THE EFFECT OF SIMULATED WEIGHTLESSNESS ON PERFORMANCE AND MOOD

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OBJECTIVE

To study the effect of simulated weightlessness on the performance and mood of male bedrest subjects.

BACKGROUND

The influence of the force of gravity of human biology was never investigated until the emergence of the space program. As the number of manned space flights increased, scientists were given a chance to research the body's response to zero gravity. They found that the major physiological changes included fluid shifts from the lower to the upper body and severe deconditioning of the heart caused by inactive muscles. With advancing technology space flights will become significantly longer in duration, and thus a need to counteract debilitating physiological changes is of great importance.

To better understand the effects of weightlessness on humans, researchers conduct bedrest studies to simulate zero gravity. It has been shown that a "head-down" tilt position or antiorthostatic hypokinesia is the best model to induce the adaptation period to weightlessness under laboratory conditions.[1] In this position a sense of disorientation occurs. As a result of immobility a loss of muscle tone ensues.

Past studies have shown that during the first two-to-three days of bedrest, subjects experience increased fatigue, lower mental work ability, decreased optical perception, and impaired sleep. These symptoms are most likely caused by an inverted position and the resulting fluid shifts. As bedrest continues the subjects become more fatigued, irritable, unable to concentrate, and experience increasing difficulty in sleeping. A careful study of performance parameters such as perception, reaction time, short term memory, vigilance, tracking, motor coordination, problem solving, and information processing, should determine performance efficiency.

METHODOLOGY

At NASA Ames 12 healthy male subjects aged 32 to 42 were chosen to participate in this bedrest study. The subjects lived in a confined testing facility for a total of 42 days. This period was divided into 7 days of ambulatory pre-bedrest, 30 days of bedrest, and 5 days of ambulatory post-bedrest. During bedrest the subjects remained in a head-down (-6°) position for the 30 days.

Prior to pre-bedrest performance testing, each subject was given 10 trial performance tests. These tests were administered in order to familiarize the subjects with the test and to stabilize improvement on any given test. Careful study of each performance test battery has shown stabilization within seven trials.[2]

The performance test itself was administered on the Automated Portable Test (APT) System on a portable NEC computer. The test consists of a Visual Analog Scale (VAS) mood test and ten separate performance tests. The entire test required less than twenty minutes to complete.

The VAS mood test, added to the performance test, is an upgraded substitute for pencil and paper mood tests which tend to become dull and result in stereotypical responses. In this test a subject places a mark across a horizontal line corresponding to the strength of his particular feeling at that time. At each end of the line are two adjectives (usually antonyms). The VAS mood test adjectives are listed below:

MOOD STATE	TEST ADJECTIVES
Motivation	Interested/Bored
Arousal State	Alert/Sleepy
Tension Level	Relaxed/Tense
Feeling	Happy/Sad
Fatigue	Energetic/Weary
Ease of Concentration	Very Low/Very High
Physical Discomfort	Very Low/Very High
Feeling	Pleasant/Unpleasant

Following these displays are two sleep questions: "How much trouble did you have falling asleep last night?" (Not at all/Very much) and "How many times did you wake up last night?"

There are many advantages to a test such as this one. The test is easy for a subject to understand; it is quick to fill out; and it does not require much motivation. Also, the subject is not confined to answering in quantitative terms.[3]

The following is a description of each performance test.

The REACT 1 test measures simple reaction time between the presentation of a stimulus and the subject's response time. The subject is instructed to press a key when a box on the screen changes from a filled box to an outlined box. The subject is prompted by a short beep.

In the Code Substitution test a row of nine random letters is displayed at the top of the screen with an associated digit below each letter. When a row of scrambled letters appears below, the subject identifies the appropriate corresponding digit. This test rates cognitive and perceptual ability combined with visual search and perceptual speed.

A subject's spatial ability is tested in the pattern comparison portion of the performance test. The subject is shown two adjacent patterns of asterisks on the screen. He must determine whether the patterns are similar or different.

In the Sternberg Short Term Memory test the subject is presented with a target set of four digits which are flashed on the screen. Afterwards several four-digit sequences are displayed. The subject then indicates if any of the originally displayed digits are present in the new sequences. After a few sequences a new target set appears. This is a cognitive item recognition test and a vigilance test.

