secular incidence and mortality rates (*13*) from this tumor. Unfortunately, it is not possible to distinguish between persons homozygous and heterozygous for the wet allele. Possibly a differential susceptibility to cancer may exist between these genotypes.

This hypothesis does not conflict with hormonal, dietary fat, and carcinogenic factors, whose importance has been suggested in the pathogenesis of breast cancer (*14, 15*) and which were recently summarized by MacMahon and Cole (*14*). Also, evidence suggests that the allele for wet cerumen may have an influence on fat metabolism. Kataura and Kataura (*16*) found that the relative proportion of polyunsaturated to saturated fatty acids was increased in dry cerumen, and Miyahara and Matsunaga (*17*) reported that wet cerumen was significantly more frequent in patients diagnosed with arteriosclerosis than in patients with other diseases. More recently, lysozyme and immunoglobulin G have been found in cerumen and were highly associated with the dry-type cerumen (*7*). Since these immunological factors are also found in the secretions of the breast and axillary apocrine glands, one might speculate that additional, possibly antiviral, immunological substances that could affect susceptibility to oncogenic viruses may be present in secretions of the apocrine system.

As one moves geographically westward from Asia to Western Europe, the increasing mortality rate for breast cancer is inversely related to the genetic gradient (or cline) of dry cerumen (*5*). The intermediate rates of breast cancer mortality and incidence that are reported in Eastern Europe and Asia Minor may reasonably be the current biomedical reflection of the historical and prehistorical admixture of Asian and European populations with differing genetic susceptibilities to breast cancer (*18*).

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18. For example, modern Finland and Hungary are believed to have been originally populated by peoples from the Ural Mountains region of Siberia. These peoples, in turn, represented a chain of intermediate Mongoloid-Europoid populations dating back to the time of first settlement of the Western Siberian forest belt [C. S. Coon, *The Living Races of Man* (Knopf, New York, 1965), pp. 60–67]. Soviet anthropologists suggest that considerable intermixing of populations of Asiatic and European peoples occurred in this area in the past [M. G. Levin, in *The Peoples of Siberia*, M. G. Levin and L. P. Potapov, Eds., S. P. Dunn, Transl. (Univ. of Chicago Press, Chicago, 1964), pp. 99–104]. Further gene flow from Asia to Europe also took place during historical times. The admixture of the Turks with the Mongols in the 13th to 15th centuries is also well documented.
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11 March 1971; revised 29 April 1971 ∎

Rowing: A Similarity Analysis

Abstract. *The theory of models is employed for calculating the speed of geometrically similar racing shells. The theoretical prediction, that shells should have a speed proportional to the number of oarsmen raised to the 1/9 power, is in excellent agreement with observations. A significant implication for the proportions of lightweight and heavyweight eight-oared shells, indicating how both might attain the same speed, is developed.*

Why should larger boats containing many oarsmen go faster than smaller ones containing fewer oarsmen? The task of predicting the performance of a single man as he engages in athletic tasks such as running, jumping, flying, or, as in this case, rowing is in general difficult, since a specific knowledge is required of how chemical energy is converted to work and of how that work is utilized against external forces to produce motion. The theory of geometrically similar models makes possible enormous simplifications, provided the objective is changed from a prediction of absolute performance of a particular boat and crew to a comparison of the speeds of geometrically similar boats containing different numbers of oarsmen.

Consider the schematic representation of a shell in Fig. 1. The fundamental postulate of the following analysis will be that competitive shells are geometrically similar. The validity of this assumption is revealed in Table 1, where the length l and beam b are compared for shells accommodating one, two, four, and eight oarsmen. Despite the variety of sizes among the boats, the slenderness ratio l/b is reasonably invariant of the length of the boat. Also reasonably invariant is the boat weight per oarsman, which will have important consequences.

