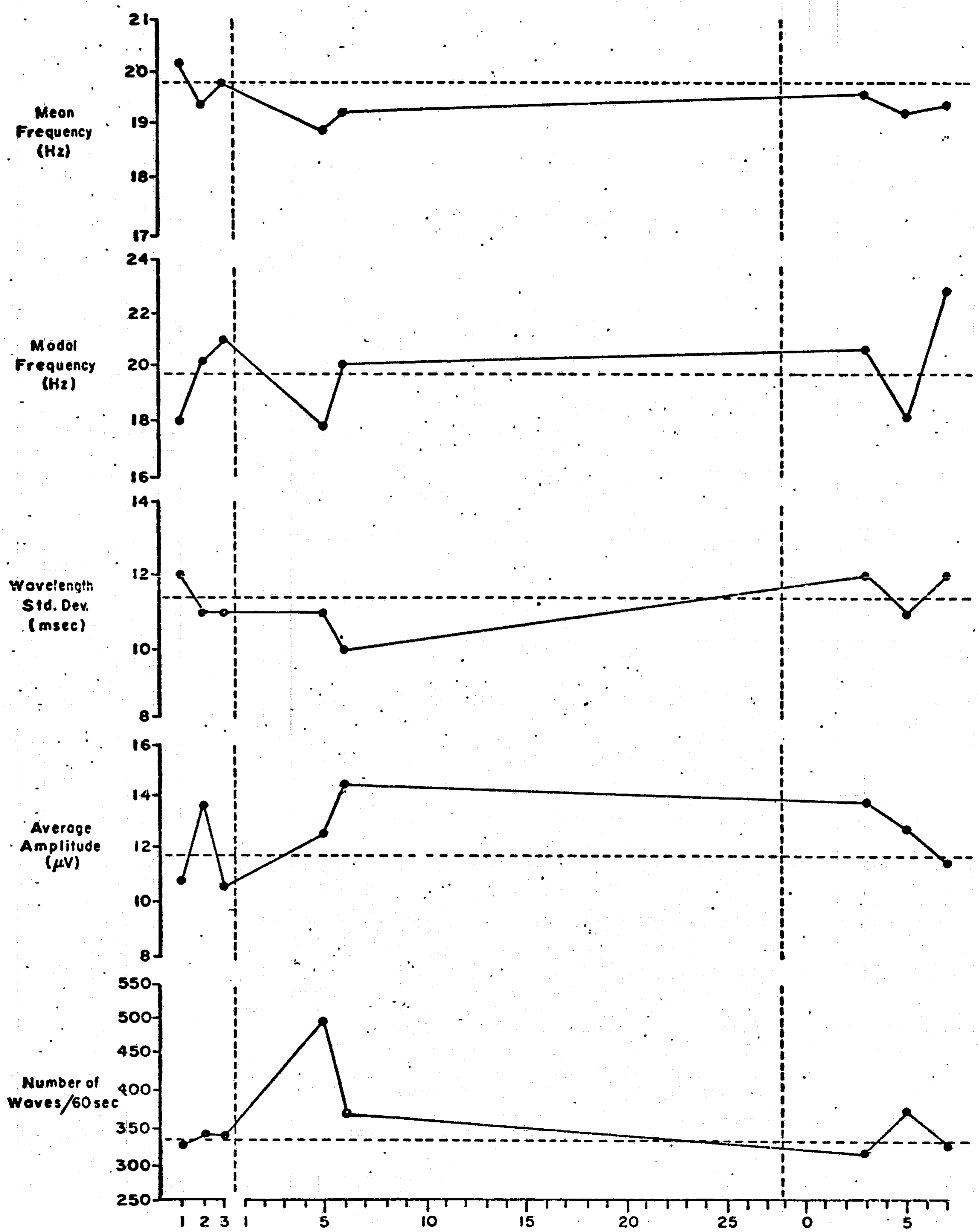


Fig. 1

J.K., BETA, AWAKE

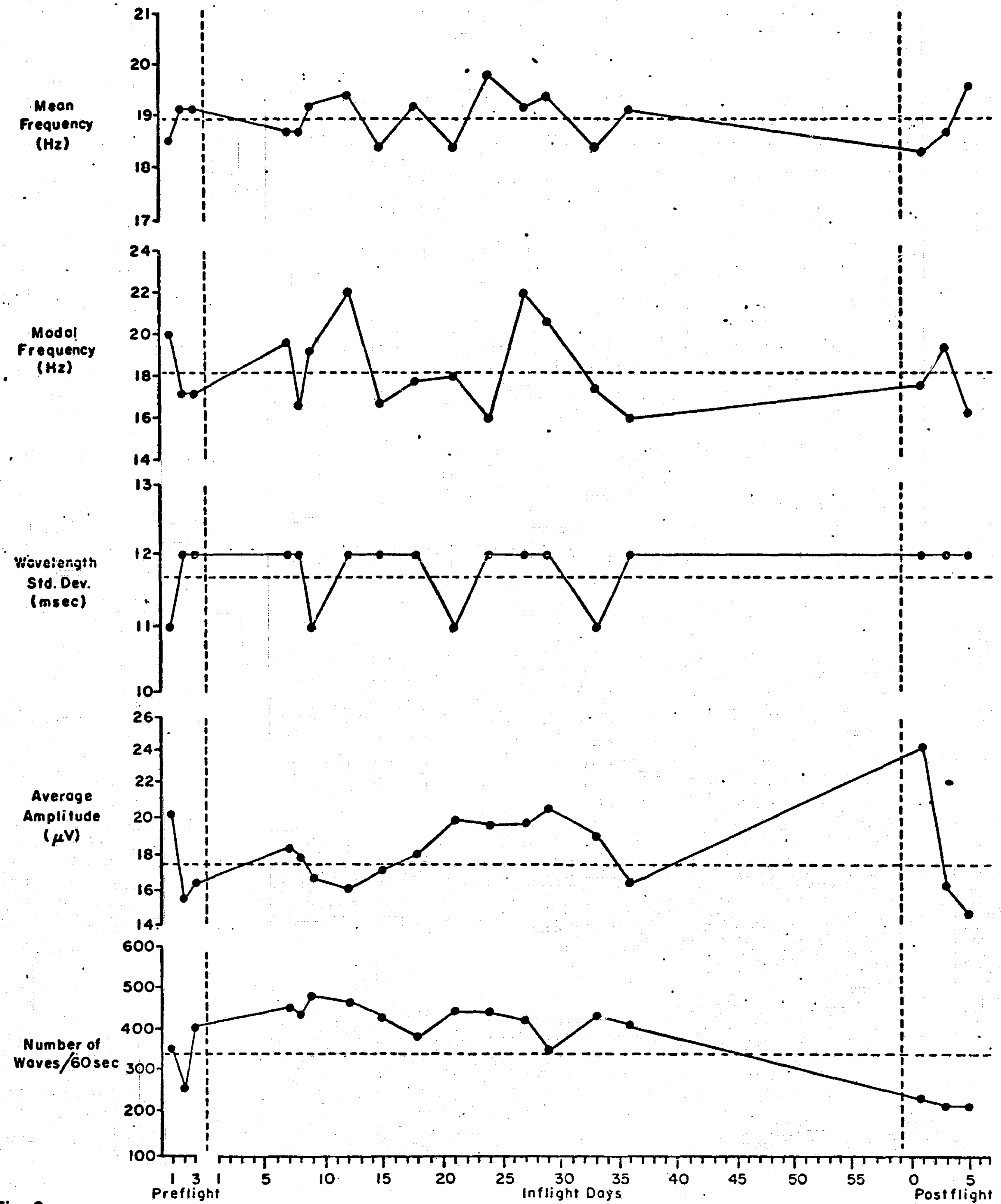


Fig. 2

O.G., BETA, AWAKE

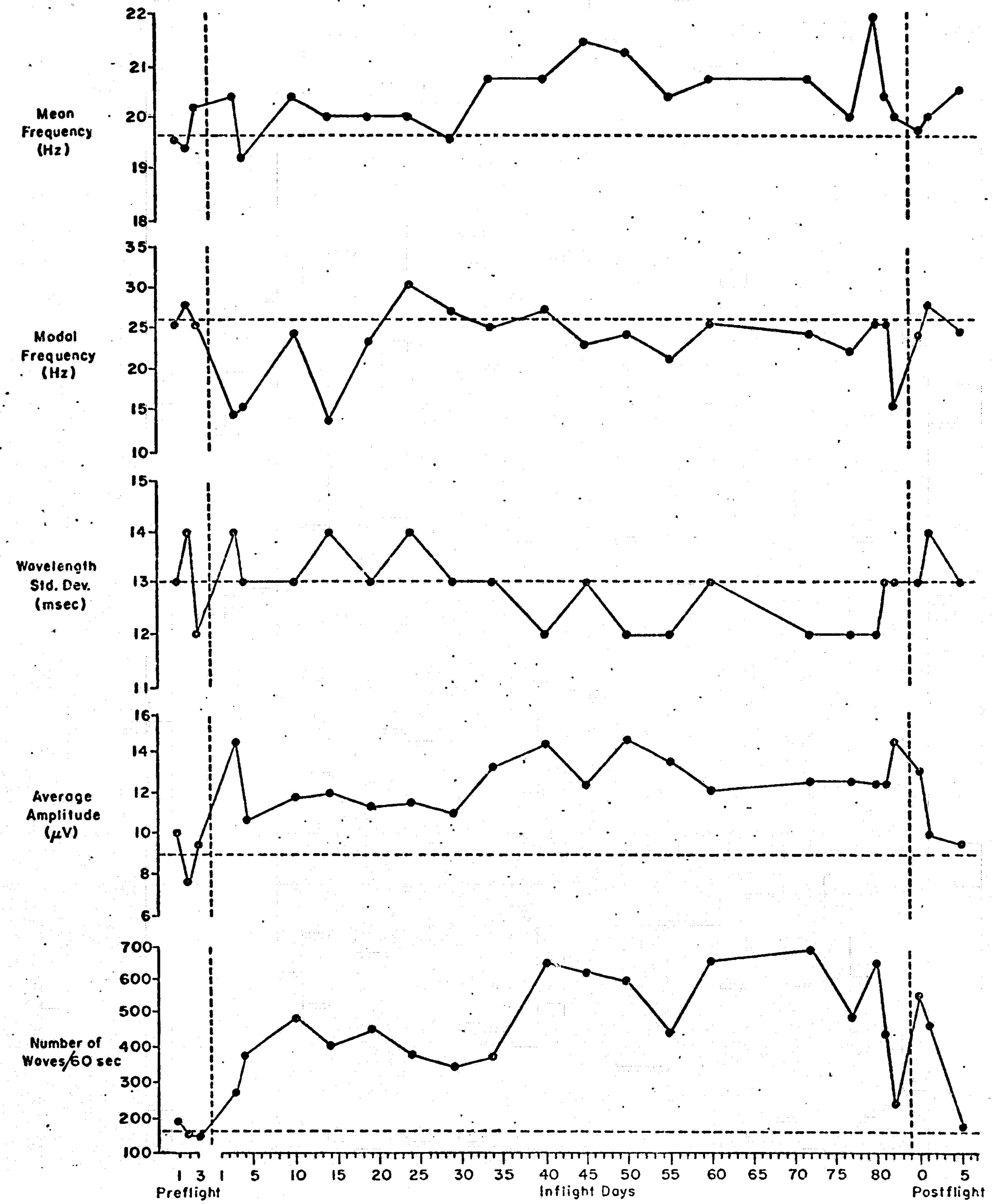


Fig. 3 E.G., BETA, AWAKE

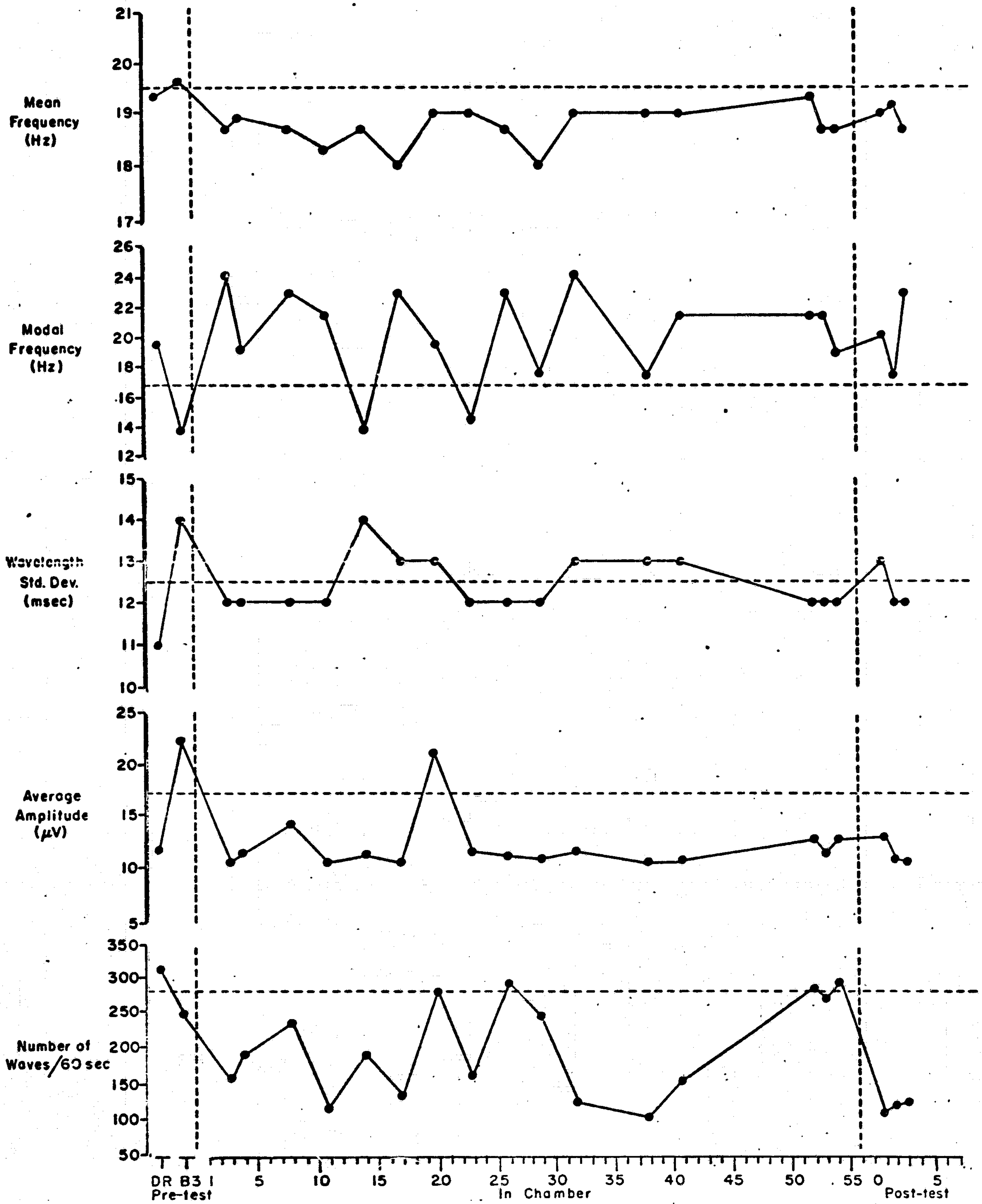


Fig. 4

W.T., BETA, AWAKE

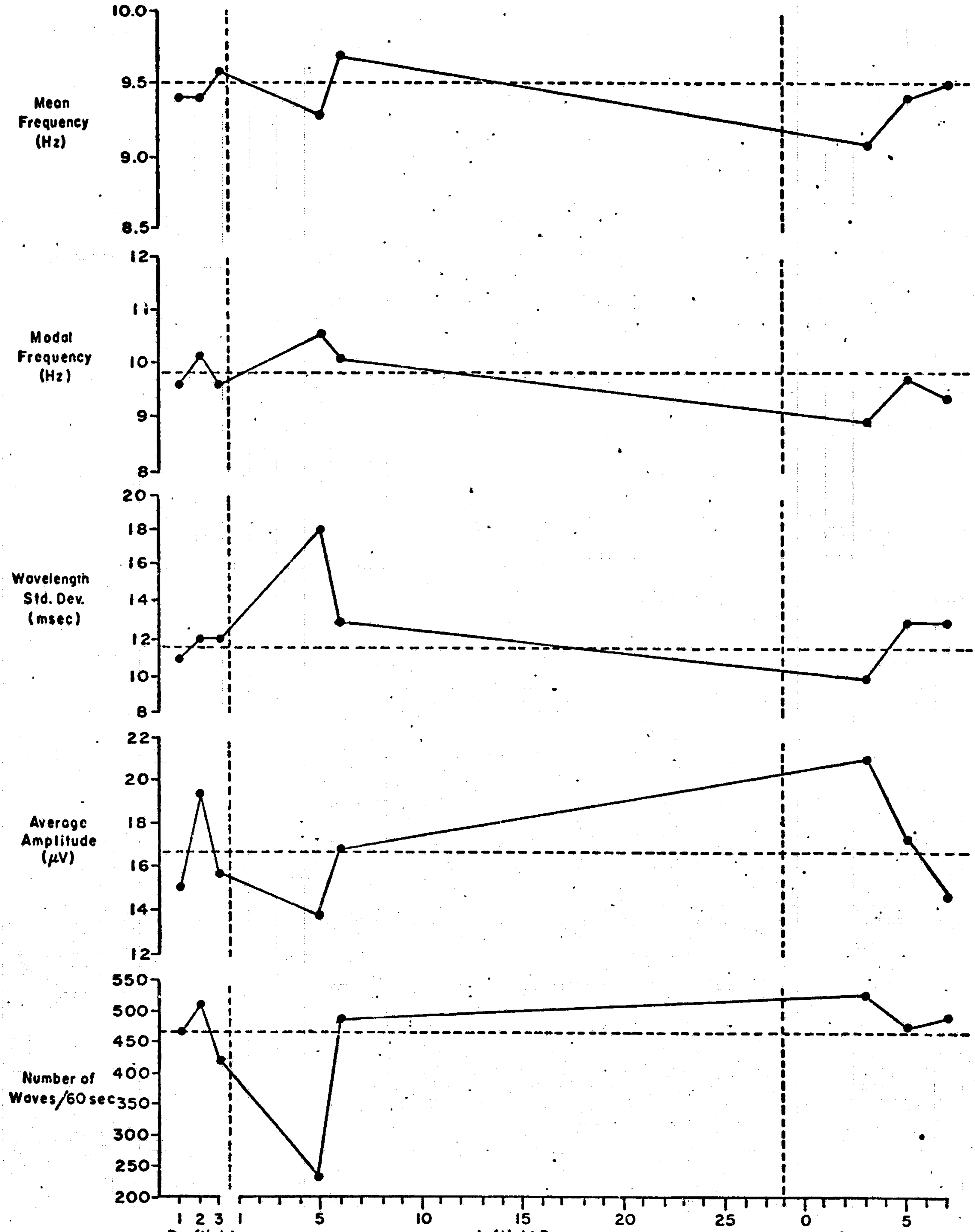


Fig. 5

J.K., ALPHA, AWAKE

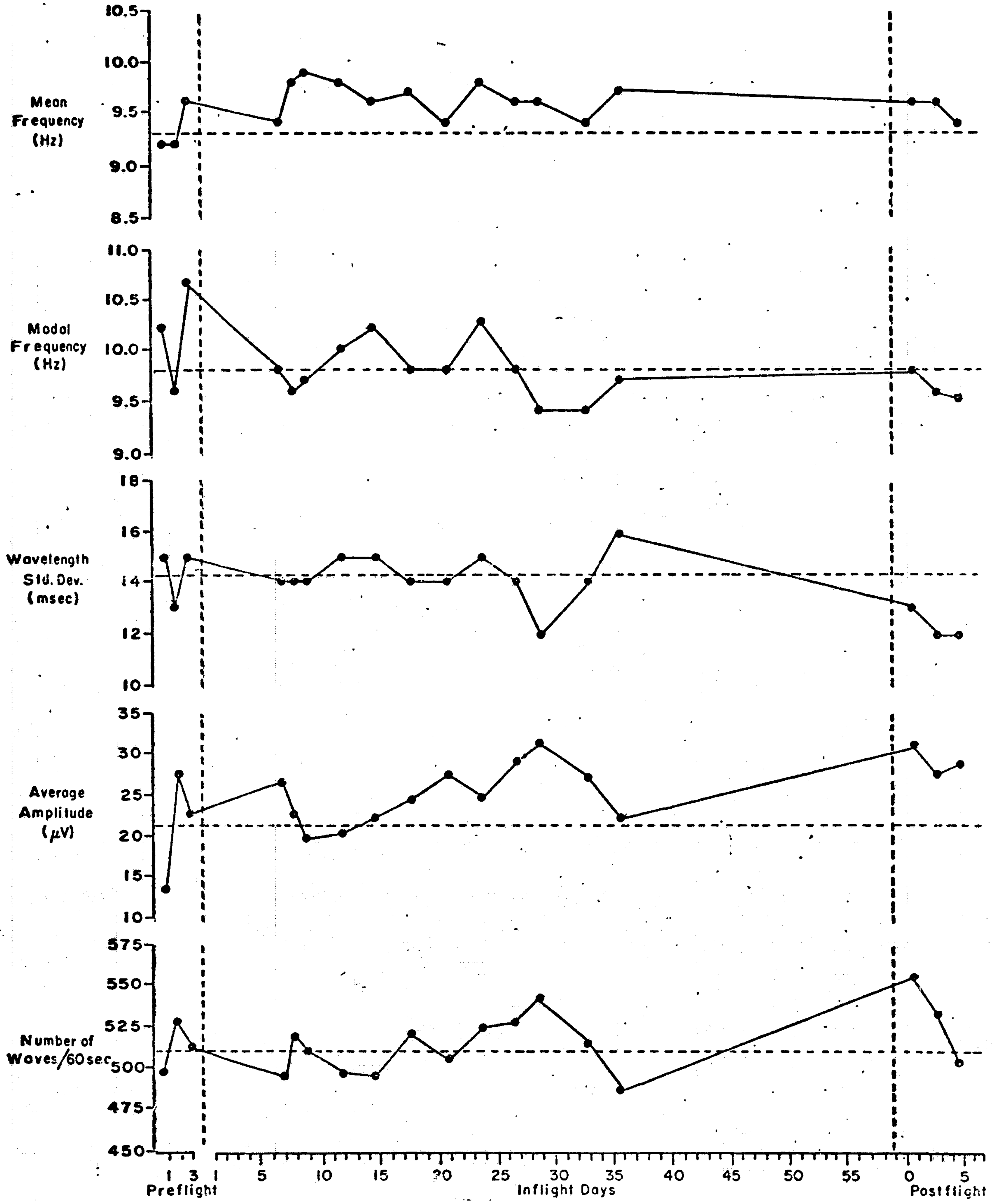


Fig. 6 O.G., ALPHA, AWAKE

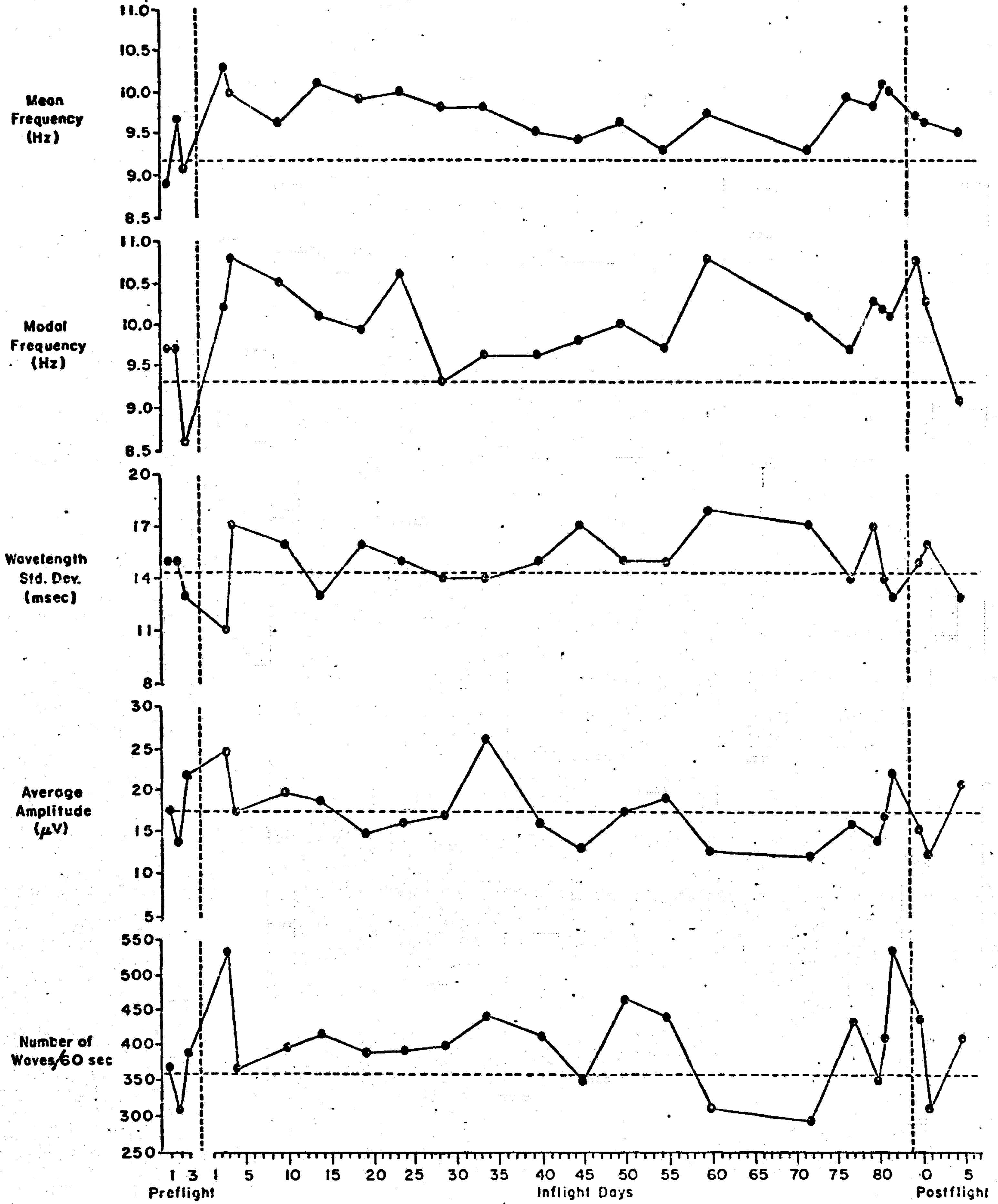
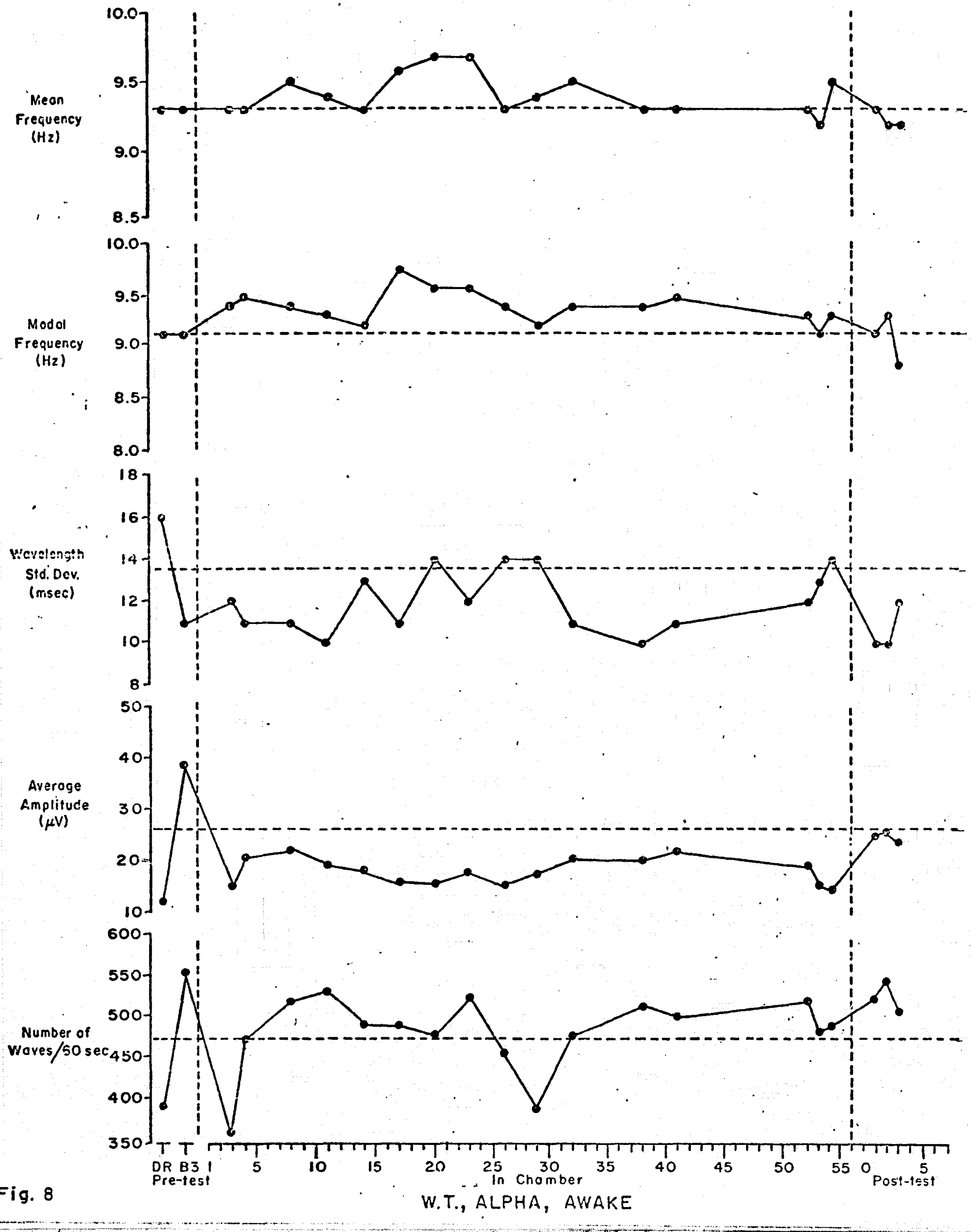


Fig. 7

E.G., ALPHA, AWAKE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9.5
9.0
8.5
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10.0
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9.0
8.5
8.0
Modal Frequency (Hz)
18
16
14
12
10
8
Wavelength Std. Dev. (msec)
50
40
30
20
10
Average Amplitude (μV)
600
550
500
450
400
350
Number of Waves/60 sec
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Pre-test
In Chamber
Post-test
W.T., ALPHA, AWAKE

Fig. 8

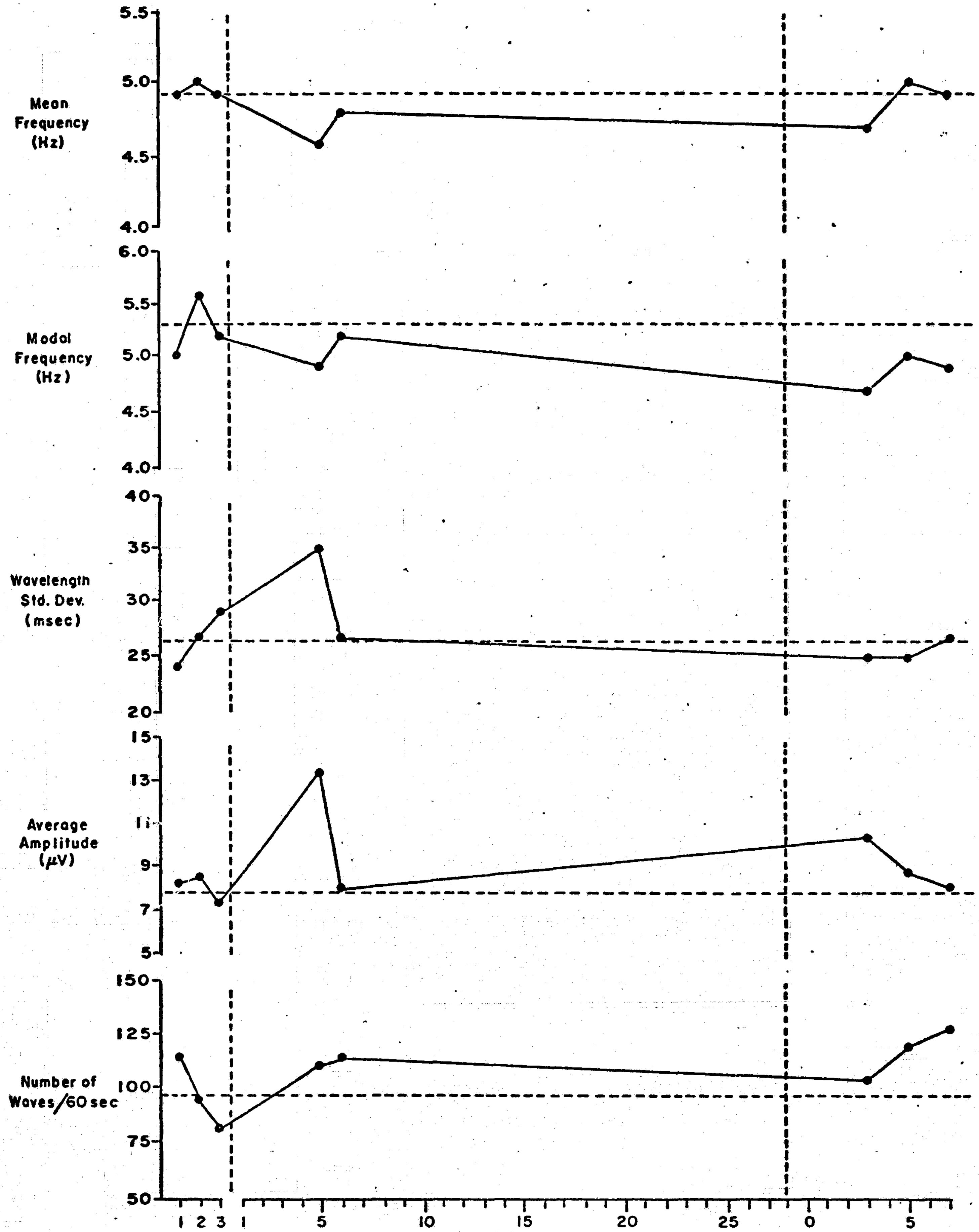

Fig. 9

J.K., THETA, AWAKE

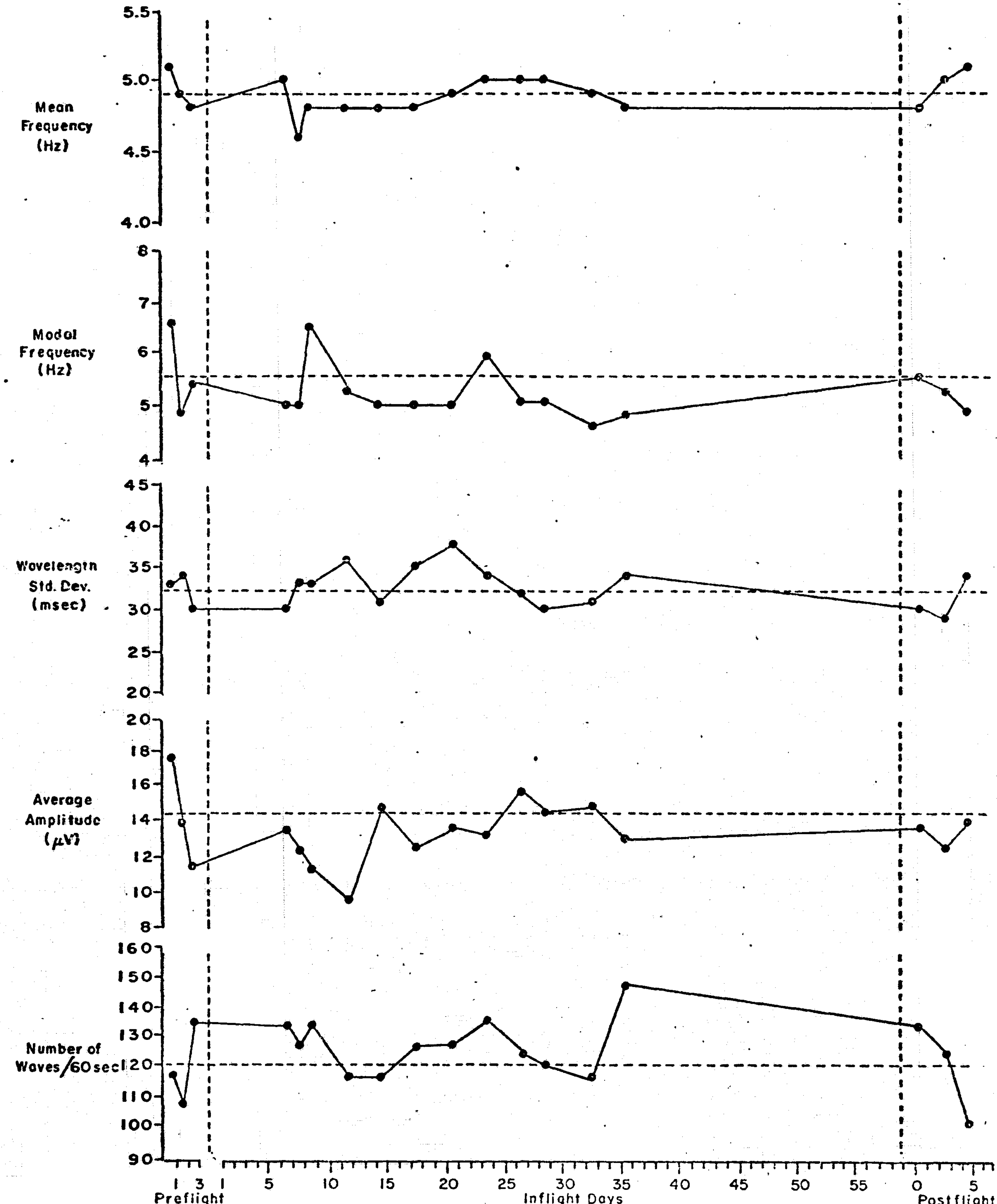

Fig. 10

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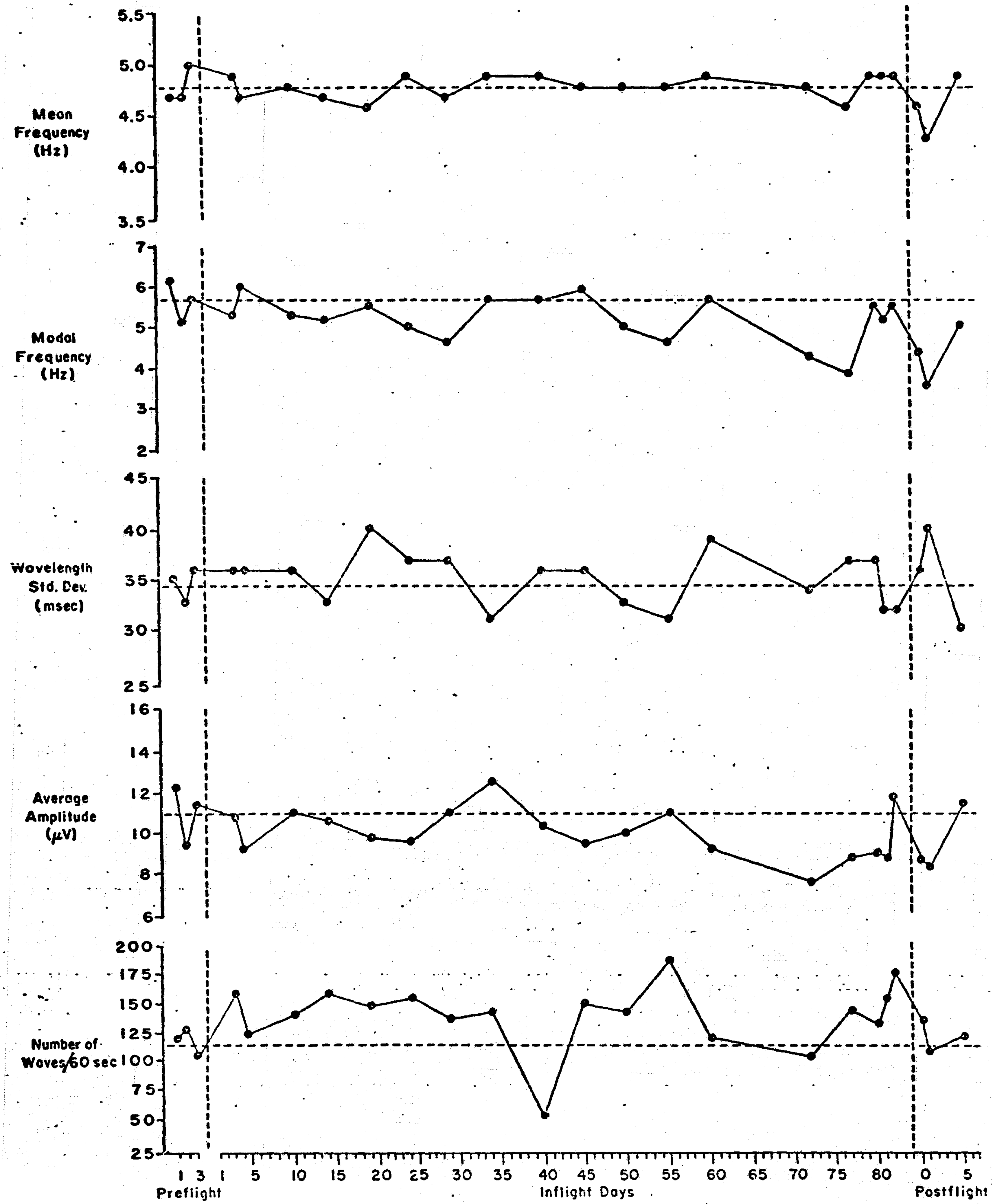


