Griffin

Restricted

THE EFFECTS OF ANALEPTIC DRUGS ON FATIGUE FROM PROLONGED MILITARY ACTIVITIES

VIII. Desert Tank Operation (Camp Young)

~~RESTRICTED~~

by

Northwestern University Collaborators*

As a parallel to a previous study in this series on the effects of benzedrine on tank operation at Ft. Knox, Ky., we were authorized to study its effects on tank operation under desert conditions. Under a directive of the Surgeon General and the Desert Warfare Board, the Surgeon** at Camp Young, Indio, California, arranged for the necessary men and equipment ~~and~~ to serve on alternate days for four experimental sessions and one pre-testing period. These groups were further divided into two sub-groups of four members each that served as the tank crews for two light tanks. The tanks were the light M-3 type, 1938 model, and were essentially the same as those used in the Ft. Knox tank study with the exception that these tanks had mounted guns and thus less ventilation. The acrid transmission fumes were not present in these tanks. The experiment was originally designed for the use of the more modern M-5 tanks, but mechanical difficulty with those models available made their use impossible except for one day. For the remainder of the time all crews used the same M-3 tanks.

Having completed the tank study at Ft. Knox, Ky., and having observed the effects of benzedrine upon human performance when administered under the elevated temperatures

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* This project, No. MRPD-26, Contract No. CMEmr-46, was jointly directed by Dr. A. C. Ivy of the Department of Physiology, Northwestern Medical School, and Dr. R. H. Seashore, Department of Psychology, Northwestern University. Collaborators included Mr. Stanley C. Harris, who administered the physiological measures and the subjective questionnaire; Dr. A. C. Van Dusen and Mr. J. E. Birren, who together with Dr. R. H. Seashore, administered the sensori-motor tests and prepared the formal reports.

** Military arrangements at Camp Young were planned and facilitated by the Surgeon, Lt. Col. Geo. E. Iterman, MC, and Maj. Wm. Dock, MC, with the approval of the Desert Warfare Board. The experimenters wish to express their sincere appreciation for the valuable assistance of these officers and the enlisted men hereinafter to be named.

in special laboratory rooms, some modifications of the procedure used at Ft. Knox were made in this study. The former tank study showed that the tank driving time used was not extremely fatiguing. Thus it was desirable to extend the driving period in this experiment, yet since the influence of the drug under high temperature conditions was observed while the subjects remained relatively inactive, the length of the driving period was not greatly extended for the desert driving in order to assure a good safety margin for the men.

The position of the tank driver, assistant driver, radio and machine gun operator, and tank commander were described in the earlier tank report, together with the physical inconveniences caused by the design of the tank's interior. All men wore dust-proof goggles, but none were respirators, even though the dust was the greatest difficulty the men encountered here as in the previous tank study.

As in all the studies of this series, an initial period of instruction in the test routine was given on the day prior to the first experimental session. Besides familiarizing the men with the tests and experimenters, it provided a chance for them to surpass the early stages of rapid learning in the behavioral tasks, and to overcome any apprehensiveness about the study. The project was always spoken of as a "vitamin" research experiment which would aid them and their comrades in all branches of the service, and to indicate that although no deleterious effects had yet been discovered, any negative effect noticed should be reported. The men were never aware of the true natures of the substances used, as both the drug and placebo were administered in identically appearing capsules and were referred to as "different vitamins."

The experimental design, shown in Table I, has counterbalanced such factors as test order, order of administering vitamin, daily variations, etc., in order to permit the statistical determination of the effect of benzedrine upon the subjective reports and behavioral measurements following a prolonged desert tank assignment. All members of a single crew received the same substances, as indicated in Table I. benzedrine sulfate is vitamin #5 (10 mgm.), the placebo is vitamin #1 (5 grains, milk sugar). The driving time for one tank was set one-half hour ahead of that for the second tank to permit questioning and testing very soon after the driving assignment. The test battery required approximately forty-five minutes and there were only slight variations in the waiting time of the second group.

The first crew began their cross-country driving over the desert terrain at 8:00 A.M. for the first two experiments, reporting back to the testing laboratory at 10:30 A.M., stopped only long enough for their "vitamin," and drove again until 12:00 noon. After lunch with their own military unit (1 hour) they serviced their tanks and resumed their drive at 1:00 P.M. and returned to the laboratory for an hour of questioning and testing at 3:00 P.M. The tank was driven continuously except for short stops when the crew rotated their positions so that each of the four served one-fourth of the total driving time in each crew position each day. The tank was operated "buttoned-up" (all hatches closed) for thirty minutes. This operation was performed during the last fifteen minutes of the second driver's time and the first fifteen minutes of the third driver's time. These first two experiments used six hours driving time. The second crew started out one-half hour later, reported at the laboratory at 11:00 A.M. for their "vitamin," returned to their mess at noon, and after an hour for lunch resumed driving until they reported for testing at 5:30 P.M.

