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## A SELF-ASSESSMENT QUESTIONNAIRE TO DETERMINE MORNINGNESS-EVENINGNESS IN HUMAN CIRCADIAN RHYTHMS

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(June 1976)

**SUMMARY** An English language self-assessment Morningness-Eveningness questionnaire is presented and evaluated against individual differences in the circadian variation of oral temperature. 48 subjects falling into Morning, Evening and Intermediate type categories regularly took their temperature. Circadian peak times were identified from the smoothed temperature curves of each subject. Results showed that Morning types had a significantly earlier peak time than Evening types and tended to have a higher daytime temperature and lower post peak temperature. The Intermediate type had temperatures between those of the other groups. Although no significant differences in sleep lengths were found between the three types, Morning types retired and arose significantly earlier than Evening types. Whilst these times significantly correlated with peak time, the questionnaire showed a higher peak time correlation. Although sleep habits are an important determinant of peak time there are other contributory factors, and these appear to be partly covered by the questionnaire. Although the questionnaire appears to be valid, further evaluation using a wider subject population is required.

**KEY WORDS** Individual differences, Circadian rhythms, Self-rating questionnaire.

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## INTRODUCTION

An aspect of individual differences in circadian rhythms which has attracted much interest is "Morningness" and "Eveningness", and dates from the work of O'Shea (1900). However, systematic enquiry into these differences was not evident until the work of Freeman and Hovland (1934) and of Kleitman (1939). Although the former group identified four types of individual difference Kleitman rejected this classification and revived the two categories of "Morning type" and "Evening type". He also identified an "Intermediate type" but he considered this category to be of minor importance. Some recent investigators, for example Folkard (1975) have proposed that inter-individual differences in daily peak times of performance are not very evident and the differences found by Freeman and Hovland and by Kleitman were only apparent because comparisons were mostly made between the peak times of different types of psychological performance tasks, rather than intra-test comparisons.

Öquist (1970) produced a Swedish language Morningness-Eveningness questionnaire which appeared to be able to distinguish between these two extremes. Östberg (1973a) modified this questionnaire for use in a circadian rhythm study of food intake and oral temperature and concluded that the questionnaire did distinguish between the two types and that there are Morning type - Evening type differences in patterns of food intake and oral temperature.

Östberg (1973b) re-designed the questionnaire for a shift-work study. The questionnaire had 14 questions and Östberg claimed that this Swedish questionnaire had the ability to discern individual differences for suitability to shift work. He concluded that Morning types did not adapt their habits to the needs of shift work as readily as Evening types and that Morning types have a more autonomous circadian rhythm.

The aim of the present study was to further assess the concept of Morningness-Eveningness and to design and evaluate an English language Morningness-Eveningness questionnaire.

AN ENGLISH LANGUAGE "MORNINGNESS-EVENINGNESS" QUESTIONNAIRE

Design The Östberg (1973b) Swedish language Morningness-Eveningness questionnaire was used as the basis for an English language version. However the different culture of British people necessitated many modifications to the questionnaire, including the addition of new questions and the deletion of others. The opportunity was also taken to completely revise all aspects of questionnaire, particularly the scoring.

In constructing the new questionnaire care was taken with phraseology, clarity and shortness of questions and the avoidance of leading or embarrassing questions which might give false answers. Most of the answers were designed to be forced choice with no "do not know/cannot decide" category. Four choices of answer were given, indicating; definite morning type, moderate morning type, moderate evening type,

and definite evening and were equally serious questions a time scale into periods of 15 minutes of questions was implemented was arranged. The order within each answer order to avoid any

The questionnaire range 18-32 years age. Scoring The questionnaire scale and the result relation between the for an item analysed within the four choices degree of discrimination there is some overlap was set. Three therefore being unequal 19 questions were given powers of discrimination the item analysis. were rounded off into defined Morningness. Between values indicatingness. The time scale of high Eveningness neither Morningness. Scoring For question appropriate score for box.

