Hiroshima J. Med. Sci.
Vol.38, No.2, 69~74, June, 1989
HIJM 38-11

Fatigue Caused by Visual Display Terminal Work: An Experimental Investigation

Junko TANAKA

Department of Hygiene, Hiroshima University School of medicine, 1-2-3, Kasumi, Minami-ku, Hiroshima 734, Japan

ABSTRACT

Experiments were carried out to examine fatigue during VDT work under circumstance in which the conditions of rest and work were combined. Four experimental conditions based on rest types and work content were designed as follows: 1, (input of interesting sentences) + (dynamic rest); 2, (input of interesting sentences) + (static rest); 3, (input of meaningless numbers) + (dynamic rest); and 4, (input of meaningless numbers) + (static rest).

One operation unit was comprised of 50 min of VDT work and 15 min of rest. Subjects were assigned to three operation units in both the morning and afternoon.

Flicker test, kinetic vision examination, inquiry into subjective symptoms, and test of single digit addition for 10 minutes according to Kraepelin's examination were conducted both before and after morning and afternoon operation sessions, for four times per day. Flicker test and kinetic vision examination were carried out immediately before and after each individual operation unit.

Results obtained are shown as follows:

1) When input conditions were compared, e.g. sentence input vs. number input, there was no significant difference in the complaint rate of subjective symptoms, the amount of single digit addition or in Flicker test value. The decrease in kinetic vision levels after each afternoon operation in the sentence input group was slightly smaller than that in the number input group.

2) When rest conditions were compared, there was no difference in the results of total input, Flicker test value and amount of single digit addition between dynamic rest and static rest. The complaint rate of subjective symptoms in the static rest group at the end of afternoon operations, increased remarkably as compared with the dynamic rest group.

3) The recovery of kinetic vision levels was more marked in the dynamic rest group than in the static rest group.

From these results, it is inferred that in order to recover from fatigue caused by VDT work, dynamic rest is more effective than static rest. Therefore, dynamic rest, applied at the job site should be an efficient means of recovery from fatigue.

Key words: *VDT work, Subjective symptom, Rest conditions, Work contents*

Microelectronic technology has made rapid progress in the last two decades and many workers in the industrial field are exposed to visual display terminal (VDT) work[1,4,25]. It is often said that VDT work has adverse effects on the worker's physical and psychological condition[7,12,16,20,28,31], in particular exerting a strong effect on the latter[2,3,8,11,19]. Clearly, VDT work requires mental exertion. On the other hand, there are reports that active rest[32,35], which means active exercise during rest time, is effective in recovery from mental fatigue. Since VDT work is mental work by nature, it is hypothesized that active rest during VDT work would be more effective than non-active rest.

The need to reduce the negative effects of VDT work on physical as well as psychological health has increased. In response to such demands, various recommendations and regulations for VDT work have been presented[14,15] in the industrialized countries. In Japan, two sorts of recommendation have been proposed by the committee on VDT work sponsored by the Japan Society of Industrial Hygiene[31] and the Ministry of Labor. However, there is no report concerning the type of rest during VDT work for relief from mental fatigue. An experiment was designed to examine the fatigue incurred during VDT work under which one of two rest and work conditions was combined.

SUBJECTS AND METHODS

Subjects were four women's junior college sophomores (19 or 20 years old) who had learned computer skills in the preceding year. The experiments were carried out in the third week of December,

Table 1. Schedule of the experiment.
A — D; subjects

Conditions	Combination of the experiment			
	first day	second day	third day	forth day
input of interesting sentence and dynamic rest	A	D	C	B
input of interesting sentence and static rest	B	A	D	C
input of meaningless numbers and dynamic rest	C	B	A	D
input of meaningless numbers and static rest	D	C	B	A

1986. The computers used were IBM 5560s, and the character color was green with a black background. Temperature and humidity were kept between 20 and 21 °C and 40 and 50%, respectively. There have been many reports[9,10,30,33,36] on variables in the work situation, such as tables, chairs, lighting and the level of screen brightness. In the present experiment, these conditions were in accordance with Ministry of Labour guidelines[29] and the report of the Industrial Health Meeting[31].

