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A diurnal type scale

Construction, consistency and validation in shift work

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TORSVALL L, ÅKERSTEDT T. A diurnal type scale: Construction, consistency and validation in shift work. *Scand j work environ health* 6 (1980) 283—290. The purpose of the present study was (i) to construct a short scale with high internal reliability for use as a measure of "diurnal type" (morning or evening disposition), (ii) to validate the constructed index against sleep/wake behavior in connection with different workhours, (iii) to study inter- and intraindividual consistency over a 1-a interval, and (iv) to examine the effects of changed workhours on diurnal type scores. Three hundred shift workers filled out the same questionnaire twice with a 1-a interval. An index of seven items was constructed yielding a Cronbach alpha coefficient of 0.75. The analysis showed that the morning active (MA) individuals rose earlier and went to bed earlier than the evening active (EA) individuals, and the former had a longer sleep length than the latter during days with a morning shift, while the opposite was true for afternoon and night shifts. During days with a morning shift more EA individuals took naps, but during days with a night shift the MA group took naps more often than the EA group. The MA individuals had fewer sleep complaints than the EA individuals during the morning shift. The correlation was high ($r = 0.79$, $p < 0.001$) for the index between the two administrations with a 1-a interval in between. Those who had changed from shift work to day work tended to report a more pronounced morning active disposition. However the interindividual consistency was still pronounced. It was concluded that the analysis resulted in a short diurnal type scale with high internal reliability and high consistency between measurements and that it differentiated between morning and evening types in sleep/wake habits.

Key terms: interindividual differences, reliability.

A number of attempts have been made to develop a questionnaire to estimate "diurnal type" (morningness/eveningness) (8, 11, 14). On the whole, these questionnaires seem to be able to predict "early" or "late" behavior patterns fairly well, as well as peak times of biological rhythms (1, 7, 9, 12, 13, 15, 16, 19). However, while the spread of the "diurnal type" concept attests to its usefulness, there still remains problems in the application of the scales used to measure it. These problems concern aspects of psychometric quality, as well as feasability "in the field."

Psychometrically the questionnaires have been criticized of being somewhat impure in that they contain several different dimensions (3, 20). This heterogeneity is not surprising in light of the varying foci of the items. Thus, aside from questions concerning the end points of the wake span, the scales also include questions on times of day that are far removed from the end points. Since morningness/eveningness concerns the former type of item by definition, there seems little reason to include the latter type in a scale designed to measure morningness/eveningness.

While many diurnal type scales have been constructed, we have not been able to find information on the stability and reliability of the scores. Such data are of particular interest since the scales have

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Table 1. The seven subgroups resulting from work-schedule changes.

Subgroup		Number of workers
1—1	Those who retained day work	18
2—2	Those who retained 2-shift work	16
3—3	Those who retained 3-shift work	73
4—4	Those who retained 4-shift work	77
3/4—1	Those who changed from 3- or 4-shift work to day work	21
3/4—2	Those who changed from 3- or 4-shift work to 2-shift work	69
4—3	Those who changed from 4-shift work to 3-shift work	41

been used mainly in connection with groups that alternate between different work/sleep patterns, and this alternation may, to an unknown extent, influence the scores. As to size, existing scales are acceptable as long as they are administered alone or with limited additional questionnaires. However, if there is a need to obtain diurnal type scores in connection with a larger survey study with another major purpose, then existing scales often prove to be too long to add to the major questionnaire. Thus there is a need for as short a scale as possible.

Another problem of feasibility is the applicability of the items to the scheduling of workhours. We have found that groups on irregular work schedules have difficulties answering some items that concern habitual diurnal type behavior. More hypothetical and general formulations would probably be easier to answer.

The purpose of the present study was to construct a short, homogeneous diurnal type scale that can be used independently of present work schedules, to test its stability/consistency over time (including its resistance to changes of the work/sleep patterns), and to investigate its validity in terms of sleep/wake behavior.

Subjects and methods

Subjects and general design

A total of 375 shift and day workers from a steel manufacturing plant participated in a longitudinal study on the long-term effects of shift work on health and well-being. The diurnal type scale was included in the questionnaire. The same questionnaire was filled out twice with a 14-month interval. The return rate was 97 %.