For questions 1,2,10 referred to the appropriate. For question 17 the as the reference point this point is taken. The scores are added Morningness-Evening

Definitely Morning  
Moderately Morning  
Neither Type  
Moderately Evening  
Definitely Evening

and definite evening type. The choices for each answer were clear and were equally semantically placed from each other. In a few questions a time scale was used. This scale was clearly divided into periods of 15 minutes over a seven hour time range. The order of questions was important, and a logical sequence of question topics was arranged. The order of choices from Morningness to Eveningness within each answer was balanced over the whole questionnaire, in order to avoid any fixed response pattern.

The questionnaire was administered to 150 adults, within the age range 18-32 years approximately equally divided between the sexes. Scoring The questionnaires were then scored with an arbitrary scale and the results item analysed. This analysis portrayed the relation between the scores of the questionnaire. Ideal results for an item analysed question would produce a response distribution, within the four choices, resembling a step function. But this degree of discrimination is seldom obtained with questionnaires and there is some overlap of responses. A criterion for acceptable overlap was set. Three questions failed to meet this criterion, and therefore being unable to discriminate, were rejected. The remaining 19 questions were given a loading factor based upon the putative powers of discrimination of Morningness-Eveningness determined from the item analysis. For simplicity of scoring these loading factors were rounded off into whole numbers. The highest numbers indicated definite Morningness, and the lowest numbers definite Eveningness. Between values indicated moderate Morningness and moderate Eveningness. The time scales were assigned a 1-5 range, in the direction of high Eveningness to high Morningness. A score of 3 indicated neither Morningness nor Eveningness. The scores were:

Scoring For questions 3,4,5,6,7,8,9,11,12,13,14,15,16 and 19, the appropriate score for each response is displayed beside the answer box.

For questions 1,2,10 and 18, the cross made along each scale is referred to the appropriate score value range below the scale. For question 17 the most extreme cross on the right hand side is taken as the reference point and the appropriate score value range below this point is taken.

The scores are added together and the sum converted into a five point Morningness-Eveningness scale:

	Score
Definitely Morning Type	70-86
Moderately Morning Type	59-69
Neither Type	42-58
Moderately Evening Type	31-41
Definitely Evening Type	16-30

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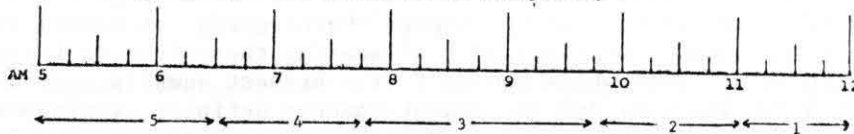
The final questionnaire

Instructions:

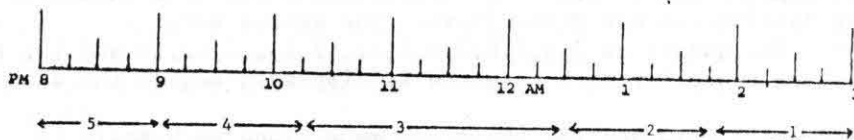
1. Please read each question very carefully before answering.
2. Answer ALL questions.
3. Answer questions in numerical order.
4. Each question should be answered independently of others. Do NOT go back and check your answers.
5. All questions have a selection of answers. For each question place a cross alongside ONE answer only. Some questions have a scale instead of a selection of answers. Place a cross at the appropriate point along the scale.
6. Please answer each question as honestly as possible. Both your answers and the results will be kept, in strict confidence.
7. Please feel free to make any comments in the section provided below each question.

The Questionnaire, with scores for each choice

1. Considering only your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day ?



2. Considering only your own "feeling best" rhythm, at what time would you go to bed if you were entirely free to plan your evening ?



3. If there is a specific time at which you have to get up in the morning, to what extent are you dependent on being woken up by an alarm clock ?

