ACTIVITY DURING REST PERIODS --- EFFECT UPON PSYCHOLOGICAL FATIGUE

by

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INTRODUCTION

Fatigue

Fatigue has been a topic for much discussion. Offner (1911) gave as his definition of fatigue a condition of our organism that is developed by long continued work, in addition to other symptons, is characterized in particular by a reduction in the capacity for, and pleasure in, work. Sixty years later McFarland (1971) stated that fatigue, in general, refers to a group of phenomena associated with impairment, or loss of efficiency and skill, and the development of anxiety, frustration, or boredom. Although others have defined fatigue somewhat differently, the basic idea is usually present that fatigue brings about a reduction in capacity and/or efficiency.

As industry became mechanized the need arose for more workers engaged in mental tasks. These mental tasks involved keeping account records, planning production and employment levels, providing cost analyses, and other similar operations involving figures as well as sensory tasks such as vigilance and inspection. As more employees became involved in these mental tasks people began to study this type of task as they had the physical tasks. The studies showed that performance in the mental tasks declined over time as it had with the physical tasks. Thus, the concept of fatigue began to take on an added meaning.

Fatigue resulting from bodily or physical activity was referred to as physical fatigue while fatigue resulting from mental activity was called mental fatigue or psychological fatigue. Bills (1943) associated physical fatigue with aches and pains of the gross musculature, soreness, a feeling of powerlessness to move, and a sensation of limpness. In psychological fatigue, Bills stated that the small muscles of the face, hands, and neck region including the eyes became uncomfortable. He also stated that restlessness and a feeling of tension were prevalent in psychological fatigue as opposed to the listlessness associated with physical fatigue.

Measurement of psychological fatigue. With the increased interest in psychological fatigue came the desire to measure this effect and compensate for it whenever possible. Bills (1943) presented four methods of measuring psychological fatigue: objective method, organic method, by-product method, and the subjective method. The objective method measures fatigue by the amount of work accomplished. This method assumes that the worker continues to try just as hard all the time and his output is only limited by capacity. Thus, fatigue is assumed to be a diminished capacity for work. The organic method is concerned with the physiological changes that occur in the body during and after a period of work and the physiological changes that are caused by the extra energy requirements of the mental effort. The

by-product method is concerned with recording and noting external signs such as squirming, fidgeting, and reduced emotional control. Finally, the subjective method obtains responses from the subjects as to their individual attitudes toward the task, their feelings of relative comfort, discomfort, or tiredness and their desire to quit the task.

Boredom and monotony. Psychological fatigue can also refer to boredom and monotony if the performance of work associated with them is shown as a decrement. Boredom refers to a state in which inadequate motivation and inclination to get away from a situation conflict with the inclination to continue. Monotony refers to a state of mind caused by repetitive work. Quite often boredom and monotony are used interchangeably. In the case of boredom and monotony the worker's attitude toward the work changes as result of the task itself. This change in attitude is reflected as a performance decrement. Boredom and monotony are characterized by sameness and continuity. These involve repeating one or a few operations over and over again. Poffenberger (1928) conducted an experiment on this sameness characteristic associated with boredom and monotony. A group of students (no number given) performed each of two tasks. One task was an intelligence test and the other consisted of adding pairs of digits. The adding of the pairs of digits provided the sameness quality. The results clearly showed the fatiguing effect of the boredom and monotony associated with

the sameness of the addition task. The addition task showed a performance decrement of 20 per cent while the intelligence test showed an improvement of 20 per cent. Poffenberger's study was cited by Bills (1943) and although Bills does not go into great detail concerning the study he does present enough material to relate boredom and monotony due to sameness with a performance decrement.

Blocking. Psychological fatigue can also be associated with the concept of blocking. A block occurs when a person is unable to respond and cannot, even by an effort, continue until a short time has elapsed. Bills (1931) conducted a study on blocking in which he chose the following mental tasks: (1) alternate addition and subtraction; (2) reversible perspective; (3) color naming; (4) giving opposites; and (5) making substitutions. The tasks chosen were selected on the basis of preliminary investigations which tended to show that blocks were more likely to occur in homogeneous tasks, and those having a high degree of continuity. Since the length of a block was small, the tasks were chosen so that the responses would come frequently, and thus a gap in these responses would indicate the presence of a block. Bills arbitrarily defined a block as a pause in responses equivalent to the time of two or more average responses.

In the first two tasks ten subjects worked continuously for seven minutes on each of eight consecutive days. For the third task 21 subjects worked for ten minutes on each

of two days. The fourth task used twelve subjects who worked ten minutes on each of two practice days and three experimental days. In the final task twelve subjects reported for three days and worked for ten minutes on each day.

As a result of the infrequency of errors in these five tasks another experiment was conducted in which the subjects worked steadily for one hour. Twelve subjects were used for this experiment and half of them worked on the substitution task while the other half worked on the color naming task. Bills does not state why two different tasks were used in the experiment. The number of blocks per minute were combined for the two tasks. Bills reached the following conclusions and interpretations of the results:

1. In mental work involving considerable homogeneity and continuity, there occur, with almost rhythmic regularity, blocks or pauses during which no responses occur. Blocks occupying the time taken for two to six responses occurred on the average at about three per minute. There were individual differences.

2. Practice tends to reduce the size and frequency of the blocks.

3. Fatigue tends to increase the size and frequency of the blocks, producing a greater irregularity of responses without reducing the number of responses per minute to any extent, over periods up to one hour.

4. The responses between the blocks tend to bunch toward the center of the response chart. Fatigue tends to exaggerate the bunching.

5. Rapidly responding individuals tend to have fewer and shorter blocks than slower responding individuals.

6. Errors tended to occur in conjunction with blocks.

A review of this experiment by Reynolds (1971) revealed the following:

1. Most of the experiment was run by a few subjects for a very short period for each task.

2. Results were obtained by trends in the output rather than by accepted tests of significance.

3. According to Bills, the phenomenon of blocking should not interfere with objective decrement readings on output due to psychological fatigue because of no decrease in output, but it could affect the amount of errors due to the increased fatigue.

Importance of studying fatigue. One of the most important objectives to be gained by studying psychological and physical fatigue is whether the fatigue resulting from a task has an unfavorable influence on the health of the worker. The problem of determining the influence of fatigue on the worker is no easy one. The effects on health do not necessarily show themselves at once. It may be weeks, months, or even years before a diminution of health can be attributed to the direct fatigue induced by the occupation

or to the adverse conditions under which the work is performed. In the short run the fatigued workers are more susceptible to accidents and thus safety in operations is desireable in all industrial situations.

The worker's comfort, or discomfort, in performing a task can also have an important effect upon fatigue. A worker may become fatigued as a result of working in an uncomfortable position. A physical change in the position or the equipment can relieve the discomfort. The energy spent while in an uncomfortable position can reduce the worker's efficiency in the performance of the task. Thus, economics also plays a role in the study of fatigue. A fatigued worker is liable to make many more mistakes and have a lower production rate than a rested worker. This can result in the loss of many dollars per week needlessly.

Rest Periods

Rest periods have been proven to be a valuable aid in reducing fatigue. A wide variation of work and rest schedules have been tried in several different kinds of work situations. Of course the necessity of a rest period is also dependent upon the task. The National Industrial Conference Board (1919) reported that employers deemed rest periods desirable chiefly for monotonous operations, operations requiring intense concentration, operations requiring a fixed position or severe physical exertion, or for operations exposing

workers to unfavorable ventilation. Bills (1943) also reported that work involving a high degree of sameness or monotony required more frequent rest periods. Bartley and Chute (1947) also stress the importance of rest periods for all of the types of jobs stressed by the National Industrial Conference Board Report.

Some research has been conducted to determine the value of rest periods. The National Industrial Conference Board Report cites numerous reports of improved output as a result of rest periods. This data pertains to the period prior to 1919 and as such should not be considered too valuable. Statistical tests of significance were not available and the methods of obtaining the results were not cited.

Bartley and Chute (1947) cite an example of a manufacturing concern which utilized a 20 minute rest period following 40 minutes of work. The length of the rest period required the hiring of one additional person for every two initially employed, but the increased production rate and employee satisfaction more than compensated for the added cost. The details of the study were not given and tests of significance were not available leaving in doubt the true value of the study.

Bhatia and Murrell (1969) conducted an experiment in an actual industrial situation in which they instituted formal rest periods. Their study was conducted using six ten minute and then four 15 minute rest periods. The study was concerned with production rate and earnings as well as the

attitudes of the twelve women operators. The task was the manufacture of account books.

There were several disadvantages involved in using this particular plant. The work was repetitive, but it was small-batch and as such the output measurement depended upon the accuracy of the rates allowed for each batch. The experimenters were unable to make measurements of working and resting time prior to the experiment. The number of operatives studied was small.

Production was found to increase slightly under each rest period situation even though one hour of the day was devoted to formal rest periods. The workers preferred the ten minute rest periods to the 15 minute rest periods.

Activity During the Rest Period

The activity during a rest period can take on many different forms when a rest is considered as a break from the task. Rest is usually thought of as complete relaxation, talking with fellow employees, moving about, or taking refreshments. A rest period could also be thought of as performing a second task for a few minutes as a break from the main task. This second task is a rest from the main task, but it goes beyond a rest in that useful work is accomplished during it. In the above definition of rest as relaxation and so on, no useful work is done. Useful work pertains to the production for which the

employee is paid. It would seem that all rest periods should be taken up in performing a second task and thus accomplishing useful work, but this is not the case. Many workers require a true rest period to recover from fatigue while other workers simply do not have a second job to perform during a rest.

The value of rest periods has been studied and accepted, but the question of how to spend time during the rest period is still open to debate. Bills (1943) states that the activity during rest is dependent upon the particular occupation. If the work involves a physical element then complete relaxation during rest is best. If the work is mental then a mildly stimulating activity such as listening to music, talking, or strolling about maintains tension and alertness and at times relieves cramped muscles. Offner (1911) has done work in the area of psychological fatigue and rest periods and his findings tend to support the hypotheses offered by Bills. Offner cites two studies as examples. In the first study an addition test and bisection of lines test was interrupted by a moderate walk and a four-minute calisthenic exercise. The results showed the walk and calisthenics to be directly stimulating to the mental work. Offner does not state what is meant by "stimulating to the mental work." This study was performed prior to 1900 and tests of statistical significance were not available then. The study is just mentioned by Offner with almost no detail of what the experiment encompassed.

