Additional Validity Evidence for the Reduced Version of the Morningness-Eveningness Questionnaire (MEQr)

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The aim of the present work was to validate the reduced version of the Morningness-Eveningness Questionnaire by means of sleep-wake behaviour monitored by actigraph. A sample of 110 university students, 40 males and 70 females, wore one actigraph (AMI 32K) on non dominant wrist for three consecutive nights and days. After the record session, all the Ss were administered the Italian version of the MEQr. Sleep onset and weak-up time were computed using the event marker data. Moreover correlation analyses were performed between each of the 5 items of the MEQr and the corresponding pattern of motor activity. In ecological conditions the morning awakening time is the sleep-wake behaviour mostly predictive for circadian typology. On the whole results indicate a good external validity of MEQr. **(Sleep and Hypnosis 2006;8(2):47-53)**

Key words: Morningness-Eveningness Questionnaire, Chronopsychology, Motor Activity, Circadian Typology, Circadian Rhythms.

INTRODUCTION

From a chronobiological point of view morningness dimension is an important individual difference (1,2). In this context we refer to three major circadian types: morning-, intermediate- and evening-type subjects. Individuals (also called “larks”) who spontaneously wake up early in the morning, are more active in the first part of the day and tend to go to bed early in the evening belong to the first category. On the contrary, the evening-type individuals (also called “owls”) find difficult to wake up in the morning and tend to be more active in the second part of the day. Finally, those who show patterns of behaviour belonging to an intermediate area between the two extremes of this continuum (3) are called intermediate- or neither-type individuals.

Investigations in chronobiology and chronopsychology have provided important differential results, especially between the extreme groups (i.e. morning- and evening-types). The most extensively studied parameters have been body temperature and subjective alertness. Evening-type subjects start their waking day at a lower body

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temperature than morning-type subjects, and their body temperature increases throughout the day to reach its peak in the late afternoon. Morning-types show a steeper rise in body temperature and reach their peak approximately 1 or 2 hours earlier than evening-types (1). But what distinguishes morning-types from evening-types even more is the circadian variation of subjective alertness (4). The peak of subjective alertness curve in a morning-type occurs late in the morning while in an evening-type it occurs in the late afternoon. These differences have also be found in conditions where the subjects are environmentally isolated or under constant routine (5,6).

Taking these data into account it has been shown that a two-week monitoring of the peak of oral temperature and wrist monitor activity can provide a reliable means in order to select morning- and evening-types. Unfortunately, this method is not easily achievable. The construction of self-evaluation instrument appears instead a useful means for the distinction of morning- or evening-types. Several self-report instruments have been developed for identifying the individual circadian typology. The first questionnaires for the chronotype self-assessment date back to the seventies (7,8,9). In the 1976 Horne and Östberg developed the Mornigness-Eveningness Questionnaire (MEQ) (10). Later on several questionnaires were prepared. Folkard Monk and Lobban (11) formulated a questionnaire (Circadian Type Questionnaire - CTQ) of twenty questions whose aim was to try and predict adjustment to shift work on the basis of three dimension: rigidity/flexibility, vigorosity/languidity, and the last indicating morning/evening types. Torsvall and Åkerstedt (12) claimed that previous morningness-eveningness questionnaires assessed more than morning and evening behaviors of preferences. They also argued that these questionnaires were too long and that some of the items were inappropriate for shift-workers. To address these issues, they developed a reduced scale (Diurnal Type Scale - DTS) of seven items only. Smith, Reilly and Midkiff (13) put forward a 13-item scale that distils the best items from the three more used circadian questionnaires (i.e. MEQ, CTQ and DTS). For this reason this questionnaire is well-known as Composite Scale (CS). Recently (14,15) it has been developed a scale that contains no references to specific time of day, and the twelve items have a common response format in order to reduced the response bias attributable to the scale format. Such a questionnaire, named Preference Scale, has been specifically constructed to promote greater measurement standardisation in shiftwork research.