Not at all dependent.....	<input type="checkbox"/>	4
Slightly dependent.....	<input type="checkbox"/>	3
Fairly dependent.....	<input type="checkbox"/>	2
Very dependent.....	<input type="checkbox"/>	1

4. Assuming adequate environmental conditions, how easy do you find getting up in the mornings ?

Not at all easy.....	<input type="checkbox"/>	1
Not very easy.....	<input type="checkbox"/>	2
Fairly easy.....	<input type="checkbox"/>	3
Very easy.....	<input type="checkbox"/>	4

5. How alert do you feel during the first half hour after having woken in the mornings ?

Not at all alert.....	<input type="checkbox"/>	1
Slightly alert.....	<input type="checkbox"/>	2
Fairly alert.....	<input type="checkbox"/>	3
Very alert.....	<input type="checkbox"/>	4

6. How is your appetite during the first half-hour after having woken in the mornings ?

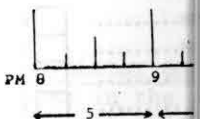
Very poor.....	<input type="checkbox"/>	1
Fairly poor.....	<input type="checkbox"/>	2
Fairly good.....	<input type="checkbox"/>	3
Very good.....	<input type="checkbox"/>	4

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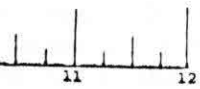
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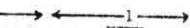
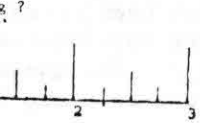
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.....	<input type="checkbox"/>	1
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.....	<input type="checkbox"/>	4

7. During the first half-hour after having woken in the morning, how tired do you feel ?

Very tired.....	<input type="checkbox"/>	1
Fairly tired.....	<input type="checkbox"/>	2
Fairly refreshed.....	<input type="checkbox"/>	3
Very refreshed.....	<input type="checkbox"/>	4

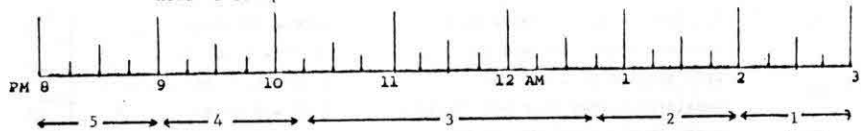
8. When you have no commitments the next day, at what time do you go to bed compared to your usual bedtime ?

Seldom or never later....	<input type="checkbox"/>	4
Less than one hour later.	<input type="checkbox"/>	3
1 - 2 hours later.....	<input type="checkbox"/>	2
More than two hours later	<input type="checkbox"/>	1

9. You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is between 7.0 - 8.0 AM. Bearing in mind nothing else but your own "feeling best" rhythm How do you think you would perform ?

Would be on good form....	<input type="checkbox"/>	4
Would be on reasonable form	<input type="checkbox"/>	3
Would find it difficult..	<input type="checkbox"/>	2
Would find it very .. difficult	<input type="checkbox"/>	1

10. At what time in the evening do you feel tired and as a result in need of sleep ?



11. You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day and considering only your own "feeling best" rhythm which ONE of the four testing times would you choose ?

8.00 - 10.00 AM.....	<input type="checkbox"/>	6
11.00 AM - 1.00 PM.....	<input type="checkbox"/>	4
3.00 - 5.00 PM.....	<input type="checkbox"/>	2
7.00 - 9.00 PM.....	<input type="checkbox"/>	0

12. If you went to bed at 11.0 PM at what level of tiredness would you be ?

Not at all tired.....  0  
 A little tired.....  2  
 Fairly tired.....  3  
 Very tired.....  5

13. For some reason you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which ONE of the following events are you most likely to experience ?

Will wake up at usual time and will NOT fall asleep  4  
 Will wake up at usual time and will doze thereafter  3  
 Will wake up at usual time but will fall asleep again  2  
 Will NOT wake up until later than usual  1

14. One night you have to remain awake between 4.00 - 6.00 AM in order to carry out a night watch. You have no commitments the next day. Which ONE of the following alternatives will suit you best ?

Would NOT go to bed until watch was over  1  
 Would take a nap before and sleep after  2  
 Would take a good sleep before and nap after  3  
 Would take ALL sleep before watch  4

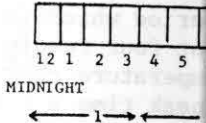
15. You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own "feeling best" rhythm which ONE of the following times would you choose ?

