Small Publications in Historical Geophysics

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A Study of Sleep Time as a Function of Season of the Year in the 1700s Using Geophysical Data

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1. Background

The normal duration of sleep during night for grown-up people is generally considered to be some 7 – 8 hours. This is also what is usually recommended by medical institutes. In the Nordic countries, at latitudes around 60° or more, it is sometimes stated that this figure might be slightly shorter during summer and slightly longer during winter.

In modern society, life is very much governed by such things as electric light, alarm clocks and fixed time schedules, supporting or even requiring a fairly constant time of sleep throughout the year, independently of the season. In earlier centuries, however, the sleep of people in the Nordic countries might have been more dependent on the sun, in that case implying a considerably shorter duration of sleep in summer and longer in winter. At least this is sometimes assumed; there are sparse notes indicating this. To the author's knowledge, however, there are hardly any data stored to confirm that this has actually been the case. For natural reasons a person at that time did not register throughout a year when she or he went to bed and when she or he rose in the morning.

Nevertheless, it now appears that there is, in an indirect sense, an almost complete set of data of such a kind for a person living in Scandinavia in the 1700s. This is due to the geophysical observations made at that time at the Uppsala Observatory in Sweden, close to 60° latitude. The observations were initiated by Anders Celsius, the founder of the observatory, and continued by his assistant and brother-in-law, Olof Hiorter. Apart from such quantities as temperature and air pressure, Celsius and Hiorter started systematically observing the direction of the geomagnetic field. This was, during a few periods, made about once every hour for every day during a whole year. Hiorter's geomagnetic observations throughout mainly the year 1747 now turn out to be possible to use for studying his going to bed in the evening and his rising from bed in the morning as a function of the season of the year. In that respect this is a most unusual, perhaps even unique, data set from the 1700s. We will now use this data set to find to what extent his sleep time was actually dependent on the season of the year.

2. Geomagnetic data used

Celsius had started geomagnetic observations in Uppsala after a stay of his by Graham in London. Graham had constructed a sort of large compass, with a needle one foot long, for accurate studies of the magnetic field, and Celsius had ordered such a one when he was there for his own use. Back in Uppsala, Celsius studied Graham's finding in London of a daily variation in the magnetic declination, i.e. in the horizontal direction of the magnetic field. Observing his long magnetic needle about once every hour Celsius (1740) established that there was such a variation also in Uppsala and that it had an amplitude of some 10′. After some time, Celsius mostly left to Hiorter to care for the magnetic measurements; Hiorter did so with great patience.

In 1740 – 1741 Hiorter according to Celsius´ wishes made observations of the magnetic needle about once every hour between about 6 in the morning and 11 in the evening, almost every day during a year. This led to the unexpected discovery, published later by Hiorter (1747), that there was a connection between the magnetic field and the northern lights (aurora borealis). What Hiorter and Celsius had discovered was that strong northern lights were connected to large disturbances in the direction of the magnetic field, of the order of 1^{o}; see e.g. Widmalm (2012) and Ekman (2016).

Later on, after the sudden death of Celsius, Hiorter in 1746 - 1747 resumed the observations of the magnetic needle (Hiorter, 1747). Now he obviously observed it repeatedly during all the time he was awake, during a year. This is what gives us the possibility to study to what degree his sleep time, or rather his time of going to bed and his time of rising again, was dependent on the season of the year.

The data collected by Hiorter, now in the Uppsala University Library, consist of tables showing the time in hours and minutes and the corresponding direction of the magnetic needle. Times given are local mean solar time. The readings are made frequently each day, with a somewhat irregular interval of the order of one hour. The observations performed in this way span a whole year, beginning in late 1746 and continuing through 1747. This allows us to start our investigation with December 1746 and end it with November 1747, thereby covering the seasons from midwinter via midsummer to the next midwinter. There is a gap in the observations, however, leaving February without data.

It should be mentioned here that the dates in the data set are given according to the calendar then in use in Sweden, which was still the Julian calendar. The shift to the present Gregorian calendar was made some years later, in 1753, the difference amounting to 11 days. This means that the winter solstice according to the calendar used occurred closer to the middle of December than today, and the summer solstice closer to the middle of June.