In the other study similar results were obtained using a rest that consisted of a gymnastic lesson that did not require a great demand on energy or attention. This study was also performed around 1900 and Offner presented little detail. These studies, although of little value due to the detail available and the year in which they were performed, are presented here to show that as early as 1900 there was an interest in the activity performed during a rest period and its effect upon the performance of the task.

Offner maintains that physical activity during a rest period is also fatiguing work and as such demands a period of rest itself. However, this physical activity is accompanied by secondary results that are extremely helpful for recuperation after mental work. These secondary results are best realized when there is no activity of any kind directly after the physical activity. This statement is in agreement with Bills' that complete relaxation is the best type of rest after a physical activity. Offner's findings concerning a mild rest could be compared to Bills' hypothesis concerning activity during rest from a mental task.

Chapman (1917) looked at the idea of a rest in two different manners. In one experiment, he alternated an addition task with a cancellation task while in a separate experiment he alternated the addition task with complete rest.

Chapman conducted the addition-cancellation experiment in the manner shown in Figure 1. He tested five groups of high school students ranging in size from 18 to 29 subjects. Every thirty seconds the experimenter gave a command for the subjects to turn the pages of their test booklet and thus bringing about the alternation.

A 14 per cent increase was found in the addition task due to changing tasks, but the upward change in the cancellation was insignificant. Chapman believed the nature of the task to be the reason for the lack of increase in the cancellation. The addition required a knowledge of previous results while the cancellation did not.

In the second experiment Chapman alternated addition and rest according to the manner shown in Figure 2. Twenty-four undergraduates were used in this test. The results of this experiment showed an increase of 21 per cent in the output of addition problems when alternate rest periods were present. Chapman attributed the lower production in the continuous task to "interference" due to previous work. This phenomenon is now referred to as psychological fatigue.

Reynolds (1971) presented a review of Chapman's study. The strong points of the study were the number of subjects used and the arrangement of the test periods. The weak points were the arbitrary scale needed to score the tasks

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.

TRIAL	Half-minute Periods					
	1	2	3	4	5	6
I	A	A	A	A	A	A
II	C	C	C	C	C	C
III	A	C	A	C	A	C
IV	C	A	C	A	C	A
V	C	C	C	C	C	C
VI	A	A	A	A	A	A

"A" Addition Task

"C" Cancellation Task

Chapman's addition-cancellation sequence.

Figure 1.

TRIAL	Half-minute Periods								
	1	2	3	4	5	6	7	8	9
I	A	R	A	R	A	R	A	R	A
II	A	A	A	A	A	A	A	A	A
III	A	R	A	R	A	R	A	R	A

"A" Addition Task

"R" Rest Period

Chapman's addition-rest sequence.

Figure 2.

and the short test periods. The test periods were only three minutes and four and one half minutes long. These lengths of test periods cannot answer any of the questions concerning long term effects upon alternating a task with another task or a complete rest.

Bills (1943) states that a mildly stimulating activity such as talking or moving about would be better than Chapman's complete relaxation during rest, but since the rest periods were only 30 seconds long there was little time to engage in much activity.

Wyatt (1927) conducted an experiment in which the subjects received a 15 minute rest period between two hours of work on addition problems. The activity during the rest period consisted of complete relaxation, uncontrolled rest, listening to music or drinking tea, or taking a walk. The results of the experiment were that the complete relaxation gave a gain of about 10 per cent and the uncontrolled rest yielded slightly less. Listening to music or drinking tea resulted in a 4 per cent gain while the walk brought about a gain of less than 2 per cent. The small gains suggest that 15 minutes is too long a rest under the circumstances, no matter how it is spent. Bills (1943) believed the warming-up factor in adding figures would also be an important consideration.

Wyatt's study might have been quite valuable if he

had used shorter rest periods. The long rest period can be a disturbance in the sense that a person can lose the rhythm he has developed, especially in the case of a mental task. He will then be slow to regain this rhythm after the rest. Maier (1955) also expressed the opinion that a shorter rest period is preferable to a longer one. Maier recommended that rest periods be five minutes long.

The National Industrial Conference Board (1919) reported that a majority of establishments provided employees with a place outside of the workroom where they could go to relax. Many employers expressed the belief that mild exercise, better ventilation, and a drink of water as well as other methods of relaxation are bound to provide a favorable influence on fatigue. Other employers reported the taking of nourishment such as coffee and snacks during short rest periods. Setschenow (1935) is credited with this theory of active rest which was later developed by Marschak and others. Marschak (1936) conducted an experiment in which he compared the effects of passive recovery and active recovery on the capacity for work following the period of recovery. The work was either static or dynamic and consisted of raising a weight with one finger on one hand and holding it as long as possible or raising a weight repeatedly until it could no longer be lifted. The passive recovery was a complete rest while the active recovery consisted in exercising with rhythmic movements the opposite hand of the one used to do the static or dynamic work. The active recovery

resulted in an improvement in performance following recovery greater than that of the passive recovery. These findings contradict Bills' and Offner's statements that the passive recovery, or complete relaxation, would be more beneficial in a physical type task. Marschak does not state the number of subjects used and does not give any statistical tests of significance. The length of the rest periods was unavailable. Therefore, this study should not be considered too seriously in evaluating activity during rest periods.

Miles and Skilbeck (1944, original 1923) conducted an experiment in which they studied the effect of introducing a change of task during the rest period instead of using the rest for relaxation. During the change of task period the workers gathered material needed for their work from a storeroom. Previously the workers obtained the material during the first 15 minutes of the day and then as needed during the remainder of the day.

Production was found to decline at 11 a.m. and 3 p.m. each day so the change of task was introduced for a period of 15 minutes at 10:50 a.m. and at 2:30 p.m.. The desired result was not obtained in the afternoon change so the change period was switched to 3 p.m..

The results showed that the production rate did not fall off as much as it had prior to the introduction of the change of task period. The morning change was more effective than the afternoon change in maintaining the production rate. An

increase of 14.2 per cent was obtained in the production rate.

The experimenters concluded that where little demand is placed on the worker's physical energy, and where psychological fatigue is accompanied with boredom arising from long-continued monotonous work, a change of task period is at least as effective as a rest period of relaxation.

Reynolds (1971) reviewed Miles' and Skilbeck's study and found several faults in the experimental set-up. The experimenters did not state the number of subjects used, their background, or their age. There is no mention of the exact periods or number of runs covered during the experiment. A control group was not used which allows the possibility of the increased production rate being attributable to increased attention as shown by the Hawthorn experiments. The experimenters did not present statistical evidence that there was a difference between the change of task method and the previous method.

This experiment points out the possibility of benefits when a change of task is introduced as a break from the main task. A change of task could be more beneficial than an actual rest in certain situations.

Laporte (1966) also conducted an experiment in which he used two different types of rest periods. One of the rests was a passive rest and the other was an active rest where

the activity consisted of performing some light gymnastic movements during the rest. The study was conducted on a group of 80 women of the Brussels Post Cheque Office. The women were tested for fatigue before and after the rest pause using each of four tests. These tests were: (1) the flicker fusion frequency test which measures eye and general fatigue; (2) Wechsler's digit symbol test which measures the time to fill a page with number substitutions; (3) the hand dynamometer test which measures instantaneous strength; and (4) Pieron's tremor test which measures neuro-muscular coordination.

The results of the study showed that the gymnastic pause was superior to the passive pause in regard to hand steadiness, general and eye fatigue, muscular strength, and the speed at which the subjects worked following the rest period.

The task the women performed was a mental type task and in this case the study would tend to support Bills' and Offner's contentions that a mildly stimulating activity is a better rest from a mental task than complete relaxation. Bills suggested walking or strolling about during rest from a mental task and this would be comparable to the light gymnastic exercises providing these were not very demanding physically. The use of the gymnastic activity and the results obtained also tend to support the studies reported by Offner.

Zuercher (1965) conducted an experiment on the influence of extraneous stimulation on vigilance performance. The

measure of vigilance was the increase in visual threshold as a function of observation time. The subjects watched a light blink at about once a second at a standard brightness and were to detect when the brightness increased. If a detection was missed the next signal would be even brighter. The brightness of the signal was increased until a detection was made. The measure of performance was the change of threshold over time. A secondary measure was a tabulation of the errors.

Eighteen college men served as subjects. The subjects were tested on four trials of twelve minutes each under each of three conditions. The difference in the conditions was the type of break the subjects received. The three conditions were identical except for the break during the fourth trial. One condition served as a control and the subjects received no break. During one of the other conditions the subjects were told to stand, stretch, and breathe deeply during their break (movement condition). For the third condition the subjects were told to converse with the experimenter (conversational condition). The breaks were not actual rest periods since the subjects were told that a signal could appear during the break, but in actuality none did.

The movement condition resulted in a significant improvement over the control. The difference between the conversational condition and the control was not significant. There was no significant difference between the movement and

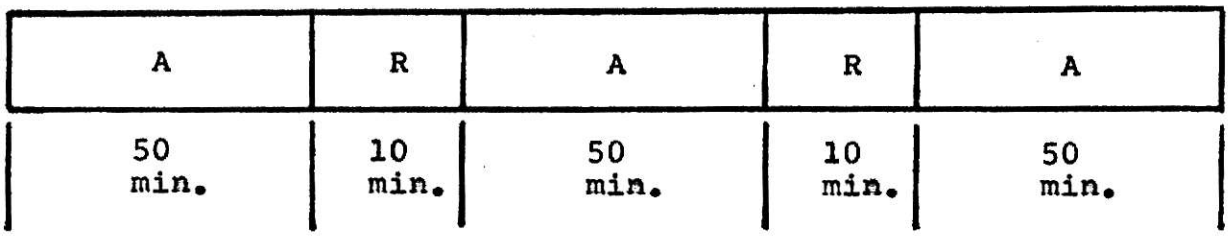
conversational conditions.

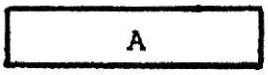
According to Bills' statements, Zuercher had the right idea for his activity during the breaks. Both the movement and the conversation would have been recommended by Bills as having the desired qualities to lessen psychological fatigue. One criticism of Zuercher's study might be that the breaks were not rest periods as such since the subjects had to maintain their vigilance during them. Thus, the subjects would not gain the full benefit to be derived from the activity during the breaks. Perhaps an experimental condition that had combined movement and conversation would have added to the study. It would have been interesting to compare the results of the two factors combined as well as separately.

