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An Endogenous Metric for the Control of Perception of Brief Temporal Intervals

P. A. HANCOCK[a]

Motor Behavior Laboratory
Institute for Child Behavior and Development
University of Illinois at Urbana-Champaign
Champaign, Illinois 61820

The biochemical clock hypothesis, advanced by Hoagland[1] in 1933, suggested the existence of a unitary neurophysiological process which subsumed the human perception of brief temporal intervals. The resultant, necessary, and exclusive linear relationship required by this construct was supported by early observations, as shown in FIGURE 1. In subsequent investigations, although a general linear trend has been affirmed, the lack of consistency across individuals has refuted the notion of a simple governing metabolic pacemaker as originally envisaged.[2,3]

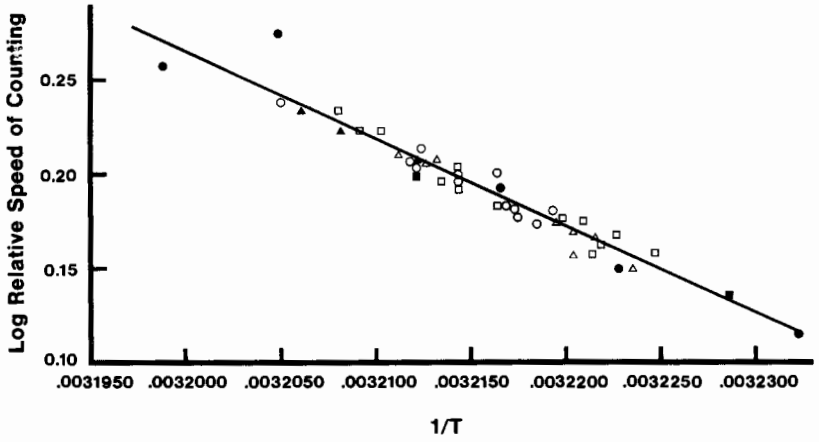

FIGURE 1. Composite of data from Hoagland[1] and François[5] showing the relationship between log relative speed of counting and the reciprocal of absolute temperature, an Arrhenius plot. Note that body temperature ranges from 36.3°C (97.3°F) at *right* to 39.5°C (103.1°F) (extreme *left* data point). The data are for six individuals. (From Hoagland.[1] Reproduced by permission.)

The present experiments were predicated upon this search for an endogenous and ubiquitous temporal mechanism. Specifically, the study examined the effects of selective head-temperature elevation and depression upon time judgment. In the first experiment, each of twelve subjects undertook one presentational order of four thermal conditions. In each condition, subjects produced operative estimates of 1-, 11- and 41-sec periods, with forty trials on each period. In the control condition, subjects produced estimates while seated in a sound- and light-proof room. In the placebo

[a]Present address: Department of Safety Sciences, Institute for Safety and Systems Management, University of Southern California, Los Angeles, California 90089.

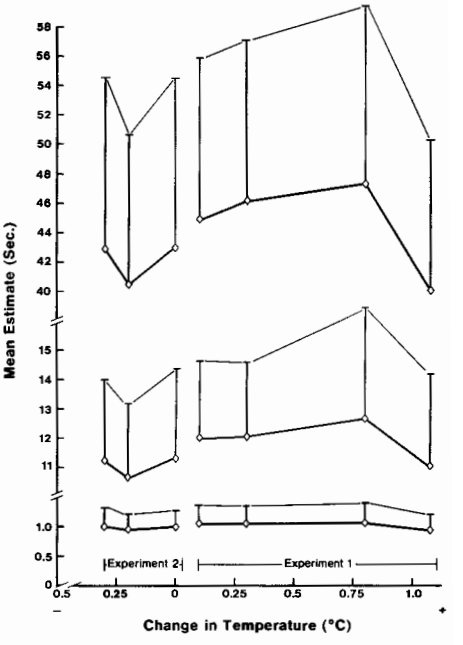

FIGURE 2. Overall means (*diamond symbols*) and standard deviations (*vertical bars*) by period against increase and decrease in deep meatal temperature. Results are for the mean of twelve subjects in each experiment.

condition, a heating helmet was worn but not activated, while in the two heat conditions prescribed temperature increases, measured in the deep auditory meatus, were stabilized above initial monitored baseline values prior to experimental commencement. The pattern of results for the mean estimation of all periods, under each thermal condition, was consistent across subjects, although absolute magnitude of the estimate varied with the individual. Analysis distinguished the mean at the highest elevation, 1.1°C, as significantly shorter than the three alternate unvarying means (FIG. 2). In the second experiment, twelve different male subjects performed the same task under control, placebo, and cold conditions. The use of a water-cooled unit provided insufficient temperature depression, leaving results somewhat equivocal for this experiment (FIG. 2).

Despite the latter result, overall findings suggest a nonlinear relationship between head temperature and duration estimation. This contradicts the direct isomorphism relating physiological change and temporal percept, as implied by the biochemical clock hypothesis. However, this is based upon nonlinearity rather than subject inconsistency. Consequently, the present study implies the existence of a thermally sensitive endogenous mechanism involved in the perception of brief temporal intervals. How such a mechanism is related to circadian variation in time judgments[4] and underlies or interacts with certain alternate cognitive functions is the subject of continuing investigation.

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