A SUN SHADING HEADGEAR USED BY A DUTCH OLYMPIC SCULLER: A COMPARATIVE STUDY

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Introduction

Due to their high metabolic rate during a competition endurance athletes produce much heat. It is calculated that an Olympic Dutch sculler produces around 1200 $W*m^{-2}$ during a race[7]. As long as heat is dissipated to the environment it will not lead to any problems, however, these high rates are uncompensable. So heat storage in the body will occur. It is believed that high heat storage reduces endurance performance[2].

In the onset of the Olympic Games 2004, held in the hot Athens summer, Dutch Olympic sculler Dirk Lippits and his personal sponsor DSM teamed up with research institute TNO Science and Industry to develop products that would enhance his performance during this Olympic Games. It was predicted that the Athens summer climate[i] would not be able to facilitate a sufficient heat loss and therefore would induce heat storage. Next to the insufficient heat loss due to the climate it would also warm up the body due to the high radiant (solar) temperature (T_r) which was estimated to be 45°C (670 $W*m^{-2}$).

From research it is known that cooling of the head skin is very effective in reducing heat strain[5] and enhancing rating of perceived exertion[1] and perceived comfort[4]. Therefore a sun shading headgear was developed which shades the head from the solar radiation without compromising the heat loss from the head (figure 1).

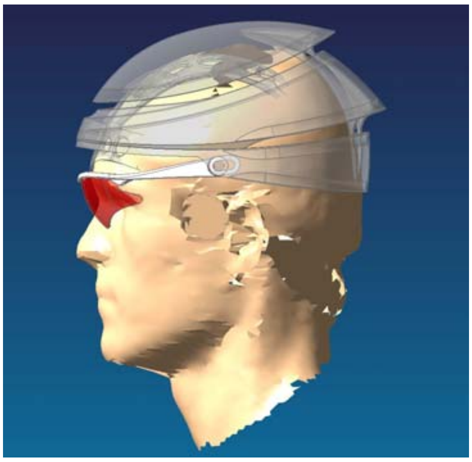

Figure 1. The overleaping but hanging panels shade the head from solar radiation without obstructing the heat loss under the headgear.

The purpose of this study is to compare rowing with the new developed headgear (N) with rowing bareheaded (B) and rowing with a standard 100% cotton cap (C) in a radiant rich environment. Moreover, the following parameters were of special interest; average head skin temperature ($\overline{T}_{h-s}$), heart rate (HR) and four different sensation scales (rating

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[i] The climate during the races of the Olympic sculler was predicted from historical observations of the National Technical University of Athens www.meteo.ntua.gr.

of perceived exertion, perceived wetness, perceived comfort and perceived temperature[3]).

Methods

Six healthy male subjects were subjected to three 30 min rowing exercise bouts on a row ergometer (Concept2, Morrisville, USA). Conditions B, C and N were provided in a random order, on different days but during the same time. In a conditioned room (ambient temperature 21.4 (± 0.2) °C and relative humidity 65 (± 5) %) two infrared lamps (1 kW per lamp) were placed on either sides of the row ergometer, perpendicular to the direction of movement and in the middle of the movement range (figure 2). The minimal distance to the lamps was ~80 cm, and at this distance produced a T_r of 50°C.

Figure 2. The experimental setup

Four well trained subjects rowed the entire exercise bouts at an external power of 2.5 $W*kg^{-1}$, two less trained subjects rowed at 1.5 $W*kg^{-1}$.

Head skin temperature was measured symmetrically and as high up the forehead as possible with two thermocouples. $\overline{T}_{h-s}$ was registered ever 3 s, HR every 5 s and the sensation scales at 10, 20 and 30 min after the start of the exercise.

An ANOVA repeated measures was used to test for within subject differences in the overall results and between the average values of 1 min. Significance was reached if $p \leq 0.05$. The study was approved by a medical ethical committee.

Results

Head skin temperature (figure 3)

Two complete $\overline{T}_{h-s}$ datasets were lost due to the detrimental effect of the sweat on the used tape. The ANOVA repeated measures did no indicate any differences. However a clear trend of a lower $\overline{T}_{h-s}$ was observed in N compared to B and C, therefore a paired t-test was used and indicated a significant lower temperature in N compared to C from t=13 min till the end of exercise.

Heat rate

HR increased throughout the exercise bouts but did not reach significance.

