Arh. hig. rada *15* (1964) 183

EFFECT OF THE NUMBER AND LENGHT OF REST PAUSES ON WORK OUTPUT IN STATIC EFFORT*

B. Petz

Institute of Psychology, Faculty of Letters, University of Zagreb, Zagreb

(Received June 6, 1964)

It was considered of interest to see how changes in the number and length of rest pauses affect work output. The experiment was carried out on 11 subjects by the Henry mercury dynamometer. The total lenght of the experiment amounted to 4 minutes, while the ratio between the total length of work and the total time of rest was 3:1. The following situations were analysed:

Lenght of work and rest pauses in seconds (numbers in brackets = pauses):

Without the rest = 240
(A) 90 + (60) + 90 = 240
(B) 60 + (30) + 60 + (30) + 60 = 240
(C) 45 + (20) + 45 + (20) + 45 + (20) + 45 = 240

The subject squeezed the rubber bulb as much as he could, and tried to maintain the maximum strain without visual control. The height of the mercury column was read every 5 seconds. »Work output« was obtained by adding up all the readings. The results: The average work output was 892 in experiment (A), 955 in (B), and 977 in (C). If there were no rest pauses at all and the work alone lasted 4 mintes, the work output was 880.

The differences obtained are statistically significant. The results show that in the static effort of this kind it is better to have more shorter than less fewer longer rest pauses.

In the literature of occupational psychology it is generally considered more useful to take several short rest pauses than a single long one. It is interesting, however, to note that *experimentally* this attitude has so far been only vaguely proved. Several authors have carried out respective investigations in practice, in certain working situations, trying to find out *when* it is most effective to introduce rest pauses, what should

* This paper, in a shorter form, was presented at the XIV International Congress of Industrial Medicine, Madrid, 1963.

be their, *lenght* and *how many* pauses in the course of the working time would prove most appropriate (*Shepard* (1), *McGehee and Owen* (2). and others).

However, since the practical objective of these investigations was primarily to increase production, in most of these experiments *several* factors were varied at the same time, so that final effect could hardly by interpreted. If, for instance, in the course of working time the length or the number of rest pauses are varied, the *actual* working time and the total duration of rest are changed as well. Thus, for instance, *McGehee and Owen* succeeded in increasing the work output in an office by introducing two rest pauses lasting 8 minutes each, but they also prolonged the working time by an additional 15 minutes of work.

This shows that in most of these experiments the actual working time and the duration of rest were not constant under all experimental conditions. *Pressey* (3) seems to have been one of the very few authors who tried to keep the experimental situation unchanged in this respect, by studying the work output in the course of the working time within which both the total duration of work and the total duration of rest were *more or less* constant.

However, under *laboratory* conditions there have already been conducted several experiments which in this respect were methodologically »flawless«. They were organized in such a way as to ensure that in spite of introducing variations regarding the number and the length of rest pauses, the *total* duration of work and the *total* duration of rest remained the same in all experimental situations. *Müller and Karrasch* (4) examined the total recovery pulse (EPS – Erhohlungspulssumme) after a one-hour experiment, by varying the number and lenght of rest pauses but keeping the relation between rest and work unchanged in all experimental situations, e. g. 1 : 2. Thus, for instance, the subject was working on a bicycleergometer for an hour with four 5-min rest pauses, or with eight 2.5-min rest pauses, or with thenty 1-min rest pauses, etc. In these experiments they found that EPS was the lower, the shorter were the pauses introduced. *Cristensen* (cited by 4), under similar experimental conditions, has found that maximum oxygen consumption, maximum pulse frequency, and maximum amount of lactic acid were lowest when work was broken by *frequent, short* rest pauses.

Althorgh these experiments quite significantly support the assumption that it is better to have more short rest pauses than less long ones, the *criteria* by which this conclusion is made still seem quite remote from practice: can it not be questioned whether either the EPS, or the maximum oxygen consumption, or the maximum amount of lactic are higly correlated with man's actual *working* capacities?

