MEMOIRS OF THE SCHOOL OF ENGINEERING, OKAYAMA UNIVERSITY, Vol. 4, No. 1, SEPTEMBER 1969

On a Relation between the Flicker value and the Working Condition

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(Received June 10, 1969)

The appropriate disposition of the worker improves the ability of the worker and the efficiency of the labor and further decreases the rate of inferior goods and the rate of accidents[1)2)3)].

In previous paper[4)], the variation of the flicker value, the trend of the miss frequency and the relation between them under the condition which has one surveillance point and one back-ground condition are analyzed. In this paper, the surveillance point is increased to two points and the back ground condition also two in order to examine which condition influences strongly to the flicker value in the working time.

It was found that the variation of the flicker value is strongly connected with the qualification, the number of the surveillance and its miss-frequency.

§ 1. Introduction

It is useful to analyze the relation between the working enviroments and the worker for the determination of the appropriate disposition of the worker. So in the previous paper, the author analyzed the variation of the flicker value during the working time, the learning curve of the miss frequency and the relation between the pattern of the flicker value and the another result of the psychological test. The subject operated the simulator under the given condition that he had to watch one surveillance point and one background condition.

In this paper, the surveillance point is increased to two points and the back ground condition also two. The experiment is done under the conditions that combines these cons ditions. The flicker value and the miss-frequency of the surveillance points are measured. The author analyzes which conditions influence strongly to the flicker value in the working time.

§ 2. Equipment, experimental condition and subject

The experimental and analyzing method are the same in the previous paper[4)]. The equipment is remodelled as the followings. When the subject doesn't trace correctly the forehead which is moved by handle according with the mark which is controlled by the turnning gear, then this miss-frequency is counted by the counter of the phototube. By this remodelling, the subject has to watch mainly two parts on the screen. One part is the color stimulus part and the other the forehead of the handle. The background condition is the moving scene on the screen. So two kinds of scene are prepared. The brightness of the one scene is $10 \sim 30$ lux and the other $30 \sim 60$ lux. The next notation is used in the paper.

K : working condition (K1, K2, K3)
C : surveillance point of the forehead of the handle
S : surveillance point of the color stimulus
H : scene on the screen
H1 : the brightness is $10 \sim 30$ lux
H2 : the brightness is $30 \sim 60$ lux

The subject doesn't see clearly anything in the scene on H1 but can see many things on H2. Table 1 shows the combination of these conditions and the number of the subject. On

Table 1. The combination of various conditions

K	surveillance point		scene H		subject (persons)
	C	S	H1	H2	
K1		0	0		43
K2	0	0	0		38
K3	0	0		0	40

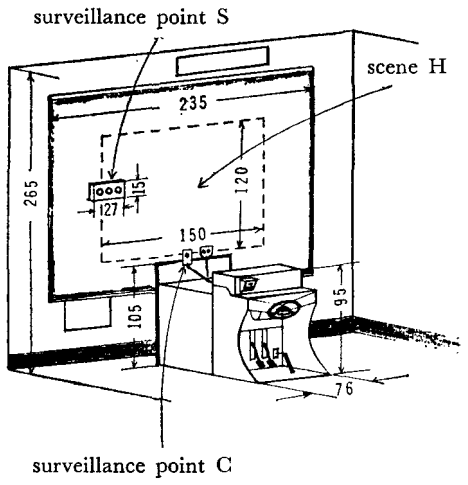

Fig 1. The disposition in laboratory

the working condition K1, the subject watches mainly S and the scene uses H1, so on. Fig 1 shows the disposition of the apparatus.

§ 3. Results

1) The variation of the flicker value in the working time.

Fig. 2 shows the variation of the flicker value in each working condition (K1, K2, K3). When the condition is changed from K1 to K2 or K3, then the time when the flicker value of the working time falls below that of the beginning of the work becomes earlier and the decrement

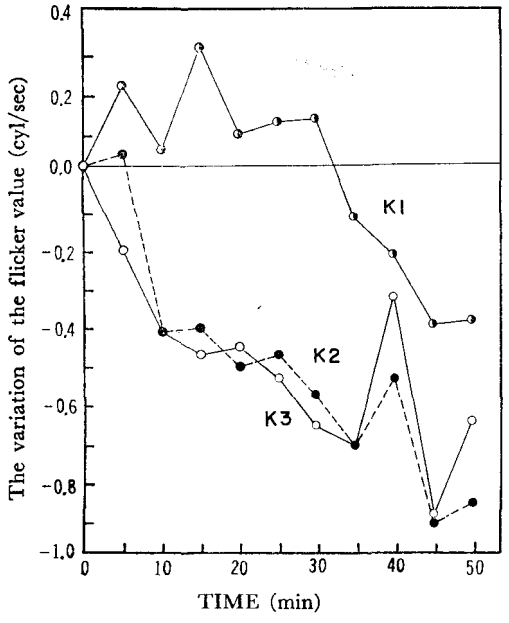

Fig 2. The variation of the flicker value in each working condition

of K2 or K3 is about two times of that of K1. On K1, its time is about 35 minutes after the beginning, on K2, 15 minutes and on K3, at the first. Therfore the degree of the fatigue increses from K1 to K3 and that of K1 is equal to the degree that the subject works about 15 minutes on K2 or K3. When the surveillance point is increased from one to two points, then the beginning time of the fatigue becomes very earlier and the degree of it of the latter is about two times of the former. The subject can see many things in the scene as the working condition is changed from K2 to K3. Then the flicker value decreases from the beginning of the work. This shows that the fatigue begins at the first time of the work.

