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Body temperature changes during the practice of g Tum-mo yoga

IN their recent letter[1], Benson *et al.* do not provide sufficient information to determine whether the temperature changes reported indeed resulted from the practice of yoga. The 'control' time shown on their graphs ranged from 5 to 10 min, and significant fluctuations in temperature appeared to occur within even that brief time. For example, if the 1 °C change in finger temperature recorded during this time for the first subject, V.G.J., were extrapolated for the 55-min meditation period, a temperature change of ~5 °C would result, which represents most of the reported effect of 5–9 °C. The change in the toe temperature was even greater than the finger temperature change during the 'control' period.

I would like to see results of tests on non-meditating individuals, and on those individuals studied, to determine how their temperatures vary over periods of 1–1.5 hours, corresponding to the duration of meditation. I would also want experiments to be performed in a temperature controlled environment, as I suggest that room temperature changes of 2 °C, such as occurred during the trial of the second subject, could lead to greater changes in the temperature of the extremities.

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1. Benson, H. *et al. Nature* **295**, 234–236 (1982).

BENSON *ET AL.*[1] present an interesting account of three persons who increase their finger and toe temperatures apparently by a Tibetan Buddhist meditational practice known as g Tum-mo (heat) yoga. To ensure that any observed changes in body temperature are directly attributable to this method of meditation, the use of a control group is desirable. As this study did not include a control group, it is possible that the observed effects were the result of some other factor, for example: (1) changes in the ambient air temperature (as was the case for two of the subjects, A and B, in this investigation); (2) the consumption of certain food known to increase metabolic activity; and (3) the placement of toe and fingers during the meditation and recovery period, for example, if toes or fingers were placed in an axillary cavity, this would effect a rapid rise in temperature. In addition, the location and method of attachment of the disk thermistors may be partly responsible for the changes in temperature. Further investigation should include the use of matched controls; possibly additional practitioners of g Tum-mo yoga could be used if they were willing to refrain from meditating during the testing period.

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1. Benson, H. *et al. Nature* **295**, 234–236 (1982).

BENSON REPLIES—With regard to the comments of Strassburg and Pasachoff, the subjects in our experiment served as their own controls in an 'off–on–off' design. As the studies were performed in the isolated, mountain hermitages of the monks, it was not feasible to control the ambient temperature. The monks could not serve as their own matched controls at a later time because they would involuntarily lapse into g Tum-mo meditation while sitting quietly for prolonged periods, as we described for subject L.T. Closely-matched, simultaneously-studied controls would have been desirable, but this was not possible in a small Himalayan hut. Despite the changing ambient temperatures and lack of between-subject control, we believe the reported results are valid for the following reasons.

It is unlikely that the reported increases in skin temperature could have occurred spontaneously. Our study was performed in relatively cold to cool ambient temperatures[1]. There are two major modes of preserving body temperature in humans at cool ambient temperatures: heat conservation and increased heat production[2]. In the first adaptation, heat flow from the body centre to the skin is reduced through vasoconstriction of the arterioles in the skin. Thus, less heat is lost to the environment, but at the expense of decreased skin temperatures. When a comfortably warm individual enters an ambient temperature of 25 °C and does not change clothing or activity, his mean body skin temperature can decrease from ~33 °C to 31 °C, and heat loss to the environment is reduced by ~25%. Since the fingers and toes are thin cylinders with little mass in which to store heat, their temperatures usually decrease more, and much more rapidly, than those of the thorax and abdomen. Ordinarily, finger temperatures in environments such as those of our experiment are ~4 °C higher than ambient[3]. During the meditation period, however, the subjects' finger temperatures were 10–14 °C higher than ambient temperatures. The finger temperatures during the control period were already higher than expected. If the increases were spontaneous shifts, one would expect a return to normal, not a further deviation. In the second adaptation, the metabolic rate increases, and more heat is produced. Although it is possible that these men had learned to increase their metabolism to produce more body heat, this is also unlikely. Meditation practices generally have been associated with decreased metabolic rates[4]. Furthermore, the subjects' heart rates were within normal limits and relatively stable throughout. An increased heart rate would be expected in conditions of increased metabolism.

Pasachoff extrapolated several of the increasing, control-period temperatures of subject G.J; he disregarded those of the other subjects which were either stable or decreasing. Both Strassburg and Pasachoff mention the changing ambient temperatures as a possible confounding influence. There was, however, no consistent relationship between the temperature changes in the air and those of the skin of the subjects. For example, in G.J., the finger and toe temperature increases preceded the increases in air temperature; his finger temperature returned to baseline when ambient temperature was highest. In L.T., finger temperature increased during the meditative period at a time when ambient temperature was decreasing. As for the possibility that the location and method of attachment of the thermistors may have been partly responsible for the temperature changes, the thermistors were placed at representative skin sites of the thorax, abdomen and extremities and remained closely taped to the skin during each experiment. Both increases and decreases in skin temperature were recorded. Although there may have been some damping of the magnitude of the observed alterations in temperature, the method of application of the thermistors did not inhibit the decreases during the recovery period.

Finally, Strassburg mentions that placement of toes or fingers in an axillary cavity would bring about a rapid rise in temperature. This is true, but the subjects were under constant observation by four people throughout the experiments and assumed no such position. It is intriguing, however, to contemplate the resulting posture with one's toes in one's armpits or, perhaps, in someone else's armpits?

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