Each oarsman in either the lightweight or heavyweight class is assumed indistinguishable from other members of his class in weight and capability for sustained power output. The principal force that hinders the motion of the boat through the water is assumed to be skin friction drag. The great l/b ratio and relatively low velocity of the boats suggest that wave drag is small, and, in fact, full-scale towing tank tests have shown that the resistance due to leeway and wave-making together constitute only 8 percent of the total drag at 20 km per hour, the Olympic target speed, for an eight-oared shell (*1*).

The assumptions may be summarized as follows.

1) There is geometric similarity between boats, and the draft, or, equiv-

Table 1. Shell dimensions and performances. Values in the last four columns represent: I, 1964 Olympics, Tokyo (2); II, 1968 Olympics, Mexico City (3); III, 1970 World Rowing Championships, St. Catharines, Ontario (4); IV, 1970 Lucerne International Championships, Switzerland (5). Shell dimensions from J. A. Garofalo, shell builder.

No. of oarsmen	Modifying description	Length, l (m)	Beam, b (m)	l/b	Boat weight per oarsman (kg)	Time for 2000 m (minutes)			
						I	II	III	IV
8	Heavyweight	18.28	0.610	30.0	14.7	5.87	5.92	5.82	5.73
8	Lightweight	18.28	0.598	30.6	14.7				
4	With cox	12.80	0.574	22.3	18.1				
4	Without cox	11.75	0.574	21.0	18.1	6.33	6.42	6.48	6.13
2	Double skull	9.76	0.381	25.6	13.6				
2	Pair-oared shell	9.76	0.356	27.4	13.6	6.87	6.92	6.95	6.77
1	Single skull	7.93	0.293	27.0	16.3	7.16	7.25	7.28	7.17

alently, the volume of water displaced by the boats, is similar.

2) The boat weight per oarsman is a constant, k.

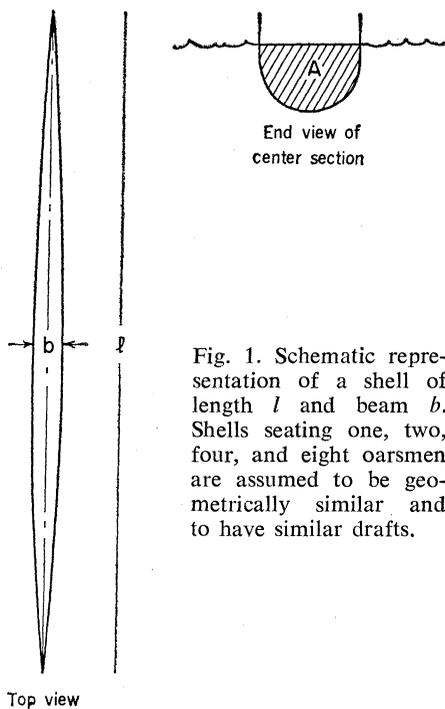3) Each oarsman contributes power P_0 and weight W_0.

Fig. 1. Schematic representation of a shell of length l and beam b. Shells seating one, two, four, and eight oarsmen are assumed to be geometrically similar and to have similar drafts.

End view of center section

Top view

4) Skin friction drag is the only hindering force.

A cross section of a given boat is schematically represented in Fig. 1, in which the cross-sectional area A under the water line is illustrated. The volume of water displaced by the whole boat, length l, is proportional to the total weight of the boat plus n oarsmen:

$$Al \propto \text{(weight of boat)} +$$

$$\text{(weight of oarsmen)} \propto$$

$$nW_0 + knW_0 \propto n$$

But the area A is proportional to the square of some characteristic length of the boat (that is, L^2), and the length is directly proportional to L. Therefore,

$$n \propto L^3$$

The total power required to move the boat at velocity v is proportional to the product of the drag force D and the velocity v:

$$vD \propto nP_0$$

The skin friction drag is proportional to the product of the wetted area $A^{1/2}l$ and the square of the velocity. Thus, D is proportional to L^2v^2. Since P_0 is independent of scale and L^2 is

proportional to $n^{2/3}$ from above, the final result for the dependence of the velocity v on the number of oarsmen n becomes

$$v^3 \propto \frac{n}{L^2} \propto \frac{n}{n^{2/3}} = n^{1/3}$$

$$v \propto n^{1/9}$$

The last four columns of Table 1 present representative times for 2000 m for Olympic and World Championship crews of heavyweight oarsmen, who were rowing several types of boats. These times, drawn as triangles, circles, and crosses, are plotted against the number of oarsmen per boat on a log-log plot in Fig. 2. Excellent agreement is found between these data and the similarity analysis, shown as a solid line of slope $-1/9$ in the figure.

