CONTENTS

WALTER JOSEPH MEEK
1878 - 1963

Dr. Meek was born in Dillon, Kansas, on August 15, 1878. He received his A. B. degree from the University of Kansas in 1902; his A. M. degree from Penn College in Iowa in 1907; and his Ph. D. degree from the University of Chicago in 1909. In 1908 he was appointed Instructor in Physiology at the University of Wisconsin under Dr. Joseph Erlanger. He was appointed Assistant Professor in 1910; Associate Professor in 1913; and Professor in 1918. In 1919 he became Chairman of the Department of Physiology and retained this position until 1948 when he became Research Professor of Physiology. He was Assistant Dean of the Medical School from 1920 - 42; Acting Dean from 1942 - 45; and Associate Dean from 1945 until his retirement in 1949.

As Assistant Dean, Dr. Meek was advisor to premedical students and had the primary responsibility for medical school admissions. He was an excellent teacher and a stimulating and lucid lecturer in both undergraduate and medical physiology courses. He was highly successful in selecting and training graduate students.

Dr. Meek published over one hundred scientific articles. His research interests dealt mainly with the heart, circulation, gastrointestinal tract and the autonomic nervous system. The studies on the heart are classics and include early studies with A. J. Carlson on the heart of the Limulus and a long series with J. A. E. Eyster on the origin and conduction of the heart beat in mammals. Eyster and Meek authored a review on this subject which was published as the first article in Physiological Reviews (Vol. 1, No. 1, pg. 1, 1921). With the advent of cyclopropane anesthesia Dr. Meek became interested in the effects of anesthetic agents on cardiac irritability and rhythm and demonstrated the incompatability of cyclopropane anesthesia and epinephrine.

During the first World War a Chemical Warfare Unit was establishec at the University under the leadership of Drs. Eyster and Meek. They made many of the initial investigations on the biological effects of mustard gas, lewisite and phosgene.

Dr. Meek's avocations provided expression in both scholarly and manual recreation. He was keenly interested in medical history and his published historical papers make delightful reading. He was an avid gardner, a bookbinder and a skilled metal worker. The Meek's delighted in furnishing their home with fine old furniture, rugs and spreads. Over a quarter of a century they assembled one of the best private collections of American pewter in the country.

Dr. Meek had a modest, unassuming manner and was easily approachable by students and colleagues alike. He had keen critical faculties based on sound logic and was quickly able to get at the meat of a problem. His scientific work was characterized by energy, experimental skill, originality and critical ability. These characteristics were conveyed to the many co-workers and students who were associated with him.

Dr. Meek's accomplishments were recognized in a number of awards and citations. In 1944 he was awarded honorary membership in the Wisconsin State Medical Society and was recipient of its Man of the Year Award. He was elected to the National Academy of Science and the American Society of Anesthesiologists elected him to honorary membership in recognition of his important contributions to the physiological effects of anesthetic agents. In 1948 the University of Wisconsin conferred upon him the honorary D. Sc. degree.

Dr. Meek took a very active interest in the American Physiological Society. He became a member in 1908; served on Council for two terms, 1915 - 19 and 1932 -36; served as Secretary from 1924 to 1929; and President from 1930 to 1932. He was Chairman of the Board of Publication Trustees (later the Publications Committee) from its founding in 1933 to 1946. He was appointed Chairman of the Semicentennial Committee for the fiftieth anniversary meeting of the Society. He served as historian from 1938 to 1954 and compiled the history of the first fifty years of the Society with the help of W. H. Howell and C. W. Greene. He was truly one of the stalwarts of the Society.

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VIIth INTERNATIONAL CONGRESS OF DIABETES

The Seventh International Congress of Diabetes will be held in Buenos Aires, Argentina, August 23-28, 1970. The Congress will honor Professor Bernardo A. Houssay. For further information write V. G. Foglia, M.D., Paraguay 2155 7th Floor, Buenos Aires, Argentina.

XXIV INTERNATIONAL CONGRESS OF PHYSIOLOGICAL SCIENCES

A Report and an Evaluation of the Role of Such Congresses

by

VERNER J. WULFF AND MAURICE B. VISSCHER

Scientifically and socially the XXIV International Congress of Physiological Sciences, held in Washington, D. C. August 25-31, 1968, under the auspices of the International Union of Physiological Sciences, was an outstanding success, according to the reports received. This poll will, it is hoped, contribute to an evaluation of the merits of this type of Congress. Reports came from 106 physiologists, mostly chairmen of sessions, 44 of whom are from abroad. The Congress was attended by 3, 430 members from 57 countries and, although the reports received represent a small percentage of the total attendance, many respondents stated that their own views were shared by other participants.

The positive reaction to the Washington Congress is the result of a number of factors such as 1) the screening and selection of voluntarily contributed papers for oral presentation: 2) a varied program of the volunteer papers and invited contributions consisting of symposia, recent advances in physiology and lectures: 3) the care taken in scheduling simultaneous sessions for minimal overlap of subject matter, thus minimizing the frequently experienced frustrations resulting from the desire to attend more than one session at a time: 4) the termination of most formal sessions about 11:00-11:30 a. m. and 3:30-4:30 p. m., permitting adequate time for informal discussions and delaying the onset of "meeting fatigue" which many have experienced in the past: 5) the existence of coffee lounge-discussion rooms and the general excellence of the facilities, including the proximity of the two hotels in which all the sessions were held, the pleasing social arrangements and the marvelous weather. In addition, 18 Satellite Symposia were held in various parts of this country before and after the Washington Congress. These Satellite Symposia were attended by 2, 573 scientists and, it is generally believed, contributed significantly to the success of the International Congress of Physiological Sciences itself.

The 677 volunteer papers i.e., fifteen minute contributed papers including discussion, which were scheduled for presentation over a 5 day period, clearly constituted an important part of the Congress program. The papers scheduled for presentation, and the 108 alternate papers to substitute for absentees, were selected by panels of specialists from 1, 446 submitted abstracts and grouped into 82 sessions of related papers. Of these 82 sessions, twenty-seven were devoted to vertebrate and invertebrate nervous systems including areas such as vision, audition, synaptic and neuromuscular transmission, motor and sensory systems, the autonomic ganglia, neurochemistry and others; fourteen sessions were devoted to the cardiovascular system including such areas as contractility of the myocardium, cardiac electrophysiology and metabolism, capillary permeability, vascular smooth muscle, baro-and chemoreceptors, blood coagulation and others; ten sessions were devoted to various aspects of internal and external secretion such as the catecholamines, adrenergic mechanisms in cardiovascular control, hormone metabolism, thyroid, angiotensin, female sex hormones and target organs and others; eight sessions were devoted to active transport and various aspects of gastrointestinal physiology, six sessions were devoted to respiratory physiology, six to various aspects of temperature regulation and the balance were in the areas of renal function, water balance, nutrition, vertebrate and invertebrate muscle and space physiology. Fifteen of the volunteer paper sessions were preceded by an introduction by one of the co-chairmen. Abbreviated versions of these lectures are published (1). Abstracts of all papers scheduled for presentation as well as those not selected for presentation and abstracts describing the 14 ten minute films shown at the Congress are published (2). A number of respondents indicated it would be desirable to list all papers in the program, i.e. those presented as well as those not presented, to facilitate finding relevant abstracts and authors and promoting discussion. More than half of the volunteer papers were from scientists abroad.

There was virtual unanimity in the opinion that the volunteer papers constituted an essential part, some said the backbone, of the Washington Congress and should continue to be a part of future Congresses. Although opinions as to quality of the orally presented volunteer papers ranged from excellent to mediocre, a clear majority indicated the calibre to be better than expected on the basis of previous experiences and attributed this improvement to the selection process. Many of the respondents commented favorably on the shortness of the volunteer paper sessions allowing ample time for informal discussion.

To balance the specialized nature of the volunteer papers, the broader aspects of the state of physiology were presented by 147 invited speakers in symposia, invited lectures and six sessions on recent advances in physiology, abstracts of which are published (1). Of these three types of presentation, the recent advances lectures drew the most favorable comments, many respondents regarding this feature as an innovation which should be encouraged and continued in future congresses. Although comments on the symposia and invited lectures ranged from "excellent" to "too specialized" to "nothing new", a majority of respondents were strongly in favor of continuing this aspect of the Congress program.

The eighteen Satellite Symposia held before and after the Washington Congress contributed importantly, if indirectly, to the success of the major meeting. The large attendance at these Symposia, totaling 2,573 of whom 635 were from abroad, undoubtedly contributed to the attendance in Washington both of scientists from abroad and from the United States. Perhaps an even greater contribution, although an indeterminate one, was the impact of the information disseminated in the pre-Congress Satellite Symposia on the scientific discourse at the Washington Congress. The Satellite Symposia (listed in Table I) were highly specialized conferences, the detailed information and probing of which complemented the broader aims of the Congress symposia, invited lectures and recent advances. Unfortunately, no unified plan for the publication of the proceedings of the Satellite Symposia exists and the interested reader is directed to the various organizers (Table I) for publication information. The proceedings of some Satellite Symposia will not be published for lack of funds.

TABLE I

Organizers and Satellite Symposia of the XXIV International Congress of Physiological Sciences

Cerebral and Cerebellar Motor Control	Brooks, V.B.
Olfaction and Taste	Pfaffmann, C.
Regulation of Food & Water Intake	Epstein, A.N.
Molecular Basis of Membrane Function	Tosteson, D.C.
Comparative Physiol. - Excitable Membranes	Bennett, M.V.L.
Intestinal Transport	Armstrong, W. M.
Significance of Electrogenic Ion Pumps	Marshall, W.H.
CO_2: Chemical, Biochemical & Physiol. Aspects	Forster, R.E.
Airway Dynamics	Bouhuys, A.
Altitude and Cold	Smith, R.E.
Physiological & Behavioral Temperature Reg.	Hardy, J.D.
Conference on Depressed Metabolism	Musacchia, X.J.
Pulmonary Circulation	Fishman, A.P.
Comparative Physiology of the Heart	McCann, F.V.
Exocrine Glands	Botelho, S.Y.
Thrombus Formation and Dissolution	Guest, M.M.
Workshop: O_2 Microelectrode & Peripheral Circ.	Penneys, R.
Lactogenesis	Reynolds, M.

Opinion was virtually unanimous concerning the desirability and the value of the coffee lounge-discussion rooms that were available at the Washington Congress and it was generally appreciated that their value was enhanced by curtailment of the duration of most of the programmed scientific sessions. Awareness of the existence of the discussion rooms and the frequency of their use increased noticeably as the Congress progressed, despite the fact that the discussion facilities were announced in the program. This latency in their use must be attributed to the novelty of this feature of the Congress. Many respondents indicated that the discussion rooms should not have been allocated to specific subjects, that professional hosts were not necessary, especially during the programmed scientific sessions when the discussion rooms were rather underpopulated, and that refreshments other than coffee or tea should have been available. On the other hand, some respondents made a strong case for programmed discussion sections late in the afternoon, led by outstanding and gifted scientists in specific areas. Clearly, the discussion room was a unique feature of the Washington Congress which should be preserved, but details such as the distribution and use of these rooms merit additional discussion and experimentation.