During the interval, changes took place in work schedules due to the strained world market for steel products. Seven subgroups could be discerned from the results of the changes; they are presented in table 1. All the changes were compulsory. Day workhours were 0700—1600; 2-shift work included hours from 0445 to 1300 and 1300 to 2115 with weekly rotation; 3-shift work also included a night shift 2115—0445; and the 4-shift work used the same hours for shift changes as 3-shift work but with 2—3 d on each shift.

Items

On the basis of previous studies (8, 11, 14) and the criteria mentioned in the introduction, we chose the questions presented in table 2. The points of time used in the items have been used earlier by Åkerstedt & Fröberg in an unpublished study and have been found to differentiate among morning and evening active individuals.

Results

Index construction

The seven items were subjected to a factor analysis (18). The correlation matrix (table 3) showed moderate but, in most cases, significant intercorrelations. The unrotated factor matrix (table 4) showed that all seven items may be accounted for by one main factor after the signs of three items have been reversed, ie, it appears justified

Table 2. Questions chosen for the questionnaire. Figures in parentheses indicate scoring.

Question	Optional answers
1. When would you prefer to rise (provided you have a full day's work — 8 h) if you were totally free to arrange your time?	(4) before 0630 (3) 0630—0729 (2) 0730—0829 (1) 0830 or later
2. When would you prefer to go to bed (provided you have a full day's work — 8 h) if you were totally free to arrange your time?	(1) before 2100 (2) 2100—2159 (3) 2200—2259 (4) 2300 or later
3. If you always had to go to bed at 2400, what do you think it would be like to fall asleep then?	(4) very difficult — would lie awake for a long time (3) rather difficult — would lie awake for some time (2) rather easy — would lie awake for a short while (1) easy — would fall asleep practically at once
4. If you always had to rise at 0600, what do you think it would be like?	(1) very difficult and unpleasant (2) rather difficult and unpleasant (3) a little unpleasant but no great problem (4) easy — no problem at all
5. When do you usually begin to feel the first signs of tiredness and need for sleep?	(1) before 2100 (2) 2100—2159 (3) 2200—2259 (4) 2300 or later
6. How long a time does it usually take before you "recover your faculties" in the morning after rising from a night's sleep?	(4) 0—10 min (3) 11—20 min (2) 21—40 min (1) more than 40 min
7. Please, indicate to what extent you are a morning or evening active individual!	(4) pronounced morning active (ie, morning alert and evening tired) (3) to some extent morning active (2) to some extent evening active (ie, morning tired and evening alert) (1) pronounced evening active

Table 3. Correlation matrix of the seven diurnal type items used in the analysis (N = 318).

		1	2	3	4	5	6	7
1	Preferred time to rise							
2	Preferred time to go to bed	—0.27***						
3	Ability to fall asleep at 2100	—0.10	0.33***					
4	Ease/difficulty of rising at 0600	0.49***	—0.22***	—0.34***				
5	Time when tiredness first appears	—0.16**	0.41***	0.42***	—0.27***			
6	Minutes to recover faculties	0.32***	—0.36***	—0.35***	0.46***	—0.40***		
7	Degree of rhythm	0.20***	—0.08	—0.23***	0.31***	—0.19***	0.35***	

** $p < 0.01$, *** $p < 0.001$.

to include all the items in one scale. The rotated factor matrix (table 5) still preserved the early/late dimension but sorted out the evening and morning items. The result essentially only restated that of the unrotated matrix.

After the scores for the evening items were reversed, the mean of the seven items was used as the score for each individual. Fig 1 shows that the individuals were approximately normally distributed on the scale.

For a check of the internal reliability (homogeneity) of the index, Cronbach's coefficient alpha was computed (10), which yielded $\alpha = 0.75$ (varying between 0 and 1, with 60 as the lowest acceptable limit). For the workhour subgroups the values were D = 0.73, 2-shift = 0.56, 3-shift = 0.75, 4-shift = 0.76. Thus the homogeneity of the index must be considered acceptable.