An intriguing application of the similarity rule derived above concerns the observation that, among crews in eight-oared shells, the heavyweight crew (average weight, 86 kg per man) consistently beats the equivalently advantaged lightweight crew (73 kg per man) by four or five lengths in 2000 m and is therefore 5 percent faster. The description of the shells themselves in Table 1 indicates that the length and weight of the eight-oared shells are the same, and the only difference between the two lies in the beam of the heavyweight boat, which is 2 percent wider than the lightweight boat. The beam of the heavyweight boat would have to be 9 percent wider than the lightweight boat if the cross sections (A in Fig. 1) below the water were to be similar, so that a mild departure from similarity between light and heavy boats must be anticipated; that is, the heavy boat sits deeper in the water. Nevertheless, let us take the assumption that the wetted area of both light and heavy boats is the same. When this assumption is made, the speed of the boat is limited by the capacity of the crew for sustained power output. An argument
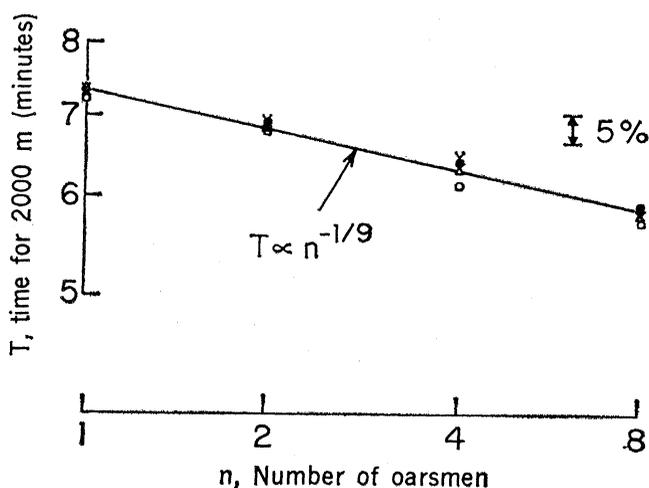

Fig. 2. Test of the theory of models result. The $-1/9$ power law (solid line) is compared with racing times for 2000 m, all in calm or near calm conditions. (Triangles) 1964 Olympics, Tokyo; (solid circles) 1968 Olympics, Mexico City; (crosses) 1970 World Rowing Championships, Ontario; (open circles) 1970 Lucerne International Championships.

$T \propto n^{-1/9}$

rages as to the precise power of body weight that provides the best fit with data, but physical reasoning demonstrates that the factors limiting power output—that is, tensile strength of muscles, tendons, and bones, the rate of supply of oxygen admitted by the lungs and carried by the blood, and the rate of removal of heat from the working muscles—all are proportional to body surface area (thus, $W^{2/3}$) for geometrically similar animals. Then the power available to the heavyweight oarsmen is $K^{2/3}$ that of the lightweights, where K is the weight ratio, 86/73. Therefore,

$$\frac{V_{\text{heavyweight}}}{V_{\text{lightweight}}} \propto K^{2/9} \simeq (1.2)^{2/9} = 1.05$$

The heavyweights are thus predicted to be 5 percent faster than the lightweights, as is observed. Notice that if the assumption is taken instead that the length of both light and heavy boats are equal but that the below-water cross section A is proportional to displacement and thus to total weight, the result is

$$\frac{V_{\text{heavyweight}}}{V_{\text{lightweight}}} \; K^{1/18} \simeq 1.01$$

In this case, the heavyweights beat the lightweights by only 1 percent, which is smaller than the observed margin.