The four experimental conditions concerning rest conditions and work content were designed as follows. Work content was determined according to 2 conditions; input of interesting sentences and input of meaningless numbers. Rest conditions were also organized under 2 types: dynamic rest involving gymnastic exercises outdoors for 8 min and static rest involving listening quietly to music for 8 min in the operation room.

The four experimental conditions were: (input of interesting sentences) + (dynamic rest), (input of interesting sentences) + (static rest), (input of meaningless numbers) + (dynamic rest), and (input of meaningless numbers) + (static rest).

The schedule of the experiment is shown in Table 1. One operation unit comprised 50 min of VDT work and 15 min of rest. There were 3 operation units in both the morning and afternoon, or a total of 6 operation units, 300 min of VDT work, per day. The daily VDT work schedule is shown in Fig. 1.

Measurement A comprised the Flicker test[5], kinetic vision examination[23], inquiry of subjective symptoms (using "Inquiry of Subjective symptom"[21,34] recommended by the Study Group on Industrial Fatigue), and test of single digit addition for 10 min according to Kraepelin's examination[6]. Measurement A was performed at each pre-operation, post-operation 3, pre-operation 4 and post-operation 6, 4 times a day altogether. Measurement B involved Flicker test and kinetic vision examination and was carried out immediately before and after each operation unit (Fig. 1).

The total number of inputs, that is the number of figures or characters keyed in by subjects in each operation unit was considered to be the work amount.

In order to obtain the rate of decrease from

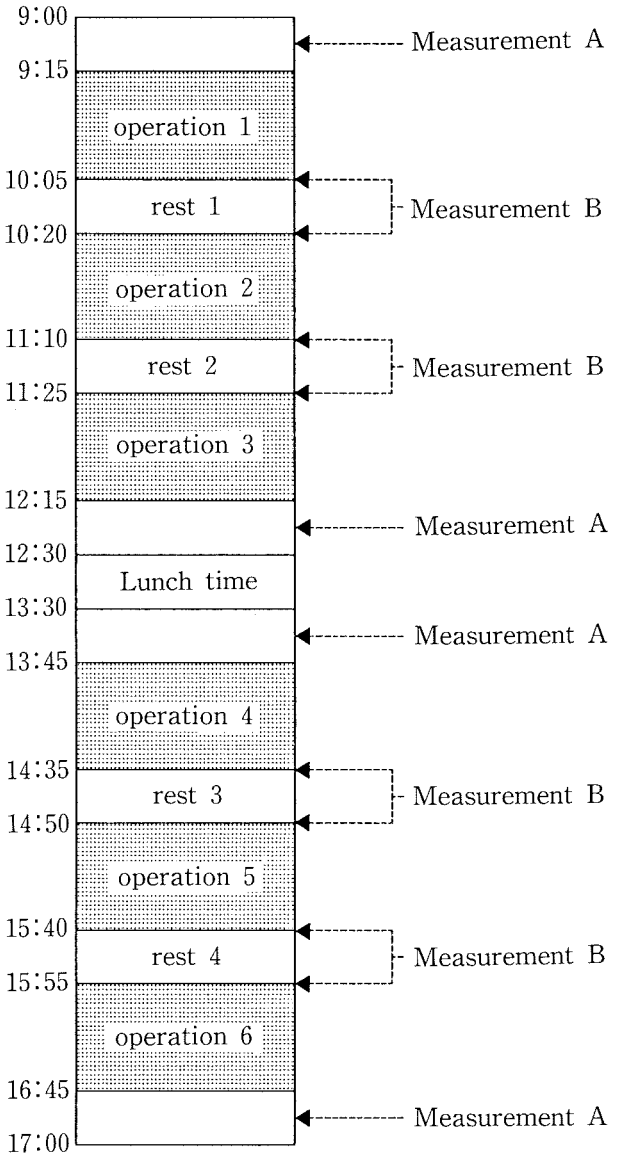

Fig. 1. VDT daily work schedule.
Measurement A; Flicker test
Kinetic vision examination
Inquiry of subjective symptoms
Single digit addition
Measurement B; Flicker test
Kinetic vision examination