8.00 - 10.00 AM.....  4  
 11.00 - 1.00 AM.....  3  
 3.00 - 5.00 PM.....  2  
 7.00 - 9.00 PM.....  1

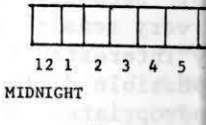
16. You have decided to engage in hard physical exercise . A friend suggests that you do this for one hour twice a week and the best time for him is between 10.00 - 11.00 PM. Bearing in mind nothing else but your own "feeling best" rhythm how well do you think you would perform ?

Would be on good form...  1  
 Would be on reasonable form  2  
 Would find it difficult.  3  
 Would find it very ..  4  
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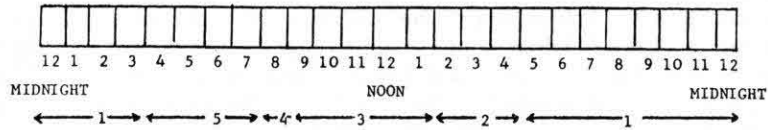
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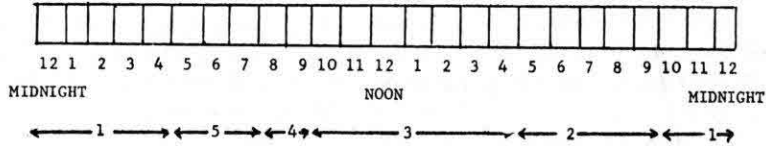
19. One hears "evening" Which ONE you consid

EXTERNAL VALIDATION  
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17. Suppose that you can choose your own work hours. Assume that you worked a FIVE hour day (including breaks) and that your job was interesting and paid by results. Which FIVE CONSECUTIVE HOURS would you select ?



18. At what time of the day do you think that you reach your "feeling best" peak ?



19. One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be ?

Definitely a "morning" type  6  
 Rather more a "morning" than an "evening" type  4  
 Rather more an "evening" than a "morning" type  2  
 Definitely an "evening" type  0

EXTERNAL VALIDATION OF THE QUESTIONNAIRE The criterion of individual differences in the circadian variation of oral temperature was taken as an external validation of the questionnaire. 48 subjects were randomly selected from the original pool of 150 subjects and were paid to regularly measure their oral temperature, using calibrated mercury-in-glass thermometers. It was found from the completed questionnaires that the sample consisted of 18 moderate to definite Morning types, 20 moderate to definite Evening types and 10 Intermediate types. For each day throughout a three week period each of these subjects took their oral temperature at approximately half hourly intervals commencing upon awakening and ending at bed-time. Measurements were not taken during sleep. A high daily sample rate over many days was necessary to average out: (a) error of fine measurement inherent with mercury-in-glass thermometers, (b) daily individual fluctuations within the circadian trend of oral temperature. Subjects retained their own thermometer. They were carefully trained in reading thermometer scales and were instructed to place the thermometer well under the tongue with mouth shut for five minutes. Measurements were not taken (1) during eating, drinking, smoking and changing environment, and within 20 minutes of completing these activities, (2) during exercise, and within 2 hours of completing exercise. Subjects were

not restricted in their normal daily activities and kept careful logs of bed and rising times.

At the end of the period an averaged waking oral temperature change was compiled for each subject by dividing up the waking day into 15 minute epochs, making about sixty epochs in all, and averaging all measurements taken over the three week period which fell into each epoch. These epochs each contained about four readings.

In order to smooth the averaged waking oral temperature curve for each subject and to objectively identify the peak time a curve fitting technique had to be employed. The commonly accepted least squares fitting of a cosine model, the "cosinor model", was, not seen to be suitable in this instance. The reasons being that, firstly, the temperature data were not available for the complete 24 hour period as the data were not collected during sleep. Secondly, Harris (1974) has noted that the cosinor analysis is not very sensitive to skewness and as the present study was particularly interested in individual differences in temperature curves and possible differences in skewness, this method of analysis would be inappropriate. Instead, the method of least squares fitting of polynomials was considered to be more suitable and a polynomial curve fitting program (BMD05R-1966-Health Sciences Computing Facility, UCLA) using the sextic term was employed.