The prime purpose of the International Congresses of Physiological Sciences is to bring together a group of physiologists from all over the world for scientific discourse. This scientific discourse should, if the success of the XXIV Congress is correctly interpreted, achieve two objectives: 1) to disseminate information, that is, to learn of advances in areas other than one's small specialty; and 2) in concert with other specialists, to probe the frontiers of our knowledge of phenomena of living systems. It is clear that the Washington Congress achieved both these objectives: one was contributed by the Volunteer Papers and the Satellite Symposia, and the other by the rather extensive program of Symposia, Invited Lectures and Recent Advances in Physiology. The impact of the Satellite Symposia on the Congress could be enhanced by scheduling all Satellite Symposia to occur prior to the Congress and the value of these Symposia could be increased by adopting a uniform plan for publication of the proceedings.

Many respondents expressed their appreciation to Professor Wallace O. Fenn, President of the Congress, and to the other dedicated and able physiologists who assisted in the organization of the XXIV International Congress of Physiological Sciences. One person who deserves singular praise is Mrs. Helena B. Lemp, Congress Manager, to whose considerable efforts and ingenuity the smoothness of the Washington Congress and, therefore, the overwhelmingly favorable reaction of the participants must be attributed. A manual (3) written by Mrs. Lemp, who has managed several other large International Congresses for the FASEB, may be useful to those planning international scientific gatherings in the future.

The financial support for the XXIV International Congress of Physiological Sciences provided yet another reason, heretofore not mentioned, for the success of this meeting. Support for the Congress came from many sources. The International Union of Physiological Sciences made a significant contribution. Major support was provided by contracts or grants from several Federal Agencies, the Atomic Energy Commission, the National Institutes of Health, Public Health Service, Department of Health, Education and Welfare through grants from the National Institute of General Medical Sciences, and the National Heart Institute, the National Science Foundation and, very importantly, by the members of the American Physiological Society and the Society of General Physiologists, each of whom was assessed $30 toward the support of the Congress. Supplemental funds contributed by manufacturing and other private agencies were also made available. The availability of both private and governmental support was indispensable to the successful conduct of this Congress. It would have been impossible to utilize funds from governmental sources alone in such a way as to accomplish the total objectives of the Congress, and the unrestricted private funds were not large enough to cover such expensive items as publication costs and travel subsidy for invited participants.

Coming at a moment in time when considerable skepticism concerning the value of large broadly based scientific meetings existed in the scientific community, the XXIV International Congress of Physiological Sciences has apparently served to dispel much of this doubt and rekindle faith in the value of such meetings. Without doubt the factors which contributed to the success of the Washington Congress were many and some of these were unique to the locale. But those non-geographic features which were favorably received could well serve as guides in the organization of future congresses.

It is perhaps impossible to put a monetary value on one or another element in the whole process of scientist to scientist communication. However, science has always been, and hopefully will always be, an international venture. The role of person-to-person communication is a significant one and if the various countries of the world are to benefit from international cooperation, some mechanism must be maintained for facilitating such communication. The fact that physiologists from 57 countries assembled for a week to discuss their problems and that their practically unanimous report was that the meeting was scientifically valuable, should dispel doubt as to whether international collaboration can still be promoted by broadly based international scientific congresses, if they are imaginatively and carefully arranged and adequately funded. There may be other mechanisms that could be developed, but at present none offers the same opportunity for the participation of scientists without established reputations.

REFERENCES

1. Abstracts of Lectures and Symposia. Proceedings of the International Union of Physiological Sciences, Vol. VI, Federation of American Societies for Experimental Biology, Washington, D. C., 1968.

2. Abstracts of Volunteer Papers and Films. Proceedings of the International Union of Physiological Sciences, Vol. VII, Federation of American Societies for Experimental Biology, Washington, D. C., 1968.

3. Lemp, H. B. Manual for the Organization of International Scientific Congresses. To be published Jan. 1969 by Federation of American Societies for Experimental Biology, Washington, D. C.

FIRST AIBS NATIONAL BIOLOGICAL CONGRESS

November 6-10, 1970
Detroit, Michigan

The Congresses will be concerned with various Social, Educational and Scientific problems. The morning sessions will be devoted to interdisciplinary symposia covering the major scientific advances in all areas of Biology. National and International leaders in the Bio-Medical Sciences will be invited to participate in these symposia.

Afternoon sessions will be devoted to papers contributed by biologists active in specific research. Progress in areas of biology ranging from molecular, genetic and developmental biology to evolutionary, ecological and environmental sciences will be reviewed. Invitations will be extended to younger scientists to contribute original research papers that will shed additional light on the subjects covered by the major symposia.

Special evening programs, open to the public, will be designed to provide a forum in which the interrelationships of biology, technology, society and public affairs are considered. National, State and Local leaders will be invited to participate in these public meetings. Among the topics to be considered, for whose solution biological knowledge is vital, are water and air pollution, pest control, population pressures, community health, food quality and the effects of drugs on human development and behavior. We need your ideas on other topics that might be considered.

Educational and scientific programs will be arranged for local high school and college students who are interested in a career in the biological-medical sciences. In addition to lectures by outstanding scientists, there will be special programs by leading science councilors who will describe career opportunities in biology. Exhibits by book publishers and suppliers of equipment will be of interest to scientists. In addition, organized tours for students and the general public are planned in order to give them an opportunity to see the current "tools" used by the biologists.

It should be clearly understood that the National Biological Congress will not supplant the regular AIBS Meetings, which will continue to be held on college campuses in late August. The 1969 Meeting will be held at the University of Vermont, Burlington, August 17-22, and plans are well under way for the 1970 Meeting which will be held at Indiana University, August 23-28 just preceding the Fall Meeting of the American Physiological Society.

For further information, please contact Dr. John R. Olive, AIBS, 3900 Wisconsin Avenue, N.W., Washington, D.C. 20016.

NEWTON'S THERMOMETER: A MODEL FOR TESTING NEWTON'S LAW OF COOLING

GEORGE W. MOLNAR

I. Introduction. In order to forestall misinterpretation it is best to begin by explaining our use of the word "cooling," because this word is often confused with the process of heat transfer, as when we say the body cools by radiation, convection, etc. When heat input exactly equals output, there is no change in body temperature; the body is in the steady state. When heat input exceeds output, the body temperature rises; the body warms. When heat input is less than output, the body temperature falls; the body cools. In all three cases there is heat transfer by radiation, convection, etc. In only the third case, however, does the body undergo cooling. By cooling we mean only the fall in temperature, not the transfer of heat. We are concerned with degrees of temperature, not with calories of heat. In particular we are concerned with the time course of the falling body temperature and the factors which affect this course. Newton's law of cooling is of interest because it expresses the simplest and most basic time course possible. Other time courses can be considered to be deviations from this basic trend caused by one or more extraneous factors.

Newton's law of cooling is an assumption and incredible though it may seem to the reader, whether physicist or physiologist, there is no definitive body of experimental data which defines the limits within which reality conforms to the "law". For the past 200 years it has been suspected that the law holds for only a small range of temperature, but this range has never been established, nor the magnitude of error to be encountered beyond the range. It is possible that this range is sufficiently broad to make the application of the law to biothermal problems both practical and useful. An examination of Newton's law of cooling, its limitations, and its applicability in biothermal investigations is therefore in order.

The history of Newton's law is very interesting but a complete account is a report in itself. Briefly Newton published anonymously in 1701 a paper entitled "Scala graduum Caloris. Calorum Descriptiones & Signa" (6). As the title indicates, he was concerned with the establishment of a scale of temperature. In describing his methods he stated his assumptions about heat transfer and cooling in a somewhat cursory fashion, but he presented no evidence in support of his assumptions. It so happens that Newton's thermometer is an adequate device for testing certain aspects of his law of cooling. It is therefore of both scientific and historical interest to examine the results obtained with his thermometer.

II. Newton's Thermometer. To establish the melting point temperatures of metals and alloys up to that of tin, Newton used a thermometer containing linseed oil. He gave no further description. On a recent trip abroad, this writer learned that there is to be found neither relic nor additional information at either the Royal Society of London or at Cambridge University (Trinity College and the Whipple Science Museum).

On returning to New York and browsing in the New York Public Library, he found the following description by Desaguliers (erstwhile chaplain to the Prince of Wales). (1).

"But as I mention Sir Isaac Newton's Thermometer, I think it will not be improper to give an account of the manner of making of it, as I made three of them once by Sir Isaac's direction. I took a tube of half an inch bore 3 feet long, with a ball of two inches diameter at one end of it, and to the tube pasted a list of paper in order to mark a scale upon it. Then with a measure containing 1/4 of a cylindrick inch, I first fill'd the ball with quicksilver, which contained 21 of those measures (67.6 ml); then at every measure of mercury pour'd into the tube I made a mark upon the paper to form the scales, finding those marks commonly about an inch from one another, but a little farther asunder where the bore of the tube was narrowest, and a less distance than an inch where the bore was bigger, and for greater exactness subdivided all those divisions of the scale into decimals. Then the mercury being well taken out of this thermometer, linseed-oil was pour'd into it up to the 10th or 12th division on the scale of the tube ..."

A replica prepared by a glass blower is shown in Figure 1. By toying around with it we have acquired some understanding of its oddities and appreciation for its virtues. The amber color of the linseed oil makes it clearly visible. (Roemer, living at the same time as Newton, colored the spirits of wine in his thermometer with saffron (5). The wide bore makes it easy for one to pour the oil into the stem. For the filling of a thermometer with a quarter inch stem, we found it necessary to direct the oil down a still smaller tube inserted into the stem all the way down to the bulb. Linseed oil has a coefficient of expansion about four times that of mercury and gives a satisfactory expansion in the large bore thermometer, about three centigrade degrees per millimeter. Because of its high boiling point, linseed oil can be used for measuring temperatures up to the melting point of tin (232^{o} C).

The value of the long stem becomes obvious from a consideration of the technique Desaguliers described that Newton used for determining the hardening points of metals. The bulb of the thermometer was preheated in a sand bath resting on a furnace. Then:

"...the Crucible containing the mixture of lead, tin, and tin-glass "bismuth", was taken off the fire and set upon the ground. We took the thermometer out of its sand cricuble, and thrust its ball into the mixture and took it out again immediately, and this for several times till the mixture in cooling made a skin about the ball of the thermometer; and this we call'd the Degree of Heat capable of melting the Mixture."

For the performance of this maneuver from the standing position, the long stem serves as a convenient handle much as with a golf club.

Finally in 1738 Martine (4) reported some observations on an oil thermometer. He gave no dimensions although he had Newton's thermometer in mind.

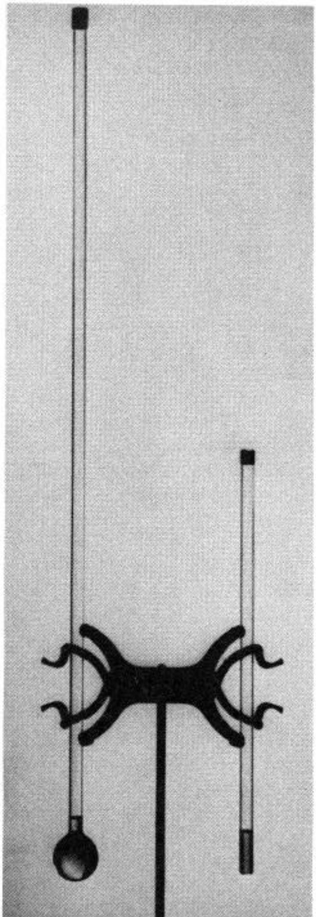

Fig.1. Left, replica of Newton's thermometer made according to the specifications reported by Desaguliers in 1744. Right, the same without the bulb (and shorter).