Reynolds (1971) has conducted the most recent study of the effect of a change period upon task performance. Reynolds' task was an addition task and the change period involved working on a cancellation task. The subjects were 20 college males who were matched into two groups of ten each. Reynolds set up his experiment in the manner shown in Figure 3. Group 1 worked on a change of task schedule while Group 2 worked on the addition task for the total duration of the experiment. Reynolds reached the following conclusions as a result of his experiment:

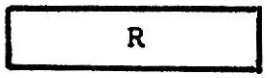
1. The change-of-task group had a lower error rate than the no change group (1.71 versus 2.03). The difference in

Group 1 Change of Task



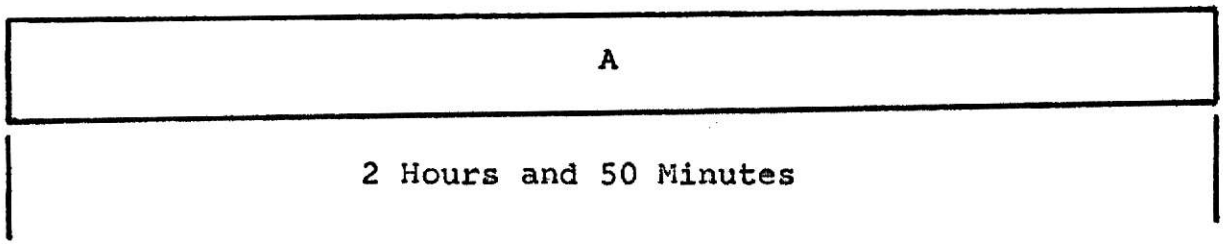


Addition Task



Ranking Task

Group 2 No Change of Task



Reynolds' test sequence.

Figure 3.

periods indicated that fatigue was present after the change of task. The adding and ranking problems may not have been different enough to slow the effect of fatigue.

2. The change-of-task group maintained a steady rate of problems attempted (17.77, 16.06, 16.35) while the rate for the no change group declined (16.67, 14.53, 14.10). This is evidence that the change of task reduced the effects of psychological fatigue.

3. The rate of correct problems followed the same pattern as that of the problems attempted. The change-of-task figures by period were 16.14, 14.51, and 14.26 while the no change figures were 14.62, 12.78, and 11.85.

Reynolds' study goes beyond the work of Chapman and others. Reynolds presented tests of significance which were unavailable to earlier researchers and also corrected errors in the design of previous studies. The time period of almost three hours gives a good indication of what could happen over a long period of time. Since Reynolds' study was done in a laboratory situation there is still a need to relate his findings to an industrial situation.

THE PROBLEM

Rest periods have been proven to be a valuable method of relieving fatigue. Many studies have been conducted dealing with the frequency and length of rest periods, but there has been limited study concerned with the actual manner in which the rest periods should be spent. There is still a need for further research to attempt to define what type of activity during a rest is best for a particular type of task, whether it results in physical or psychological fatigue.

The problem studied in this thesis deals with the reduction of psychological fatigue by the use of an active rest period as opposed to an inactive one. The first hypothesis tested was that for a multiplication task resulting in psychological fatigue, the performance of groups receiving rest periods would be better than that of a group which worked continuously with no rest. More specifically, the hypothesis tested stated that the number of problems attempted and the number done correctly would be greater for the groups receiving a rest than for the one that did not. Furthermore, the number of errors would be fewer for the rest groups as opposed to the no rest group. The second hypothesis was that when dealing with psychological fatigue, an active rest

consisting of such activities as listening to music, talking or strolling about, or having something to drink in a room apart from the work area would be more beneficial than an inactive rest of complete relaxation at the work station. This hypothesis stated that the number of problems attempted and the number done correctly would be greater in the active rest group than the inactive rest group. Also, the errors would be fewer in the active rest group as opposed to the inactive rest. Bills (1943) indicated that this active rest would provide the most beneficial recovery from psychological fatigue, but he did not offer an experiment as proof. A few studies have been conducted studying the effects of an active rest, an inactive rest, and no rest, but they have not combined all of the factors of an avtive rest as described by Bills.

METHOD

Overview

Two experimental treatments and a control were conducted using a total of 30 subjects. The subjects were divided into three groups of ten on the basis of a pretest. The control group worked with no rest periods throughout the duration of the task while the two experimental groups each received two rest periods during the working of the task. The treatments consisted of different activity during the rest periods for each experimental group.

Task

The task chosen for the experiment and the pretest consisted of multiplying a three-digit number by another three-digit number. An example of a page which the subjects worked is given in Figure 4.

Experimental Design

The multiplication task was chosen because it was felt that this task would minimize any possible learning beyond the present knowledge of the subjects. A pilot study indicated that learning was not present. The task was also chosen since it was believed that it would be the type of task to bring on psychological fatigue easily.

846 639	946 227	327 504	184 359
305 900	508 740	857 834	283 591
615 890	136 481	198 495	549 526
227 567	909 153	463 122	357 424

Sample task page.

Figure 4.

A matched subjects design was used whereby a pretest served as the basis for matching the subjects into three groups. The pretest was administered to all subjects at the same time. During the experiment each group was of course located in a room by itself. The three groups performed the experiment simultaneouly.

Figure 5 shows the work schedule for each of the three groups. Since the task involved the subjects sitting for two hours and 30 minutes or two hours and 45 minutes depending upon the group, it was decided to provide the subjects with somewhat comfortable chairs. The chairs used were straight back models which provided padding at the seat and the upper part of the back. It was believed that this type of chair would minimize the discomfort associated with sitting for a long period of time in a wooden, unpadded chair and allow the subjects to concetrate on the task.

Of course the ideal would have been to conduct the experiment in a real world industrial situation, but for this thesis this was not possible. The laboratory situation chosen should yield results similar to those to be expected in a real world situation.

Experimental Treatments

Pretest. The subjects were given a 50 minute pretest one week prior to the running of the experiment. The pretest required performing a multiplication task in order to provide

Group 1 Inactive Rest

Work	Rest	Work	Rest	Work
50 min.	7.5 min.	50 min.	7.5 min.	50 min.

Group 2 No Rest

Work
2 hours and 45 minutes

Group 3 Active Rest

Work	Rest	Work	Rest	Work
50 min.	7.5 min.	50 min.	7.5 min.	50 min.

Work schedule.

Figure 5.

a means of dividing the 30 subjects into three groups of ten each. The pretest was also used to detect any subject who had a performance rate greatly above or below the other subjects.

From the scores of the pretest the subjects were ranked by the number of problems done correctly. A matched subjects design was used to divide the subjects into the three groups. Figure 6 shows this ranking and how the groups were formed. No subject was eliminated because of the pretest. Correlation coefficients were calculated to determine the effectiveness of the matching. The correlation coefficient between groups 1 and 2 was .981; between groups 1 and 3 was .969; and between groups 2 and 3 was .985. The instructions that were presented for the pretest are shown in Figure 7.

No rest group. Group 2 was randomly selected to be the no rest group. This group spent the entire work session performing the multiplication task. This amounted to two hours and 45 minutes (see Figure 5). The instructions presented to this group are shown in Figure 8.

Inactive rest group. Group 1 was randomly selected to be the inactive rest group. This group worked on a work-rest-work-rest-work schedule of 50-7.5-50-7.5-50 minutes (see Figure 5). Thus the total working time was two hours and 30 minutes with a total of 15 minutes of rest. The nature of the activity involved during the rest was the treatment for the group. The treatment involved having the subjects

Subject	Number Correct on Pretest	Group 1	Group 2	Group 3
1	131	x		
2	126		x	
3	120			x
4	109			x
5	109		x	
6	96	x		
7	96	x		
8	94			x
9	93		x	
10	92		x	
11	87	x		
12	87			x
13	86			x
14	80	x		
15	78	x		
16	77		x	
17	74			x
18	73		x	
19	66			x
20	60		x	
21	60	x		
22	55		x	
23	50	x		
24	50			x
25	46	x		
26	43		x	
27	39			x
28	35			x
29	30		x	
30	25	x		

	Group 1	Group 2	Group 3
No. Attempted	993	997	993
No. Errors	244	239	233

Group matching.

Figure 6.

1. You are about to begin a task that will take about 50 minutes.
2. The task consists of multiplying a three-digit number by another three-digit number.
3. You will start with the problem in the upper left of the page, work across that row, and then work the following row from left to right, etc. When you finish the problems on one page turn to the next page in your booklet and continue working.
4. Finish a problem completely before going on to the next one. i.e. perform the multiplication and addition for one problem before continuing on to the next problem.
5. Accuracy is important in this experiment, but do not spend time checking answers.
6. You will mark the task with the pencil provided. You may change an answer as you work that problem, but do not go back to previous problems.
7. Once you begin the task you will work until you are told to stop.
8. If any numbers are illegible, skip to the next problem.
9. Do not turn the page to begin until you are told to do so.
10. Do you have any questions?

Pretest instructions.

Figure 7.

1. You are about to begin a task identical to the one you have already done except that this task will take approximately three hours.
2. The task consists of multiplying a three-digit number by another three-digit number.
3. You will start with the problem in the upper left of the page, work across that row, and then work the following row from left to right, etc. When you finish the problems on one page turn to the next page in your booklet and continue working.
4. Finish a problem completely before going on to the next one. i.e. perform the multiplication and addition for one problem before continuing on to the next problem.
5. Accuracy is important in this experiment, but do not go back to previous problems.
6. You will mark the task with the pencil provided. You may change an answer as you work that problem, but do not go back to previous problems.
7. Once you begin the task you will work until you are told to stop.
8. If any numbers are illegible, skip to the next problem.
9. Do not turn the page to begin until you are told to do so.
10. Do you have any questions?

No rest instructions.

Figure 8.

relax at their work stations, but not allowing them to move about, talk to anyone, or engage in any activity. The subjects remained quietly seated at their desks. See Figure 9 for the instructions presented to this group.

Active rest group. Group 3 was randomly selected to be the active rest group. This group worked on the same work-rest-work-rest-work schedule of 50-7.5-50-7.5-50 minutes as the inactive rest group (see Figure 5). The nature of the activity involved during the rest period was the treatment for the group. Under the active rest treatment, when the subjects had a rest period they left the room in which they were working and went into an adjacent room set up specifically for the rest period. During the rest periods the subjects were free to move about, listen to music, talk with one another and partake of refreshments such as coffee, soft drink, or water. See Figure 10 for the instructions presented to this group.

Procedures

Before the start of the pretest each subject filled out an information sheet such as the one shown in Figure 11.