Peak times were identified from each subject's polynomial curve. The temperature for every hour from 09<sup>00</sup> - 23<sup>00</sup> was assessed from each curve and pooled for each of the Morning, Evening and Intermediate groups. Unrelated "t tests" were performed with pairs of groups in respect of the data for each of the hours assessed. "T tests" were also performed with peak times for the three combinations of pairs of groups. The curves for all subjects within each group were pooled and are shown in Figure 1.

To assess whether any differences in peak times between the three groups might be due to differences in sleep-waking patterns the temperature logs of each subject were scrutinised for bed-times and arising times. Subjective estimates of sleep length were also taken.

Spearman rank order correlations were calculated between pairs of dimensions taken from: Morningness-Eveningness, oral temperature peak time, bed-time, arising time and sleep length. Comparisons, using "t tests" were made between Morning, Evening and Intermediate types in respect of bed-time, arising time, peak time and sleep length.

## RESULTS

It can be seen from Figure 1 that the average temperature curves up to 18<sup>00</sup> show Morning types to have a higher temperature than Evening types. Beyond 18<sup>00</sup>, and after the peaks, the earlier trend was reversed with a higher evening temperature and a slower temperature decline for Evening types. However statistical analysis of hourly points along the curves revealed no significant differences between any of the groups. The standard deviations for each point within

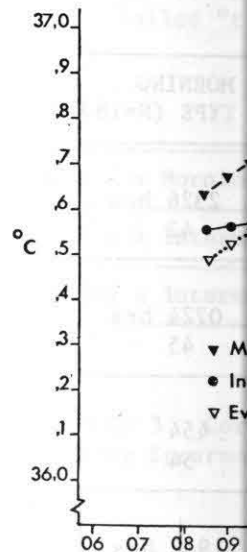


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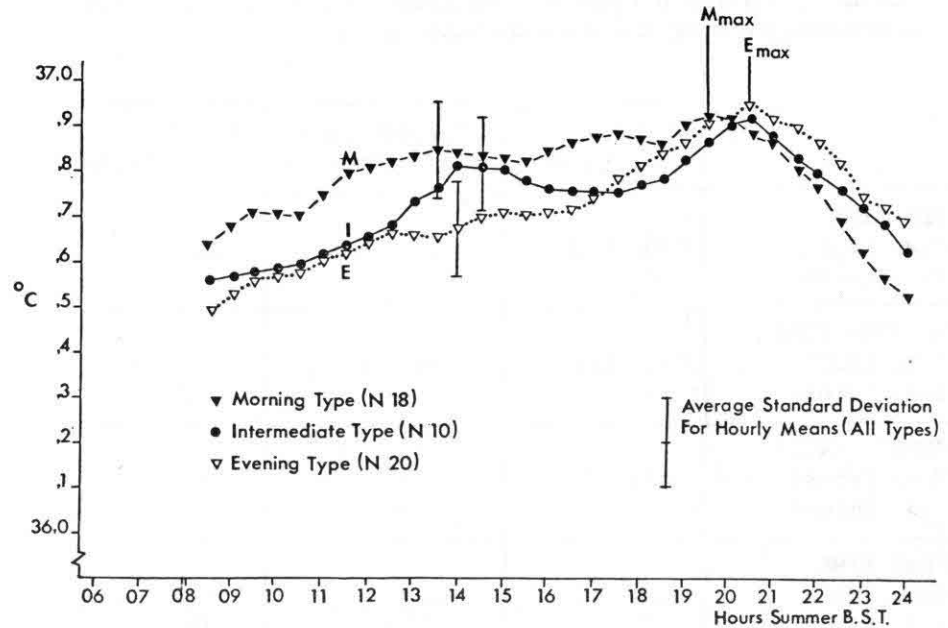