"But there is another difficulty which will hold in all oil thermometers, or made with a viscid liquor, that it adheres too much to the sides of the tube. In a sudden cold or fall of the oil a good deal sticks by the way, and only sinks gradually after, so that at first the surface appears really lower than the present temperature requires. And beside, as at all times some must continue to stick and moisten the inside of the tube, in different degrees of heat and cold, the oil becoming alternately more or less viscid, will adhere sometimes more and sometimes less; and therefore will inevitably disturb the regularity and uniformity of the thermometer."

We did not find this stickiness to be a problem so long as the glass was first burned clean in the annealing oven.

III. Testing of Newton's Law of Cooling. If Newton had taken the trouble to test his ideas about heat transfer and cooling with his thermometer, he could very easily have become too discouraged to publish his paper even anonymously. Fortunately he refrained from performing the crucial experiment. We did this by heating our thermometer in a sand bath and then timing its cooling in a small wind tunnel with laminar air flow. The tunnel air temperature was maintained constant above general room temperature at about $27^{o} \pm 0.1^{o}$ C. The digital readout timer registered time to 0.01 minute. Cooling was followed both by the descent of the oil with a hand lens and by a thermocouple inserted down the stem into the bulb. The results obtained by the two methods were the same. The data were treated as follows: Newton's law of cooling is expressed by the equation,

$$(T - T_a)_t = (T - T_a)_o \, e^{-kt}$$

where T = temperature of the thermometer

T_a = temperature of the air

t = time

k = cooling constant

$$\frac{(T - T_a)_t}{(T - T_a)_o} = e^{-kt}$$

$$\ln \frac{(T - T_a)_t}{(T - T_a)_o} = -kt$$

The successive temperature differences $(T - T_a)_t$ were divided by the initial difference $(T - T_a)_o$, and these ratios were plotted on semi-log paper. Therefore all plots, regardless of the values for T and T_a, had a common Y-intercept and they differed only in the direction of the trend. According to Newton's assumption the trend should be linear with a slope, -k. The indication that cooling has followed Newton's law therefore is the linearity of the semi-log plot of the successive temperature difference ratios. Deviation from linearity is evidence that "extraneous" factors exerted an influence during cooling.

An example of the results obtained with Newton's thermometer is shown by the lower trend (solid circles) in Figure 2. The points do not follow a single straight line; instead they follow a curve onto which one can impose three lines with successively smaller slopes, -k. Thus Newton's thermometer appears not to "obey" his "law" of cooling.

Three reasons can be adduced to account for the deviation of the trend from linearity in Figure 2.

1. The oil cooled faster in the stem than in the bulb because the surface-area/volume ratio was greater in the stem than in the bulb (roughly 3 times greater when heated to about 200° C). As cooling proceeded and the oil contracted into the bulb, this difference diminished and cooling therefore slowed. The result was that the consecutive temperature excesses were in progressively larger, instead of constant, ratio.

2. Convection currents caused mixing of the cooler oil in the stem with the warmer oil in the bulb. This process accelerated cooling but as cooling proceeded the currents diminished and cooling slowed *pari passu*. As a result again the consecutive temperature excesses were not in constant ratio.

3. Heat transfer by radiation is proportional to the difference between the fourth powers of the absolute temperatures of the thermometer and of the air, and not the first powers as Newton assumed. The difference between the 4th powers diminishes faster than the difference between the 1st powers as cooling proceeds, and so the rate of cooling progressively diminishes more than by a constant ratio of consecutive

differences.

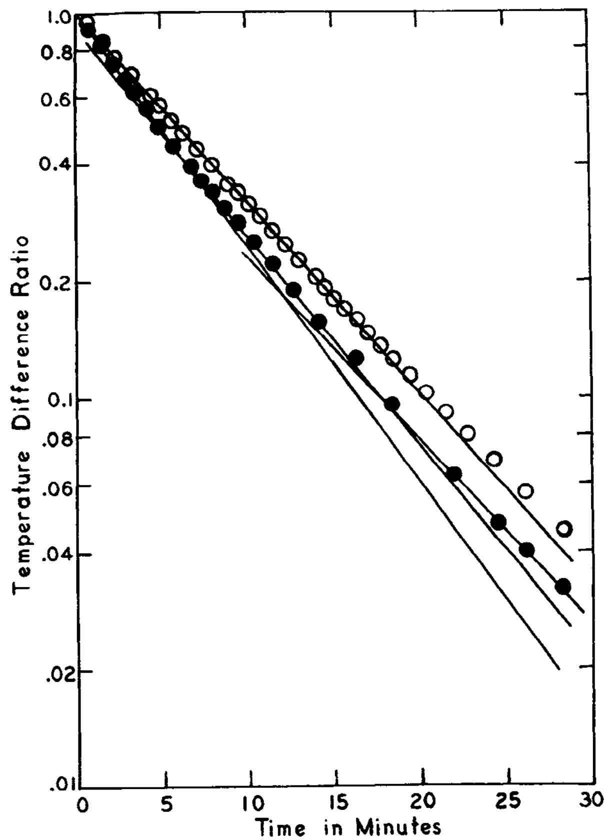

Fig.2. Semi-log plot of the course of cooling of Newton's thermometer in air moving 5 miles/hr. O = with a porous plug at the bottom of the stem. ● = without a porous plug, from 183^{o} toward 25^{o} C.

The first possibility was tested by following the cooling of linseed oil in a half-inch tube without a bulb, shown on the right in Figure . The results are shown in Figure 3 by the lower curve (solid circles). After eight minutes the points deviate slightly from the straight line fitted to the points up to that time. The deviation, however, is much less than it was with a bulb attached as in Figure 2. Hence it appears likely that faster cooling in the stem than in the bulb accounts for most of the deviation from linearity in Figure 2.

To test the possibility that the residual deviation in Figure 3 was due to convection currents, a polyurethane foam plug was placed down in the oil in the tube. The porous plug impeded currents but not the expansion and contraction of the oil. The results are shown by the upper curve (open circles) in Figure 3. The points now fall all on the straight line. Hence with a uniform and constant surface-area to volume ratio, and with minimization of thermal currents, the linseed oil cooled geometrically from 130° to 25° C in air moving 5 miles/hr.

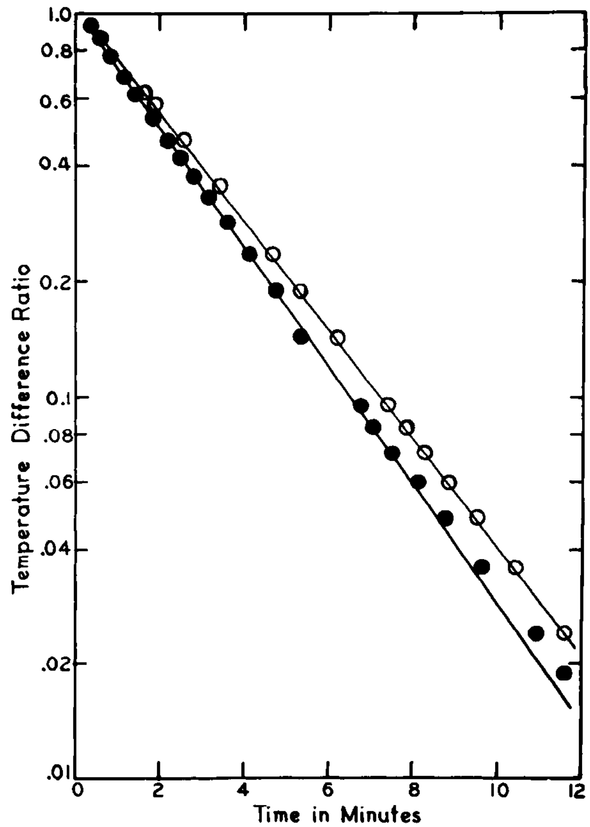

Fig.3. Semi-log plot of the course of cooling of linseed oil in a tube of the same dimensions as the stem of Newton's thermometer. Air flow = 5 miles/hr. O = with a porous plug. ● = without a plug. Cooling from 150° toward 25° C.

In addition to being linear the upper curve in Figure 3 is also of lesser slope (k = -0.326) than is the initial trend of the lower points (k = -0.355). The later trend of the lower points is of an intermediate slope (k = -0.339). This is further evidence that there were mixing currents which by slowing with cooling decelerated cooling and that they were blocked by the foam plug. (The plug was about 2% by weight of oil + plug.)

The experiment was repeated by putting the plug down the stem of the thermometer. As shown by the open circles in Figure 2, the restriction of currents between stem and bulb straightened the trend very considerably by comparison with the trend of the solid circles in Figure 2. Nevertheless there is still a residual terminal deviation with the open circles. Since the plug did not prevent the contraction of the oil from the stem into the bulb, most of which took place initially and little terminally, there was still an interchange of heat between bulb and stem which progressively diminished and thereby slowed cooling.

The slopes give quantitative evidence. For the lower trend they are -0.141, -0.124, and -0.108 for the three segments. With the plug the slope for the initial trend is -0.113 and for the later trend it is -0.103. Thus both the faster cooling in the stem than in the bulb and the interchange between stem and bulb by convection currents and by contraction of the oil account for the deviation of the cooling of Newton's thermometer from Newton's law. The experiments were repeated with water and the results were the same as with oil. The convection currents could be easily made apparent with a drop of India ink.

Confirming evidence for these conclusions is provided by a thermometer with negligible heat exchange via the stem and uniform temperature in the bulb, namely, a mercury thermometer with a small cylindrical bulb (ca. 4x15 mm) and a fine capillary stem. The results of one of three experiments of cooling in the wind tunnel are shown by the lower curve in Figure 4. This mercury thermometer cooled strictly according to Newton's law from 200° to 29° C.

That radiation is seemingly not an important factor in these experiments is probably due to the fact that the fraction of heat transfer by radiation was intentionally minimized by performing the experiments in a wind of 5 miles/hr. The opposite condition, the maximization of the fraction of heat transfer by radiation, was attempted by Ericsson in 1876 (3). He followed the cooling of water in a thin, blackened, copper sphere 2.75 inches in diameter. He placed the sphere within a large double-walled sphere through which he circulated ice water. The intervening air was exhausted but Ericsson did not report the resulting pressure. He presumed that heat transfer was by radiation alone. He stirred the water with a paddle to insure uniformity of temperature from center to surface. Revolving the paddle 30 times per minute did not raise the temperature of the water measurably. He measured the water temperature with a mercury thermometer having a cylindrical bulb.

Figure 5 shows the results from his tabulation for one experiment for cooling from 56.7° toward 0.5° C. The trend is initially linear but then progressively non-linear upward. The deviation at 74 minutes is 0.8°; i.e., when the linearly extrapolated temperature difference would have been 5.7° (0.1 of the initial difference), the temperature difference on the curve of measurements is 6.5° (0.115 of the initial difference). Ericsson ascribed this deviation to a diminution in "emissive power" with fall in temperature. Since he published in the decade preceding the appearance of the Stefan-Boltzmann law, he was unaware of the role of the 4th power of absolute temperatures in heat transfer by radiation. The deviation from linearity in Figure 5 was most probably due to the fact that the difference between the 4th powers diminishes more rapidly than the difference between the 1st powers. Even so under conditions maximizing the fraction of heat transfer by radiation, the deviation was small even after 9/10th of the cooling had taken place. At this time the error of Newton's law was $(6.5^o - 5.7^o)/6.5^o \times 100 = 12.3\%$.

