tion of the latencies of these spikes, the column height gives the number of discharges during these 15 augmenting responses for each latency range. The numerical values of these latencies are 4.2 ± 0.9 msec, 12.8 ± 0.9 msec, and 16.0 ± 0.7 msec.

These results—which are in keeping with those of Morillo (*8*), who found latencies shorter than 10 msec after stimulation of the "specific" system and a delay longer than 10 msec after stimulation of the "nonspecific" system—suggest that two systems, conventionally labeled "specific" and "nonspecific," or different parameters of one thalamocortical system participate in the augmenting response. The different rates of rise of the prepotentials (Fig. 1, C_2 and C_3, vertical sweeps) and the shift of the firing level of the spikes of the second group (Fig. 1, B_6, B_7, and C_2) are similar to the observations of Machne *et al.* (*9*) in frog motorneurons and of Andersen and Løyning (*10*) in pyramidal cells of the hippocampus, both of whom postulated the existence of locally different synaptic contacts of presynaptic fibers at the cells. The generally complete depolarization after the first group of spikes (Fig. 1*E*) also suggests that there are two different and clearly separate periods of afferent impulses. A second depolarizing wave of "recruiting" character was also found after a first short-latency response of "specific" character during low-frequency stimulation of the caudate nucleus (*11*).

However, whether these postsynaptic responses represent the effect of: (i) two sets of fibers with different conduction velocities; (ii) a direct afferent and a multisynaptic network (*12*); or (iii) a different location of the excitatory synapses on cell-bodies and dendrites (*9, 10, 13*), or a combination of these, cannot be decided from our results. But they do stress the concept that the postsynaptic potentials during augmenting waves consist also of a primary response combined with a response of a recruiting character (*14*).

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Atmospheric Jet Streams

In a brief report titled "Atmospheric jet streams" [*Science* **141**, 1045 (13 September 1963)], J. D. Isaacs purports to give a physical explanation for atmospheric jet streams without regard to current hypotheses.

Atmospheric physicists feel that they understand, in a general way, the formation of jet streams poleward of 30°. A mean (time-averaged) jet stream may be found in middle latitudes which can be related to the large south-to-north gradient of temperature at those latitudes produced by the distribution of solar heating on a spherical earth. Middle latitude jet streams have been obtained by integrating the fundamental equations of planetary aerodynamics without inclusion of mechanisms resembling those hinted at by Isaacs [Smagorinsky, *Monthly Weather Rev.* *91*, 3 (1963)].

Isaacs refers to a "diurnal heat pulse" from the sun's radiation which "moves through the main body of the atmosphere at approximately Mach 1" over jet stream latitudes and at Mach 1.4 over the equator. This seems to mean that the cited Mach numbers correspond to the tangential velocities of earth points resulting from terrestrial rotation. We assume that Isaacs considers the phenomenon of sunrise on parcels of air in the free atmosphere as a "diurnal heat pulse." Assuming that this was the sort of process Isaacs had in mind using Mach numbers, we shall try to examine the remainder of his implied hypothesis.

Isaacs implies that some special hydrodynamic phenomenon (jet stream) will appear near the latitude at which Mach 1 is found from the above-indicated reasoning. The very idea of expressing earth transport speeds as Mach ratios is not easy to accept, for such transport speeds are measured in a nonrotating coordinate system whose origin moves with the center of the earth, while any gas-dynamic phenomena resulting from the processes Isaacs considers will give rise to particle velocities which must be measured in a coordinate system at rest with respect to the gas. Special circumstances could not possibly be expected to arise near that latitude (about 40°) at which the transport speed of the earth happens to be the same as the speed of sound in a gas at typical atmospheric temperatures.

Other serious difficulties were overlooked by Isaacs. Direct absorption of insolation by atmospheric gases constitutes only a tiny fraction of total atmospheric energy input. The earth's surface, not the free atmosphere, is the site of the dominant atmospheric energy input; so to suggest, without any quantitative examination, that repetitive absorption of a tiny fraction of the sunlight incident on a given parcel of the atmosphere at a series of successive sunrises is responsible for the jet stream seems quite absurd. Furthermore, the implied poleward shift of the jet stream in the case of a "more carbonic atmosphere" evidently arising from the reduced speed of sound in CO_2 would be significant only for geochemically enormous changes in the CO_2 content of the atmosphere.

Isaacs states that "at the equator, the heat pulse travels through the atmosphere at Mach 1 only at very high altitudes (about 150 km)." This remark prompted us to plot, on a meridional cross section, the locus of all points at which the local transport speeds of air parcels at rest with respect to the rotating earth are numerically equal to the local speed of sound. This locus leaves the earth's surface, in each hemisphere, near 40° latitude, slopes upward toward the pole until it nears the tropopause at about 50° latitude, curves back toward the equator to another reversal point near the stratopause over latitude 35° approximately, recurves poleward again as it ascends to the mesopause just equatorward of 50° latitude, and then arches up into the thermosphere over the equator at about 150 km. We think Isaacs should be troubled by the fact that his argument would predict that his jet stream ought to be a warped sheet of high-velocity filaments lying everywhere along this complex line in a representative meridional plane.

