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EFFECTS OF HEAT STRESS AND TIME ON TASK ON REACTION TIME[1].

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INTRODUCTION

Several studies have shown that heat stress caused a deterioration in cognitive performance, and that the magnitude of this deterioration was related to the duration of the exposure to high temperature. Particularly in sustained attention tasks, to which some sports activities could be compared, performance decrements were observed under heat stress, and these decrements became more important with the prolongation of the exposure (Mackworth, 1950; Mortagy & Ramsey, 1973). Nevertheless these observations have often been realised without control group, so it was impossible to distinguish between the effect of heat stress, and the effect of time on task.

The aim of the present experiment was to test the hypothesis of an interaction between heat stress and time on task. Such an interaction was evidenced in a tracking task by Beshir, El-Sabagh & El-Nawawi. (1981), in a protocol including ambient temperatures of 20°C, 26°C and 30°C. Nevertheless this experiment was also designed to test an hypothesis concerning the work/rest ratio effect, and a visual analysis of the results seems to indicate that this interaction was mainly located in the last measurement of each work session, suggesting a possible interference of motivational processes. We think that an appropriate test of this interaction hypothesis require to face subjects with a continuous task. Moreover, the subjects have to ignore the exact duration of the test.

According to Hancock (1986), performance alterations are due to dynamic variations in body core temperature. This hypothesis could explain that performance decrements do not appear under a critical threshold in ambient temperature (approximately 29-30°C; Mackworth, 1950; Pepler, 1958). It has also been established that performance decrements do not appear before 20-30 minutes of exposure (Hohnsbein, Piekarski, & Kampmann, 1983; Mackworth, 1950; Pepler, 1958; Wilkinson, 1969). According to Hancock (1986) this half-hour could represent a period of temporary resistance of the organism's homeostasis. An analysis of the evolution of body temperature, under thermal stress, appears necessary to a better understanding of performance alterations.

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[1] This experiment had been performed at the National Institute for Sport and Physical Education, Paris.

METHOD AND PROCEDURE

14 subjects (mean age: 36.3; SD: 8.9) volunteered in this experiment. A climatic chamber was used, which allowed to control ambient temperature and relative humidity. The subjects were successively submitted to two conditions: (1) 20°C E.T.[2] (23°C dry temperature, 50% relative humidity) and (2) 38°C E.T. (42°C dry temperature, 70% relative humidity). Air velocity was negligible. In each condition the subjects were submitted to the climate during 30 minutes before the beginning of the experiment.

Subjects had to perform in each condition a binary choice reaction time task. This task was presented on a computer, connected to two joysticks. At each trial, a preparation signal appeared 0.5 second before the response signal. The response signal corresponded to the highlighting of one of two squares, horizontally aligned on the screen. Subjects have to respond to the left signal by titling the left joystick on the left, and conversely for the right signal and the right joystick. Response time were recorded by the computer.

This task was performed continuously for 45 minutes, from the 30th minute of exposure to the climate. Response time and errors were collected for statistical treatments for the 60 trials performed from the 30th, 45th, and 60th minutes of exposure. The order of climate conditions was systematically controlled between subject. The subjects were not informed before the experiment of the exact duration of the test.

Reaction time data were treated by a two-factor analysis of variance (climate x time on task), with three levels of repeated measurement on the second factor.

Oral temperature were measured in the 38°C session at the entrance in the climatic chamber, and after 30, 45 and 60 minutes of exposure. Data were processed by a one-way analysis of variance with 4 levels of repeated measurement.

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[2] Effective temperature (E.T.) was proposed by Houghten et Yagloglou (1923) for assessing heat stress. It combined in a global index dry temperature, relative humidity and air velocity.

RESULTS

Mean data are represented in figure 1. Results indicated a significant effect of climate ($F_{1,13}$=27.362, p<.001), and a significant effect of time on task ($F_{2,26}$=5.498, p<.01). The linear trend for time on task was significant ($F_{1,13}$=6.727, p<.02). There was no interaction effect ($F_{2,26}$=.003).

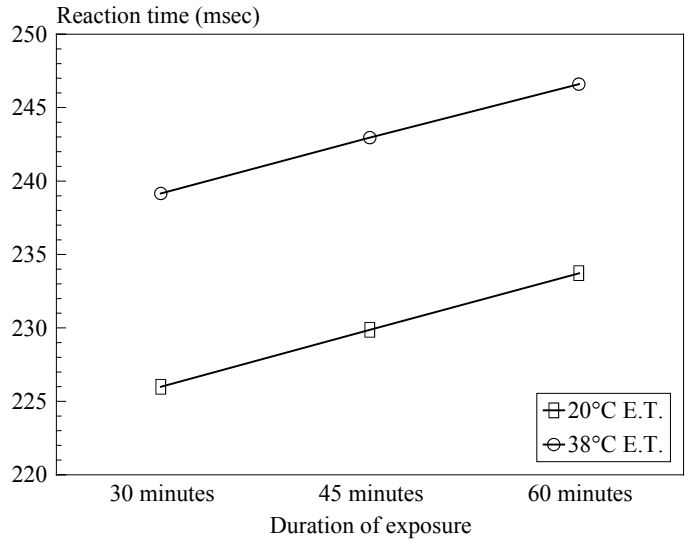

Fig. N°1: Mean Reaction time, according to Time on Task and Climate Condition.

The analysis for oral temperatures revealed a significant effect of duration of exposure (F3,39=48.268, p<.001). Post-hoc analysis showed that there was a significant raise in oral temperature during the first 30 minutes of exposure. But there was no differences between subsequent measurements.

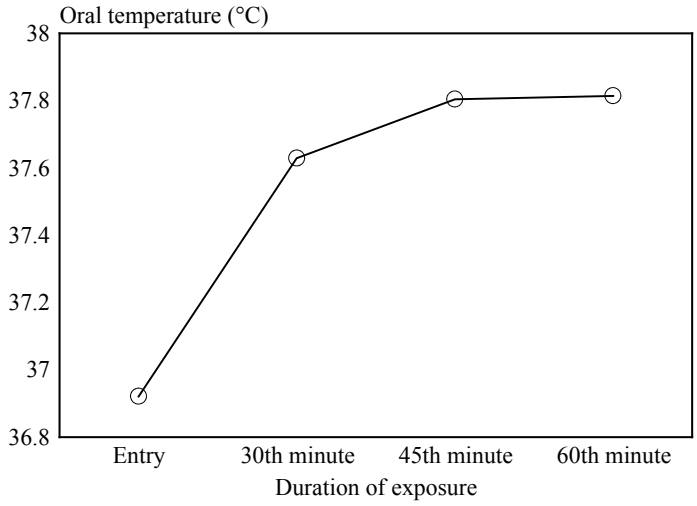

Fig. N°2: Mean Oral Temperature, according to the Duration of the Exposure to Heat Stress.

DISCUSSION AND CONCLUSIONS

The observed deterioration of performance is consistent with the results reported by Mortagy and Ramsey (1973) with similar exposure durations. Nevertheless these results indicate that, respective to the studied range of exposure duration, the effect of heat stress and the effect of time on task are independent. These results contradict those by Beshir, El-Sabagh & El-Nawawi. (1981), and suggest that the duration of exposure does not constitute *per se* a determinant factor of the decrease of performance.

Nevertheless this result could be dependent on our experimental conditions (i.e. nature and duration of the task). Longer exposures, particularly associated with physical exertion, could result in important dehydration and have a specific effect on performance (Epstein et al., 1980).

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