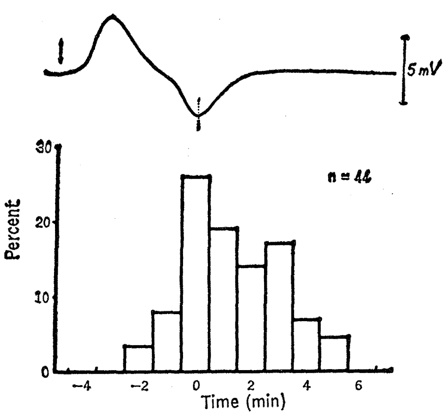

Fig. 3. Probability distribution of onset times of 44 cases of elicited eating in four rats (below). Onset of drinking was measured from the peak of the wave of slow potential change (above) corresponding to spread of waves of cortical spreading depression into the frontal pole.

were curiously followed at regular intervals of about 15 seconds by wide mouth opening (yawning?). In two other animals drinking was consistently preceded by stereotyped air-licking and licking of the walls of the box.

The variety of behaviors elicited by single waves of CSD suggests that a general release of motivating systems is involved; however, the fact that when tested with both food and water in the box some animals exhibited a preference for one prior to the other indicates some specificity of the energizing effect. For example, one animal voraciously ate after a CSD wave, and began to drink only after several minutes of eating. When food was withdrawn from the box, he began to drink with a shorter latency, however, only after frantic exploratory activity and biting of the floor and edges of the box. After a CSD wave the same animal vigorously approached the experimenter's hand, which he normally avoided, and attempted to seize food from it. Another rat only drank and never ate, even when the water was withdrawn.

In one animal unilateral CSD waves became ineffective in eliciting drinking after drinking was elicited five times consecutively with bilateral waves of CSD. This suggests that the motivating effect is prone to adaptation and that the effect is stronger when simultaneously induced in both hemispheres.

A number of studies have demonstrated that CSD attenuates activity in the hypothalamus. Single waves of unilateral CSD depress the electroencephalogram, evoked responses (*3*), and single unit activity (*4*, *5*) in the lateral hypothalamus, especially on the side ipsilateral to the hemisphere depressed. Lateral hypothalamic self-stimulation is suppressed more by ipsilateral than by homolateral CSD (*4*, *6*). Repeated waves of CSD decrease hypothalamic noradrenaline (*7*), and reinstate aphagia in animals recovered from lateral hypothalamic lesions (*8*). These results, in conjunction with the data showing impairment of alimentary responses by repeated waves of CSD (*1*), strongly suggest that the cerebral cortex exerts tonic control over some hypothalamic motivational systems. Withdrawal of cortico-hypothalamic facilitation presumably results in motivational decrement for certain behaviors.

It is tempting to interpret the energizing effects of CSD as being an aftereffect of such motivational inhibition, for example, as a result of rebound activity of the subcortical areas depressed during the CSD. Our studies show that when drinking is disrupted by single waves of unilateral or bilateral CSD, the recovery of drinking corresponds in time to the peak of the onset distribution of Fig. 2 (*9*). Hence, the elicited drinking corresponds temporally to recovery from motivational depression, in accord with the hypothesis of subcortical rebound from depression.

Alternatively, the motivation may be induced by direct activation of subcortical areas, possibly as a result of spreading depression entering the entorhinal cortex, amygdala, or caudate nucleus (*10*), or by accompanying increase of extracellular potassium. For example, eating and drinking have been induced in goats by the injection of KCl into the third ventricle, and have been interpreted as a result of nonspecific stimulation of hypothalamus by spread of extracellular K^+ via the vascular system (*11*).

Whatever the mechanism involved, it is clear that waves of CSD have an energizing effect in additon to their well-known inhibitory properties, which preponderate with short intervals between individual CSD waves and obscure the excitatory components.

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9. When single waves of unilateral CSD were administered while an animal was drinking, the drinking frequently continued at a normal rate through the course of depression; however, on the average, drinking was disrupted for about 1 minute ($n = 20$). Single waves of bilateral CSD inhibited drinking for 4.5 minutes on the average ($n = 15$).
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12. J.P.H. is a visiting scientist from Tufts University, Medford, Mass., sponsored by the National Academy of Sciences and Czechoslovak Academy of Sciences exchange program.

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Hyperbaric Oxygen

The report by Joanny *et al.* (*1*) provides further evidence for the involvement of lipid peroxides and the inhibition of the production of adenosine triphosphate by hyperbarbric oxygen. However, their results as presented suffer from several serious uncertainties. First, no control data is presented showing the relative conversion of the different substrates to $^{14}CO_2$ in an atmosphere of air or under nitrogen at the different pressures used for oxygen (3, 6, and 10 atmospheres).

Second, it is not likely that the stirring rate (shaking the chamber at 120 times per minute) was adequate to rapidly mix the gas phase, the turbulence of which depends on the oscillating surface of the medium. My own experience with a small chamber of almost exactly the same volume and shape (*2*) suggests that adequate gas transfer is best achieved by direct mechanical mixing of the gas phase. The higher the pressure—and thus the viscosity—of the gas, the slower will be both diffusive and convective transfer of $^{14}CO_2$. In the absence of quantitative information (CO_2 transfer times between medium and trap), the degree to which the oxygen pressures of 3, 6, and 10 atm actually inhibited the oxidation of the various substrates used remains uncertain because decreases in the amount of

CO_2 recovered would correlate with pressure.