The experimenter (or assistant) read the instructions to the subjects for the pretest and the experiment and they followed along with their own copy in the front of their task booklet. After any questions were answered, the subjects were told to turn to the next page in their booklet and

1. You are about to begin a task identical to the one you have already done except that this task will take approximately three hours.
2. The task consists of multiplying a three-digit nimber by another three-digit number.
3. You will start with the problem in the upper left of the page, work across that row, and then work the following row from left to right, etc. When you finish the problems on one page turn to the next page in your booklet and continue working.
4. Finish a problem completely before going on to the next one. i.e. perform the multiplication and addition for one problem before continuing on to the next problem.
5. Accuracy is important in this experiment, but do not spend time checking answers.
6. You will mark the task with the pencil provided. You may change an answer as you work that problem, but do not go back to previous problems.
7. During the course of this task you will be given two rest periods. When the experimenter signals the start of a rest period you are to circle the problem you are working on and then close your task booklet. During the rest period remain seated and do not speak to the experimenter or other subjects. Try to just relax and not think about the task. The experimenter will tell you when to begin the task again.

Inactive rest instructions.

Figure 9a.

8. When you start the task following a rest period begin with the problem following the last one you worked on. Do not finish an incomplete problem you were working on when you stopped.
9. Once you begin the task you will work until you are told to rest or told that the task is over.
10. When told to stop for a rest or at the end of the task stop working immediately, do not finish a problem first.
11. If any numbers are illegible, skip to the next problem.
12. Do not turn the page to begin until you are told to do so.
13. Do you have any questions?

Inactive rest instructions.

Figure 9b.

1. You are about to begin a task identical to the one you have already done except that this task will take approximately three hours.
2. The task consists of multiplying a three-digit number by another three-digit number.
3. You will start with the problem in the upper left of the page, work across that row, and then work the following row from left to right, etc. When you finish the problems on one page turn to the next page in your booklet and continue working.
4. Finish a problem completely before going on to the next one. i.e. perform the multiplication and addition for one problem before continuing on to the next problem.
5. Accuracy is important in this experiment, but do not spend time checking answers.
6. You will mark the task with the pencil provided. You may change an answer as you work that problem, but do not go back to previous problems.
7. During the course of this task you will be given two rest periods. When the experimenter signals the start of a rest period you are to circle the problem you are working on and then close your task booklet. The experimenter will then direct you into an adjacent room which has been set up for the rest periods. There you can move about the room, converse with the experimenter and/or other subjects (do not discuss the experiment), or partake of Active rest instructions.

Figure 10a.

the refreshments that will be served. The experimenter will tell you when it is time to return to the other room to continue the task.

8. When you start the task following a rest period begin with the problem following the last one you worked on. Do not finish an incomplete problem you were working on when you stopped.
9. Once you begin the task you will work until you are told to rest or told that the task is over.
10. When told to stop for a rest or the end of the task stop working immediately, do not finish a problem first.
11. If any numbers are illegible, skip to the next problem.
12. Do not turn the page to begin until you are told to do so.
13. Do you have any questions?

Active rest instructions.

Figure 10b.

Subject Name (print) _____

Age _____

Student _____ Non-student _____

Information sheet.

Figure 11.

begin the task. Subjects were instructed that accuracy was important, but not to spend time checking their answers. The results of a pilot study helped to determine the number of pages in the task booklet in such a way as to insure against any subject finishing all of the problems.

Each of the 50 minute work sessions for the two rest groups was subdivided into five ten minute sessions. At the end of these ten minute sessions a reading was taken to determine how many problems each subject had worked. Figure 12 is an example of the form used. The experimenter recorded the page, row, and column of the problem the subject was working on at the end of the ten minute interval. After the experiment the number of problems done, the number correct, and the number of errors was determined for each ten minute interval. A very similar procedure was followed regarding the no rest group. The only difference was that while the active and inactive rest groups were on a rest break the no rest group was still working.

At the end of the pretest and the experiment every subject was asked to answer a question concerning his feelings of tiredness. This question was used to obtain a subjective feeling as to how fatiguing or tiring the task had been. Figure 13 represents this question and the rating scale used.

At the end of the experiment the inactive and active rest groups were asked to answer one additional question.

Subject _____

Type of Rest _____

Check No.	Page	Row	Column	No. Done	No. Correct	No. Errors
Period 1 1						
2						
3						
4						
5						
TOTAL						
Period 2 no rest						
1						
2						
3						
4						
5						
TOTAL						
Period 3 no rest						
1						
2						
3						
4						
5						
TOTAL						

Data gathering.

Figure 12.

Circle the response which best describes your feelings of tiredness or fatigue now that the task is over.

1. Extremely good
2. Very good (as after a good night's rest)
3. Good
4. Medium
5. Tired
6. Very tired (as at the end of a hard day's work)
7. Extremely tired

Do you have any comments?

Subject's fatigue rating.

Figure 13.

This question dealt with how helpful the subjects viewed the rest periods and it is shown in Figure 14.

Subjects

Thirty female subjects were used in this experiment. The subjects were all students at Kansas State University, Manhattan, Kansas. The subjects were selected from the pledge class of one of the campus sororities. The selection of subjects from one group made the task of scheduling the experiment easier. The ages of the subjects ranged from 17 to 20 with a mean of 17.9. All female subjects were used to avoid any differences due to the sex of the subject. All male subjects could have also been used. The subjects were paid for their participation in the pretest and the experiment at the end of the experiment. The pay rate was $1.75 per hour.

Assistants

It was necessary to have five assistant experimenters aid the experimenter in the running of the subjects and data collecting during the experiment. Two experimenters were then assigned to each group. The duties of the experimenters (assistants) were to read the instructions for the task and record the progress of the subjects throughout the task at regular intervals. They were also to record any unexpected or unusual happenings which might affect the results of the experiment. The assistants were all friends of the experimenter and were not paid for their help.

How helpful do you feel the rest periods were in providing a break, and in lessening any tired or fatigued feelings? Circle the appropriate response.

1. Very Helpful
2. Helpful
3. Somewhat Helpful
4. It's Difficult to Judge
5. Not at all Helpful

Do you have any comments?

Rating of the rest periods.

Figure 14.

RESULTS

Overview

The results of this experiment clearly show that an active type of rest is superior to an inactive type of rest or no rest at all in the performance of a mental task. The active rest group averaged more problems attempted and more correct per ten minute interval than either of the other groups. An analysis of the total number of problems attempted, number correct, and number of errors showed that the three groups were statistically equal. This is an important finding since the no rest group worked a total of 15 minutes longer than the two rest groups.

Statistical Tests

In this experiment the three treatment groups were compared by subdividing the three 50 minute work sessions into ten minute intervals. For the analysis of mean values the two seven and one half minute periods in which the no rest group was working and the other two groups were on a rest break were omitted. In comparing total work accomplished the two seven and one half minute periods for the no rest group are included. The data obtained for each ten minute interval is shown in Appendix I. This data represents the number of problems attempted and the number of errors per

subject for each ten minute interval for all three groups. The results were compared by means of an analysis of variance on the IBM 360 computer using AARDVARK programming. Further analysis was conducted using one tailed t-tests and Duncans Multiple Range Test with an alpha level of five per cent.

Mean Values

The analysis of mean values was computed for the number of problems attempted, number done correctly, and the number of errors comparing mean values for ten minute intervals. The analysis of the number of correct problems is not independent of the number attempted and the number of errors. By definition the number of problems correctly done is based upon the number attempted and the number of errors. The mean values considering all three groups combined were 22.31 problems attempted, 17.52 problems correct, and 4.79 errors per ten minute interval. The mean values of the problems attempted, number correct, and number of errors are shown in Table 1 by treatment groups, 50 minute work sessions, and ten minute intervals. Tables 2 to 4 represent the analysis of variance for the number of problems attempted, number done correctly, and the number of errors per ten minute interval.

Number of problems attempted. The analysis of variance showed a significant difference among the three groups in

TABLE 1

Mean Values of Problems Attempted, Number of Errors, and Number Done Correctly per Ten Minute Interval

		Number Attempted *	Number Errors **	Number Correct ***
Group	1 (Inactive)	21.84	4.85	16.99
	2 (No Rest)	21.41	4.92	16.49
	3 (Active)	23.68	4.59	19.09
Work Session	1	22.03	4.74	17.29
	2	22.69	4.89	17.80
	3	22.22	4.74	17.48
Ten Minute Interval	1	21.81	4.91	16.90
	2	23.31	4.69	18.62
	3	21.96	4.41	17.54
	4	22.11	4.64	17.47
	5	22.37	5.29	17.08
Overall Means		22.31	4.79	17.52

* Also see TABLE 5

** Also see TABLE 6

*** Also see TABLE 7

TABLE 2

Analysis of Variance of the Number of Problems Attempted per Ten Minute Interval

Due to	D.F.	Mean Square	F	Alpha Hat
Rest Type (R)	2	218.07	52.690	0.000
Work Session (W)	2	17.27	4.173	0.017
Ten Minute Interval (T)	4	31.94	7.717	0.000
Subject Triplet (S)	9	1132.62	273.662	0.000
RW	4	11.51	2.782	0.028
RT	8	8.00	1.934	0.056
RS	18	160.74	38.837	0.000
WT	8	25.73	6.216	0.000
WS	18	5.47	1.322	0.176
TS	36	4.27	1.032	0.426
RWT	16	5.98	1.446	0.123
RWS	36	7.91	1.911	0.003
WTS	72	5.97	1.442	0.023
Error	216	4.14		
Total	449			