Fig. 11 E.G., THETA, AWAKE

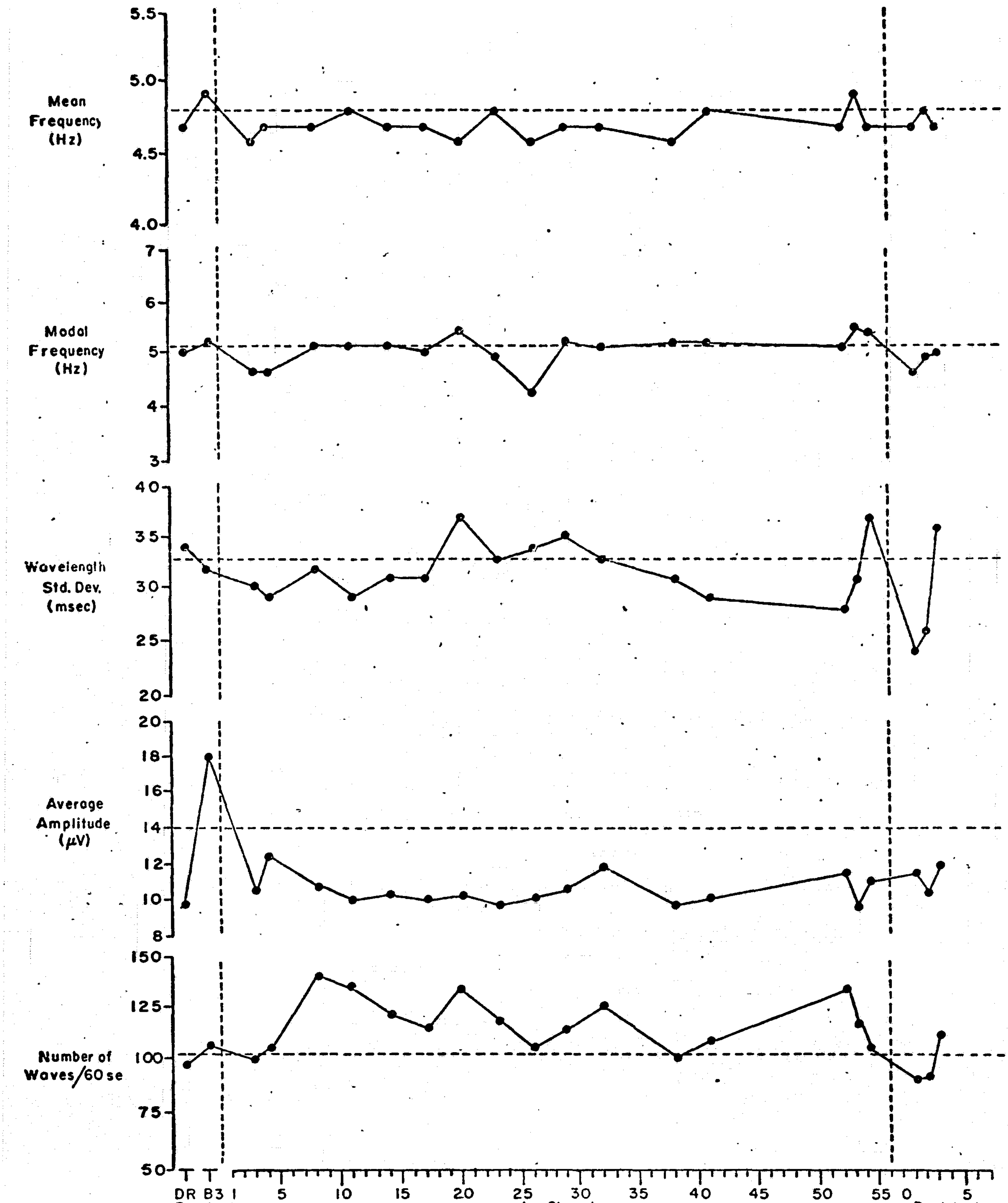


Fig. 12

W.T., THETA, AWAKE

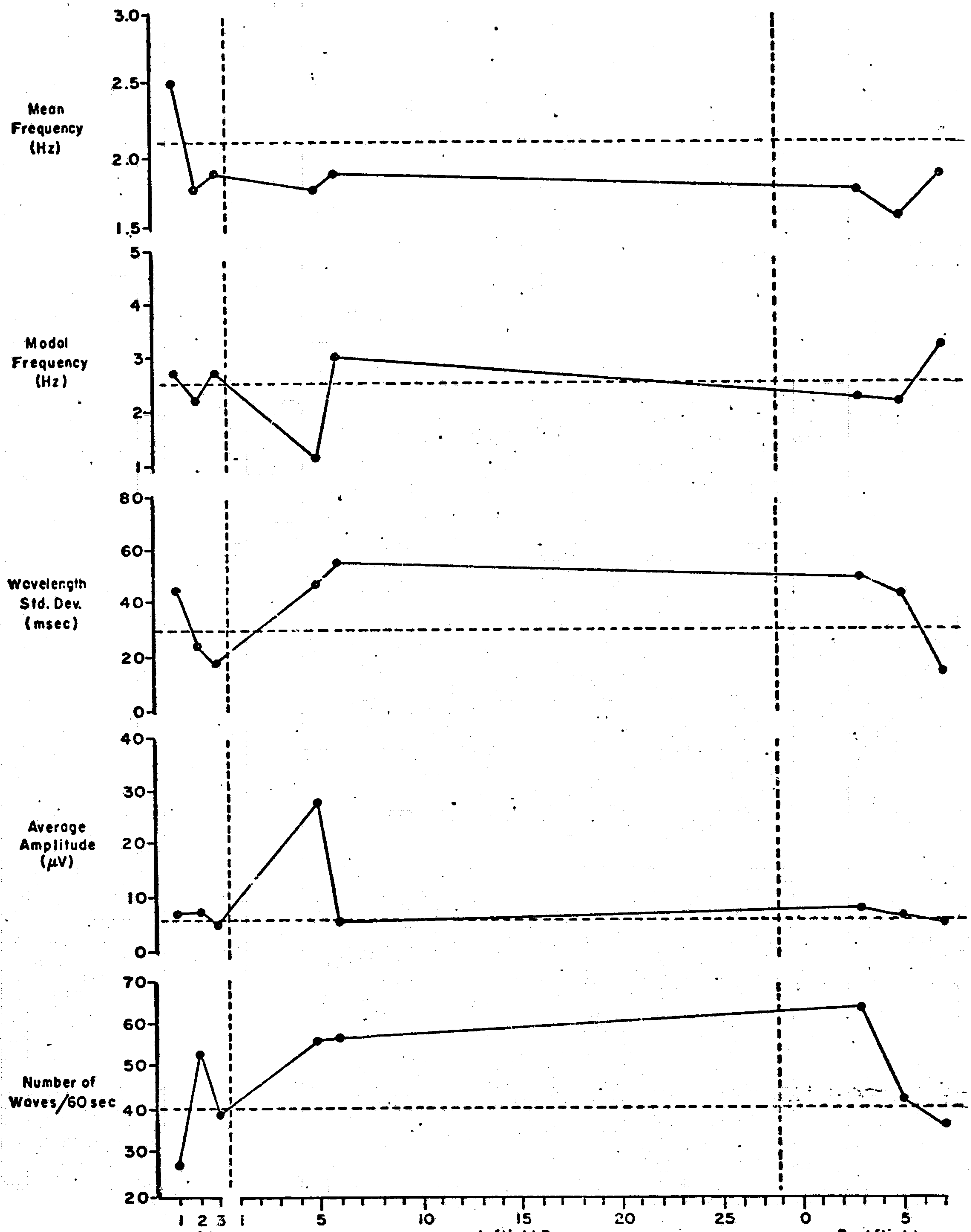


Fig. 13

J.K., DELTA, AWAKE

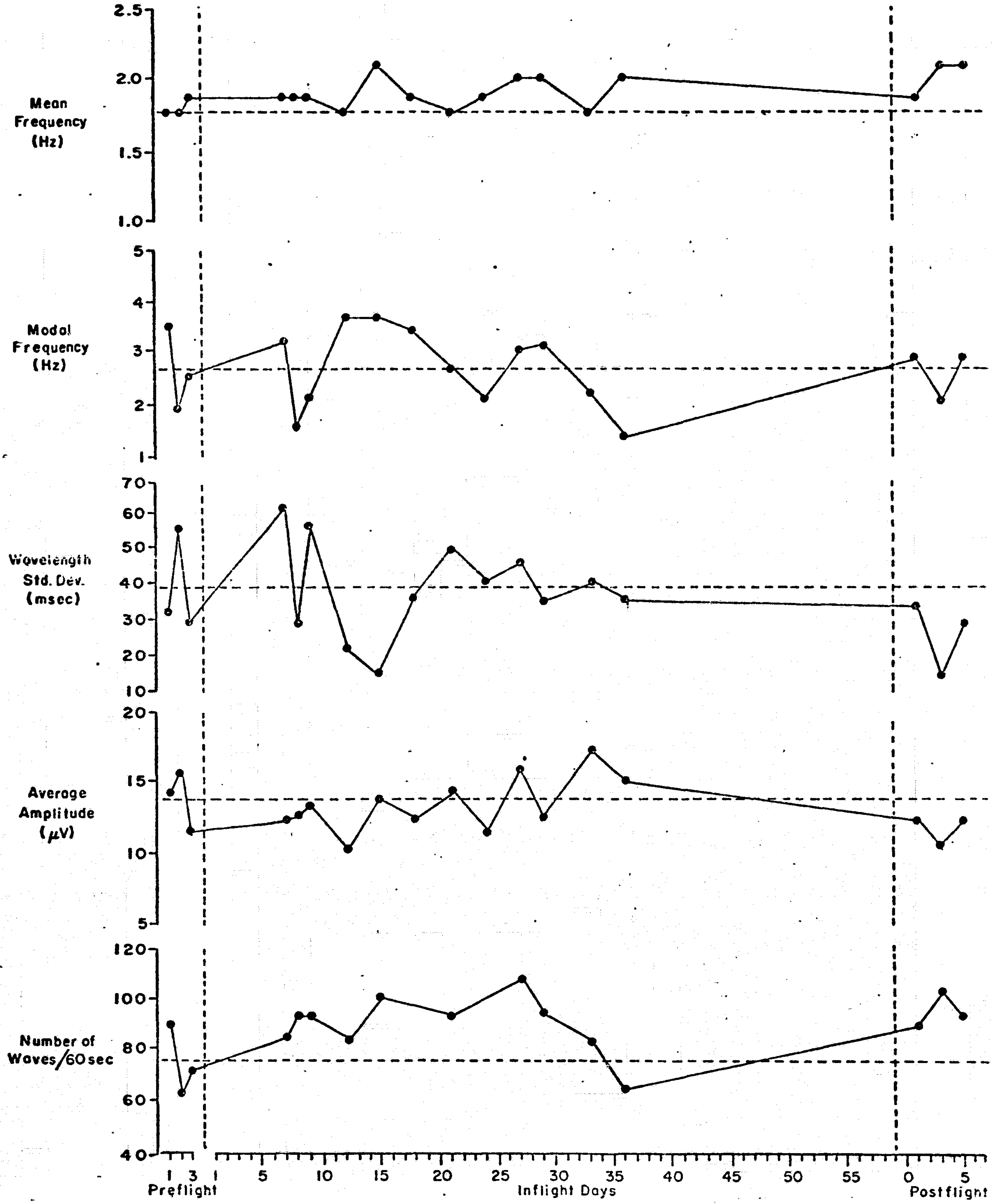


Fig. 14

O.G., DELTA, AWAKE

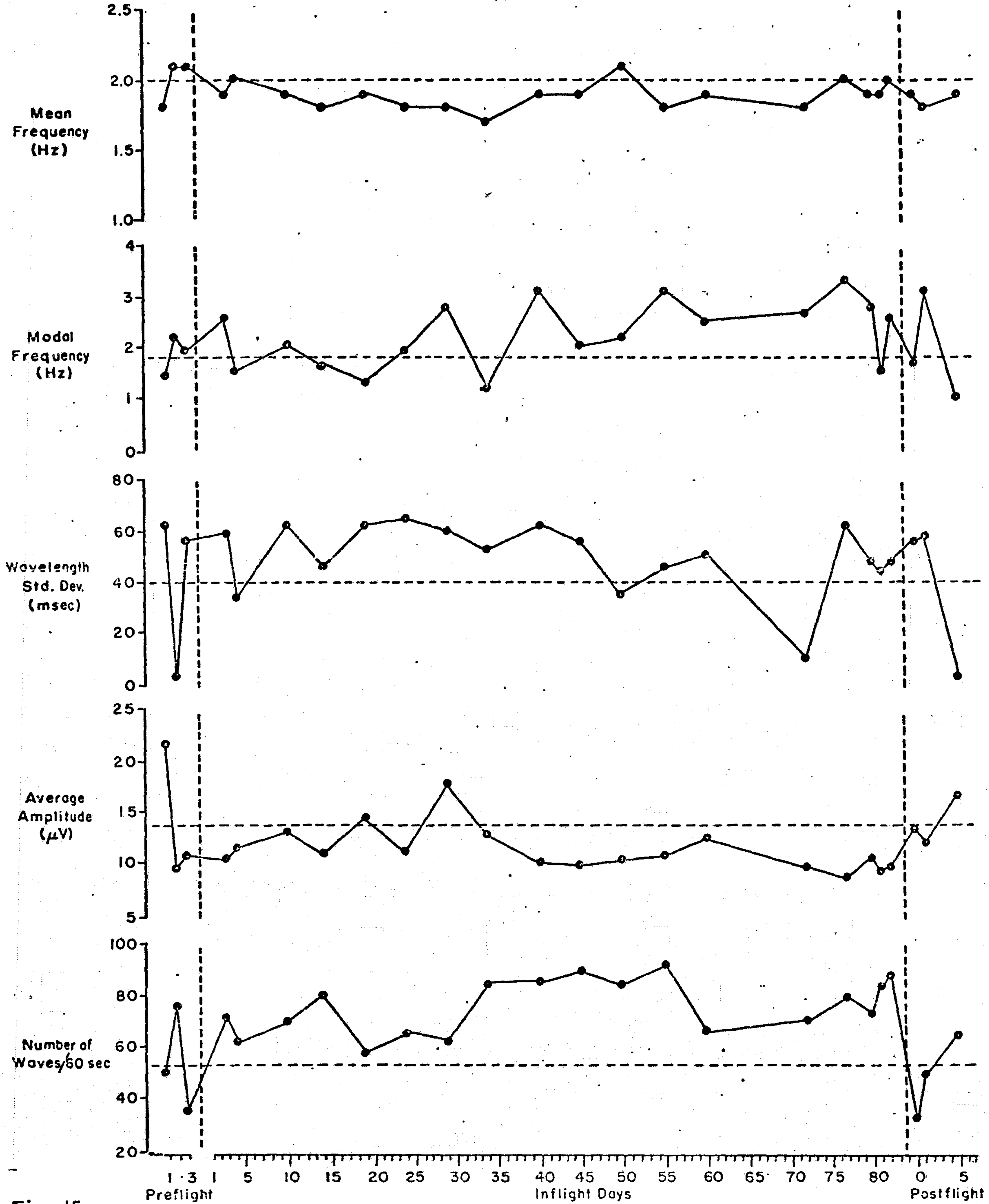


Fig. 15

E.G., DELTA, AWAKE

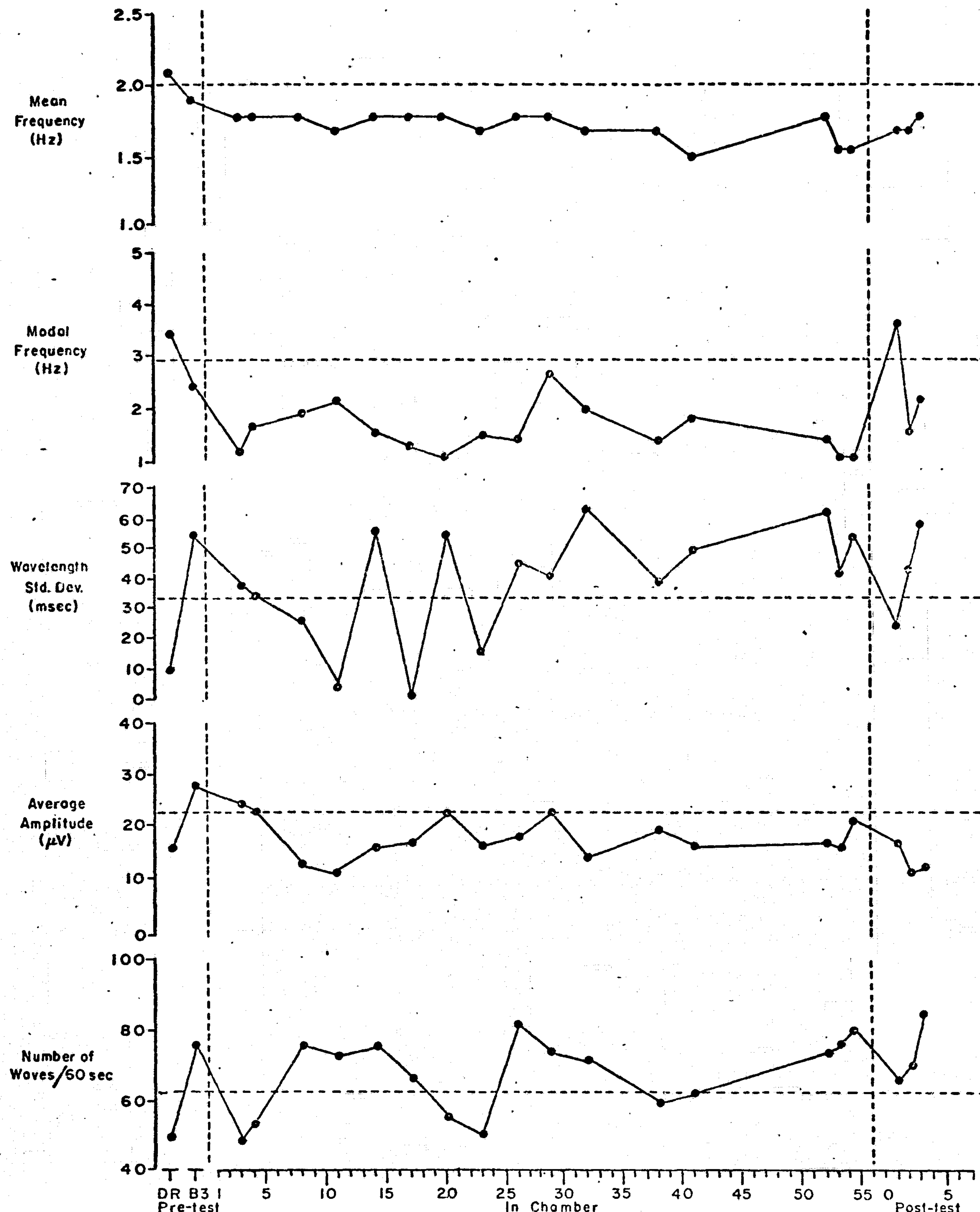


Fig. 16

W.T., DELTA, AWAKE

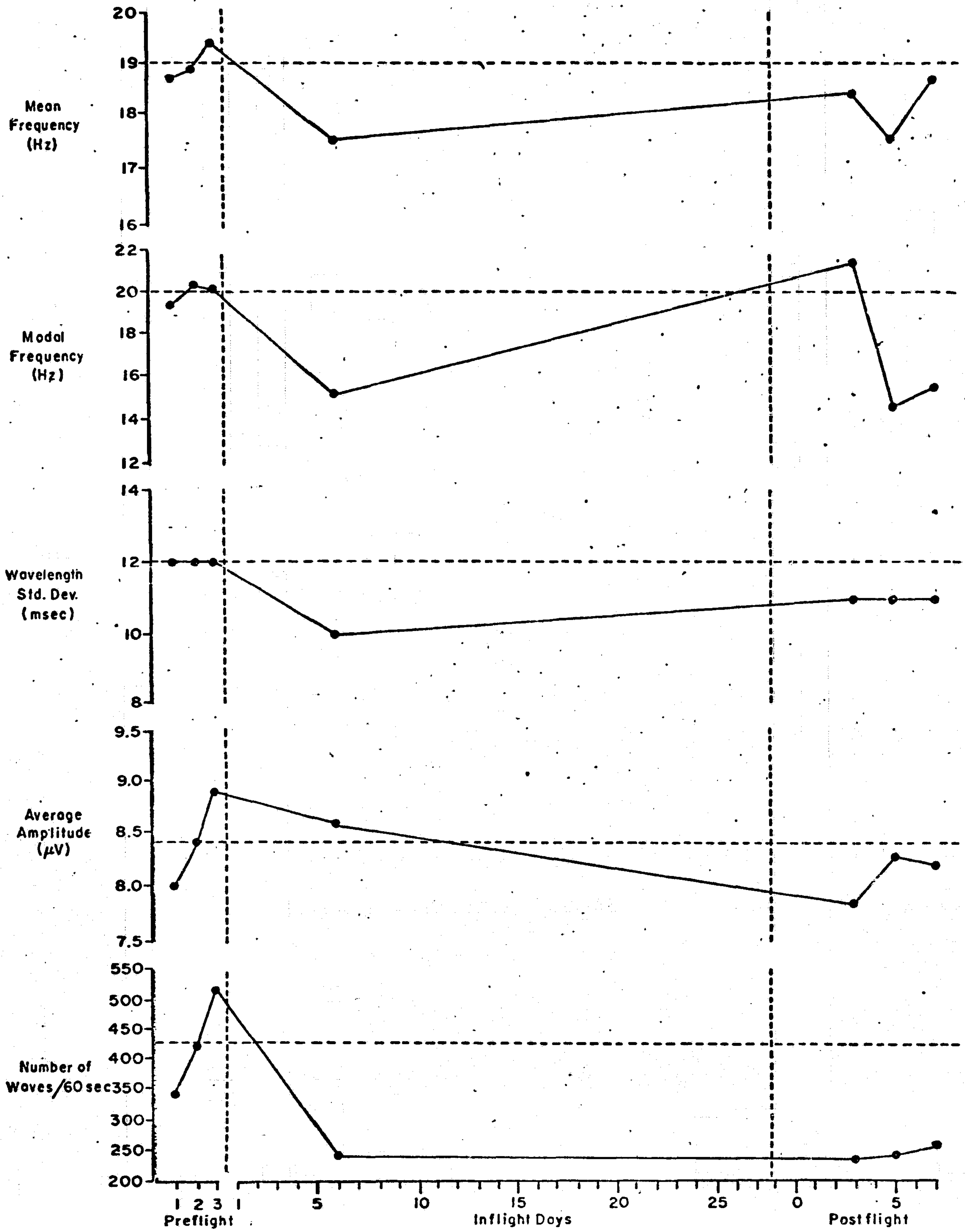


Fig. 17 J.K., BETA, REM

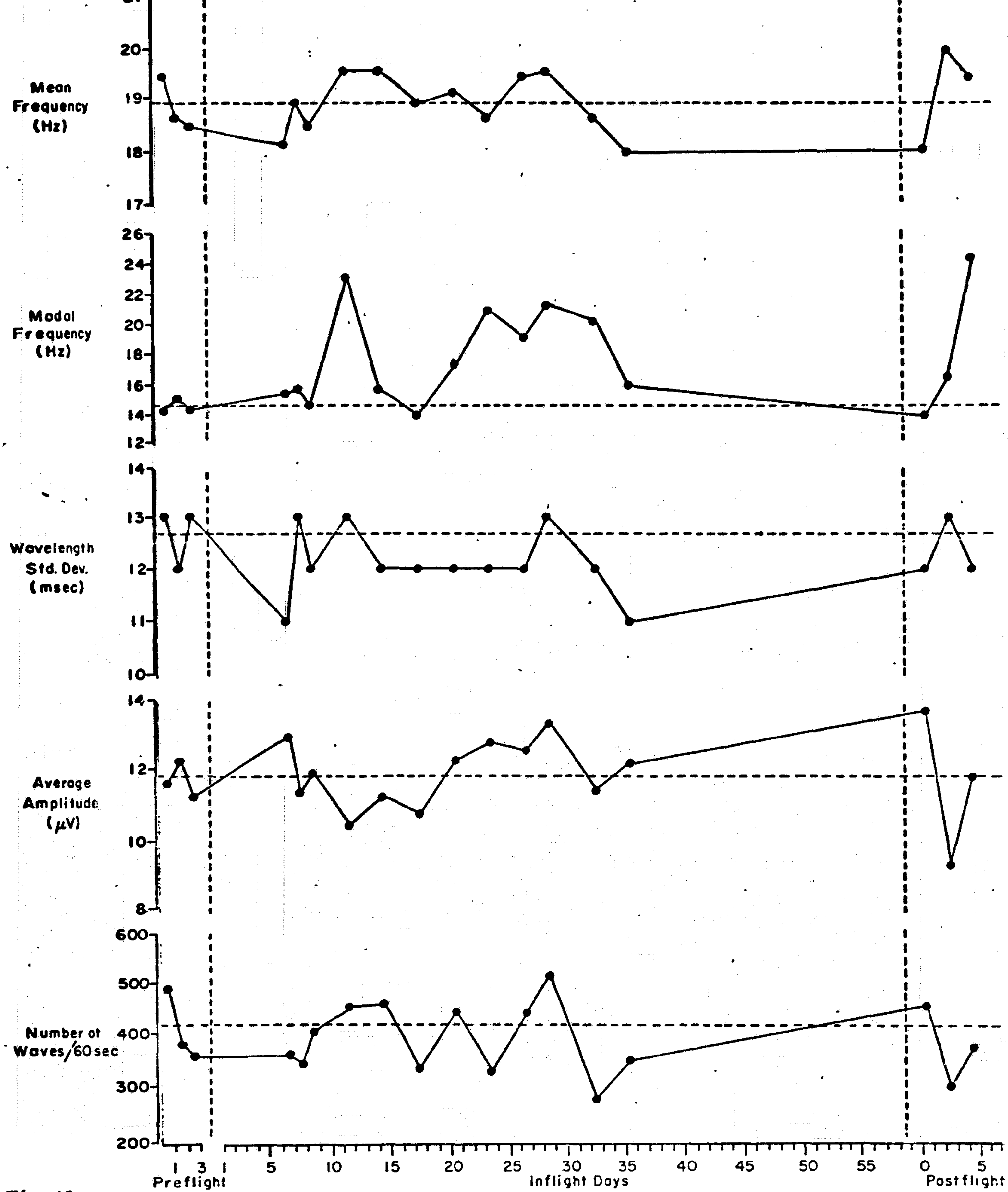


Fig. 18

O.G., JETA, REM

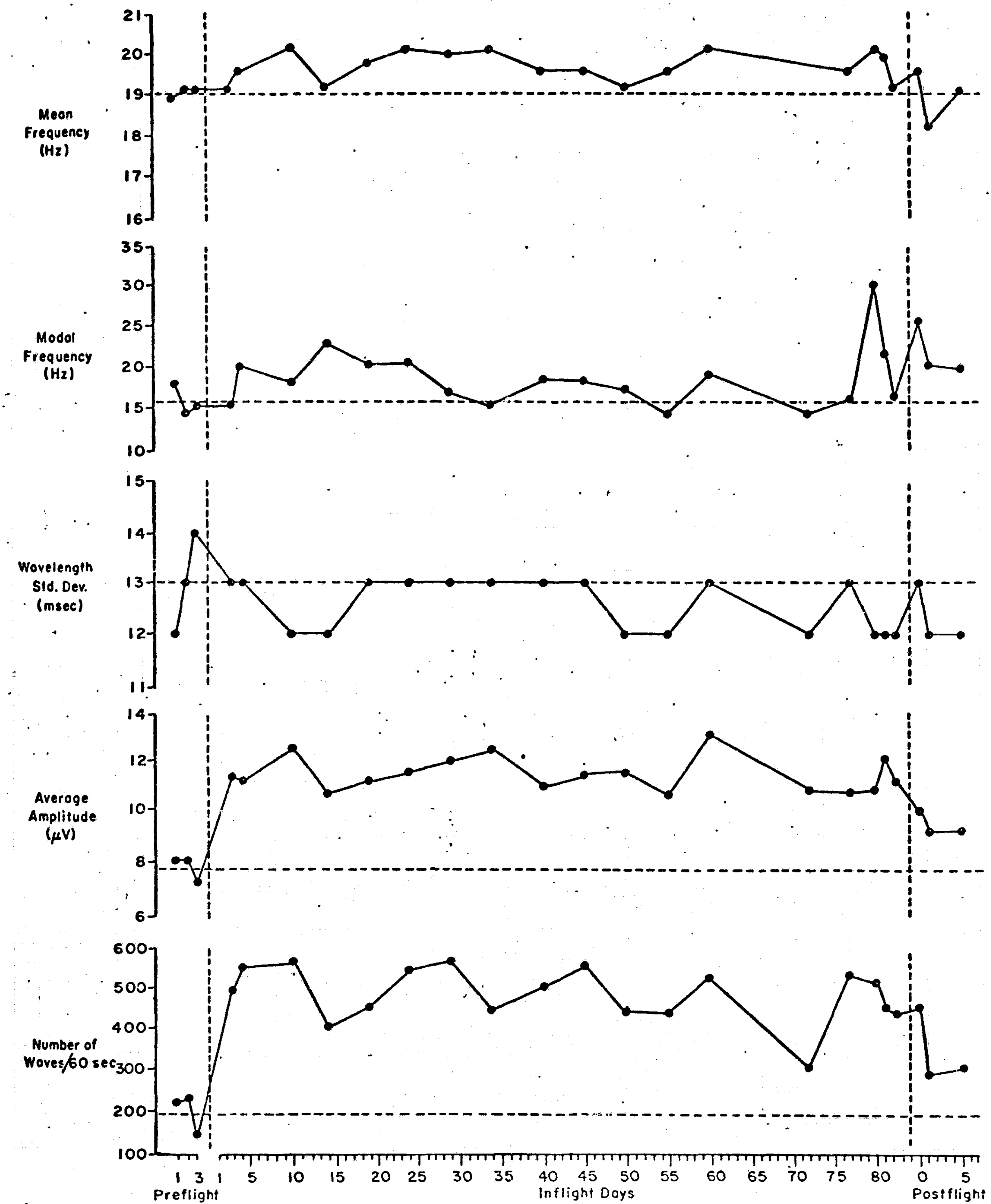


Fig. 19

E.G., BETA, REM

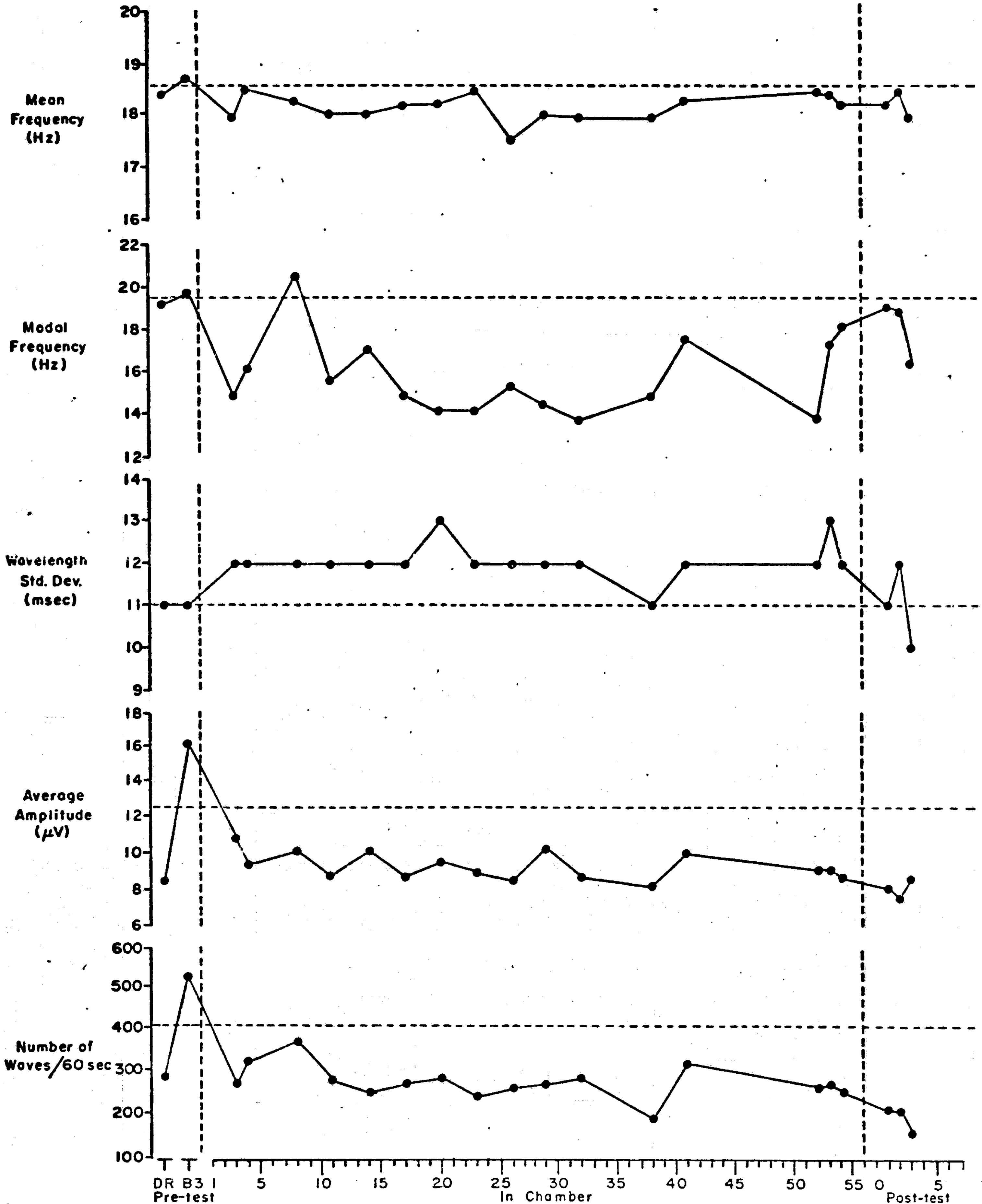


Fig. 20

W.T., BETA, REM

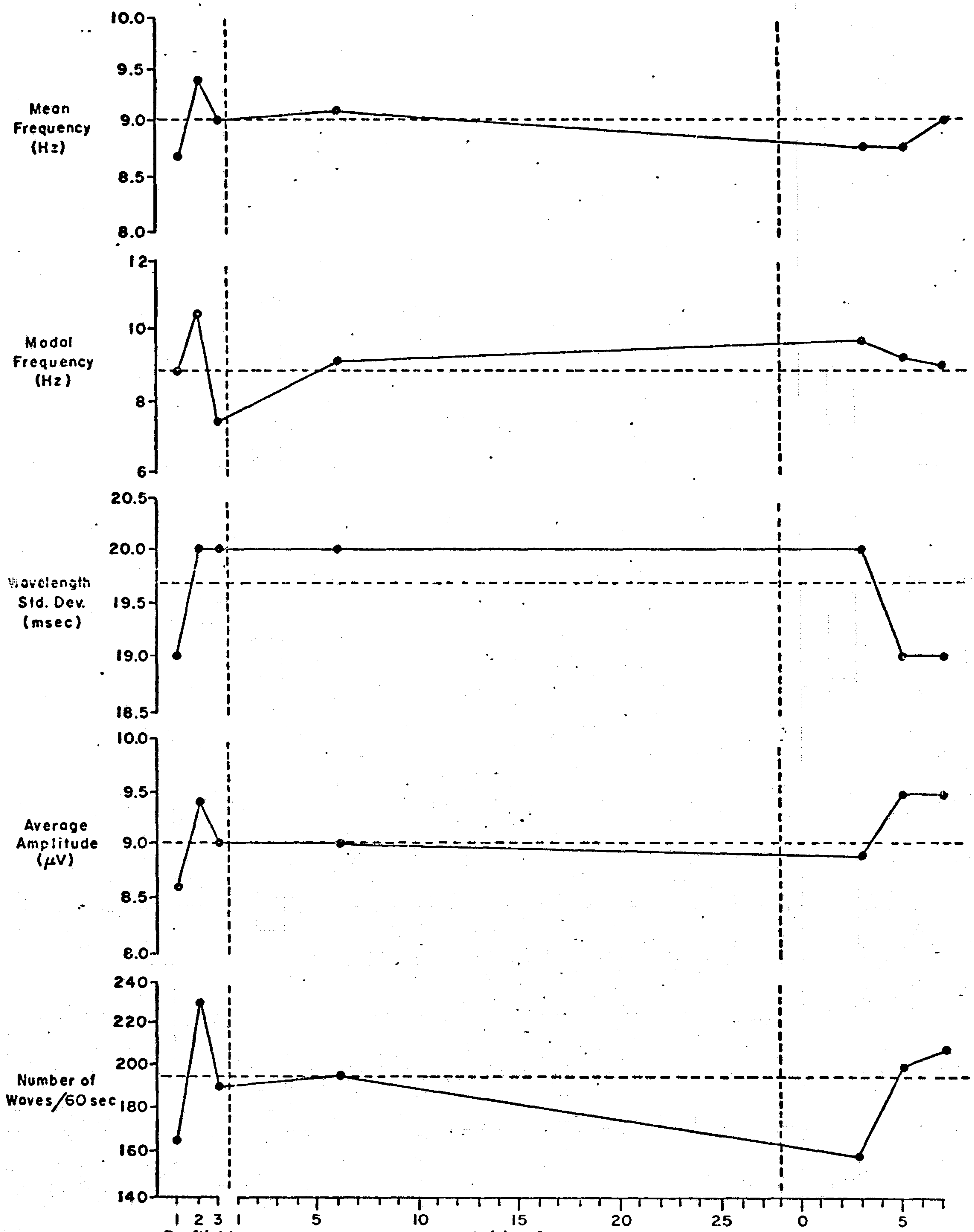


Fig. 21

J.K., ALPHA, REM

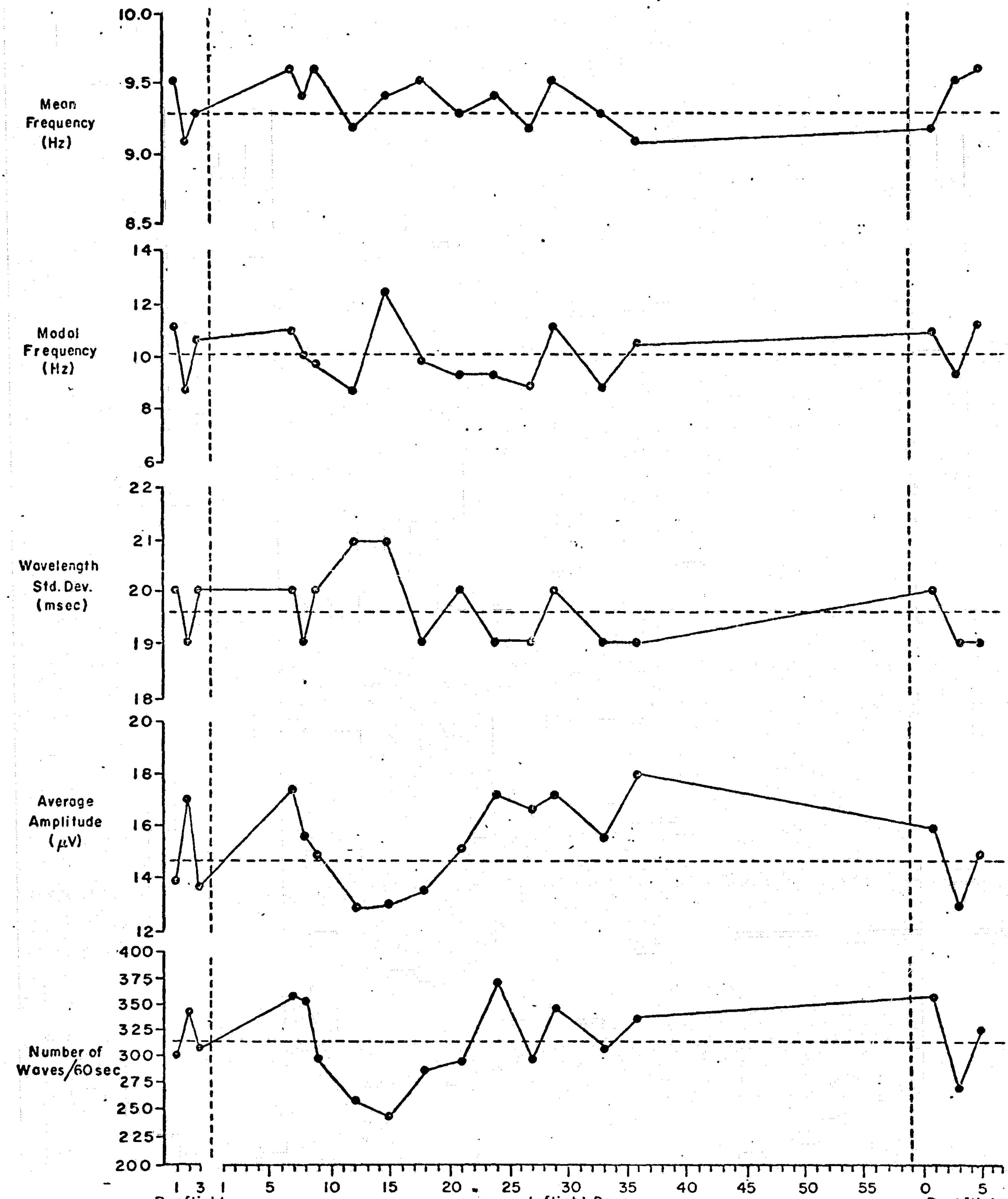


Fig. 22

O.G., ALPHA, REM

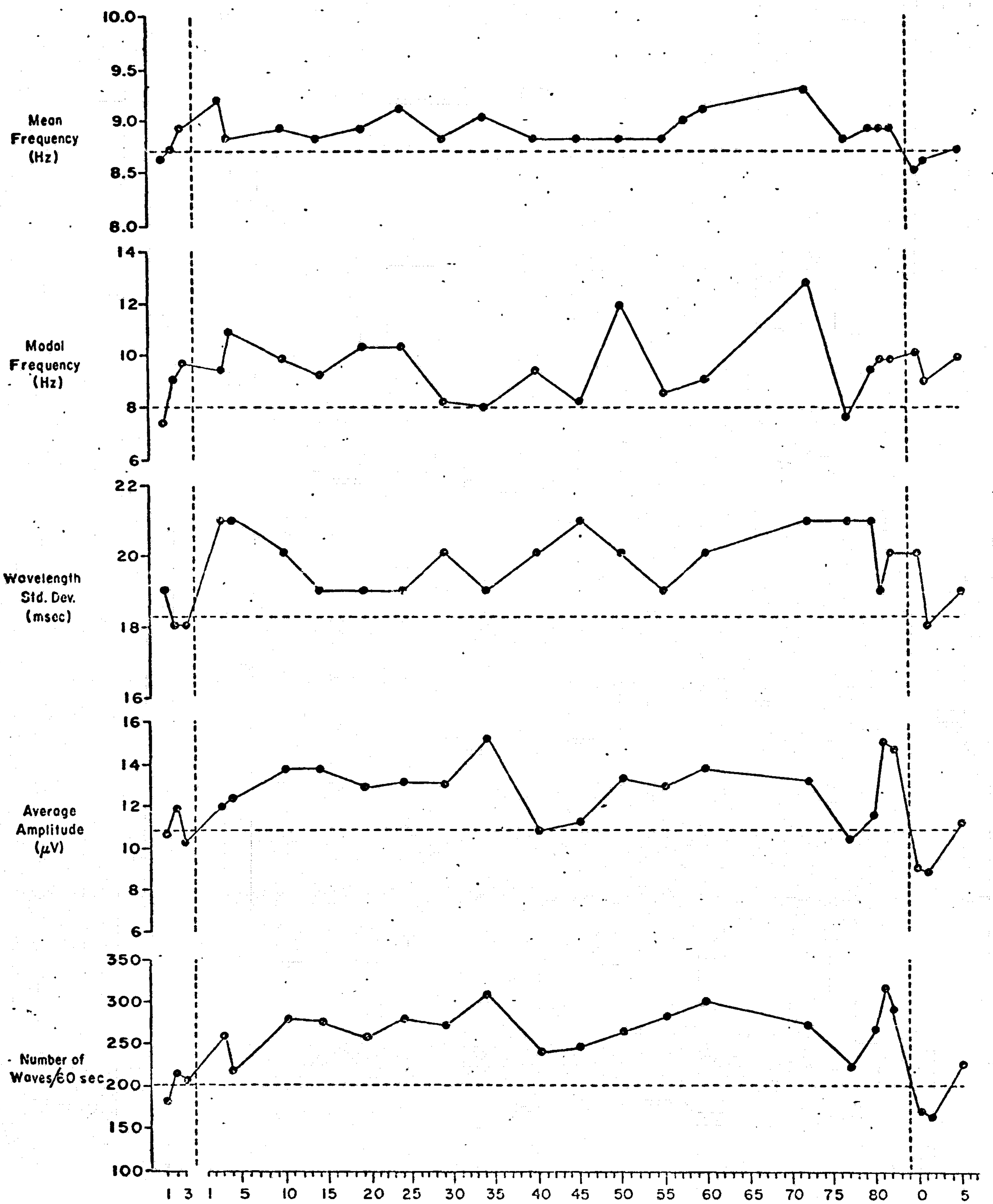


Fig. 23

E.G., ALPHA, REM

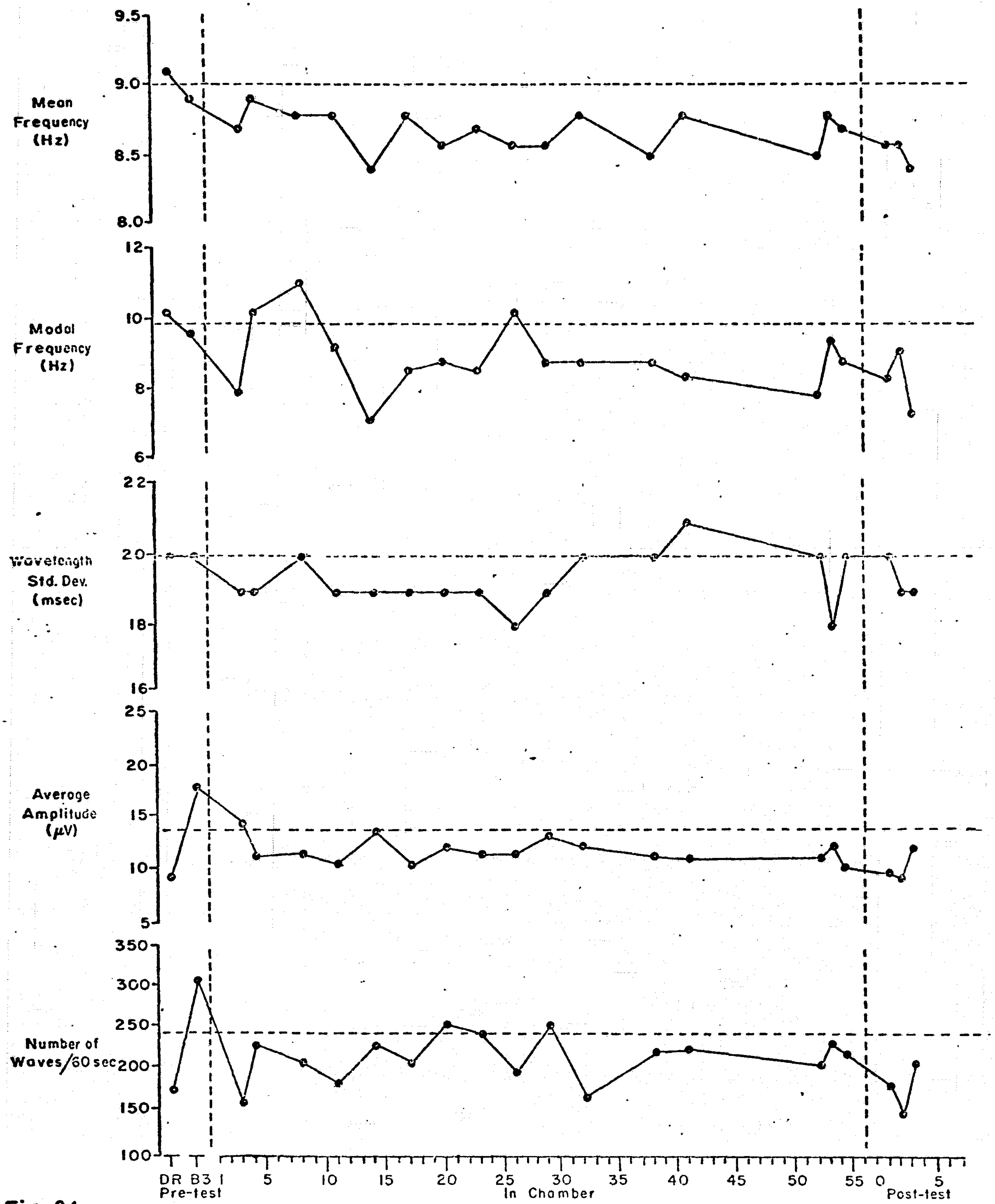


Fig. 24

W.T. ALPHA, REM

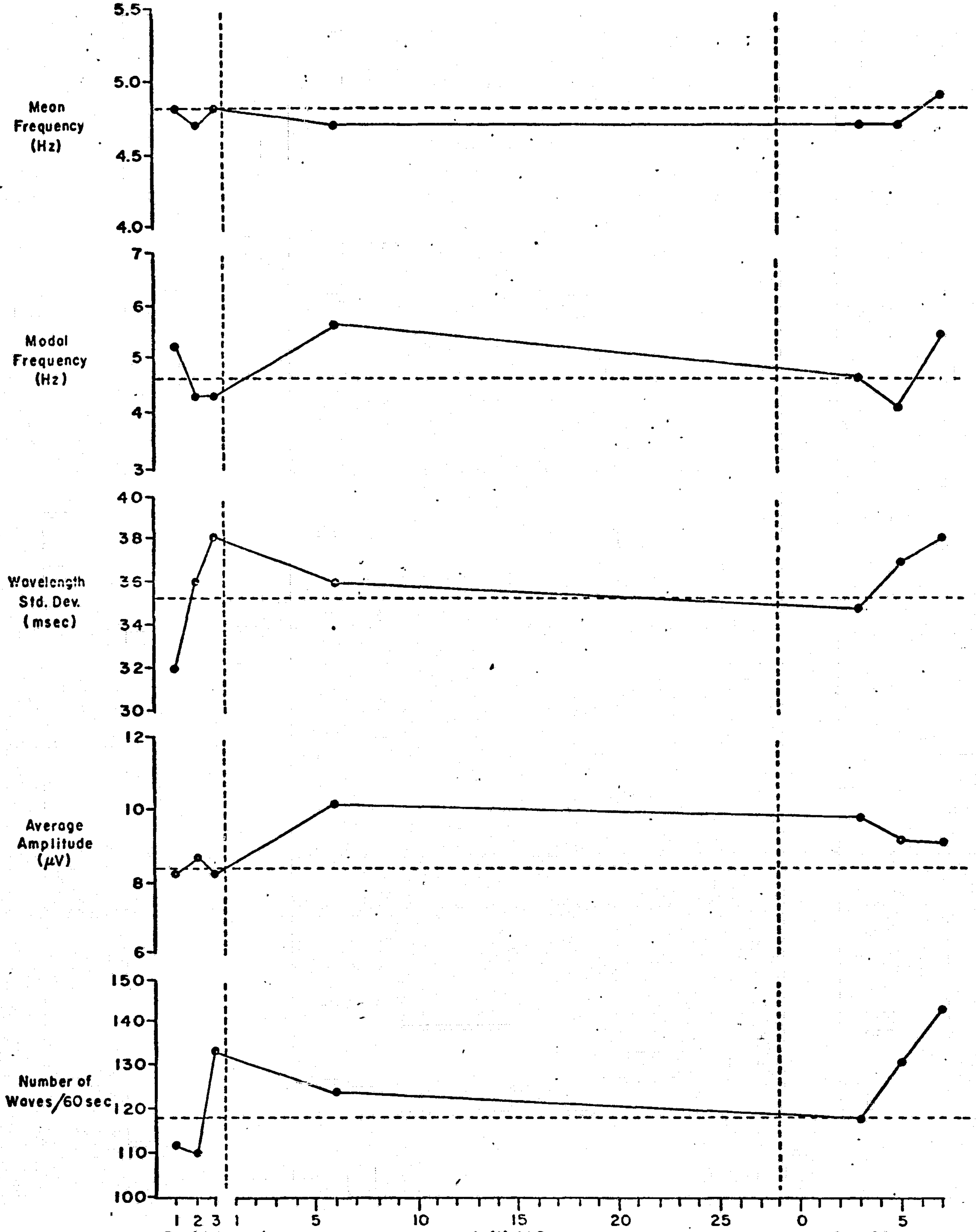


Fig. 25

J.K., THETA, REM

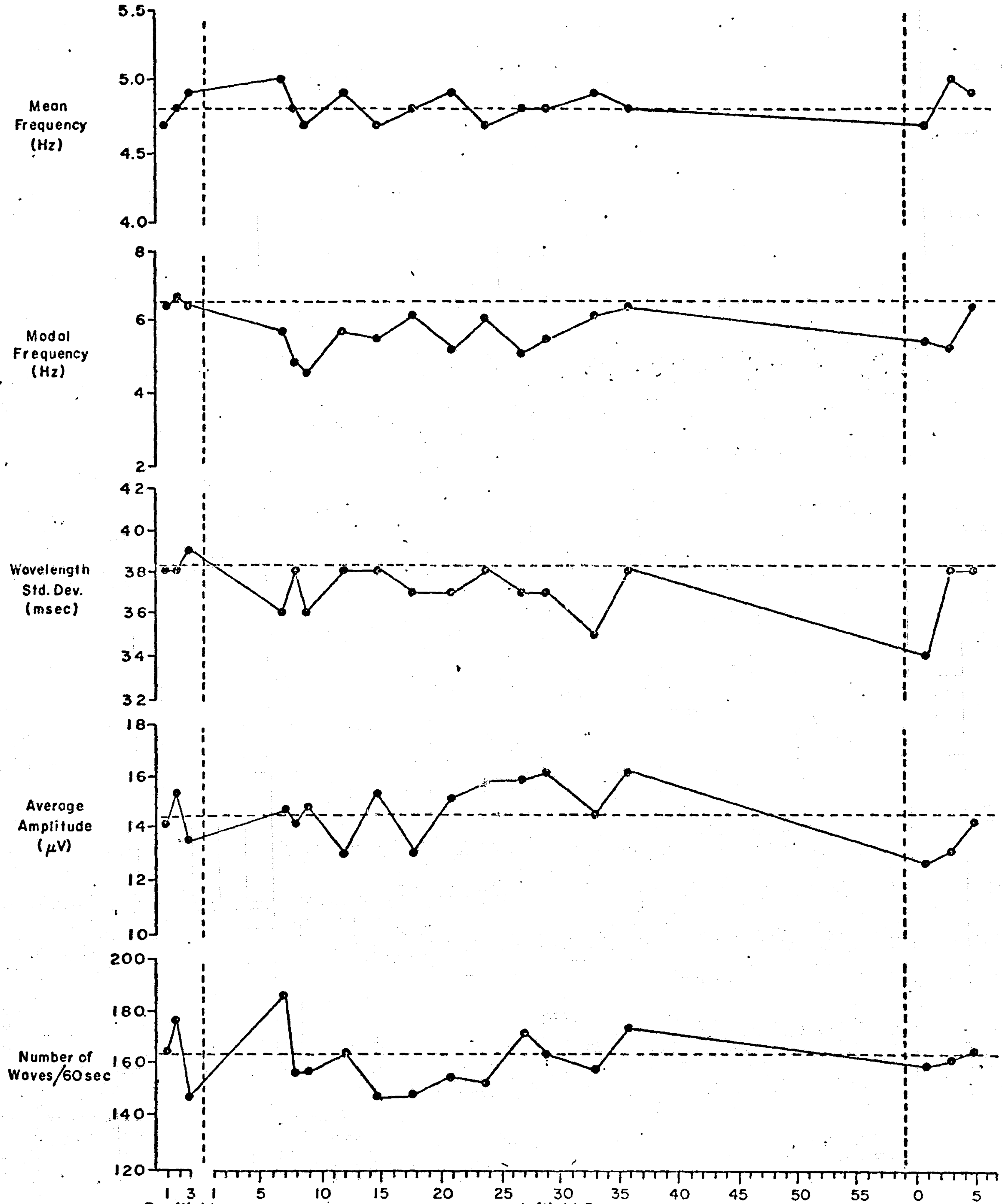


Fig. 26

O.G., THETA, REM

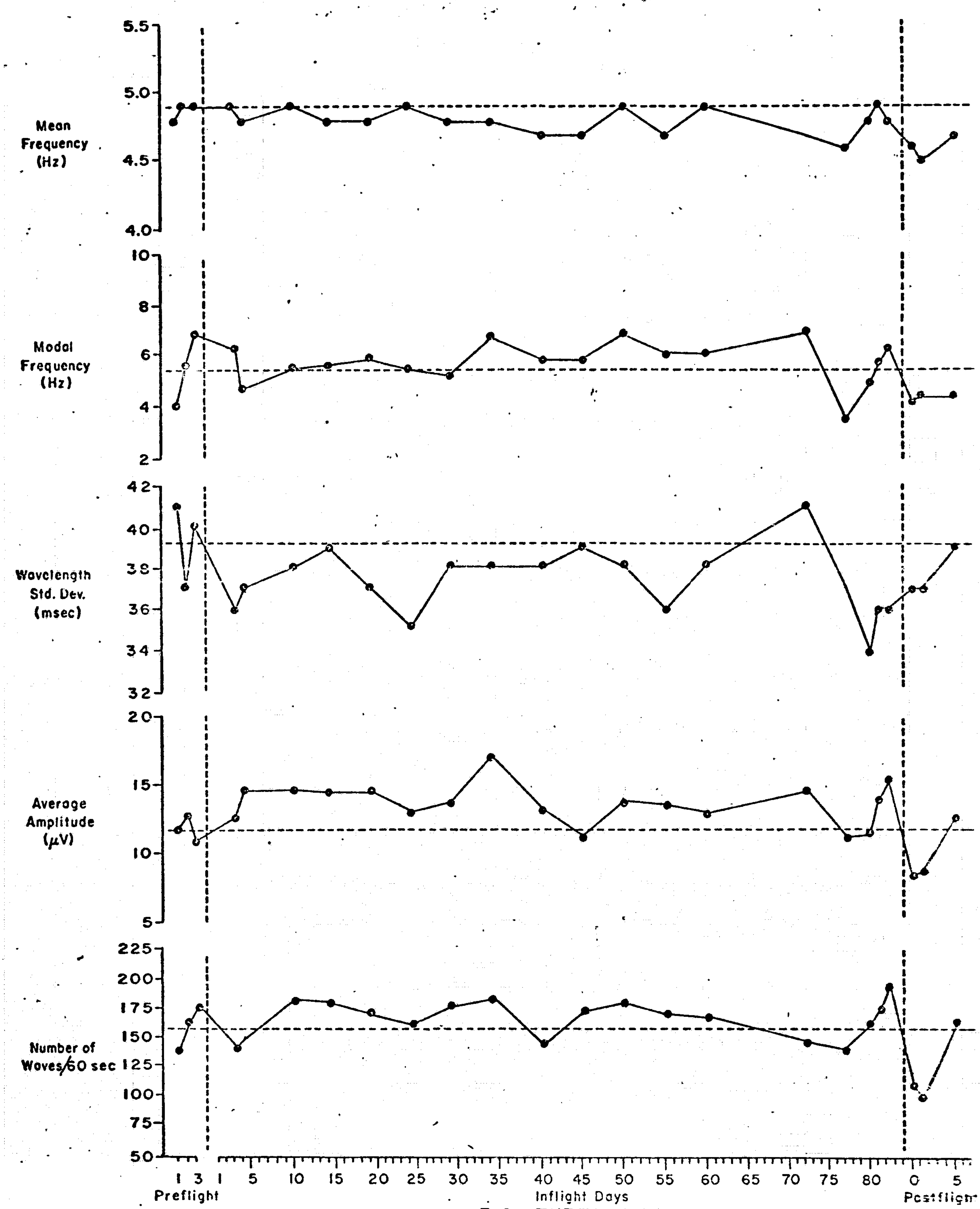


Fig. 27

E.G., THETA, REM

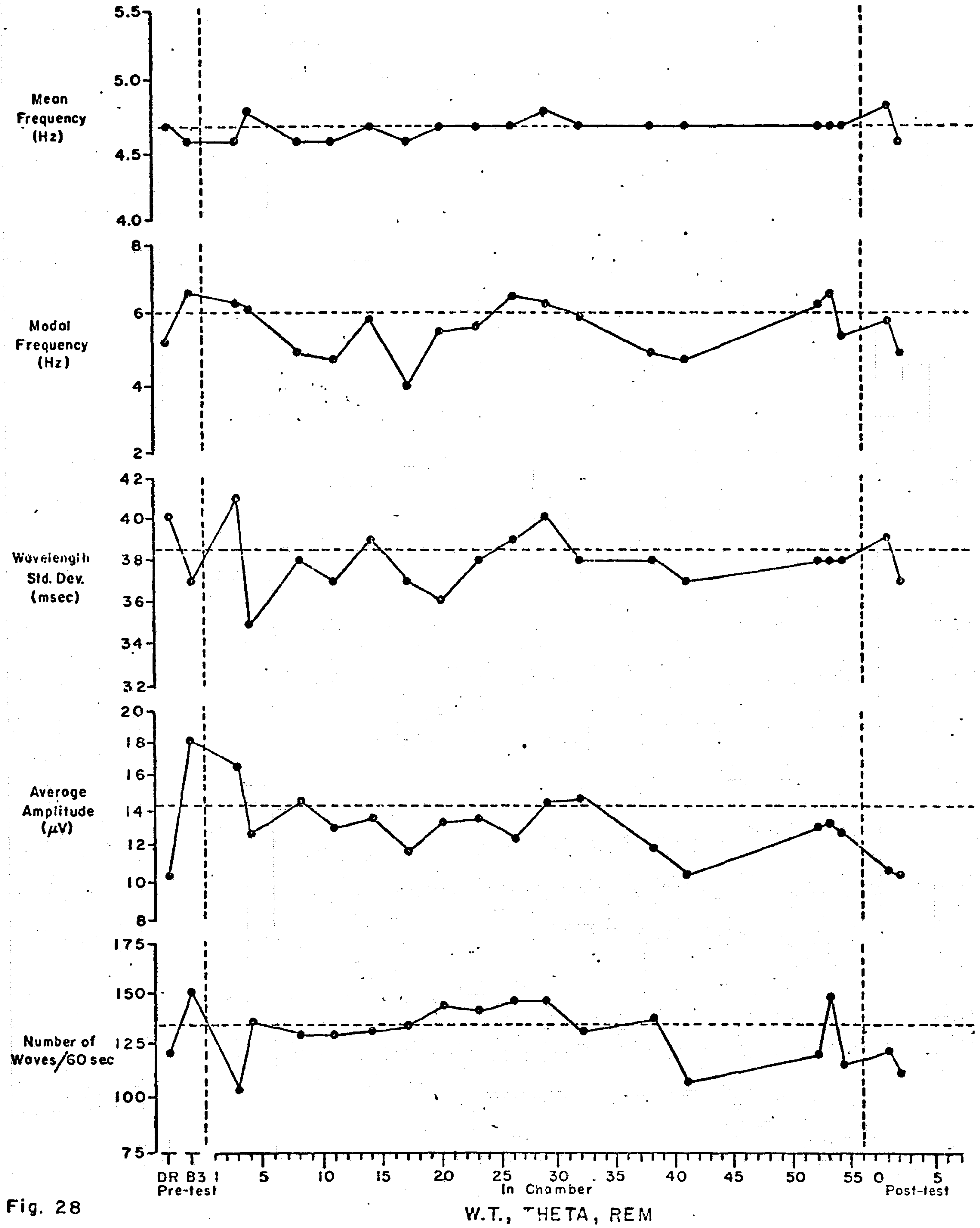


Fig. 28

W.T., THETA, REM

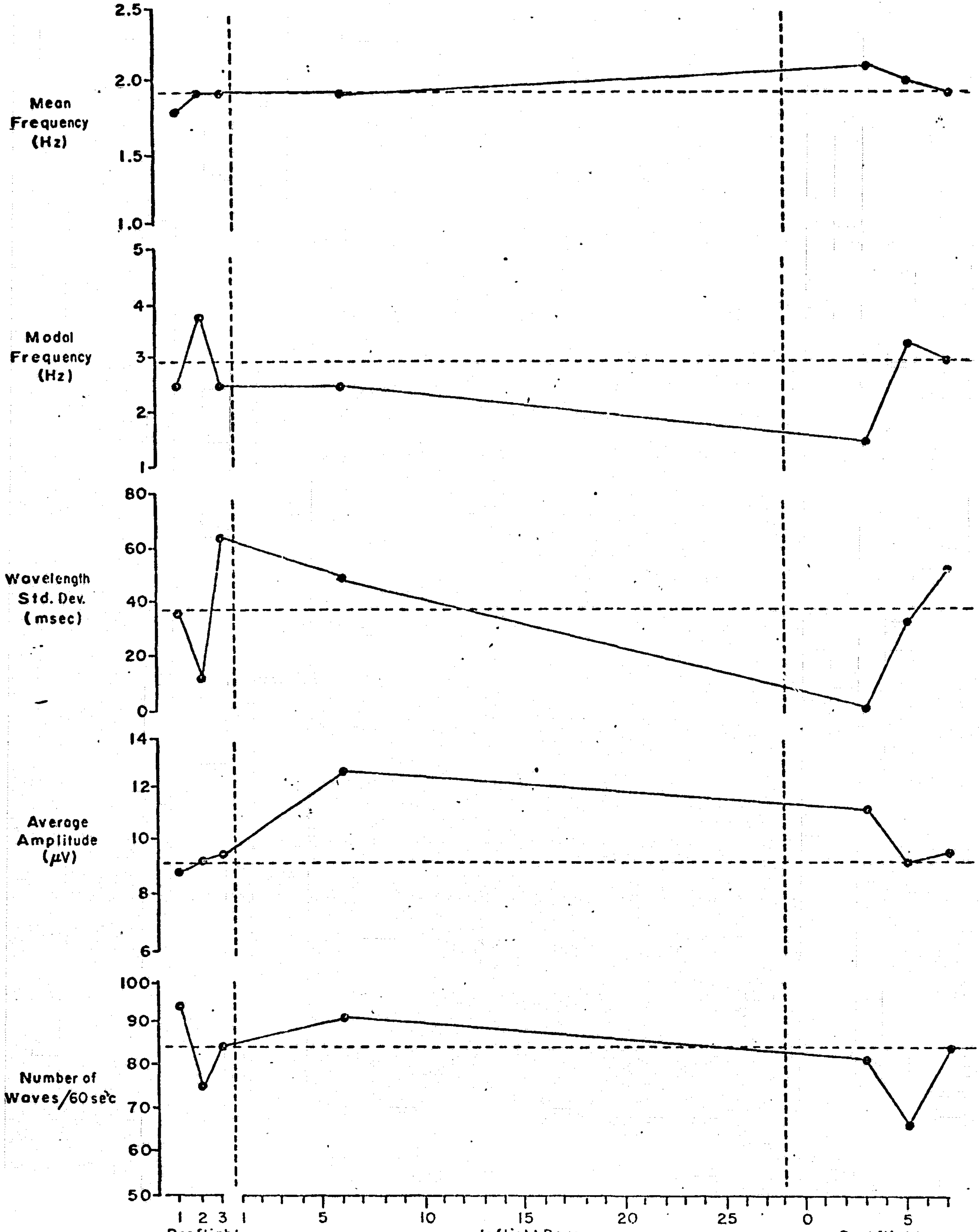


Fig. 29

J.K., DELTA, REM

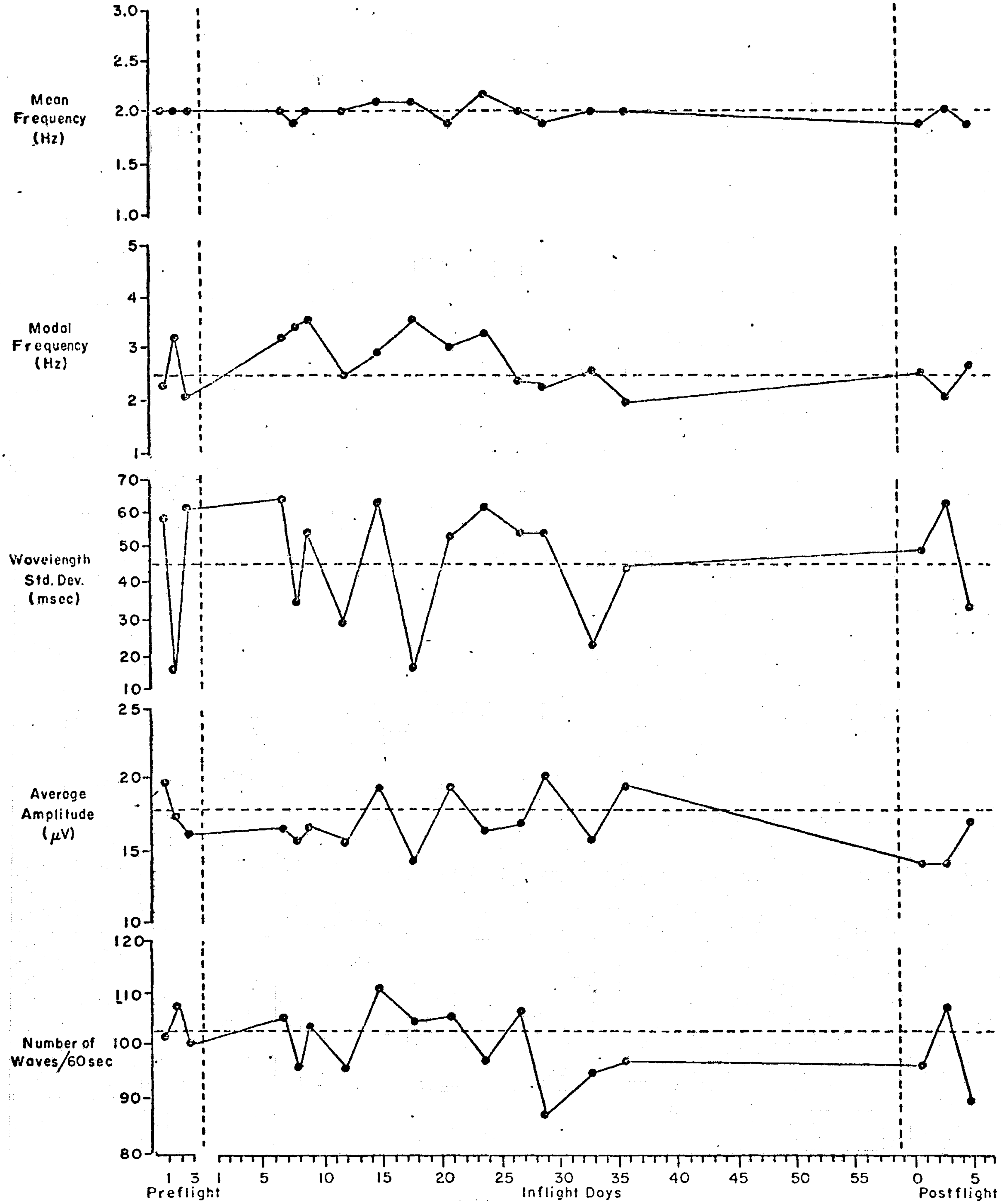


Fig. 30

O.G., DELTA, REM

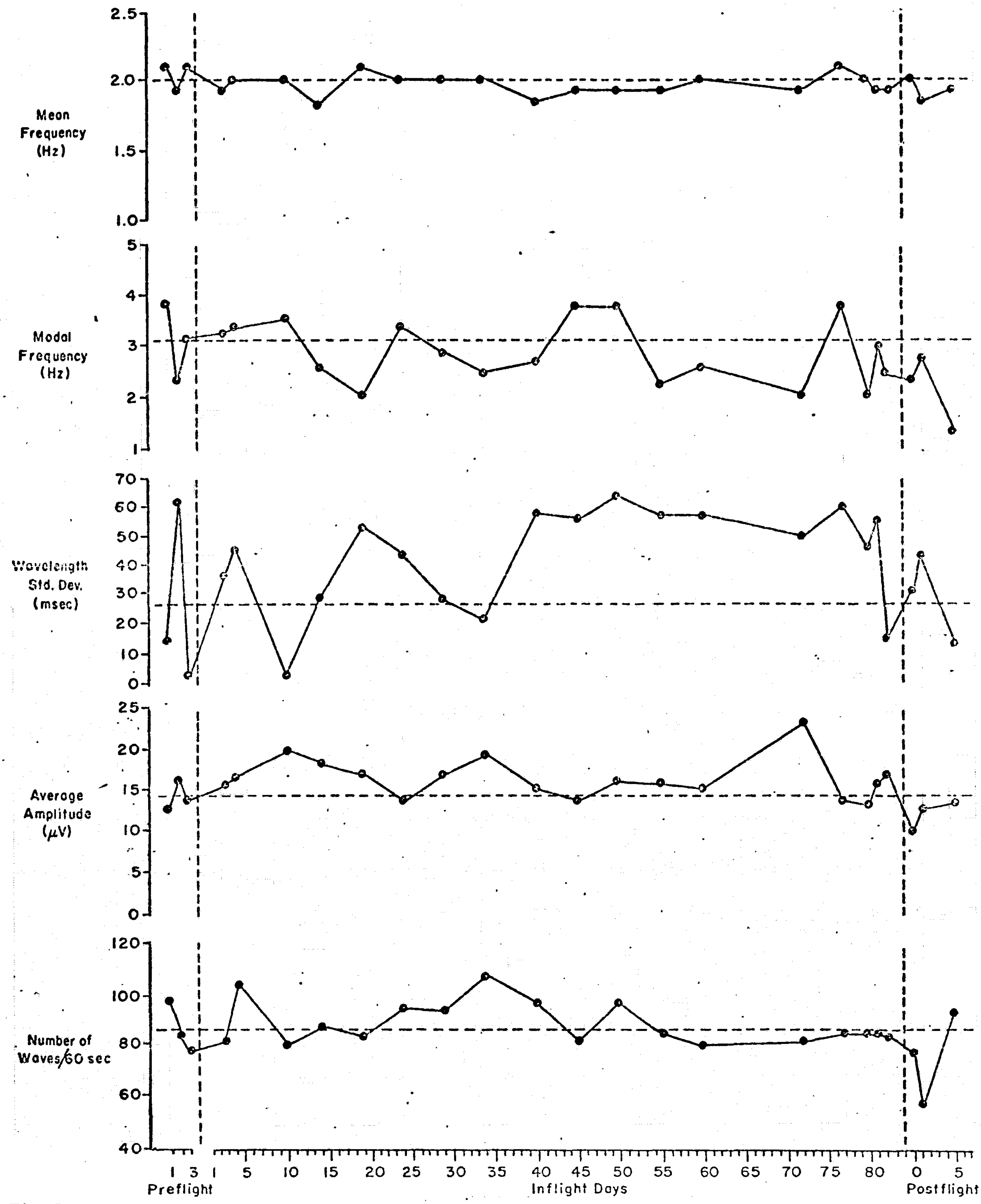


Fig. 31

E.G., DELTA, REM

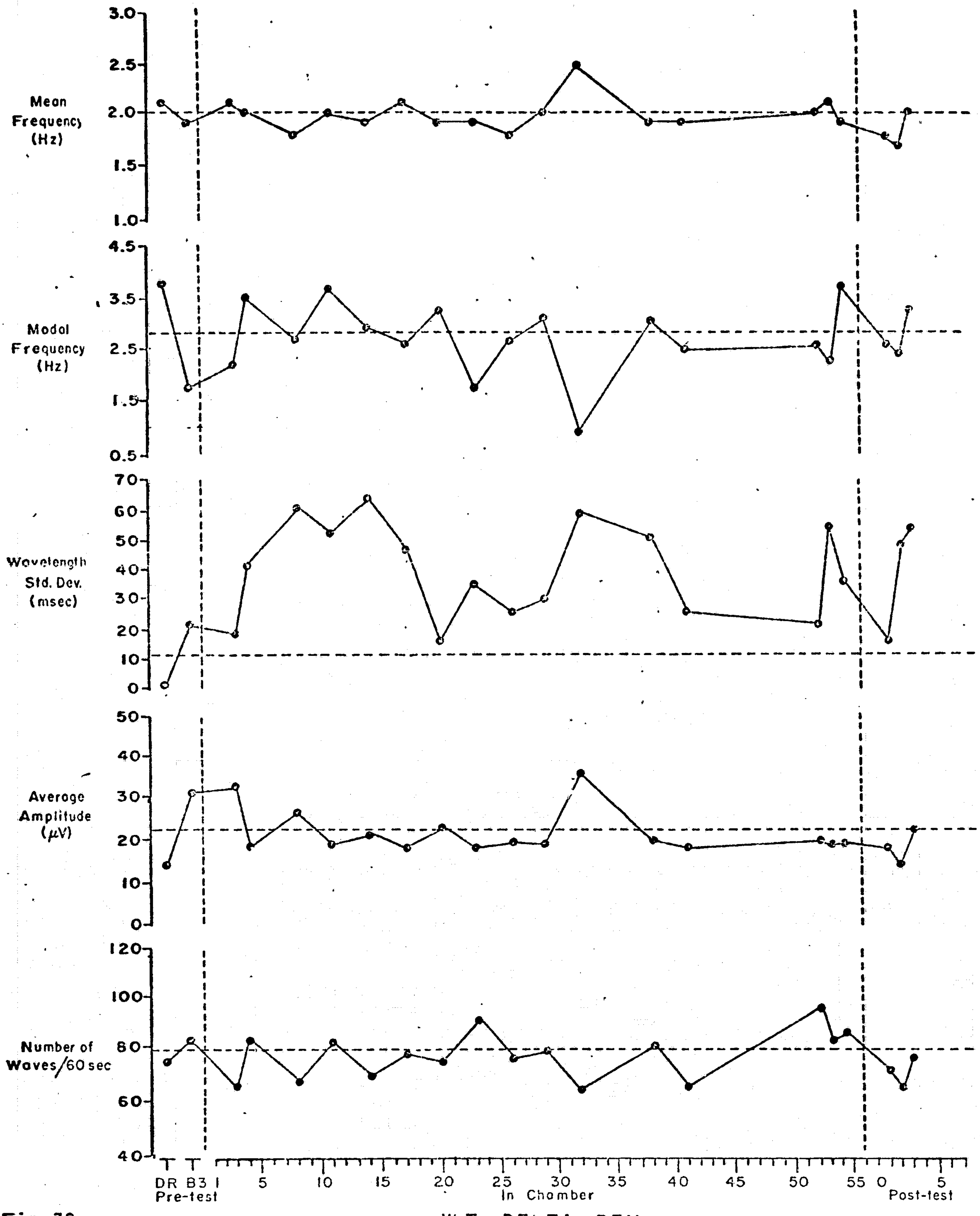


Fig. 32

W.T., DELTA, REM

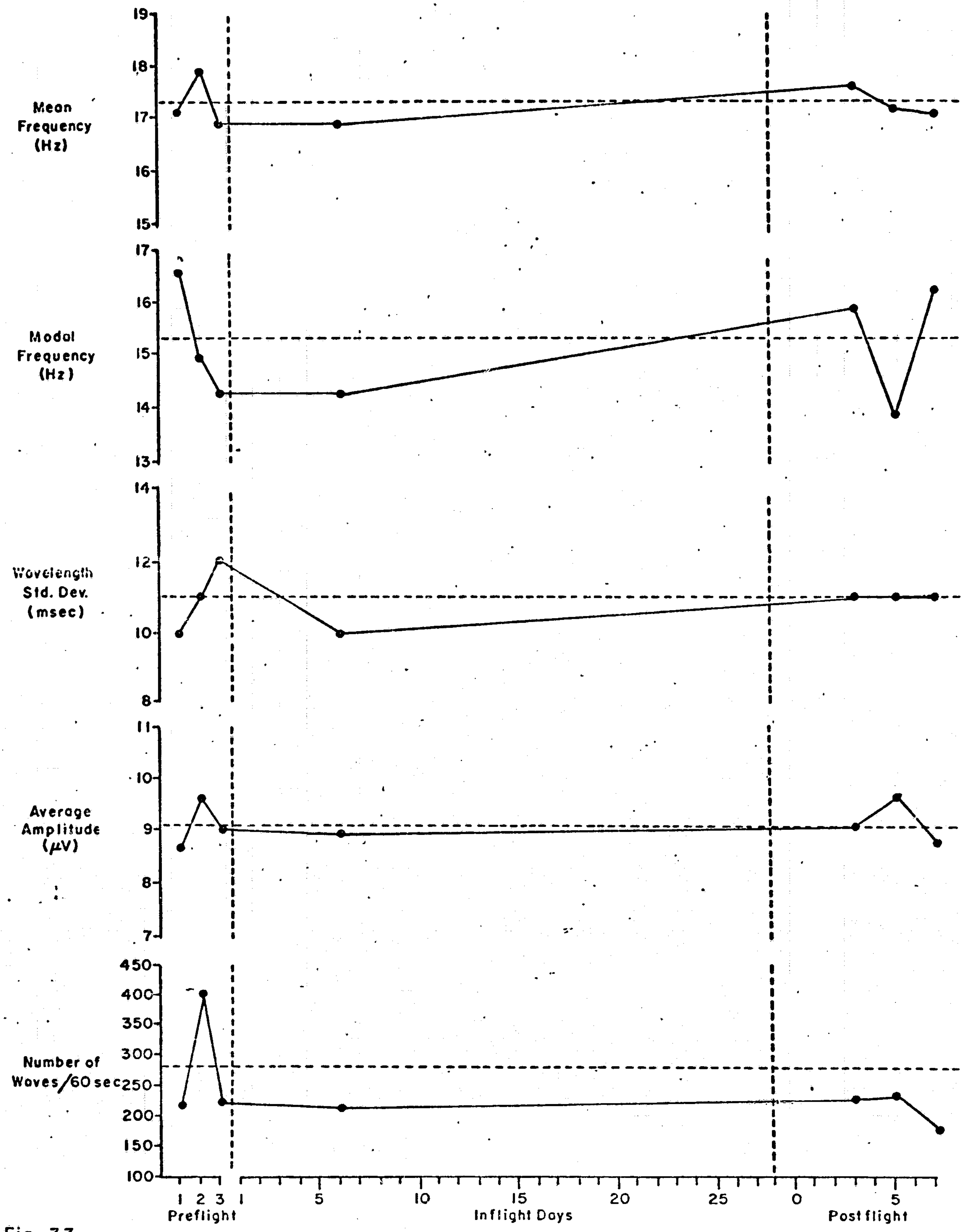


Fig. 33

J.K., BETA, STAGE 2

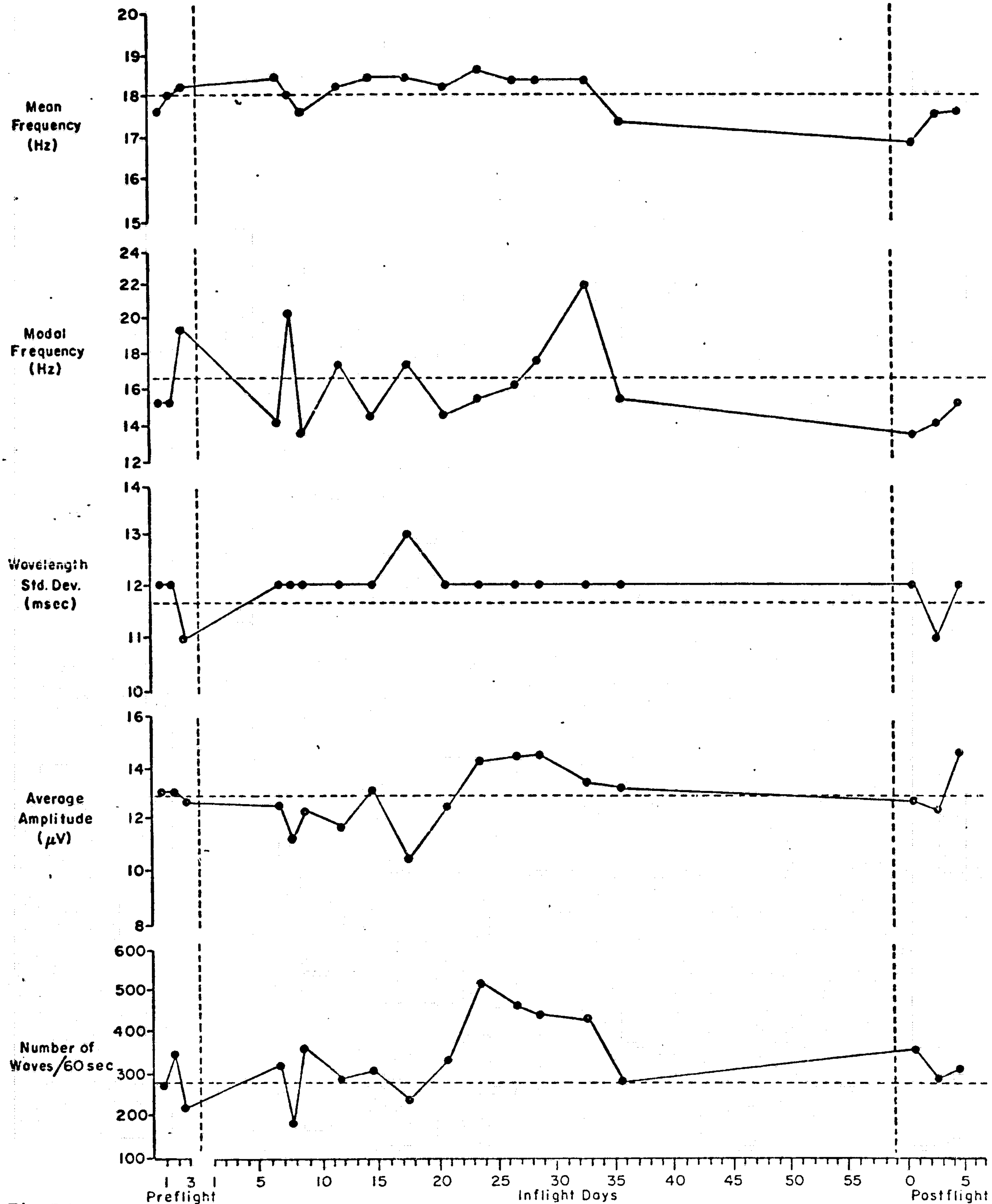


Fig. 34

O.G., BETA, STAGE 2

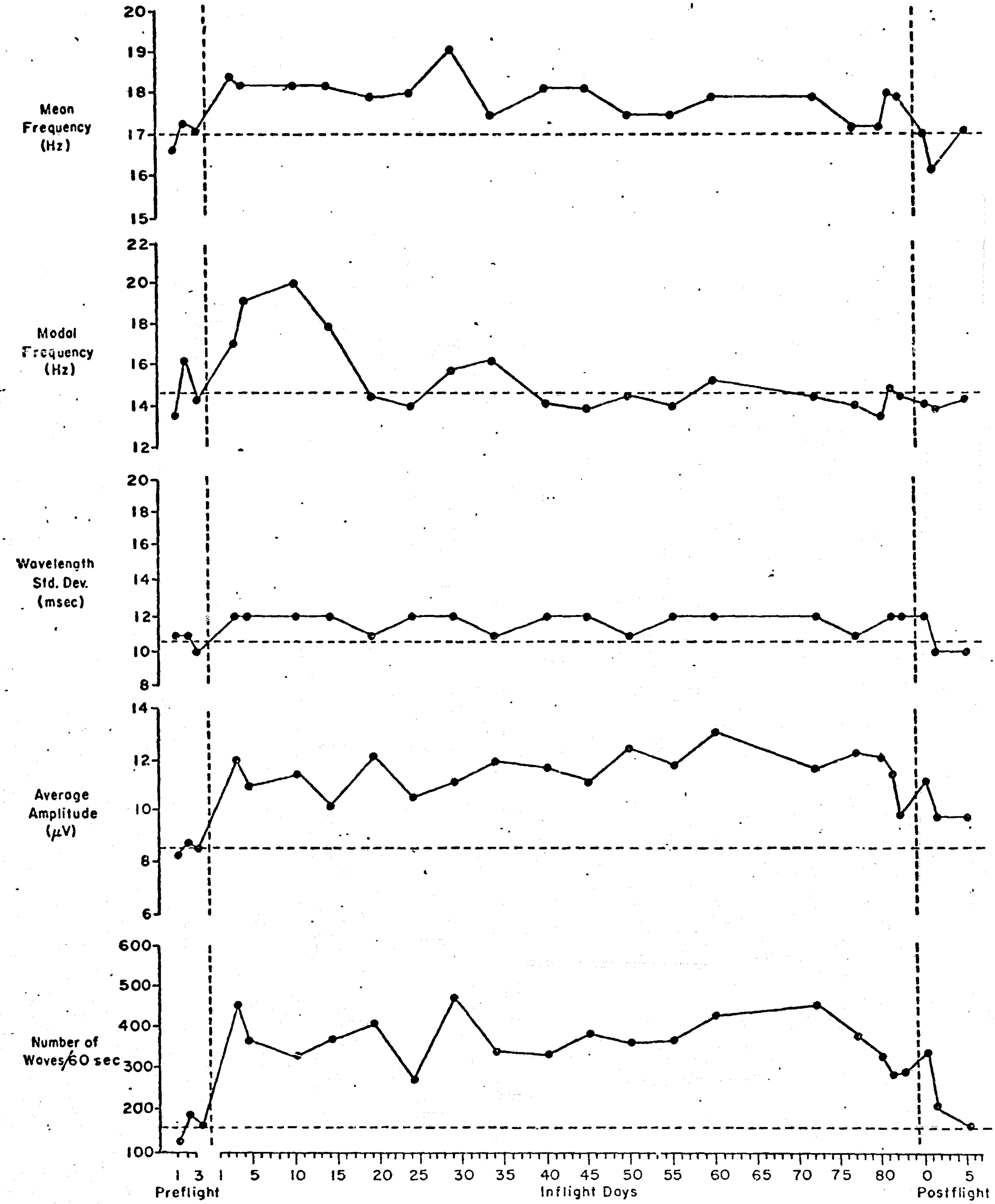


Fig. 35

E.G., BETA, STAGE 2

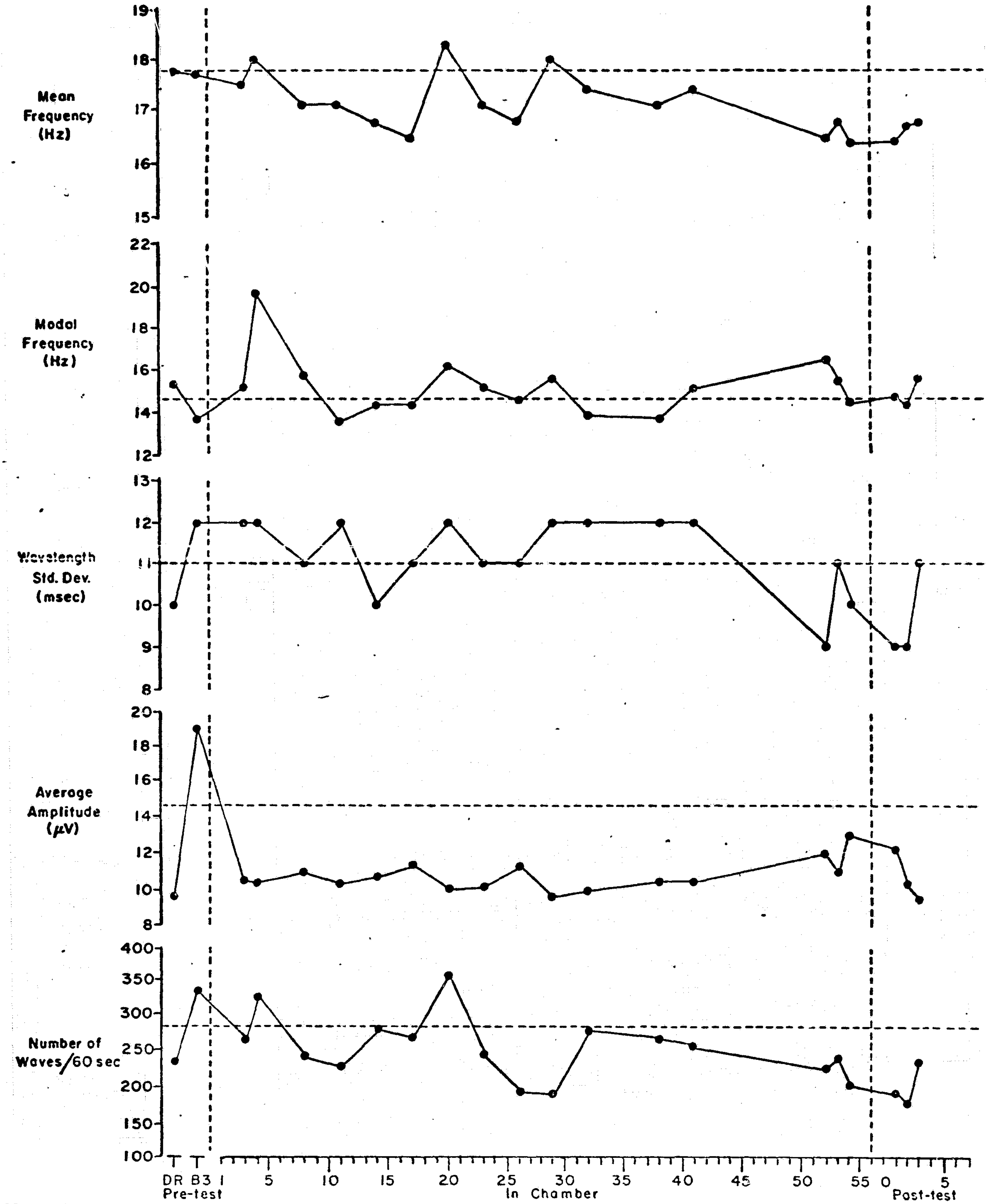


Fig. 36

W.T., BETA, STAGE 2

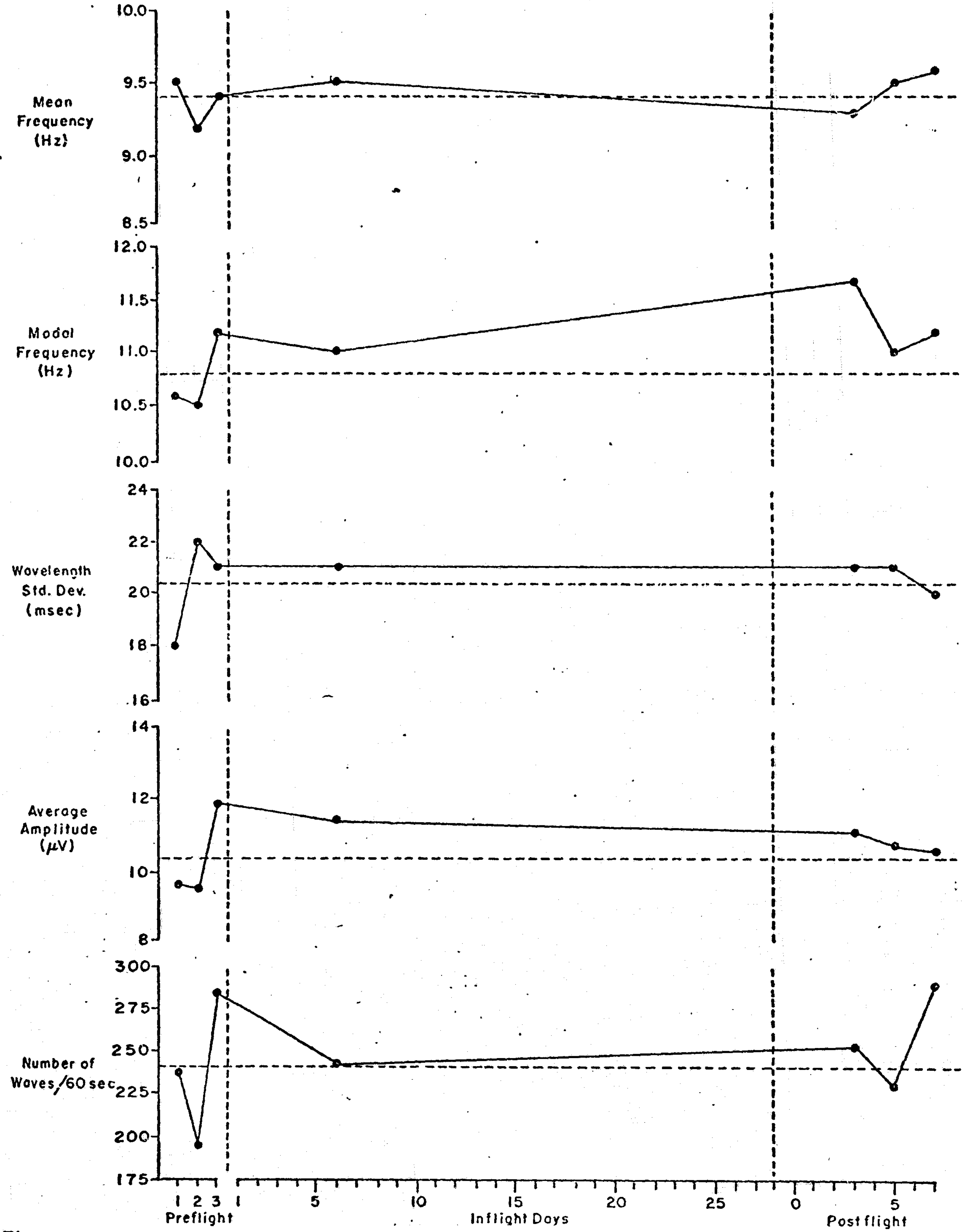


Fig. 37

J.K., ALPHA, STAGE 2

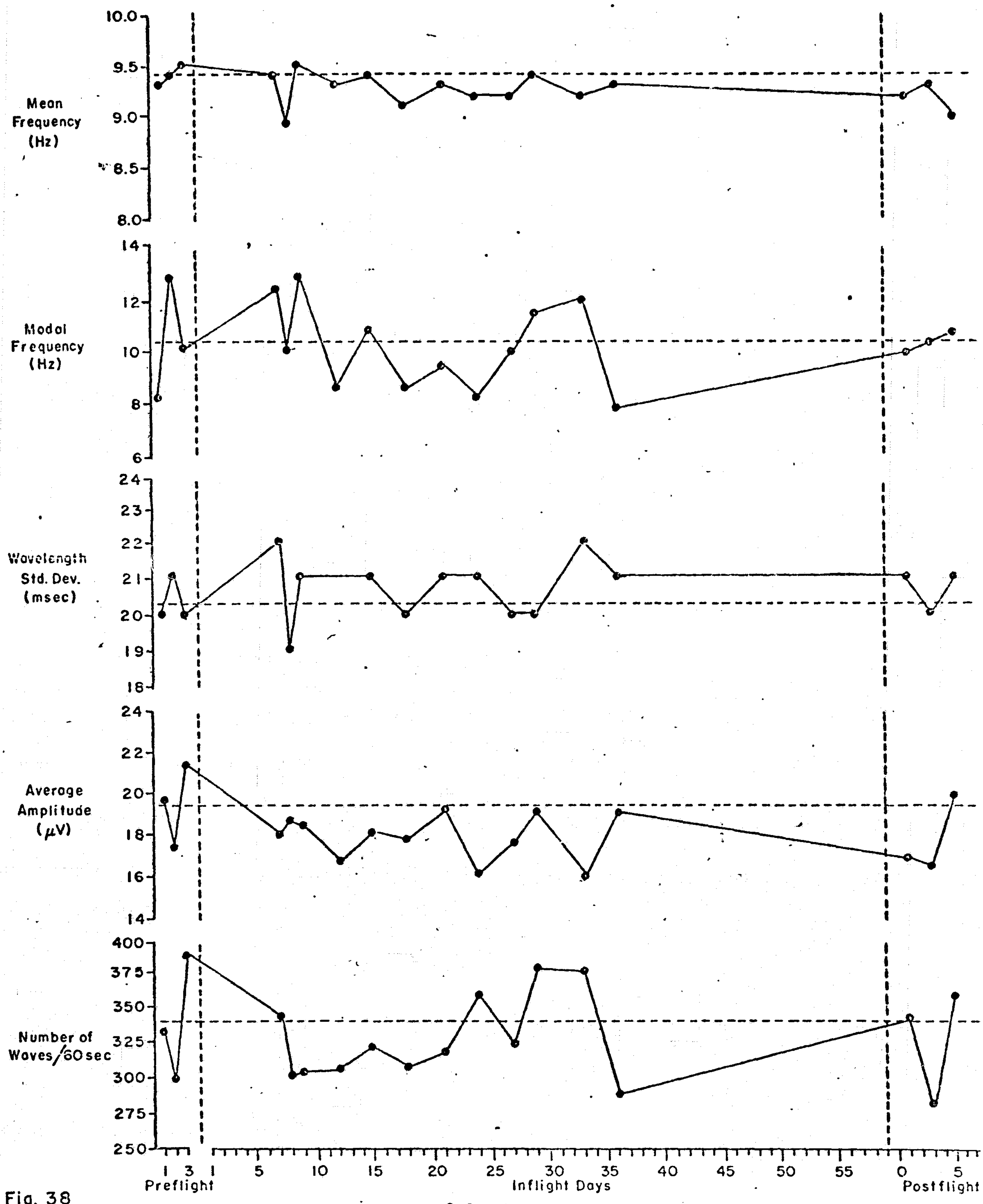


Fig. 38

O.G., ALPHA, STAGE 2

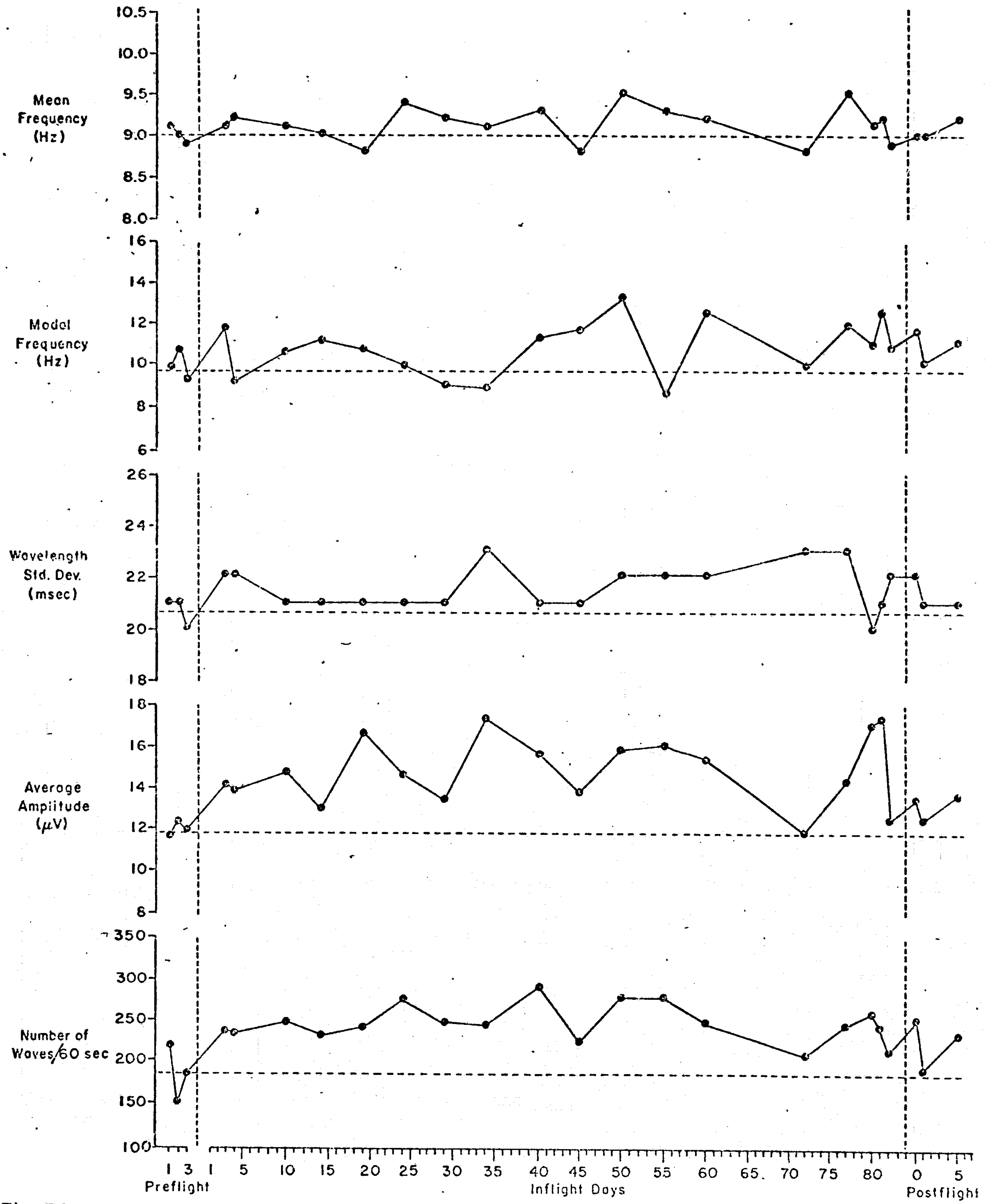


Fig. 39 E.G., ALPHA, STAGE 2

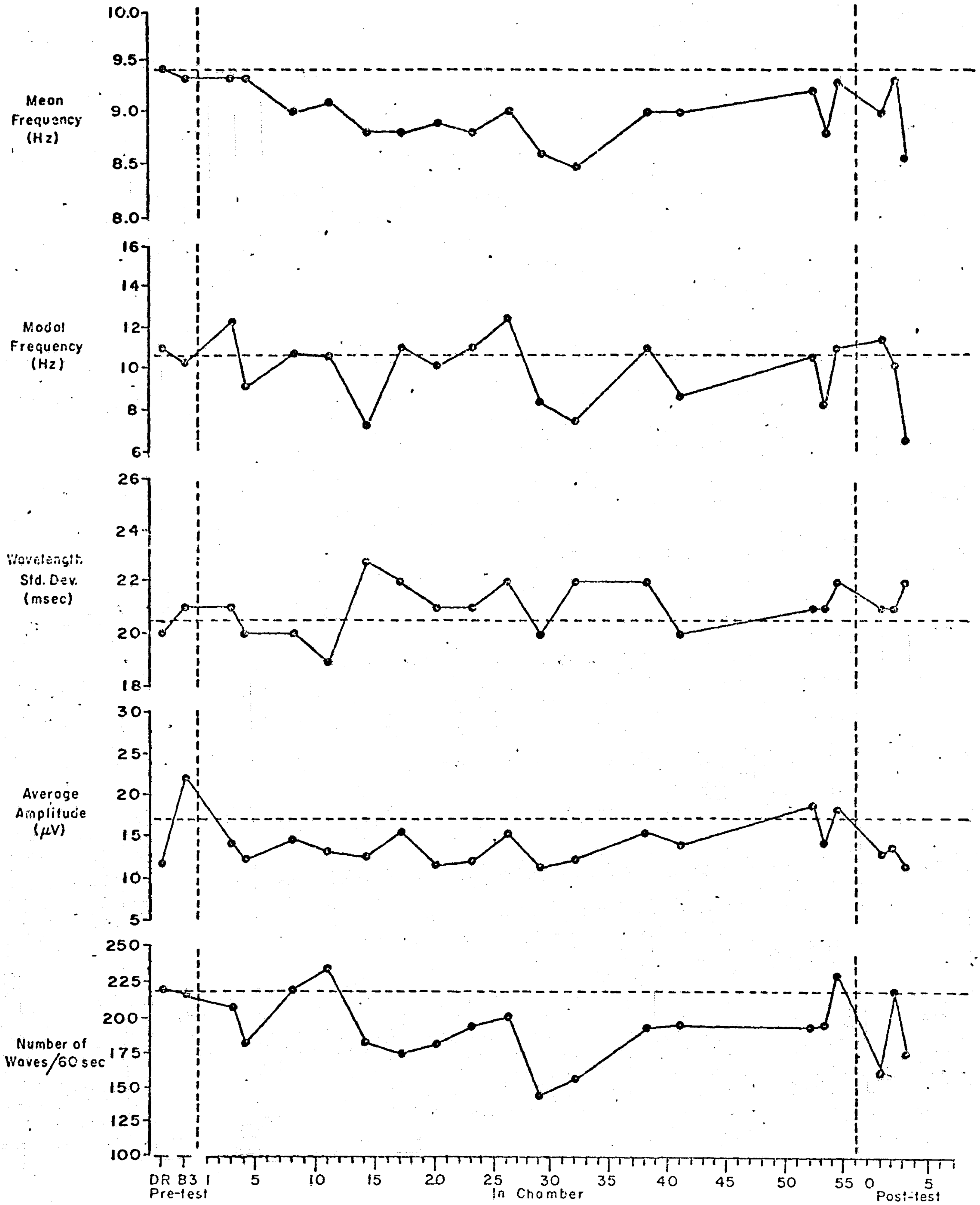


Fig. 40

W.T., ALPHA, STAGE 2

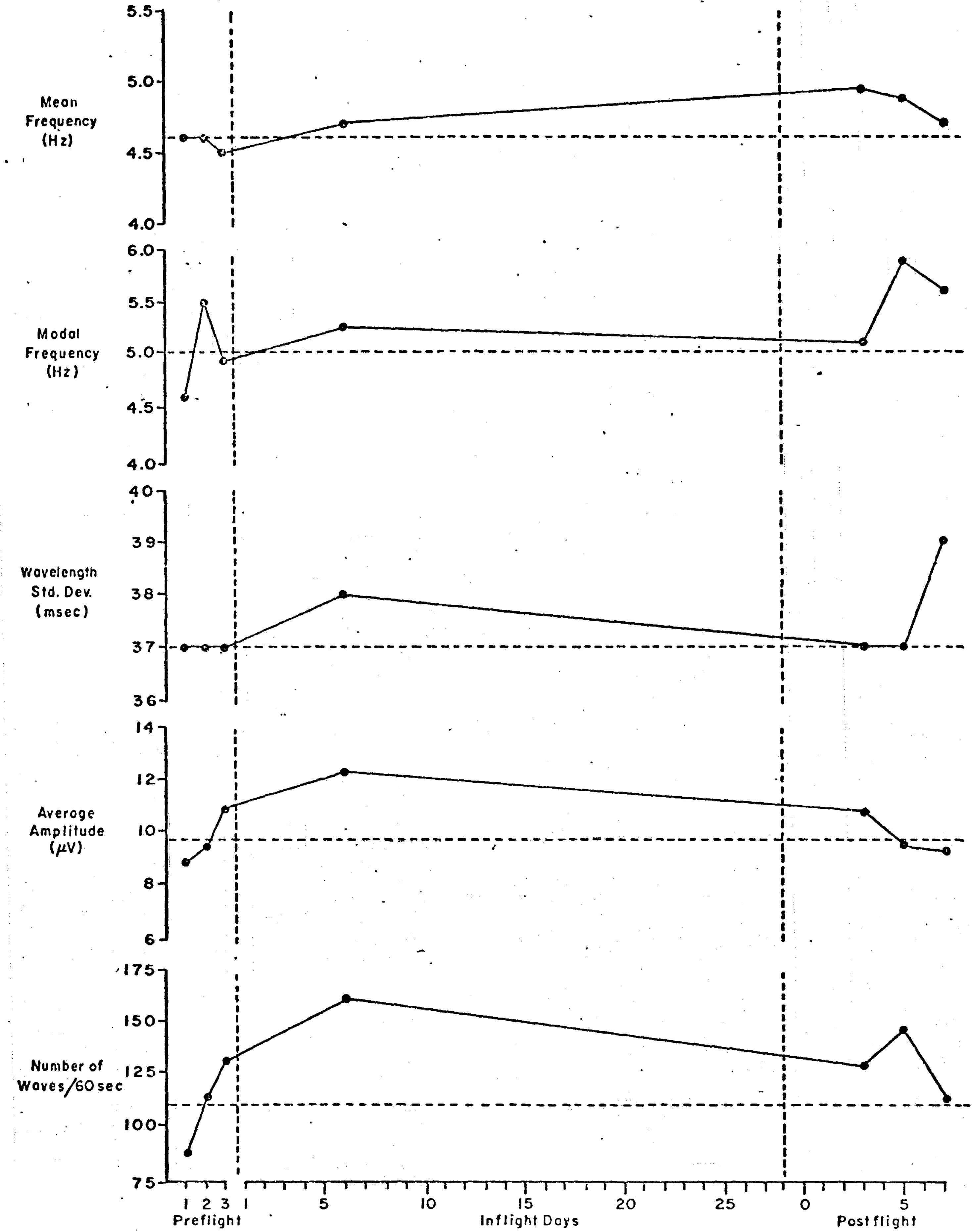


Fig. 41

J.K., THETA, STAGE 2

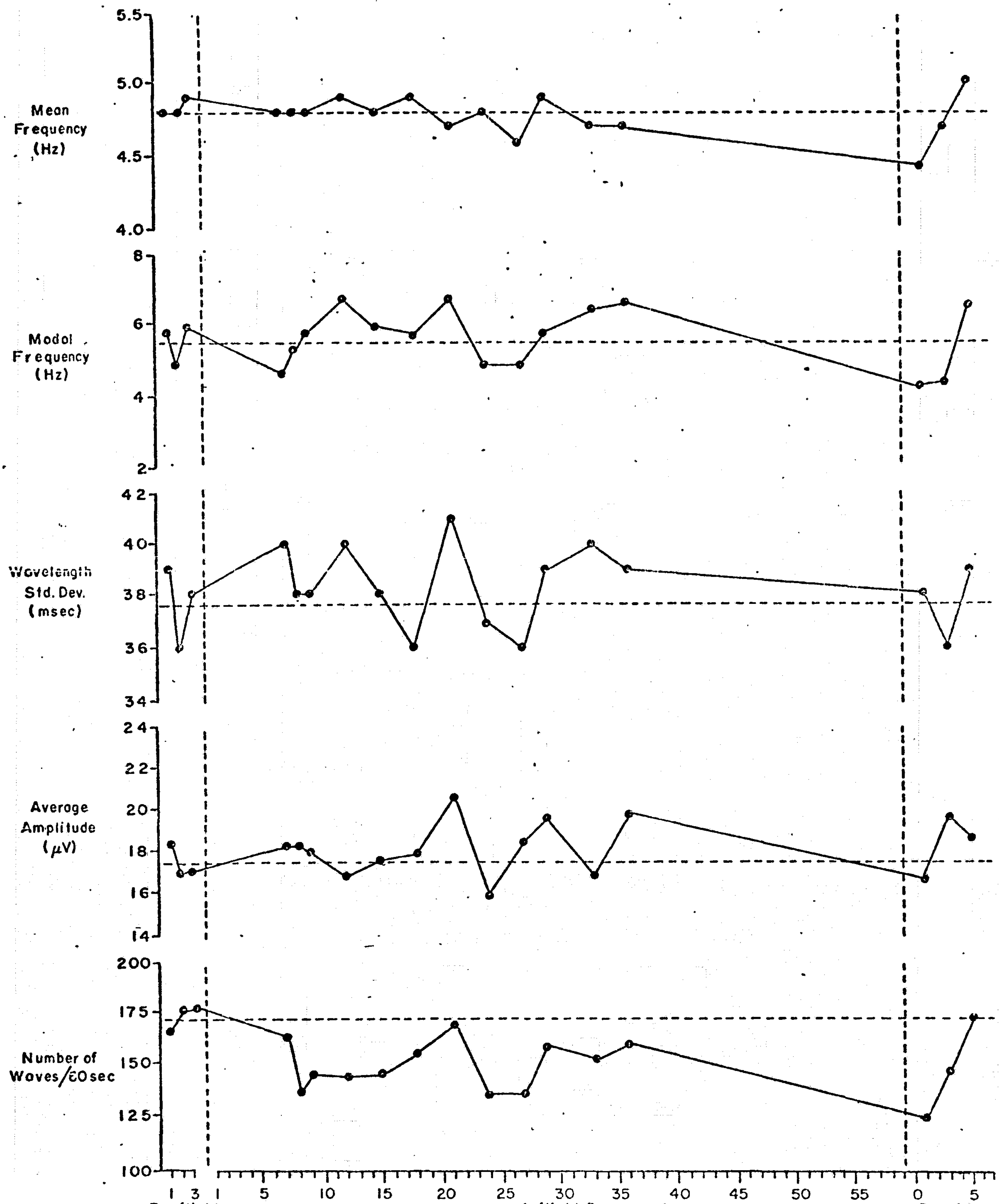


Fig. 42

O.G., THETA, STAGE 2

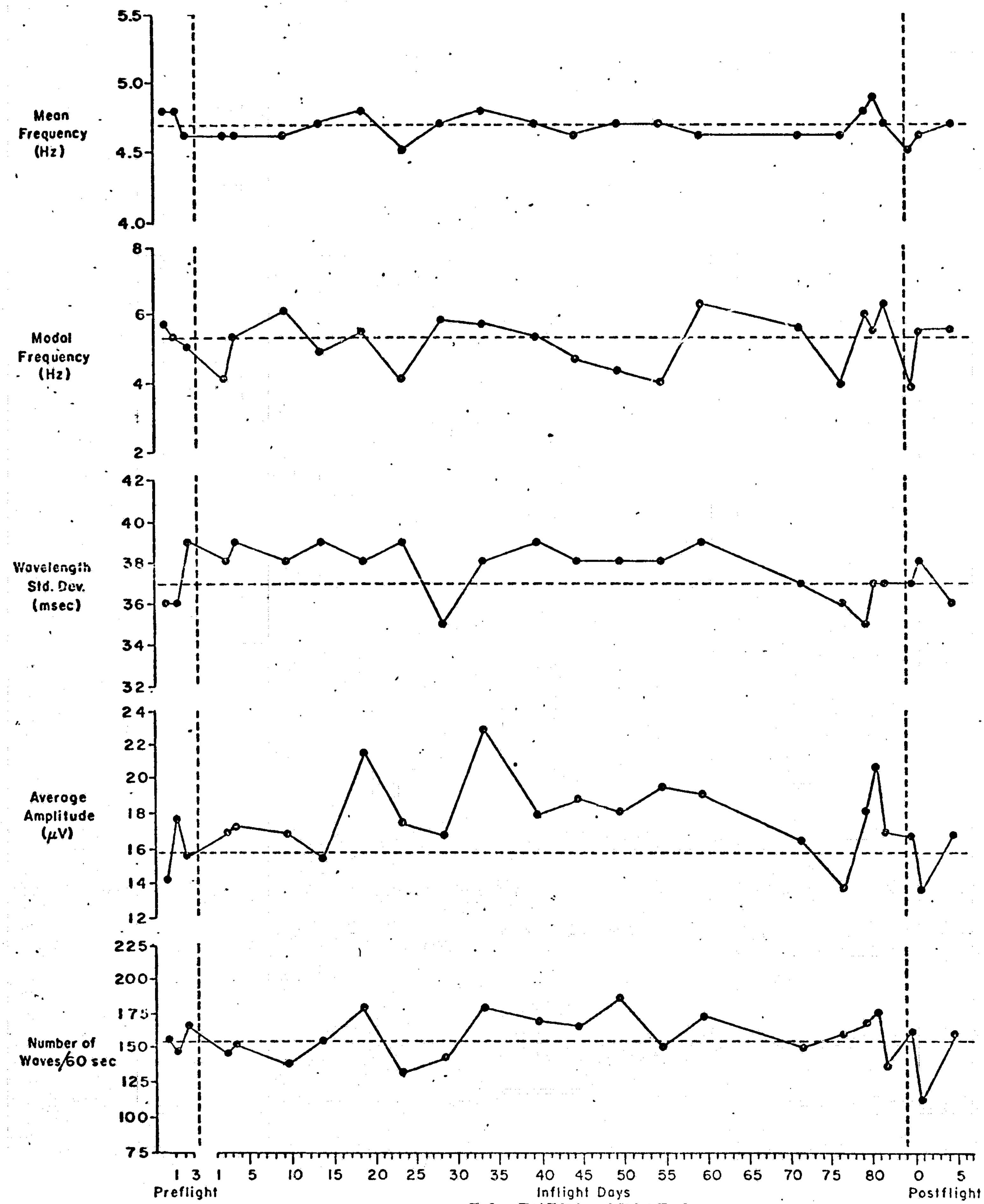


Fig. 43

E.G., THETA, STAGE 2

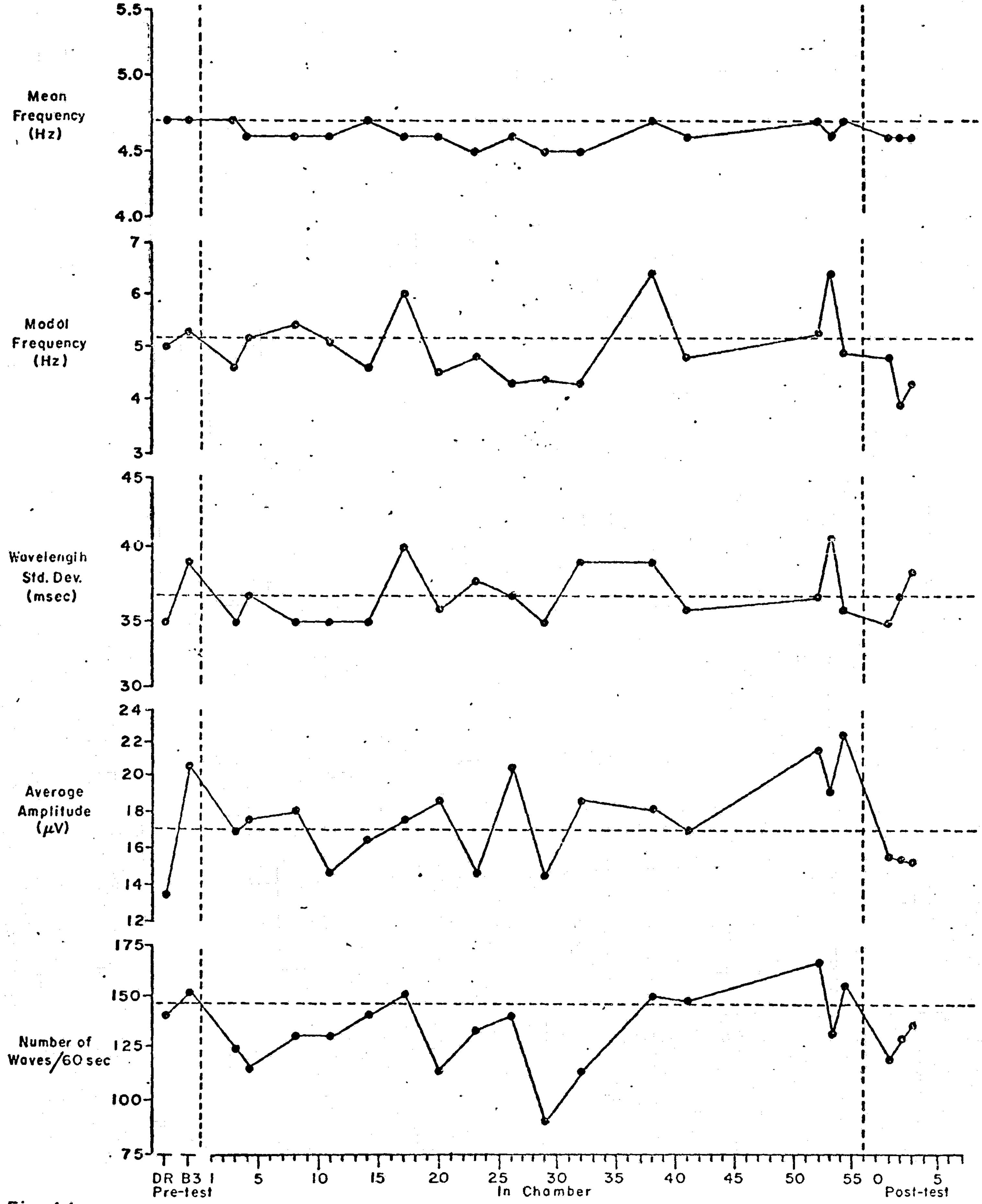


Fig. 44

W.T., THETA, STAGE 2

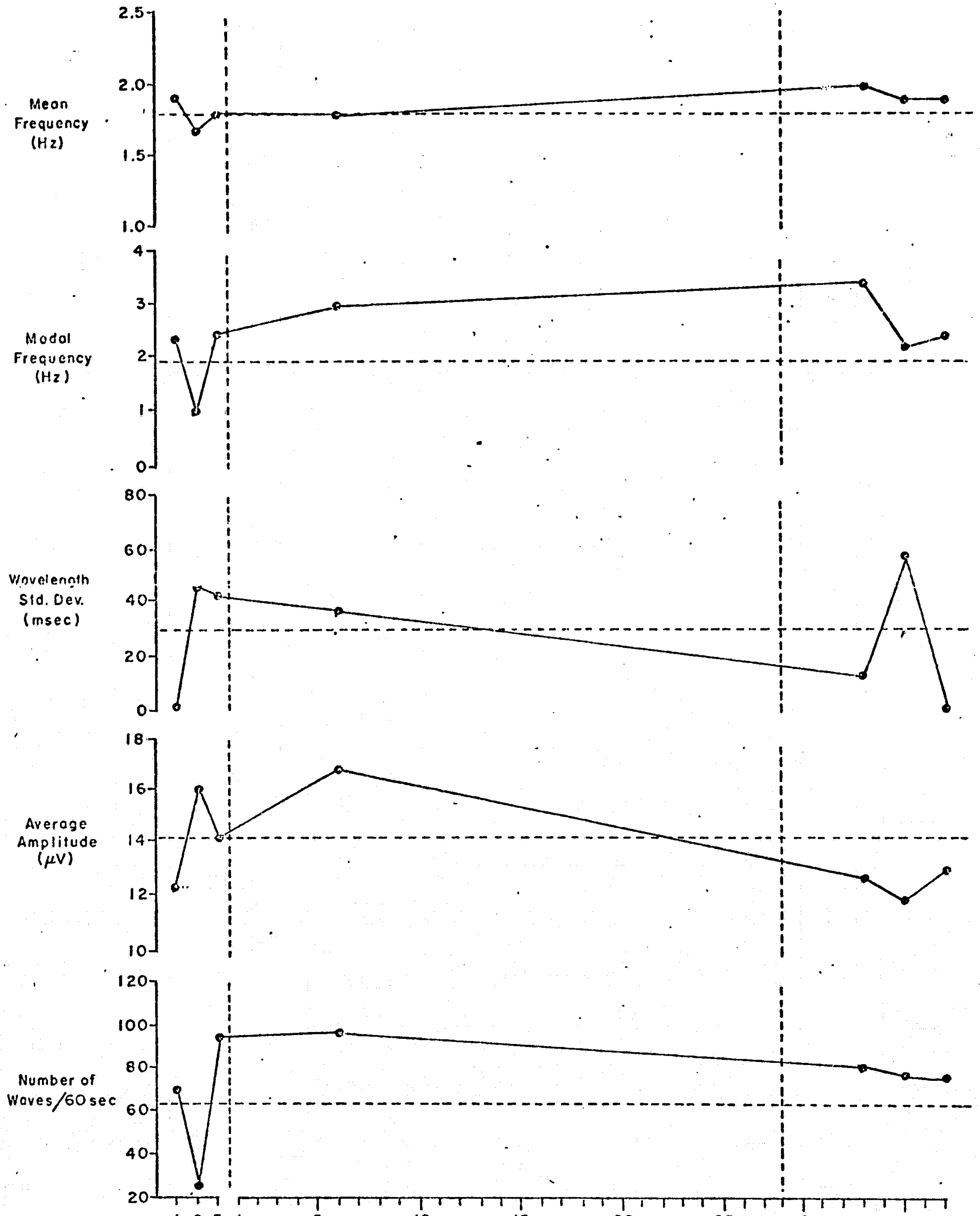


Fig. 45

J.K., DELTA, STAGE 2

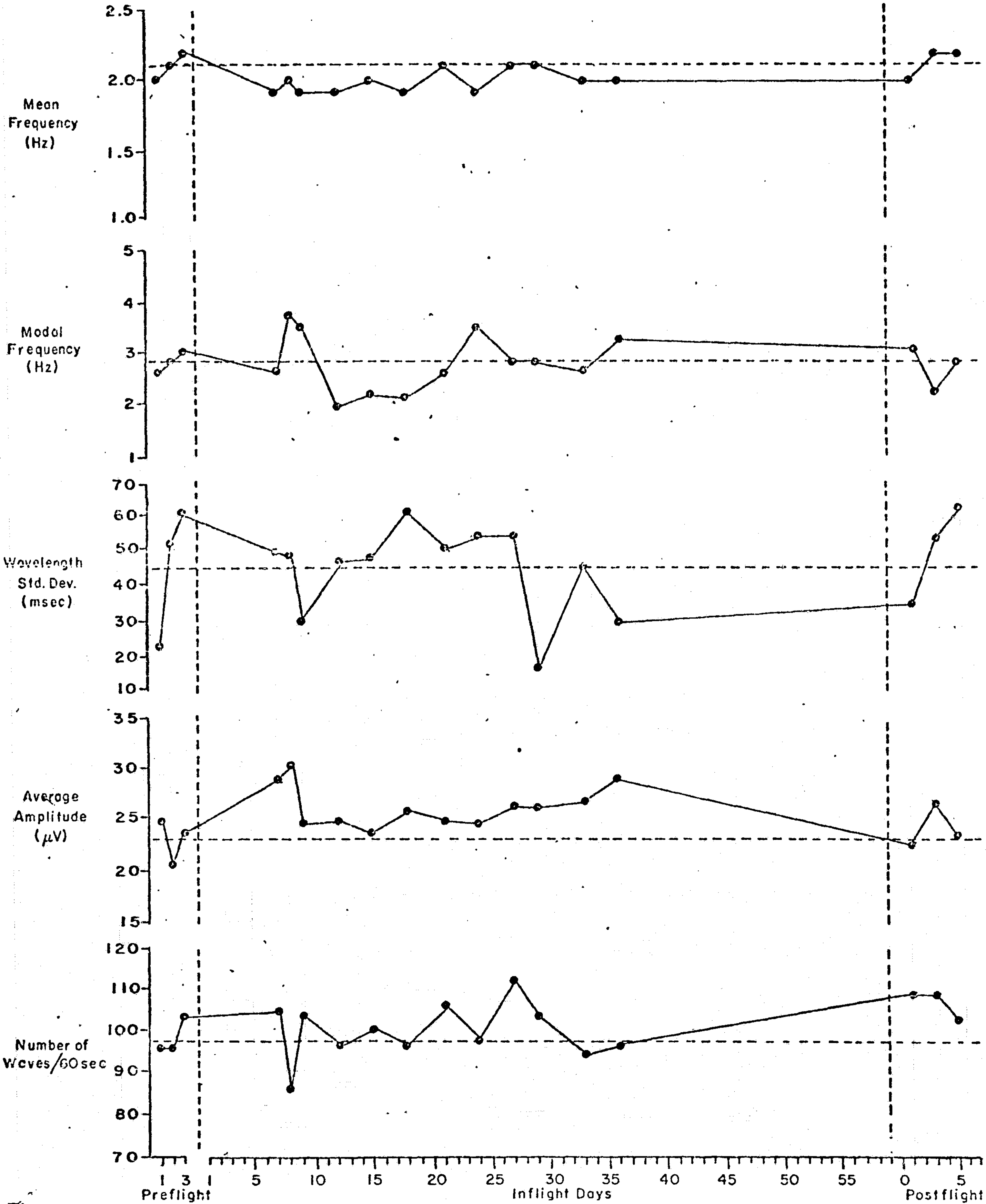


Fig. 46

O.G., DELTA, STAGE 2

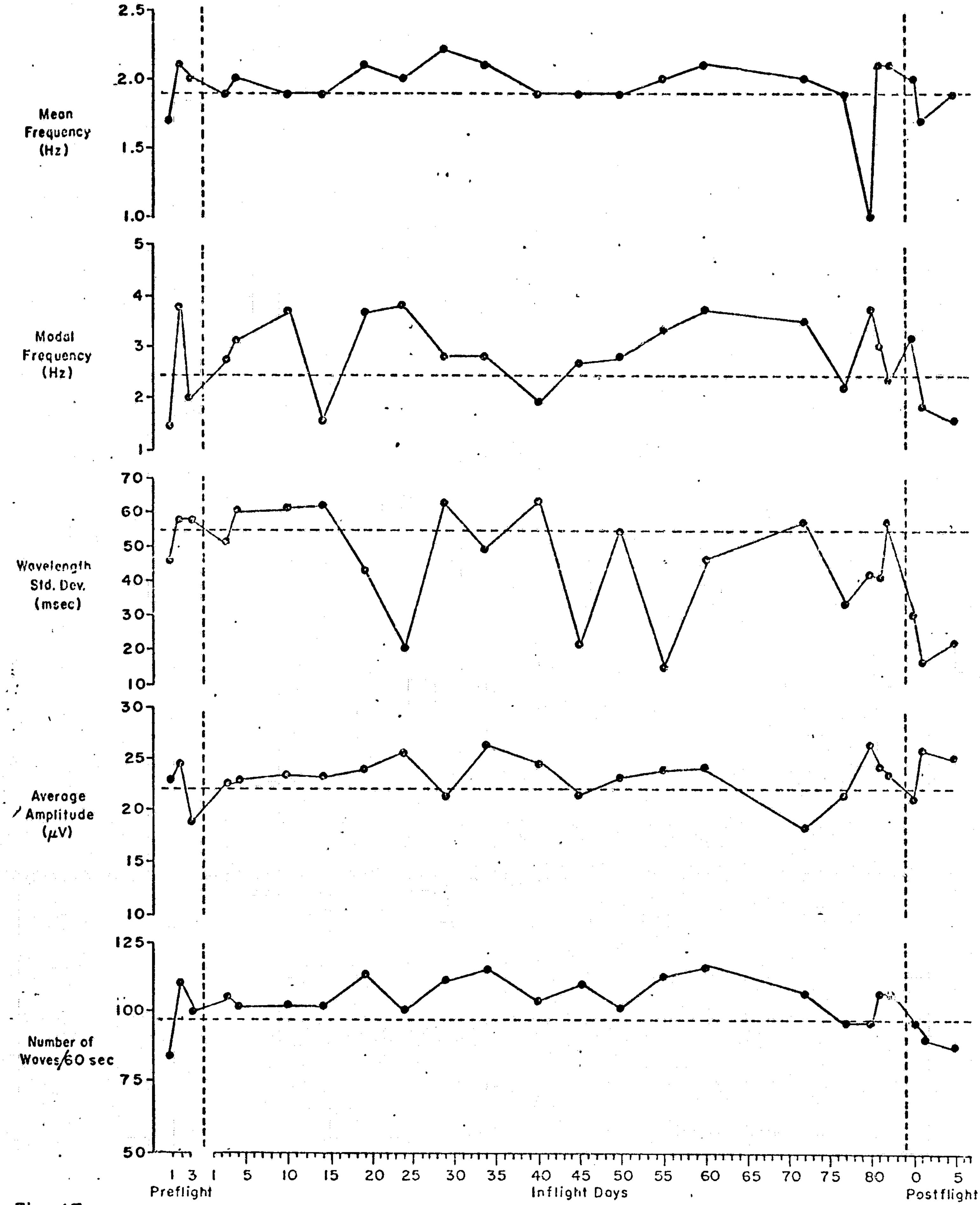


Fig. 47

E.G., DELTA, STAGE 2

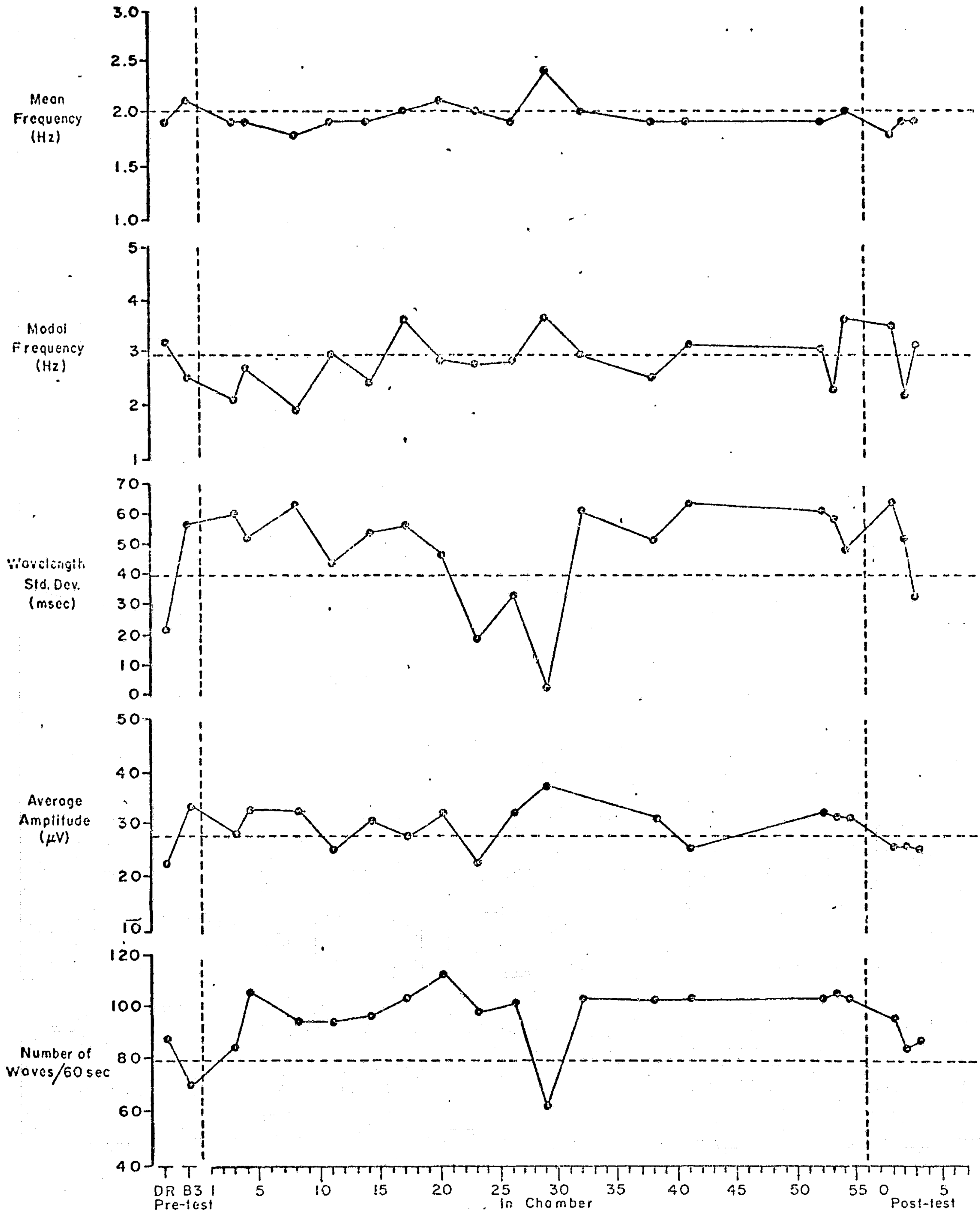


Fig. 48

W.T., DELTA, STAGE 2

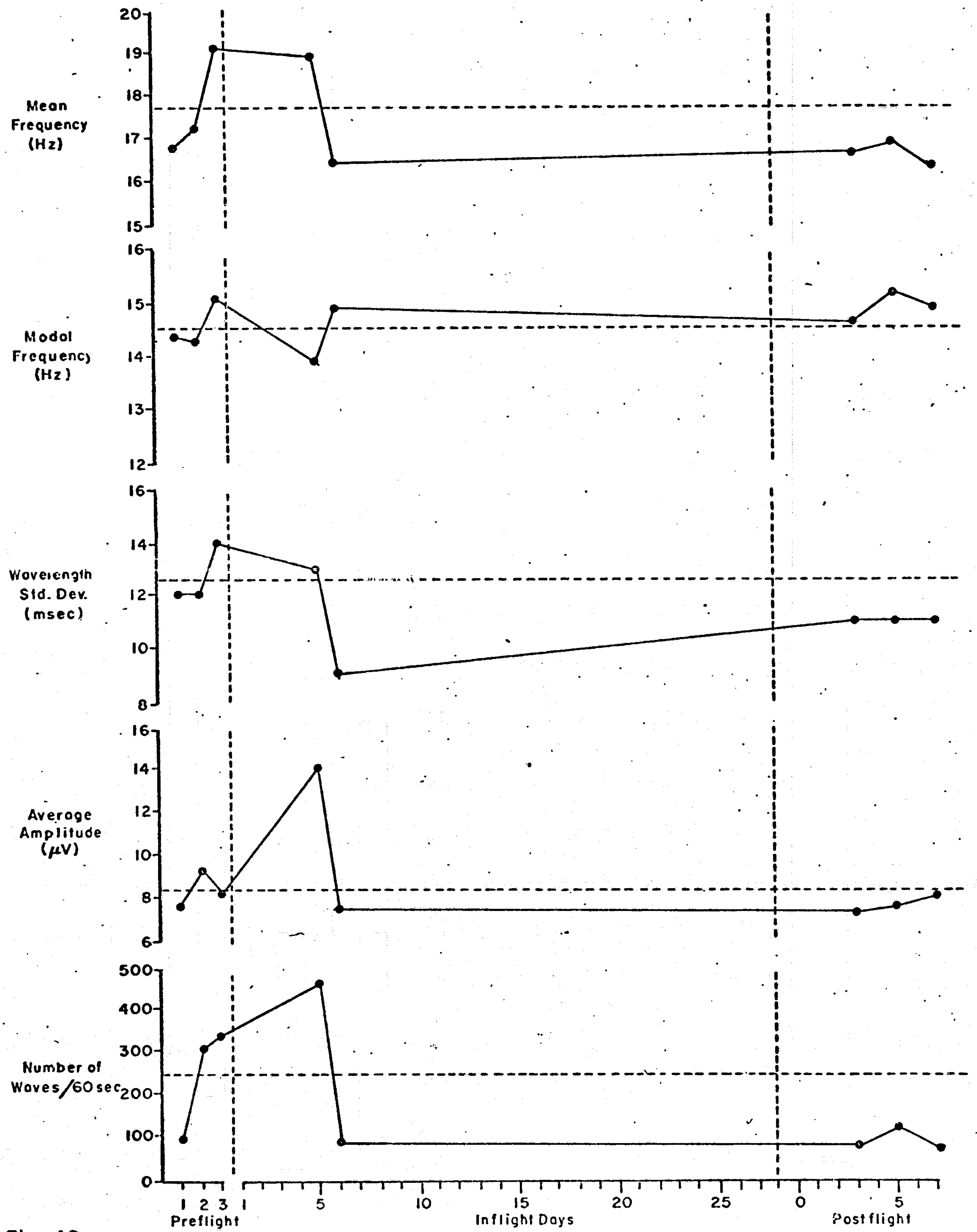


Fig. 49