Despite the large amount of circadian questionnaires the most used in chronopsychological research is the Morningness-Eveningness Questionnaire (MEQ) (10). The MEQ is a 19-items mixed-format scale in which subject is requested to indicate his/her own life rhythms and habits as far as going to sleep and waking up are concerned, and to supply further useful information to find the most suitable rhythm. Questions are multiple choice, with each answer being assigned a value. Their sum gives a score ranging form 16 to 86, with lower values corresponding to evening-types. Nevertheless its spread and adaptation in many languages, the MEQ has been criticised (16), first of all in relation to the procedures for constructing the test. In fact, in the first presentation Horne and Östberg did not supply detailed information about the psychometric characteristics of the instrument, about the type of item analysis which was carried out and about the criterion used to give the scores. However, further researches showed that MEQ had adequate internal measurement properties with a full scale coefficient alpha always upper .80 (17,18).

Another criticism concerns the length. Besides, obviously, prolonging the time needed for the compilation, it was noted

(19,20) that the numerous data collected by the MEQ are not correlated to a single dimension and therefore may assume a confusing value. Therefore it could be derived problems about internal coherence of the questionnaire which could be instead improved deleting some questions. For example Minervini and co-authors (21) found as few useful the items number 5, 6, 8, 13 and 16, Adan and Almirall (22) the items 6, 11, 13 and 15.

For the above reasons it has been considered (22,23,24) useful the attempt to realise a short version of the MEQ. Recently it is meeting a fair success (25) the reduced version, only five items, of the MEQ put forward by Adan & Almirall (22): the MEQr.

The psychometric characteristics of the scale are reported in the work of Adan and Almirall (22); further information can be found in other works (26,27), all of them confirming its good psychometric qualities, stability and predictive validity. On the whole, the MEQr seems to take the form of a particularly reliable tool, which can be used to advantage in chronopsychological research.

Studies on the external validity of the MEQr are still few. As yet only motor activity (28), or body temperature and subjective alertness (estimated in laboratory) (26) have been used as external criteria for MEQr validation. Aim of the present study is to get an additional validation of the MEQr, using for the first time as external criteria the sleep-wake pattern monitored by actigraph. The choice to use an actigraph as the instrument for data collection derived from the possibilities to observe subjects in ecological conditions. We keep into account to verify also out of the laboratory, i.e. in the every day life, whether the MEQr is able to discriminate the evening-type from morning-type.

METHODS

A sample of 110 healthy university students, 40 males and 70 females, age range 21-30 years, took part as volunteers in the study. We preferred to select exclusively students only because the absence of strict work schedules (social Zeitgeber) allowed them to follow their preferential rhythms. Actigraphic recordings were obtained using motion logger 32K actigraphs (Ambulatory Monitoring Inc., Ardsley, NY). Actigraphs were initialised for zero crossing (mode 18, internal device code), with a 1-minute epoch. In order to obtain at least 48 consecutive hours of good data for each subject participants wore the actigraph on the non dominant wrist for three consecutive nights. To avoid a possible confounding week-end effect the recording sessions were planned from Tuesday to Friday. Subjects were free to spend their day-time and sleep-time outside of the laboratory and to perform their usual activities. They were instructed to use the actigraph event marker button to signal when they went to the bed and when they woke up in the morning. Data were analysed through the Action 3.2 software to measure motor activity and sleep: in particular sleep onset and wake-up time. Mesor and acrophase were computed using cosinor analysis.

At the end of the actigraph recording session, participants filled in the Italian version of the reduced Morningness-Eveningness Questionnaire (26). The questionnaire was administered at the end of the experiment so as to avoid a possible bias by the subjects in their daily activity.

As regards the activity indexes a series of ANOVAs were carried out: circadian typology (at three levels: morning-, intermediate-, evening-type) (between). Some correlations were finally made in order to verify possible relationships between the score obtained in the MEQr and some parameters of the sleep-wake cycle i.e.: sleep onset time, wake-up time and hours of sleep. Recently (29,30) it was observed that the midpoint of sleep, rather sleep onset or end time, gave the best correlation with the MEQ score. So we decided to compute also this index.

We have finally tried to verify the correspondence among the preferences that the subjects had expressed through their answers to the questionnaire and the behaviour really observed through the actigraph recording, apiece of the five items. In particular: item 1 (preferred morning wake-up time) was compared to mean wake-up time recorded by actigraph; item 2 (tiredness within 30 minutes after morning wake-up) was compared to mean motor activity within 30 minute after morning wake-up; item 3 (preferred sleep-onset time) was compared to mean sleep-onset time recorded by actigraph; item 4 (hour of maximum efficiency) was compared to the acrophase; item 5 (which type you considered your self) was compared with the cut-off scores.

