Mental Work Takes Few Calories

General Science

National Academy of Sciences Holds Its Annual Spring Meeting

IF you eat one oyster cracker or one-half a salted peanut you will get enough extra calories for one hour of intense mental effort, Dr. Francis G. Benedict, director of the Nutrition Laboratory of the Carnegie Institution stated at the meeting this week of the National Academy of Sciences.

With his wife, Mrs. Cornelia Golay Benedict, this scientist has studied the effects of mental effort on the energy requirements of the body.

"The popular tradition that fish is a brain food has given way to the idea that mental effort demands calories," he said in reporting the experiments which he and his wife have conducted.

"It is the experience of nearly everyone that intense, sustained mental effort results in a feeling of profound fatigue, not only in mind but likewise in the entire body. The disposition to seek instinctively fresh air, to open a window and to stretch the limbs after a period of mental work is pronounced.

"When one considers the sense of extreme, almost overpowering fatigue in both mind and body following a sustained mental effort, it is surprising that there is such an insignificant effect upon the general metabolism or level of vital activity," Dr. Benedict commented on the results of his and Mrs. Benedict's experiments.

The two scientists first measured the energy requirements of the body when resting, twelve hours after the last meal and when the mind was as nearly free from activity as possible. Observations were also made of the rate and character of breathing and of the heart rate.

Then the same measurements and observations were made while the person being observed was doing problems in mental arithmetic. The problems consisted of multiplying in his mind such figures as 76 by 69. They were given in a clear voice by the investigator. The person doing them indicated by a tap on a telegraphic key that he had solved the problem, whereupon a new one was given him.

The same observations and measurements were also made during attention periods when the subject responded, by tapping the telegraphic key, to such stimuli as flashing lights or the ringing of a buzzer.

The scientists found a noticeable increase in the heart rate, a considerable change in the character and type of the breathing movements, an increase in the volume of air passing through the lungs, a small increase in the carbon dioxide produced and a smaller increase in the oxygen consumed by the body during the periods of mental effort.

The increase in oxygen consumption, which may be taken as the best index of energy transformations, is such as to suggest that the increase in heat production as a result of intense mental effort of this type is very small, Dr. Benedict explained.

"The professor absorbed in intense mental effort for one hour has an extra demand for food or for calories during the entire hour not greater than the extra needs of the maid who dusts off his desk for five minutes," Dr. Benedict stated.

Optical Slicing

A POWERFUL new weapon of research, a microscope that can dissect a cell photographically while it is still alive without cutting it or even touching it, was described by Francis F. Lucas of the Bell Telephone Laboratories, New York.

Employing invisible ultraviolet rays of a single wave-length and using photographic plates instead of the human eye, Mr. Lucas is able to section optically living normal and malignant cells at very high magnifications and with a degree of precision never heretofore achieved.

The average living cell is about one three-thousandth of an inch in diameter. With his new invention, Mr. Lucas can "slice" such a cell into sections spaced about one one-hundred-thousandth of an inch apart and photograph each section without materially interfering with the normal behavior of the cell. In the average cell thirty or more photographs may be taken on uniformly spaced optical planes. The whole architecture of the living contents can be pictured at magnifications as high as 5,000 diameters.

Fish Hearing

FISH have a good sense of hearing. They can perceive vibrations too low for the human ear to catch, and can hear sounds clear to the highest notes of piano or violin range and a little beyond.

Dr. Karl von Frisch of the University of Munich told how he wormed out of a collection of minnows the answer to the much-disputed question of how well fish can hear.

He appealed to the fish in the way that is said to bring the best results with men: through their stomachs. He offered them food, at the same time sounding a tuning-fork or blowing a whiste. After a while the minnows came to know that the sound meant dinner-time, and would come crowding up to the feeding place when they heard it, leaping and scrambling for the expected food.

Dr. von Frisch taught the fish to distinguish between sounds, by feeding them to the accompaniment of one note, and scaring them off with a tap of a glass rod when he sounded another. In this way he learned how small an interval in pitch they could discern. The minnow with the best musical ear could distinguish perfectly the two sounds of a minor third—the "la-do" interval.

The German scientist stated that he could not find a vibration rate that the fish could not hear. The lowest rate of any of his tuning forks, sixteen to the second, seemed to be perfectly perceivable to them. Some of his experiments indicate that fish may have two sets of organs for detecting sound: the ear for medium and high pitched notes, and some other organ for the slow vibrations.

More Air Power

TRI-MOTORED airplanes will fly just as fast on one motor as they do now on three when designers learn how to make machines so that the flow of air around them is smooth and free from eddies.

This thought from the address of Dr. Joseph S. Ames, president of Johns Hopkins University and chairman of the National Advisory Committee for Aeronautics, indicates the importance of scientific investigation to improve the aerodynamic efficiency of airplanes.

"Careful estimates prove that if all the parts of the machine were designed so the flow of air around it were smooth and free," Dr. Ames explained, "the airplane could maintain its speed with roughly only one-third the power ordinarily used. This fact points to the possibility and need of reducing drag by the proper design."