Table 2. Recovery rates of kinetic vision level after each rest.

	rest 1	rest 2	rest after lunch time	rest 3	rest 4	
the sentence input group	110.7	115.4	114.7	102.7	105.6	N.S.
the number input group	112.7	110.4	116.2	106.3	114.3	
the dynamic rest group	112.9	114.5	117.1	112.3	120.6	$p<0.05$
the static rest group	110.8	110.5	113.8	97.5	100.3	

Measurement A data, a formula was as follows.

Rate of decrease:

$$\left(1 - \frac{\text{post-operation unit value}}{\text{pre-operation unit value}}\right) \times 100\ (\%)$$

In cases where the rate of decrease is below 0, the post-operation unit value shows an increase compared with the pre-operation value.

In order to determine the recovery rate from kinetic vision examination data, the following formula was used.

Recovery rate:

$$\frac{\text{post-rest kinetic vision level}}{\text{pre-rest kinetic vision level}} \times 100\ (\%)$$

The inquiry concerning subjective symptoms of fatigue was divided into 3 groups[21,34] according to symptoms. Group I: drowsiness and dullness, Group II: difficulty in concentration, Group III: projection of physical disintegration. The rate of subjective symptoms was calculated for all symptoms and for the 3 groups individually.

RESULTS

In the Kinetic vision examination, the post-operation level, as compared with the pre-operation level, decreased in all operation units in the dynamic rest groups (rate of decrease: 8.4 ~ 13.2%) (Fig. 2). The value in the static rest groups decreased in the morning operations (rate of decrease: 4.0 ~ 13.3%), but in the afternoon operation, a smaller decrease or even an increase was observed (rate of decrease: -4.9 ~ 4.0%) (Fig. 2). The value in the number input groups decreased in all operation units. Whereas the value in the sentence input groups decreased in the morning operations, in the afternoon operation a smaller decrease, or increase, was observed. There was no significant difference between the recovery rates of kinetic vision in input groups, whereas there was a significant difference in the resting groups ($p<0.05$, median test)[13] (Table 2).

The Flicker test value of pre-operation 1 was higher than that of post-operation 6 (Fig. 3). There was no significant difference between the value of pre-operation 1 and that of post-operation 6 in either the input groups or the resting groups.

The complaint rate of subjective symptoms increased at post-operation 3 and post-operation 6 as compared with that at pre-operation 1 (Fig. 4). There was no significant difference in the complaint rate between input conditions. In both the sentence input group and the number input group, the complaint rates at post-operation 6 was increased markedly over those at pre-operation 1 ($p<0.05$). The complaint rate in the static rest group was higher than that in the dynamic rest group at post-operation 6, but the difference was not significant.

Overall, the complaint rate of Group I in the static rest group at post-operation 6 was higher than that at pre-operation 1 ($p<0.01$, Fig. 5).

The amount of single digit addition and error rate is shown in Figs. 6 and 7. No significant difference was noted in either the amount or the error rate