Subjects are classified with the some qualfication into two groups (say L1, L2) in which L1 gathers the subject who has the qualification and L2 non qualification. This classification is done to examine whether the qualification influences to the flicker value in the working time or not. Table 2 shows the classification with the qualification on K2 and K3. Fig 3 shows the variation of the flicker value in each group.

Table 2. Subjects are classified with the qualification on K 2 and K 3

D	working condition		qualification		subject (persons)
	K 2	K 3	L 1	L 2	
D 1	0		0		19
D 2	0			0	19
D 3		0	0		25
D 4		0		0	15

The difference between H1 and H2 is shown more evidently in D1 and D3 (Fig. 3) than that of K2 and K3 (Fig. 2). The condition of H2 influences to the qualified subject more powerfully than H1. But the decrement of the value is not so large in D1 and D3. Its decrement in D2 or D4 is about three times of that in D1 or D3. It makes clear that the drgree of the fatigue of the non-qualified subject is greater than that of the qualified subject.

2) The variation of the flicker value classified with the mean miss-frequency of the surveillance point C.

Subjects are classified into three groups (C1, C2, C3), in order to examine the relation bet-

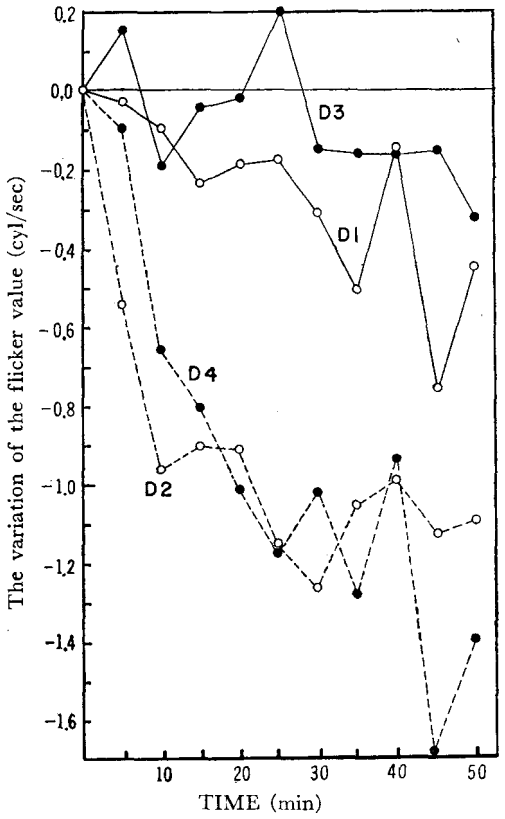

Fig 3. The variation of the flicker value classified with the qualification

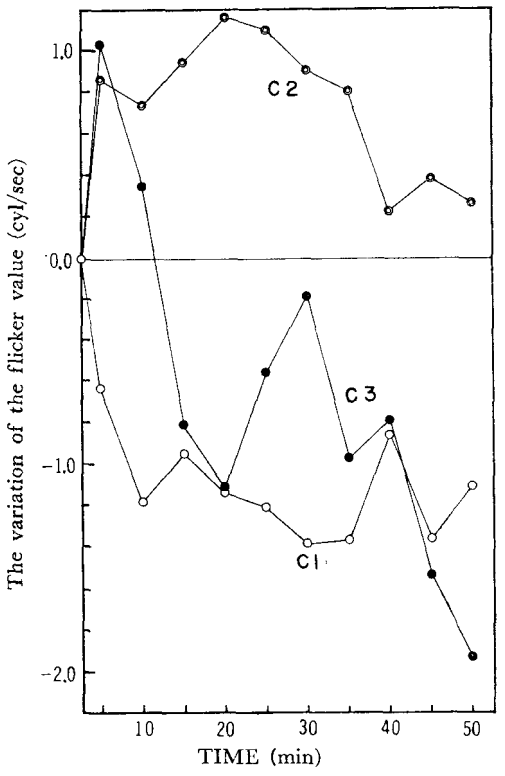

Fig 4. The variation of the flicker value classified with miss-frequency of C on K 2

ween the miss-frequency of the surveillance point C and the flicker value in the working time. In each group, the subject has the following mean miss-frequency, i. e. the average of the times.