TABLE 3

Analysis of Variance of the Number of Errors per Ten Minute Interval

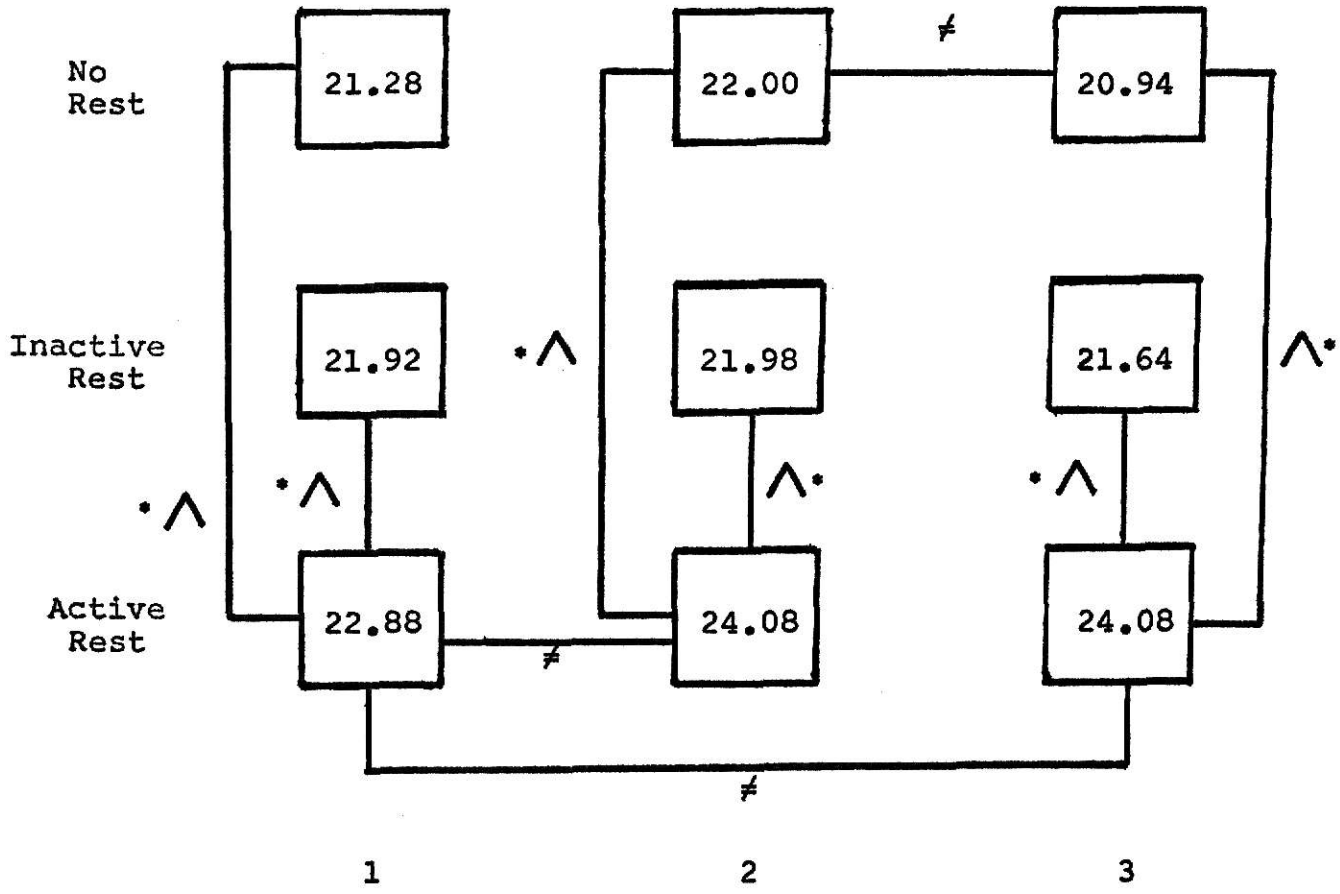
Due to	D.F.	Mean Square	F	Alpha Hat
Rest Type (R)	2	4.47	1.191	0.306
Work Session (W)	2	1.08	0.287	0.751
Ten Minute Interval (T)	4	9.87	2.630	0.035
Subject Triplet (S)	9	139.93	37.296	0.000
RW	4	2.54	0.677	0.609
RT	8	4.47	1.192	0.305
RS	18	81.74	21.787	0.000
WT	8	2.54	0.678	0.710
WS	18	4.54	1.210	0.255
TS	36	3.55	0.947	0.560
RWT	16	8.70	2.319	0.004
RWS	36	6.06	1.615	0.020
WTS	72	3.28	0.874	0.746
Error	216	3.75		
Total	449			

TABLE 4

Analysis of Variance of the Number of Problems Done Correctly per Ten Minute Interval

Due to	D.F.	Mean Square	F	Alpha Hat
Rest Type (R)	2	284.97	44.911	0.000
Work Session (S)	2	10.08	1.589	0.207
Ten Minute Interval (T)	4	40.46	6.377	0.000
Subject Triplet (S)	9	1433.58	225.933	0.000
RW	4	18.83	2.967	0.021
RT	8	6.35	1.001	0.437
RS	18	57.06	8.993	0.000
WT	8	35.15	5.540	0.000
WS	18	3.58	0.565	0.922
TS	36	8.08	1.273	0.151
RWT	16	11.58	1.825	0.029
RWS	36	10.42	1.641	0.017
WTS	72	6.87	1.083	0.327
Error	216	6.35		
Total	449			

the mean number of problems attempted by the subjects per ten minute interval. One tailed t-tests showed that the active rest group average of 23.68 problems attempted per ten minute interval was significantly different from the inactive rest group average of 21.85 and the no rest group average of 21.41. There was no difference between the inactive rest and no rest averages. One tailed t-tests showed significant differences among groups as shown in Figure 15. The active rest group attempted significantly more problems than the other two groups in each work session. There was no difference between the inactive rest group and the no rest group for any work session. The analysis of variance also showed the number of problems attempted per ten minute interval for 50 minute work sessions to be significant. The Duncans test of the 50 minute work sessions is shown in Table 5. Work session two was significantly different from work sessions one and three. The number of problems attempted per ten minute interval was also significant in the analysis of variance. Table 5 also represents the Duncans test for the ten minute intervals. The second ten minute interval was found to be significantly different from the other four. The analysis of variance also showed significance in the subject effect and the rest type by work session, rest type by subject, and work session by ten minute interval interactions. The results of the Duncans tests on these effects are shown in Appendix II. The rest type



Only significant differences are indicated.
All tests have an alpha level = 5%.
* One tailed t-test significance in the indicated direction.
≠ Two tailed test resulting in significance.

Significance tests of number of problems attempted per ten minute interval.

Figure 15.

TABLE 5

Duncans Test of Work Sessions (W) and Ten Minute Intervals (T)

--- Number of Problems Attempted

Work Session	Means	Non-Significant Groupings Connected by Column of Asterisks
W(2)	22.69	
W(3)	22.22	*
W(1)	22.03	*

Ten Minute Interval		
T(2)	23.31	
T(5)	22.37	*
T(4)	22.11	*
T(3)	21.96	*
T(1)	21.81	*

by work session interaction is also shown in Figure 15 as two tailed tests. Two three way interactions were also significant.

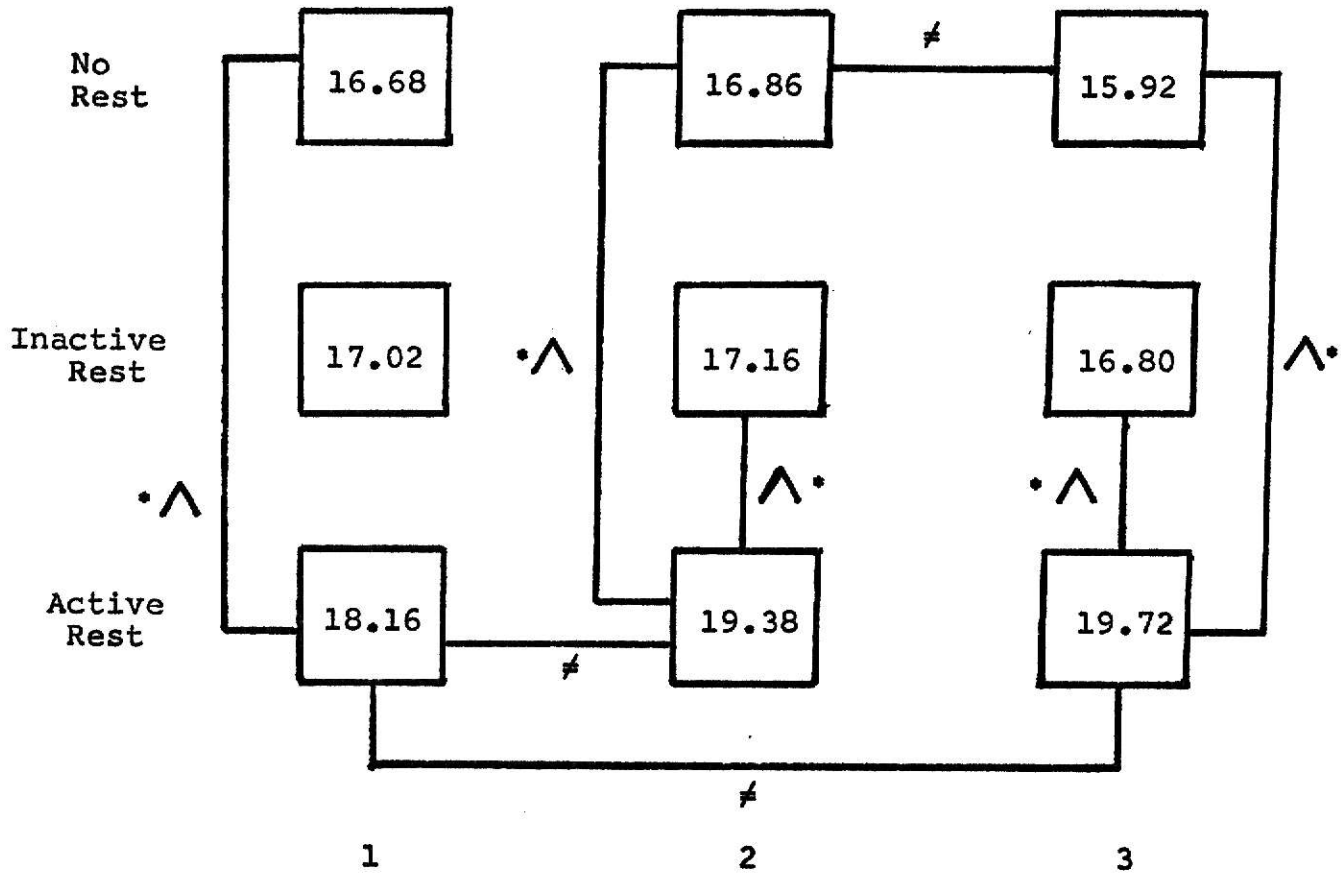
Number of errors. The analysis of variance did not show a significant difference among treatment groups in the mean number of errors per ten minute interval. There was a significant difference among ten minute intervals. The Duncans test, Table 6, shows the error rate for the fifth ten minute interval to be significantly different from the other intervals. Significant differences were also found in the subject effect and the rest type by subject interaction. The Duncans tests of these effects are shown in Appendix II. Two three way interactions were also significant.

Number of problems correct. Significant differences were found in the number of problems correct for the treatment groups. One tailed t-tests showed that the active rest group average of 19.09 problems done correctly per ten minute interval was significantly different from the inactive rest group average of 16.99 and the no rest group average of 16.49. There was no difference between the inactive rest and no rest averages. One tailed t-tests showed differences among groups as shown in Figure 16. The active rest group did significantly more problems correctly than the inactive rest and no rest groups in work sessions two and three. The active rest group also

TABLE 6

Duncans Test of Ten Minute Intervals --- Number of Errors

Ten Minute Interval	Means	Non-Significant Groupings Connected by Column of Asterisks	
T(5)	5.29	*	
T(1)	4.91	*	*
T(2)	4.69		*
T(4)	4.64		*
T(3)	4.41		*



Only significant differences are indicated.
All tests have an alpha level = 5%.
* One tailed t-test significance in the indicated direction.
≠ Two tailed test resulting in significance.