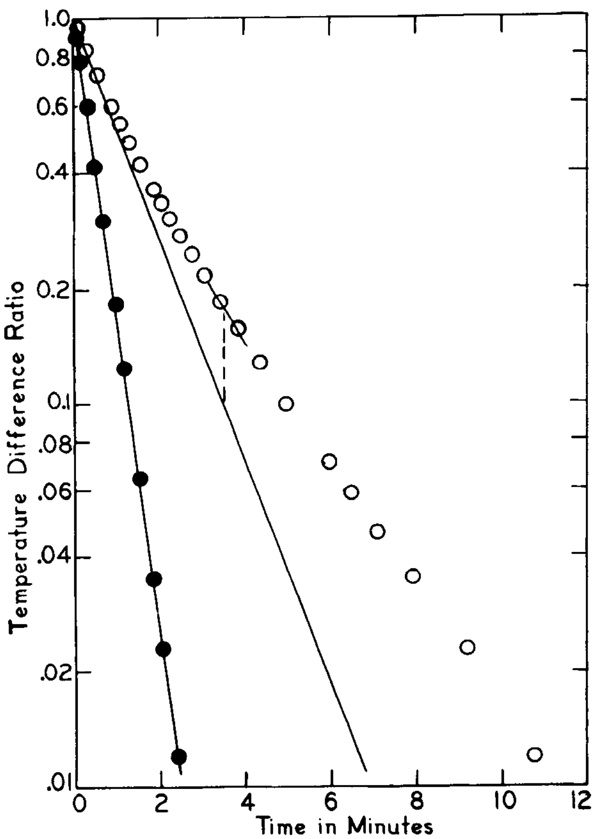

Fig.4. Semi-log plot of the course of cooling of a sphere of water under conditions maximizing the fraction of heat transfer by radiation. Data of Ericsson in 1876 (3).

Finally to ascertain the course of cooling in still air, the mercury thermometer was permitted to cool in the wind tunnel with no air flow through it but with a hole (diameter = 17.5cm) in the top. This arrangement excluded most of the stray currents in the room but permitted the

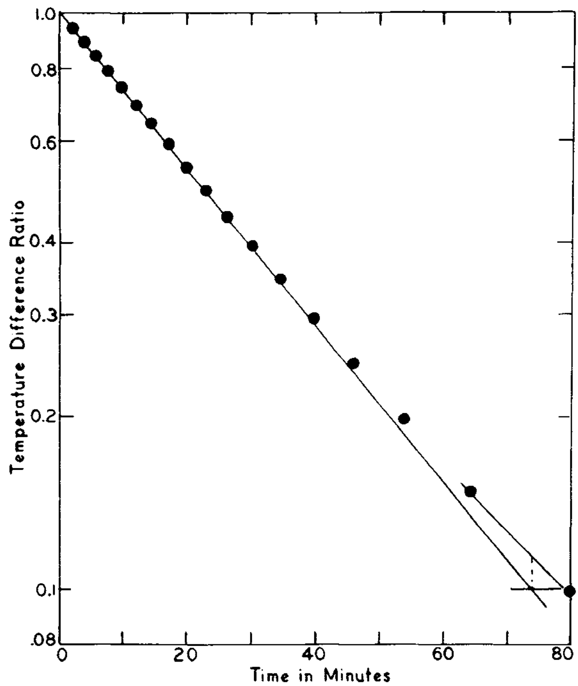

Fig.5. Semi-log plot of the course of cooling of a mercury thermometer with a bulb 4 x 15 mm and a stem with a fine capillary bore. 0 = still air. ● = air moving 5 miles/hr. From 200° toward 29° C.

vertical currents of natural convection. The results are shown in the upper curve of Figure 4. The trend is obviously non-linear; i.e. , cooling did not proceed geometrically as it did for the same thermometer in a wind (lower curve Fig. 4). The linear extrapolation crosses the 0.1 ordinate at 3.5 minutes. At this time the measured ratio is 0.177; i.e., the measured temperature difference at 3.5 minutes was 0.177 x 172° = 30.4° while the linear extrapolation calls for 0.1 x 172° = 17.2°. Thus the deviation of expected from observed was (30.4° - 17.2°)/30.4° x 100 = 43.4%. This is about 3.5 times the deviation from linearity observed by Ericsson with his radiator; therefore the effect of radiation is only a partial explanation. Much more important is the fact that as cooling proceeds in still air and the surface to air temperature difference diminishes, the natural convection generated by this temperature difference diminishes. The heat transfer coefficient therefore progressively diminishes and cooling is retarded more and more.

IV. Discussion. These results with simple devices prove that cooling in air can proceed geometrically over a range of more than 170 C, providing the heat transfer coefficient remains constant as in a steady forced convection. This range of temperature is sufficient for most cooling and warming experiments on organisms. Although mention has been made of Newton's law in the physiological literature (7), it has as yet not been systematically developed and exploited. The limitation however is not one of range of temperature.

The view that Newton's law holds only for a small range of temperature antedates the Stefan-Boltzmann law by at least a century. According to Dulong and Petit (2), Erxleben reported in 1777 that cooling deviates more from Newton's law the greater the temperature range for cooling. Without going into details it is sufficient to say that most if not all of the experiments reported after Newton were performed under still air conditions. Newton had however specified the use of a constant current of air. He placed his cooling object "non in aere tranquillo sed in vento uniformiter spirante" so that equal amounts of air warmed in equal times by the heat from the cooling object (a block of iron for Newton) would be uniformly replaced by cold air and would carry away amounts of heat proportional to the temperature of the cooling object.

In the analysis of cooling data therefore it is legitimate to start with the expectation that the temperature changes have followed Newton's law, i.e., that on a semi-log plot the trend will be linear. Non-linearity will be an indication that "extraneous" factors interfered during cooling.

Two such factors with Newton's thermometer were the difference in the surface-area/volume ratio for the stem and bulb and the presence of convection currents between stem and bulb. These two factors could be eliminated by remaking the thermometer so that it was geometrically uniform and by impeding the convection currents, i.e., by using a tube without a bulb and by inserting a sponge.

A third factor observed with the mercury thermometer was the progressive diminution in the heat transfer coefficient in still air. Under this condition the cooling constant cannot be constant. It is therefore advantageous to perform experiments in moving air, if only a slight draft, to maintain the heat transfer coefficient constant.

The reason that Newton's thermometer can serve as a model is that there are biological structures which are geometrically similar to the stem and bulb of Newton's thermometer, e.g., the finger and hand of man, tail and body of rat, proboscis and head of the elephant, etc. Further the transport of heat by the blood stream is similar to the transport by the convection currents of the oil. Therefore cooling of the hand may possibly be non-Newtonian even as cooling of Newton's thermometer is non-Newtonian. If hand cooling should prove to be Newtonian, then it would be worthwhile to look for the factor which minimized the effect of the fingers on the cooling of the hand.

V. Conclusions

1. Cooling proceeds geometrically from at least 200° C down to

room temperature, i.e., according to Newton's law, if the cooling object is geometrically uniform, the internal conductivity remains constant, and the heat transfer coefficient remains constant. These conditions obtain with a mercury thermometer cooling in a constant stream of air.

2. In the analysis of body temperature changes, it is in order to start with the assumption that Newton's law holds for the conditions of the experiment. To see if the data comply, they should be plotted on a semi-log grid. If the trend deviates from linearity, then the "interfering" factors should be sought for. In the case of Newton's thermometer two factors were found: the greater surface-area/volume ratio of the stem versus the bulb, and the convection currents between stem and bulb. Comparable factors may obtain in an organism as between finger and hand.

3. To insure that the heat transfer coefficient remains constant during an experiment, it is best to proceed even as Newton did, i.e., to permit cooling to occur in a constant stream of air instead of in still air.

VI. Acknowledgements. Mr. I. Kaye, Librarian, and Mr. L. P. Townsend, Archivist, of the Royal Society rendered assistance. Erich A. Pfeiffer, Ph.D., Southern Research Support Center, VA Hospital, Little Rock, Arkansas, suggested the use of a foam plug to impede convection currents.

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SIXTH INTERNATIONAL TISSUE RESEARCH CONFERENCE

The Sixth International Tissue Conference entitled "Blood Cells as a Tissue" will be held at the Lankenau Hospital, Philadelphia, Pa. on October 30-31, 1969. The following topics will be discussed: Regulatory Mechanisms, Metabolism and Function of Normal and Abnormal Cells, and Recent Developments in Therapy. For further information please contact William L. Holmes, Ph.D., Division of Research, Lankenau Hospital, Lancaster and City Line Avenues, Philadelphia, Pa. 19151.

A FLOATING LABORATORY FOR PHYSIOLOGICAL AND BIOCHEMICAL RESEARCH - THE R/V ALPHA HELIX

HERMANN RAHN

Scene 1966: The Great Barrier Reef of Australia

Ten scientists, in shirt sleeves, sitting around the breakfast table discussing yesterday's observations and last night's experiments. Before starting the day's work they step out on the fan tail of the Alpha Helix, which is covered with aquaria and cages of animals and specimens brought in during yesterday's collection. Then back into the air conditioned lab for their experimental and analytical work. The morning activity is interrupted briefly by lunch, and the lab work or animal collection continues until the evening meal, followed by a seminar and further work in the lab.

A similar scene is repeated in 1967 - 1200 miles up the Amazon, and in 1968, in the ice pack of the Bering Sea and the Gulf of Alaska.

In this relative comfort, isolation, and exotic environment ten scientists at a time can obtain a productive six-to twelve-week period of experimental work on organisms not easily available otherwise, as well as the stimulating company of their colleagues, all specialists in their own areas. To date more than 120 scientists in all have participated in these unusual ventures.

The "Alpha Helix" is a modern, ocean-going, research vessel, with laboratories which provide both standard and specialized equipment. The ship is so constructed and equipped that it is possible to place a biological research laboratory in any part of the world. Through the aid of this vessel physiologists and biochemists can carry on research programs, with both sophisticated laboratories and other logistic support, in geographical areas where many investigations would otherwise be impossible.

The idea for this ship and its design originated with Dr. P. F. Scholander of Scripps Institution of Oceanography, and at his suggestion it is designated as a National Facility, for use of scientists from this country and abroad. It was built with financial support from the National Science Foundation and is managed by Scripps Institution of Oceanography.