J.K., BETA, STAGE 3

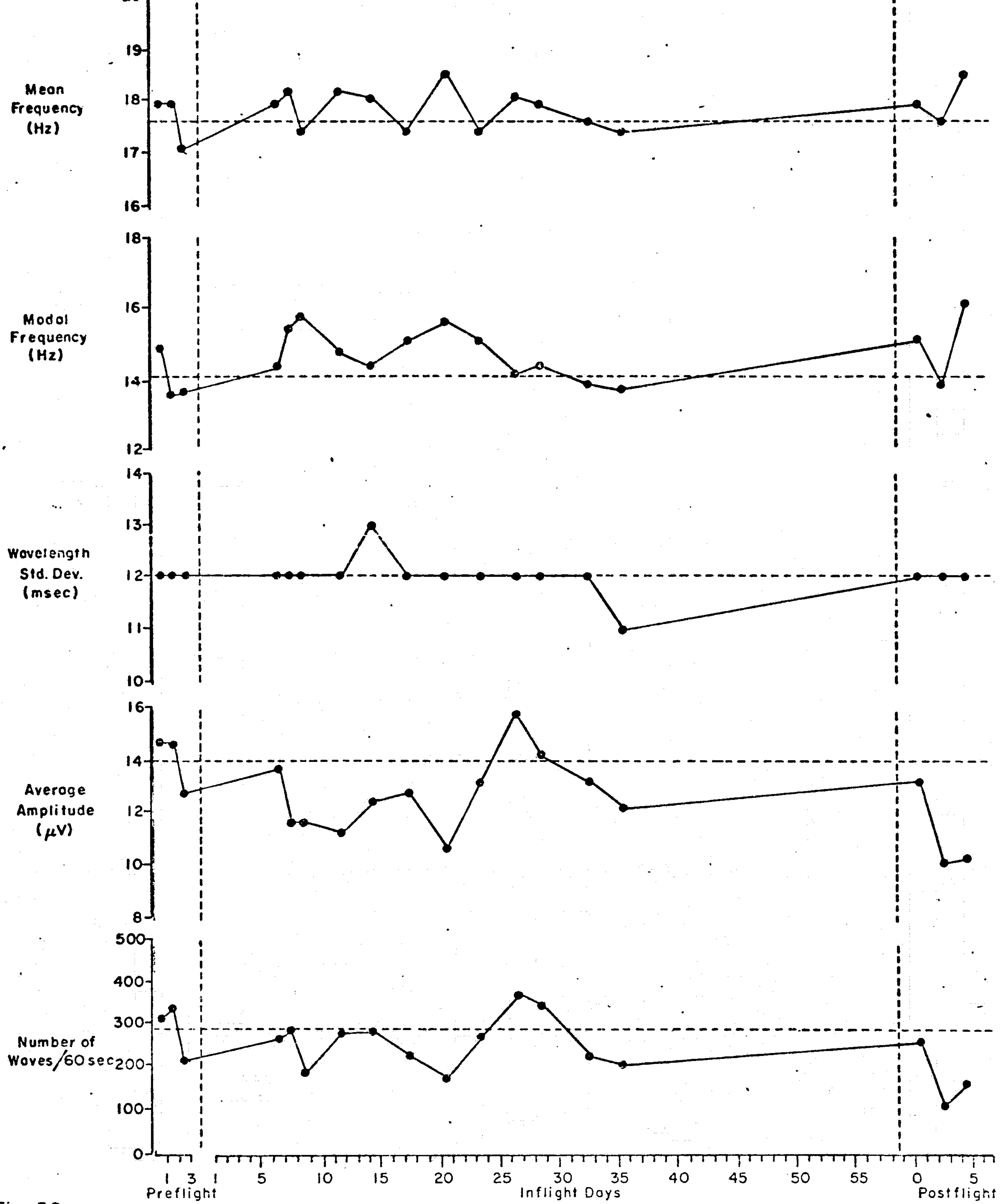


Fig. 50

O.G., BETA, STAGE 3

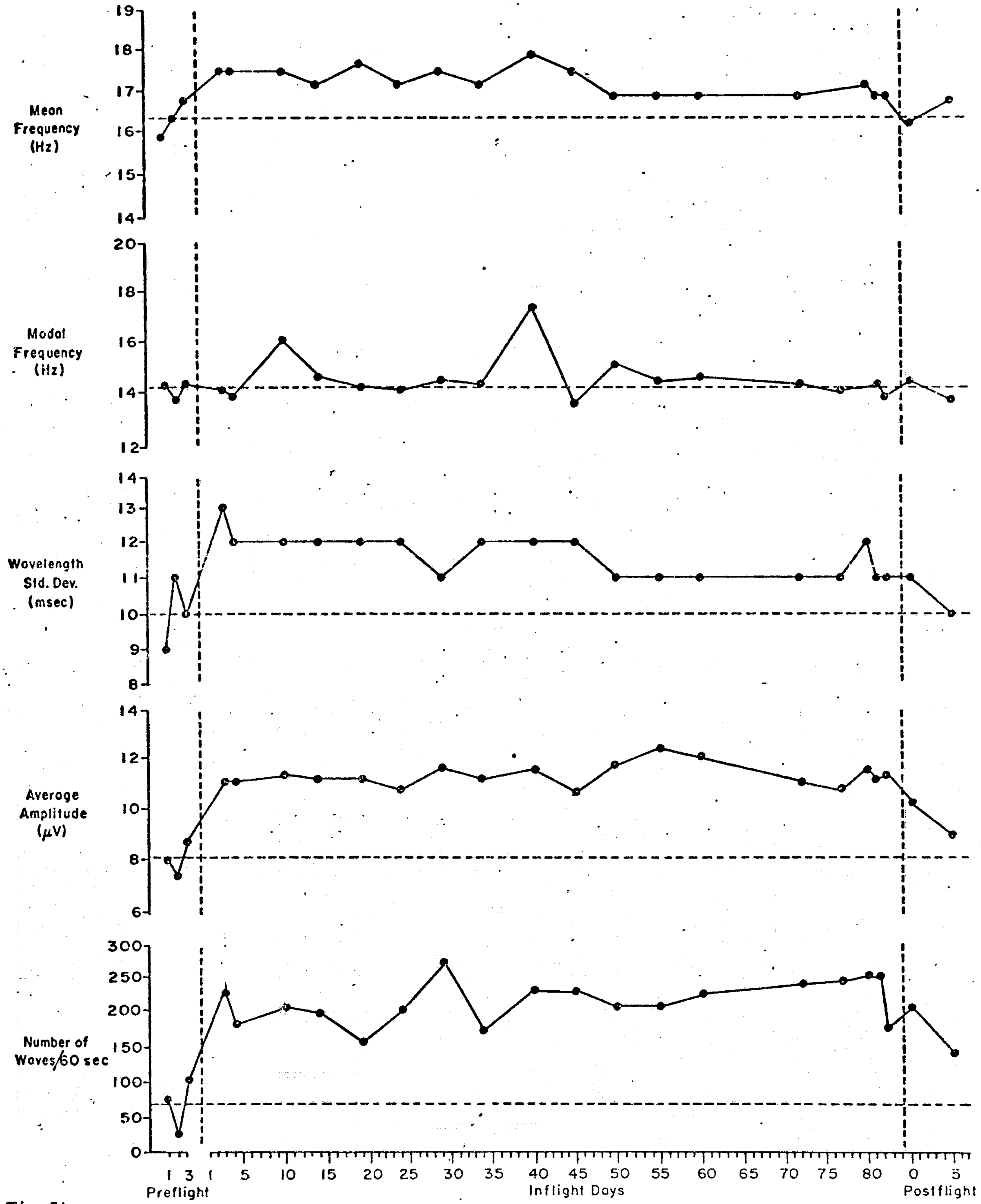


Fig. 51

E.G., BETA, STAGE 3

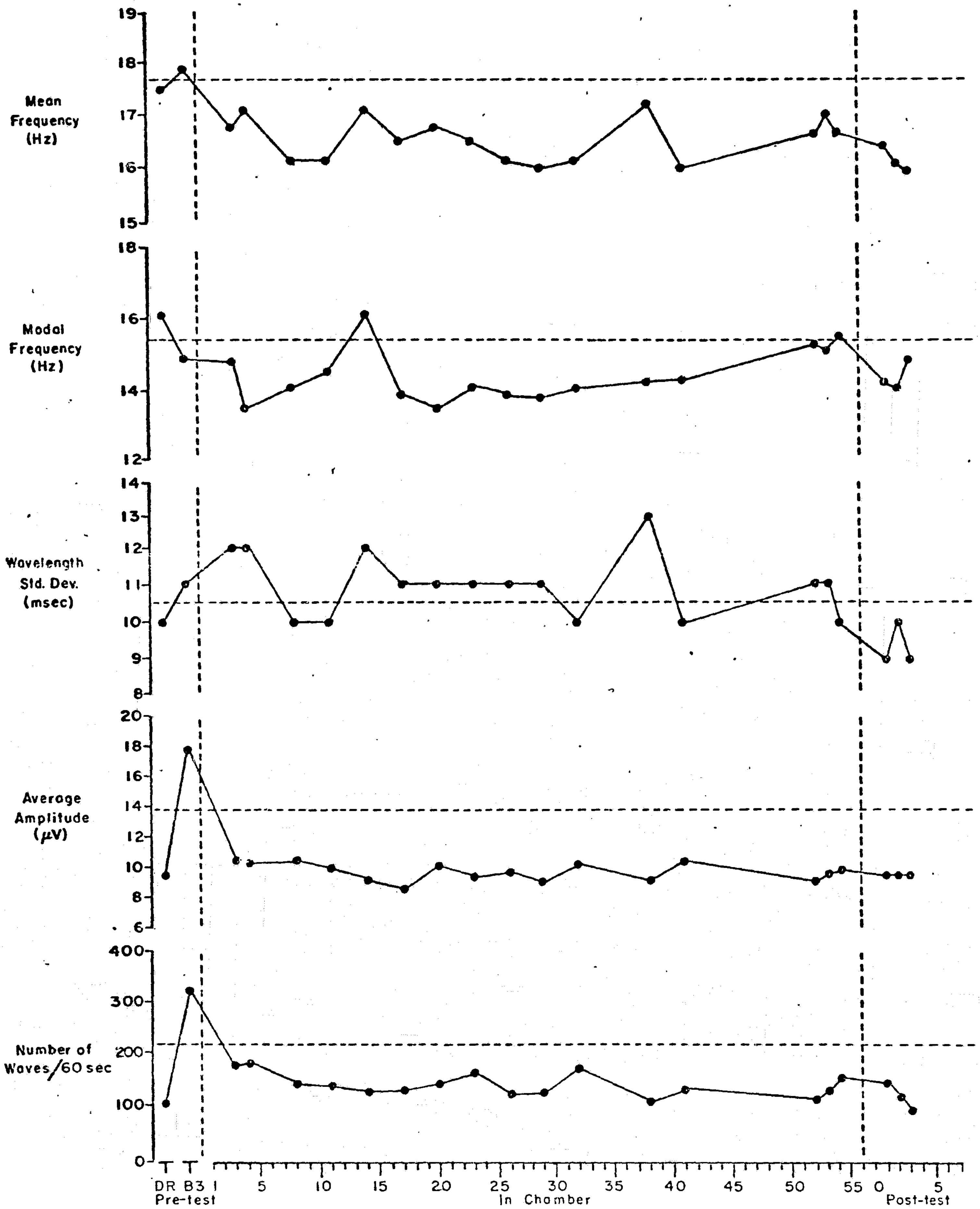


Fig. 52 W.T., BETA, STAGE 3

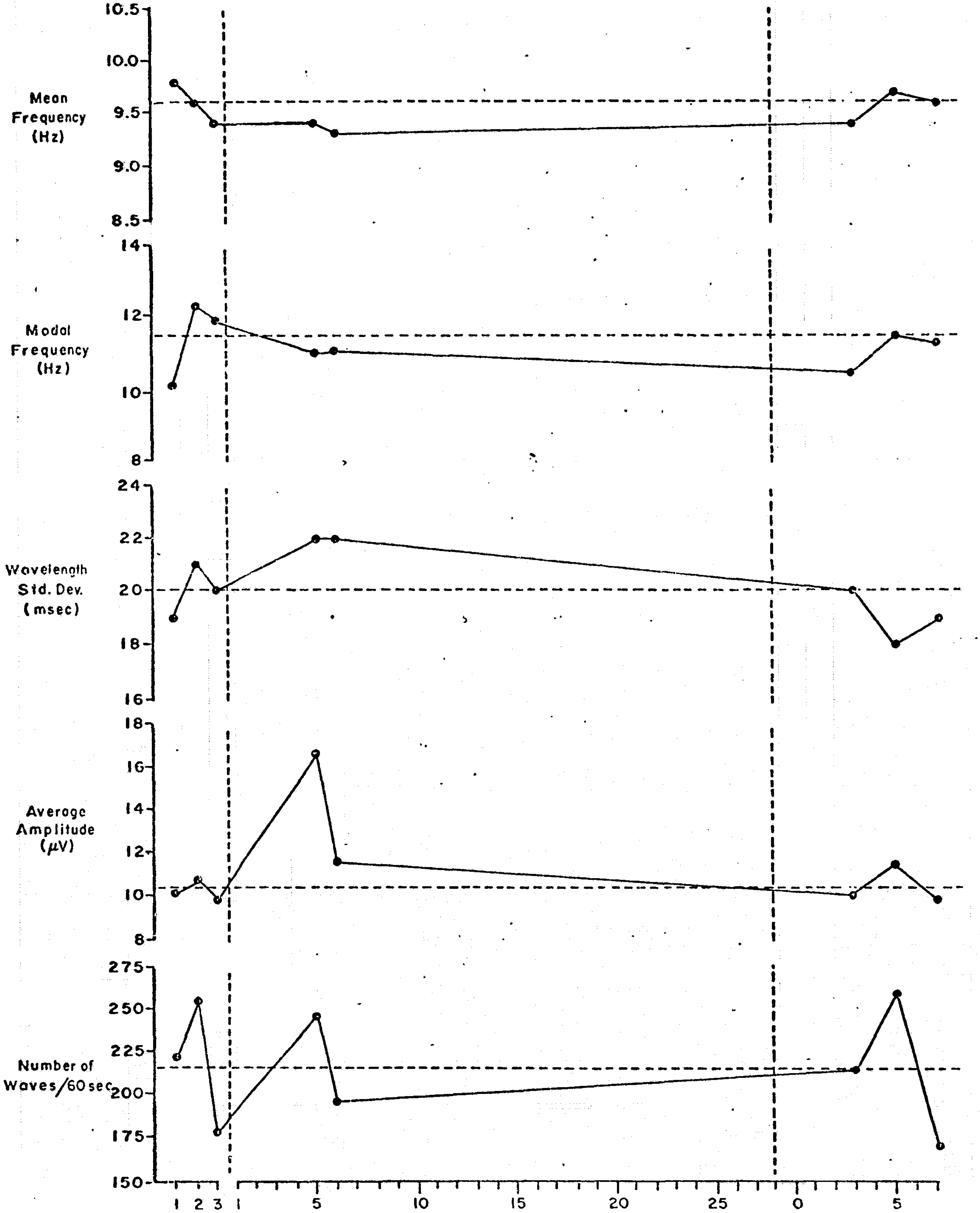


Fig. 53

J.K., ALPHA, STAGE 3

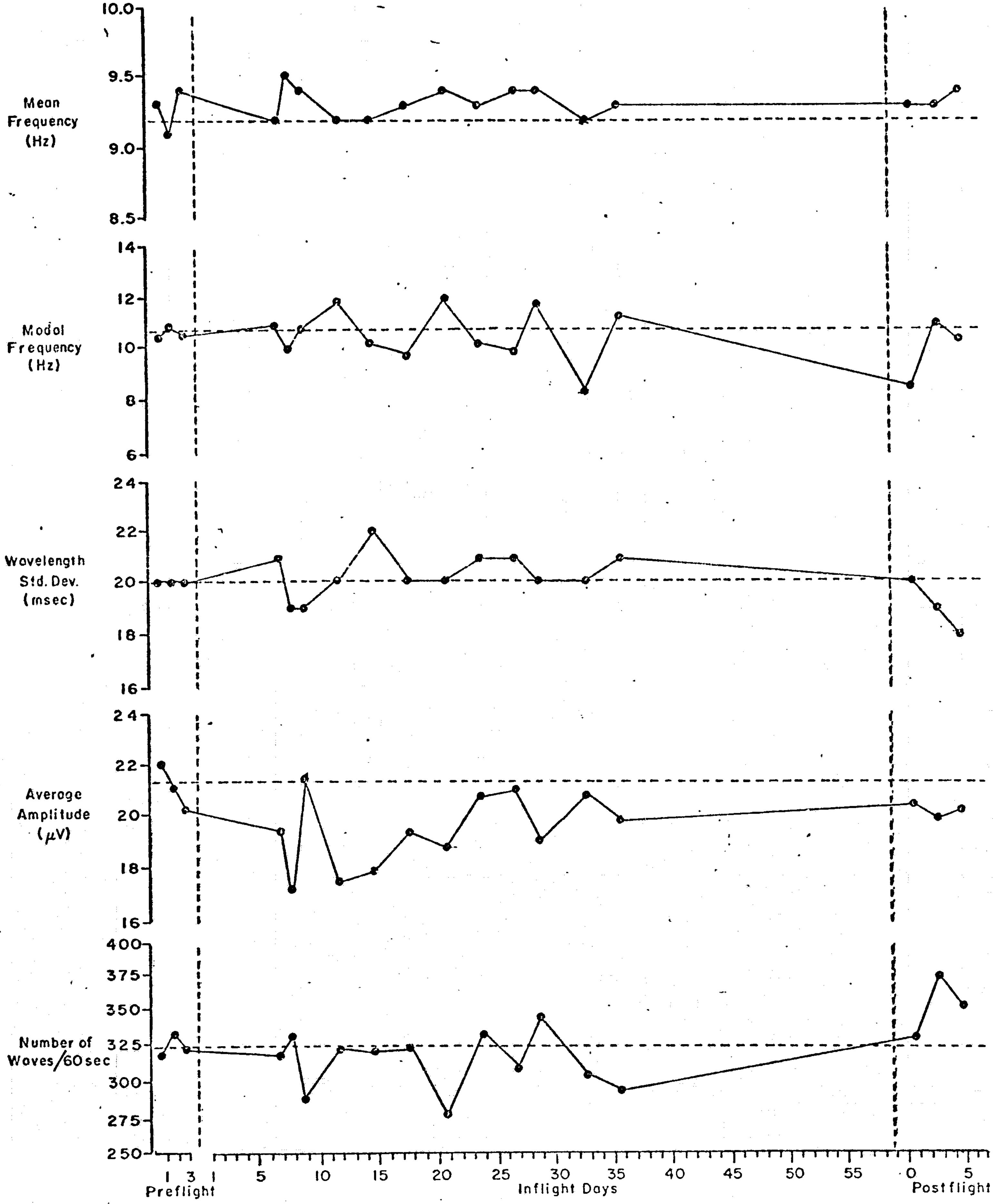


Fig. 54

O.G., ALPHA, STAGE 3

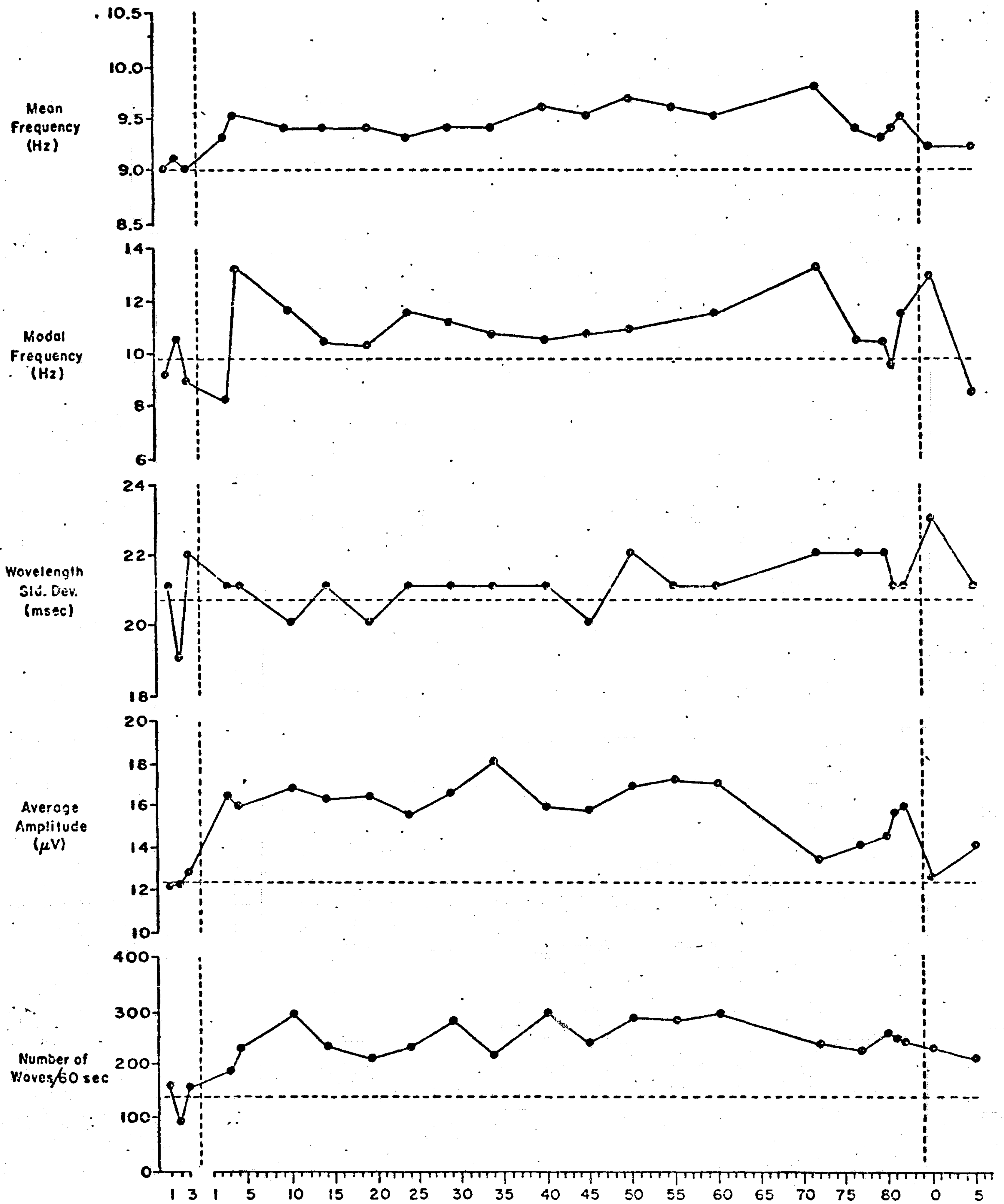


Fig. 55 E.G., ALPHA, STAGE 3

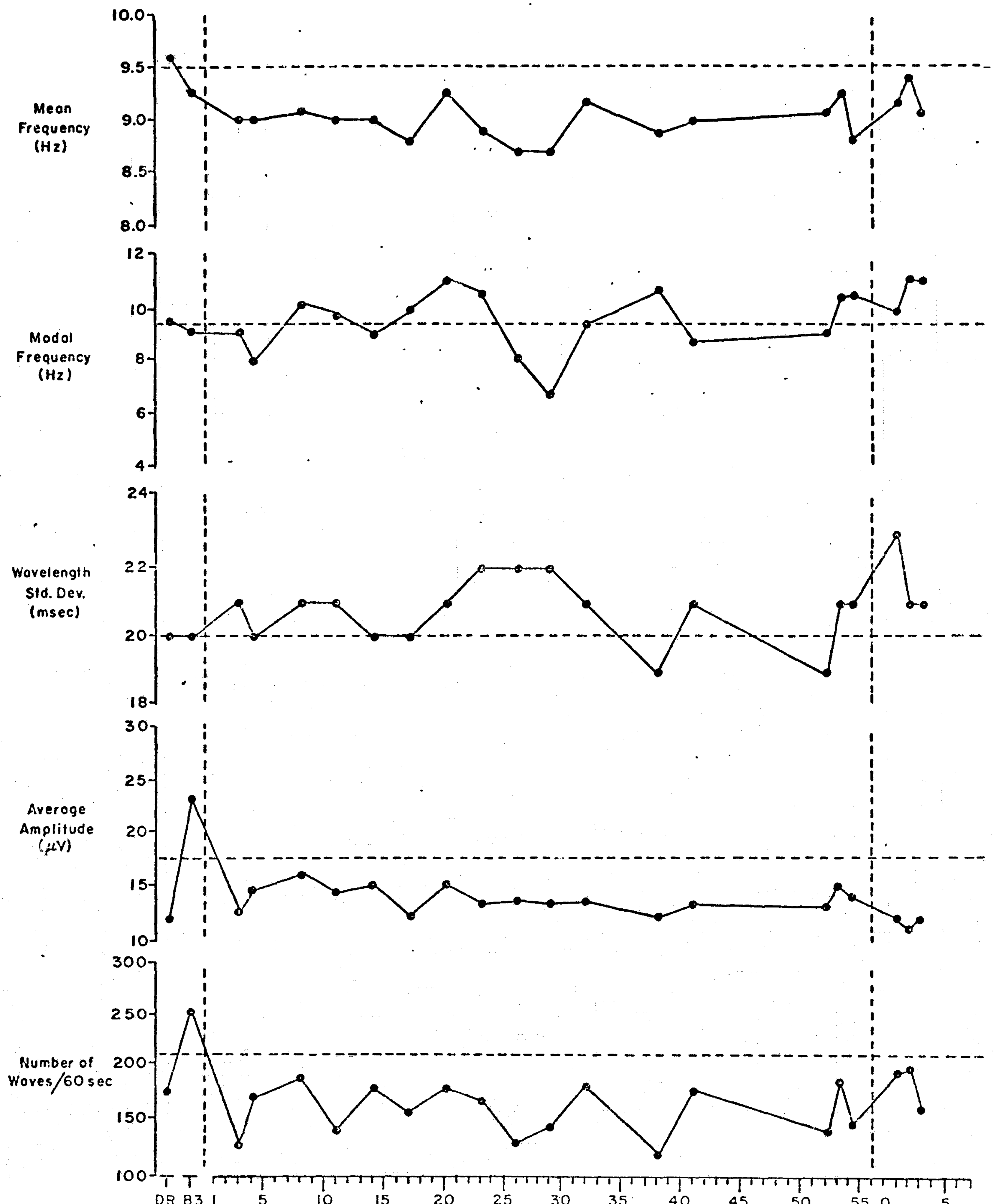


Fig. 56

W.T., ALPHA, STAGE 3

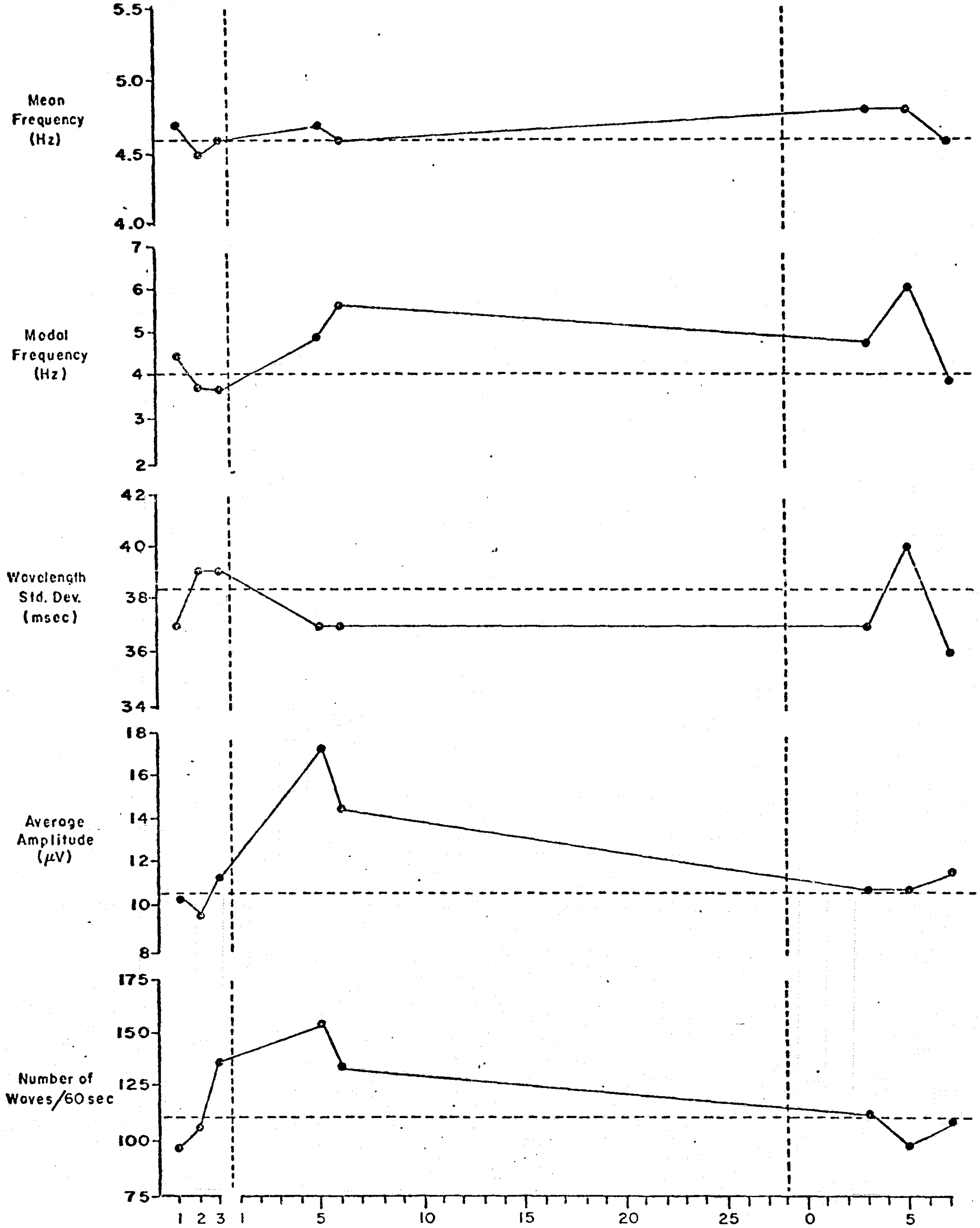


Fig. 57

J.K., THETA, STAGE 3

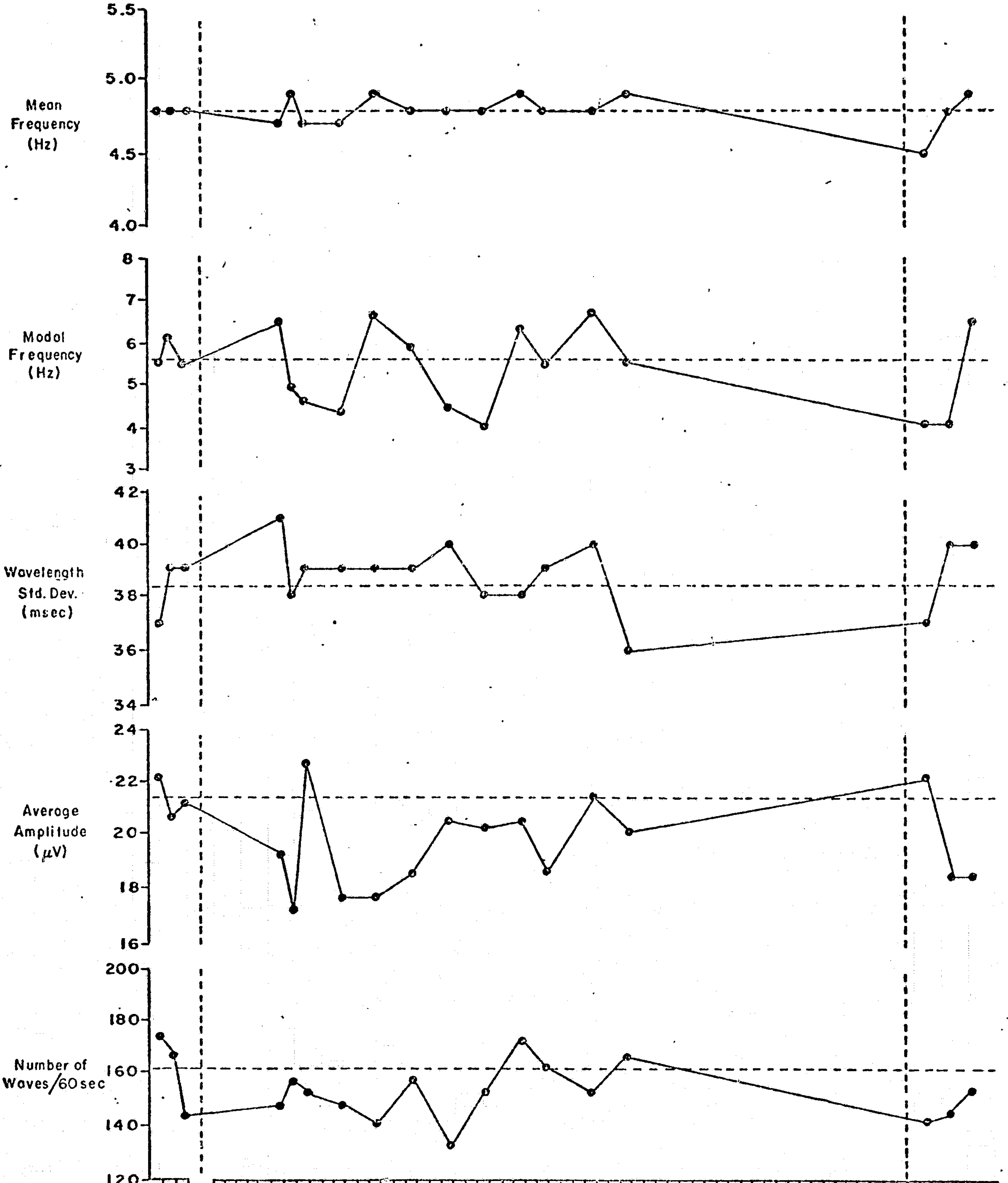


Fig. 58

O.G., THETA, STAGE 3

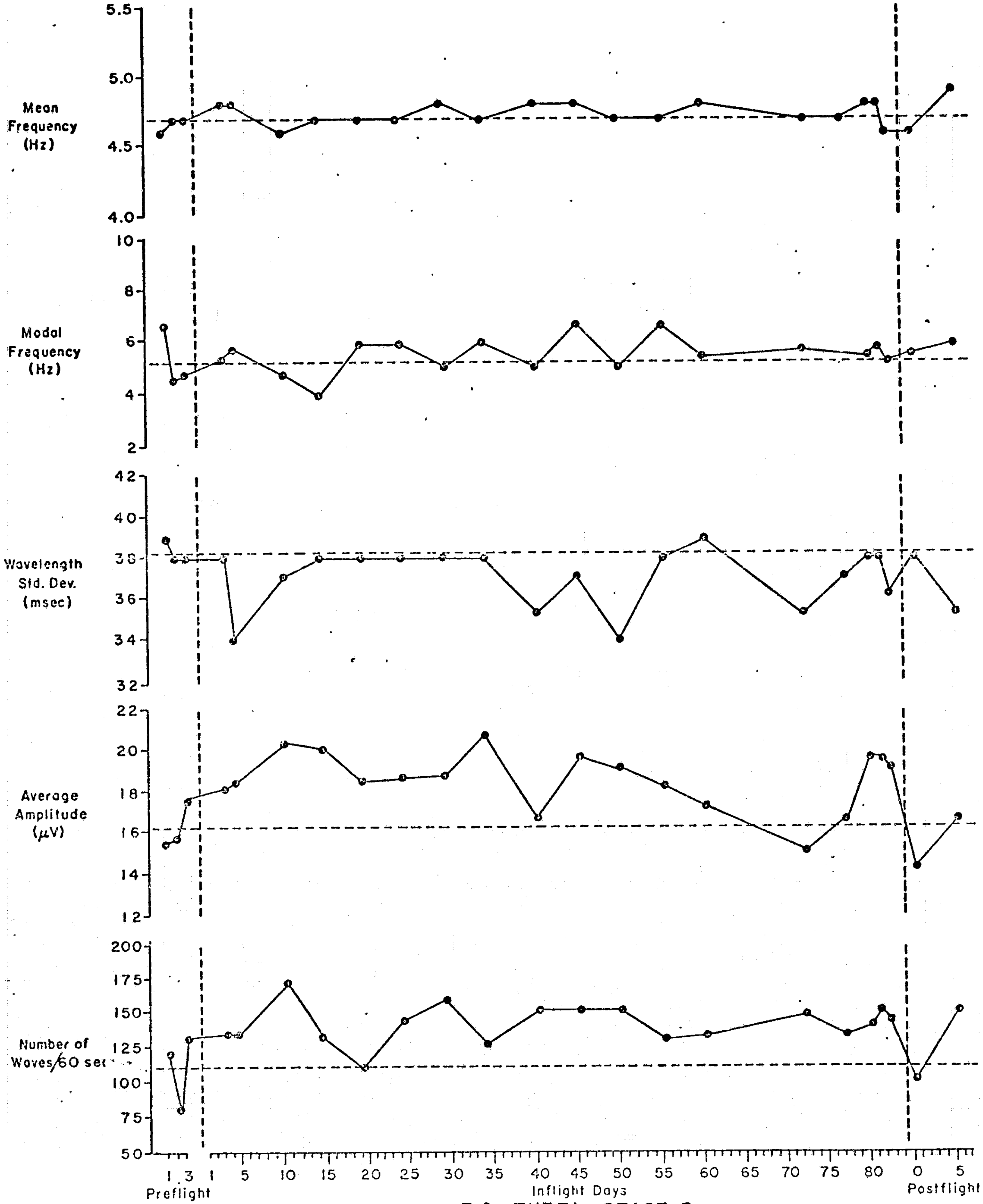


Fig. 59

E.G., THETA, STAGE 3

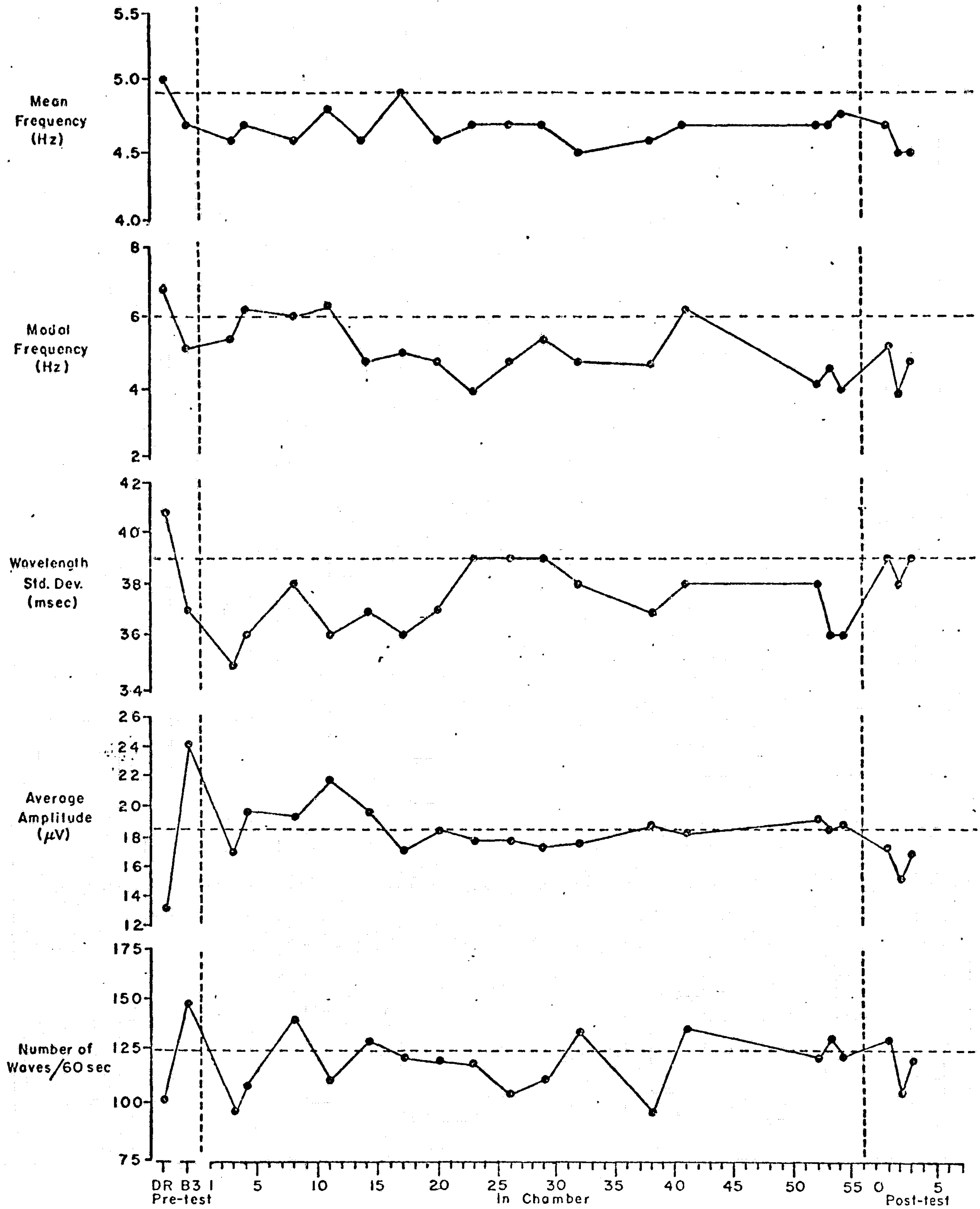


Fig. 60

W.T., THETA, STAGE 3

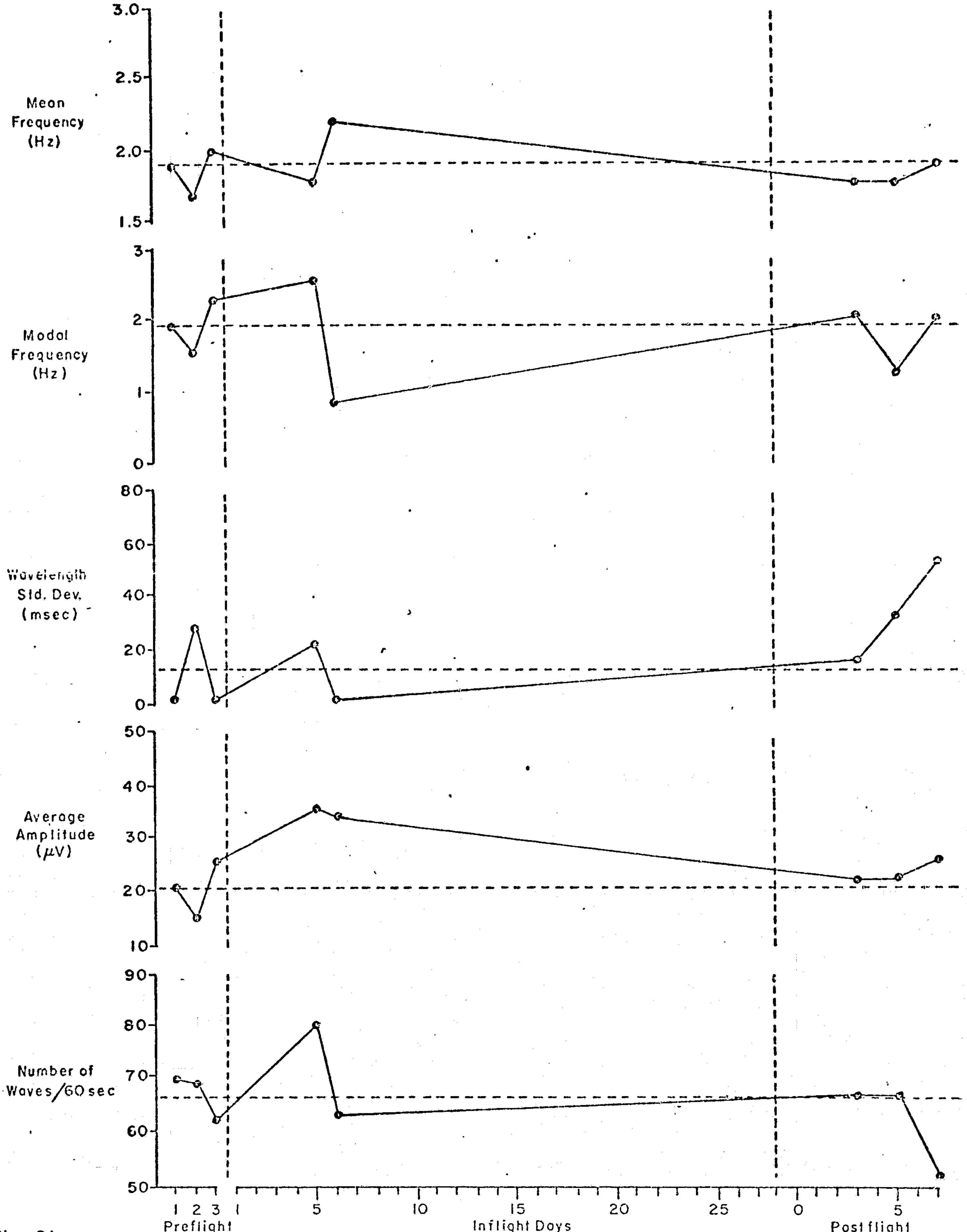


Fig. 61

J.K., DELTA, STAGE 3

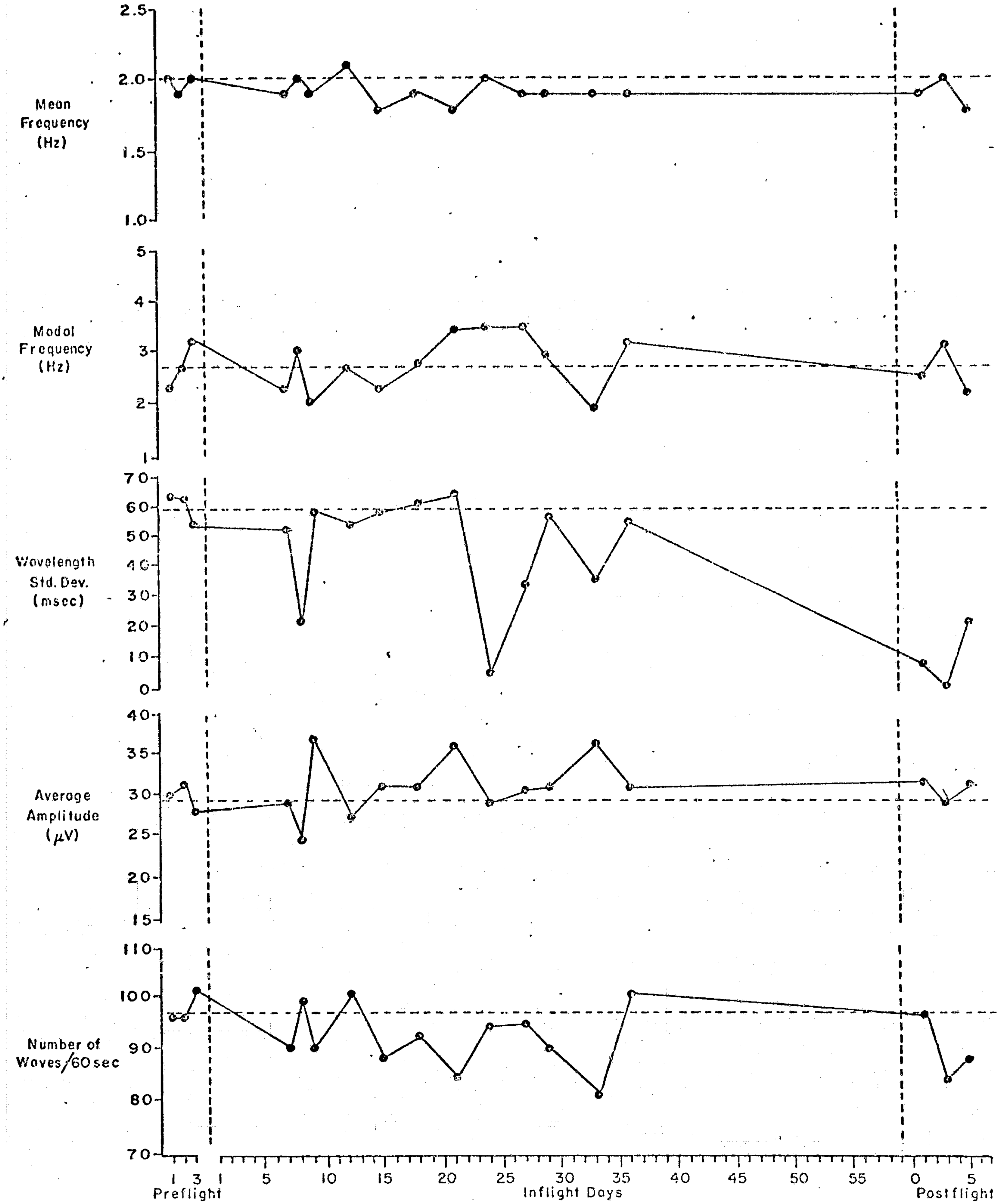


Fig. 62

O.G., DELTA, STAGE 3

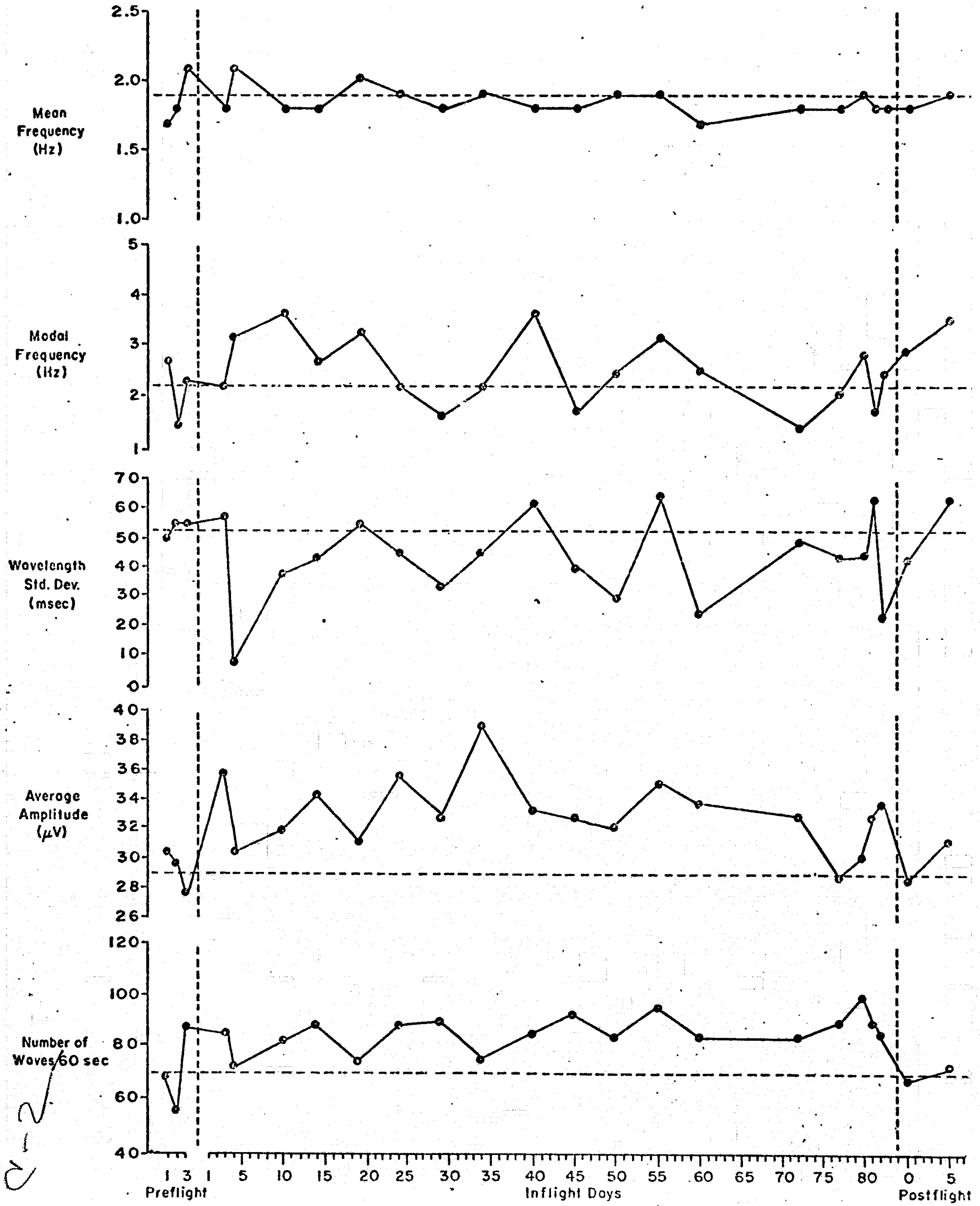


Fig. 63

E.G., DELTA, STAGE 3

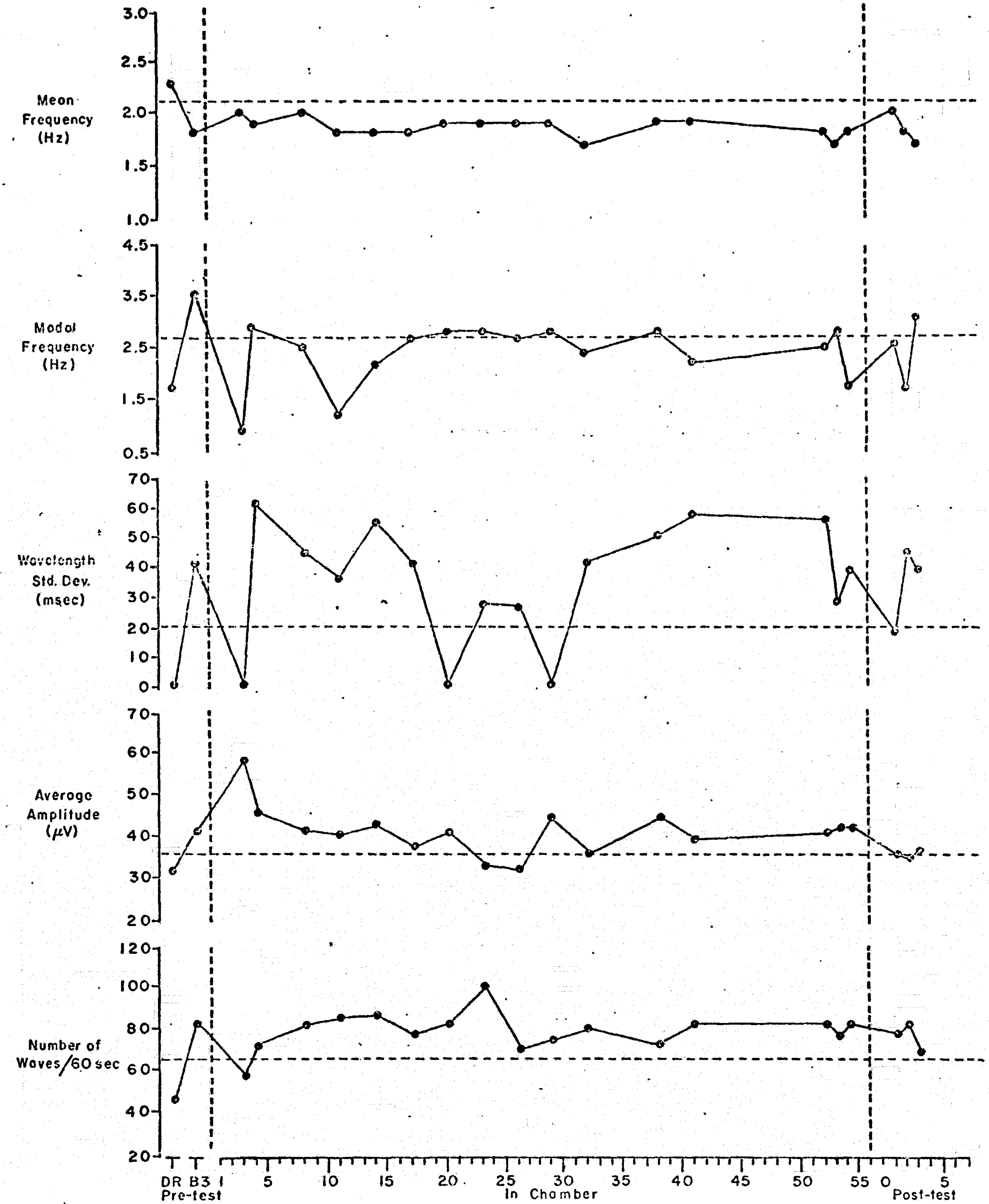
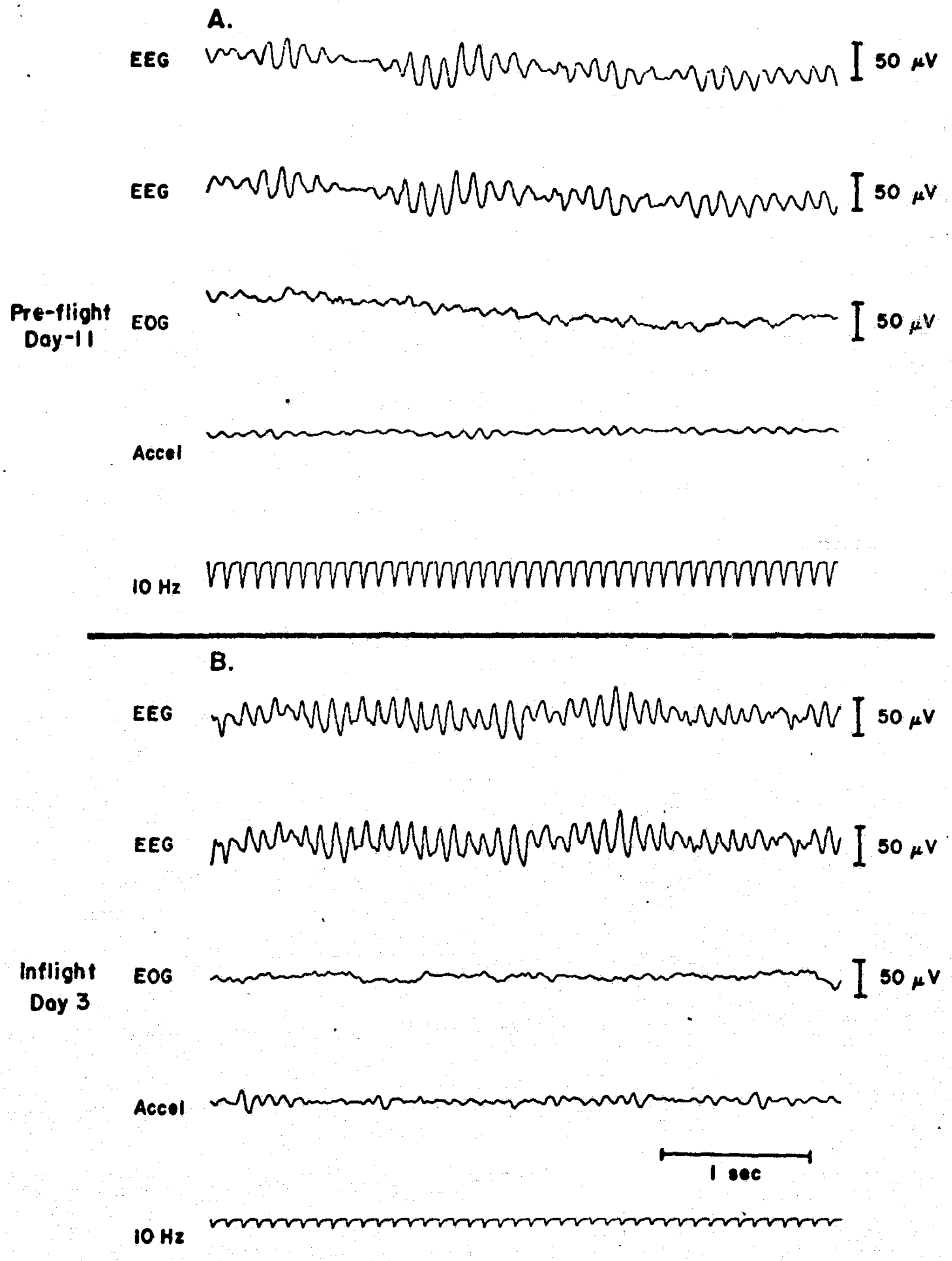


Fig. 64 W.T., DEL–A, STAGE 3



Subj. E.G., 84-DAY FLIGHT
AWAKE
Fig. 65

SKYLAB EEG ANALYSIS

Average Values

Condition: Awake

FREQUENCY BAND	MEASUREMENT	Subject J.K.			Subject O.G.			Subject E.G.			Subject W.T.		
		PRE	IN	POST	PRE	IN	POST	PRE	IN	POST	PRE	IN	POST
BETA	AVERAGE AMP.	11.8	13.6 Δ	12.8 Δ	17.4	18.3 Δ	18.5 Δ	9.0	12.7 ***	10.9 Δ	17.1	11.6 Δ	11.6 Δ
BETA	MEAN FREQ.	19.8	19.1 *	19.4	18.9	19.0	18.9	19.7	20.5	20.1	19.5	18.7 **	19.0 *
BETA	MODAL FREQ.	19.7	19.0	20.7 Δ	18.1	18.5	17.8	26.3	22.9	25.6 Δ	16.9	20.3 Δ	20.2 Δ
BETA	NO. WAVES / MIN	342	436 *	344	337	429 **	224 **	167	481 ***	405 *	280	204 Δ	119 *
ALPHA	AVERAGE AMP.	16.8	15.4 Δ	17.9 Δ	21.2	25.0 Δ	29.2 *	17.5	17.2	15.9 Δ	26.4	18.7 Δ	25.0 Δ
ALPHA	MEAN FREQ.	9.5	9.5	9.3	9.3	9.6 **	9.5	9.2	9.8 **	9.6	9.3	9.4	9.2
ALPHA	MODAL FREQ.	9.8	10.4 Δ	9.3 Δ	10.2	9.8	9.6 Δ	9.3	10.1 *	10.1 Δ	9.1	9.4 **	9.1
ALPHA	NO. WAVES / MIN	470	361 Δ	501 Δ	514	511	533	353	405 Δ	384 Δ	477	482	527 Δ
THETA	AVERAGE AMP.	7.9	10.7 Δ	9.1 Δ	14.3	13.2 Δ	13.4 Δ	11.0	10.1 Δ	9.6 Δ	14.0	10.6 Δ	11.7 Δ
THETA	MEAN FREQ.	4.9	4.7 *	4.9	4.9	4.9	5.0	4.8	4.8	4.6	4.8	4.7	4.7
THETA	MODAL FREQ.	5.3	5.1	4.9 *	5.6	5.2 Δ	5.2 Δ	5.6	5.2 Δ	4.3 **	5.1	5.1	4.9
THETA	NO. WAVES / MIN	97	113 Δ	118 *	120	127 Δ	119	116	140 *	123 Δ	103	118 Δ	99
DELTA	AVERAGE AMP.	6.9	17.5 Δ	7.3 Δ	13.9	13.6	11.9 Δ	13.8	11.0 Δ	13.9	22.3	18.1 Δ	14.0 Δ
DELTA	MEAN FREQ.	2.1	1.9 Δ	1.8 Δ	1.8	1.9 Δ	2.0 *	2.0	1.9	1.9	2.0	1.7 **	1.7 *
DELTA	MODAL FREQ.	2.5	2.2 Δ	2.6	2.7	2.7	2.6	1.8	2.3 Δ	1.9 Δ	2.9	1.6 **	2.5 Δ
DELTA	NO. WAVES / MIN	40	57 *	48 Δ	75.3	90.3 Δ	94.7 *	54	75 *	47 Δ	63	68 Δ	74 Δ

Δ >5%, n.s.
* $p<0.10$