Significance tests of number of problems done correctly per ten minute interval.

Figure 16.

did more correctly than the no rest group in work session one. There was no difference between the inactive rest group and the no rest group for any work session. The number of problems done correctly per ten minute interval was also significant in the analysis of variance. A Duncans test shown in Table 7 reveals that the rate of correct problems in the second ten minute interval is significantly different from the other intervals. Significance was also found in the subject effect and the rest type by work session, rest type by subject, and work session by ten minute interval interactions. The Duncans tests of these effects are shown in Appendix II. The rest type by work session interaction is also shown in Figure 16 as two tailed tests. Two three way interactions were also significant.

Totals

Table 8 shows the total number of problems attempted, total number correct, and the total number of errors for each group. An analysis of variance was conducted comparing the totals by subject for the two rest groups and the no rest group. The no rest group totals included the additional 15 minutes of work. The analyses of variance of the totals are shown in Table 9. There were no significant differences among groups in the total attempted, total done correctly, and total errors while there were differences among subjects.

TABLE 7

Duncans Test of Ten Minute Intervals --- Number of Problems Done Correctly

Ten Minute Interval	Means	Non-Significant Groupings Connected by Column of Asterisks
T(2)	18.62	
T(3)	17.54	*
T(4)	17.47	*
T(5)	17.08	*
T(1)	16.90	*

TABLE 8

Total Number of Problems Attempted, Total Errors, and Total Correct by Treatment Group

Group	Total Attempted	Total Errors	Total Correct
No Rest	3211	741	2470
No Rest*	3514	809	2705
Inactive Rest	3277	728	2549
Active Rest	3552	689	2863

* includes 15 minutes inactive and active groups were on rest breaks

TABLE 9

Analyses of Variance of Total Problems Attempted, Total Correct, and Total Errors

Total Problems Attempted

Due to	D.F.	Mean Square	F	Alpha Hat
Rest Type	2	2220.63	0.795	0.467
Subject Triplet	9	17720.58	6.346	0.000
Error	18	2792.23		
Total	29			

Total Problems Correct

Due to	D.F.	Mean Square	F	Alpha Hat
Rest Type	2	2646.90	2.143	0.146
Subject Triplet	9	22802.64	19.822	0.000
Error	18	1150.39		
Total	29			

Total Errors

Due to	D.F.	Mean Square	F	Alpha Hat
Rest Type	2	374.70	0.293	0.749
Subject Triplet	9	2444.09	1.913	0.116
Error	18	1277.92		
Total	29			

Subjective Judgments

Table 10 shows the results of the questionnaire concerned with the subject's feelings of tiredness or fatigue after the experiment. Table 11 shows the subjects' responses to the questionnaire concerned with the helpfulness of the rest periods in lessening any tired or fatigued feelings.

TABLE 10

Response to the Question, Which Best Describes Your Feelings of Tiredness or Fatigue now that the Task is Over?

	No Rest	Inactive Rest	Active Rest
Extremely Good			
Very Good			
Good			
Medium		1	
Medium-Tired			1
Tired		3	5
Very Tired	8	2	
Extremely Tired	2	2	3
No Response		2	1

TABLE 11

Response to the Question, How Helpful Do You Feel the Rest Periods Were in Providing a Break, and in Lessening any Tired or Fatigued Feelings?

	Inactive Rest	Active Rest
Very Helpful	1	7
Helpful	4	1
Somewhat Helpful	1	1
It's Difficult to Judge	3	
Not at all Helpful	1	1

DISCUSSION

General Results

The results of this experiment clearly show the advantage of an active type of rest period as opposed to an inactive type of rest or no rest at all in the performance of the multiplication task. This experiment showed that the active rest was significantly better than the inactive rest and the no rest in the number of problems attempted and the number done correctly per ten minute interval. This supports Bills' (1943) and Offner's (1911) contentions that for a task involving a mental aspect an active type of rest is best. The findings also showed that there was no difference in performance between the inactive rest and the no rest groups. The inactive rest did not bring about the positive effect upon performance that the active rest did. There was no significant difference between the total problems attempted, total correct, and total errors. This finding is important since the no rest group worked 15 minutes longer than the rest groups.

Fatigue and Learning

This task did not show the performance decrement that was expected. Maier (1955) stated that fatigue would occur within an hour with this type of task. The multiplication task had the characteristics of sameness and continuity

associated with psychological fatigue, but the fatigue was not apparent. The performance of the no rest group did not show the expected decrement even though the subjects in this group indicated feelings of being very tired or extremely tired on the fatigue questionnaire.

There was an indication that a learning effect cancelled the fatigue effect. There was a significant interaction in the rest type by work session effect for the problems attempted and the number correct. Work sessions two and three were significantly different from work session one of the active rest group. More problems were done correctly in work sessions two and three indicating the positive effect of the active rest. The active rest showed a learning effect between work sessions one and two. The inactive rest and no rest groups did not show any learning between work sessions one and two. This suggests that a learning effect was cancelled by a fatigue effect for the inactive rest and no rest groups. An analysis of variance was conducted comparing the 50 minute pretest with the first 50 minute work session of the experiment to test the learning effect. The analyses of variance for the number of problems attempted, number correctly done, and the number of errors per 50 minutes are shown in Table 12. There was a significant difference between the number attempted in the first work session of the experiment, 110.13, and the pretest, 99.43. Work session one of the experiment also resulted in significantly more problems

TABLE 12

Analyses of Variance of the Pretest versus the First Work Session of the Experiment --- Total Problems Attempted, Total Correct, and Total Errors

Total Problems Attempted

Due to	D.F.	Mean Square	F	Alpha Hat
Condition	1	1717.35	47.379	0.000
Subject	29	1309.85	36.137	0.000
Error	29	36.25		
Total	59			

Total Correct

Due to	D.F.	Mean Square	F	Alpha Hat
Condition	1	1728.06	38.581	0.000
Subject	29	1567.13	34.988	0.000
Error	29	44.79		
Total	59			

Total Errors

Due to	D.F.	Mean Square	F	Alpha Hat
Condition	1	1.07	0.041	0.840
Subject	29	285.69	11.108	0.000
Error	29	25.72		
Total	59			

correct than the pretest (86.30 for the experiment versus 75.57 for the pretest). There were also differences among subjects. The findings suggest that a learning effect was involved in the performance of the task. This learning effect seemed to cancel the fatigue that was expected between work sessions one and two of the no rest group. The fatigue effect was evident between work sessions two and three of the no rest group. The no rest group attempted and did correctly significantly fewer problems in work session three than work session two. The findings indicate that for this type of multiplication task the effects of learning begin to lessen and the fatigue becomes dominate after about two hours of continuous work. A fatigue effect was also evident in the error rate per ten minute interval. The last interval was significantly different from the other four in the error rate. This indicates fatigue at the end of the 50 minute work sessions.

Individual Differences

There were significant differences due to subjects in the mean values per ten minute interval and in the totals for the problems attempted, problems done correctly, and the number of errors. This was not an unexpected finding. The purpose of the pretest was to match the three groups and minimize the chance of individual differences affecting the experimental results. A correlation of the effectiveness of the matching comparing the pretest and work session one

of the experiment yielded a coefficient of .94. The analysis of variance resulted in significant differences in the rest type by subject interaction for the problems attempted, number correct, and the number of errors per ten minute interval. Table 13 represents the results of the Duncans test comparing each matched triplet of subjects for the number of problems correct. In each triplet the subject receiving the active rest performed better than, or at least as well as, the other subjects. The rest type by subject interactions for the problems attempted and number of errors are not as meaningful as that for the number of correct problems because the subject triplets were formed by matching on the basis of correct problems. The triplets would have been different, and thus the comparisons of the triplets different, if the problems attempted or the errors had been the matching criteria.

Questionnaires

Fatigue. When analyzing a job and attempting to determine how fatiguing the work is the employee's feelings should be taken into consideration. In the case of this experiment the multiplication task did not result in the step by step performance decrement that was expected, but the subjects indicated that they were indeed fatigued by the task. Of the 27 subjects answering the fatigue questionnaire, 25 indicated that they were either tired, very tired, or extremely tired. In the no rest group eight subjects

TABLE 13

Duncans Test Comparing Each Matched Triplet of Subjects for the Number of Correct Problems --- Rest Type by Subject Interaction

Non-Significant Groupings Connected by Column of Asterisks

Subject Triplets: Ranked from best to worst	1		2	
	R(1)	27.87 *	R(3)	28.00
	R(2)	26.53 *	R(2)	24.87
	R(3)	26.27 *	R(1)	19.87

3		4		5		6	
R(1)	21.87 *	R(3)	22.67	R(3)	19.73	R(1)	18.40 *
R(2)	21.13 *	R(2)	20.67	R(1)	16.80	R(3)	18.00 *
R(3)	20.00 *	R(1)	17.60	R(2)	13.07	R(2)	14.53 *

7		8		9		10	
R(3)	16.67 *	R(3)	14.93 *	R(3)	13.53	R(3)	11.07
R(1)	15.53 *	R(1)	14.20 *	R(1)	11.07 *	R(2)	7.87 *
R(2)	12.93	R(2)	12.47	R(2)	10.80 *	R(1)	6.73 *

R(1) Inactive Rest
R(2) No Rest
R(3) Active Rest

indicated that they were very tired while the other two felt extremely tired. While no significance tests were applied to these few data, there appear to be differences in subjective response to the treatments. The feelings of the workers should be important to an industry. A worker's feelings of fatigue may not necessarily show up in his performance, but they could eventually lead to worker difficulties.

Rest periods. A limited amount of research has been conducted considering the type of activity the workers engage in during rest periods from mental tasks. There is little research to indicate that one type of activity is more helpful than another in eliminating or lessening any tired or fatigued feelings and thus, aiding performance. In this experiment seven of the subjects in the active rest group found the rest periods to be very helpful in lessening fatigue while only one subject in the inactive rest group found the rest periods to be very helpful. Subjective judgments are important in providing additional insight into certain areas. In this experiment the active rest group's rating of the rest periods as very helpful corresponds to the high performance of the group following the rest periods.