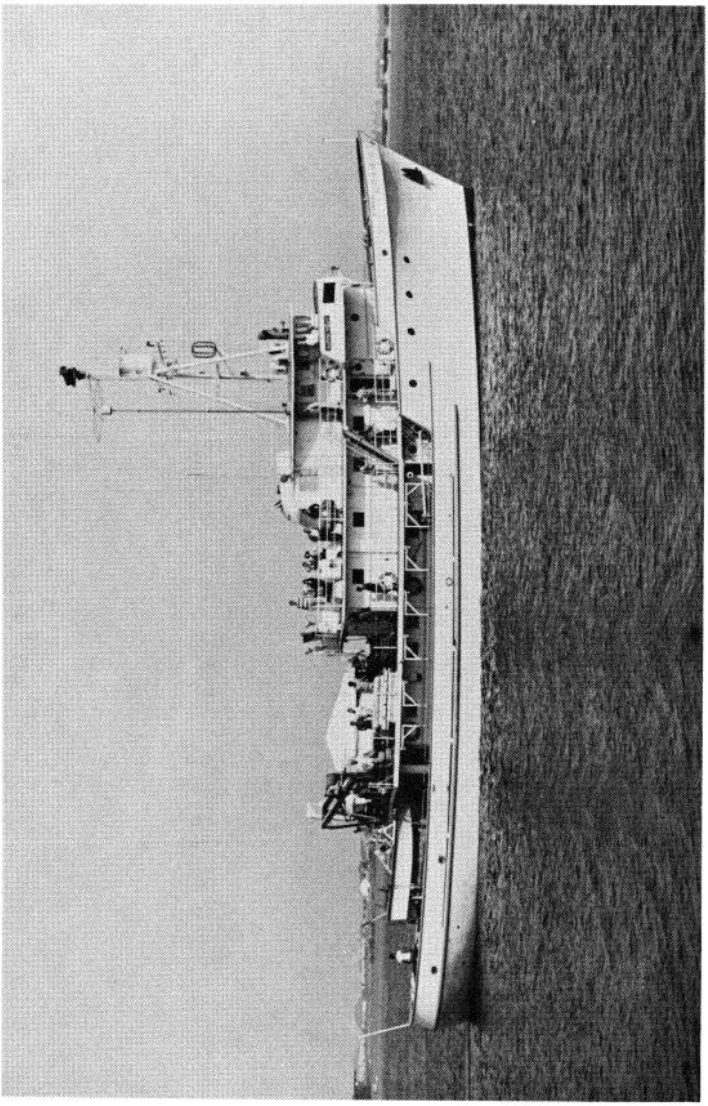
The Alpha Helix is 133 feet long. Its hull is strengthened for use in Arctic ice, and it is air conditioned for use in the tropics, an advantage which will be appreciated by many a laboratory worker who has struggled with problems of high temperatures and humidity. It has modern navigation and communication equipment, and in addition to the well equipped laboratories, it carries a limited amount of collecting gear, a jeep, and prefabricated shore laboratories which can be set up and used to increase the research capacity of the ship. It also carries a number of small work boats and a 24-foot cabin cruiser for more extended side trips. The design provides a large, fully equipped laboratory on the main deck (about 25 x 25 feet) and a smaller "wet" laboratory, particularly well suited for experiments on live material. This latter area can be chilled below the temperature maintained by the air-conditioning of the ship. Below deck is a special machine shop, a walk-in freezer, a "dark" laboratory suitable for electrophysiological or optical work, and an adjacent photographic dark room.

Ten scientists can be accommodated on board, and the prefabricated housing can be set up on shore to increase both laboratory space and the number of researchers who can work with the ship. The ship is manned by a crew of twelve, who assist in the over-all objectives of the mission.

Expeditions to date have been to the Great Barrier Reef of Australia in 1966, in 1967 to the Amazon River in Brazil and the Galapagos Islands, and to the Bering Sea and the Gulf of Alaska in 1968. On each expedition there have been several consecutive scientific programs, each lasting six to twelve weeks, with a Chief Scientist responsible for the over-all coordination of each program. These programs have been on a variety of problems relating to the physiology and biochemistry of aquatic and terrestrial organisms, both plant and animal. One group of scientists replaces the preceding group on a predetermined date so that there is no overlap nor any loss of time in use of the facility. The Scripps Institution, through a grant funded by the National Science Foundation, provides subsistence and usually supports travel expense to and from the ship. Necessary specialized equipment not already available on board is provided by the individual scientist, but expenses for general supplies, collection of animals, and other essential purchases are supported by the expedition.

Use of the Alpha Helix is determined by the Director of Scripps Institution of Oceanography on the recommendation of a National Advisory Board. This Board reviews proposals from scientists who propose studies which require use of a modern laboratory vessel, and its recommendations are greatly influenced by desired geographical area, scientific merit, feasibility of operation, and suitability for such purposes.

In 1969 the Alpha Helix will be stationed in New Guinea, and the Board is now ready to review proposals for the 1970 expedition. Any scientist who wishes to use this particular laboratory facility may submit a proposal. Inquiries and proposals should be addressed to the Director of Scripps Institution of Oceanography, University of California, La Jolla, California 92037.



THE R/V ALPHA HELIX

THIRD INTERNATIONAL BIOPHYSICS CONGRESS

The Third International Biophysics Congress of the International Union for Pure and Applied Biophysics will be held August 29 through September 3, 1969 at the Massachusetts Institute of Technology, Cambridge, Mass. The scientific program will include sessions of contributed papers, general symposia on Natural History of Macromolecules, Protein Structure and Function, Artificial Internal Organs and Physiological Support Devices, Assembly of Large Structures, and the Molecular Basis of the Memory Trace.

Detailed information can be obtained from Prof. Walter A. Rosenblith, Room 20B-221, M.I.T., Cambridge, Mass. 02139.

II INTERNATIONAL SYMPOSIUM ON GASTROINTESTINAL MOTILITY

The Second International Symposium on Gastrointestinal Motility will take place in Rome, September 10-14, 1969. The programme will include a limited number of reports followed by discussion and a Round Table. A maximum of 60 participants will be invited and the English language will be used throughout. For further information please contact Dr. Doc. Aldo Torsoli, c/o 2a Clinica Medica dell' Universita, Viale del Policlinico, 00100 Rome.

PHYSIOLOGY THROUGH THE VIEW-FINDER

A review of the status and future of teaching films and television

L. M. N. BACH

What teaching physiologist has not recently been confronted with the specter of television cameras looming before his most prized laboratory demonstrations? From all indications, few physiologists will escape being persuaded, encouraged, enthused, distracted or otherwise alerted to the excitement and frustration of teaching by television (21). The whole issue seems to be a mixed blessing at best but almost impossible to dodge. With the inevitable approach of one more pervasive fact of academic life, the old questionnaire machine was cranked up, the findings and relevant literature examined, a committee created and a report duly rendered.

Under the auspices of the Education Committee of the APS, an ad hoc Subcommittee on Teaching Films and Television was appointed consisting of G. D. Davis (LSU), J. E. Markee (Duke), N. C. Staub (UC-SF) and L. M. N. Bach (Tulane), Chairman. A questionnaire was distributed during the spring of 1968, soliciting the experiences and opinions of teaching films and television from 90 physiology departments. Of the 63% responding (57 returns), 77% (44) used teaching films, 52% (30) employed live TV and 37% (21) utilized TV tapes in their teaching; 18% (10) did not indicate use of any of these media. (For the usual reason that many respondents used more than one medium, the total exceeds 100%.) The following report is composed of questionnaire findings, citations from the expanding literature, and deliberations of committee members admixed with hopeful appropriateness. Institutional sources are freely cited to promote exchanges among physiologists who wish to gain by another's experiences.

INSTITUTIONAL UTILIZATION

A recent comprehensive survey of TV use (18, 19) reveals that acceptance is accelerating and appears to be determined more by desirability than expense; approximately 2/3 of tax-supported and 1/3 of private medical schools are using TV for teaching. However, the rush to TV in medical school teaching may be more apparent than real (18). While over half of the medical schools in this country have introduced television teaching in the past ten years, only 10% of all medical school departments employ the technic for teaching purposes and 20% of these express some uncertainty about its feasibility. TV teaching in medical schools is far from the saturation point. The Council on Medical Television has statistics on medical schools which have now given up the use of TV (25). While it is probably too early to say that TV has "caught fire" in the medical school setting, it appears that TV may fare better than teaching films which never reached the saturation level (18). One suppressant of TV use, in the committee's view, is the necessary centralization of production facilities. Frequently this is just inconvenient enough to depress more extensive utilization.

Responding institutions vary widely in the number and variety of films, live and taped TV utilized for physiological teaching; their number and distribution are given in the following tabulation: 32-Tennessee; 17-Oregon; 13-Michigan State; 7-Tulane; 6 each - MCV, Stritch; 5 each-Georgia, Hahneman, Illinois, Jefferson, LSU, New York Medical; 4 each-Albany, Einstein, Louisville, Nebraska, Pittsburgh, St. Louis; 3-North Carolina; 2 each-Colorado, Indiana, Kentucky, Marquette, Mayo, Mississippi, New Jersey, New Mexico, Oklahoma, Rochester, Upstate-Buffalo, Utah; 1 each-UCI, Chicago, Medical, Columbia, Cornell, Creighton, Dartmouth, Florida, Southern California, Vanderbilt, West Virginia. These data have no special meaning but are provided for readers who wish to compare institutions.

USE OF VARIOUS MEDIA AND PROXIMATE PURPOSES SERVED

As the non-casual reader will find (vide infra), the great preponderance of film users is almost completely masked by the great interest expressed in the use of television by many respondents. In this epoch of accountability, we must answer "for what purpose?" What purpose is better served by TV and film than by any other traditional teaching technic? The data in Table I illuminate the issue a bit. Among the 46 respondents who use film or TV, purposes served are distributed as follows:

TABLE I

PURPOSE	FILM	TV TAPE	TV LIVE
Lecture substitute	5% (2)	5% (2)	2% (1)
Lecture supplement	71% (33)	19% (9)	15% (7)
Laboratory substitute	9% (4)	13% (6)	13% (6)
Laboratory supplement	56% (26)	26% (12)	32% (15)
Demonstration substitute	13% (6)	28% (13)	22% (10)
Demonstration supplement	24% (11)	24% (11)	37% (17)

The most popular purpose served by any medium is the supplementation of, rather than substitution for, lecture, laboratory or demonstration work; TV (both live and taped) ranks high as a substitute for live demonstrations, however. There is no immediate explanation for this. Perhaps traditional techniques give a feeling of reliance to most teachers but, with so much uncertainty in the world today, even the old reliables may not capture the audience as completely as we fondly hope. Redoubtably, no physiologist is about to abandon totally the chariot that brought us this far, since the least popular ambition is substitution for lectures by film or TV. However, several committee members felt rather firmly that TV or films, produced and employed effectively, could eventually substitute completely for laboratory and demonstration exercises.

Since the obligation of a medical school is to transmit information concerning new knowledge and skills to students struggling with the information explosion, TV must be considered as an important vehicle (22) and may well be the turning point in medical education in this country

(19). However, TV offers no obvious advantage in simple transmission of information; on the contrary, warmed-over lecture material becomes lethal on the TV screen (8). There is no reason to doubt that TV can teach as many skills and facts as any other educational method (5); in fact, it is reported that one effect of TV has been a shift of emphasis from obtaining results to understanding and interpreting them (19).

The most common reasons for installing TV in medical schools appear to be facilitation of laboratory teaching, improvement of observation and discussion (19), image multiplication for several observing groups and optimization of viewing of technical procedures (18). A teaching tool with so many advantages cannot be ignored and the variety of ingenious adaptations which its use has generated attests to its vigor.

DEMONSTRATIONS AND TECHNICAL PROCEDURES

One department finds that demonstrations with live and taped TV (for replay) and two-way audio permit very efficient teaching (New Jersey). Committee members point out that the use of two-way audio is a must; with tape, it is possible to interrupt and respond to questions. In any event, the demonstration must be good in its own right before using TV at all (e.g., dissections must show up clearly and completely). Users must not only know how to work TV but must also be excellent demonstrators. Another school (Colorado) claims success with TV and two-way audio and would now like to try color as well. However committee members feel that color TV is not sufficiently good at this time to warrant the expense; color film is much superior to anything TV can do currently.