** $p<0.05$
*** $p<0.01$

TABLE I

SKYLAB EEG ANALYSIS

Average Values

Condition: Stage REM Sleep

FREQUENCY BAND	MEASUREMENT	Subject J.K.			Subject O.G.			Subject E.G.			Subject W.T.		
		PRE	IN	POST	PRE	IN	POST	PRE	IN	POST	PRE	IN	POST
BETA	AVERAGE AMP.	8.4	8.6	8.1	11.8	12.0	11.7	7.8	11.5 ***	9.6 **	12.4	9.4 Δ	8.1 Δ
BETA	MEAN FREQ.	19.0	17.5 Δ	18.2 *	18.9	18.9	19.2	19.0	19.6 **	19.0	18.6	18.1	18.2
BETA	MODAL FREQ.	20.0	15.2 Δ	17.3 Δ	14.7	17.9 **	18.4 Δ	15.9	18.9 Δ	22.4 **	19.6	15.8 *	18.2 *
BETA	NO. WAVES / MIN	430	245 Δ	252 **	412	398	383 Δ	198	489 ***	352 **	406	275 *	195 *
ALPHA	AVERAGE AMP.	9.0	9.0	9.3	14.9	15.7 Δ	14.6	10.9	12.9 **	9.6 Δ	13.6	11.8 Δ	10.3 Δ
ALPHA	MEAN FREQ.	9.0	9.1	8.9	9.3	9.4	9.4	8.7	8.9	8.6 *	9.0	8.7 **	8.5 *
ALPHA	MODAL FREQ.	8.9	9.2	9.4 Δ	10.1	10.0	10.6	8.0	9.5 **	9.6 *	9.9	8.9 Δ	8.2 *
ALPHA	NO. WAVES / MIN	195	196	189	316	312	318	202	269 ***	183 Δ	242	213 Δ	183 Δ
THETA	AVERAGE AMP.	8.4	10.2 Δ	9.4 **	14.4	15.0	13.3 Δ	11.8	13.6 **	9.5 *	14.2	13.3 Δ	11.8 Δ
THETA	MEAN FREQ.	4.8	4.7	4.8	4.8	4.8	4.9	4.9	4.8	4.6 **	4.7	4.7	4.7
THETA	MODAL FREQ.	4.6	5.6 Δ	4.7	6.5	5.6 **	5.7 **	5.3	5.6 Δ	4.3 Δ	6.0	5.6 Δ	5.6 Δ
THETA	NO. WAVES / MIN	118	124	131 Δ	163	161	161	159	168 Δ	123 *	135	131	124 Δ
DELTA	AVERAGE AMP.	9.2	12.8 Δ	10.0 Δ	17.9	17.2	15.0 *	14.2	16.3 Δ	11.7 *	22.7	21.7	18.4 Δ
DELTA	MEAN FREQ.	1.9	1.9	2.0 *	2.0	2.0	1.9 Δ	2.0	1.9	1.9	2.0	2.0	1.8 Δ
DELTA	MODAL FREQ.	2.9	2.5 Δ	2.6 Δ	2.5	2.9 Δ	2.5	3.1	2.8 Δ	2.1 Δ	2.8	2.7	2.8
DELTA	NO. WAVES / MIN	84	91 Δ	78 Δ	103	101	98	86	87	74 Δ	79	78	75 Δ

Δ >5%, n.s.
* $p<0.10$
** $p<0.05$
*** $p<0.01$

TABLE II

SKYLAB EEG ANALYSIS

Average Values

Condition: Stage 2 Sleep

FREQUENCY BAND	MEASUREMENT	Subject J.K. PRE	Subject J.K. IN	Subject J.K. POST	Subject O.G. PRE	Subject O.G. IN	Subject O.G. POST	Subject E.G. PRE	Subject E.G. IN	Subject E.G. POST	Subject W.T. PRE	Subject W.T. IN	Subject W.T. POST
BETA	AVERAGE AMP.	9.1	8.9	9.2	12.9	12.8	13.3	8.6	11.6 ***	10.3 **	14.5	10.9 Δ	10.8 Δ
BETA	MEAN FREQ.	17.3	16.9	17.3	18.0	18.2	17.4 *	17.0	17.9 **	16.8	17.8	17.2	16.6 *
BETA	MODAL FREQ.	15.3	14.3 Δ	15.4	16.6	16.6	14.4 *	14.8	15.5	14.2	14.6	15.2	14.9
BETA	NO. WAVES / MIN	282	217 Δ	252 Δ	280	346 Δ	321 Δ	159	372 ***	239 *	285	256 Δ	205 Δ
ALPHA	AVERAGE AMP.	10.4	11.5 Δ	10.9	19.5	17.9 Δ	17.8 Δ	11.9	14.7 **	12.9 **	17.3	14.4 Δ	12.9 Δ
ALPHA	MEAN FREQ.	9.4	9.5	9.5	9.4	9.3	9.2 *	9.0	9.1	9.1	9.4	9.0 **	9.0
ALPHA	MODAL FREQ.	10.8	11.0	11.3	10.4	10.2	10.4	9.8	10.7 Δ	10.7 *	10.7	10.1 Δ	9.5 Δ
ALPHA	NO. WAVES / MIN	239	244	259 Δ	341	303 Δ	327	182	242 **	220 *	220	195 Δ	188 Δ
THETA	AVERAGE AMP.	9.7	12.3 Δ	9.8	17.5	18.2	18.3	15.9	18.0 Δ	15.6	17.1	18.0 Δ	15.6 Δ
THETA	MEAN FREQ.	4.6	4.7	4.8 **	4.8	4.8	4.7	4.7	4.7	4.6	4.7	4.6	4.6 *