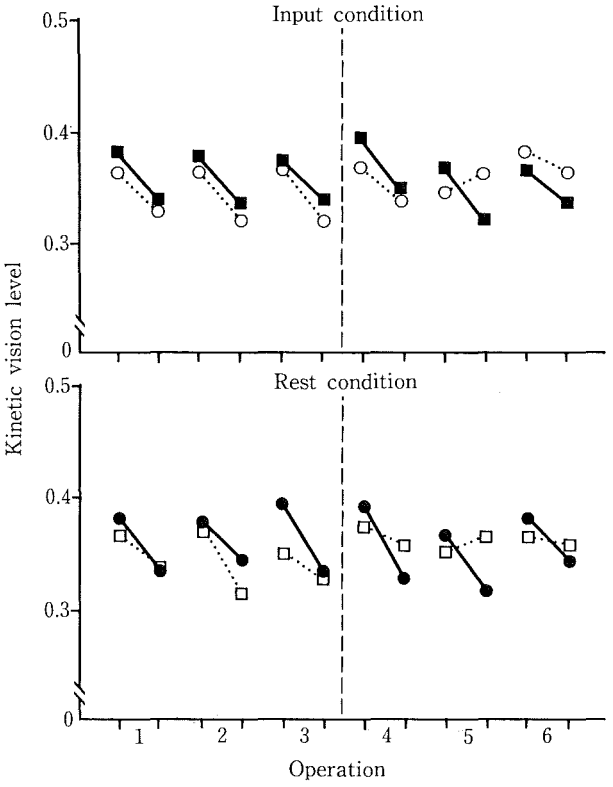

Fig. 2. Kinetic vision levels; pre- and post-operation.
■——■ ; number input group
○·····○ ; sentence input group
●——● ; dynamic rest group
□·····□ ; static rest group
These symbols are used in Figs. 3,4,5,6,7 and 8.

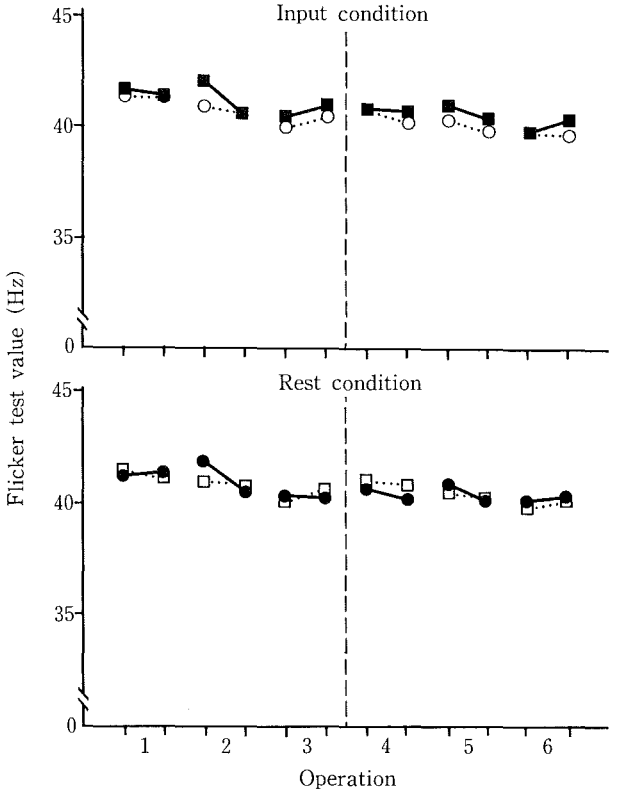

Fig. 3. Flicker test values; pre- and post-operation.

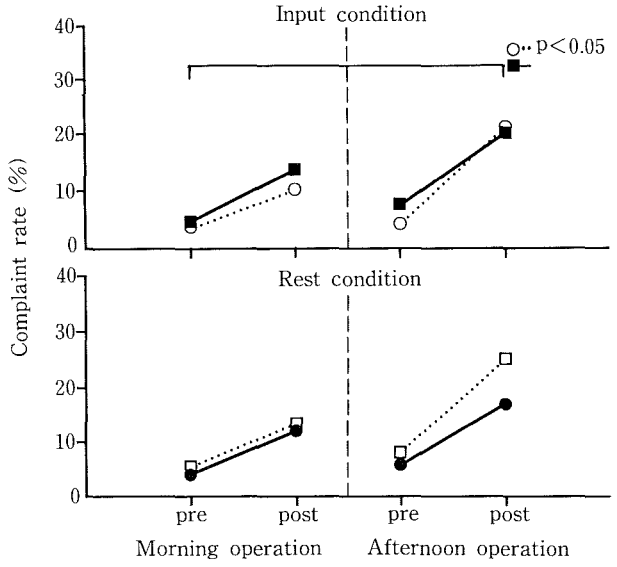

Fig. 4. Complaint rates of subjective symptoms.

of input or rest conditions.