Consistency

To study the interindividual consistency of the diurnal type index, we calculated the correlation between the two administrations. The coefficient for the total group was $r = 0.79$ ($p = < 0.001$). The coefficients for most of the workhour subgroups reached this level irrespective of whether the workhours had been changed or not (table 6). The lowest correlations were found for the permanent day workers and for those who changed from shift work to day work.

The absolute scores on the index changed very little between administrations (fig 2). The only significant change occurred for those who changed from 3/4-shift work to

Table 4. Factor loadings and communalities for the seven items used in the unrotated factor analysis.

Variables	Factors		
	I	II	h^2
1 Preferred time to rise	*0.502*	0.369	0.387
2 Preferred time to go to bed	*—0.488*	0.234	0.293
3 Ability to fall asleep at 2100	*—0.506*	0.315	0.355
4 Ease/difficulty of rising at 0600	*0.668*	0.294	0.532
5 Time when tiredness first appears	*—0.555*	0.311	0.405
6 Minutes to recover faculties	*0.752*	—0.055	0.569
7 Degree of rhythm	*0.416*	0.119	0.188
Sum of squares	2.239	0.491	2.730
Percent	31.98	7.01	39.00

Table 5. Factor loadings and communalities for the seven items used in the rotated factor analysis.

Variables	Factors		
	I	II	h^2
1 Preferred time to rise	0.201	*0.590*	0.388
2 Preferred time to go to bed	*—0.534*	—0.087	0.293
3 Ability to fall asleep at 2100	*—0.595*	—0.030	0.355
4 Ease/difficulty of rising at 0600	0.380	*0.623*	0.533
5 Time when tiredness first appears	*—0.634*	—0.062	0.405
6 Minutes to recover faculties	0.273	*0.336*	0.188
7 Degree of rhythm	*0.648*	0.385	0.569
Sum of squares	1.720	1.010	2.730
Percent	24.57	14.43	39.00

day work ($p < 0.05$), ie, they tended towards increased "morningness." The overall difference between the subgroups in the analysis of variance was weakly significant ($p < 0.05$) and showed a tendency towards morningness in both the permanent (1—1) and newly transferred (3/4—1) day workers.

Validation

In order to validate the diurnal type index and study its association with background parameters, we divided the response distribution into three equal diurnal type groups — morning, intermediate, and evening. These groups were subsequently compared (analysis of variance) with respect to demographic variables, sleep/wake habits, sleep complaints, and some other variables.

Fig 3 shows that the morning types rose the earliest of the three groups, followed

Table 6. Product-moment correlations between the two administrations for the diurnal type scale, for the whole group and the subgroups resulting from work-schedule changes.

	N	r	p
Total group	323	0.79	0.001
Subgroup 1—1	19	0.62	0.01
Subgroup 2—2	18	0.94	0.001
Subgroup 3—3	74	0.80	0.001
Subgroup 4—4	77	0.84	0.001
Subgroup 3/4—1	21	0.48	0.05
Subgroup 3/4—2	69	0.85	0.001
Subgroup 4—3	41	0.85	0.001

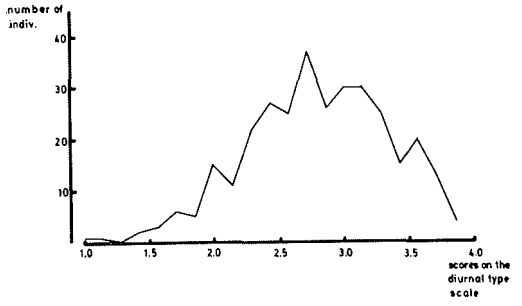

Fig 1. Distribution of the scores on the diurnal type scale (N = 327).

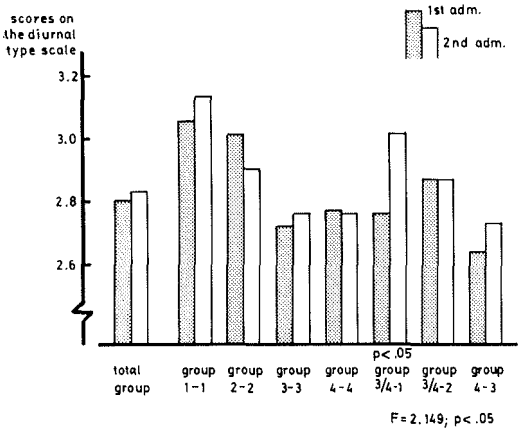

Fig 2. Absolute values from the two administrations for the diurnal type scale for the total group and the subgroups resulting from work-schedule changes.