The last two experiments had the same schedule with the exception that each crew started its drive one-half hour earlier in the morning and reported for testing one-half hour later in the afternoon. This extended the driving time from six to seven hours and the driving time of each of the four crew members was extended proportionately.

The vitamin dosage in both the long and short drives consisted of a single capsule, administered an hour to an hour and one-half before a regular lunch, and testing occurred four and one-half to five hours afterwards. The driving time in the first two experimental sessions was not extremely fatiguing and the extension of an hour for the last two sessions apparently did not produce a much higher degree of fatigue than that of the first.

Table II lists the various measures of fatigue used. The tests and procedures were exactly the same as those reported for the Desert Infantry Experiment, studied concurrently with the tank groups and include a group of objective measures of the cardio-vascular system, a battery of sensori-motor tests and the subjective report of the men given in four administrative groups. As in the previous studies each person took the tests in the same order each day and filled out a four-item questionnaire on ease of going to sleep following each experimental day.

Table I. Experimental Design

Tank Crew	Serial No.	Grade	Test Order	Drug Order
A1				
Baldridge, E.L.	36057416	Pvt.	1 2 3 4	1 3 1 3
Carter, L.D.	17056793	Pvt.	2 3 4 1	1 3 1 3
Hoerchler, R.H.	36542111	Pvt.	3 4 1 2	1 3 1 3
Hensley, O.A.	36057368	Pvt.	4 1 2 3	1 3 1 3

Work Schedule
Alternate Days

Exps. 1 & 2	Exps. 3 & 4
Lunch 12:00-1:00 P.M. for all Groups	
Drug 10:30 A.M.	
Drive: 8 A.M.-12 noon 1 P.M.-3 P.M.	7:30 A.M.-12 noon 1:00 P.M.-3:30 P.M.

A2				
DI Cicco, J.L.	32268006	Pvt.	1 2 3 4	3 1 3 1
Cella, F.C.	32278963	Pvt.	2 3 4 1	3 1 3 1
Rizzo, C.A.	32305294	Pvt.	3 4 1 2	3 1 3 1
Kellbach, R.A.	36238555	P.f.c.	4 1 2 3	3 1 3 1
Drug 11:00 A.M.				
Drive: 8:30 A.M.-12:00 Noon 1:00 P.M.- 3:30 P.M.				8:00 A.M.-12:00 Noon 1:00 P.M.-4:00 P.M.

B1				
Hadden, C. W.	36173006	Pvt.	1 2 3 4	3 1 3 1
Brogens, L.	14019964	Cpl.	2 3 4 1	3 1 3 1
Tollefsen, C.A.	32000654	Pvt.	3 4 1 2	3 1 3 1
Mivseck, H.M.	35285700	Pvt.	4 1 2 3	3 1 3 1
Drug 10:30 A.M.				
Drive: 8:00 A.M.-12:00 Noon 1:00 P.M.- 3:00 P.M.				7:30 A.M.-12:00 Noon 1:00 P.M.- 3:30 P.M.

B2				
Malone, R.C.	6926504	S.Sgt.	1 2 3 4	1 3 1 3
Demko, W. S.	35284747	Pvt.	2 3 4 1	1 3 1 3
Potter, J. T.	16062905	Cpl.	3 4 1 2	1 3 1 3
Korinko, M.C.	33139993	Pvt.	4 1 2 3	1 3 1 3
Drug 11:00 A.M.				
Drive: 8:30 A.M.-12 Noon 1:00-3:30 P.M.				8:00 A.M.-12:00 Noon 1:00 P.M.- 4:00 P.M.