There was no significant difference in the total number of inputs between the resting groups (Fig. 8). Regarding input conditions, the total number of inputs in the number input groups was greater than in the sentence input groups. The error rate of the total number of inputs showed no significant difference between input groups and resting (Fig. 8).

DISCUSSION

Fatigue caused by VDT work is affected not only

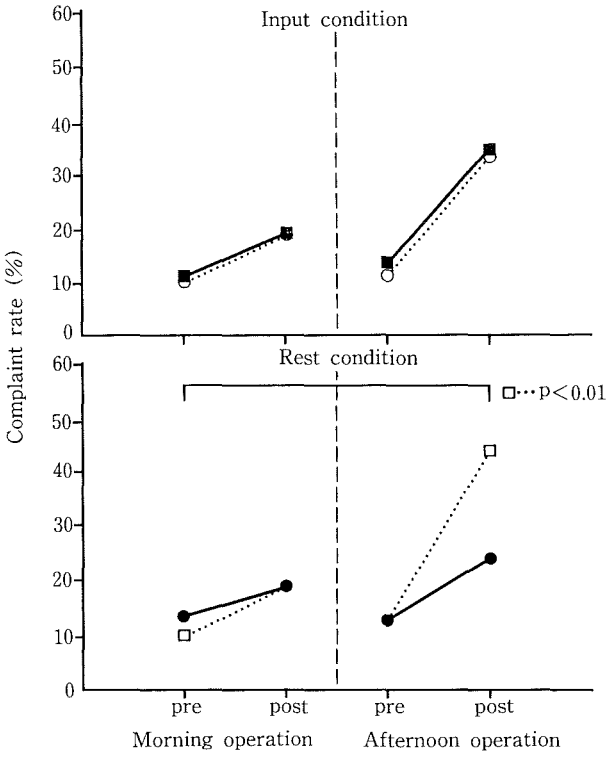

Fig. 5. Complaint rates of Group I for subjective symptoms.

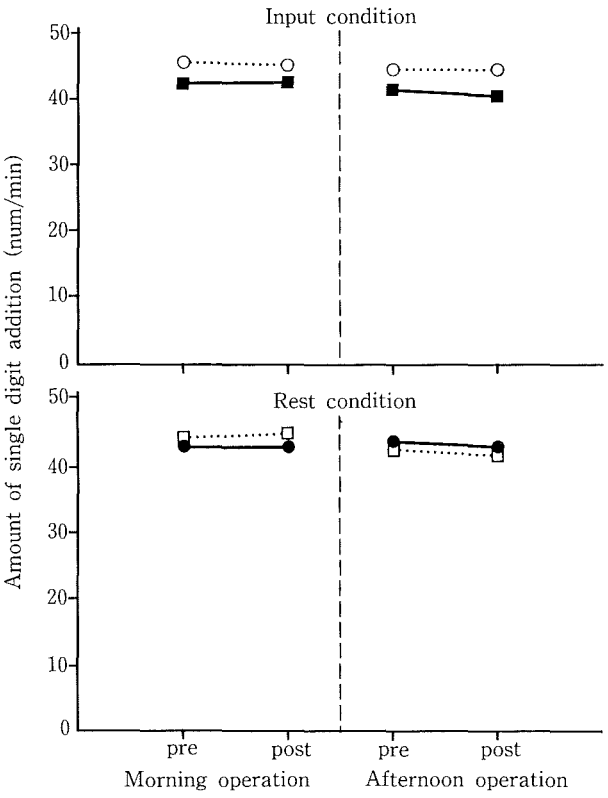

Fig. 6. Amount of single digit addition.

by working circumstances and working time but also by worker age, experience, work content, living conditions, and commuting conditions. Although