The next test is a video game called Air Combat Maneuvering (ACM). The subject is instructed to shoot at a moving "spacecraft" at the top of the screen. The missile launcher can be moved to the right or left. Points are accumulated by hitting the spacecraft. The score is not shown at the end of the game. It has been found that this video game is completely stabilized after the sixth trial.[4] This test measures two-dimensional pursuit tracking.

The subject is instructed to alternately tap two keys as rapidly as possible in the finger-tapping test. The test consists of three separate runs: two keys with the dominant hand, two keys with both hands, and two keys with the subdominant hand. This is a test of manual motor skill and dexterity.[5]

Cognitive reasoning, logic, and verbal ability are measured in the Grammatical Reasoning test. The subject reads a simple statement about the order of two letters, A and B, which are presented next to the statement. The subject responds if the sequence is true or false.

The last test is the Manikin Spatial Transformation test. A figure of a sailor is shown on the screen with a box below his feet and on each hand. A pattern (*** or 000) is in the box below his feet and matches one in his hands. The figure stands facing toward or away from the subject. The subject must determine which hand holds the matching pattern. The test measures a spatial ability to transform mental images.

RESULTS

Only the change between pre-bedrest and bedrest can be analyzed because the experiment is still in progress. The results of the computed well-being score in the mood test and the score of the Air Combat Maneuvering were plotted as can be seen in figures 1 and 2.

For the mood parameter, day one represents the first day of bedrest. Day -6 is the beginning of the pre-bedrest period. As can be seen, the subjects' moods began low when they first entered the facility. Gradually their moods improved as they became accustomed to the new surroundings. On the first day of bedrest the moods of the subjects again went down.

For the performance aspect the results are strikingly different. The average score started out very low and gradually increased. This trend has continued through

the eighth day of bedrest. Unlike the mood parameter, the performance scores went up during the first day of bedrest.

DISCUSSION

There have been many previous bedrest studies ranging up to 120 days in duration. In Soviet bedrest studies, subjects have shown increased fatigue and irritability, mood changes, memory loss, and difficulty in logical thinking.[6] Many subjects experienced a lack of motivation to perform even the most simple tasks.

Bedrest studies to research changes in sleep patterns during long periods of simulated weightlessness have been conducted.[7] In one particular study scientists found an increase in deep sleep. In other studies, difficulties in sleeping have been commonly observed. Many subjects could not fall asleep easily, slept for shorter periods of time, and woke up more often during the night. Sleeping disorders such as these began after the first two to three days of bedrest and occurred in up to 60% of the test subjects. It has also been found that head down bedrest as opposed to horizontal bedrest, magnifies these effects.

Conflicts exist in reported results of bedrest performance. In a 35-day bedrest study, reduced reaction time and performance of simple psychomotor tasks were found. However, other researchers have found little or no change in performance during bedrest. In another study some performance elements decreased while others remained the same.

There has been much speculation as to the contradictory results of these performance studies. There is evidence that performance decrements are more obvious in longer studies. Also, the type of performance test has an important role. Some tests are more sensitive to the effects of bedrest.

CONCLUSION

The performance results of the bedrest study at Ames were not what were expected. The Air Combat Maneuvering performance test was tested to assure its reliability. However, the results from this study show a continued increase in performance. One would assume that scores would become constant if not decrease by the first days of bedrest because an inverted position would affect performance. It is also interesting to observe that while the subject's moods deteriorated, their performance improved.

Although the performance results were surprising, the mood results were as expected. At the beginning of pre-bedrest the subjects were nervous and therefore had lower moods then usual. Once accustomed to the facility, the subjects' moods improved. When bedrest started, the subjects were again nervous and uncomfortable so their low moods were reflected in the test. These mood fluctuations are very normal in experiments such as this one.

One can only wait to learn the final results of this bedrest study. However, there is still much more to learn about the effect of simulated weightlessness on performance and mood.

END NOTES

1. K. K. Ioseliani et al., "Operator's Mental Adaption and Work Capacity in Simulated Weightlessness," translated from Russian (1985), p. 20.

2. R. L. Wikes et al., "Stability, Reliability, and Cross Mode Correlations of Tests in a Recommended 8-Minute Performance Assessment Battery," Essex Orland Technical Report, April, 1986.

3. Allison Bond and Malcolm Lader, "The Use of Analogue Scales in Rating Subjective Feelings," British Journal of Medical Psychology, 94 (March, 1981), p. 148.