RESULTS

According to the obtained score, using the Italian cut-off criteria (4-10 evening-type; 11-18 intermediate-type; 19-25 morning-type) subjects were assigned to one of the three groups: morning-type (n=21: 3 males and 18 females), intermediate-type (n=58: 24 males and 34 females) and evening-type (n=31: 13 males and 18 females) subjects.

As regards mesor no significant differences were found among circadian types (evening-type= 124.65±28.78; intermediate-type= 131.82±15.13; morning-type=125.14±23.54).

As regards acrophase significant differences were found ($F_{2,107}=5.94$; $p<.005$) among circadian types (evening-type=17:28±1:21; intermediate-type= 16:46±1:39; morning-type= 16:05±0:54). In particular evening-type reach the acrophase significantly later than morning-type ($p<.01$) (Post Hoc Test Tukey HSD for unequal sample).

As regards sleep onset time significant differences were found ($F_{2,107}=9.36$; $p<.0005$): morning-types (24:12±0:46) tend to have a sleep onset earlier than both intermediate- (01:05±1:16) ($p<.05$) and evening-types (01:34±0:58) ($p<.0005$) (Post Hoc Test Tukey HSD for unequal sample).

As regards morning wake-up time significant differences were found ($F_{2,107}=10.15$; $p<.0001$) among circadian types (evening-type= 09:55±1:30; intermediate-type= 08:59±1:23; morning-type= 08:13±1:01). In particular evening-types wake up later than both intermediate- ($p<.05$) and morning-type ($p<.0005$) (Post Hoc Test Tukey HSD for unequal sample).

As regards total sleep time no significant differences were found ($F_{2,107}=1.41$; $p=.25$) among circadian types (evening-type= 08:35±1:21; intermediate-type= 07:59±1:05; morning-type= 08:01±1:13).

As regards midpoint of sleep significant differences were found ($F_{2,107}=12.32$; $p<.00001$) among circadian types (evening-type=05:75±1:05; intermediate-type= 05:02±1:13; morning-type= 04:22±0:39). In particular evening-types reach the midpoint later than both intermediate- ($p<.05$) and morning-type ($p<.0001$), and intermediate- later than morning-type ($p<.05$) (Post Hoc Test Tukey HSD for unequal sample).

Concerning correlation analyses carried out between MEQr score and actigraph indexes we found a significant results for acrophase ($r= -.35$; $p<.0001$), sleep onset ($r= -.43$; $p<.0001$), morning wake-up ($r= -.49$; $p<.0001$) and midpoint of sleep ($r= -.52$; $p<.0001$). No significant correlation were found between MEQr score and hours of sleep ($r= -.18$; $p= .06$).

In table 1 are shown data regarding item 1 score analysis: comparison between preferred morning wake-up time with morning wake-up time recorded by actigraph. We highlighted the cell were we expected the higher frequency, i.e. where was correspondence between wake-up time desired (score of item 1) and wake-up time observed. In these cell we obtained always a value higher than 50%.

Table 1. Percentage distribution of the subjects determined by answer to item 1 (Considering only your own "feeling best" rhythm, at what time you get up if you were entirely free to plan your day?) of the MEQr and by morning wake-up time recorded by actigraph.

Item 1	Before 7:45	7:45 – 9:45	After 9:45
Score 1 and 2	7.69%	41.02%	51.28%
Score 3	20.00%	61.82%	18.18%
Score 4 and 5	56.25%	31.25%	12.50%

In table 2 are shown data concerning item 2 analysis: comparison between subjective tiredness within 30 minutes after morning wake-up (score of item 2) with the mean motor activity within 30 minute after morning wake-up. We highlighted the cell were we expected the higher frequency. In this case results are less congruent to expectation but we have to consider that normal mean activity in young adults is near 200. Therefore it is not amazing to find few subjects in the two extreme columns.

In table 4 are shown data regard item 4: comparison between hour of maximum efficiency (score of item 4) with the acrophase. In this case results are few comfortable but we have to consider that motor activity acrophase is probably more correlated to body temperature rhythm then subjective alertness rhythm. Therefore it is not amazing to find few subjects in the left column.