What would happen if the lightweight shell were geometrically similar to the heavyweight but shorter by the ratio $K^{-1/3}$? In this case, the wetted area of the lightweight shell would be $K^{-2/3}$ the wetted area of the heavyweight shell, but since the power available would also be $K^{-2/3}$ that of the heavyweights, the two shells would have the same speed. The remarkable conclusion becomes that, if the lightweight shell were shortened by 1.1 m in length and made 2.4 cm narrower in beam from its present dimensions, the lightweight crew could keep up with the heavyweights. The practical validity of this results is certain to be checked, sooner or later, by a sufficiently enlightened lightweight crew.

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12 February 1971; revised 13 May 1971 ■

Human Auditory Attention: A Central or Peripheral Process?

Abstract. *The click-evoked electrical responses of the human cochlear nerve were recorded from the external ear canal concurrently with the cortical evoked potentials from the scalp. Paying attention to the clicks during a discrimination task resulted in a highly significant enhancement of the cortical response but no change in the cochlear nerve response. Hence no evidence was obtained for the operation of a peripheral gating mechanism during attention in man.*

Attention may be considered to be a process in the nervous system that enables an observer to extract more information from a selected stimulus configuration. There is controversy in both the neurophysiological and the psychological literature as to what the neural mechanisms of attention may be, and in particular whether attention involves a peripheral "filtering" or "gating" of sensory inputs (1).

In human observers opportunity exists to study both the behavioral and electrophysiological aspects of various well-defined types of attention. A sensitive physiological index of human attention to an acoustic signal is the amplitude of the electrical activity it evokes in the cerebral cortex. Paying attention to a sound typically enlarges the cortical averaged evoked potential (AEP) recorded from the scalp (2). A second electrophysiological measure of attentiveness in man is the contingent negative variation (CNV); this negative slow-potential shift precedes and accompanies perceptual judgments and reportedly varies with the degree of attention being devoted to the task (3).

Prompted by the recent discovery that the human cochlear nerve response can be recorded from the external auditory meatus (4), we decided to investigate the physiological mechanisms of human auditory attention by measuring the changes induced in the cortical AEP and the cochlear nerve response by different attentive conditions. We have determined that attending to clicks resulted in an increased AEP at the vertex without any demonstrable change in the concurrently recorded action potentials of the cochlear nerve. We thus could not substantiate the hypothesis that auditory attention involves a gating of neural transmission at the most peripheral levels of the auditory pathway.

The cochlear nerve response was recorded from a small (3-mm) tungsten needle electrode inserted beneath the skin of the superior wall of the external auditory meatus, 5 to 8 mm from the tympanic membrane, under local anesthesia. A very flexible wire leading from the electrode was glued to the skin surface of the ear canal and pinna. The auditory AEP was recorded from the vertex (5). The reference electrode for both these recordings was placed on the mastoid process ipsilateral to the implanted ear. Eye movements were monitored with electrodes placed on the inferior and superior orbital ridges to ensure that the AEP's were uncontaminated by electroocular artifacts. Click-evoked potentials were amplified with a polygraph and computer averaged on-line (6). Clicks were generated by passing 2-μsec square waves through earphones worn by the subject. The experimenters served as subjects (7).

In the first experiment, clicks of 55 db sensation level (8) were presented to the ear containing the electrode at a rate of one every 1.3 seconds. Between 10 and 20 single clicks of 51 db were randomly distributed throughout each separate series of 300 clicks. Attention was manipulated by having the subjects either listen to the clicks in order to detect the faint ones, or read a book and entirely ignore the clicks (9). At the conclusion of each attention series the number of faint clicks detected was reported (10). Attention and control conditions were alternated for successive series of clicks until the subject became fatigued. Click-evoked responses from the auditory meatus and vertex were averaged concurrently over the final 256 of the louder clicks in each series; responses evoked by the fainter clicks were not averaged.

The typical morphology of the cochlear nerve response is shown in the left columns of Fig. 1A. The most prominent features are a pair of sharp negative deflections $N1$ and $N2$ following