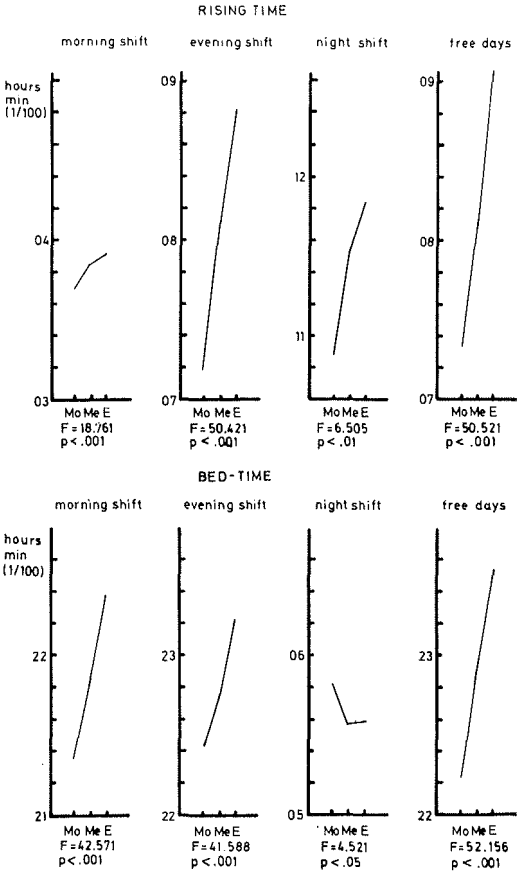

Fig 3. Time of rising and bedtime for the diurnal type groups during days with morning, evening, and night shifts and during free days.

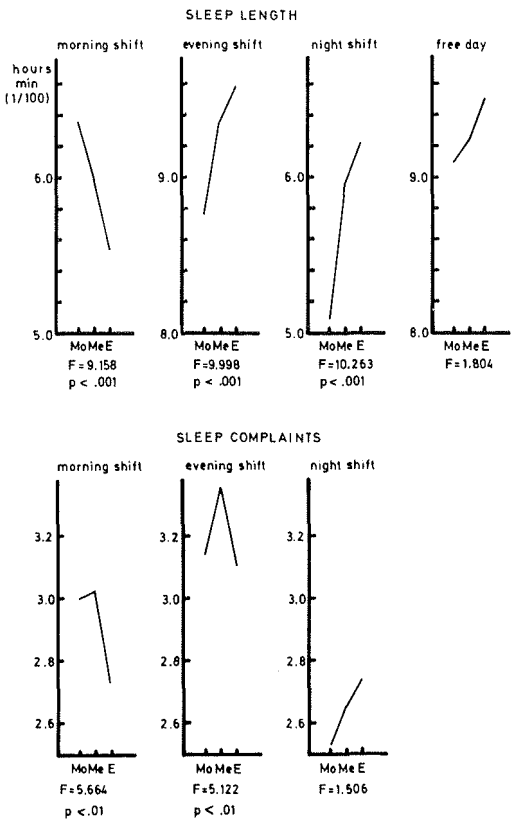

Fig 4. Sleep length and sleep complaints for the three diurnal type groups during days with morning, evening, and night shifts. [The sleep complaint questions are scored from 1 (many complaints) to 4 (no complaints)]

by the intermediate and the evening types. The greatest differences appeared during days with an evening shift and free days, but it is noteworthy that the morning types managed to rise significantly earlier also on the extremely early morning shift. The morning types also went to bed earlier than the evening types, except after night shifts when they went to bed a few minutes later than the other two groups.