Large classes enjoy demonstrations not previously possible provided free communication is incorporated and the presentation is moving, active and informative; some of the best of these have been preserved on tape (LSU). Although taping TV is more time consuming than repeat demonstrations to small groups, the end-product is more uniform and permits better view of procedures (George Washington).

Many basic science teachers employing TV demonstrations arrange to have the students, instructor and demonstration all together in the same room since removal of one element to a separate location is too distracting (18); an arrangement of this sort has been found to maximize student time in observation of technics too complex for effective student use (12). The majority of schools employing two-way audio with TV find this arrangement excellent for student exchange with instructors during demonstrations (15).

It is worth noting that TV tape is also excellent for patient demonstrations in correlation clinics. By "preserving" the patient examination on tape, problems of patient accessibility are resolved.

Another school (Marquette) finds that both short films and TV tapes are very useful adjuncts for teaching physiology, especially as a supplement for presentation of laboratory data and particularly as an aid in briefing students about laboratory technics. Informal TV tapes stressing scientific information (rather than high-power commercial productions) are useful for demonstrating technically difficult laboratory exercises, in their opinion. Students are brought closer to demonstrations by live TV (Minnesota) and the technic provides students with an instructor's "eye-view" of materials and technics (Chicago Medical). CC-TV (closed circuit television) is routinely used to improve effectiveness of demonstrations (Michigan). The committee generally viewed TV as highly useful also for large classes where complex instrumentation was involved.

TV is especially useful for demonstration of technical procedures in the opinion of the committee although the use of 8 mm film cartridges (vida infra) may be more desirable. Upstate-Buffalo reports that they are turning more often to TV demonstrations to meet increased student demands. By this means, the staff is not overtaxed with attention to technical procedures involving large numbers of students. While TV demonstrations are more efficient, the staff should be present at all times to conduct the show, answer questions and guide the discussion. Another school (Utah) comments that TV tape is highly flexible for this purpose especially with the original experimenter as commentator and lecturer. In this case, the great care required for independent film or tape is avoided; without him, amateur TV tape programs are useless. Creighton feels that TV and film, while valuable supplements to experiments and demonstrations cannot ever completely substitute. A series of short demonstration tapes is planned for the near future by Maryland to supplement both lecture and laboratory.

Maryland has already produced one short film on cannulation and arterial catheterization which is in use; a TV tape on nerve conduction is also employed to feed display oscilloscopes. Stritch reports the effective use of FM tape also for replay through student polygraphs. A similar system has long been employed by Baylor.

Two schools report experience with incorporation of physiological data systems in conjunction with audio-visual facilities (18). A compilation of several abstracts dealing with educational TV (19) includes a description of TV use with the physiograph, inclusion of physiological sensors, use with demonstrations of drug effects on heart action and the EKG, studies of peripheral circulation, fluoroscopy and kineradiography for physiological studies, catheterization and technics for cannulation of fine vessels, and (12) physiological tracings, use of pupil rathe than nictitating membrane for drug studies, and effects of anticonvulsant TV has also been employed for linking research activities with teaching, such as studies of REM sleep and with microcirculation research (25).

Many additional examples are indicated in the appendix.

Committee members point out that the use of student TV monitors for instruction in laboratory technics was extensively pioneered by dental schools where close-up views of oral surgical procedures are important and otherwise difficult. Carried to the physiology laboratory, this technic allows everyone to see the same view. Laboratory monitors are especially valuable for "step-see", "step-do" teaching procedures, such as cannulation, electrode placement, etc. Members of the committee also point out that a split-screen arrangement can be used to good advantage with technical and laboratory demonstrations. Tracings can be incorporated with live TV presentations (but cannot be introduced into an existing tape effectively). In this manner, the recordings, the data and the experiment itself (including display of difficult aspects) can be combined for maximum student use.

TITLES AND TOPICS FOR VISUAL PHYSIOLOGY

We counted 103 different films, TV tapes and live TV demonstrations listed by respondents who employed these for teaching. Of these 68 (66%) were films, 23 (22%) were live TV and 11 (12%) were TV tapes.

Few subject areas in physiology have escaped the all-seeing and permanently recording eye. The variety and incidence of topic areas available on film or tape and employed with live TV are displayed in Table II. Some films and tapes have been outstanding and others should never see the dark of the viewing room. Without immediate regard to quality, a complete listing of all films, live and taped TV topics, including producers and users will be found in the appendix. Interested readers may talk with representative users to determine the utility of any of the titles indicated; at least we hope some discussion will be generated in the interests of developing future standards of production and utilization.

TABLE II

TOPIC	FILM	TV TAPE	LIVE TV	TOTAL
Heart	30	1	3	34
Circulation	14	1	2	17
Kidney	10	1	2	13
Respiration	16	1	2	19
Gastrointestinal	11	2	2	15
Endocrine and Reproductive	5	-	1	6
Muscle	3	-	2	5
Receptors	4	-	1	5
Peripheral and central nervous system	15	1	2	18
Special topic or purpose	9	3	7	19
TOTALS	117	10	24	151
Per cent of total	77%	7%	16%	

The conclusion is hard to escape that a writhing, twitching, quivering heart is eminently a visual topic; whether its popularity on film stems from this feature or some more subtle virtue is not clear. The most popular film titles are indicated in Table III.

TABLE III

Title	Producer or Narrator	Percentage of Film Users (N = 43)
1. De Motu Cordis (William Harvey)	Sir Henry Dale	36% (15)
2. Principles of mechanics of respiration	J. Whittenberger	23% (10)
3. Kidney function in health and disease	R. F. Pitts	21% (9)
4. Basic mechanisms in neurophysiology	J. Schadé	18% (8)
5. Bloodflow in batwing	Nicoll and Webb	12% (6)
6. Human gastric function	S. Wolf	12% (6)

All other titles listed were employed by fewer than five respondents.

Why are these films so popular? From experience, users feel that they uniformly show excellent production characteristics, they are carefully planned by teachers for educational purposes, they are organized and narrated by authorities in the field, and, while many are obsolete in certain respects, they represent a level of teaching in specific areas which the usual department may be hard put to equal. Student acceptanc is generally high and several departments have used some of these films for many years with continuing success.

TV AND FILM PRODUCTION BY PHYSIOLOGISTS

Physiology departments have most often been the innovators where TV has been introduced into medical school teaching (18. 19) and 22 physiology departments exceed in number all other medical school disciplines employing this medium (18).

Respondents were asked to list their own film and TV tape productions which were useful in their teaching. These could potentially be made available for others who might be interested and are shown in Table IV.

TABLE IV

TEACHING FILMS AND TAPES PRODUCED BY PHYSIOLOGISTS

Title	Producer	Institution	Date	Film	Tap
1. Turtle heart as a pump	-	Upstate-Buffalo	-	X	X
2. Cardiac dynamics	-	Jefferson	-	X	
**3. Cardiac intracellular recording	T. C. West	Washington-Seattle	-	X	
4. Electrocardiography	-	Michigan State	-		X

TABLE IV (continued)

Title	Producer	Institution	Date	Film	Tape
5. Nervous control of the heart	-	Michigan State			X
*6. Nervous control; arrhythmias	A. S. Harris	LSU	1968		X
*7. Cardiac arrhythmias		New Jersey		X	X
8. Cardiac fibrillation		Jefferson			X
*9. Cardiovascular responses	L. R. Yonce	N. Carolina	1968		X
*10. Arterial pulse	J. Reming-ton	Georgia	1965		X
*11. Capillary circula-tion	J. Stiefel	Mich. State	1965		X
*12. Microcirculation in batwing	L. D'Agrosa	St. Louis	1966		X
13. Artificial respira-tion	A. L. Bennett	Nebraska		X	
*14. Urine secretion in dog	J. Stiefel	Mich. State	1967		X
*15. Pancreatic secre-tion	Loizzi & Ingraham	Illinois	1966		X
*16. Nerve action po-tential	-	New Jersey	1967	X	
17. Action potential	Frazier	Kentucky	1963	X	
*18. Nerve conduction	E. B. Wright	Florida	1966	X	
**19. Muscle contraction under microscope	-	Yeshiva		X	
*20. Decerebrate cat	R. W. Morse	Georgia	1967		X
*21. Decerebrate cat and study of reflexes	L. M. N. Bach	Tulane	1968		X
22. CNS in labora-tory animals	-	Utah			X
*23. I^{131} uptake in dog	Biochem.	LSU	1967		X
24. Reproduction	-	Mich. State			X
**25. Ovulation in the rat	R. Blandau	Washington - Seattle		X	
*26. Partuition in guinea rat	J. Stiefel	Mich. State	1966		X

Films (F) and Tapes (T) depicting animal dissection and surgery have been made by the following: Illinois (F), * Western Reserve (F)** St. Louis (T)*, New Jersey (F-open chest)*, Tulane (T-stereotaxic technic).

Films and tapes depicting various laboratory technics, probably

*department recommends for use by others.
**produced by one department, used by one or more other departments

including surgical procedures, have been made by: New Jersey (F), Colorado (T), Chicago Medical (F), Mississippi (F), George Washington (T), Downstate New York (F), Tufts (F)**, Columbia (F & T), Pittsburgh (F & T), St. Louis (T)*.

Respondents were asked to describe outstanding lectures or demonstrations personally offered or observed which would be worth taping or filming for general distribution. Several respondents indicated topics which are listed accordingly in Table V.

TABLE V

PROPOSED TAPES OR FILMS

Title	Producer	Institution
1. Turtle heart as a pump	C.V. Paganelli	Upstate-Buffalo
2. Nervous control of heart and cardiac arrhythmias	A.S. Harris	LSU
3. Heart and large vessel pressures	H. Rahn	Upstate-Buffalo
4. Open loop gain of different circulatory reflexes	K. Sagawa	Mississippi
5. Venomotor tone	C. Honig	Rochester
6. System analysis of circulatory regulation	A. C. Guyton & T. Coleman	Mississippi
7. Hindlimb blood flow	D.W. Rennie	Upstate-Buffalo
8. Regulation of interstitial fluid volume and pressure	J. Prother & A. C. Guyton	Mississippi
9. Lymphatics	H.S. Mayerson	Tulane
10. Oxygen and metabolic depletion in shock	J.W. Crowell	Mississippi
11. Mechanics of breathing	H. van Liew & L. Farhi	Upstate-Buffalo
12. In vitro and in vivo demonstration of pulmonary function	L.H. Hamilton	Marquette
13. Pancreatic secretion and gall-bladder function	M.H.F. Friedman	Jefferson
14. Demonstration of the electroretinogram	W.J. Stekiel	Marquette
15. Functional properties of visual neurons	G. Poggio	Johns Hopkins
16. Properties of first order neurons	V.B. Mountcastle	Johns Hopkins
17. Study of chronic animals with brain lesions	P. Bard	Johns Hopkins

Most of these are subjects not previously filmed or taped for general distribution. The titles suggest important contemporary teaching areas not ordinarily feasible for laboratory experiments or demonstrations except in those departments where active relevant research is conducted. This indicates the increasing difficulty which physiology departments may have in supplying costly equipment and specially trained faculty for teaching enduring concepts of emerging importance.

