COMPARISONS OF SLEEP-WAKE HABITS OF MORNING AND EVENING TYPES IN JAPANESE WORKER SAMPLE

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The Japanese version of the morningness-eveningness questionnaire and life habits inventory were administered to approximately 400 workers and the distribution of morningness-eveningness scores and the differences between the sleep-wake habits of morning and evening types were investigated. The score distribution was normalized. Significant differences between the two types were found in terms of retiring and arising time, sleep length, sleep latency, adequate amount of sleep, mood on arising, frequency of staying awake all night, and variability in bed and arising times. These results suggested that evening type workers had more irregular and/or flexible sleep-wake habits than did the morning type, that social restriction on account of a regular job had an influence on workers' sleep length, in particular that of the evening type, and that circadian sleep-wake rhythm of the evening type might externally desynchronize with other physiological rhythms.

Regarding some factors relating to tolerance to shift work, previous studies have reported that individual differences of circadian phase position (i.e., morning and evening types) might be predictors to make possible the measurement of individual tolerance to shift work. In general, it is said that evening type people adjust easier to their shift schedule than the morning type people do (Hildebrandt and Stratmann, 1979; Ishihara et al., 1983; Moog, 1987; Östberg, 1973). However, it is unknown why evening type workers have a higher tolerance to shift work than the morning type and what fundamental differences in circadian
system exist between the two types. In addition, few studies have been made regarding the individual differences of circadian phase position and tolerance to shift work in Japan.

In our previous studies, we translated into Japanese the English version of the Morningness-Eveningness Questionnaire (MEQ), which was developed by Horné and Östberg (1976) based on Östberg's MEQ (1973), and reported that differences in psychological and physiological measures and life habits including sleep-wake habits were found between the morning and evening types in the student sample (Ishihara et al., 1985, 1986, 1987). In particular, remarkable differences in two the types were irregularity and/or flexibility in sleep-wake habits. Evening type students had more irregular and/or flexible habits compared with morning type students (Ishihara et al., 1987).

The purposes of the present study are to investigate 1) how M-E scores obtained from the workers are distributed, and 2) whether the differences in sleep-wake habits between the morning and evening workers are similar to those in the student sample.

METHODS

The Japanese version of the MEQ of Horne and Östberg (1976) and life habits inventory (LHI), which was developed to obtain data on some extensive waking habits in addition to sleep habits and was made up of 31 questions, were administered to approximately 400 Japanese white-collar workers (age range: 19-64 years). They were all day workers and staff members belonging to a certain university, with the exception of 8 who were shift workers. The number of subjects surveyed was 346 (mean age: 37.3±11.4 years), and the numbers of males and females were 183 and 163, respectively. A single M-E score was computed for each subject according to the scoring criteria of Horné and Östberg (1976). Consequently, 112 morning type subjects (Ss) (definitely and moderately morning types, ≥ 59 of M-E score) and 24 evening type Ss (definitely and moderately evening types, ≤ 41 of M-E score) were found, and their responses to LHI regarding the following were analyzed: bed and arising time, sleep length, subjective evaluation of sleep, napping, and variability in bedtime, arising time, and sleep length.

The level of significance was set at 0.05 or better, two-tailed.

RESULTS

Figure 1 shows the M-E score distribution. Mean score and median were 54.5 (SD=8.32) and 55.7, respectively. There was no significant difference between the scores of men (54.7±8.91) and women (54.3±7.60). Although score distribution was slightly negatively skewed (−0.124) and slightly leptokurtic (3.347), it did not significantly differ from the normal distribution.
Comparisons of M-E Types in Workers

Fig. 1. Distribution of the subjects' scores on the MEQ.

Table 1. Sleep parameters for morning and evening type workers.