About one-third of the subjects took naps during days with morning and night shifts. The distribution between the diurnal type groups was however quite different. During days with a morning shift 24 % of the morning group, 31 % of the intermediate group, and 46 % of the evening group took maps, while the percentages during night shift days were reversed — 41, 41 and 18 %, respectively ($\chi^2 = 18.08$, $p < 0.001$).

From fig 4 it can be seen that the morning types slept longer than the evening types during days with a morning shift, while the relation was reversed during days with evening and night shifts and during free days.

For every shift the following questions were combined into an index of sleep complaints (2) (alpha = 0.73): Do you have difficulties falling asleep; do you get disturbed by noise during sleep; do you wake up too early; do you feel refreshed after sleep? The results are presented in fig 4.

During days with a morning shift the morning types had the least number of complaints, while the evening types had the most. This relation was reversed, although not significantly so, for days with a night shift.

To estimate personality traits, the short version of the Eysenck Personality Inventory (7) was employed. The results showed a low but significant correlation between diurnal type and neuroticism ($r = 0.17$; $p < 0.01$) — less neuroticism in the morning types. No correlation was found with extroversion ($r = 0.05$, not significant).

The three diurnal type groups differed greatly with respect to age and in some areas connected with age. The morning active group was on the average 19 a older than the evening active group, and the former also had, of course, longer employment and more experience with shift work. The correlation between age and diurnal type was $r = -0.57$ ($p < 0.001$), ie, higher age was accompanied by a more pronounced morning type disposition.

Discussion

The analysis resulted in a seven-item index which showed a rather high internal reliability. The inter- and intraindividual consistency was high between measurements repeated with a 1-a interval, particularly when the changes in workhours are taken into consideration for some groups. There was however a weak tendency for the group which changed from shift work to day work to become somewhat more morning active. That group had, together with the permanent day workers, the highest (most morning active) scores on the diurnal type index. Still it is remark-

able that individuals who are used to morning shifts starting at 0445 but change to 0700 do not experience a more pronounced adjustment of diurnal type. One possible explanation may be that the shift worker alternates between such extreme sleep/wake patterns that the early start of the morning shift is balanced by the two other shifts, the result being no permanent effect of the morning shift. Probably the effects may have been more pronounced if the subjects had been permanent morning or night workers.

As to validity, the morning types, as expected, were the first to bed and the first to rise. Evening types were found at the other extreme, with the intermediate types in between. The largest differences during the work weeks occurred for bedtimes in connection with morning work, when the morning types went to bed very early in the evening. For time of rising the largest differences occurred during periods with an evening and night shift, probably because the evening types could sleep longer in the morning then. The differences were preserved also in connection with days off. Morning types complained less about sleep during days with morning shifts than the evening types, while the distribution was roughly equal during the other two shifts.

The differences in bedtimes and times for rising were also reflected in sleep length. Morning types slept longer than the evening types during days with a morning shift, while the opposite was true during days with an evening and night shift. Because of the short length of the "main sleep" during days with a morning shift (evening types 5.5 h) and night shift (morning types 5.1 h) about one-third of the participants took naps during days with these shifts. In connection with morning shifts mainly evening types took naps, while the reverse was true for the night shifts.

Apparently then, the general items in the questionnaire differentiate between morning and evening subjects in the expected manner also on different shifts. Thus, the concurrent validity must be considered reasonably high.

Diurnal type and personality have been studied in several earlier studies (4, 5, 9, 11, 17), and often a difference in extroversion has been found between morning and evening types. We did not find such a difference in this study. As others (9, 17) have also failed to find such relations, it appears that, if existent, extroversion is not a major trait of evening types. We found however a low but significant correlation between diurnal type and neuroticism.

Furthermore we found that age was strongly related to diurnal type in that older individuals were more morning active. The results agree with those of other studies (11, 17). The reason for this trend towards morningness with increased age is not clear. It seems improbable in the present group that older individuals should have had longer experiences with early workhours. Rather, the explanation may reside in the process of ageing. One intriguing possibility is that the displacement towards an earlier phase can depend on a shortening of the period of the diurnal rhythm with increased age, as it seems possible that period length is inversely related to phase (21). However, no data exist to support the connection with age.

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