Table 4. Percentage distribution of the subjects determined by answer to item 4 (At what time of day do you think that you reach your "feeling best" peak?) of the MEQr and by acrophase time recorded by actigraph.

Item 4	Before 10:00	10:00 – 16:00	After 16:00
Score 1 and 2	---	15.38%	84.62%
Score 3	---	25.00%	75.00%
Score 4 and 5	---	48.57%	51.43%

In table 5 are shown data regard item 5: comparison between the score for the answer to item 5 with the total typology obtained by the total MEQr score. In this comparison both indexes are subjective. Actually in all highlighted cell we found a percentage values higher than 60%.

Table 2. Percentage distribution of the subjects determined by answer to item 2 (During the first half-hour after having woken in the morning, how tired do you fell?) of the MEQr and by mean motor activity within 30 minutes from morning wake-up.

Item 2	Less than 150	150 – 200	200 - 250	More than 250
Score 1	41.66%	8.33%	33.33%	16.66%
Score 2	19.05%	30.95%	35.71%	14.28%
Score 3	11.36%	31.82%	50.00%	6.82%
Score 4	---	8.33%	41.66%	50.00%

Data relative to sleep onset time (item 3) are shown in table 3. Once again we highlighted the cell were we expected the higher frequency. As it is possible to observe very few subjects go to bed early than 22:00, also among the morning-types. Probably in this case data were masked by social Zeitgebers.

Table 3. Percentage distribution of the subjects determined by answer to item 3 (At what time in the evening do you feel tired and as a result in need of sleep?) of the MEQr and by sleep onset time recorded by actigraph

Item 3	Before 22:15	22:15 – 24:30	After 24:30
Score 1 and 2	---	25.00%	75.00%
Score 3	4.17%	54.17%	41.66%
Score 4 and 5	10.%	80.00%	10.00%

Table 5. Percentage distribution of the subjects determined by answer to item 5 (One hears about "morning" and "evening" types of people. Which one of these types do you consider yourself to be?) of the MEQr and by circadian typology determined by MEQr scores.

Item 5	Morning	Intermediate	Evening
Score 0	---	10.00%	90.00%
Score 2	---	63.89%	36.11%
Score 4	33.33%	66.67%	---
Score 6	90.91%	9.09%	---

DISCUSSION

The results for the validation through external criteria of the reduced version of MEQr are extremely satisfactory. A subject bias can be reasonably excluded for the subject was unaware of the aim of the study. Except for hours of sleep, all objective sleep-wake cycle indexes are significantly correlated to MEQr score and significantly differed among circadian types. Our results confirm that the sleep-wake cycle feature that distinguishes circadian typology is the phase of sleep (sleep onset time and wake-up time) and not the total sleep time (hours of sleep). Moreover our data agree with previous works (29,30) about another interesting issue: the mid-point of sleep, rather sleep onset and wake-up time, gave the best correlation with the MEQr score. Probably the mid-point of sleep reduces the variance derived by short and long sleeper subjects. Taking into account that a physiological circadian phase marker as the dim-light melatonin onset also showed higher correlation with mid-sleep time than with either sleep onset or wake-up time (31) we suggest that the mid-point of sleep could be considered as a marker of the circadian system nadir.

These results are all the more telling if we bear in mind that the subjects were monitored under extremely ecological conditions (i.e. at home, free to behave according to their own rhythms though also partially entrained by social rhythms). Subjects had to answer to MEQr items evaluating their ideal rhythm, not the real daily life rhythms, on the contrary actigraph monitored the really behaviour. For this reason we think our results should be considered strong.

It is interesting to notice that under ecological conditions the parameter that mostly distinguishes the chronotype is the time of the morning awakening. On the contrary the parameter that less differentiates the chronotype is the sleep onset time. It is possible that the sleep onset time is mostly affected by social Zeitgebers. Therefore it is possible hypothesise that morning awakening is the behavioural variable more linked to the endogenous pacemaker.

Finally, the MEQr discriminating power was then replicated with behavioural indices, and it can be concluded that the reduced version of the MEQ may be used to advantage to individuate the circadian typologies both in experimental research and in applied psychology.

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