3. Calculations of monthly bed and rising times during a year

The calculations of the times of going to bed and rising again have been performed according to the following. For each day the time in the morning of the first reading and the time in the evening of the last reading of the magnetic needle have been noted. The first time is assumed to be associated with waking up and rising, and the last time likewise to be associated with going to bed and falling asleep.

For each month, then, the mean value of the first times in the morning as well as the mean value of the last times in the evening are calculated. To give an impression of the internal variability of these times also the corresponding standard deviations for each month are calculated.

In some cases it is evident that the first or last time of the day does not correspond to the normal rising or going to bed. Then that time has been excluded from the data set. Doubtful cases in this respect are very few and their treatment does not have any substantial influence on the resultant monthly mean value.

There are also days lacking observations, in some cases a whole series of days. Then simply the available days of the month have been used, without further manipulations. As already mentioned, there are no data at all from February.

The resultant monthly mean values of the first and last observation times are given in Tables 1 and 2. Table 1 shows the last evening time, corresponding to going to bed, and Table 2 shows the first morning time, corresponding to rising from bed. All times are given as local mean solar time. The original Julian calendar has been kept unchanged, causing midwinter to be just before mid December and midsummer to be just before mid June.

Let us first consider Table 1. It reveals that the evening time is independent of the month of the year. The last observation is constantly made somewhere around 22 30. This implies that going to bed occurs at approximately the same time all through the year.

We now turn to Table 2. This, on the other hand, reveals that the morning time is strongly dependent on the month of the year. The first observation is made around 07 30 at midwinter (December), around 06 00 at the equinoxes (March and September), and around 03 50 at midsummer (June). There is a continuous decrease in time from midwinter via the vernal equinox to midsummer, and then a continuous increase in time from

Table 1. Time of last magnetic observation in the evening ≈ time of going to bed, monthly means December 1746 – November 1747.

Month	Time	St. dev.
December	22 51	37
January	22 58	29
February		
March	22 13	44
April	21 41	39
May	22 00	41
June	22 16	38
July	22 28	48
August	21 52	35
September	22 00	28
October	21 58	35
November	22 01	53

Table 2. Time of first magnetic observation in the morning ≈ time of rising from bed, monthly means December 1746 – November 1747. (Brackets denote interpolated value.)

Month	Time	St. dev.
December	07 29	22
January	07 14	33
February	(06 30)	
March	05 45	43
April	04 56	26
May	04 06	67
June	03 50	61
July	04 15	47
August	04 51	26
September	06 06	17
October	06 30	34
November	07 36	42

midsummer via the autumnal equinox to midwinter again. Thus rising from bed occurs at a time strongly following the season of the year.

The morning times of Table 2 are illustrated in Figure 1. The figure clearly shows a smooth variation of the rising time in the morning with the season of the year. We note that the rising time around midsummer is no less than 3 ½ - 4 hours earlier than around midwinter.

The variability in terms of standard deviation of the observed times during a month is, according to Tables 1 and 2, about half an hour. There is an indication of a somewhat larger variability in rising time in summer.

Assuming that it may take about a quarter of an hour from the last evening observation to falling asleep, and likewise about a quarter of an hour from waking up to the first morning observation, we may find approximate values of the duration of sleep from the times given by Tables 1 and 2. For winter we obtain a sleep duration of 8 ½ - 9 hours, and for summer a sleep duration of 5 - 5 ½ hours. The difference is considerable; according to above it is almost wholly due to the difference in rising time in the morning.