Table II. Measures Employed

1. Physiological and Related Measures
   A. Itemized subjective report on condition of wakefulness, fatigue, aches and pains, bodily discomfort, etc.
   B. Diastolic Blood Pressure
   C. Systolic Blood Pressure
   D. Pulse Pressure
   E. Pulse Rate
2. Measures of Speed and Precision
   A. Visual discriminative reaction time
   B. Arm-hand steadiness in aiming
3. Measures of Tremor and Body Sway
   A. Body Sway
      1. Eyes Open
      2. Eyes Closed
4. A. Serial Discrimetor
   B. Flicker Fusion

Results

Table III summarizes the subjective reports of the men by vitamin and by experiment. The benzedrine is Vitamin #3, the placebo is Vitamin #1. The subscript A represents short drive conditions, of experiment one and two, the subscript B, the longer drive condition of experiments three and four. Incomplete data were available for the first two short drive experiments, but what information was gathered has been included. The subjective reports of all men were available for the last two experiments.

Table III. General Subjective Report

Question	Drug 1A	Drug 3A	Drug 1B	Drug 3B
1. hours sleep night before experiment				
average hours	7.9	8.0	7.5	7.8
number cases	7-9	7-9	5-10	6-9
range	16	16	15	16
2. Headache				
None	16	16	15	15
Mild	0	0	0	1
Dull	0	0	0	0
Sharp	0	0	0	0
3. Estimate no. of hrs. could continue assignment				
Average hours	11.2	10	10.8	9.8
Number Cases	8-1	8-1	6-24	7-15
Range	11	11	0	0
Median	16	15	14	16

Table III Continued

Question	Drug 1A	Drug 3A	Drug 1B	Drug 3B
4. Effect of capsule				
Help	5	10	13	15
Hinder	0	0	0	0
No Effect	10	5	2	1
5. Sleepiness after Capsule				
Yes	2	1	3	1
No	2	3	12	15
6 Condition of Muscles				
Tired	0	1	0	1
Sore	0	0	0	0
Pain	0	0	0	0
O.K.	4	5	15	15
7. Feel all right?				
Yes	3	4	15	16
No	0	0	0	0

Because of incomplete subjective data on the first two experiments, no comparison can be made between such reports for the two driving conditions. There were no significant differences between the "ritamin" conditions in frequency of headaches. Only one mild headache for each condition was reported. Twenty-five reported the benzedrine capsule as helpful while 18 of the subjects taking the placebo reported it also beneficial. Two-thirds of the cases during the short driving condition reported the placebo as ineffective, and an equal number reported that the drug helped. Five under the placebo condition as compared to two under the drug condition reported sleepiness during the drive after the capsule. Only two cases of tired muscles were reported, and both occurred on the day of the drug administration.

Table IV. Negative Subjective Symptoms

Question	Drug 1A	Drug 3A	Drug 1B	Drug 3B
2. Ringing or buzzing in ears.	3	0	5	4
5. Gas on stomach or in intestines.....	0	1	0	0
9. Tremors - fingers, hand, etc				
Very mild.....	1	1	1	1
Mild.....	1	0	6	6
Coarse.....	0	1	0	0

Table IV Continued

Question	Drug 1A	Drug 2A	Drug 1B	Drug 2B
11. Palpitations or cardiac distress.....	0	0	1	0
16. Fidgety or restless..	1	0	1	0

Table V. Positive subjective Symptoms

Question	Drug 1A	Drug 2A	Drug 1B	Drug 2B
12. Feel talkative and excited.....	0	0	2	0
16. Feel exhilarated and gay.....	1	2	2	2

As for the negative symptoms shown in Table IV, there were no significant differences between the total number reported by the control subjects and those under benzedrine conditions. The same is true for the positive symptoms given in Table V. Of the sixty records of the sleeping period following any experimental session examined, only two negative instances were reported and each occurred under the placebo condition. We may conclude that neither the control nor the drug had any deleterious effect upon sleeping.

Table VI shows the comparison between the scores of all subjects under the benzedrine condition to their scores under the placebo condition, without regard to the experiment (length of drive), in which the condition occurred. The percentage of absolute change in score from the placebo to the drug condition, is given together with the direction of the change. Fisher's P indicates the statistical significance of the difference between the performance under the two conditions and may be interpreted as the percent of future cases in which raw score differences as great as these could be expected through the operation of chance factors alone. The condition which gives the largest physiological value and the best sensori-motor test scores have been indicated and those changes between the two conditions which have P values less than 10% have been underlined, indicating statistical significance.