4. Marshall B. Jones, "A Video Game for Performance Testing," American Journal of Psychology, 47 (1981), p. 150.

5. David M. Gill et al.," Finger Tapping: Effect of Trails and Sessions," Perceptual and Motor Skills, 62 (1986), p. 675.

6. Charles Winget and Charles DeRoshia, "Psychosocial and Chronophysiological Effects of Inactivity and Immobilization," To be published, p. 9.

7. Ibid., p. 10.

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9. Wilkes, R. L. et al., "Stability, Reliability, and Cross Mode Correlations of Tests in a Recommended 8-Minute Performance Assessment Battery," Essex Orlando Technical Report, April, 1986.

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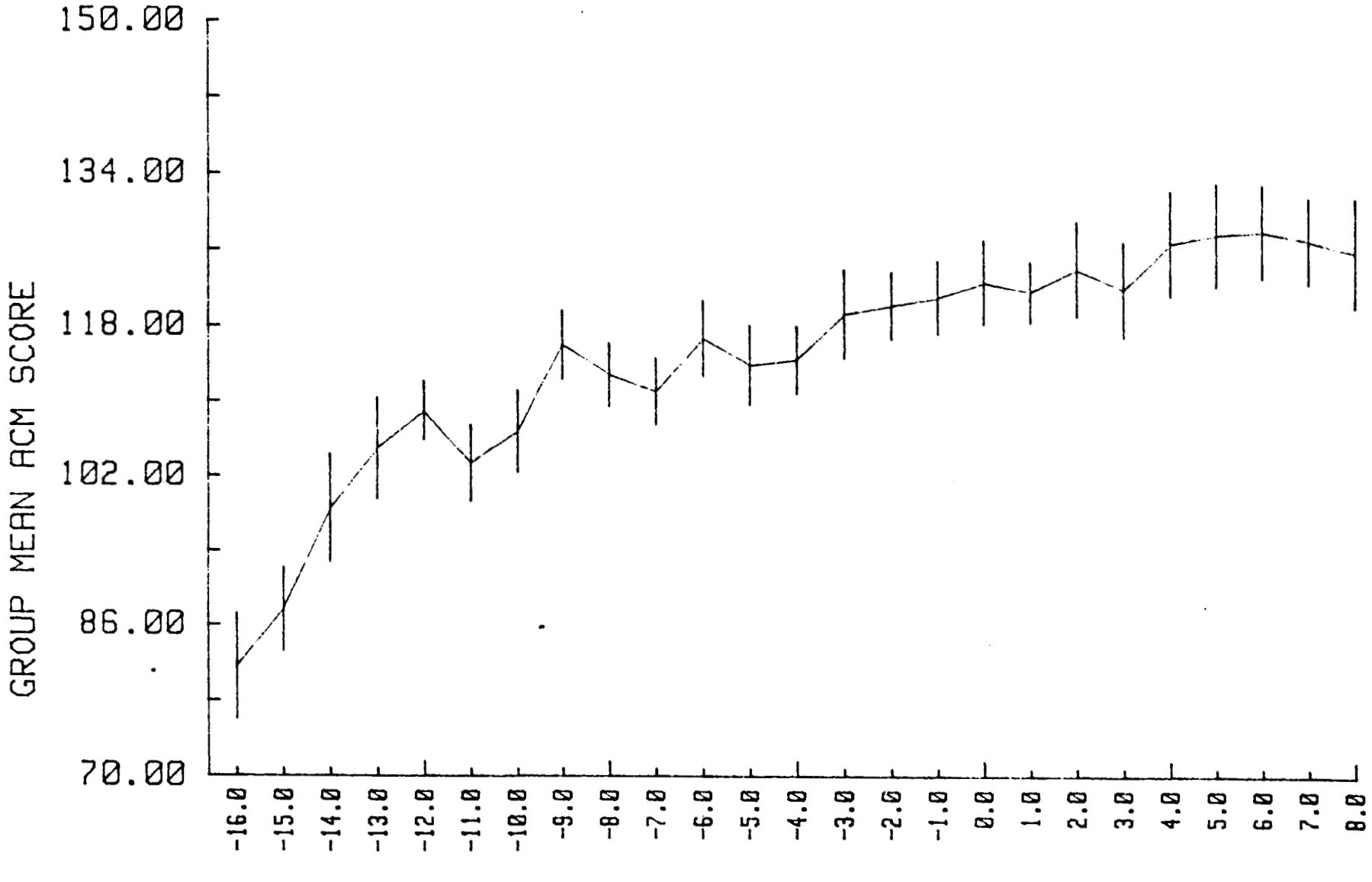

Figure 1.- ARC/JSC orientation, pre-bedrest, bedrest perf:ACM: group means.