THETA	MODAL FREQ.	5.0	5.3 Δ	5.5 *	5.5	5.8 Δ	5.1 Δ	5.3	5.2	4.9 Δ	5.2	5.1	4.3 *
THETA	NO. WAVES / MIN	109	161 Δ	128 Δ	172	149 **	147 *	154	156	144 Δ	146	134 Δ	129 *
DELTA	AVERAGE AMP.	14.1	16.9 Δ	12.5 Δ	23.2	26.4 **	24.2	22.1	23.4 Δ	23.5 Δ	27.0	30.0 Δ	26.5
DELTA	MEAN FREQ.	1.8	1.8	1.9 *	2.1	2.0	2.1	1.9	2.0 Δ	1.9	2.0	2.0	1.9 Δ
DELTA	MODAL FREQ.	1.9	3.0 Δ	2.7 Δ	2.8	2.8	2.7	2.4	3.0 Δ	2.2 Δ	2.9	2.8	2.9
DELTA	NO. WAVES / MIN	63	97 Δ	78 Δ	98	100	107 *	97	106 Δ	91 Δ	79	98 *	89 Δ

Δ >5%, n.s.
* $p<0.10$
** $p<0.05$
*** $p<0.01$

TABLE III

SKYLAB EEG ANALYSIS

Average Values

Condition: Stage 3 Sleep

FREQUENCY BAND	MEASUREMENT	Subject J.K.			Subject O.G.			Subject E.G.			Subject W.T.		
		PRE	IN	POST	PRE	IN	POST	PRE	IN	POST	PRE	IN	POST
BETA	AVERAGE AMP.	8.4	10.8 Δ	7.8 Δ	14.0	12.8 Δ	11.2 *	8.1	11.4 ***	9.7 **	13.8	9.8 Δ	9.6 *
BETA	MEAN FREQ.	17.7	17.7	16.6 Δ	17.6	17.8	18.0	16.3	17.2 **	16.5	17.7	16.6 **	16.1 *
BETA	MODAL FREQ.	14.6	14.4	14.9	14.1	14.8	15.1 *	14.2	14.6	14.2	15.5	14.5 Δ	14.4 Δ
BETA	NO. WAVES / MIN	245	284 Δ	97 *	282	258 Δ	181 *	70	218 ***	175 **	216	143 Δ	120 Δ
ALPHA	AVERAGE AMP.	10.3	14.1 *	10.4	21.1	19.5 *	20.2	12.3	15.9 ***	13.2 Δ	17.9	14.0 Δ	12.2 Δ
ALPHA	MEAN FREQ.	9.6	9.4	9.6	9.3	9.3	9.3	9.0	9.5 ***	9.2 **	9.5	9.0 **	9.2
ALPHA	MODAL FREQ.	11.5	11.1	11.1	10.6	10.5	9.9 Δ	9.8	10.9 Δ	10.6 Δ	9.4	9.5	10.7 *
ALPHA	NO. WAVES / MIN	217	219	215	324	314	352 *	140	246 ***	216 **	213	159 Δ	183 Δ
THETA	AVERAGE AMP.	10.4	15.9 *	11.0 Δ	21.4	19.6 *	19.6 Δ	16.2	18.6 **	15.4	18.8	18.7	16.6 Δ
THETA	MEAN FREQ.	4.6	4.7	4.7	4.8	4.8	4.7	4.7	4.7	4.8	4.9	4.7	4.6 Δ
THETA	MODAL FREQ.	4.0	5.3 *	4.9 *	5.7	5.5	4.9 Δ	5.2	5.4	5.6 Δ	6.0	5.1 Δ	4.6 Δ
THETA	NO. WAVES / MIN	114	145 Δ	108 Δ	161	153	146 Δ	110	140 **	122 Δ	125	119	119
DELTA	AVERAGE AMP.	20.6	35.3 *	23.9 Δ	29.6	31.2 Δ	31.2 *	29.0	32.9 **	29.6	36.9	41.2 Δ	36.0
DELTA	MEAN FREQ.	1.9	2.0 Δ	1.8 Δ	2.0	1.9 Δ	1.9 Δ	1.9	1.9	1.9	2.1	1.9 Δ	1.8 Δ
DELTA	MODAL FREQ.	1.9	1.8 Δ	1.8 Δ	2.7	2.8	2.6	2.2	2.5 Δ	3.2 **	2.7	2.4 Δ	2.5 Δ
DELTA	NO. WAVES / MIN	66	72 Δ	62 Δ	98	92 Δ	89 Δ	70	84 Δ	69	65	79 Δ	76 Δ

Δ >5%, n.s.
* $p<0.10$
** $p<0.05$
*** $p<0.01$

TABLE IV

INCIDENCE OF ALTERATIONS ($p<0.10$)

Condition: Awake

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	1	0	0	0	0	0	0	0
MEAN FREQ.	0	0	2	0	0	0	0	0
MODAL FREQ.	0	0	1	1	0	0	0	0
NO. WAVES/MIN	3	0	0	0	1	0	2	0
INFLIGHT DECREASE								
AVERAGE AMP.	0	0	0	0	0	0	0	0
MEAN FREQ.	1	1	0	0	1	0	0	1
MODAL FREQ.	0	0	0	0	0	0	0	1
NO. WAVES/MIN	0	0	0	0	0	0	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	0	0	1	0	0	0	0	0
MEAN FREQ.	0	1	0	0	0	0	1	0
MODAL FREQ.	0	0	0	0	0	0	0	0
NO. WAVES/MIN	1	0	0	0	1	0	1	0
POSTFLIGHT DECREASE								
AVERAGE AMP.	0	0	0	0	0	0	0	0
MEAN FREQ.	0	1	0	0	0	0	0	1
MODAL FREQ.	0	0	0	0	2	0	0	0
NO. WAVES/MIN	1	1	0	0	0	0	0	0