Further Research

Research should definitely be conducted on other types of tasks. There should be studies relating different types

of tasks and activity during rest periods. Bills (1943) and Offner (1911) state that when a task involves a physical element then complete relaxation is the best type of rest. There has been limited research conducted in this area. Marschak (1936) found an active type of rest to be more beneficial than complete relaxation, but his report was lacking in many respects. He did not present the number of subjects tested, the length of the rest periods, or any tests of significance. The hypothesis of complete relaxation after a physical task could be dependent upon the type of physical task. If the task results in exhaustion then complete relaxation seems to be a logical response to physical fatigue. If the task is fatiguing to some particular muscles, but not completely exhausting, then perhaps some form of an active rest would be better than complete relaxation. A variety of both physical and mental tasks should be studied. Some aspect of a rest period may be more beneficial in lessening fatigue from one task than another.

Another area for further research would be the frequency at which the workers receive a rest period. In this experiment it might have been better to extend the work session from 50 minutes to an hour and a half or two hours. For another type of task a rest period might be necessary every half an hour. The frequency of rest periods would be dependent upon the type of task and each task should be studied separately.

Self imposed rest periods as opposed to specified ones is also an important consideration. Workers do not have the same tolerance for a job. Some may not feel tired at all when they have to stop for a rest period while others may have been ready for the rest long before they received it. These individual differences show the need for a study comparing self imposed with specified rest periods.

A change of task period is at times preferable to a rest period. The change of task can provide a recovery from fatigue and at the same time result in the accomplishment of work. By introducing change of task periods the amount of time devoted to rest periods can be reduced. A proper frequency and distribution of rest periods and change of task periods can result in increased performance and employee job satisfaction. This experimenter does not know of any research that has attempted to combine the positive effects of the change of task period and the rest period. This experiment has shown the value of rest periods and that the activity during the rest is important. Reynolds (1971) conducted an experiment over a three hour period in which a change of task group of subjects performed significantly better than a group receiving no change. The next area for research is a combination of the change of task and rest period effects. An experiment of this nature should be conducted using as a period of study the length of a working day.

Most experiments are conducted in a laboratory situation. Conditions are more easily controlled and the findings can usually be related to industrial situations. There should be an attempt to conduct experiments in actual industrial situations with periods of study equal in length to the working day. This experiment showing the value of an active rest as a break from a mental task could be reproduced in industry. There are possible problems associated with conducting experiments in industrial situations. Variables cannot be controlled as easily as in a laboratory situation. An experimenter would also have to be aware of the possibility of findings due to the increased attention paid to the workers rather than an effect due to treatments (Hawthorne Effect). If these problems and any others can be minimized then the benefit from an industrial experiment can be well worth the effort required to conduct it.

Practical Implications

Previous research on the type of activity during rest periods has contained deficiencies such as a lack of tests of significance, no control group, or a short period of study. Bills (1943) and Offner (1911) stated that a rest period consisting of mildly stimulating activity such as the active rest in this experiment would be the best type of break from a mental task, but they did not offer any evidence. This experiment is the first to the knowledge of this experimenter that corrects these deficiencies and

proves the value of an active type of rest as a break from a mental task. Zuercher (1965) conducted an experiment on vigilance in which he found a break consisting of movement to be better than no break. He also found a break consisting of conversation to be equal to the no break and movement conditions. His findings indicate that perhaps movement is the most important aspect of an active rest. In this case the location of the rest area outside of the workroom provides the desired movement. Zuercher's period of study was only 48 minutes long and should be expanded.

The results of this experiment can be directly applied to industry through a better utilization of the time spent during rest periods. Industries should be more concerned with a benefit to be derived from the rest period rather than with providing a rest just for the sake of a rest. A better utilization of rest periods will result in more productive workers as well as less fatigued ones. The analysis of the performance totals also indicates that time can be devoted to rest periods without sacrificing production. There were no significant differences in the totals for the treatment groups even though the no rest group worked 15 minutes longer than the rest groups.

CONCLUSIONS

An active type of rest is clearly superior to an inactive type of rest or no rest at all in the performance of a mental task. The active rest group attempted and did correctly more problems per ten minute interval than the inactive rest and no rest groups. An analysis of the total number of problems attempted, number correct, and number of errors showed that the three groups were statistically equal. This finding is important since the no rest group worked a total of 15 minutes longer than the two rest groups.

There are many areas for further research in this field. A variety of both physical and mental tasks should be studied. There should also be studies concerned with the frequency and duration of rest periods. Self imposed versus specified rest periods is also an area for consideration.

This experiment has corrected the deficiencies of previous research such as a lack of tests of significance, no control group, or a short period of study. The results of this experiment can be applied to industry through a better utilization of the time spent during rest periods.

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APPENDIX I

Raw Data

Inactive Rest Group

First 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
1	25/4	30/1	25/4	25/5	23/10
2	15/3	14/5	15/2	15/4	14/4
3	25/2	26/2	21/5	22/1	23/7
4	23/3	19/2	19/3	19/2	18/4
5	15/6	10/4	11/4	12/4	12/3
6	18/3	18/6	19/6	14/4	16/4
7	19/2	23/3	22/5	20/3	22/5
8	32/2	34/2	33/3	32/1	33/5
9	31/7	30/10	27/11	28/10	28/11
10	25/9	29/11	20/5	23/13	24/10

Inactive Rest Group

Second 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
1	26 / 6	31 / 6	29 / 3	26 / 4	29 / 4
2	14 / 4	16 / 4	15 / 3	16 / 2	15 / 2
3	24 / 4	23 / 0	23 / 1	25 / 3	20 / 0
4	17 / 4	22 / 3	19 / 4	20 / 4	23 / 3
5	8 / 3	11 / 7	9 / 5	12 / 3	8 / 3
6	17 / 5	16 / 2	18 / 5	16 / 2	18 / 3
7	21 / 4	23 / 5	21 / 3	25 / 2	20 / 6
8	29 / 3	34 / 2	30 / 2	29 / 3	32 / 6
9	30 / 13	33 / 9	25 / 8	26 / 8	25 / 10
10	26 / 8	29 / 14	28 / 10	22 / 12	25 / 11

Inactive Rest Group

Third 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
1	26 / 11	27 / 5	26 / 2	26 / 6	30 / 5
2	15 / 6	16 / 4	16 / 4	16 / 6	11 / 4
3	19 / 2	24 / 3	22 / 1	22 / 4	19 / 5
4	18 / 4	17 / 3	19 / 0	21 / 2	20 / 1
5	10 / 4	16 / 7	11 / 5	9 / 3	10 / 2
6	19 / 2	18 / 2	18 / 1	19 / 3	19 / 2
7	19 / 7	20 / 2	22 / 4	21 / 3	23 / 3
8	28 / 4	30 / 1	31 / 3	31 / 2	26 / 7
9	28 / 14	28 / 12	28 / 4	27 / 9	29 / 11
10	28 / 8	24 / 7	25 / 11	26 / 12	29 / 9

No Rest Group

First 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
11	19/6	24/4	15/1	13/4	18/1
12	29/11	30/2	26/3	20/4	31/8
13	26/2	28/1	24/2	26/2	28/5
14	23/11	22/9	20/6	19/8	22/8
15	16/3	14/2	14/1	12/1	10/0
16	28/3	31/0	28/1	25/2	26/1
17	23/7	23/3	21/11	22/10	21/6
18	26/10	23/5	24/1	23/2	24/7
19	16/7	16/8	17/9	13/7	16/10
20	19/2	19/2	17/2	9/6	25/7

No Rest Group

Second 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)					
	7½	17½	27½	37½	47½	57½
11	13/4	14/5	19/6	18/5	21/7	22/5
12	20/4	31/9	28/6	26/6	29/3	26/15
13	23/3	32/3	31/6	27/2	32/8	27/3
14	9/4	23/9	20/6	18/8	31/14	16/6
15	10/2	10/2	13/1	10/1	14/3	15/2
16	20/0	31/1	29/1	27/2	29/1	26/1
17	17/10	25/12	25/10	27/9	23/9	23/6
18	18/2	26/4	26/3	27/3	26/3	25/5
19	8/2	10/4	15/7	9/5	15/6	15/5
20	12/2	17/1	18/3	15/6	18/4	20/3

No Rest Group

Third 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)					
	7½	17½	27½	37½	47½	57½
11	13/0	14/5	15/6	14/0	17/6	15/4
12	19/3	26/6	29/3	28/8	30/8	29/9
13	20/3	28/4	27/3	30/1	28/3	26/2
14	12/7	17/5	18/6	18/9	20/8	22/9
15	10/0	13/2	13/3	13/2	8/1	15/4
16	17/1	27/1	27/2	28/2	30/1	27/2
17	19/9	22/12	25/12	26/13	26/11	27/11
18	18/4	24/4	22/2	24/4	23/3	25/2
19	12/7	16/7	19/9	19/5	14/7	13/10
20	13/1	15/3	11/4	15/2	16/4	13/2

Active Rest Group

First 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
21	28/5	30/5	26/2	26/6	30/4
22	24/6	30/14	22/7	26/13	22/8
23	32/2	33/4	28/2	28/1	29/0
24	27/4	29/9	24/8	27/5	29/7
25	15/4	13/5	18/7	17/8	18/6
26	18/4	21/2	20/2	18/1	21/4
27	24/2	29/10	20/6	22/4	26/4
28	19/4	24/4	22/4	20/4	20/5
29	14/1	14/3	16/1	15/2	15/2
30	21/3	25/5	21/8	24/8	24/1

Active Rest Group

Second 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
21	29/5	34/7	27/3	33/2	27/5
22	21/9	27/8	26/9	23/8	23/10
23	30/3	34/1	29/4	30/1	31/3
24	29/7	32/5	27/8	31/4	29/9
25	15/7	20/5	21/10	22/8	18/6
26	19/3	20/4	21/4	23/5	24/8
27	22/2	25/5	27/3	24/3	20/3
28	18/3	21/2	22/3	21/1	23/4
29	14/2	18/3	19/5	18/0	17/6
30	21/2	25/4	24/2	25/3	25/8

Active Rest Group

Third 50 Minute Work Session

No. Attempted / No. Errors

Subject Number	Time (Minutes)				
	10	20	30	40	50
21	30/4	31/2	31/2	33/2	33/0
22	24/12	25/6	20/10	25/9	26/11
23	27/1	32/2	32/5	32/3	29/4
24	27/4	32/7	29/6	30/3	32/8
25	21/9	21/9	16/10	21/7	21/10
26	17/5	15/1	27/2	18/4	21/4
27	22/3	23/3	25/3	25/4	25/4
28	18/2	21/1	23/1	18/1	22/3
29	18/6	19/2	18/2	13/2	18/6
30	23/3	24/3	23/2	25/0	23/5