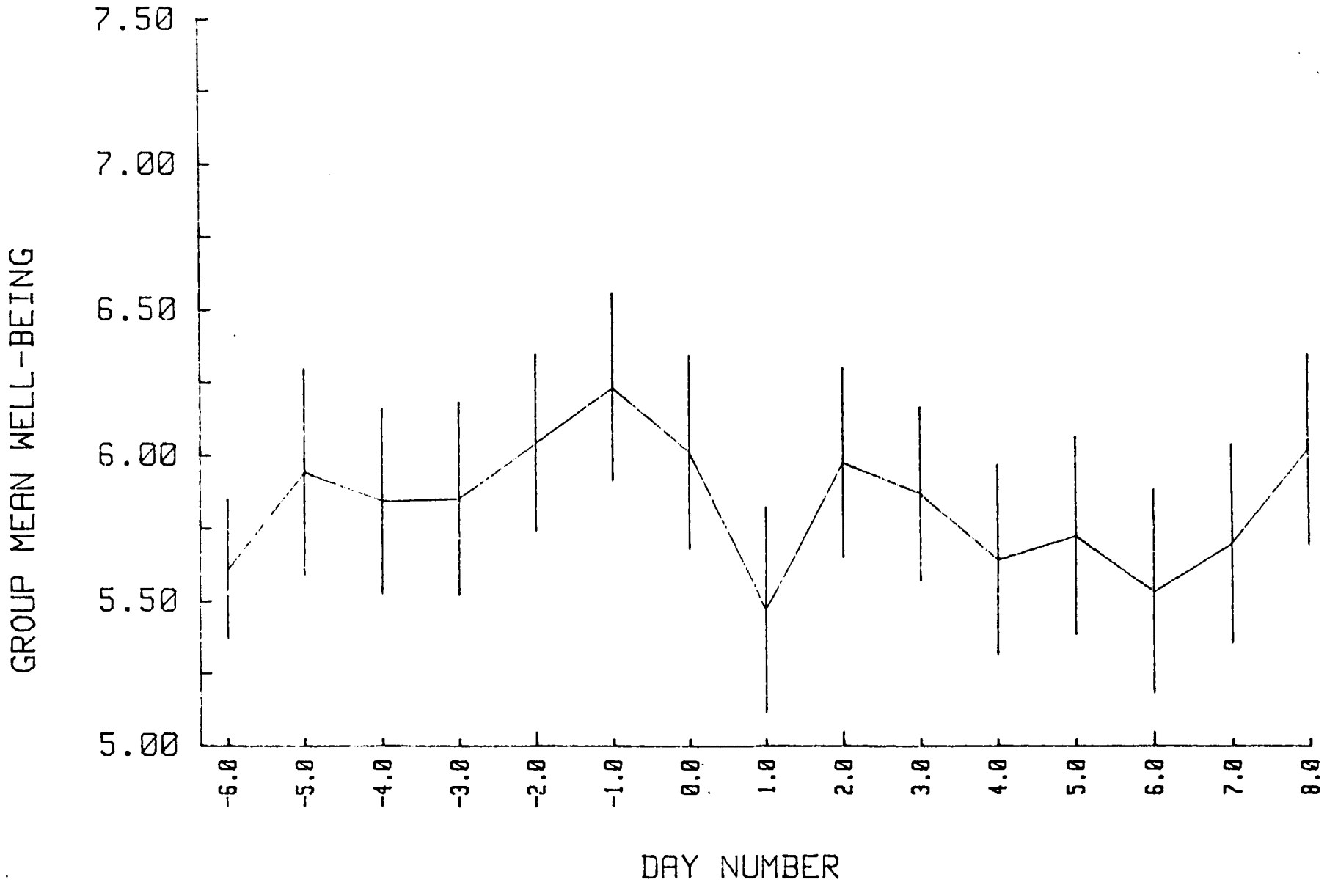

Figure 2.- ARC/JSC pre-bedrest and bedrest:mood:wellb.