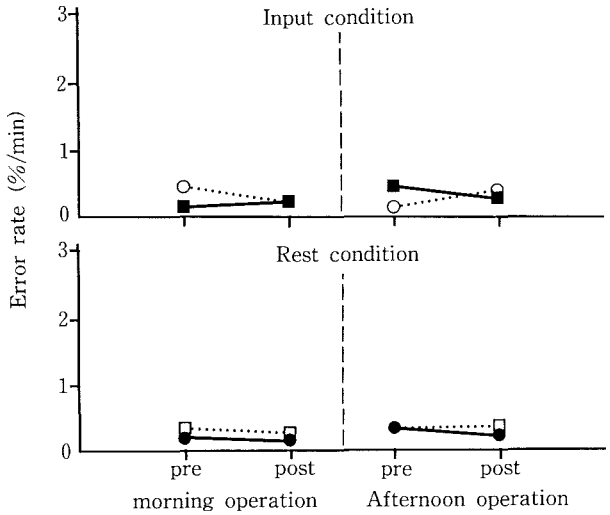

Fig. 7. Error rates in the amount of single digit addition.

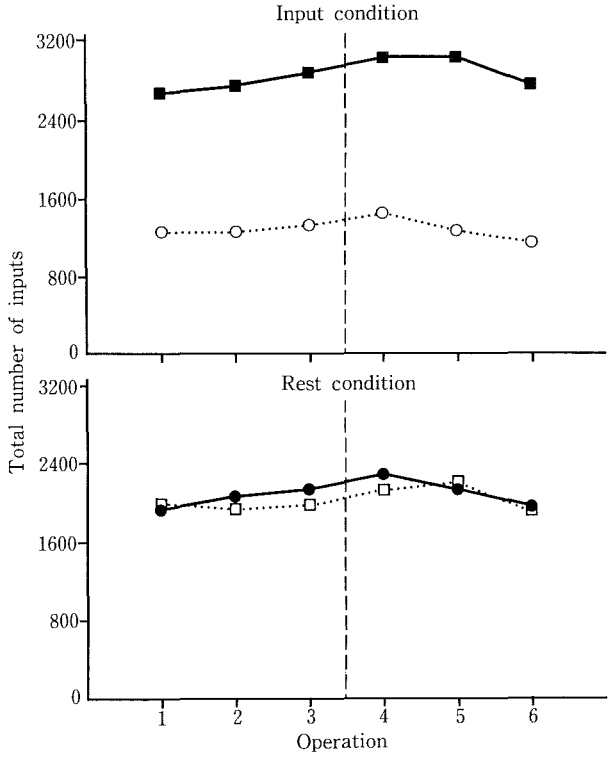

Fig. 8. Total number of inputs.

there have been many reports[17,18,22,24,26,27] dealing with these factors, no concrete recommendations or guidelines for VDT work have been mentioned. The present study focused on a relatively unexplored factor experimentally examining differences in fatigue under varying conditions of rest.

The total number of inputs in the number input groups was twice that of the sentence input groups. However, the total number of inputs in the sentence input groups differed only slightly from that in the number input group. This is because in order to input one KANJI character multiple keying is required, and the keying for character conversion was not counted in the total number of inputs.

There was no significant difference in the complaint rates of subjective symptoms of fatigue and the amount of single digit addition between the sentence input group and the number input group. The Flicker test value at post-operation 6 was lower than that at pre-operation 1, both in the sentence input group and the number input group. However, the rate of decrease of kinetic vision levels in the sentence input groups of the afternoon operation was smaller than in the number input groups. Thus, it was inferred that the recovery from fatigue was not sufficient during resting time in the case of the sentence input group.

Regarding rest conditions, the complaint rate of subjective symptoms of fatigue in the dynamic rest groups increased slightly at post-operation 6, while in the static rest groups it increased markedly. This suggests that the fatigue in static rest was more severe than in dynamic rest, though the total number of inputs was at the same level. The complaint rate in the static rest group was raised by the high complaint rate of Group I, which involved symptoms of "drowsiness and weariness". Based on these findings, it is inferred that drowsiness and weariness have a tendency to increase in cases of static rest. Because the rate of decrease in kinetic vision levels in the static rest groups of afternoon operation was smaller than in the dynamic rest groups, it is inferred that recovery from fatigue during resting time in the case of the static rest group was insufficient.