TABLE V

INCIDENCE OF ALTERATIONS ($p<0.10$ and >5%, n.s.)

Condition: Awake

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	3	0	1	0	1	0	1	0
MEAN FREQ.	0	0	2	0	0	0	1	0
MODAL FREQ.	0	1	2	1	0	0	1	0
NO. WAVES/MIN	3	0	1	0	3	1	3	1
INFLIGHT DECREASE								
AVERAGE AMP.	0	1	1	1	2	1	1	1
MEAN FREQ.	1	1	0	0	1	0	1	1
MODAL FREQ.	1	0	0	0	2	0	1	1
NO. WAVES/MIN	0	1	1	0	0	0	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	3	0	3	0	1	0	1	0
MEAN FREQ.	0	0	0	0	0	0	1	0
MODAL FREQ.	1	1	1	0	0	0	1	0
NO. WAVES/MIN	1	0	2	1	2	0	2	1
POSTFLIGHT DECREASE								
AVERAGE AMP.	0	1	1	1	2	1	1	1
MEAN FREQ.	0	1	0	0	0	0	1	1
MODAL FREQ.	0	0	2	0	3	0	0	1
NO. WAVES/MIN	1	1	0	0	0	0	1	0

TABLE VI

INCIDENCE OF ALTERATIONS ($p<0.10$)

Condition: Stage REM Sleep

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	1	0	1	0	1	0	0	0
MEAN FREQ.	1	0	0	0	0	0	0	0
MODAL FREQ.	1	0	1	0	0	0	0	0
NO. WAVES/MIN	1	0	1	0	0	0	0	0
INFLIGHT DECREASE								
AVERAGE AMP.	0	0	0	0	0	0	0	0
MEAN FREQ.	0	0	0	1	0	0	0	0
MODAL FREQ.	0	1	0	0	1	0	0	0
NO. WAVES/MIN	0	1	0	0	0	0	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	1	0	0	0	1	0	0	0
MEAN FREQ.	0	0	0	0	0	0	1	0
MODAL FREQ.	1	0	1	0	0	0	0	0
NO. WAVES/MIN	1	0	0	0	0	0	0	0
POSTFLIGHT DECREASE								
AVERAGE AMP.	0	0	0	0	1	0	2	0
MEAN FREQ.	1	0	1	1	1	0	0	0
MODAL FREQ.	0	1	0	1	1	0	0	0
NO. WAVES/MIN	1	1	0	0	1	0	0	0

TABLE VII

INCIDENCE OF ALTERATIONS ($p<0.10$ and $>5\%$, n.s.)

Condition: Stage REM Sleep

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	1	0	2	0	2	0	2	0
MEAN FREQ.	1	0	0	0	0	0	0	0
MODAL FREQ.	2	0	1	0	2	0	1	0
NO. WAVES/MIN	1	0	1	0	1	0	1	0
INFLIGHT DECREASE								
AVERAGE AMP.	0	1	0	1	0	1	0	0
MEAN FREQ.	1	0	0	1	0	0	0	0
MODAL FREQ.	1	1	0	1	1	1	2	0
NO. WAVES/MIN	1	1	0	1	0	0	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	1	0	0	0	1	0	1	0
MEAN FREQ.	0	0	0	0	0	0	1	0
MODAL FREQ.	2	0	2	0	0	0	0	0
NO. WAVES/MIN	1	0	0	0	1	0	0	0
POSTFLIGHT DECREASE								
AVERAGE AMP.	0	1	1	1	2	1	2	1
MEAN FREQ.	1	0	1	1	1	0	1	1
MODAL FREQ.	1	1	0	1	2	1	2	0
NO. WAVES/MIN	2	1	1	1	1	1	2	1

TABLE VIII

INCIDENCE OF ALTERATIONS ($p<0.10$)

Condition: Stage 2 Sleep

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	1	0	1	0	0	0	1	0
MEAN FREQ.	1	0	0	0	0	0	0	0
MODAL FREQ.	0	0	0	0	0	0	0	0
NO. WAVES/MIN	1	0	1	0	0	0	0	1
INFLIGHT DECREASE								
AVERAGE AMP.	0	0	0	0	0	0	0	0
MEAN FREQ.	0	0	0	1	0	0	0	0
MODAL FREQ.	0	0	0	0	0	0	0	0
NO. WAVES/MIN	0	0	0	0	1	0	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	1	0	1	0	0	0	0	0
MEAN FREQ.	0	0	0	0	1	0	1	0
MODAL FREQ.	0	0	1	0	1	0	0	0
NO. WAVES/MIN	1	0	1	0	0	0	1	0
POSTFLIGHT DECREASE								
AVERAGE AMP.	0	0	0	0	0	0	0	0
MEAN FREQ.	1	1	1	0	0	1	0	0
MODAL FREQ.	1	0	0	0	0	1	0	0
NO. WAVES/MIN	0	0	0	0	1	1	0	0

TABLE IX

INCIDENCE OF ALTERATIONS ($p<0.10$ and >5%, n.s.)

