Cloth Color Preference Under the Influences of Body Heating Due to Hot Bath Immersion

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Abstract. The experiment is aimed at knowing the effect of “body heating” on color preference. Eleven subjects with normal color vision served as subjects. Two tests, one of the “No Bath” and the other of the “Bath” were conducted. Hot bath immersion with 38.5°C was performed for 30 min from 07:30 h to 08:00 h. Then, they were instructed to choose a single colored cloth out of 41 cloth colors (24 × 52 cm), preferred by themselves, every five min from 08:00 h to 09:00 h under the ambient temperature (Ta) of 27°C. Most subjects preferred cooler color after “body heating” than after “no body heating”. This finding was discussed in terms of greater differences between core temperature and its set point after “body heating”, because cooler color would be helpful psychologically in allowing raised core temperature approach its set point.

Materials and Methods

Subjects

Eleven adult female subjects (age: 20.13 ± 0.35 yrs (mean ± SD), height: 156.75 ± 1.21 cm, and body mass: 50.13 ± 1.66 kg) participated in the present study. Each test was conducted at the follicular phase to avoid the effects of the menstrual cycle on core temperature (Cunningham and Cabanac, 1971). All subjects refrained from heavy exercise and from alcoholic or caffeine containing drinks at least 12 hours before the start of each experiment. They had normal color vision. Experimental procedures were fully explained to them before the beginning of experiments. They gave their informed consent for their participation in the experiments.

Procedure

The experimental schedule is shown in Fig. 1. The subjects entered a chamber at 22:30 h. The ambient temperature is kept at a global temperature of 27°C and a relative humidity of 50% R.H. The subjects were instructed to rest quietly for 30 min, and then to sleep in the dark until 07:00 h the following morning. Sensation from warm to cool colors might be possibly different individually. Therefore, before retiring, each subject was
asked to array 41 randomly placed cloth colors (4 × 5 cm, cotton 100%) from very warm to very cool colors. They arrayed these cloths in the order from red through yellow and green to blue. According to a preliminary test, they showed reproducibility with regard to the arraying colors test. They woke up 07:00 h the next morning. The subjects were asked to rest for 30 min in a sedentary position, and during this time sensors for the measurements of tympanic were carefully attached. After 30 min rest, the measurements started. Two tests, one of the “No Bath” and the other of the “Bath” were conducted. Hot bath immersion with 38.5°C was performed for 30 min from 07:30 h to 08:00 h. After the bath they were instructed to choose a single color out of 41 cloth colors (24 × 52 cm, cotton 100%), preferred by themselves, every 5 min from 08:00 h to 09:00 h under CIE (Commission Internationale de l’Eclairage) standard illumination (TOSHIBA, FL 40 S-N-EDL/M, 5503K, Ra=98, Type AAA). The intensity of the test illumination was 1000 lx at the subjects eye level and 900~1100 lx at the test cloth level. Munsell values (HV/C) of cloth color used are listed in Table 1.

### Table 1 Munsell values (HV/C) of cloth colors

<table>
<thead>
<tr>
<th>H</th>
<th>V/C</th>
<th>H</th>
<th>V/C</th>
<th>H</th>
<th>V/C</th>
</tr>
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<tbody>
<tr>
<td>4.3R</td>
<td>4.1/14.2</td>
<td>2.3Y</td>
<td>8.0/12.0</td>
<td>8.1BG</td>
<td>4.1/6.8</td>
</tr>
<tr>
<td>5.4R</td>
<td>4.0/13.7</td>
<td>6.3Y</td>
<td>8.3/12.7</td>
<td>0.9B</td>
<td>4.1/6.7</td>
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<tr>
<td>6.2R</td>
<td>3.5/12.3</td>
<td>7.4Y</td>
<td>8.6/11.4</td>
<td>4.7B</td>
<td>4.0/8.1</td>
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<tr>
<td>6.3R</td>
<td>4.1/12.8</td>
<td>2.5GY</td>
<td>7.2/11.9</td>
<td>6.4B</td>
<td>4.2/8.0</td>
</tr>
<tr>
<td>6.4R</td>
<td>4.1/14.8</td>
<td>6.0GY</td>
<td>6.9/9.2</td>
<td>9.7B</td>
<td>3.9/9.6</td>
</tr>
<tr>
<td>6.9R</td>
<td>4.5/14.0</td>
<td>8.4GY</td>
<td>5.8/9.0</td>
<td>2.1PB</td>
<td>3.4/8.9</td>
</tr>
<tr>
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<td>4.1/12.6</td>
<td>9.6GY</td>
<td>5.2/10.1</td>
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<td>3.6/9.7</td>
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<tr>
<td>9.2R</td>
<td>4.2/12.9</td>
<td>0.6G</td>
<td>5.1/8.5</td>
<td>6.0PB</td>
<td>3.0/10.5</td>
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<tr>
<td>0.3YR</td>
<td>5.2/11.6</td>
<td>2.7G</td>
<td>4.7/9.9</td>
<td>6.0PB</td>
<td>3.2/11.1</td>
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<tr>
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</table>