In view of this we decided to carry out a series of experiments in which work *output* was to be the criterion for the effectiveness of various numbers and various lengths of rest pauses.

METHOD

Since our experiments were to relate to *static effort*, they were bound to last a *short time*. The total duration of each experiment was limited to 4 minutes. The relation between work and rest was 3 : 1, i. e. the work lasted 3 minutes, and the rest 1 minute. The number of rest pauses varied from 1 to 3. Thus there were three experimental situations:

Experiment A: Work 90 sec, rest pause 60 sec, work 90 sec = total 240 sec.

Experiment B: Work 60 sec, rest pause 30 sec, work 60 sec, rest pause 30 sec, work 60 sec, = total 240 sec.

Experiment C: Work 45 sec, rest pause 20 sec, work 45 sec, rest pause 20 sec, work 45 sec, rest pause 20 sec, work 45 sec = = total 240 sec.

One more experimental situation was observed: *work was uninterruptedly* carried out throughout all 240 seconds. This variation was introduced to see whether work output would after all be higher if all the time designed for the experiment (i. e. 240 seconds) was spent on work.

The experiments were performed by means of the Henry mercury dynamometer on 11 subjects. The subject was sitting in front of the dynamometer, embracing the rubber bulb with his right hand. To avoid the slipping of the fingers, his fist was »tied up« to the bulb by a strip of material. At the given signal his task was to grip the bulb as hard as he could and continue to maintain the maximum effort *without any visual control*. In order to make it impossible for the subject to have visual control and also to make him assist in the experimenter's work, at the moment of gripping the rubber bulb he had to put in action a stop-watch and every 5 seconds loudly inform the experimenter about the number of seconds passed. Thus, every 5 seconds the experimenter recorded the height of the mercury column. In all the subjects, with smaller or greater variations, the column of mercury significantly went down in the course of static effort. The experimenter stopped the subject in his effort in the intervals designed for the respective experiment, and then the work went on according to the procedure already described. During the rest pauses the subject relaxed his grip on the rubber bulb.

The »work output« was obtained by *summing up* the readings of the mercury columns in 5-sec intervals.

For each subject the order of the experiments was selected at random, and each subject performed each series of experiments three times. The subject's average work output in all three experiments was considered representative for him in individual experimental situations.

Each subject carried out only one experiment a day.

RESULTS

The average work output in the experiments A, B, and C, and in the experiment without any rest pause was as follows:

	Without pause	*A*	*B*	*C*
Work output	880	892	955	977

As is seen, the *lowest* work output was achieved in the experiment *without any pause,* although the actual work in this experiment lasted longer than in other experiments. Amongst the experiments with rest pauses, the lowest work output was obtained in the experiment with one single pause, and the highest in the experiment with three rest pauses.

Table 1
Experimental situations

Subjects	Without pause	A	B	C
1	991 (4)	1157 (3)	1232 (1)	1217 (2)
2	1139 (2)	1055 (4)	1057 (3)	1173 (1)
3	762 (4)	775 (3)	931 (1)	890 (2)
4	1074 (4)	1121 (3)	1220 (2)	1260 (1)
5	544 (4)	596 (3)	655 (2)	671 (1)
6	765 (2)	728 (3)	840 (1)	637 (4)
7	904 (1)	839 (2)	746 (4)	774 (3)
8	862 (4)	916 (2)	881 (3)	1157 (1)
9	725 (4)	886 (3)	925 (2)	992 (1)
10	1079 (2)	894 (4)	1130 (1)	1009 (3)
11	833 (4)	844 (3)	890 (2)	963 (1)
Rank sum T_i	35	33	22	20

$$\chi_r^2 = \left(\frac{12}{Nk\,(k+1)} \times T_i^2 \right) - 3\,N\,(k+1)$$

$$= \left(\frac{12}{44 \times 5} \times 3198 \right) - 33 \times 5 = 9.44$$

$df = k - 1 = 3$

$P < 0.05$

It should be taken into account that the differences in »work output« would have been even greater, if »work output« had been determined in a more exact way, because by reading the height of the mercury column every 5 seconds, neither the height of the column at the moment the subject gripped the bulb nor the height obtained in the course of the firs 5 seconds were recorded. In the experiment without any rest pause these walues were not recorded once, in the A experiment they were not recorded twice, in the B experiment 3 times, and in the C experiment 4 times.