Condition: Stage 2 Sleep

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	1	0	2	0	2	1	3	1
MEAN FREQ.	1	0	0	0	0	0	1	0
MODAL FREQ.	0	0	1	0	2	0	2	0
NO. WAVES/MIN	2	0	1	0	1	0	2	1
INFLIGHT DECREASE								
AVERAGE AMP.	0	1	1	1	0	0	0	0
MEAN FREQ.	0	0	0	1	0	0	0	0
MODAL FREQ.	1	0	0	1	0	0	0	0
NO. WAVES/MIN	1	1	1	1	1	1	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	1	0	1	0	0	0	1	0
MEAN FREQ.	0	0	0	0	1	0	1	0
MODAL FREQ.	0	0	1	0	1	0	1	0
NO. WAVES/MIN	2	0	2	0	1	0	2	1
POSTFLIGHT DECREASE								
AVERAGE AMP.	0	1	1	1	0	1	1	0
MEAN FREQ.	1	1	1	0	0	1	0	1
MODAL FREQ.	1	0	0	1	2	1	1	0
NO. WAVES/MIN	1	1	0	1	2	1	1	0

TABLE X

INCIDENCE OF ALTERATIONS ($p<0.10$)

Condition: Stage 3 Sleep

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	1	0	2	0	2	0	2	0
MEAN FREQ.	1	0	1	0	0	0	0	0
MODAL FREQ	0	0	0	0	1	0	0	0
NO. WAVES/MIN	1	0	1	0	1	0	0	0
INFLIGHT DECREASE								
AVERAGE AMP.	0	0	1	0	1	0	0	0
MEAN FREQ.	0	1	0	1	0	0	0	0
MODAL FREQ.	0	0	0	0	0	0	0	0
NO. WAVES/MIN	0	0	0	0	0	0	0	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	1	0	0	0	0	0	1	0
MEAN FREQ.	0	0	1	0	0	0	0	0
MODAL FREQ.	1	0	0	1	1	0	1	0
NO. WAVES/MIN	1	0	2	0	0	0	0	0
POSTFLIGHT DECREASE								
AVERAGE AMP.	1	1	0	0	0	0	0	0
MEAN FREQ.	0	1	0	0	0	0	0	0
MODAL FREQ.	0	0	0	0	0	0	0	0
NO. WAVES/MIN	2	0	0	0	0	0	0	0

TABLE XI

INCIDENCE OF ALTERATIONS (p<0.10 and >5%, n.s.)

Condition: Stage 3 Sleep

EEG PARAMETER	BETA RANGE Skylab n=3	BETA RANGE S.M.E.A.T. n=1	ALPHA RANGE Skylab n=3	ALPHA RANGE S.M.E.A.T. n=1	THETA RANGE Skylab n=3	THETA RANGE S.M.E.A.T. n=1	DELTA RANGE Skylab n=3	DELTA RANGE S.M.E.A.T. n=1
INFLIGHT INCREASE								
AVERAGE AMP.	2	0	2	0	2	0	3	1
MEAN FREQ.	1	0	1	0	0	0	1	0
MODAL FREQ.	0	0	1	0	1	0	1	0
NO. WAVES/MIN	2	0	1	0	2	0	2	1
INFLIGHT DECREASE								
AVERAGE AMP.	1	1	1	1	1	0	0	0
MEAN FREQ.	0	1	0	1	0	0	1	1
MODAL FREQ.	0	1	0	0	0	1	1	1
NO. WAVES/MIN	1	1	0	1	0	0	1	0
POSTFLIGHT INCREASE								
AVERAGE AMP.	1	0	1	0	1	0	2	0
MEAN FREQ.	0	0	1	0	2	0	0	0
MODAL FREQ.	1	0	1	1	1	0	1	0
NO. WAVES/MIN	1	0	2	0	1	0	0	1
POSTFLIGHT DECREASE								
AVERAGE AMP.	2	1	0	1	1	0	0	0
MEAN FREQ.	1	1	0	0	0	1	2	1
MODAL FREQ.	0	1	1	0	0	1	1	1
NO. WAVES/MIN	2	1	0	1	2	0	2	0

TABLE XII

NUMBER OF ALTERED PARAMETERS

Subject	Flight	Inflight p<0.10	Inflight >5%, n.s.	Inflight Total	Postflight p<0.10	Postflight >5%, n.s.	Postflight Total	Overall Total p<0.10	Overall Total p<0.10 and >5%, n.s.
J.K.	28-day	8	32	40	11	29	40	19	80
O.G.	59-day	8	18	26	16	18	34	24	60
E.G.	84-day	26	19	45	21	23	44	47	89
W.T.	SMEAT	11	32	43	14	35	49	25	92

TABLE XIII

SUMMARY OF MOST COMMON INFLIGHT ALTERATIONS

Parameter	Subj.	Condition: Awake	REM Sleep	Stage 2 Sleep	Stage 3 Sleep
Beta Range, No. Waves/Min	J.K.	*	↓	↓	Δ
	O.G.	**	0	Δ	↓
	E.G.	***	***	***	***
	W.T.	Δ	↓↓	↓	↓
Beta Range, Average Amplitude	J.K.	Δ	0	0	Δ
	O.G.	Δ	0	0	↓
	E.G.	***	***	***	***
	W.T.	↓	↓	↓	↓
Alpha Range, Mean Frequency	J.K.	0	0	0	0
	O.G.	**	0	0	0
	E.G.	**	0	0	***
	W.T.	0	↓↓↓	↓↓↓	↓↓↓
Alpha Range, Modal Frequency	J.K.	Δ	0	0	0
	O.G.	0	0	0	0
	E.G.	*	**	Δ	Δ
	W.T.	**	↓	↓	0
Alpha Range, Average Amplitude	J.K.	↓	0	Δ	*
	O.G.	Δ	Δ	↓	↓↓
	E.G.	0	**	**	***
	W.T.	↓	↓	Δ	↓
Theta Range, Average Amplitude	J.K.	Δ	Δ	*	*
	O.G.	↓	0	↓↓	↓↓
	E.G.	↓	**	**	**
	W.T.	↓	↓	0	0
Delta Range, No. Waves/Min	J.K.	*	Δ	Δ	Δ
	O.G.	Δ	0	0	↓
	E.G.	*	0	Δ	Δ
	W.T.	Δ	0	*	Δ
Delta Range, Average Amplitude	J.K.	Δ	Δ	Δ	*
	O.G.	0	0	**	Δ
	E.G.	↓	Δ	Δ	**
	W.T.	↓	0	Δ	Δ

Δ = increase, >5%, n.s.
* = increase, p<0.10
** = increase, p<0.05
*** = increase, p<0.01
0 = no change

↓ = decrease, >5%, n.s.
↓↓ = decrease, p<0.10
↓↓↓ = decrease, p<0.05

TABLE XIV

INFLIGHT MEDICATIONS

Drug	Mission Days on Which Drug Was Taken J.K. (28-day flight)	O.G. (59-day flight)	E.G. (84-day flight)
Scopolamine	1	2, 3, 60	1, 2, 3, 4
Dextroamphetamine	1	2, 3, 60	1, 2, 3, 4
Pseudoephedrine HCl			60
Ephedrine			1, 2, 3, 8, 33, 82
Promethazine			1, 2, 3, 8, 33, 82
Flurazepam HCl			37, 49, 59, 63, 71, 75, 83, 84
Oxymetazoline HCl	14	15, 16	62, 74, 75, 80
Mylanta: Al $(OH)_3$; simethacone; Mg $(OH)_2$		3	
Secobarbital		53, 54, 55, 56	
Aspirin			17, 67

TABLE XV

APPENDIX A

Flight 28-day

Subject JK

Condition Awake

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
16.0	20.2	18.0	337	12	14	10.9	1	PREFLIGHT
14.0	19.4	20.2	345	11	14	13.8	2	
14.6	19.8	21.0	344	11	18	10.7	3	
16.7	18.9	17.9	497	11	20	12.6	5	INFLIGHT
15.2	19.2	20.0	375	10	17	14.5	6	
14.7	19.6	20.8	319	12	11	13.9	31	POSTFLIGHT
15.9	19.2	18.2	381	11	17	12.9	34	
16.8	19.4	23.0	332	12	13	11.5	36	

Table A1

Flight 59-day
Subject OG
Condition Awake
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
13.7	18.5	20.0	349	11	12	20.1	B1	PREFLIGHT
14.4	19.1	17.1	258	12	10	15.6	B2	
15.3	19.1	17.1	403	12	16	16.4	B3	
13.8	18.7	19.8	452	12	17	18.3	7	INFLIGHT
14.4	18.7	16.6	437	12	16	17.9	8	
14.6	19.2	19.2	478	11	18	16.8	9	
16.3	19.4	22.0	462	12	14	16.1	12	
16.3	18.4	16.8	427	12	15	17.1	15	
14.6	19.2	17.9	389	12	14	18.0	18	
19.1	18.4	18.0	447	11	21	19.9	21	
14.9	19.8	16.0	446	12	13.	19.7	24	
14.6	19.1	22.0	424	12	16	19.8	27	
14.9	19.4	20.6	340	12	11	20.5	29	
16.8	18.4	17.4	428	11	16	19.0	33	
16.0	19.1	16.0	413	12	16	16.4	36	
14.3	18.3	17.7	237	12	12	24.4	R1	POSTFLIGHT
16.8	18.7	19.4	217	12	10	16.2	R3	
16.5	19.6	16.3	217	12	10	14.8	R5	

Table A2

Table A3

Flight 84-day

Subject EG

Condition Awake

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
14.9	19.6	25.6	194	13	6	10.0	B1	PREFLIGHT
16.0	19.4	28.1	156	14	6	7.6	B2	
19.1	20.2	25.3	152	12	8	9.4	B3	
15.9	20.4	14.3	274	14	12	14.5	3	INFLIGHT
14.3	19.2	15.2	378	13	13	10.7	4	
20.0	20.4	24.4	483	13	18	11.9	10	
17.9	20.0	13.9	406	14	14	12.0	14	
14.7	20.0	23.8	452	13	14	11.4	19	
14.3	20.0	30.3	384	14	12	11.6	24	
16.9	19.6	27.8	348	13	15	11.0	29	
13.7	20.8	25.0	374	13	14	13.3	34	
15.2	20.8	27.8	664	12	28	14.5	40	
21.0	21.5	23.5	630	13	26	12.4	45	
17.9	21.3	24.4	596	12	24	14.8	50	
16.1	20.4	21.7	459	12	18	13.8	55	
22.7	20.8	25.6	673	13	22	12.1	60	
19.6	20.8	24.4	703	12	26	12.7	72	
17.5	20.0	22.7	490	12	23	12.7	77	
20.2	22.0	25.9	657	12	28	12.6	80	
15.2	20.4	25.6	443	13	16	12.6	81	
14.3	20.0	15.4	249	13	8	14.7	82	
13.7	19.8	24.3	556	13	20	13.2	R0	POSTFLIGHT
18.5	20.0	28.0	470	14	20	10.0	R1	
14.7	20.6	24.5	188	13	9	9.5	R5	

Table A4

Flight SMEAT

Subject WT

Condition Awake

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
15.6	19.4	19.8	311	11	13	11.9	Dr	PREFLIGHT
14.1	19.6	13.9	248	14	10	22.3	B3	PREFLIGHT
								PREFLIGHT
14.6	18.7	24.1	161	12	7	10.5	3	INFLIGHT
14.1	18.9	19.2	196	12	9	11.4	4	INFLIGHT
13.6	18.7	23.0	235	12	9	14.0	8	INFLIGHT
14.1	18.3	21.5	118	12	7	10.8	11	INFLIGHT
16.5	18.7	13.9	195	14	8	11.3	14	INFLIGHT
14.3	18.0	23.0	134	13	8	10.7	17	INFLIGHT
18.7	19.0	19.8	279	13	11	12.1	20	INFLIGHT
14.6	19.0	14.6	169	12	6	11.6	23	INFLIGHT
17.7	18.7	23.0	290	12	14	11.1	26	INFLIGHT
19.0	18.0	17.7	246	12	11	11.0	29	INFLIGHT
14.3	19.0	24.1	124	13	6	11.7	32	INFLIGHT
17.7	19.0	17.4	103	13	5	10.6	38	INFLIGHT
14.3	19.0	21.5	156	13	6	10.9	41	INFLIGHT
14.8	19.4	21.5	287	12	14	12.9	52	INFLIGHT
14.6	18.7	21.5	270	12	12	11.6	53	INFLIGHT
13.8	18.7	19.0	293	12	12	12.7	54	INFLIGHT
								INFLIGHT
								INFLIGHT
14.3	19.0	20.2	110	13	8	12.9	P1	POSTFLIGHT
19.2	19.2	17.5	121	12	6	11.0	P2	POSTFLIGHT
14.6	18.7	23.0	125	12	6	10.8	P3	POSTFLIGHT

Flight 28-day
Subject JK
Condition Awake
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
9.7	9.4	9.6	469	11	29	15.1	1	PREFLIGHT
9.4	9.4	10.1	517	12	29	19.4	2	
9.8	9.6	9.6	423	12	29	15.8	3	
9.5	9.3	10.6	231	18	10	13.9	5	INFLIGHT
7.0	9.7	10.1	491	13	30	16.8	6	
7.7	9.1	8.9	529	10	42	21.6	31	POSTFLIGHT
9.5	9.4	9.7	480	13	24	17.4	34	
8.3	9.5	9.4	495	13	30	14.8	36	

Table A5

Table A6

Flight 59-day
Subject OG
Condition Awake
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
7.1	9.2	10.2	498	15	24	13.2	B1	PREFLIGHT
8.6	9.2	9.6	526	13	29	27.8	B2	PREFLIGHT
9.2	9.6	10.7	517	15	24	22.7	B3	PREFLIGHT
7.2	9.4	9.8	495	14	26	26.6	7	INFLIGHT
8.1	9.8	9.6	518	14	25	22.6	8	INFLIGHT
10.1	9.9	9.7	513	14	26	19.9	9	INFLIGHT
7.0	9.8	10.0	496	15	27	20.5	12	INFLIGHT
7.5	9.6	10.2	493	15	30	22.2	15	INFLIGHT
9.3	9.7	9.8	521	14	25	24.9	18	INFLIGHT
9.4	9.4	9.8	507	14	32	27.8	21	INFLIGHT
8.3	9.8	10.3	524	15	26	25.9	24	INFLIGHT
7.9	9.6	9.8	528	14	33	29.0	27	INFLIGHT
9.7	9.6	9.4	540	12	36	31.7	29	INFLIGHT
9.2	9.4	9.4	515	14	29	27.1	33	INFLIGHT
8.9	9.7	9.7	485	16	28	22.1	36	INFLIGHT
								INFLIGHT
								INFLIGHT
								INFLIGHT
								INFLIGHT
								INFLIGHT
								INFLIGHT
8.8	9.6	9.8	559	13	41	31.7	R1	POSTFLIGHT
9.2	9.6	9.6	534	12	36	27.7	R3	POSTFLIGHT
9.1	9.4	9.5	507	12	32	28.3	R5	POSTFLIGHT

Flight 84-day
Subject EG
Condition Awake
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
7.9	8.9	9.7	365	15	19	17.4	B1	PREFLIGHT
8.3	9.7	9.7	306	15	17	13.6	B2	
8.6	9.1	8.6	388	13	23	21.6	B3	
10.1	10.3	10.2	530	11	40	24.2	3	INFLIGHT
9.6	10.0	10.8	356	17	23	17.5	4	
7.9	9.6	10.5	392	16	23	19.3	10	
9.7	10.1	10.1	414	13	26	18.6	14	
10.4	9.9	9.9	385	16	21	14.8	19	
10.4	10.0	10.6	386	15	27	15.9	24	
8.5	9.8	9.3	398	14	24	16.7	29	
9.7	9.8	9.6	443	14	33	25.1	34	
9.1	9.5	9.6	410	15	26	15.3	40	
8.7	9.4	9.8	349	17	16	12.8	45	
9.3	9.6	10.0	464	15	24	17.5	50	
9.1	9.3	9.7	443	15	24	18.9	55	
10.4	9.7	10.8	308	18	15	12.5	60	
9.9	9.3	10.1	289	17	13	12.1	72	
9.3	9.9	9.7	430	14	24	15.6	77	
10.2	9.8	10.3	350	17	18	13.9	80	
9.7	10.1	10.2	410	14	28	16.9	81	
8.3	10.0	10.1	536	12	33	22.0	82	
10.2	9.7	10.8	440	15	23	15.1	R0	POSTFLIGHT
8.7	9.6	10.3	306	16	22	12.1	R1	
8.2	9.5	9.1	405	12	24	20.6	R5	

Table A7

Flight SMEAT

Subject WT

Condition Awake

Frequency Range Alpha

Table A8

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
7.9	9.3	9.1	397	16	19	13.8	DR	PREFLIGHT
8.5	9.3	9.1	556	11	37	39.0	B3	PREFLIGHT
								PREFLIGHT
7.6	9.3	9.4	353	12	21	15.3	3	INFLIGHT
8.9	9.3	9.5	475	11	28	20.7	4	INFLIGHT
9.3	9.5	9.4	521	11	37	22.2	8	INFLIGHT
8.2	9.4	9.3	531	10	45	19.2	11	INFLIGHT
8.8	9.3	9.2	491	13	31	18.9	14	INFLIGHT
9.4	9.6	9.8	489	11	40	17.8	17	INFLIGHT
6.8	9.7	9.6	480	14	32	16.3	20	INFLIGHT
8.8	9.7	9.6	526	12	38	18.8	23	INFLIGHT
9.5	9.3	9.4	454	14	26	16.1	26	INFLIGHT
9.2	9.4	9.2	389	14	26	18.1	29	INFLIGHT
8.4	9.5	9.4	480	11	40	20.9	32	INFLIGHT
9.3	9.3	9.4	518	10	36	20.3	38	INFLIGHT
9.5	9.3	9.5	503	11	42	22.3	41	INFLIGHT
9.1	9.3	9.3	527	12	36	19.4	52	INFLIGHT
10.4	9.2	9.1	484	13	36	16.9	53	INFLIGHT
8.1	9.5	9.3	486	14	26	15.7	54	INFLIGHT
								INFLIGHT
								INFLIGHT
8.5	9.3	9.1	522	10	44	25.0	P1	POSTFLIGHT
8.8	9.2	9.3	548	10	43	25.6	P3	POSTFLIGHT
8.5	9.2	8.8	510	12	30	24.3	P3	POSTFLIGHT

Flight 28-day

Subject JK

Condition Awake

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
4.1	4.9	5.0	115	24	6	8.2	1	PREFLIGHT
6.8	5.0	5.6	95	27	6	8.3	2	
5.5	4.9	5.2	82	29	5	7.2	3	
4.3	4.6	4.9	110	35	6	13.4	5	INFLIGHT
6.7	4.8	5.2	115	27	9	8.0	6	
4.3	4.7	4.7	105	25	9	10.4	31	POSTFLIGHT
6.7	5.0	5.0	119	25	10	8.9	34	
5.7	4.9	4.9	129	27	9	8.1	36	

Table A9

Table A10

Flight 59-day

Subject OG

Condition Awake

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
6.0	5.1	6.6	117	33	6	17.6	B1	PREFLIGHT
4.1	4.9	4.8	108	34	6	13.9	B2	
6.7	4.8	5.4	135	30	7	11.4	B3	
4.2	5.0	5.0	133	30	8	13.4	7	INFLIGHT
4.3	4.6	5.0	127	33	7	12.3	8	
3.7	4.8	6.5	134	33	6	11.3	9	
6.8	4.8	5.3	116	36	6	9.8	12	
6.3	4.8	5.0	116	31	8	14.6	15	
4.4	4.8	5.0	127	35	7	12.7	18	
5.5	4.9	5.0	128	38	6	13.8	21	
4.7	5.0	5.9	136	34	7	13.2	24	
4.4	5.0	5.1	124	32	8	15.5	27	
6.2	5.0	5.1	120	30	7	14.4	29	
6.8	4.9	4.7	116	31	7	14.7	33	
6.7	4.8	5.1	148	34	7	13.0	36	
6.6	4.8	5.6	133	32	6	13.7	R1	POSTFLIGHT
4.5	5.0	5.3	124	29	8	12.4	R3	
6.0	5.1	4.8	101	34	8	14.0	R5	

Table A11

Flight 84-day

Subject EG

Condition Awake

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
6.5	4.7	6.1	121	35	8	12.2	B1	PREFLIGHT
4.9	4.7	5.1	126	33	9	9.5	B2	
4.3	5.0	5.7	101	36	6	11.4	B3	
5.1	4.9	5.3	157	36	9	10.7	3	INFLIGHT
4.5	4.7	6.0	124	36	5	9.4	4	
3.8	4.8	5.3	141	36	6	10.9	10	
4.4	4.7	5.2	157	33	8	10.6	14	
5.9	4.6	5.5	148	40	6	9.7	19	
4.8	4.9	5.0	154	37	9	9.8	24	
4.5	4.7	4.6	136	37	6	10.9	29	
4.4	4.9	5.7	142	31	10	12.4	34	
4.8	4.9	5.7	52	36	6	10.3	40	
4.7	4.8	5.9	150	36	5	9.5	45	
3.8	4.8	5.0	142	33	9	10.0	50	
6.7	4.8	4.6	189	31	10	11.3	55	
5.5	4.9	5.6	123	39	7	9.4	60	
4.5	4.8	4.3	101	34	5	7.7	72	
5.6	4.6	3.9	143	37	6	8.8	77	
5.3	4.9	5.5	134	37	6	9.3	80	
4.7	4.9	5.2	153	32	8	9.1	81	
4.4	4.9	5.5	175	32	11	11.9	82	
4.0	4.6	4.4	137	36	6	8.9	R0	POSTFLIGHT
5.1	4.3	3.5	110	40	10	8.3	R1	
6.8	4.9	5.0	121	30	7	11.5	R5	

Flight SMEAT
Subject WT
Condition Awake
Frequency Range Theta

Table A12

Phase	Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day
PREFLIGHT	4.3	4.7	5.0	98	34	5	9.9	DR
	3.7	4.9	5.2	107	32	8	18.0	B3
INFLIGHT	4.3	4.6	4.7	99	30	6	10.6	3
	4.4	4.7	4.7	105	29	8	12.4	4
	3.6	4.7	5.1	144	32	11	10.9	8
	6.0	4.8	5.1	136	29	9	10.0	11
	3.9	4.7	5.1	122	31	7	10.3	14
	4.4	4.7	5.0	115	31	7	10.0	17
	4.7	4.6	5.4	136	37	6	10.3	20
	4.6	4.8	4.9	118	33	7	9.9	23
	6.3	4.6	4.3	106	34	6	10.2	26
	5.1	4.7	5.2	114	35	6	10.8	29
	3.6	4.7	5.1	126	33	8	11.9	32
	3.7	4.6	5.2	100	31	7	9.9	38
	4.5	4.8	5.2	109	29	12	10.3	41
	4.3	4.7	5.1	135	28	8	11.7	52
	4.5	4.9	5.5	118	31	8	9.8	53
	4.6	4.7	5.4	105	37	6	11.1	54
POSTFLIGHT	4.7	4.7	4.7	90	24	10	11.7	P1
	4.6	4.8	4.9	93	26	6	11.4	P2
	4.6	4.7	5.0	113	36	11	12.0	P3

Flight 28-day

Subject JK

Condition Awake

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.9	2.5	2.7	28	46	3	7.1	1	PREFLIGHT
0.8	1.8	2.2	53	25	4	7.7	2	
0.9	1.9	2.7	39	19	3	5.9	3	
1.1	1.8	1.2	56	48	3	28.1	5	INFLIGHT
1.6	1.9	3.1	58	56	3	6.9	6	
1.1	1.8	2.3	64	50	5	8.0	31	POSTFLIGHT
1.5	1.6	2.2	43	44	3	7.1	34	
0.8	1.9	3.3	37	16	2	6.9	36	

Table A13

Table A14

Flight 59-day

Subject OG

Condition Awake

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
1.1	1.8	3.5	89	32	5	14.1	B1	PREFLIGHT
0.9	1.8	1.9	63	56	4	15.7	B2	
0.9	1.9	2.6	74	29	5	11.9	B3	
1.2	1.9	3.2	85	62	6	12.4	7	INFLIGHT
1.1	1.9	1.6	92	29	9	12.9	8	
1.6	1.9	2.2	92	57	7	13.4	9	
1.6	1.8	3.8	84	22	4	10.2	12	
1.1	2.1	3.8	102	15	7	13.9	15	
0.9	1.9	3.4	99	37	7	12.5	18	
0.9	1.8	2.7	92	49	8	14.5	21	
2.6	1.9	2.1	88	40	8	11.9	24	
1.1	2.0	3.0	108	46	11	16.0	27	
0.9	2.0	3.2	94	35	7	12.5	29	
1.4	1.8	2.3	82	40	4	17.5	33	
1.2	2.0	1.4	66	37	4	15.0	36	
0.8	1.9	2.9	89	34	8	12.4	R1	POSTFLIGHT
0.8	2.1	2.1	103	13	8	10.9	R3	
1.0	2.1	2.9	92	29	6	12.4	R5	

Flight 84-day

Subject EG

Condition Awake

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
1.0	1.8	1.4	51	62	4	21.6	B1	PREFLIGHT
1.0	2.1	2.2	76	1	5	9.4	B2	
1.1	2.1	1.9	34	57	3	10.3	B3	
0.8	1.9	2.6	71	59	4	10.1	3	INFLIGHT
1.0	2.0	1.5	61	32	4	11.2	4	
0.9	1.9	2.0	69	62	5	13.0	10	
1.0	1.8	1.6	80	45	6	10.7	14	
1.5	1.9	1.3	57	62	4	14.2	19	
1.1	1.8	1.9	64	63	4	10.8	24	
1.1	1.8	2.8	61	61	4	17.3	29	
1.2	1.7	1.2	83	52	5	12.2	34	
1.1	1.9	3.1	84	62	6	9.7	40	
1.1	1.9	2.0	89	54	6	9.6	45	
0.8	2.1	2.2	83	34	5	9.9	50	
0.9	1.8	3.1	91	44	6	10.1	55	
1.2	1.9	2.5	65	50	5	12.0	60	
0.9	1.8	2.7	69	9	4	9.4	72	
0.8	2.0	3.3	78	62	5	8.9	77	
2.3	1.9	2.8	73	48	4	10.0	80	
1.1	1.9	1.5	83	43	6	9.2	81	
0.9	2.0	2.6	86	58	5	9.4	82	
1.5	1.9	1.7	31	54	3	13.7	R0	POSTFLIGHT
0.8	1.8	3.1	48	58	4	11.8	R1	
1.1	1.9	1.0	63	1	5	16.3	R5	

Table A15

Table A16

Flight SMEAT

Subject WT

Condition Awake

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp (μV)	Day	
2.2	2.1	3.4	50	10	3	16.6	DR	PREFLIGHT
1.0	1.9	2.4	76	55	4	28.0	B3	
1.4	1.8	1.2	49	38	4	24.0	3	INFLIGHT
0.9	1.8	1.7	54	34	7	22.8	4	
0.8	1.8	1.9	76	26	4	13.2	8	
0.8	1.7	2.2	73	4	4	11.4	11	
0.9	1.8	1.6	76	56	5	16.5	14	
2.2	1.8	1.3	66	1	3	17.4	17	
0.8	1.8	1.1	56	55	6	22.4	20	
1.0	1.7	1.5	51	16	3	16.6	23	
1.5	1.8	1.4	82	45	6	18.3	26	
1.0	1.8	2.7	74	41	4	21.7	29	
1.6	1.7	2.0	72	64	6	14.7	32	
1.2	1.7	1.4	60	39	4	19.1	38	
0.9	1.5	1.8	63	50	4	17.7	41	
0.9	1.8	1.4	74	63	5	17.2	52	
1.1	1.6	1.1	76	42	6	16.1	53	
1.0	1.6	1.1	80	54	6	21.1	54	
1.5	1.7	3.7	66	24	4	17.5	P1	POSTFLIGHT
1.5	1.7	1.6	70	43	6	11.7	P2	
1.1	1.8	2.2	86	59	6	12.9	P3	

Flight 28-day

Subject JK

Condition Stage REM

Frequency Range Beta

	Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day
PREFLIGHT	17.7	18.7	19.4	348	12	14	8.0	1
	17.6	18.9	20.4	420	12	15	8.4	2
	16.8	19.4	20.2	522	12	20	8.9	3
INFLIGHT	---	---	---	---	---	---	---	5
	18.5	17.5	15.2	245	10	10	8.6	6
POSTFLIGHT	18.7	18.4	21.5	243	11	14	7.8	31
	34.5	17.5	14.7	249	11	11	8.3	34
	15.6	18.7	15.6	265	11	12	8.2	36

Table A17

Flight 59-day
Subject OG
Condition Stage REM
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
14.6	19.4	14.4	489	13	17	11.7	B1	PREFLIGHT
14.9	18.7	15.1	386	12	16	12.3	B2	PREFLIGHT
16.5	18.5	14.6	362	13	13	11.3	B3	PREFLIGHT
14.6	18.2	15.5	365	11	18	13.0	7	INFLIGHT
14.0	18.9	15.9	349	13	13	11.4	8	INFLIGHT
14.4	18.5	14.8	409	12	17	11.9	9	INFLIGHT
17.3	19.6	23.2	453	13	16	10.5	12	INFLIGHT
19.2	19.6	15.9	468	12	15	11.3	15	INFLIGHT
15.5	18.9	14.0	339	12	13	10.8	18	INFLIGHT
13.8	19.1	17.4	449	12	16	12.3	21	INFLIGHT
16.0	18.7	21.0	337	12	13	12.8	24	INFLIGHT
16.0	19.4	19.1	444	12	15	12.6	27	INFLIGHT
14.2	19.6	21.3	521	13	15	13.4	29	INFLIGHT
15.3	18.7	20.2	280	12	12	11.5	33	INFLIGHT
15.3	18.0	16.0	358	11	15	12.2	36	INFLIGHT
16.3	18.1	14.0	461	12	15	13.8	R1	POSTFLIGHT
19.3	20.0	16.8	307	13	10	9.4	R3	POSTFLIGHT
15.8	19.4	24.5	381	12	14	11.8	R5	POSTFLIGHT

Table A18

Table A19

Flight 84-day

Subject EG

Condition Stage REM

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
14.6	18.9	18.2	220	12	9	8.0	B1	PREFLIGHT
23.5	19.1	14.4	226	13	10	8.0	B2	
18.7	19.1	15.1	148	14	8	7.3	B3	
16.8	19.1	15.5	496	13	19	11.4	3	INFLIGHT
21.7	19.6	20.0	553	13	17	11.1	4	
14.4	20.2	18.4	574	12	24	12.6	10	
13.9	19.2	23.3	405	12	13	10.7	14	
14.2	19.8	20.2	457	13	17	11.1	19	
17.7	20.2	20.6	548	13	18	11.7	24	
27.0	20.0	17.2	570	13	19	12.0	29	
16.8	20.2	15.5	450	13	15	12.5	34	
17.2	19.6	18.9	504	13	18	11.0	40	
17.9	19.6	18.5	562	13	19	11.4	45	
16.4	19.2	17.9	445	12	14	11.5	50	
16.7	19.6	14.3	442	12	16	10.8	55	
15.3	20.2	19.1	528	13	17	13.3	60	
15.6	17.9	14.3	309	12	16	10.9	72	
15.2	19.6	16.7	537	13	18	10.8	77	
25.9	20.2	30.6	520	12	14	10.9	80	
17.5	20.0	22.7	461	12	15	12.1	81	
18.9	19.2	16.7	442	12	15	11.2	82	
17.2	19.6	25.8	455	13	14	10.0	R0	POSTFLIGHT
24.9	18.3	21.1	294	12	13	9.3	R1	
24.0	19.1	20.2	307	12	12	9.4	R5	

Flight SMEAT

Subject WT

Condition Stage REM

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
14.9	18.4	19.4	288	11	12	8.5	DR	PREFLIGHT
16.2	18.7	19.8	524	11	16	16.2	B3	
13.7	17.9	14.9	272	12	14	10.9	3	INFLIGHT
15.2	18.5	16.1	323	12	12	9.5	4	
14.8	18.3	20.6	373	12	13	10.1	8	
19.8	18.0	15.7	276	12	11	8.8	11	
17.7	18.0	17.1	251	12	10	10.2	14	
14.3	18.2	14.9	273	12	12	8.9	17	
15.5	18.3	14.1	281	13	11	9.6	20	
14.7	18.5	14.1	245	12	11	9.0	23	
18.2	17.5	15.4	261	12	12	8.5	26	
14.9	17.5	14.5	270	12	11	10.3	29	
14.1	18.0	13.8	282	12	12	8.9	32	
15.2	17.9	14.9	193	11	10	8.3	38	
16.5	18.3	17.7	313	12	13	10.0	41	
17.2	18.5	13.9	266	12	13	9.2	52	
22.4	18.4	17.4	273	13	13	9.2	53	
14.1	18.2	18.2	255	12	9	8.9	54	
22.7	18.2	19.2	213	11	10	8.1	P1	POSTFLIGHT
16.7	18.5	18.9	209	12	11	7.7	P2	
13.7	17.9	16.4	162	10	10	8.6	P3	

Table A20

Flight 28-day Condition Stage REM

Subject JK Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
6.9	8.7	8.9	165	19	8	8.6	1	PREFLIGHT
9.0	9.4	10.4	231	20	9	9.4	2	
8.0	9.0	7.5	190	20	8	9.0	3	
---	---	---	---	---	---	---	5	INFLIGHT
8.5	9.1	9.2	196	20	8	9.0	6	
11.2	8.8	9.8	159	20	9	8.9	31	POSTFLIGHT
9.2	8.8	9.3	200	19	10	9.5	34	
9.1	9.0	9.0	208	19	8	9.5	36	

Table A21

Flight 59-day
Subject OG

Condition Stage REM
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
11.1	9.5	11.2	300	20	15	13.9	B1	PREFLIGHT
10.6	9.1	8.6	339	19	19	17.0	B2	
8.4	9.3	10.6	308	20	13	13.7	B3	
8.3	9.6	11.0	358	20	16	17.4	7	INFLIGHT
8.6	9.4	10.1	352	19	14	15.7	8	
9.5	9.6	9.8	296	20	12	14.9	9	
7.3	9.2	8.6	259	21	9	13.3	12	
8.0	9.4	12.4	247	21	10	13.4	15	
9.1	9.5	9.9	285	19	12	13.6	18	
8.0	9.3	9.4	292	20	13	15.1	21	
8.5	9.4	9.4	372	19	15	17.2	24	
7.8	9.2	8.9	298	19	12	16.6	27	
9.7	9.5	11.2	346	20	16	17.1	29	
7.8	9.3	8.7	308	19	12	15.6	33	
8.1	9.1	10.5	335	19	14	18.0	36	
6.6	9.2	11.0	357	20	14	15.9	R1	POSTFLIGHT
10.2	9.5	9.4	271	19	15	13.0	R3	
9.6	9.6	11.4	325	19	12	14.9	R5	

Table A22

Flight 84-day

Subject EG

Condition Stage REM

Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
8.0	8.6	7.4	187	19	8	10.6	B1	PREFLIGHT
7.2	8.7	9.0	214	18	11	11.8	B2	
8.5	8.9	7.6	205	18	10	10.2	B3	
9.4	9.2	9.4	260	21	10	11.9	3	INFLIGHT
7.2	8.8	10.8	215	21	8	12.2	4	
7.9	8.9	9.8	284	20	11	13.7	10	
8.9	8.8	9.1	281	19	10	13.7	14	
7.3	8.9	10.2	254	19	10	12.8	19	
8.5	9.1	10.2	283	19	14	13.0	24	
7.2	8.8	8.1	270	20	9	12.9	29	
6.9	9.0	8.0	306	19	10	15.1	34	
7.4	8.8	9.3	238	20	9	10.9	40	
9.3	8.8	8.1	246	21	10	11.2	45	
7.7	8.8	11.8	258	20	10	13.2	50	
8.6	8.8	8.5	279	19	11	12.8	55	
8.9	9.1	9.0	297	20	11	13.7	60	
7.5	9.3	12.7	270	21	10	13.0	72	
7.4	8.8	7.6	220	21	9	10.3	77	
9.0	8.9	9.4	265	21	12	11.5	80	
7.9	8.9	9.7	319	19	11	15.0	81	
7.6	8.9	9.7	288	20	13	14.7	82	
12.1	8.5	10.0	167	20	7	8.9	R0	POSTFLIGHT
9.2	8.6	8.9	158	18	7	8.7	R1	
7.5	8.6	9.8	224	19	9	11.1	R5	

Table A23

Table A24

Flight SMEAT
Subject WT
Condition Stage REM
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
8.7	9.1	10.2	174	20	11	9.2	DR	PREFLIGHT
7.0	8.9	9.6	310	20	11	18.0	B3	
7.5	8.7	7.9	163	19	7	14.2	3	INFLIGHT
7.7	8.9	10.2	226	19	9	11.1	4	
7.3	8.8	11.0	210	20	8	11.7	8	
8.8	8.8	9.3	178	19	8	10.7	11	
7.6	8.4	7.2	225	19	10	13.5	14	
8.1	8.8	8.5	203	19	9	10.3	17	
8.2	8.6	8.8	253	19	11	12.1	20	
7.5	8.7	8.5	241	19	11	11.5	23	
8.3	8.6	10.2	190	18	9	11.4	26	
6.7	8.6	8.8	250	19	11	13.4	29	
8.0	8.8	8.8	167	20	7	12.2	32	
6.9	8.5	8.8	219	20	9	11.3	38	
7.7	8.8	8.4	222	21	8	11.2	41	
9.5	8.5	7.8	205	20	8	11.1	52	
7.4	8.8	9.4	229	18	8	12.2	53	
7.6	8.7	8.8	224	20	10	10.3	54	
8.4	8.6	8.3	179	20	8	9.8	P1	POSTFLIGHT
10.7	8.6	9.1	146	19	7	9.0	P2	
6.9	8.4	7.3	223	19	12	12.0	P3	

Flight 28-day
Subject JK
Condition Stage REM
Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
5.0	4.8	5.2	112	32	5	8.3	1	PREFLIGHT
4.1	4.7	4.3	110	36	6	8.7	2	PREFLIGHT
5.0	4.8	4.3	133	38	7	8.3	3	PREFLIGHT
---	---	---	---	---	---	---	5	INFLIGHT
4.5	4.7	5.6	124	36	7	10.2	6	INFLIGHT
5.8	4.7	4.6	118	37	6	9.8	31	POSTFLIGHT
5.5	4.7	4.1	131	35	7	9.2	34	POSTFLIGHT
5.5	4.9	5.4	143	38	8	9.1	36	POSTFLIGHT

Table A25

Flight 59-day
Subject OG
Condition Stage REM
Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
5.0	4.7	6.4	164	38	6	14.1	B1	PREFLIGHT
3.8	4.8	6.6	177	38	8	15.4	B2	
6.5	4.9	6.4	147	39	7	13.6	B3	
4.5	5.0	5.7	187	36	8	14.8	7	INFLIGHT
4.3	4.8	4.8	157	38	8	14.1	8	
4.7	4.7	4.6	158	36	7	14.9	9	
6.3	4.9	5.7	163	38	7	13.1	12	
5.1	4.7	5.5	147	38	6	15.4	15	
4.1	4.8	6.1	148	37	7	13.1	18	
4.8	4.9	5.2	156	37	11	15.6	21	
4.1	4.7	6.0	153	38	8	15.6	24	
5.7	4.8	5.1	172	37	8	15.9	27	
3.8	4.8	5.5	162	37	7	16.2	29	
3.8	4.9	6.1	158	35	7	14.5	33	
3.8	4.8	6.4	174	38	8	16.2	36	
3.6	4.7	5.4	159	34	8	12.7	R1	POSTFLIGHT
4.7	5.0	5.3	161	38	7	13.1	R3	
3.8	4.9	6.3	163	38	7	14.2	R5	

Table A26

Flight 84-day
Subject EG
Condition Stage REM
Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp (μV)	Day	
3.6	4.8	4.0	136	41	8	11.8	B1	PREFLIGHT
4.2	4.9	5.4	163	37	9	12.6	B2	
4.4	4.9	6.6	177	40	7	11.0	B3	
5.0	4.9	6.1	142	36	7	12.5	3	INFLIGHT
4.3	4.8	4.5	150	37	8	14.3	4	
4.0	4.9	5.3	188	38	8	14.5	10	
4.5	4.8	5.5	182	39	7	14.4	14	
3.9	4.8	5.7	170	37	7	14.4	19	
5.0	4.9	5.3	159	35	11	12.9	24	
5.5	4.8	5.2	177	38	7	13.7	29	
3.7	4.8	6.5	188	38	8	17.0	34	
5.9	4.7	5.7	145	38	7	12.2	40	
4.4	4.7	5.7	173	39	9	11.6	45	
3.9	4.9	6.7	185	38	9	14.2	50	
5.4	4.7	6.0	169	36	7	13.5	55	
6.5	4.9	5.9	167	38	7	13.0	60	
3.6	4.7	6.6	146	41	7	14.6	72	
4.7	4.6	3.7	140	37	6	11.6	77	
5.3	4.8	4.8	164	34	6	11.9	80	
4.0	4.9	5.5	176	36	8	13.6	81	
4.7	4.8	6.1	195	36	7	15.1	82	
5.6	4.6	4.2	113	37	7	8.4	R0	POSTFLIGHT
4.9	4.5	4.3	96	37	4	8.7	R1	
4.9	4.7	4.3	161	39	8	11.5	R5	

Table A27

Flight SMEAT

Subject WT

Condition Stage REM

Frequency Range Theta

Table A28

	Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day
PREFLIGHT	5.3	4.7	5.3	120	40	7	10.3	DR
	4.7	4.6	6.6	150	37	5	18.0	B3
INFLIGHT	4.8	4.6	6.3	103	41	5	16.5	3
	4.1	4.8	6.1	136	35	6	12.7	4
	5.2	4.6	5.0	128	38	5	14.6	8
	4.7	4.6	4.8	128	37	5	13.0	11
	4.9	4.7	5.9	131	39	5	13.8	14
	4.0	4.6	4.0	135	37	6	11.8	17
	6.6	4.7	5.6	146	36	7	13.3	20
	3.9	4.7	5.7	141	38	5	13.7	23
	4.3	4.7	6.5	146	39	5	12.2	26
	5.9	4.8	6.3	146	40	7	14.3	29
	4.1	4.7	5.9	131	38	5	14.7	32
	5.6	4.7	5.0	138	38	5	11.9	38
	6.0	4.7	4.8	108	37	6	11.4	41
	4.3	4.7	6.3	120	38	5	13.0	52
	4.9	4.7	6.6	148	38	6	13.2	53
	4.5	4.7	5.5	117	38	7	12.9	54
POSTFLIGHT	4.6	4.9	5.8	122	39	5	10.7	P1
	4.8	4.6	5.0	114	37	5	10.4	P2
	---	---	---	---	---	---	---	P3

Flight 28-day
Subject JK

Condition Stage REM
Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
1.0	1.8	2.5	94	36	5	8.9	1	PREFLIGHT
1.3	1.9	3.8	75	13	5	9.3	2	
1.0	1.9	2.5	84	64	7	9.5	3	
---	---	---	---	---	---	---	5	INFLIGHT
1.0	1.9	2.5	91	50	6	12.8	6	
0.9	2.1	1.5	82	1	5	11.3	31	POSTFLIGHT
1.7	2.0	3.3	67	34	4	9.2	34	
1.4	1.9	2.9	84	53	5	9.4	36	

Table A29

Flight 59-day

Subject 06

Condition Stage REM

Frequency Range Delta

Period	Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day
PREFLIGHT	1.0	2.0	2.3	101	58	7	19.8	B1
	1.0	2.0	3.2	108	16	7	17.7	B2
	0.8	2.0	2.1	100	61	7	16.1	B3
INFLIGHT	1.2	2.0	3.2	105	64	6	16.8	7
	1.0	1.9	3.4	96	35	6	15.9	8
	1.1	2.0	3.6	104	54	8	16.7	9
	1.5	2.0	2.5	96	29	8	15.5	12
	1.4	2.1	2.9	111	63	7	19.4	15
	1.1	2.1	3.6	104	17	8	14.4	18
	1.3	1.9	3.0	106	53	9	19.2	21
	1.4	2.2	3.3	98	62	6	16.5	24
	0.8	2.0	2.4	107	54	7	17.0	27
	2.1	1.9	2.3	88	54	6	20.1	29
	1.1	2.0	2.6	95	23	8	15.9	33
	9.0	2.0	2.0	98	44	10	19.5	36
POSTFLIGHT	1.1	1.9	2.6	97	49	6	14.0	R1
	1.1	2.0	2.1	108	63	6	14.0	R3
	2.4	1.9	2.8	90	34	6	17.0	R5