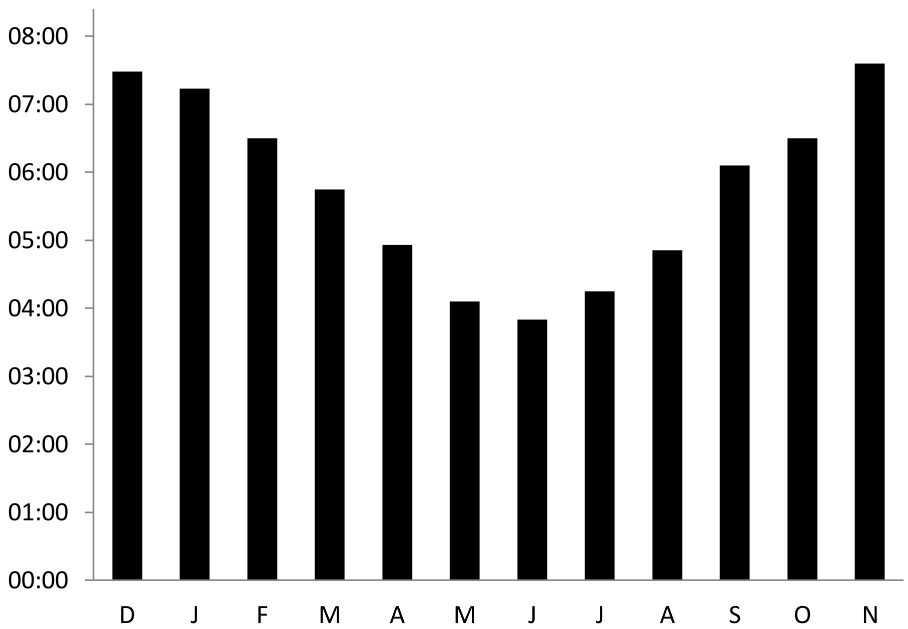

Figure 1. Monthly means according to Table 2 of times of first observation in the morning, i.e. of times of rising from bed, December 1746 – November 1747.

4. Comparisons with sunrise

It is instructive to compare the rising time in the morning according to Table 2 with the time of the sunrise (for the latter see also Nautical Almanac Office, 1961). Such a comparison is made in Table 3, showing for each month the approximate time of the sunrise (for the middle of the month) as well as the time difference between the rising from the bed and the rising of the sun. Times and calendar are here treated in a consistent way with the earlier sections.

Table 3 reveals a clear pattern: The rising from bed in the morning follows the sun through the year, although with a smaller annual amplitude. In winter the rising from bed occurs about 1 hour before sunrise, and in summer it occurs about 1 hour after sunrise; in spring and autumn it occurs almost simultaneously with the sunrise. The span between the extreme times of sunrise is 6 hours while the corresponding span for rising from bed is somewhat less than 4 hours.

Table 3. Difference between monthly morning observation/rising times according to Table 2 and times of sunrise.

Month	Sunrise	Difference
December	09 00	- 91
January	08 25	- 71
February	07 10	(- 40)
March	05 45	0
April	04 15	41
May	03 00	66
June	02 40	70
July	03 25	50
August	04 40	11
September	05 55	11
October	07 05	- 35
November	08 20	- 49

5. A check with temperature data

There is another set of geophysical data from the Uppsala Observatory which could be used as a kind of check, namely temperature. Temperature was read from a number of thermometers a few times per day. The first observation each day in the late 1740s was usually made as close as possible to sunrise. This means that in summer the first temperature observation, like the first magnetic one, should indicate the time of rising from bed. In winter, on the other hand, this does not hold.

Now, from the meteorological journal we find for June 1747, i.e. around midsummer, that the monthly mean of the time of the first temperature observation is 03 45. This agrees with the corresponding magnetic time, 03 50, in Table 2. From the temperature data such early morning times seem to be valid for all summers in the latter half of the 1740s, confirming the connection between early sunrise and early rising from bed found in Sections 3 and 4. (In the first half of the 1740s the observations seem to have been started more regularly at about the same time every morning irrespective of the season.)

6. Conclusions

Using the remarkable set of geomagnetic data collected at the Uppsala Observatory December 1746 – November 1747 by Olof Hiorter, on the original initiative of Celsius, we have been able to draw conclusions about his sleep there, at 60^o latitude, during different seasons of the year:

1. The duration of sleep is very much shorter during summer than during winter, 5 – 5 ½ hours versus 8 ½ - 9 hours. The difference is almost wholly due to the difference in rising time in the mornings, the rising time being 3 ½ - 4 hours earlier around midsummer than around midwinter.

2. The rising time in the mornings decreases continuously from midwinter via the vernal equinox to midsummer and then increases continuously from midsummer via the autumnal equinox to midwinter again, as shown by Figure 1. The rising time around midwinter is about 07 30 and around midsummer about 03 50.

3. The rising time in the mornings follows the sunrise through the year, although with a smaller annual amplitude. In winter it occurs about 1 hour before sunrise, in summer about 1 hour after sunrise.

The early rising time in the mornings in summer are supported by temperature data at the observatory, also for other years in the late 1740s.

These results are probably the first documented evidence clearly showing that a person in the 1700s at 60^o latitude actually had a sleep strongly dependent on the season of the year.

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