Data analysis
The data analyzed in our present experiment were those collected for the last 30 min from 08:30 h to 09:00 h. The data with tympanic, thermal sensation and color preference were compared between “no body heating” and “body heating” by a paired t-test. ** and * represent statistically significant differences at 1% and 5% level respectively.

### Results

Fig. 2 shows an individual comparison of average preferred cloth color between “no body heating” and “body heating”, preferred every 5 min from 08:30 h to 09:00 h. Most subjects preferred warmer colors in “no body heating” than in “body heating” (p<0.05). Cooler colors (13 ± 6, mean ± SD) were preferred for first 30
Fig. 3 shows a comparison of average tympanic temperature between “no body heating” and “body heating”, measured every min during the experimental period. The tympanic temperature was significantly higher in “body heating” than “no body heating” (p<0.01), except for the first few mins. Thermal sensation vote during the last 30 min was - 0.05 ± 0.69 (mean ± SD) in “no body heating” and 0.77 ± 0.92 in “body heating”, which was significantly different (p < 0.05).

Discussion

What physiological mechanisms could explain our finding that “body heating” accompanied with an increase of tympanic temperature made the subjects to prefer cooler color than “no body heating”? When face was fanned for 30 min by cool air just before the beginning of color selection test, being accompanied with the 0.2°C fall of tympanic temperature (“face cooling”), the subjects preferred warmer color (Kim SH and Tokura, submitted) than in “no face cooling”. These authors discussed that differences between actual core temperature and its set point might have been greater by “face cooling”, which seemed to be relevant to the warmer color selection. In other words, “face cooling” motivated the subjects to prefer warmer color psychologically on the basis of greater load error between core temperature and its set point. The dressing behavior in the cold was more intense in the morning than in the evening (Kim HE and Tokura, 1994), in the luteal phase than in the follicular phase (Kim HE and Tokura, 1995) and in “face cooling” than in “no face cooling” (Kim HE and Tokura 1994). All these findings were interpreted in terms of different load error between core temperature and its set point, suggesting that not only color preference, but also dressing behavior in the cold are essentially controlled by load error between core temperature and its set point. With these in mind, data in our present experiment could be interpreted in terms of different load error in “body heating” and its set point. When the subjects immersed their bodies for 30 min in hot bath, their tympanic temperatures became significantly higher than otherwise (Fig. 3). It means that differences between core temperature and its set point were greater in “body heating” due to hot bath immersion. Greater differences between core temperature and its set point in “body heating” made the subjects to select cooler color, because cooler color is helpful psychologically to allow raised core temperature approach its set point, and further “warmer” colors such as red, serville orange and yellow are perceived as warm, while “cold” colors such as

Fig. 2 An individual comparison of the cloth color preference of 11 subjects between “no body heating” and “body heating” conditions. Each value in “no body heating” and “body heating” conditions was averaged from 7 values during the last 30 min from 08:30 h to 09:00 h. Ordinate: The number arrayed from warm sensation (upper) to cool (bottom) by each individual before the start of experiments. Colors selected as “warm” by each subject were scored as high numbers and those as “cool” as low numbers, which was expressed as “relative unit”. *: p<0.05.
blue-green, blue and purple-blue as cold (Wright, 1962; Tinker, 1938). Other opinion against set point concept is available (Kanosue et al., 1997), because each controller has its own threshold different from one controller to another. But, this idea does not exclude the idea of the existence of set point integrating whole bodily thermoregulatory responses. On the other hand, the visual acuity under the influence of “body heating” (Michael and Davis, 1973; Regan et al., 1977; Matthews et al., 1979) might be partly responsible for different color preference.

However, it might be possible to interpret our findings in terms of the setpoint hypothesis, since there is indirect evidence supporting our idea in the case of dressing behavior (Kim HE and Tokura, 1995) and thermal comfort sensation (Cunningham and Cabanac, 1971). Probable higher skin temperatures in “body heating”, although they were not measured in present experiment, are considered not to be related to the determination of color preference (Kim SH and Tokura, submitted).

Thus, it is concluded that “body heating” before the test could influence color preference. But, further experiments are needed to draw definite conclusions.

References

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