We see nothing at all in his bewildering report that sheds light on, or even relates meaningfully to, jet streams in the mid-latitude westerlies.

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Behavior: Confinement, Adaptation, and Compulsory Regimes in Laboratory Studies

A few generalizations emerging from ethologically oriented laboratory studies of wild rodents have important bearings on the rationale and design of experiments on learning and reinforcement. Depriving animals of natural outlets for activity by confining them in small and barren enclosures greatly influences their behavior. Thus, when given the means to modify their environment in ways that do not subject them to great stress, captive rodents exercise this control repeatedly (*1*, *2*). These animals find it rewarding to attain and to exercise a high degree of control over their environment, perhaps in partial substitution for the freedom of action enjoyed in the wild but denied by confinement. Accordingly, rodents repeatedly turn on and off (or otherwise modify) any suitable variable placed under their control, whether it is intracranial stimulation, a motor-driven activity wheel, lights or sound, or whether it is merely the ability to visit a nest, run a wheel, jump on and off a platform, patrol an enclosure, traverse mazes, or gnaw wood into fine fibers.

The initial responses of rodents in laboratory enclosures do not reflect the preferences or behavior of animals adapted to the experimental situation, but rather those of animals forced to endure unnatural and completely arbitrary conditions and schedules of confinement and experimentation. The time required for animals to adapt to the "insults" of laboratory experimentation is measured not in minutes or hours but in days or weeks (*1*, *2*). Thus, even in experiments for which the design and analysis do not penetrate beyond regarding the animal as a convenient experimental machine or black box, the responses to daily short experimental sessions generally give information only about the initial, and often rebellious, reactions of the "machine" to abnormal and enforced working conditions. Only studies over long periods permit the delineation of adaptational from adapted behavior.

When a confined animal is exposed to arbitrary or unexpected changes in environment or regime, but is provided with the means for counteracting these changes, it typically does so. For example, if the experimenter turns on a motor-driven activity wheel in which an animal is forced to run, but which the animal can turn off, the animal immediately and invariably turns the motor off (*1*). Conversely, if an animal is running a motor-driven activity wheel that it has turned on itself, and the experimenter turns the motor off, it immediately turns the motor back on. Similarly, if a light is periodically turned on by the experimenter and the animal can operate a stepping switch which steps it off by degrees, the animal generally steps it fully off (*1*). If, instead, the experimenter periodically turns the light off, the animal, even though nocturnal, often steps the light fully on. Only after weeks of this full opposition to arbitrarily imposed conditions does the animal adapt to the regime and adjust the changed light intensity to a characteristically preferred low level, rather than merely to the opposite extreme of the imposed condition.

Thus, taken alone, the nature of a specific stimulus (or activity) is an unreliable guide for interpreting the behavior of small mammals given control over its initiation or cessation, or both, or forcefully exposed to it. Stimuli which are rewarding or punishing in certain circumstances have the opposite effect under other conditions (*1*, *2*). The seemingly enigmatic findings on self- and non-self-initiated intracranial stimulation and on the effects of shock on learning and avoidance (*3*) no longer are paradoxical when the effects of subjecting experimental animals to compulsory regimes and of greatly limiting their control over their environment are taken into account.

Using such atypical species representatives as domestic rats and mice for laboratory studies of behavior narrows the animal response spectrum to a point where its significance for adaptation, survival, and evolution becomes highly questionable. These selectively inbred animals are hundreds of generations removed from the wild. Their bland behavior tells us mainly how animals react to experimental regimes after many of the characteristic adaptive responses of the species have been largely or completely lost. Domestic animals remain convenient vegetalized strains for physiological studies, but only wild animals provide the full range and vigor of responses upon which solutions to the central problems of behavior must be based.

Important advantages to the use of wild rodents stem from their extraordinary capacities to learn complex contingencies and to gain detailed familiarity with a vast laboratory "habitat." Mice of the genus *Peromyscus* have mastered programs in which seven different manipulanda involving four different functions were in use concurrently (*2*). These animals also learn their way through burrow-simulating mazes of unprecedented complexity—containing hundreds of blind alleys—without extrinsic reward (*4*). There is no reason to believe that these remarkable feats even approach the limits of the learning capacity of the wild animal, although they far exceed the performances of domestic rodents. The animals readily learn to distinguish the functions of several identical manipulanda. Accordingly, identical levers can be used both to initiate and terminate environmental and activity changes, and they can be located at many positions and their functions interchanged and rotated, bringing this variable under close experimental control.

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