The total number of inputs was influenced work fatigue and the effect of practice, the latter increasing the number of total inputs from operation 1 to operation 4. The recovery rate of kinetic vision levels in all groups decreased after rest following operation 4, when the number of total inputs reached its highest level. Regarding the recovery rate of kinetic vision, there was no significant difference between input conditions, but there was a significant difference between resting conditions. These results indicate that dynamic rest is more effective than static rest in recovery from VDT work fatigue.

As physical fatigue has been considered one of the important problems for industrial workers, countermeasures should be established quickly. Due to the development of microelectronics and the subsequent decrease in physical labor, physical fatigue is now being replaced by mental fatigue. The present study indicated that in VDT work dynamic rest is more effective in recovery from mental fatigue. Therefore, dynamic rest at the VDT job site should be employed as an effective and acceptable countermeasure to this special type of fatigue.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Professor Hisanori Okuda for his guidance and valuable advice. My appreciation also to Assistant

Professor Yukio Hiraoka.

An earlier version of this report was presented at the 58th Annual Meeting of The Japanese Society for Hygiene (Okayama, 1988).

(Received August 26, 1988)
(Accepted May 1, 1989)

REFERENCE

1. **Endo, Y.** 1983. "Konnichi no MEka to rodosha ishiki". Digest of Science of Labour **38**: 3.
2. **Horie, Y.** 1987. A study on optimum term of work hour with rest pause for VDT workers. The Japanese Journal of Ergonomics **23**: 373—383.
3. **Hosokawa, T.** 1985. "VDTsagyo ni okeru sagyo-jikan kanri no igi". Digest of Science of Labour **40**: 35—40.
4. **Ishigaki, T.** 1983. "Seisan-genba ni okeru MICRO-ELECTRONICS no eikyo". Digest of Science of Labour **38**: 28—35.
5. **Kirihara, H.** 1962. "Kinou kensa-ho". p. 239—243. DOBUN SHOIN, TOKYO.
6. **Kirihara, H.** 1962. "Kinou kensa-ho". p. 369—373. DOBUN SHOIN, TOKYO.
7. **Minagawa, Y. and Chiba, N.** 1985. Relationship Between Work condition and Fatigue-Feeling in VDT Workers by Questionnaires. Jpn. J. Ind. Health **27**: 587.
8. **Misawa, T., Yoshino, K. and Shigeta, S.** 1984. An Experimental Study on the Duration of a Single Spell of Work on VDT Performance. Jpn. J. Ind. Health **26**: 296—302.
9. **Misawa, T. and Shigeta, S.** 1986. An experimental study of work load on VDT performance Part 1. Effects of polarity of screen and color of display. Jpn. J. Ind. Health **28**: 420—427.
10. **Misawa, T. and Shigeta, S.** 1986. An experimental study of work load on VDT performance Part 2. Effects of difference in input devices. Jpn. J. Ind. Health **28**: 462—469.
11. **Miyao, M., Ono, Y. and Maeda, K.** 1985. "VDT sagyo ni okeru ichirenzoku-sagyo no kangaekata". Digest of Science of Labour **40**: 46—50.
12. **Miyao, M., Sakakibara, H., Yamada, S. and Ono, Y.** 1985. Health Care of VDTs Operators (1) Results of Medical Checks. Jpn. J. Ind. Health **27**: 588.
13. **Mizuno, T.** 1973. "tohkei no kiso to jissai". p. 206—208. KOSEI KAN, Tokyo.