Fig 1 Mean Daytime Oral Temperature Curves For Morning & Evening Types Based Upon Questionnaire (N 48)

each group were about  $0.1^{\circ}\text{C}$ , indicating fairly large individual differences of temperature within each group. There was a significant difference ( $p: 0.05$ ) between the peak times of Morning and Evening types, with Morning types peaking earlier at an average of  $19^{32}$  hours BST and Evening types of  $20^{40}$  hours BST. The Intermediate type which had an average peak time of  $20^{25}$  hours BST showed no significant differences of peak time with either of the other two groups, and generally exhibited a temperature curve located between the other two groups. From the standard deviations of peak times shown in Table 1 it can be seen that there were large individual differences within each of the Morning, Evening and Intermediate groups. Of particular interest with the Intermediate type was a pronounced post lunch dip of body temperature, followed by a trough at about  $17^{00}$  BST hours. A second incline then ensued, peaking at about  $20^{25}$  hours BST.

TABLE 1 Sleep parameters and temperature peak times for Morning, Evening and Intermediate types.

	EVENING TYPE (N=20)	INTERMEDIATE TYPE (N=10)	MORNING TYPE (N=18)
BED TIME			
Mean (BST)	0105 hrs	2330 hrs	2326 hrs
s.d. (mins)	27	58	42
ARISING TIME			
Mean (BST)	0918 hrs	0807 hrs	0724 hrs
s.d. (mins)	68	52	45
SLEEP LENGTH			
Mean (mins)	434	452	454
s.d. (mins)	47	51	54
PEAK TIME			
Mean (BST)	2040 hrs	2025 hrs	1932 hrs
s.d. (mins)	82	134	113

From Table 1 and 2 it can be seen that there is a significant difference in bed time between Morning and Evening types with the Evening type going to bed on average 99 minutes later than the Morning type. The Intermediate type appears to retire, on average, at a similar time to the Morning type, resulting in the Intermediate type retiring significantly earlier by an average of 95 minutes, than the Evening type. There was no significant differences between all three groups in sleep length. There were significant differences between all three groups for arising time, with the Morning type getting up on average 114 minutes earlier than the Evening type, and the Intermediate types arising at a time located roughly halfway between the times of the other two groups.

From the matrix of Table 3 there are several significant correlations to be seen. Although correlations between peak time and bed time (+0.37) and between peak time and arising time (+0.42) are significant they are lower than the correlation between peak time and Morningness-Eveningness (-0.51). As might be expected bed time and arising time are highly correlated (+0.65). However sleep length is not significantly correlated with any other variables. Bed time and arising time are both significantly correlated with Morningness-Eveningness (-0.67, -0.79 respectively).

TABLE 2 Statis  
times between Mo  
two-tailed "t te

Evening x Morning
Evening x Intermed
Morning x Intermed

TABLE 3 Corre  
using Spearman

1. Morningness-Eve
2. Peak Time
3. Bed Time
4. Arising Time
5. Sleep Length

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#### DISCUSSION

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1932 hrs 113

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TABLE 2 Statistical comparisons of sleep parameters and peak times between Morning, Evening and Intermediate types, using two-tailed "t tests".

	Bed Time	Arising Time	Peak Time	Sleep Length
Evening x Morning Types	0.001	0.001	0.05	NS
Evening x Intermediate Types	0.001	0.001	NS	NS
Morning x Intermediate Types	NS	0.001	NS	NS

TABLE 3 Correlations of measures with significance levels using Spearman rank order correlations.

	1	2	3	4	5
1. Morningness-Eveningness					
2. Peak Time	-0.51**				
3. Bed Time	-0.67***	+0.37*			
4. Arising Time	-0.79***	+0.42**	+0.65***		
5. Sleep Length	+0.07	-0.13	-0.16	-0.08	

\*\*\* Significant at p:0.001 (two-tail)

\*\* Significant at p:0.01 (two-tail)

\* Significant at p:0.05 (two-tail)