The drag of the different parts of a plane like the wings, engine and fuselage can be studied separately in wind tunnels now in existence, it was pointed out. The drag of the machine as a whole, however, may be twice as great as the sum of the drag of its parts, due to distortion of flow when the parts are combined, Dr. Ames said.

"This additional drag, called interference drag, can be studied only by placing the entire airplane in the throat of a wind tunnel," he pointed out. "There is not in existence at the present time a tunnel of sufficient size to hold a modern airplane, but one is under construction by the National Advisory Committee for Aeronautics at its laboratory at Langley Field, Va. Fortunately this laboratory now has in operation a tunnel having an open throat 20 feet in diameter, which is the largest in the world. This is provided with engines sufficient to produce an airstream having a velocity in excess of 100 miles per hour."

In naming some problems that have been solved in wind tunnels, Dr. Ames described a cowling or hood for standard air cooled engines which, he said, results in an increase of speed of approximately 20 miles per hour for the ordinary commercial airplane.

Tuberculosis

EVOLUTION while you wait has been observed in cultures of tuberculosis bacilli by Dr. S. A. Petroff, bacteriologist of the Trudeau Sanatorium, N. Y.

From cultures of avian tuberculosis, which is an affliction of birds, Dr. Petroff has isolated what seem to be three distinct varieties of the germ. They grow differently, react differently to chemical and physical treatment, and have different physiological effects. One of the three types is quite virulent in its effects on chickens, the other two less so.

Similarly, from the tuberculosis of cattle a series of three cultured varieties was obtained. Their general appearance in mass was the same as that of the corresponding three types from the avian bacilli. They resembled them also in that one variety was strongly pathogenic, this time toward guinea pigs and rabbits, while the other two were less so.

Human tuberculosis germs proved less susceptible to separation into distinct strains or varieties. Dr. Petroff had best success with the long-cultured and somewhat vitiated "BCG" bacilli, which are used in the preparation of a vaccine widely used on infants in France. These bacilli separated out into two varieties, one of which had considerable effect on guinea pigs but little on rabbits, while the second variety appeared to be harmless to both animals. Cultures derived directly from human tuberculosis could not be separated into stable varieties. Dr. Petroff is of the opinion that human T. B. germs do produce many varieties, but that these do not "stay put" under laboratory conditions.

Dr. Petroff found it possible to convert one type of his bacilli into another by suitable culture methods, changing a virulent form into a mild one and vice versa.

This variability of the bacilli of different types of tuberculosis, and the instability of a variety that workers may succeed in isolating, agrees with fluctuating changes that have been found in other bacteria. The physiological changes that take place in the germs may supply a basis for the understanding of the wide variability in tuberculosis as found in human patients, which has always been a puzzle to doctors.

Centrifuge-Microscope

A MICROSCOPE fitted to a high-speed centrifuge, making it possible to watch living cells as they are whirled about at a speed of from 2000 to 3000 revolutions a minute, is the powerful new weapon of biological research described by Prof. E. Newton Harvey of Princeton University and Alfred L. Loomis, banker-scientist of Tuxedo Park, N. Y.

The instrument, constructed in the private laboratory of Mr. Loomis, consists of a rapidly rotating frame on which a glass slide, bearing the cell to be studied, can be mounted. As the frame whirls, the various parts of the cell's living contents are thrown toward the outside by centrifugal force.

Travelling with the microscope slide is the powerfully magnifying object-lens of a microscope, so placed that it can be kept in focus on the cell under observation. By means of two reflecting prisms the image it forms is reflected out through an eyepiece placed directly over the center of the instrument. Through the latter lens the observer watches the course of events in the whirling cell.

Light to illuminate the experiment is supplied from a new type of mercury vapor lamp, the invention of Mr. Loomis. It is so constructed that it can be flashed on and then off again in so small a fraction of a second that it can hardly be called time at all; yet it gives full illumination while it is turned on. This intermittent illumination is necessary because if there were light shining on the cell all the time the image under the eyepiece would be nothing but a spinning blur. But by catching it at just one point in its circuit at each revolution, the series of instantaneous flashes string themselves together like the intermittent flashes of the motion picture on the screen, and appear to the observer as a steady, stationary picture. So steady is the image, Prof. Harvey reported, that perfectly clear photographs have been made.

Nerve Telephony

THE nerve of hearing carries the impulses it receives when stimulated as a minute fluctuating electric current, very similar to the current in a telephone circuit. So much alike are they that a telephone receiver can be "hooked up" with the auditory nerve, and the current, after amplification by means of vacuum tubes, will reproduce sounds received by the ear.

Ernest Glen Wever and Charles W. Bray of the psychological laboratory of Princeton University told how they made this discovery. They inserted an electrode in the auditory nerve of a cat, grounded the other end of the circuit elsewhere on the animal's body, and after amplifying the current "lisened in" with a telephone receiver.

"We found that sound stimuli applied to the ear of the animal are reproduced in the receiver with great fidelity," the experimenters reported. "Speech is easily understandable. Simple tones, as from tuning forks, are received at frequencies which, so far as the observer can determine by ear, are identical with the original."

Sounds of wave frequencies as high as 3,300 per second, approximately the top of the violin range, were audible.

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