<table>
<thead>
<tr>
<th>Type</th>
<th>Bedtime</th>
<th>Arising time</th>
<th>Sleep length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H*</td>
<td>P**</td>
<td>H</td>
</tr>
<tr>
<td>Morning type</td>
<td>23:20</td>
<td>22:34</td>
<td>6:28</td>
</tr>
<tr>
<td>(N=112)</td>
<td>80</td>
<td>54</td>
<td>39</td>
</tr>
<tr>
<td>Evening type</td>
<td>0:21</td>
<td>23:51</td>
<td>7:16</td>
</tr>
<tr>
<td>(N=24)</td>
<td>61</td>
<td>77</td>
<td>33</td>
</tr>
</tbody>
</table>

*H: habitual time.  **P: preferential time. Mean values in hr: min. SDs in minutes.

Habitual sleep parameters (bedtime, arising time, and sleep length) obtained from LHI and preferential bed and arising times from MEQ are shown in Table 1. Significant differences between the morning and evening types were found in all habitual sleep parameters, namely, the morning type Ss went to bed about 60 min earlier, got up about 50 min earlier, and slept about 30 min longer than the evening type Ss (bedtime: t=3.51, df=134, p<0.001; arising time: t=5.52, df=134, p<0.001; sleep length: t=2.13, df=134, p<0.05). Split-plot two-factorial design (Kirk, 1982) was used to examine the relation of chronotypes to habitual and preferential data. There were significant main effects of factor A (morning vs. evening) and factor B (habitual vs. preferential), but no significant interaction AB for bedtime (factor A: F(1/134)=29.46, p<0.001; factor B: F(1/134)=18.27, p<0.001). With respect to arising time, significant main effects of both factors and significant interaction AB were found (factor A: F(1/134)=95.14, p<0.001; factor B: F(1/134)=11.46, p<0.001; interaction AB: F(1/134)=17.69, p<0.001).

Figures 2 and 3 show various sleep-waking habits. Vertical axes represent frequency transformed into percentage. To clarify the different tendency of habits...
Fig. 2. Comparisons between the morning and evening types of sleep-wake habits. a: Sleep latency. b: Number of awakenings during sleep. c: Adequate amount of sleep. -++, very short; --, fairly short; ±, adequate; +, fairly long; ++, very long. d: Depth of sleep. --++, very deep; +, fairly deep; --, fairly light; --, very light. e: Variability of sleep length. f: Mood on arising. +++, very good; ++, fairly good; --, fairly bad; --, very bad. g: Frequency of staying awake all night.

Significant differences were found between the two types in answer to all the questions in LHI, except number of awakenings (Fig. 2b), depth of sleep (Fig. 2d), variability of sleep length (Fig. 2e), differences between holiday (weekend) and weekday for bedtime (Fig. 3c), and variability of arising time on weekdays (Fig. 3d). From these results of sleep-waking habits, the morning type Ss evaluated themselves as falling asleep more easily (Fig. 2a: $\chi^2=11.72, df=4, p<0.02$), having a more adequate amount of sleep (Fig. 2c: $\chi^2=14.69, df=4, p<0.005$), and having a better mood on arising (Fig. 2f: $\chi^2=62.83, df=3, p<0.001$) than the evening type. In contrast, the evening type Ss reported not only a large frequency of staying awake all night per month (Fig. 2g: $\chi^2=21.08, df=3, p<0.001$) but also a greater variability in bed and arising times than the morning type Ss (Fig. 3). Concerning variability of bedtime, the variability on weekdays of the evening type was greater than for the morning type (Fig. 3a: $\chi^2=11.16, df=4, p<0.025$), and furthermore, bedtime on the day before a holiday and weekend for the evening type was more different and was delayed or shifted to a later time compared with
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Fig. 3. Comparisons between the morning and evening types of sleep-wake habits. a: Variability of bedtime (weekday). b: Bedtime on the day before a holiday and weekend. c: Differences between holiday and weekday (bedtime). d: Variability of arising time (weekday). e: Arising time on a holiday and weekend. f: Differences between holiday and weekday (arising time).

the morning type (Fig. 3b: $\chi^2=12.59$, df=2, $p<0.005$; Fig. 3c: $\chi^2=6.67$, df=3, $p<0.1$). Similarly for the variability of arising time, though non-significant for weekdays (Fig. 3d), arising time on holiday and weekend for the evening type was significantly different and was shifted to a later time than with the morning type (Fig. 3e: $\chi^2=6.92$, df=2, $p<0.05$; Fig. 3f: $\chi^2=25.85$, df=3, $p<0.001$).