14. **Nakasako, M.** 1982. "EUROPE ni okeru VDT taisaku no genjo". Digest of Science of Labour **37**: 19—25.
15. **Nishiyama, M.** 1986. "Ohbei no kijun, kankoku, roushi kyoyaku no naiyou to sonorodo-eiseigakuteki hyoka". p. 227—249. *In* H. Koyamauchi(ed.), "MEka to VDT rodo". RODO KAGAKU KENKYU SHO, Tokyo.
16. **Ogi, K.** 1982. "VDT sagyo no mondaiten to CHECK POINT". Digest of Science of Labour **37**: 4—13.
17. **Okuda, H. and Tanaka, J.** 1986. Fatigue of Workers Judgred from Subjective Symptoms., The Journal of The Hiroshima Medical Association **39**: 1816—1827.
18. **Shimai, T., Iwasaki, S., Takahashi, M., Narita, S. and Suzuki, H.** 1986. Survey on Subjective Symptoms in VDT Workers: Complaint Rate and Years of Service. Jpn. J. Ind. Health **28**: 87—95.
19. **Shindo, H.** 1983. "Anketo kara mita VDT sagyosha no jikaku-shojo". Digest of Science of Labour **38**: 23—27.
20. **Smith, M.J., Stammerjohn, L.W. and Chohen, B.G.F.** 1980. Job stress in video display operations. p. 201—210. *In*: Ergonomics aspects of visual display terminals. Taylor & Francis London.
21. **Study Group on Industrial Fatigue** 1970. "Sangyo hiro no ⌈jikaku sho shirabe⌋ ni tsuite no houkoku". Digest of Science of Labour **25**: 12—62.
22. **Sugita, M., Minowa, H., Ishii, M. and Etoh, R.** 1986. Factors Affecting Subjective Symptoms of VDT Workers. Jpn. J. Ind. Health **28**: 409—419.
23. **Suzumura, A., Miwa, T. and Taniguchi, M.** 1968. "dotaishiryoku no kenkyu". Ann. Rep. Environ. Med., Nagoya Univ **21**: 12—37.
24. **Tainaka, H.** 1983. "VDT sagyo no futan". Digest of Science of Labour **38**: 16—22.
25. **Takatani, T.** 1984. "VDT-rodo no shakaiteki eikyo". Digest of Science of Labour **39**: 24—27.
26. **Tanaka, J.** 1987. A Study on Subjective Symptoms of Fatigue in Gainfully Occupied Couples. Jpn. J. Ind. Health **29**: 486—493.
27. **Tanaka, J., Munaka, M., Ohtaki, M., Hiraoka, Y. and Okuda, H.** 1986. Studies on Fatigue and Living Conditions of Employees of a Land Transportation Company Judged from Inquiry of Subjective Symptoms., Medical Journal of Hiroshima University **34**: 593—601.
28. **Tarumi, K., Nakamura, T. and Fujuki, Y.** 1985. Effectors Relating to Fatigue of VDT-Workers. Jpn. J. Ind. Health **27**: 590.
29. **The Minstry of Labour** 1986. "rodo eisei no shiori(S61)", p. 201—210. CHUO RODO SAIGAI BOUSHI KYOKAI, Tokyo.
30. **Togami, H. and Noro, K.** 1987. Optimum height of VDT work table. The Japanese Journal of Ergonomics **23**: 155—162.
31. **VDT sagyo ni kansuru kento iinkai.** 1985. "VDT sagyo ni kansuru kento iinkai hokoku". Jpn. J. Ind. Health **27**: 172—194.
32. **Watanabe, T.** 1971. "Recreation" kenko no Seirigaku 7. p. 178—182. ISHIYAKU SHUPPAN, Tokyo.
33. **Yamada, S. and Morooka, K.** 1988. The influence of environment against VDT work —The effect of illumination—. The Japanese Journal of Ergonomics **24**: 209—217.
34. **Yoshitake, H.** 1975. "sangyo hiro". p. 23—35. RODO KAGAKU KENKYU SHO, Tokyo.
35. **Yoshitake, H.** 1983. "Nihonjin no Seikatsu to Hiro" Rodo Kagaku Sousho 67. p. 142—145. RODOKAGAKU KENKYUSHO, Tokyo.
36. **Yoshitake, R. and Iwanaga, K.** 1986. Effects of character luminance on physiological strain during VDT work. The Japanese Journal of Ergonomics **22**: 19—26.