Table A30

Flight 84-day
Subject EG
Condition Stage REM
Frequency Range Delta

Table A31

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.9	2.1	3.8	98	14	9	12.6	B1	PREFLIGHT
1.1	1.9	2.3	84	61	5	16.3	B2	
1.0	2.1	3.1	77	1	5	13.8	B3	
1.3	1.9	3.2	80	35	7	15.5	3	INFLIGHT
1.1	2.0	3.3	104	43	9	16.6	4	
0.8	2.0	3.5	78	1	4	19.3	10	
1.1	1.7	2.5	86	27	6	18.0	14	
0.9	2.1	2.0	82	52	5	16.9	19	
1.0	2.0	3.3	93	42	8	13.7	24	
1.1	2.0	2.8	92	26	6	16.7	29	
1.1	2.0	2.4	107	20	6	19.0	34	
1.2	1.8	2.6	94	57	8	14.7	40	
0.8	1.9	3.7	80	55	5	13.8	45	
1.0	1.9	3.7	94	63	7	16.1	50	
1.5	1.9	2.2	85	56	7	16.0	55	
1.0	2.0	2.5	78	56	7	14.7	60	
0.8	1.9	2.0	80	49	9	23.2	72	
1.1	2.1	3.7	85	60	7	13.8	77	
0.9	2.0	2.0	85	45	8	13.6	80	
0.8	1.9	3.0	85	54	6	15.7	81	
1.0	1.9	2.4	84	15	8	16.7	82	
0.8	2.0	2.3	74	29	4	9.7	R0	POSTFLIGHT
1.1	1.8	2.7	56	42	4	12.1	R1	
0.9	1.9	1.3	91	12	6	13.3	R5	

Table A32

Flight SMEAT

Subject WT

Condition Stage REM

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.8	2.1	3.8	75	1	6	14.7	DR	PREFLIGHT
1.0	1.9	1.8	83	22	6	30.7	B3	
1.0	2.1	2.2	66	19	6	32.5	3	INFLIGHT
0.9	2.0	3.5	82	41	6	18.2	4	
1.1	1.8	2.7	68	62	3	27.3	8	
0.8	2.0	3.7	84	53	5	19.3	11	
0.9	1.9	2.9	70	64	4	20.9	14	
1.1	2.1	2.6	78	48	5	17.6	17	
0.8	1.9	3.3	75	17	4	22.8	20	
1.3	1.9	1.8	90	35	7	18.2	23	
1.4	1.8	2.7	76	26	5	18.7	26	
1.2	2.0	3.1	79	30	5	18.6	29	
0.8	2.5	0.9	65	60	6	36.9	32	
1.5	1.9	3.0	80	52	5	20.0	38	
1.0	1.9	2.5	66	27	4	17.6	41	
1.1	2.0	2.6	96	22	8	20.1	52	
1.1	2.1	2.3	83	55	5	19.4	53	
1.2	1.9	3.7	85	36	7	18.7	54	
0.8	1.8	2.6	72	14	4	17.5	P1	POSTFLIGHT
2.6	1.7	2.4	76	49	7	14.2	P2	
0.9	2.0	3.3	77	55	5	23.4	P3	

Table A33

Flight 28-day
Subject JK
Condition Stage 2
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
13.8	17.1	16.6	221	10	12	8.7	1	PREFLIGHT
16.1	17.9	14.9	403	11	19	9.6	2	
13.9	16.9	14.3	223	12	16	9.0	3	
---	---	---	---	---	---	---	5	INFLIGHT
14.3	16.9	14.3	217	10	13	8.9	6	
14.2	17.6	15.9	281	11	15	9.1	31	POSTFLIGHT
17.5	17.2	13.9	289	11	15	9.7	34	
13.8	17.1	16.3	186	11	10	8.8	36	

Flight 59-day
Subject 06

Condition Stage 2
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
16.0	17.7	15.3	275	12	13	13.0	B1	PREFLIGHT
14.2	18.0	15.3	342	12	17	13.0	B2	
14.0	18.2	19.2	224	11	9	12.6	B3	
17.9	18.5	14.2	320	12	12	12.5	7	INFLIGHT
19.1	18.0	20.2	180	12	11	11.1	8	
14.0	17.7	13.8	351	12	17	12.2	9	
14.6	18.2	17.3	288	12	15	11.7	12	
14.2	18.5	14.6	306	12	12	13.1	15	
14.6	18.5	17.3	235	13	10	10.5	18	
14.6	18.2	14.6	331	12	14	12.5	21	
17.1	18.7	15.5	511	12	20	14.3	24	
16.0	18.4	16.3	469	12	18	14.5	27	
13.8	18.4	17.7	445	12	17	14.6	29	
18.0	18.4	22.0	431	12	17	13.6	33	
15.1	17.4	15.5	286	12	12	13.3	36	
17.5	16.9	13.6	354	12	19	12.8	R1	POSTFLIGHT
15.9	17.6	14.2	294	11	16	12.4	R3	
14.0	17.7	15.3	314	12	14	14.7	R5	

Table A34

Table A35

Flight 84-day

Subject EG

Condition Stage 2

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
20.8	16.7	13.7	122	11	11	8.3	B1	PREFLIGHT
14.6	17.3	16.2	190	11	10	8.8	B2	
13.8	17.1	14.4	164	10	13	8.6	B3	
15.5	18.4	17.1	460	12	16	12.1	3	INFLIGHT
13.7	18.2	19.2	365	12	12	11.0	4	
14.1	18.2	20.0	334	12	13	11.5	10	
15.2	18.2	17.9	370	12	14	10.2	14	
14.3	17.9	14.5	416	11	15	12.2	19	
17.7	18.0	14.0	277	12	15	10.5	24	
14.9	19.1	15.8	480	12	16	11.1	29	
13.7	17.5	16.1	339	11	16	12.0	34	
17.5	18.2	14.1	337	12	15	11.8	40	
15.2	18.2	13.9	387	12	15	11.2	45	
13.9	17.5	14.5	366	11	16	12.6	50	
14.3	17.5	14.1	371	12	22	11.9	55	
14.5	17.9	15.4	431	12	17	13.1	60	
14.3	17.9	14.5	454	12	21	11.8	72	
14.9	17.2	14.1	388	11	18	12.3	77	
14.7	17.2	13.7	327	18	18	12.1	80	
15.1	18.0	14.9	285	12	13	11.5	81	
18.9	17.9	14.7	311	12	13	9.9	82	
14.1	17.0	14.3	343	12	14	11.2	R0	POSTFLIGHT
14.7	16.2	13.9	209	10	13	9.8	R1	
13.8	17.1	14.4	166	10	10	9.8	R5	

Flight SMEAT
Subject WT
Condition Stage 2
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
20.6	17.8	15.4	238	10	11	9.8	DR	PREFLIGHT
13.9	17.7	13.8	332	12	14	19.2	B3	
14.5	17.5	15.2	263	12	14	10.7	3	INFLIGHT
14.3	18.0	19.8	323	12	11	10.5	4	
14.6	17.1	14.8	245	11	12	11.1	8	
13.9	17.1	13.6	230	12	18	10.3	11	
16.2	16.8	14.3	283	10	16	10.9	14	
14.1	16.5	14.3	272	11	18	11.5	17	
22.0	18.3	16.2	359	12	16	10.1	20	
13.6	17.1	15.2	245	11	13	10.2	23	
14.1	16.8	14.6	194	11	13	11.5	26	
17.1	18.0	15.7	193	12	8	9.8	29	
15.7	17.4	13.9	280	12	12	10.0	32	
15.2	17.1	13.8	268	12	16	10.5	38	
16.2	17.4	15.2	258	12	15	10.5	41	
17.1	16.5	16.5	229	9	14	12.0	52	
13.8	16.8	15.5	241	11	11	11.1	53	
14.1	16.4	14.5	205	10	12	13.0	54	
13.9	16.4	14.7	195	9	13	12.3	P1	POSTFLIGHT
13.9	16.7	14.3	180	9	12	10.4	P2	
15.2	16.8	15.7	239	11	12	9.7	P3	

Table A36

Flight 28-day

Subject JK

Condition Stage 2

Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (µV)	Day	
10.5	9.5	10.6	237	18	15	9.7	1	PREFLIGHT
10.8	9.2	10.5	195	22	9	9.6	2	
8.1	9.4	11.2	286	21	12	11.9	3	
---	---	---	---	---	---	---	5	INFLIGHT
8.9	9.5	11.0	244	21	11	11.5	6	
9.5	9.3	11.7	253	21	8	11.2	31	POSTFLIGHT
12.3	9.5	11.0	232	21	10	10.8	34	
8.5	9.6	11.2	292	20	12	10.6	36	

Table A37

Flight 59-day

Subject OG

Condition Stage 2

Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
9.7	9.3	8.3	330	20	11	19.6	B1	PREFLIGHT
8.9	9.4	12.8	300	21	11	17.4	B2	
7.6	9.5	10.1	393	20	17	21.6	B3	
10.9	9.4	12.4	342	22	11	18.0	7	INFLIGHT
8.1	8.9	10.0	300	19	10	18.7	8	
9.0	9.5	12.5	305	21	10	18.4	9	
7.0	9.3	8.6	306	19	13	16.9	12	
8.1	9.4	10.7	320	21	14	18.0	15	
8.8	9.1	8.6	308	20	13	17.8	18	
7.0	9.3	9.5	318	21	13	19.4	21	
9.7	9.2	8.2	267	21	10	16.1	24	
9.0	9.2	10.0	323	20	11	17.7	27	
7.0	9.4	11.6	278	20	11	19.1	29	
10.3	9.2	12.0	275	22	11	16.0	33	
8.9	9.3	7.9	296	21	11	19.0	36	
11.0	9.2	10.0	342	21	14	16.9	R1	POSTFLIGHT
8.0	9.3	10.4	282	20	12	16.5	R3	
7.6	9.0	10.7	358	21	13	19.9	R5	

Table A38

Flight 84-day
Subject EG
Condition Stage 2
Frequency Range Alpha

Freq. w/th L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
8.8	9.1	9.7	214	21	10	11.6	B1	PREFLIGHT
8.9	9.0	10.6	150	21	7	12.1	B2	
7.8	8.9	9.2	182	20	9	11.9	B3	
9.0	9.1	11.7	231	22	8	14.0	3	INFLIGHT
6.8	9.2	9.1	227	22	9	13.7	4	
8.9	9.1	10.5	244	21	9	14.7	10	
8.8	9.0	11.1	225	21	8	12.8	14	
7.6	8.8	10.6	235	21	7	16.4	19	
10.6	9.4	9.8	273	21	11	14.5	24	
9.3	9.2	8.9	243	21	11	13.2	29	
6.7	9.1	8.8	241	23	8	17.3	34	
8.1	9.3	11.2	290	21	10	15.7	40	
7.5	8.8	11.6	217	21	8	13.8	45	
8.6	9.5	13.2	269	22	10	15.8	50	
8.4	9.3	8.5	269	22	10	15.9	55	
7.5	9.2	12.3	247	22	10	15.2	60	
7.1	8.9	9.9	201	23	9	11.6	72	
6.8	9.5	11.9	243	23	11	14.1	77	
7.4	9.1	10.8	253	20	9	16.5	80	
8.1	9.2	12.3	237	21	8	17.1	81	
11.1	8.9	10.6	210	22	9	12.2	82	
8.9	9.0	11.4	248	22	9	13.2	R0	POSTFLIGHT
6.6	9.0	9.9	185	21	10	12.2	R1	
8.2	9.2	10.9	227	21	10	13.4	R5	

Table A39

Table A40

Flight SMEAT

Subject WT

Condition Stage 2

Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
7.9	9.4	11.0	220	20	9	12.0	DR	PREFLIGHT
9.1	9.3	10.3	219	21	10	22.5	B3	
7.4	9.3	12.3	210	21	8	14.1	3	INFLIGHT
8.7	9.3	9.2	183	20	8	12.6	4	
8.3	9.0	10.6	221	20	11	14.8	8	
11.5	9.1	10.5	237	19	13	13.6	11	
8.0	8.8	7.4	187	23	8	13.0	14	
9.5	8.8	11.1	177	22	8	15.4	17	
7.3	8.9	10.3	179	21	8	12.0	20	
6.9	8.8	11.0	191	21	8	12.5	23	
9.0	9.0	12.5	203	22	7	15.2	26	
9.2	8.6	8.5	146	20	6	11.8	29	
7.4	8.5	7.6	160	22	7	12.4	32	
9.9	9.0	11.1	194	22	9	15.5	38	
9.0	9.0	8.8	199	20	10	14.3	41	
7.5	9.2	10.5	198	21	7	19.0	52	
7.9	8.8	8.3	199	21	8	14.5	53	
6.8	9.3	11.1	230	22	10	18.9	54	
8.8	9.0	11.6	168	21	7	13.1	P1	POSTFLIGHT
6.8	9.3	10.2	220	21	8	13.9	P2	
11.8	8.6	6.8	176	22	8	11.8	P3	

Flight 28-day

Subject JK

Condition Stage 2

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	*No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
3.6	4.6	4.6	84	37	5	8.8	1	PREFLIGHT
4.7	4.6	5.5	113	37	4	9.4	2	
5.8	4.5	4.9	130	37	7	10.9	3	
---	---	---	---	---	---	---	5	INFLIGHT
5.6	4.7	5.3	161	38	6	12.3	6	
4.8	4.9	5.1	126	37	8	10.8	31	POSTFLIGHT
4.3	4.8	5.9	147	37	6	9.5	34	
4.5	4.7	5.6	111	39	6	9.2	36	

Table A41

Flight 59-day
Subject OG
Condition Stage 2
Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
4.2	4.8	5.8	166	39	8	18.3	B1	PREFLIGHT
4.2	4.8	4.9	175	36	7	17.0	B2	
3.9	4.9	5.9	176	38	8	17.1	B3	
3.7	4.8	4.7	163	40	7	18.2	7	INFLIGHT
3.7	4.8	5.3	137	38	6	18.2	8	
4.8	4.8	5.7	144	38	6	17.9	9	
3.7	4.9	6.8	142	40	8	16.9	12	
5.9	4.8	5.9	143	38	8	17.6	15	
3.6	4.9	5.7	155	36	7	17.9	18	
3.6	4.7	6.8	169	41	7	20.6	21	
5.6	4.8	4.9	135	37	6	15.9	24	
3.7	4.6	4.9	135	36	6	18.4	27	
3.9	4.9	5.7	158	39	6	19.7	29	
4.7	4.7	6.4	152	40	6	16.9	33	
5.3	4.7	6.6	158	39	8	19.9	36	
3.7	4.4	4.3	124	38	6	16.6	R1	POSTFLIGHT
3.9	4.7	4.4	145	36	6	19.7	R3	
3.9	5.0	6.5	173	39	9	18.6	R5	

Table A42

Flight 84-day

Subject EG

Condition Stage 2

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
3.8	4.8	5.7	154	36	6	14.1	B1	PREFLIGHT
3.8	4.8	5.3	146	36	7	17.8	B2	
4.0	4.6	5.0	163	39	6	15.8	B3	
4.0	4.6	4.1	144	38	7	17.1	3	INFLIGHT
4.0	4.6	5.3	151	39	6	17.2	4	
4.4	4.6	6.1	136	38	7	16.7	10	
5.1	4.[illegible]	4.9	153	39	7	15.7	14	
5.3	4.8	5.5	177	38	8	21.2	19	
4.4	4.5	4.1	128	39	5	17.6	24	
4.2	4.7	5.8	139	35	6	16.6	29	
5.0	4.8	5.7	176	38	6	22.8	34	
3.9	4.7	4.7	165	39	8	17.8	40	
3.8	4.6	4.6	162	38	9	18.8	45	
4.4	4.7	4.3	184	38	8	18.0	50	
4.4	4.7	4.0	147	38	6	19.3	55	
5.5	4.6	6.3	170	39	8	19.0	60	
4.0	4.6	5.6	146	37	7	16.3	72	
3.8	4.6	4.0	157	36	8	13.8	77	
5.0	4.8	5.9	167	35	7	18.0	80	
4.7	4.9	5.5	172	37	9	20.4	81	
4.1	4.7	6.3	135	37	5	16.8	82	
4.8	4.5	3.8	161	37	7	16.7	R0	POSTFLIGHT
3.8	4.6	5.4	112	38	5	13.3	R1	
6.5	4.7	5.5	159	36	11	16.8	R5	

Table A43

Flight SMEAT
Subject WT
Condition Stage 2
Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
6.4	4.7	5.0	140	35	10	13.3	DR	PREFLIGHT
4.3	4.7	5.3	152	39	8	20.8	B3	PREFLIGHT
								PREFLIGHT
3.9	4.7	4.6	124	35	6	17.0	3	INFLIGHT
3.6	4.6	5.2	116	37	5	17.6	4	INFLIGHT
4.7	4.6	5.4	130	35	5	18.0	8	INFLIGHT
4.6	4.6	5.1	130	35	6	14.8	11	INFLIGHT
4.8	4.7	4.6	141	35	6	16.5	14	INFLIGHT
4.3	4.6	6.0	151	40	7	17.6	17	INFLIGHT
4.5	4.6	4.5	115	36	6	18.7	20	INFLIGHT
4.3	4.5	4.8	133	38	6	14.8	23	INFLIGHT
3.6	4.6	4.3	140	37	7	20.3	26	INFLIGHT
4.8	4.5	4.2	90	35	5	14.5	29	INFLIGHT
3.6	4.5	4.3	115	39	6	18.7	32	INFLIGHT
4.0	4.7	6.4	150	39	7	18.2	38	INFLIGHT
4.0	4.6	4.8	148	36	7	17.0	41	INFLIGHT
3.9	4.7	5.3	169	37	9	21.7	52	INFLIGHT
4.7	4.6	6.4	138	41	7	19.2	53	INFLIGHT
5.6	4.7	4.9	158	36	7	22.9	54	INFLIGHT
								INFLIGHT
								INFLIGHT
3.9	4.6	4.8	121	35	6	15.8	P1	POSTFLIGHT
5.0	4.6	3.9	130	37	6	15.6	P2	POSTFLIGHT
3.9	4.6	4.3	137	39	7	15.3	P3	POSTFLIGHT

Table A44

Flight 28-day
Subject JK
Condition Stage 2
Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.8	1.9	2.3	70	1	5	12.3	1	PREFLIGHT
0.8	1.7	1.0	25	46	3	16.0	2	
1.5	1.8	2.4	95	43	6	14.1	3	
---	---	---	---	---	---	---	5	INFLIGHT
0.9	1.8	3.0	97	37	6	16.9	6	
1.2	2.0	3.4	80	14	4	12.7	31	POSTFLIGHT
1.1	1.9	2.2	78	59	5	11.9	34	
1.0	1.9	2.4	76	1	4	13.0	36	

Table A45

Flight 59-day

Subject OG

Condition Stage 2

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modul Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
1.1	2.0	2.6	96	23	6	24.9	B1	PREFLIGHT
1.9	2.1	2.8	96	51	10	20.9	B2	
1.0	2.2	3.0	103	61	8	23.9	B3	
1.3	1.9	2.7	105	49	9	28.3	7	INFLIGHT
1.0	2.0	3.8	86	48	5	30.2	8	
1.7	1.9	3.5	103	30	7	24.7	9	
0.8	1.9	1.9	97	47	6	25.4	12	
1.5	2.0	2.2	100	49	8	24.9	15	
0.8	1.9	2.1	97	61	6	23.8	18	
1.2	2.1	2.6	107	50	7	25.5	21	
1.0	1.9	3.5	98	54	6	24.9	24	
2.0	2.1	2.8	112	54	9	26.3	27	
1.3	2.1	2.8	103	12	8	26.0	29	
0.9	2.0	2.7	94	45	8	27.1	33	
1.1	2.0	3.3	97	30	7	29.1	36	
1.2	2.0	3.1	109	35	7	22.8	R1	POSTFLIGHT
0.9	2.2	2.3	109	53	8	26.6	R3	
1.3	2.2	2.8	103	63	6	23.3	R5	

Table A46

Flight 84-day Condition Stage 2

Subject EG Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.9	1.7	1.4	83	46	5	23.0	B1	PREFLIGHT
1.3	2.1	3.8	110	58	8	24.5	B2	
1.2	2.0	2.0	99	58	7	18.9	B3	
1.0	1.9	2.7	105	51	9	22.4	3	INFLIGHT
1.1	2.0	3.1	102	60	7	22.8	4	
1.0	1.9	3.7	103	61	7	23.5	10	
1.2	1.9	1.6	102	62	7	23.4	14	
1.7	2.1	3.7	114	43	11	24.0	19	
1.4	2.0	3.8	100	20	7	25.5	24	
0.8	2.2	2.8	111	63	10	21.4	29	
1.2	2.1	2.8	115	49	10	26.5	34	
1.2	1.9	1.9	103	63	7	24.4	40	
1.1	1.9	2.7	110	21	10	21.4	45	
1.5	1.9	2.8	101	54	6	23.1	50	
1.2	2.0	3.3	113	15	8	24.1	55	
1.0	2.1	3.7	116	47	9	24.2	60	
1.1	2.0	3.5	107	57	8	18.4	72	
1.1	1.9	2.2	97	33	8	21.8	77	
1.0	1.8	3.7	97	42	7	26.5	80	
0.9	2.1	3.0	107	41	9	24.9	81	
1.2	2.1	2.3	107	57	8	23.4	82	
2.0	2.0	3.2	97	30	7	21.2	R0	POSTFLIGHT
0.9	1.7	1.8	90	17	5	24.2	R1	
1.0	1.9	1.6	87	22	7	25.0	R5	

Table A47

Flight SMEAT
Subject WT
Condition Stage 2
Frequency Range Delta

Table A48

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
2.3	1.9	3.2	88	22	5	20.3	DR	PREFLIGHT
1.3	2.1	2.5	70	57	4	33.7	B3	PREFLIGHT
								PREFLIGHT
0.8	1.9	2.1	84	60	6	28.7	3	INFLIGHT
1.1	1.9	2.7	103	52	10	32.6	4	INFLIGHT
0.9	1.8	1.9	93	63	8	32.2	8	INFLIGHT
1.0	1.9	2.9	93	44	7	25.0	11	INFLIGHT
1.4	1.9	2.4	97	54	7	30.2	14	INFLIGHT
1.0	2.0	3.7	102	56	9	27.1	17	INFLIGHT
2.1	2.1	2.8	112	46	9	32.1	20	INFLIGHT
1.3	2.0	2.7	98	19	9	23.2	23	INFLIGHT
1.0	1.9	2.8	101	33	7	32.2	26	INFLIGHT
2.0	2.4	3.7	62	1	4	38.0	29	INFLIGHT
1.0	2.0	2.9	102	62	10	31.8	32	INFLIGHT
1.4	1.9	2.5	106	51	9	26.2	38	INFLIGHT
1.2	1.9	3.1	107	64	13	26.6	41	INFLIGHT
1.0	1.9	3.0	103	61	6	32.4	52	INFLIGHT
1.1	2.1	2.3	105	59	7	31.1	53	INFLIGHT
1.0	2.0	3.7	103	48	6	31.0	54	INFLIGHT
								INFLIGHT
								INFLIGHT
1.3	1.8	3.5	97	64	5	26.6	P1	POSTFLIGHT
1.4	1.9	2.2	83	52	4	26.9	P2	POSTFLIGHT
1.1	1.9	3.1	88	33	6	25.9	P3	POSTFLIGHT

Flight 28-day

Subject JK

Condition Stage 3

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
14.0	16.8	14.4	96	12	8	7.7	1	PREFLIGHT
14.9	17.2	14.3	302	12	13	9.3	2	
17.4	19.1	15.1	337	14	14	8.3	3	
14.9	18.9	13.9	474	13	17	14.0	5	INFLIGHT
14.3	16.4	14.9	94	9	7	7.6	6	
14.3	16.7	14.7	91	11	6	7.5	31	POSTFLIGHT
13.9	16.9	15.2	118	11	7	7.7	34	
18.0	16.3	14.9	81	11	8	8.3	36	

Table A49

Flight 59-day
Subject OG
Condition Stage 3
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
13.7	17.9	14.9	310	12	13	14.7	B1	PREFLIGHT
16.7	17.9	13.7	329	12	18	14.6	B2	
14.0	17.1	13.8	207	12	14	12.8	B3	
14.0	17.9	14.4	258	12	14	13.8	7	INFLIGHT
14.4	18.2	15.5	282	12	11	11.6	8	
14.2	17.4	15.8	184	12	10	11.6	9	
17.0	18.2	14.8	278	12	13	11.3	12	
16.0	18.0	14.4	280	13	16	12.4	15	
16.0	17.4	15.1	225	12	11	12.8	18	
14.4	18.5	15.7	174	12	8	10.7	21	
16.6	17.4	15.1	271	12	12	13.2	24	
13.8	18.0	14.2	370	12	14	15.9	27	
14.2	17.9	14.4	343	12	20	14.3	29	
15.7	17.6	14.0	224	12	16	13.3	33	
13.8	17.4	13.8	203	11	9	12.2	36	
13.7	17.9	15.2	261	12	11	13.3	R1	POSTFLIGHT
14.4	17.6	14.0	118	12	9	10.1	R3	
16.7	18.5	16.2	163	12	8	10.3	R5	

Table A50

Flight 84-day
Subject EG

Condition Stage 3
Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp (μV)	Day	
13.7	15.9	14.3	77	9	8	8.0	B1	PREFLIGHT
15.3	16.3	13.8	33	11	5	7.4	B2	
16.0	16.8	14.4	101	10	7	8.8	B3	
13.9	17.5	14.1	227	13	12	11.1	3	INFLIGHT
16.9	17.5	13.9	186	12	12	11.1	4	
15.6	17.5	16.1	204	12	9	11.4	10	
13.7	17.2	14.7	199	12	13	11.2	14	
16.8	17.7	14.2	166	12	10	11.2	19	
16.9	17.2	14.1	201	12	11	10.8	24	
14.1	17.5	14.5	278	11	13	11.7	29	
20.8	17.2	14.3	179	12	16	11.3	34	
14.5	17.9	17.5	234	12	11	11.6	40	
14.7	17.5	13.7	232	12	13	10.7	45	
14.9	16.9	15.2	209	11	11	11.8	50	
14.3	16.9	14.5	209	11	17	12.1	55	
14.5	16.9	14.7	228	11	18	12.1	60	
18.5	16.9	14.3	240	11	16	11.1	72	
17.2	16.7	14.1	249	11	14	10.9	77	
15.2	17.2	14.3	252	12	16	11.6	80	
16.9	16.9	14.3	251	11	14	11.2	81	
18.2	16.9	13.9	183	11	11	11.4	82	
14.1	16.2	14.5	205	11	13	10.3	R0	POSTFLIGHT
---	---	---	---	---	---	---	R1	
19.1	16.8	13.8	145	10	12	9.0	R5	

Table A51

Flight SMEAT

Subject WT

Condition Stage 3

Frequency Range Beta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
14.5	17.5	16.1	106	10	6	9.7	DR	PREFLIGHT
13.9	17.9	14.9	325	11	16	17.9	B3	
15.0	16.8	14.8	183	12	10	10.5	3	INFLIGHT
14.1	17.1	13.6	185	12	12	10.3	4	
14.4	16.2	14.1	143	10	9	10.5	8	
13.9	16.2	14.6	140	10	8	10.0	11	
14.1	17.1	16.2	135	12	10	9.4	14	
15.2	16.5	13.9	136	11	9	8.6	17	
13.8	16.8	13.6	147	11	11	10.1	20	
15.0	16.5	14.1	165	11	9	9.5	23	
14.1	16.2	13.9	125	11	9	9.8	26	
14.6	16.0	13.8	127	11	13	9.1	29	
14.8	16.2	14.1	178	10	13	10.2	32	
15.9	17.2	14.3	105	13	7	9.2	38	
15.2	16.0	14.4	130	10	10	10.4	41	
15.9	16.7	15.4	110	11	7	9.2	52	
16.1	17.0	15.2	134	11	8	9.7	53	
14.9	16.7	15.6	152	10	12	9.9	54	
20.0	16.4	14.3	143	9	8	9.6	P1	POSTFLIGHT
14.7	16.1	14.1	123	10	11	9.6	P2	
13.9	15.9	14.9	95	9	7	9.6	P3	

Table A52

Flight 28-day
Subject JK
Condition Stage 3
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
9.7	9.8	10.2	220	19	11	10.1	1	PREFLIGHT
8.9	9.6	12.3	255	21	10	10.8	2	
8.7	9.4	11.9	177	20	7	9.9	3	
4.5	9.4	11.0	246	22	12	16.6	5	INFLIGHT
9.1	9.3	11.1	191	22	7	11.6	6	
7.9	9.4	10.5	216	20	10	10.0	31	POSTFLIGHT
8.6	9.7	11.5	260	18	12	11.4	34	
6.8	9.6	11.3	169	19	9	9.9	36	

Table A53

Table A54

Flight 59-day

Subject OG

Condition Stage 3

Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
7.6	9.3	10.4	319	20	13	22.0	B1	PREFLIGHT
8.9	9.1	10.8	331	20	11	21.1	B2	
7.4	9.4	10.5	323	20	14	20.2	B3	
11.5	9.2	10.7	319	21	13	19.5	7	INFLIGHT
6.8	9.5	9.9	330	19	12	17.3	8	
7.9	9.4	10.6	289	19	10	21.4	9	
7.0	9.2	11.9	323	20	12	17.6	12	
9.6	9.2	10.2	320	22	10	17.9	15	
9.3	9.3	9.7	324	20	12	19.5	18	
7.7	9.4	12.0	278	20	12	18.9	21	
11.2	9.3	10.1	331	21	13	20.7	24	
11.1	9.4	9.8	310	21	15	21.0	27	
9.7	9.4	11.7	343	20	13	19.2	29	
8.4	9.2	8.3	306	20	14	20.9	33	
8.3	9.3	11.3	294	21	13	19.9	36	
6.7	9.3	8.5	330	20	12	20.6	R1	POSTFLIGHT
7.8	9.3	11.0	373	19	12	19.9	R3	
9.4	9.4	10.3	354	18	13	20.2	R5	

Flight 84-day

Subject EG

Condition Stage 3

Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
8.6	9.0	9.2	165	21	7	12.1	B1	PREFLIGHT
7.8	9.1	10.5	91	19	5	12.2	B2	PREFLIGHT
7.8	9.0	9.8	164	22	8	12.7	B3	PREFLIGHT
7.2	9.3	8.1	189	21	8	16.3	3	INFLIGHT
7.1	9.5	13.2	226	21	10	15.9	4	INFLIGHT
7.7	9.4	11.6	298	20	11	16.7	10	INFLIGHT
7.6	9.4	10.4	226	21	12	16.1	14	INFLIGHT
7.4	9.4	10.3	201	20	10	16.3	19	INFLIGHT
7.0	9.3	11.5	227	21	8	15.5	24	INFLIGHT
7.4	9.3	11.1	284	21	12	16.5	29	INFLIGHT
8.2	9.4	10.6	210	21	9	18.0	34	INFLIGHT
8.4	9.6	10.5	293	21	14	15.8	40	INFLIGHT
8.5	9.5	10.8	237	20	11	15.7	45	INFLIGHT
9.5	9.7	11.0	287	22	15	16.7	50	INFLIGHT
7.9	9.6	9.7	279	21	12	17.1	55	INFLIGHT
7.4	9.5	11.5	292	21	14	16.9	60	INFLIGHT
11.1	9.8	13.3	235	22	13	13.3	72	INFLIGHT
11.0	9.4	10.5	216	22	14	14.0	77	INFLIGHT
8.9	9.3	10.4	251	22	9	14.5	80	INFLIGHT
9.9	9.4	9.6	245	21	10	15.6	81	INFLIGHT
9.3	9.5	11.5	239	21	10	15.8	82	INFLIGHT
7.1	9.2	12.9	227	23	9	12.4	R0	POSTFLIGHT
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10.1	9.2	8.3	205	21	8	14.0	R5	POSTFLIGHT

Table A55

Flight SMEAT
Subject WT
Condition Stage 3
Frequency Range Alpha

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
7.5	9.6	9.6	175	20	8	12.2	DR	PREFLIGHT
9.5	9.3	9.2	251	20	11	23.6	B3	
8.2	9.0	9.1	127	21	8	12.9	3	INFLIGHT
7.3	9.0	8.0	171	20	7	14.9	4	
7.8	9.1	10.3	188	21	8	16.0	8	
8.8	9.0	9.8	141	21	6	14.7	11	
7.6	9.0	9.0	178	20	8	15.1	14	
7.2	8.8	10.0	157	20	8	12.6	17	
8.5	9.3	11.1	182	21	11	15.1	20	
6.8	8.9	10.6	169	22	7	13.3	23	
8.4	8.7	8.1	130	22	6	13.7	26	
7.2	8.7	6.8	143	22	8	13.5	29	
7.6	9.2	9.4	181	21	9	13.6	32	
6.8	8.9	10.8	119	19	5	12.4	38	
8.1	9.0	8.8	177	21	9	13.8	41	
10.0	9.1	9.1	140	19	11	13.4	52	
8.5	9.3	10.5	187	21	12	15.1	53	
7.1	8.8	10.6	148	21	8	14.1	54	
8.9	9.2	10.0	194	23	9	12.6	P1	POSTFLIGHT
8.8	9.4	11.1	196	21	8	11.7	P2	
6.9	9.1	11.0	160	21	7	12.2	P3	

Table A56

Flight 28-day

Subject JK

Condition Stage 3

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount of Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
3.7	4.7	4.4	98	37	5	10.3	B1	PREFLIGHT
4.6	4.5	3.8	107	39	6	9.7	B2	
3.6	4.6	3.7	136	39	6	11.3	B3	
4.3	4.7	4.9	156	37	8	17.3	5	INFLIGHT
4.7	4.6	5.7	134	37	6	14.5	6	
3.6	4.8	4.8	114	37	6	10.7	31	POSTFLIGHT
4.5	4.8	6.1	98	40	4	10.7	34	
3.8	4.6	3.9	112	36	5	11.7	36	

Table A57

Flight 59-day
Subject OG
Condition Stage 3
Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
5.8	4.8	5.6	174	37	7	22.1	B1	PREFLIGHT
5.5	4.8	6.1	166	39	7	20.8	B2	
5.3	4.8	5.5	143	39	6	21.2	B3	
4.4	4.7	6.5	148	41	6	19.3	7	INFLIGHT
5.3	4.9	4.9	157	38	6	17.3	8	
4.8	4.7	4.7	153	39	8	22.7	9	
5.7	4.7	4.4	148	39	7	17.8	12	
5.7	4.9	6.7	141	39	7	17.8	15	
3.8	4.8	5.9	158	39	6	18.5	18	
4.3	4.8	4.5	133	40	8	20.4	21	
4.0	4.8	4.0	153	38	6	20.2	24	
3.6	4.9	6.3	171	38	6	20.5	27	
5.0	4.8	5.5	161	39	6	18.7	29	
4.2	4.8	6.8	153	40	8	21.4	33	
5.9	4.9	5.6	164	36	7	20.0	36	
5.8	4.5	4.1	141	37	6	22.1	R1	POSTFLIGHT
4.4	4.8	4.1	143	40	8	18.4	R3	
5.9	4.9	6.5	154	40	8	18.4	R5	

Table A58

Flight 84-day

Subject EG

Condition Stage 3

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
3.9	4.6	6.7	120	39	5	15.5	B1	PREFLIGHT
5.3	4.7	4.4	78	38	4	15.7	B2	
4.4	4.7	4.5	132	38	5	17.4	B3	
4.8	4.8	5.3	135	38	8	18.2	3	INFLIGHT
4.2	4.8	5.6	135	34	7	18.3	4	
4.1	4.6	4.5	171	37	8	20.2	10	
5.4	4.7	3.8	132	38	5	19.9	14	
4.0	4.7	5.7	110	38	5	18.4	19	
4.3	4.7	5.7	140	38	5	18.7	24	
4.5	4.8	4.9	157	38	6	18.9	29	
4.9	4.7	5.9	123	38	5	20.8	34	
3.5	4.8	4.9	148	35	7	16.7	40	
4.7	4.8	6.7	148	37	9	19.5	45	
3.8	4.7	4.9	148	34	6	19.0	50	
4.4	4.7	6.6	130	38	9	18.3	55	
3.8	4.8	5.3	133	39	8	17.2	60	
3.6	4.7	5.6	148	35	6	15.0	72	
3.8	4.7	4.9	131	37	6	16.7	77	
4.1	4.8	5.3	135	38	6	19.7	80	
4.0	4.8	5.6	149	38	8	19.6	81	
5.4	4.6	5.2	141	36	5	19.2	82	
3.5	4.6	5.4	100	38	6	14.2	R0	POSTFLIGHT
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4.7	4.9	5.7	143	35	7	16.5	R5	

Table A59

Table A60

Flight SMEAT

Subject WT

Condition Stage 3

Frequency Range Theta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
3.9	5.0	6.8	102	41	4	13.3	DR	PREFLIGHT
5.2	4.7	5.1	147	37	8	24.2	B3	PREFLIGHT
								PREFLIGHT
4.6	4.6	5.4	94	35	4	17.1	3	INFLIGHT
4.0	4.7	6.2	109	36	4	19.8	4	INFLIGHT
4.3	4.6	6.0	140	38	8	19.4	8	INFLIGHT
4.5	4.8	6.3	112	36	4	21.9	11	INFLIGHT
3.7	4.6	4.8	130	37	5	19.8	14	INFLIGHT
3.7	4.9	5.0	122	36	7	17.2	17	INFLIGHT
5.4	4.6	4.8	120	37	7	18.7	20	INFLIGHT
4.9	4.7	4.0	119	39	8	17.9	23	INFLIGHT
4.7	4.7	4.6	105	39	5	17.9	26	INFLIGHT
4.2	4.7	5.4	112	39	5	17.5	29	INFLIGHT
6.3	4.5	4.8	135	38	7	17.8	32	INFLIGHT
4.1	4.6	4.7	91	37	6	18.9	38	INFLIGHT
4.3	4.7	6.2	137	38	5	18.4	41	INFLIGHT
4.7	4.7	4.2	122	38	7	19.2	52	INFLIGHT
3.5	4.7	4.6	132	36	8	18.5	53	INFLIGHT
4.7	4.8	4.1	123	36	6	19.0	54	INFLIGHT
								INFLIGHT
								INFLIGHT
4.7	4.7	5.2	131	39	7	17.3	P1	POSTFLIGHT
4.1	4.5	3.9	106	38	5	15.4	P2	POSTFLIGHT
4.3	4.5	4.8	121	39	6	17.0	P3	POSTFLIGHT

Flight 28-day
Subject JK
Condition Stage 3
Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.8	1.9	1.9	69	1	5	20.8	1	PREFLIGHT
0.8	1.7	1.6	68	29	5	15.1	2	PREFLIGHT
0.9	2.0	2.3	62	1	4	25.9	3	PREFLIGHT
0.9	1.8	2.6	80	22	7	36.3	5	INFLIGHT
1.5	2.2	0.9	63	1	6	34.3	6	INFLIGHT
1.2	1.8	2.1	67	17	4	22.2	31	POSTFLIGHT
1.0	1.8	1.3	67	33	4	22.3	34	POSTFLIGHT
1.1	1.9	2.0	53	56	3	27.3	36	POSTFLIGHT

Table A61

Flight 59-day
Subject OG
Condition Stage 3
Frequency Range Delta

	Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day
PREFLIGHT	1.0	2.0	2.3	96	63	6	28.9	B1
	1.0	1.9	2.7	96	62	6	31.6	B2
	0.9	2.0	3.2	101	54	7	28.3	B3
INFLIGHT	0.9	1.9	2.3	90	51	6	28.7	7
	0.9	2.0	3.0	99	21	7	24.1	8
	0.8	1.9	2.0	90	59	6	35.7	9
	0.9	2.1	2.7	100	54	9	27.7	12
	1.5	1.8	2.3	88	59	7	31.5	15
	0.8	1.9	2.8	92	61	6	30.5	18
	1.1	1.8	3.4	84	64	6	36.4	21
	1.0	2.0	3.5	94	5	6	29.0	24
	0.8	1.9	3.5	95	33	5	30.6	27
	1.1	1.9	2.9	90	59	6	31.7	29
	0.9	1.9	1.9	81	37	6	37.8	33
	1.2	1.9	3.2	100	55	6	30.9	36
POSTFLIGHT	1.0	1.9	2.5	97	8	7	32.2	R1
	0.9	2.0	3.2	83	1	5	29.2	R3
	0.9	1.8	2.2	88	21	5	32.2	R5

Table A62

Flight 84-day

Subject EG

Condition Stage 3

Frequency Range Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
1.2	1.7	2.7	69	50	3	30.1	B1	PREFLIGHT
1.1	1.8	1.5	55	55	5	29.5	B2	
0.9	2.1	2.3	86	55	6	27.5	B3	
1.6	1.8	2.2	84	56	5	34.8	3	INFLIGHT
1.3	2.1	3.1	71	8	7	30.1	4	
0.8	1.8	3.7	80	37	5	31.7	10	
0.9	1.8	2.7	86	42	5	34.0	14	
1.4	2.0	3.3	73	55	6	30.9	19	
1.1	1.9	2.2	86	45	9	35.3	24	
1.0	1.8	1.7	87	32	6	32.4	29	
1.4	1.9	2.2	74	45	4	38.9	34	
0.8	1.8	3.7	83	61	3	33.0	40	
1.0	1.8	1.8	91	39	6	32.5	45	
1.4	1.9	2.4	81	28	5	31.9	50	
1.4	1.9	3.1	95	63	7	35.0	55	
1.3	1.7	2.5	81	23	6	33.5	60	
1.2	1.8	1.4	81	48	6	32.5	72	
1.1	1.8	2.1	88	42	5	28.9	77	
1.0	1.9	2.8	99	43	5	30.0	80	
0.8	1.8	1.8	88	62	7	32.6	81	
0.9	1.8	2.4	82	22	6	33.7	82	
0.9	1.8	2.9	67	41	5	28.3	R0	POSTFLIGHT
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1.5	1.9	3.5	71	62	3	30.9	R5	

Table A63

Flight: SMEAT
Subject: WT
Condition: Stage 3
Frequency Range: Delta

Freq. with L.M.A. (Hz)	Mean Freq. (Hz)	Modal Freq. (Hz)	No. Waves/ 60 sec	Wavelength Std. Dev. (msec)	Wavecount at Mode (No. Waves)	Av. Wave Amp. (μV)	Day	
0.9	2.3	1.8	48	1	4	32.7	DR	PREFLIGHT
0.9	1.8	3.5	82	41	5	41.0	B3	PREFLIGHT
								PREFLIGHT
0.9	2.0	0.9	58	1	4	55.8	3	INFLIGHT
1.0	1.9	2.9	71	61	5	45.2	4	INFLIGHT
1.0	2.0	2.5	81	45	5	42.1	8	INFLIGHT
1.0	1.8	1.2	85	37	6	40.0	11	INFLIGHT
1.2	1.8	2.2	87	55	8	43.0	14	INFLIGHT
1.0	1.8	2.7	78	42	5	37.8	17	INFLIGHT
0.8	1.9	2.8	82	1	5	41.0	20	INFLIGHT
1.2	1.9	2.8	100	28	6	33.4	23	INFLIGHT
0.8	1.9	2.7	70	27	4	33.2	26	INFLIGHT
0.8	1.9	2.8	75	1	4	44.5	29	INFLIGHT
1.3	1.7	2.4	80	42	6	36.7	32	INFLIGHT
0.9	1.9	2.8	72	51	5	43.6	38	INFLIGHT
0.9	1.9	2.4	81	58	5	38.8	41	INFLIGHT
1.2	1.8	2.5	81	57	5	40.6	52	INFLIGHT
0.9	1.7	2.8	78	29	4	42.0	53	INFLIGHT
1.2	1.8	1.8	81	39	5	42.0	54	INFLIGHT
								INFLIGHT
								INFLIGHT
1.0	2.0	2.6	79	19	5	35.7	P1	POSTFLIGHT
0.8	1.8	1.8	81	45	5	34.5	P2	POSTFLIGHT
1.0	1.7	3.1	69	39	5	37.8	P3	POSTFLIGHT

Table A64