DISCUSSION

The different curve characteristics for the Morning and Evening types are in agreement with the findings of Östberg (1973a,b). Although there appears to be no significant difference in the hourly temperature values between the two groups there is a significant difference in peak times. From Figure 1 and Tables 1 and 2 it appears that there are some interesting trends in the temperature data. Although the average Morning type appears to start the waking day nearly two hours earlier than the Evening type the overall higher temperature curve up to the peak time for the former group appears not to be merely an advancement on the latter by two hours. There is

some indication that whilst the Morning type displays a relatively rapid waking temperature rise, culminating in a plateau which is terminated in a slight but obvious peak at about 19<sup>30</sup> the Evening type tends to display a steady temperature rise throughout the day eventually reaching a distinct peak of similar amplitude, but about 70 minutes later than that of the Morning type. After the peaks have been reached the rates of temperature decline for both groups appear to be similar, but with the Evening type lagging behind the Morning type by about an hour, leading to a difference in bed time of about 1½ hours. Thus it appears that whilst the difference in peak times between the two groups is probably related to the evidence that Morning types have a sleep-wakefulness life style about an hour in advance of Evening types the dynamics of the temperature curves of the two groups from arising to peak times appears to be not just a reflection of such a time lag.

Because the Intermediate group appear to have an earlier peak, at about 14<sup>00</sup>, as well as the evening peak it is possible that there is an even earlier peak for Morning types. But unlike the Intermediate types who appear to have an afternoon temperature dip there is no similar dip for the Morning types. It might appear that the plateau of the Morning type extending approximately from 11<sup>00</sup> to 19<sup>00</sup> may in fact be a bimodal phenomenon with a negligible inter-peak dip.

The question of whether or not the afternoon temperature dip of the Intermediate group can be equated with the post-lunch dip in performance reported by Blake (1967) must at present remain unanswered particularly as the present temperature data for this group was only made up of ten subjects. However this is an area worthy of further investigation especially as Hockey and Colquhoun (1972) point out in their review that although there is support for a post lunch dip in performance there is no evidence of such a dip in temperature to accompany this.

The Intermediate group is probably made up of afternoon types and also a "both Morning and Evening type". However the questionnaire was specifically designed to identify Morning and Evening types, and therefore at present the Intermediate group can only be defined as not being clearly within the parameters of either the Morning or Evening types.

The significant correlation between Morningness-Eveningness endorses the "t test" results of a significant difference in peak time between Morning and Evening types and indicates that, for these subjects at least, the questionnaire does have validity. However these subjects are not typical of a normal population, particularly in respect of life style. For example, from Table 1 the arising time for these students, particularly the Morning types, would seem to be later than an arising time which could be expected from an older population having to start a regular job of work at 07<sup>00</sup>-09<sup>00</sup> with various family commitments prior to work. Needless to say, the questionnaire has to be further assessed with a greater variety of subjects.

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Even though bed time and arising time are significantly correlated with peak time, squaring these correlations to obtain the variance shows that only a minority of the total variance of peak time can be accounted for by either bed time or arising time. Thus there is more to the determination of peak time than sleep/wake habits. It might seem therefore that one reason why the questionnaire appears to be better at predicting peak time than sleep/wake habits is that the questionnaire is more eclectic in its enquiry. Although the inclusion of one or more questions concerning sleep/wake habits might seem a desirable addition to the questionnaire, particularly as both bed-time and arising time are significantly correlated with Morningness-Eveningness, a problem does arise. Whilst sleep/wake habits are significantly different for Morning and Evening types in the present study, the habits do change with age, as Tunc (1969) has shown. Thus for example a bed time of 23<sup>30</sup> may be indicative of a Morning type within a student population, but might be more related to an Evening type in the 40-60 years age group.

Finally it must be noted that although the peak time has been used as a reference point in this study it can vary within individuals who lead fairly regular lives. For example the magnitude of the peak-time differences between Morning and Evening types may be influenced by seasonal changes in the circadian peak-time of body temperature. Horne and Coyne (1975) found in a study conducted in the climatic and environmental conditions of the British Isles that the circadian peak time of oral temperature became delayed by about an hour from December to June. This change was not related to clock time changes.

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## ACETABULARIA MED SYNTHESIS AND AS OF THE THYLAKOID

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