

## EFFECTS OF PROTECTIVE HELMETS ON BODY TEMPERATURE AND PSYCHO-MOTOR PERFORMANCE

Kaare Rodahl, Roald A. Bjørklund, Arne-Heman Kulsrud, Lorentz D. Kliiwer and Thorstein Guthe.

National Institute of Occupational Health, Norway.

### INTRODUCTION

While it is generally agreed that the use of helmets for the protection of the head of pedal cyclists and certain industrial workers is desirable, the use of such helmets may cause an increase in head temperature, and thus affect the thermal balance of the body as a whole. Furthermore, the head temperature may play a unique role in eliciting vital physiological responses to heat stress. For references, see Åstrand and Rodahl (1).

Enclosing part of the head in a helmet may cause an excessive heating of the head because it hampers heat dissipation by the evaporation of the sweat. **This** may be undesirable, because some of the brain functions appear to be especially vulnerable to heat (2). Pepler (3) and Wyon et al. (4) have reported deterioration in mental performance in subjects exposed to heat. **This** may be of particular importance to cyclists, who depend on mental alertness, balance and integrated mental and physical performance for their own safety.

The purpose of the present study was to investigate, in controlled laboratory tests, as well as under actual field conditions, the effects of the use of helmets on the body temperature, including the temperature of the head, and to what extent, if any, changes in the head temperature of the magnitude observed under the conditions examined, might have any apparent psycho-motor effects (5).

### METHODS AND PROCEDURES

The effect of using closed bicycle helmets was examined in terms of body temperature (head and thigh *skin* temperature and rectal temperature) and psychomotor performance (Simple choice and Complex choice reaction time test performed before and after exercise (5)) in six subjects exercising 60 min in the laboratory, and in four subjects bicycling 60 min in the field. Each subject exercised once without and once with the helmet at the same load.

The sensors, recording temperatures, heart rate, relative humidity inside the helmet, and the ~~Botsball~~ temperature outside the helmet, were connected to an ambulatory electronic minilogger (The Squirrel meter/logger, Grant Instruments Ltd., Cambridge, England) carried on the subject. At the completion of the experiment the stored data were transferred to a PC for treatment and display (6).

### RESULTS

It was observed that the head **skin** temperature was significantly higher when using a helmet than when not using a helmet ( $P < .001$ ), and much higher than the leg **skin** temperature ( $36.7^{\circ}\text{C}$  as against  $33.0^{\circ}\text{C}$  on the average).

In the six laboratory tests, the reaction time improved significantly following exercise, both with and without helmets ( $P<.01$ ), presumably as a result of the increased head temperature. The number of errors made, however, was significantly higher when helmets were used, than was the case when helmets were not used ( $P<.05$ ). The results of the field tests were less conclusive, due to the varying ambient temperature during the field tests.

## CONCLUSIONS

These observations suggest that the wearing of helmets under conditions of excessive heat stress, may tend to affect certain aspects of psycho-motor performance, emphasizing the desirability of producing helmets which allow sufficient exchange of air inside the helmets in order to keep the head as cool as possible.

## REFERENCES

1. Hand, P.-O. and K. Rodahl: "Textbook of Work Physiology", 3rd. Ed. McGraw-Hill Book Company, New York, 1986.
2. Baker, M.A.: Brain cooling in endotherms in heat and exercise. *Am. Rev. Physiol.* **44**: 85, 1982.
3. Pepler, R. D.: Performance and Well-being in Heat, in J.D.Hardy (ed), "Temperature; Its Measurement and Control in Science and Industry", Vol. 3, Part 3, p.319. Reinhold Book Corporation, New York, 1963.
4. Wyon, D.P.; I. Andersen and G.R. Lundqvist: The effects of moderate heat stress on mental performance. *Scand J Work Environ Health.* **5**: 352, 1979.
5. Wærsted, M.; R. A. Bjørklund and R. H. Westgaard: Shoulder muscle tension induced by two VDU-based tasks of different complexity. *Ergonomics*, **34(2)**: 137, 1991.
6. Rodahl, K.: "The Physiology of Work", Taylor & Francis, London, 1989.