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HUMAN SKIN TEMPERATURE AND BIOLOGICAL CLOCKS: A LABORATORY EXERCISE FOR PHYSIOLOGY STUDENTS

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Abstract: A simple laboratory experiment is described, consisting of taking the mean temperature between two fingers of human subjects. The results from comparing male and female students is presented. The change in skin temperature over four hours is documented, to demonstrate the importance of doing standardized experiments at the same time of day.

Introduction

The study of human skin temperature can offer interesting possibilities for study or for a laboratory exercise for students. The differences between male and female subjects can be noted, and the influence of a biological clock can be demonstrated. In the exercise described here, the mean temperatures between only the second and third fingers are studied.

Methods

The temperature between two fingers was measured by a telethermometer probe. The probe was arranged so that it remained in a stable position with the tip suspended 2mm above 2cm of paper insulation. The paper insulation covered an area sufficiently large so that both hands could be placed on it palms down. To take a reading, the hand was moved so that the probe was between the index and middle fingers, at the first joint of the index finger. The fingers were pressed firmly together against the probe. This process was repeated for the other hand. An effort was made to keep a constant position of the hands and a constant method of taking the readings. Background data was recorded on a duplicated form, including subject, date, health of subject, room air temperature, the air outside the laboratory, and oral temperature of the subject. Each subject equilibrated for at least one hour and was tested in an air-conditioned room which was maintained at 22 $\pm$0.5°C.

An intensive study was done for six months on one subject; in this case we alternated the hand which was measured first. Usually the subject was measured twice, at 1300 hours and at 1630 hours.

We also conducted one four-hour standardized experiment as described on pages 78 and 79 in Reference 1. Finger and mouth temperatures were taken; then the subject was free to sit in a lighted air-conditioned room for 30 minutes. Next, the subject reclined for 15 minutes in

light, and then for 15 minutes in darkness. Then the subject's finger and mouth temperatures were taken, and the process began again. This gave five readings at one-hour intervals under reproducible conditions. The purpose was to determine whether body temperature is under the control of a biological clock.

Results

Readings were taken from seven women of different ages. Of the seven women, three had readings in which the temperatures of both hands were the same. The hand temperatures of the other four subjects varied by as much as 1.2°C between the right and left hand, with the left hand always warmer (Table 1). Of all the readings taken (N = 14), the majority (10) were within two degrees of one another, a range of 29.6° to 31.6°. The other four readings were those in which both hands of the subject were the same. Of these, one was 25.1°, 4.5° below the range; the other was 33.4°, 1.8° above it.

Table 1.

Mean Temperature Between Two Fingers (°C).
Readings Were Taken Between 1300 Hours and 1400 Hours.

Subject	Females		Males	
	Right Hand	Left Hand	Right Hand	Left Hand
1	*33.4*	*33.4*	*31.3*	*31.8*
2	*30.3*	*30.3*	*32.3*	*33.1*
3	*25.1*	*25.1*	—	—
4	*30.6*	*31.6*	—	—
5	*30.2*	*31.4*	—	—
6	*30.0*	*30.3*	—	—
7	*29.6*	*30.2*	—	—
Mean	*29.9*	*30.3*	*31.8*	*32.4*
SD	*2.5*	*2.6*	*SD* *1.3*	*1.4*

Readings were also recorded for two male subjects. There was less similarity among the male readings (Table 1). Subject 1 stayed within a 2.2° range of temperature; however, Subject 2 had a range of 4.8°, showing more variance in his skin temperature. With the exception of one reading, the left hand was always warmer. This was true of both subjects.

In both male and female subjects, the left hand was frequently warmer than the right hand. Also, the average readings of the male subjects were warmer than those of the female subjects (Table 1).

An intensive study of one 18-year-old female (KL) was done over a 9-month period, from September 1 through the month of April. Each

day a reading was taken at 1300 and again at 1630. Her fingers became cooler as the winter progressed. Some results by month for subject KL for combined fingers are found in Table 2.

Table 2.