While films and tapes produced by others are not always acceptable to an instructor, their availability often represents subject areas not otherwise represented in the department. Films and tapes made by authorities in each field thus provide departments an opportunity to diversify and enhance their teaching functions.

THE FIRST TENTATIVE STEPS

Some schools are just beginning to employ TV tape for teaching purposes (Rochester, Washington University, Michigan). Films have not been used extensively but initial use of CC-TV is working successfully for demonstrations (USC); extensive use of audiovisual technics is planned for the near future (Hawaii). Indiana (Bloomington) is presently studying the possibilities and facilities are now available but more information is needed on the use of tapes; increased use of CC-TV is planned in new teaching quarters (Oregon). Jefferson will have to place more reliance on TV and films of experiments because of increasing economic restrictions upon the use of animals. TV is planned for laboratory teaching in the near future by Vanderbilt.

How Bothersome Is It?

In some schools, a natural reluctance by faculty towards new teaching technics presents some obstacles to extensive use of any new developmental program. This is possibly the most important fact to face in planning effective utilization of TV. The questions and reservations commonly expressed are considered in the following account. While more preparation time is usually required by participating faculty, the time is used more efficiently, there is a reduction in repetitive demonstrations, more sophisticated demonstrations are possible and there is an increase in both quality and quantity of instruction judged by material covered and grades, according to one report (19).

As in any other aspect of teaching, television requires attention to basic human factors in the learning process, including some appropriate dramatic license (3), since the inept lecturer can look sick indeed on TV (5); effective delivery of a simple message is important and the aphorism, "be accurate if you can but, whatever happens, don't let yourself be dull" especially applies to TV teaching. Reliance on factual content alone will not overcome the increased demands of TV which result from constriction of attention characteristic of the medium. An appropriately informal method of approach provides the sense of personal appeal and immediacy which TV can command even on tape. A lecture by itself is the worst kind of presentation for TV unless it is supported by a battery of visual aids and skillful production. Although TV is foreign to our academic upbringing, it is claimed that the personal touch uniquely afforded by the medium can develop an effect comparable to the memory of great teachers (5). No matter how effusive the claims, it is crucial to remember that an entertaining performance by a "star performer" has less to do with better learning by students than hard work inspired by "master teachers" (4); objective criteria to distinguish between these two elements of instruction are badly needed.

Most faculty without previous TV experience are neutral or negative about its advent and, while the innovating department was enthusiastic, the need for additional preparation and thoughtful evaluation of content found many staff members unwilling to try the technic although they were willing to concede its effectiveness (19). Often the practical problems and sheer complexity of TV for routine purposes, as well as inadequacies of staff, equipment or facilities are frustrating even though the medium properly used will live up to expectations (20). Some reservations expressed (8) include its cost, complexity and lack of familiarity and the fact that some faculty members resent being identified as "performers." In this connection, it is important to keep in mind that the selection of material and its presentation by TV is a matter of the instructor's individual taste. He shares with the TV Coordinator (each school and department should have one!) responsibility for a combined decision in these matters. Committee members have considered the development of national workshops or traveling groups to provide training in the use of TV for physiological instruction where local training is not already available.

Many an instructor feels that TV is strictly a visual medium which does not enhance his own ability and, by separating him from students, cuts off the feedback which is so essential. Teachers also miss the rapport with a visible audience which is so stimulating. The audience which passively watches does not participate actively in the learning process, an effect which is partially provided by two-way audio (5). While no objective evidence is available, staff feeling is often that TV is definitely superior to other forms of laboratory teaching (12) and that there is some reduction in staff boredom experienced with repeated demonstrations to small groups (25). Students exhibit greater interest in learning about experimental procedures when they can view it in detail in the same place and time as the demonstration (7). Another report indicates (19) that students were impressed with instructors who used TV well but that no viewing period should exceed 30 minutes; they also enjoy their new-found ability to see what the demonstrator is talking about and to relate theory to practice.

Technical Aspects

Interrelating several aspects of a problem during its exploration, transforming information from one type of read-out to another and storing images for later use or editing (18) are reputed advantages of TV in presenting information otherwise unavailable to students. In addition, compatible media (films, magnetic tape, graphics, pictures and sound) make possible the collection, organization and presentation of a limitless variety and quantity of learning resources (8). Magnification, realism, privacy, versatility, immediacy, personalization and time-conservation are provided by TV (8) which can also permit interspersion of "live" material with lectures. Scenes lacking progressive activity are boring when they last more than 10 seconds and a recapitulation at the end of film or tape helps reinforce major points in the body of the presentation. Rehearsal of key parts of the televised or filmed procedu reduces the time needed for subsequent editing (7).

With Other Visual Aids

Some faculty who lack knowledge of visual communication technics ignore the wide range of visual aids available and use TV indiscriminately (25). Experience shows that standard films and lantern slides in the lecture hall give a much better image than when transmitted via TV monitors. While a well-designed slide can be worth a thousand words, many slides are too cluttered for TV or contain lettering too small to be deciphered by a viewer 20 feet from a monitor. Members of the committee feel that judicious use of slides (graphs, anatomical views, summary statements, etc.) along with TV adds a considerable amount of information; in addition, the visual change of pace is quite helpful.

Film Versus Television

Insofar as specific media are concerned, over two thirds (71%) of the respondents who use film, employ it as a supplement to lectures and over half (56%) as a laboratory supplement; almost 1/3 (32%) use live TV to supplement demonstrations and over 1/4 (28%) utilize TV tapes as substitutes for demonstrations. These practices possibly stem from the semi-classic nature of many films whereas TV tapes are easily edited and readily serve any ad hoc purpose.

Films are regarded rather highly by a number of institutions. Two excellent films are used but TV is limited to new recordings made during demonstrations (Einstein). Secretory films are so good that they replace the laboratory teaching completely whereas our TV demonstrations are not considered outstanding (MCV). Although available TV equipment is not used, teaching films represent uniquely scholarly contributions (Pittsburgh). Although there are very few suitable films for medical students, CC-TV has also been a great source of disappointment (New York Medical). Films are of much better quality than TV (MIssissippi) and TV tape should be used only for special occasions since it requires as much work as film and offers much less quality (Tennessee). Films made on circulation, including those made locally, are extremely helpful (Virginia, Western Reserve). Topical films are employed as optional adjuncts for teaching and are well-received both by undergraduate and graduate classes (West Virginia). Well selected films used appropriately offer excellent reinforcement (Stritch). A big advantage of film is that they can be rerun by students (New Mexico). However, films are usually too obsolete for effective use (Maryland) and the dearth of good teaching films bespeaks the need for excellent up-to-date presentations (Dartmouth).

Committee members agree that few contemporary films suitable for teaching are available. Some members expressed the view that film production today can be of such high quality that it potentially exceeds TV in every teaching respect. One view was that, if all the money which has been spent on TV could have been invested in good film production facilities, including color, acceptance would be almost universal.

Since we now live in a "TV culture" (George Washington), TV is perforce equally popular and pervasive in educational systems. While it is true that film can be shown on larger scale and in color, it can only be shown effectively in the dark.

Film is never remade because of the cost factor and is difficult to edit. Television, on the other hand, needs no developing, is ready for immediate use, can be shown in bright light, can be shown live, can be immediately replayed and can be edited with ease.

Small Film Cartridges

There has been much emphasis recently upon the use of 8 mm continuous loop projection systems which provide smaller format instructional films (14, 15). These systems are frequently incorporated with programmed self-instructional material. Electrophysiological tracings, for example, can be taken from the original tape recording and filmed under conditions which are more suitable for instructional purposes. It is predicted that this type of material will make available single concept films for a mass teaching market.

The use of 8 mm film cartridges are viewed as highly promising (George Washington) and "super" 8 mm continuous loop cartridges are employed for instruction in laboratory procedures (Michigan State). Committee members felt that individualized 8 mm film cartridges were often superior to TV monitors for laboratory instruction because they conserve time and can be shown in color.

REUSE OF TAPES AND TAPE LIBRARIES

Several physiology departments engage in production of videotapes to record and store demonstrations for future use (19). One school has described such a tape collection for teaching, including material representing about 10 hours of lecture-demonstrations for physiological instruction of graduate and medical students. This school also encourages development of fifty-minute lecture tapes for use in the lecturer's absence and for rehearsal by junior instructors (1). Committee members also felt that TV tapes can be used to ease personal fears experienced by novice TV instructors who may be anxious about seeing themselves. The use of tapes permits self-examination, improvement and "polishing" performances for future occasions.

All neurophysiology lectures were taped for TV and then used by instructors to monitor teaching ability and by students for review (Georgia). Some committee members urged incorporation of student protocols with tape review conferences for best results.

Others oppose taping demonstrations because these suffer comparison with and share limitations of well-made films; in these cases the absence of two-way audio with videotape eliminates spontaneity and student interaction (19).

Separate Institutions and Interchanges

Live TV with two-way audio and TV (23) gives classroom quality instruction between physically separate institutions (Mayo and Minnesota). Interchangeable tapes for schools employing different TV systems would help considerably in exploiting existing tape libraries (St. Louis). A few intrasystem loan-outs of tape exist (UC-SF) and of course there are increasing numbers of tape libraries. The committee believes prompt and serious consideration should be given to a National Tape Library which would maintain a widely distributed access directory. Small schools would certainly profit by having a national distribution system in effect. Tapes and films are probably too expensive to copy or to distribute widely at the present time. The greatest deterrent to copying tape is the wide lack of compatibility in instrumentation, different sizes and various qualities of tape employed. It is possible to make a low quality tape copy from high quality tape (which procedure is all most installations can afford) but the reverse is not possible. One additional difficulty unique to TV tape is that real time is required for copying; the process cannot be speeded up as can audio or film copying. In any event, it is important to remember that the use of another's tape is (or should be) a highly personal decision for each instructor!

Production and Dissemination

Many drug houses are going into the business of producing TV tapes for medical education. Among these, Roche will make tapes to order for any particular TV presentation. Ampex offers a course on TV tape production and SKF provides a two-day course on lecturing and audio-visual aids, including TV.

As better tapes are developed and standards improve, it is certain that some national distribution facilities will appear, in the opinion of the committee. In anticipation of this development, committee members feel strongly that some sort of national clearing house, catalogue and access directory must be organized. Information must be made available concerning tape titles, types of tapes available, who produces tapes, and what tapes are available for loan-outs from various institutions. It is generally agreed that most available material is not suitable for distribution since it is made for highly local purposes and is often unedited.

A forum for the exchange of ideas and technics in TV production and educational standards is provided by the Association of Medical Television Broadcasters, comprising all medical schools either producing or utilizing TV (5); this Association also acts as a central repository for a growing library of taped programs. Interested readers are referred to "Educom", a publication issued by the Interuniversity Communications Council in which advances and new applications of all forms of communication media for educational purposes are described and discussed (11).

National Lectures and Networks

One advantage of TV tapes or network broadcasts is the presentation of new material in one lecture by superior teachers to a number of schools. This can mitigate the extensive travel otherwise required (8). In the opinion of the committee, national lecturers might be suitable for graduate teaching but probably not for medical student teaching since levels vary so widely. However it would be possible to arrange common national or regional hours on state, regional or national networks among schools. Of course national lectures could be taped and scheduled for distribution among interested schools; a national center would be essential for this since the maintenance of production standards and copying facilities would be too expensive for individual institutions to maintain.