Table VI. Comparison of Performance on Objective Tests Under Placebo and Benzedrine Conditions after Military Activity

Test	Direction of Change	% Change	"p" Index Significance	Largest Val. Best Score
Pulse Rate		8	1	Benzedrine
Systolic Bl. Pr.		2	5-10	Benzedrine
Diastolic Bl. Pr.		4	1	Benzedrine
Pulse Pressure	-	4	5-10	Placebo
Flicker Fusion		1	20-30	Benzedrine
Discriminative Reaction Time		4	60-70	Placebo
Body Sway (Eyes Open)		3	60-70	Benzedrine
Body Sway (Eyes Closed)		1	80-90	Benzedrine
Photoelectric Aiming*	-	2	70-80	Benzedrine
Serial Discrimeter*		6	90-100	Benzedrine

Table VII. Comparison of the Effects of Benzedrine to Placebo Condition for Two Different Lengths of Driving Time

Test	Direction of Change	"p" Index Significance	Largest Value or Best Score
Pulse Rate	-	70-80	Short Drive
Systolic Bl. Pr.		5-10	Long Drive
Diastolic Bl. Pr.		60-70	Long Drive
Pulse Pressure		10-20	Long Drive
Flicker Fusion	-	30-40	Short Drive
Reaction Time		20-30	Short Drive
Body Sway			
Eyes Open		80-90	Short Drive
Eyes Closed	-	30-40	Long Drive

Table VII above indicates whether the largest values of the physiological measures and the best scores on the sensori-motor tests were in favor of the long or short drive condition. The P values listed here indicate whether the difference between the changes in the test scores from the control to the drug condition differ significantly under the two operating conditions. Although three of the physiological measures showed changes greater under the longer drive and three of the objective tests showed changes greater under the shorter drive experiments, only systolic blood pressure showed a difference between the two operating conditions which was statistically significant and any of the others may have been caused by chance variations.

* These tests were used on only 8 subjects during the first two experiments.

Summary

Two groups of eight enlisted men each, all with tank driving experience, at the Desert Training Center, Camp Young, Indio, California, served in four alternated days of cross country desert tank drives in order to determine the effects of benzedrine upon fatigue following such an army assignment. These groups were further divided into sub-groups of four members each that served as the tank crews in M-3, 1938 model, light type tanks. Each crew drove continuously for six or seven hours cross country (except for lunch), before they made a detailed report of their subjective condition and were examined on a series of objective physiological measures and a battery of sensori-motor coordination tests.

Each man was given a capsule orally of either 10 mgm. of benzedrine sulfate or 3 grains of milk sugar (placebo) in the morning one to two hours prior to lunch and about five hours prior to the testing period. Each member of a given tank crew received the same kind of capsule, thus each day, one of the two crews was under the drug condition while the other served as a control.

The crew rotated their positions which allowed each man to serve one fourth of the total driving time in each crew position during each experimental period. The tank was operated for thirty minutes "buttoned up," i.e., all hatches closed. The driving time for the first two experimental sessions was six hours, for the last two experiments, seven hours.

The experimental design balanced out such factors as individual differences, drug and testing order, etc., so that it was possible to determine statistically the effect of the drugs upon the subjective reports and objective measures following the desert tank operation.

A slightly greater percentage reported no sleepiness and that the capsule had helped their feelings following the benzedrine administration as compared to the control, although the differences are not statistically significant. There were no significant differences between the total number of negative or positive subjective symptoms reported by the control subjects and those under the benzedrine condition.

The circulatory changes following use of the benzedrine were all small and well within clinically observed

ranges. Pulse rate, systolic and diastolic blood pressure showed slight increments under the drug, while pulse pressure showed a slight decrement. The better scores on the sensori-motor coordination tests were all made under the benzedrine condition, but the absolute differences were so small as to be of no statistical significance. A comparison of the effects of benzedrine to those of the placebo for the short and long driving periods showed that three of the four circulatory measures gave the largest values under the longer drive, while greater changes were made on short drives for three of the four objective tests. However, the difference between results following the two driving conditions were all small enough to be of no statistical or practical significance.

The absence of any significant changes in subjective reports, in physiological indices, and test performances, under the benzedrine, is probably due to the lack of any high degree of fatigue in the tank driving assignment. It has already been shown in the Fort Knox tank and truck driver studies and the Desert Infantry study that the beneficial qualities of the benzedrine are much less apparent when only a minor observable and measured degree of fatigue is present. Here again the work assignment in either the short or long tank drives was not difficult enough for the degree of physical conditioning found in the subjects to permit a discriminative effect between the benzedrine and control condition. However, it has now been demonstrated with reasonable certainty that benzedrine is at least very unlikely to produce undesirable effects under desert tank operations and it would seem feasible to use it under actual emergency situations involving a harder and longer working schedule.

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