DISCUSSION

The distribution of scores in our worker sample was normalized, and mean score and SD were 54.5 and 8.32, respectively. These values almost accorded with the results (54.7±8.63) of MECACCI and ZANI's study (1983).

Compared with the students' data (ISHIHARA et al., 1986), score distribution of workers is relatively shifted to the morningness (Fig. 4). Since ages of the two samples did not match, we cannot conclude whether the differences of distribution are attributable to the effect of age or the acquisition of a regular job. However, we think that perhaps those effects are connected with the shift of score distribution.
In the present study, the morning type workers clearly differed from the evening type workers in sleep-wake habits. Present results show the same tendency as the results that we previously reported using the student sample, i.e., the morning type students went to bed earlier and got up earlier than the evening type students, and the evening type were characterized as people having irregular/flexible sleep-wake habits (ISHIHARA et al., 1987). These results suggest that the differences of characteristics in both types are consistent even across the different samples.

The significant difference found for sleep length, i.e., sleep length of the evening type workers was significantly short compared with the morning type workers, was not found in the student sample. Although it appears that this fact, taking the results of adequate amount of sleep (Fig. 2c) and mood on arising (Fig. 2f) into consideration, indicates lack of sleep in the evening type, we do not always think of the evening type Ss as poor sleepers for the following reasons: First, even in the student sample where there was no difference for sleep length, significant differences between the two types were found for adequate amount of sleep and mood on arising, and not found for depth of sleep. Second, the above differences were found even when the morning and evening type Ss slept for the same number of hours in the laboratory. Thus, it seems that the differences of sleep length between the morning and evening types do not reflect fundamental differences.

The lack of sleep in the evening type workers is probably attributable to the social restriction of a regular job, in particular, starting time (i.e., the starting time of our subjects was fixed at 8:30). Time periods of sleeping and working in the evening type Ss came remarkably close to each other compared with those of the morning type. Thus, the later bedtime is, the greater the inevitability of shortened sleep length.

It is interesting to notice that the morning and evening types differed in the responses to habitual and preferential times, especially for arising time (Table 1). For the bedtime, however, both types of Ss want to go to bed earlier than the
habitual time, and the differences (+50 min) between preferential and habitual arising times in the evening type workers are larger than the differences (−5 min) in the morning type.

The phenomenon of internal desynchronization found in experiments that were performed under constant conditions without environmental time cues have indicated that the oscillatory system driving human circadian rhythms is a multi-oscillator system, consisting of at least two oscillators (KRONAUER et al., 1982; WEVER, 1975). The one is a strong and stable oscillator that drives body temperature rhythm, and the other is a weak and unstable oscillator that drives sleep-wake rhythm. Preferential data obtained from this study seem to represent rhythms being driven by a strong oscillator. Therefore, the fact that preferential arising time in the morning type is the same as habitual arising time suggests that the sleep-wake rhythm of the morning type may synchronize with other physiological rhythms (e.g., body temperature rhythm). In contrast, in the case of the evening type having large differences between habitual and preferential arising times, the sleep-wake rhythm may externally desynchronize with the physiological rhythms under the influence of social restriction. Probably, bad mood of the evening type on arising time may be attributed to this slight desynchronization.

Although, furthermore, the apparent phase difference between the two types is approximately 50 to 60 min as far as we judge from the data of habitual times, substantial phase difference may be greater than the apparent difference. However, we do not have enough data to confirm these suggestions.

In Japan, few studies have been made on the individual differences of the circadian phase position. It is expected that many applied studies as well as basic research will be performed on the relationship between circadian phase differences and tolerance to shift work.

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