Mean Temperature Between Two Fingers Showing Seasonal and Time-of-Day Effects (°C + SD, Female Subject KL).*

Month	Time of Day 1300 hrs	Time of Day 1630 hrs
September	*31.3 ±0.6*	*26.7 ±2.6*
October	*30.4 ±0.5*	*27.0 ±2.0*
November	*30.0 ±0.7*	*25.7 ±2.9*
February	*28.0 ±.4*	*25.0 ±.1*
March	*29.4 ±.1*	*26.0 ±.4*
April	*29.4 ±.1*	*25.0 ±.1*

*The subject equilibrated for one hour before each reading.

Another finding was that the subject's hands were always warmer in the early afternoon compared to late afternoon; the mean drop was

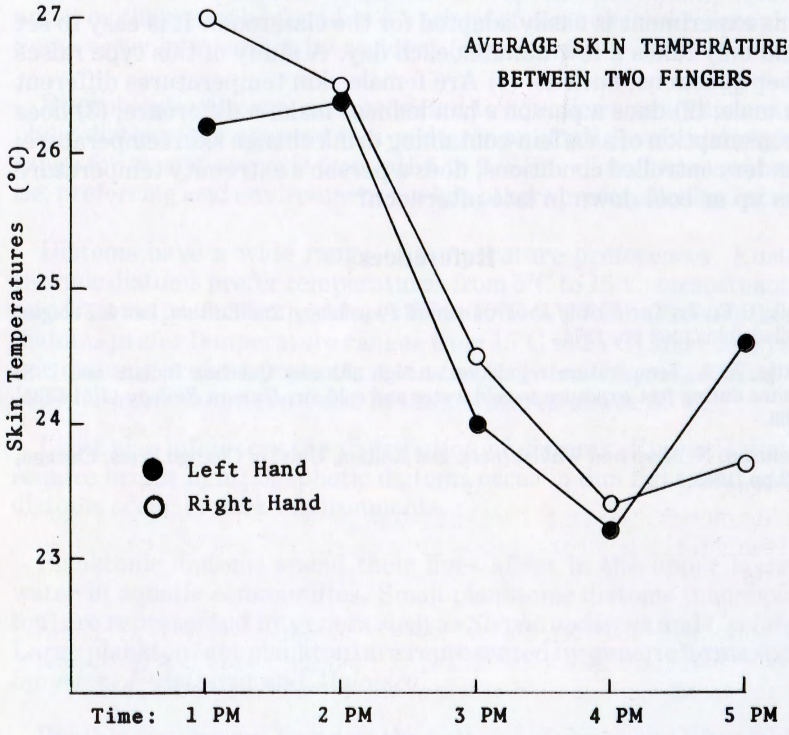

Figure 1: Carefully controlled experiment on female subject, age 18, performed on February 16. See Methods for procedure used.

4.2°C. Contrary to the others measured, this subject showed the right hand to be warmer in a majority of the readings taken; the average difference was 0.2°C. All subjects measured were right-handed.

A detailed study was done on this subject on one afternoon, from 1200 to 1700 (Fig. 1). Environmental factors were minimized (see Methods); the subject never ate lunch, and muscular tone was controlled by having the subject lie down in a darkened room before each reading. In this experiment this subject showed finger cooling by as much as 3.5°C in the afternoon. Other subjects under the influence of their particular clock-setting (which is independent of environmental factors) may show afternoon extremity temperatures which are 2° to 5° *higher* than morning skin temperatures (Little, 1969). This makes this laboratory exercise more interesting; "early-energy" kinds of individuals (Kleitman, 1963) who have warmer skin in morning and a higher oral temperature are referred to as "larks"; "late-energy" kinds of individuals who have warmer skin in late afternoon and a higher oral temperature then, are referred to as "owls."

Discussion

This experiment is easily adapted for the classroom. It is easy to set up and only takes a few minutes each day. A study of this type raises further questions, such as: (1) Are female skin temperatures different from male; (2) does a person's handedness make a difference; (3) does the consumption of a caffein-containing drink change skin temperature; (4) under controlled conditions, does a person's extremity temperature warm up or cool down in late afternoon?

References

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