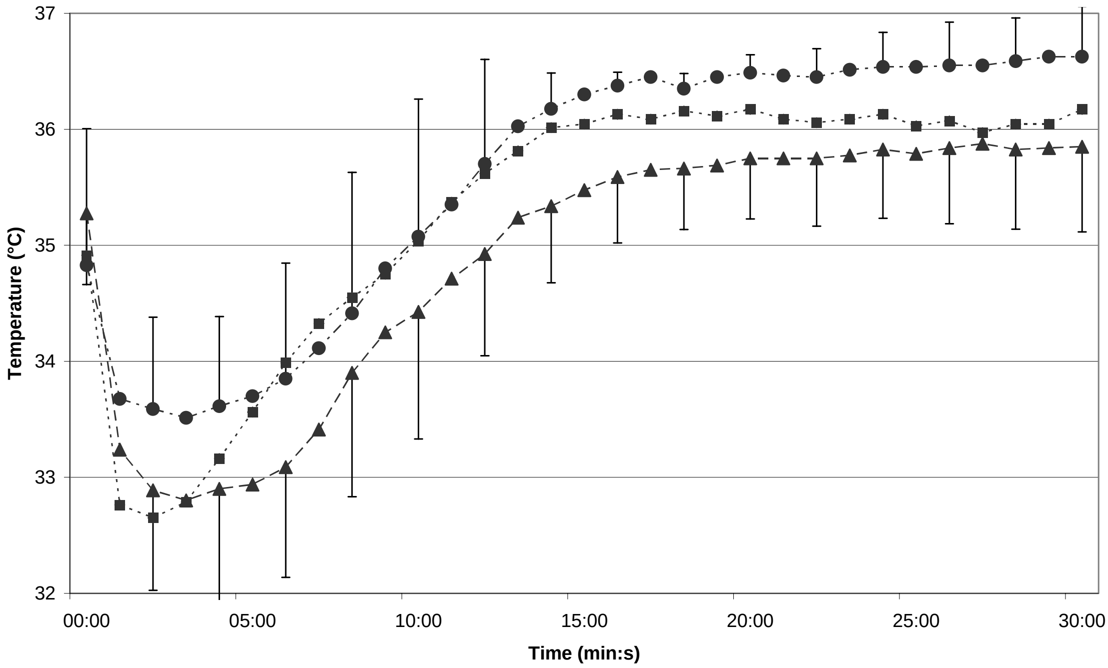

Figure 3. The average head skin temperature (n=4) in all conditions; bareheaded (B: ■), cap (C: ●) and new headgear (N: ▲). Standard deviations are only shown for condition C and N.

Sensation scales

The sensation scales did at first not result in any significant difference. However, the relatively great standard deviation of the perceived temperature at t=30 min drew the attention and appeared to be caused by a subject with a voluminous hairstyle (figure 4). There appears a significant difference if this subject is excluded from the statistical analysis indicating a favourable thermal comfort for C and N compared to B.

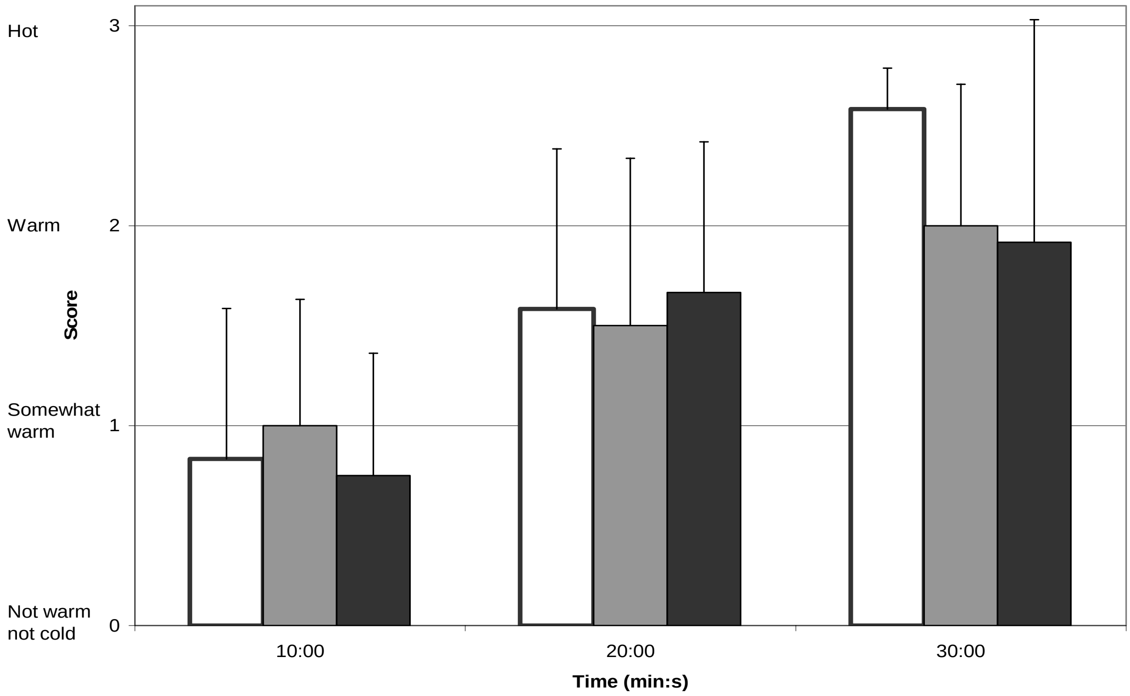

Figure 4. The average perceived temperature (n=6) in all conditions; bareheaded (B: white), cap (C: gray) and new headgear (N: black). Note the relative great standard deviation of condition N at t=30 min.

Discussion

It is calculated that the new headgear could shade the head from 60 W (30 $W*m^{-2}$). The cool capacity of the devices used in other research was at leased 90 $W*m^{-2}$ or the whole body[1,4,5] was shaded. This could explain why the ANOVA revealed no difference in $\overline{T}_{h-s}$, while the more sensitive paired t-test did. It could also explain the small (if any) difference in the subjective scales.

The perceived temperature along with $\overline{T}_{h-s}$ reached significance after 30 and 13 min respectively. It is likely that the heat production is of direct influence on these time periods. Therefore the time until effectiveness is predicted to be smaller in elite athletes due to their higher heat production.

Furthermore the new headgear appears to work best on a head with a non voluminous hair style. A voluminous hair style could reduce heat loss from sweating on the head skin by obstructing the airflow over the skin in addition of increasing the insulating capacity.

Due to the favourable perceived temperature the new headgear and the cap could enhance endurance performance in a radiant rich environment by increasing the mental status of an athlete[6]. The lower $\overline{T}_{h-s}$ only observed in the condition with the new headgear could also benefit endurance performance by reducing or blocking the warming of blood in the head skin due to solar radiation and thereby reducing heat storage.

Conclusion

Despite the small ‘cooling’ capacity this new headgear is a functional way of lowering head skin temperature along with improving temperature sensation. Therefore it holds the potential of enhancing endurance performance in a radiation rich environment. However, more research is required to test if this new concept in (rowing-)sports, enhances performance.

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