The signififance of the difference between these results was tested by a parametric and a non-parametric test, i. e. by the analysis of variance of related samples and the Friedman test relating to the analysis of variance of related ranks. Both tests showed the significance of difference on a level of significance lower than 5 % ($F = 3.69$ $P < 0.05$; $\chi_r^2 = 9.44$, $P < 0.05$). The original results of each subject, as well as the calculation procedure by means of the Friedman test are shown in Table 1. The first numbers relate to »work output«, and the numbers in bracket show the rank order obtained by ranking all the results of the subject (4 in all).

The results of these experiments have fully proved that – at least at the static effort of this kind – it is better to allow more short rest pauses than a single long one.

The mechanism of this phenomenon could be explained in this way:

Manzer (6) has already shown that restitution in the phase of rest follows the curve of negative acceleration. *Bujas and Petz* (7) have shown the same as regards static work. This means that by short rest pauses we gain relatively more than by long rest pauses, and by introducing frequent short rest pauses we shorten the interval between rest pauses. *Bujas et al.* (8) have shown that there is strong indication that in the course of work the development of fatigue follows the curve of positive accelleration, which means that frequent interruption of work by rest pauses is more economical.

REFERENCES

1. *Shepard, G. H.:* Pers. Journal, 7 (1928) 186.
2. *McGehee, W., Owen, E. B.:* J. Appl. Psych. *24* (1940) 604.
3. *Pressey, S. L. et al.:* A Psychological Survey, Harper, 1939, p. 524.
4. *Müller, E. A., Karrasch, K.:* Arb. physiol. *16* (1955) 45.
5. *Lundgren, N. P. V.:* L'étude du travail, No 121 (1961) 7.
6. *Manzer, C. W.:* Psychol. No 90 (1927).
7. *Bujas, Z., Petz, B.:* Arh. hig. rada, *1* (1950) 428.
8. *Bujas, Z. et al.:* Acta Instituti Psychologici, 1964 (in print).

SADRŽAJ

UTJECAJ BROJA I TRAJANJA ODMORA NA RADNI UČINAK KOD STATIČKOG RADA

Kod 11 ispitanika ispitano je na dinamometru na živu kako broj i trajanje odmora utječu na radni učinak. Ukupno trajanje eksperimenta iznosilo je 4 minute, a odnos rad/odmor bio je 3 : 1. Pokusi su izvršeni u ovim eksperimentalnim situacijama: bez pauze (240 sek), A = jedna pauza od 60 sek; B = dvije pauze od po 30 sek; C = tri pauze od po 20 sek.

Ispitanik je bez vidne kontrole maksimalno stisnuo gumenu krušku i držao je – stalno uz maksimalni napor – do znaka za prestanak rada. Pri tome se visina stupca žive smanjivala, a radni učinak dobiven je zbrajanjem vrijednosti očitavanja visine stupca svakih 5 sekundi.

Rezultati: »Radni učinak« u pokusu bez pauze = 880, u pokusu A = 892, u pokusu B = 955, i u pokusu C = 977. Razlike su statistički značajne, a to znači da je u radu ove vrste ukupni radni učinak veći, ako su pauze kraće i brojnije.

Psihologijski institut, Filozofski fakultet
Sveučilišta u Zagrebu, Zagreb

Primljeno 6. VI 1964.