C1 : $0 \leq$mean miss-frequency<10

C2 : $10 \leq$mean miss-frequency<20

C3 : $20 \leq$mean miss-frequency

Fig 4, 5 show the variation of the flicker value of C1, C2 and C3 on K2 and K3. The subject who has the lowest miss-frequency (i. e. C1) takes the lowest flicker value, in C2 the highest and in C3 the middle in K2. The subject who makes an effort to trace correctly may be fatigued with the work fairly. The flicker value of the subject who has the middle miss-frequency (i. e. C2) doesn't fall below that measured before work, so the subject in C2 doesn't fatigue in this work on K2. Therefore, the subject in C1 is fit for the work which requires the accuracy but may be fatigued fairly. The subject in C2 is fit for the work which requires non fatigue in the working time but is lacking in the accuracy.

Table 3. The Result of the multivariate test between groups (C1, C2, C3) on K2

	TIME (min)	C1	C2	C3
C1	5~50	Fo	1.580	2.725*
	5~25		1.744	2.320*
	30~50	d. f.	3.376*	2.244*
C2	5~50	10, 21	Fo	3.537*
	5~25	5, 26		1.764
	30~50	5, 26	d. f.	0.825
C3	5~50	10, 17	10, 5	Fo
	5~25	5, 22	5, 10	
	30~50	5, 22	5, 10	d. f.

*: significant at the 10% level

Table 3, 4 show the result of the multivariate test[5] for difference between mean values of two populations on K2 and K3. Fo between C1 and C3 as the variance ratio on 10 and 17 d. f. and Fo between C2 and C3 on 10 and 5 d. f. are significant at the 10% level on K2. But there is not the signifficant difference between C1 and C2 on K2. In this analysis, the whole observed values (i. e. 10 times) are used. The observed value of time series is di-

vided into two parts (i.e. one is that of 5~25 minutes and the other 30~50 minutes) in order to examine which parts contribute to the multivariate test. Fo between C1 and C2 which is calculated by the latter on 5 and 26 d.f. and Fo between C1 and C3 which are calculated by the former and latter on 5 and 26 d.f. are significant at the 10% level on K2. When the subject is classified with the miss-fraquency of C into three groups, then each group has statistically the different flicker pattern in the working time on K2.

On K3, the more the miss-frequency of the surveillance point C decreases, the more the flicker value in the working time decreases and the flicker value in each group falls from the beginning of the work below that measured before work. So in each group, the subject may feel the fatigue and the degree of it is the strongest in C1. There are significant differences between C1 and C2 or C3. It makes clear by this analysis that the variation of the flicker value is strongly connected with the qualification, the number of the surveillance and its miss-frequency.

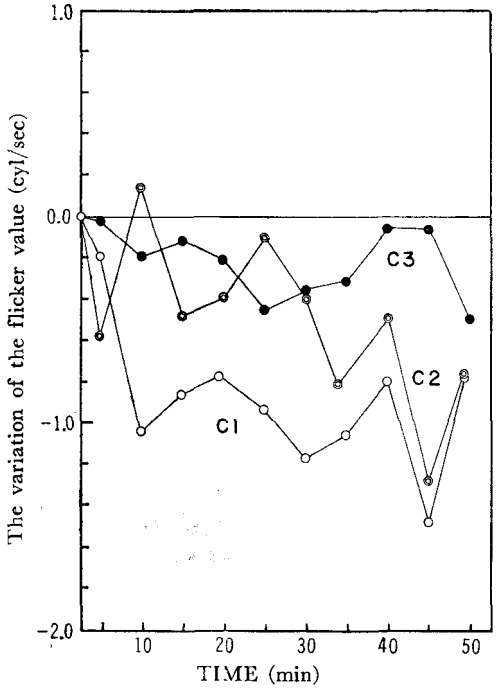

Fig 5. The variation of the flicker value classified with the miss-frequency of C on K3

Table 4. The result of the multivariate test between groups (C1, C2, C3) on K3

	TIME (min)	C1	C2	C3
C1	5~50	Fo	1.696	1.444
	5~25		3.450*	0.577
	30~50	d.f.	0.494	2.219*
C2	5~50	10, 14	Fo	0.734
	5~25	5, 19		0.676
	30~50	5, 19	d.f.	1.650
C3	5~50	10, 19	10, 14	Fo
	5~25	5, 24	5, 19	
	30~50	5, 24	5, 19	d.f.

*: significant at the 10% level

§ 4. Conclusion

We obtain the following results from the analysis of the variation of the flicker value in the working time.

1) When the surveillance point increases one to two points, then the time when the flicker value in the working falls below that of before work is earlier than the former and the decrement of it in the latter is equal to two times of the former. Therefore the degree of the fatigue in the latter may be greater than the former.

2) Subjects are classified with the some qualification into two groups, in which one group gathers the subject who has the qualification and the other non qualification. Then the decrement of the flicker value of the latter is greater than that of the former in K2 and K3. So the subject in the latter may be fatigued with the work more stronger than the subject in the former.

3) Subjects are classified with the miss-frequency of the surveillance point into three groups. Then the more the miss frequency decreases, the more the flicker value decreases in the working time. Therefore the subject who is attention to decrease the miss-frequency may feel the fatigue stronger than the subject who has high miss-frequency.

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