APPENDIX II

Additional Duncans Tests

Duncans Test of Subject Effect --- Number of Problems Attempted

Subject Triplets	Means	Non-Significant Groupings Connected by Column of Asterisks		
S(1)	29.58			
S(2)	26.98	*		
S(3)	26.24	*		
S(4)	24.96		*	
S(6)	24.31		*	
S(8)	20.80			*
S(7)	20.73			*
S(5)	20.11			*
S(10)	14.76			
S(9)	14.64			

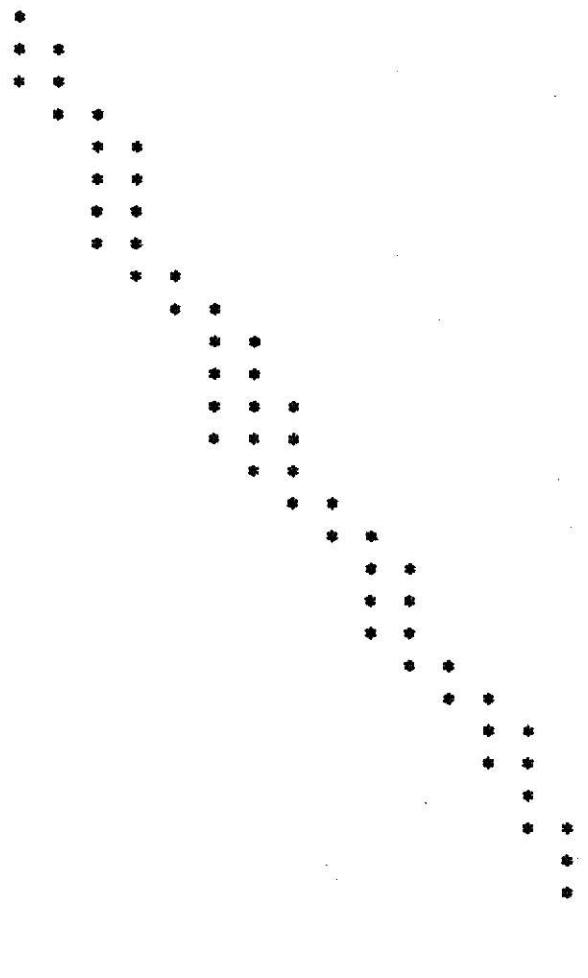
Duncans Test of Rest Type (R) by Work Session (W) Interaction---
Number of Problems Attempted

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks		
RW(3,2)	24.08	*		
RW(3,3)	24.08	*		
RW(3,1)	22.88			
RW(2,2)	22.00		*	
RW(1,2)	21.98		*	
RW(1,1)	21.92		*	
RW(1,3)	21.64		*	*
RW(2,1)	21.28		*	*
RW(2,3)	20.94			*

R 1 Inactive Rest
R 2 No Rest
R 3 Active Rest

Duncans Test of Rest Type (R) by Subject (S) Interaction ---

Number of Problems Attempted

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks
RS(1,1)	30.93	
RS(3,2)	30.40	
RS(3,1)	29.87	
RS(3,4)	28.93	
RS(1,6)	28.20	
RS(2,2)	28.00	
RS(2,1)	27.93	
RS(2,3)	27.87	
RS(1,3)	26.93	
RS(1,7)	25.53	
RS(2,4)	24.53	
RS(3,8)	24.27	
RS(2,6)	23.93	
RS(3,3)	23.93	
RS(3,5)	23.53	
RS(1,2)	22.53	
RS(1,4)	21.40	
RS(3,6)	20.80	
RS(2,8)	20.60	
RS(3,7)	20.20	
RS(1,5)	19.60	
RS(3,10)	18.47	
RS(1,8)	17.53	
RS(2,5)	17.20	
RS(2,7)	16.47	
RS(3,9)	16.40	
RS(2,10)	14.87	
RS(1,9)	14.87	
RS(2,9)	12.67	
RS(1,10)	10.93	

R 1 Inactive Rest

R 2 No Rest

R 3 Active Rest

Duncans Test of Work Session (W) by Ten Minute Interval (T) Interaction --- Number of Problems Attempted

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks
WT(2,2)	23.93	*
WT(1,2)	23.70	*
WT(2,4)	23.50	* *
WT(3,5)	22.60	* *
WT(3,3)	22.57	* *
WT(1,1)	22.50	* * *
WT(3,4)	22.33	* * *
WT(3,2)	22.30	* * *
WT(1,5)	22.27	* * *
WT(2,5)	22.23	* * *
WT(2,3)	22.13	* * *
WT(2,1)	21.63	* * *
WT(3,1)	21.30	* * *
WT(1,3)	21.17	* *
WT(1,4)	20.50	*

Duncans Test of Subject Effect --- Number of Errors

Subject Triplet	Means	Non-Significant Groupings Connected by Column of Asterisks
S(6)	7.33	*
S(8)	6.93	* *
S(10)	6.20	* *
S(7)	5.69	* *
S(3)	5.24	* *
S(4)	4.64	*
S(5)	3.58	*
S(9)	2.84	* *
S(2)	2.73	* *
S(1)	2.69	*

Duncans Test of Rest Type (R) by Subject (S) Interaction ---

Number of Errors

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks
RS(1,7)	10.00	*
RS(1,6)	9.80	*
RS(2,6)	9.40	* *
RS(3,8)	9.33	* *
RS(2,8)	8.13	* *
RS(3,10)	7.40	* *
RS(2,10)	7.00	* *
RS(2,3)	6.73	* *
RS(3,4)	6.27	* *
RS(1,3)	5.07	* *
RS(1,10)	4.20	* *
RS(2,5)	4.13	* *
RS(3,3)	3.93	* * *
RS(2,4)	3.87	* * *
RS(1,4)	3.80	* * *
RS(1,9)	3.80	* * *
RS(3,5)	3.80	* * *
RS(3,1)	3.60	* * *
RS(2,7)	3.53	* * * *
RS(3,7)	3.53	* * * *
RS(1,8)	3.33	* * *
RS(2,2)	3.13	* * *
RS(1,1)	3.07	* * *
RS(3,9)	2.87	* * * *
RS(1,5)	2.80	* * * *
RS(3,6)	2.80	* * * *
RS(1,2)	2.67	* * * *
RS(3,2)	2.40	* * *
RS(2,9)	1.87	* *
RS(2,1)	1.40	*

R 1 Inactive Rest

R 2 No Rest

R 3 Active Rest

Duncans Test of Subject Effect --- Number of Problems Done Correctly

Subject Triplets	Means	Non-Significant Groupings Connected by Column of Asterisks
S(1)	26.89	
S(2)	24.24	
S(3)	21.00	*
S(4)	20.31	*
S(6)	16.98	*
S(5)	16.53	*
S(7)	15.04	
S(8)	13.87	
S(9)	11.80	
S(10)	8.56	

Duncans Test of Rest Type (R) by Work Session (W) Interaction --- Number of Problems Done Correctly

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks		
RW(3,3)	19.72	*		
RW(3,2)	19.38	*		
RW(3,1)	18.16			
RW(1,2)	17.16		*	
RW(1,1)	17.02		*	*
RW(2,2)	16.86		*	*
RW(1,3)	16.80		*	*
RW(2,1)	16.68		*	*
RW(2,3)	15.92			*

R 1 Inactive Rest
R 2 No Rest
R 3 Active Rest

Duncans Test of Rest Type (R) by Subject (S) Interaction ---

Number of Problems Done Correctly

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks
RS(3,2)	28.00	*
RS(1,1)	27.87	*
RS(2,1)	26.53	* *
RS(3,1)	26.27	* *
RS(2,2)	24.87	*
RS(3,4)	22.67	*
RS(1,3)	21.87	* *
RS(2,3)	21.13	* * *
RS(2,4)	20.67	* *
RS(3,3)	20.00	* * *
RS(1,2)	19.87	* * *
RS(3,5)	19.73	* *
RS(1,6)	18.40	* *
RS(3,6)	18.00	* *
RS(1,4)	17.60	*
RS(1,5)	16.80	* *
RS(3,7)	16.67	* *
RS(1,7)	15.53	* *
RS(3,8)	14.93	* * *
RS(2,6)	14.53	* *
RS(1,8)	14.20	* * *
RS(3,9)	13.53	* * *
RS(2,5)	13.07	* * *
RS(2,7)	12.93	* * *
RS(2,8)	12.47	* * *
RS(1,9)	11.07	* *
RS(3,10)	11.07	* *
RS(2,9)	10.80	*
RS(2,10)	7.87	*
RS(1,10)	6.73	*

R 1 Inactive Rest

R 2 No Rest

R 3 Active Rest

Duncans Test of Work Session (W) by Ten Minute Interval (T) Interaction --- Number of Problems Done Correctly

Entry	Means	Non-Significant Groupings Connected by Column of Asterisks				
WT(2,2)	19.03	*				
WT(2,4)	18.97	*				
WT(1,2)	18.93	*				
WT(3,3)	18.47	*	*			
WT(1,1)	18.00	*	*	*		
WT(3,2)	17.90	*	*	*		
WT(3,4)	17.77	*	*	*		
WT(2,3)	17.40		*	*	*	
WT(3,5)	17.30		*	*	*	
WT(1,5)	17.07		*	*	*	*
WT(2,5)	16.87			*	*	*
WT(1,3)	16.77			*	*	*
WT(2,1)	16.73			*	*	*
WT(3,1)	15.97				*	*
WT(1,4)	15.67					*

ACTIVITY DURING REST PERIODS --- EFFECT UPON PSYCHOLOGICAL FATIGUE

by

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The effects of type activity during rest periods were tested on thirty female students (17-20 years of age). The subjects were matched by means of a 50 minute pretest into three groups of ten each. The control group spent two hours and 45 minutes working at a multiplication task. The other groups each received two seven and one half minute rest periods between two hours and 30 minutes work on the multiplication task. During the rest periods the inactive rest group subjects sat at their work stations and did not talk to anyone. The active rest group subjects moved about, talked to one another, and partook of refreshments.

The active rest group attempted and did correctly significantly more problems per ten minute interval than the other two groups. There was no difference in the error rate for the three groups. In the problems attempted, number correct, and errors per ten minute interval there was no difference between the control and the inactive rest groups. The three groups were found to be statistically equal in the totals for the number attempted, number correct, and number of errors. The findings indicate that an active rest, as a break in the performance of a mental task, is desirable.