Third, explosive decompression of any tissue will produce intra- and extracellular bubbles that would in all probability rupture cellular membranes and cause, among other effects, alteration of concentrations of Na^+ and K^+. Because the ratios of "non-inulin" Na^+ to K^+ reported by Joanny *et al.* depend on the amount of these cations remaining in the tissue slice after it has been drained of excess fluid (*3*), damage due to tissue bends could cause a net loss of K^+ and an apparent gain in Na^+ in the directions shown by their data. Such changes would correlate positively with pressure. That such effects also correlated positively with time may be taken as qualitative evidence that the effects were induced by oxygen because saturation of the tissue with gas could be assumed to have occurred in less than 1 hour. However, the degree of change in the ratios of Na^+ to K^+ caused by oxygen remains uncertain.

There is little doubt that the effects described by Joanny *et al.*—namely, inhibition of oxidation of glucose and Krebs cycle metabolites and a resulting change in Na^+ and K^+ balance—do in fact result from hyperbaric oxygen (*4*); there is doubt, however, that such effects have been clearly demonstrated by their results.

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D'Aoust suggests that high pressures of air or nitrogen would be more suitable controls for measurement of the effects of hyperbaric oxygen. High-pressure air involves increased partial pressure of oxygen and nitrogen and compression of tissues. Use of 3 atmospheres of oxygen seems to us to be a much closer control for the effect of 6 and 10 atm of oxygen than the former more complicated system. For example, in his suggested experiments, how could one control for "specific" effects of high-pressure nitrogen and for the effects of hypoxia?

Second, while we would agree that the stirring rate would have some effect on the diffusion of CO_2, we would have thought that 1 to 2 hours of incubation at a shaking rate of 120 per minute would insure reasonable mixing; it is usually considered satisfactory in manometric techniques. Significant failure to mix would result in an overestimation of the effects reported, as D'Aoust points out.

Third, we wonder whether there is any solution to the problem of tissue "bends." Slow decompression would probably result in the reversal of the effects of pressure before they could be measured. Therefore, transient effects not outlasting the increased pressure could not be studied. Our model is thus suitable for examining the consequences of fairly sudden compression and decompression, and not the effects of slow release from compression. The former seems to be one which in our opinion can be usefully studied.

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Polywater Discovered 30 Years Ago?

"Polywater" [Lippincott *et al.* (*1*) coined the term in 1969 and used it to describe a water-derived material found occasionally in glass capillaries] has subsequently generated considerable excitement, and understandably so. But glass surfaces and water vapor have been with us for years (*2*). Perhaps so has polywater.

In 1941, Eversole and Lahr (*3*) measured carefully the thickness of a rigid film of water distilled between an adjacent quartz lens and plate. The thickness of the film was measured by the extrapolation of radii of the successive Newton rings according to their equation

$$r_n^2 = (n\lambda R/\mu \cos \theta) - 2Rt$$

where r_n is the radius of the nth Newton ring, λ is the wavelength and θ the angle of the incident light beam, t is the thickness of the water film, R is the radius of curvature of the lens, and μ is the refractive index of the "water." The refractive index is what caught my attention, although its measurement was not the object of Eversole and Lahr's experiment. Their figure 3 (Fig. 1) shows the extrapolation procedure used to obtain t in the above equation. The extrapolation was repeated with air to cancel out any optical errors. The slopes of their lines for air and water as plotted should be proportional to μ (equation), and the ratio of the slopes should be exactly equal to the refractive index of water with respect to air (1.33). I calculate from the slopes that the "water" they obtained between the quartz surfaces had a refractive index of 1.44, well within the range of 1.38 to 1.51 for polywater solutions formed in capillaries (*4*).

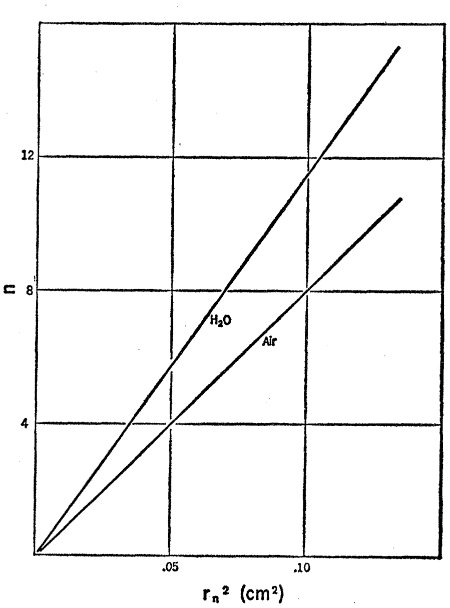

Fig. 1. Reproduction of Eversole and Lahr's figure 3 (*3*). Their data points, all well within the thickness of the lines, have been left out for simplicity. The slopes of these lines as plotted here will be proportional to the refractive index. [Courtesy of the American Institute of Physics]

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