APPROACHES TO COMPLETE AUTOMATION

A complete institutional facility available for medical student instruction is comprehended in a real-time computer assisted instruction and data analysis system at one medical school (UCI-CCM). Here a CC-TV system permits dialing by the student in response to questions, data entries and control information presented by the computer system. UCI and MCV each employ replay rooms for film, slides and TV; this lends itself easily to dial access to tape banks for selective playback to students. Automated TV and films are projected for future use also by Michigan. Cinematic self-instruction has also been described in programmed learning where a dynamic audiovisual element is combined with a static visual component (26). The incorporation of 8 mm loop film in self-instructional programs does not allow the student to proceed at his own rate, however, unless the film is repeatable for slow learners. Filming of various laboratory demonstrations, including drug actions on adrenergic and cholinergic systems and drug effects on the perfused heart have been incorporated as 8 mm loop systems with programmed instructional material. Such a technic enhances active student participation in the learning situation and provides suitable preparation for National Board Examinations which are now beginning to include cinematic material. Systematic use of immediate feedback in physiological instruction which includes the use of slides, TV of student panels, and laboratory demonstrations paralleling the lecture period and two-way audio is said to enhance the student's appreciation of the exerpimental approach to physiology (6). Audio-tutoring has been described in which 8 mm film loops, TV, laboratory work, programmed self-instruction, discussion groups and lectures are carefully developed and integrated (9, 17); the program emphasizes student learning rather than implementation of classical teaching procedures. Some committee members did not favor the use of programmed teaching with or without TV unless and until its efficacy was better proven.

A national clearing-house for programmed instruction is maintained at the University of Rochester.

LIMITATIONS, LASSITUDES AND LOST EXPERIENCES

Films and CC-TV have been little used since loss of protagonist (University of Chicago). Early experiences with TV resulted in loss of attention of class; perhaps we need to re-evaluate their use (Arkansas

Use of TV for close-ups of procedures and transmission of research material to classes have been tried with indifferent success; taken with the difficulties of TV production, no further use is planned (Stanford). TV is regularly used for amplification and demonstration and for lecture overflow; films and tapes are occasionally used but student reaction is poor and our conclusion is that personal contacts are better (Downstate-New York).

Use of TV in place of live laboratory preparations have been failures and films and TV have almost completely been dropped since students appear to learn much more effectively from standard teaching procedures (Woman's). Films and TV are inferior in value to good lectures, demonstrations and laboratories; however, increased class sizes are forcing reliance on these technics (North Carolina). At one school a large series of films was dropped some years ago because students did not find them helpful and staff refused to attend for post-film discussions.

STANDARDS AND EVALUATION

Some basic academic issues about TV have been discussed (4) in connection with needs for objective evaluation of its effect on educational standards, the most important question being: how can teaching films or television contribute to learning at peak capacity by students? There is a clear need for definition of educational objectives for various types of instructional techniques available and the audiences for which they are intended (7).

TV tapes can be quite successful if used thoughtfully in context of teaching aims and procedures (Tulane). As a general rule, we feel that "canned" materials should replace live demonstrations or exercises only where problems of time or the availability of instruments and skills make this mandatory. Production of good tapes or films is very costly; their content should be material which cannot be presented live. Live presentations afford the opportunity for sensorimotor experiences which are lost completely in "canned" materials (Oregon).

Committee members felt that TV should be used only when better than any other teaching alternative. In using TV, consideration must be given to its impact upon scheduling and the curriculum. The most fundamental point, of course, is that the instructor must decide what he wishes the student to learn, how this aim can best be satisfied through TV, if at all, and how TV can then be used effectively in satisfaction of this aim.

Televised or filmed presentations are most effective when they can be incorporated in other teaching exercises, especially when these require student participation (7).

Members of the committee point out that there is some tendency to carry over habits of misuse of film to TV. TV is often misused as a passive instrument and fails to command attention of students. Effective use of TV demands active student participation, such as combining with use of student protocols and testing procedures (2, 16). Perhaps the greatest pedagogical abuse of both film and TV is their use as gap-fillers in the schedule.

Lacking any directory adequate for the intelligent production or selection of teaching materials, we are faced with more filmed and taped material than there are appropriate audiences and occasions. A procedure for student-faculty evaluation of visual teaching materials has recently been described (10) which, leaving much to be desired, still provides the basis for a system of obtaining and distributing useful reviews which would permit a wider and more effective use of available instructional material. Use of such a technique would also help to satis fy faculty concern about student opinion of teaching.

In the very near future, maximum effectiveness of teaching films and TV will require some kind of review mechanism by panels of experts. By this means, standards of student acceptability, scientific validity, teaching effectiveness and production quality can be developed and maintained. Making known the results of such reviewing panels, perhaps through quarterly reports in The Physiologist, could provide continuous elevation of standards and maximal effectiveness of distribu tion.

In many instances (7), TV has supported teaching goals but, just as often, teaching goals are invented to capitalize upon the availability of TV equipment. The technique must not be used, if it is not used well and cannot be employed to warp the choice of instructional material in favor of that which can be well televised (6). Television is not a "gadge which can be ignored nor is it a panacea which answers every audiovisu problem (25). Certainly TV is well used when it enriches contacts between students and teachers but not when it is intended to replace teach Most of the enthusiasm for teaching films and television appears to be generated by producers rather than users of this type of material and often lacks the critical objective evaluation required for effective educa tional purposes (7).

As pointed out above, the individual teacher must decide on the effectiveness of his teaching procedures. TV and film must be an integral part of his teaching program. He must be convinced that students can learn certain aspects of his discipline as well or better through TV and film as from lectures, laboratory, demonstrations and reading. Teachers should not lose sight of the fact that their own personal effectiveness as teachers can be improved by self-examination of tapes and films which they produce.

Examinations are an important aspect of teaching and represent a means of certifying acceptable levels of understanding. The National Board of Medical Examiners, whose products pervasively influence medical student education in physiology, now incorporate film and TV in their examining technics. This has its value primarily for testing imagery recognition, such as EKG, EEG, circulation patterns, etc. This technic can be successfully employed to inquire about the meaning of visual displays of functional patterns but the use of TV beyond this approach is probably highly limited.

Several studies have provided comparisons of one sort and another between classical physiological laboratory or demonstration teaching and televised demonstrations. In one instance (22), class performance times were compared in adrenalectomy and decerebration experiments between groups which were instructed by television demonstrations and those instructed verbally or by mimeographed directions; no significant differences in performance times were revealed. In another study, groups of students were graded on their understanding of principles related to drug actions upon the nictitating membrane following direct observation or televised observation of the demonstration. No significant differences in student performance were found and the conclusion drawn was that while TV neither detracts from teaching nor improves learning, it can nevertheless improve instructional efficiency (13). A third study (24) dealt with a comprehensive evaluation of learning about respiratory regulation, with special attention to factors of verbal and visual information and reasoning ability, in which one each of three student groups read assigned literature or performed the laboratory experiment or observed a televised demonstration. There were no significant differences among the latter two groups which suggests that the laboratory experiment does not provide superior improvement of science reasoning ability over a television demonstration. In essence, these three studies suggest that televised laboratory demonstrations are neither inferior nor superior to any other method of laboratory instruction in physiology but that they can ease the time and effort which teachers must devote to laboratory teaching.

Evaluation of existing and future teaching films and tapes is badly needed relative to their potentials for specific teaching objectives. Proposals to develop appropriate published reviews have been advanced but not implemented (7). Advice concerning planning of teaching films has been provided (15), and the need for a specific audience and clearly defined objectives reiterated. A need for clear concepts of points to be presented in teaching films and their concise relationships to one another is also emphasized.

FUTURE PLANS

The committee feels that it would be useful to develop programs which will enhance the utility and versatility of television. It should be possible to use available CC-TV at Federation and fall APS meetings to show selected tapes representing different teaching technics and topic areas and to demonstrate multiple imagery. In addition, it may be possible to actually tape a live program utilizing commercial equipment on exhibition. One camera could be placed in the audience to reveal the "student's eye-view". A panel of experts might be utilized to discuss the advantages and limitations of the proceedings. In a full-scale demonstration, APS members could be invited to try out as producers and performers. The needs for departmental TV coordinators could also be more fully exemplified by demonstrating needs for advice and consultation in selection of slides, TV and film and in the distinctive functions of performers and directors.

SUMMARY

1. Most physiology departments use films and TV for teaching.
2. Television acceptance is high and growing slowly among teaching departments.
3. Films and TV are used for supplementation rather than substitution. Film is most often used to supplement lectures.
4. Demonstrations are frequently substituted for by TV tapes.
5. To be effective televised demonstrations must be excellent in themselves and must be accompanied by two-way audio.
6. Most schools appear pleased with televised demonstrations.
7. TV tape is excellent for showing technics and patient examinations.
8. Split-screen technics are recommended for laboratory reviews.
9. The heart is the most popular subject for films and tapes.
10. Six classic films continue to be highly popular with many departments.
11. A large number of tapes and films have recently been produced and recommended by physiology departments.
12. New topics suitable for general distribution have been suggested by several departments.
13. Many schools are just starting to use TV tape and live presentations.
14. A full understanding of the teaching purpose of television is essential to successful development of this technic for teaching.
15. Attention to technical aspects is important in successful production.
16. Visual aids should be used more fully with television.
17. Films and TV each have particular advantages. The user must choose between the two media depending on the purpose to be served and the circumstances.
18. Many teaching films are highly regarded by several departments.
19. Small 8 mm cartridges are excellent for laboratory technic instruction.
20. TV tapes are beginning to accumulate in libraries. These are most useful for self-assessment by the instructor. Many are unsuitable for general distribution because of their highly local nature and the need for extensive editing.
21. A national tape library must be established soon and should provide a widely distributed directory and extensive copying services.
22. Commercial outlets are being developed by several drug companies to provide tapes for medical education.
23. National lectures and networks may be feasible some day but could be administered only through a national center.
24. Complete automation of teaching is being approached in some schools (UCI, MCV, Purdue, e.g.).
25. There are many cases of failure to develop successful use of films and TV. In many instances, a reevaluation of the purposes and means of utilization of these media would be helpful.
26. Standards and evaluations are badly needed with respect to teaching and learning goals to be achieved with films and TV.
27. The employment of films and TV is a highly individual decision to be made by each instructor.
28. Review panels are needed for the development of standards for student acceptability, scientific validity, teaching appropriateness and production quality.
29. TV can be used effectively as a method of examining students in special circumstances.

30. Demonstrations and workshops developed through the APS and operating in connection with Federation and fall meetings would be desirable.

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SOME FILM CATALOGUES

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APPENDIX

List of films, TV tapes and live TV presentations employed for teaching physiology. Names of users and producers are included. Items starred (*) have been reviewed in J. Med. Education 40: 51-54, 1965. (Catalogue reference 6).

Title	Film	Tape	Live	Producer or Distributor	Users
Heart					
1. DeMotu Cordis: Wm. Harvey & discovery of circulation	X			Burroughs Welcome; AMA #160 (Sir Henry Dale)	Florida Indiana (B) LSU N.Y. Med. N.C. Oklahoma Oregon Pittsburgh Rochester St. Louis S. Calif.

Title	Film	Tape	Live	Producer or Distributor	Users
					Stritch Tulane Upstate-Buffalo Vanderbilt
2. Normal beat mechanisms	X			AMA	Oregon
3. Electrocardiography			X	Mich. State	Mich. State
4. Intracellular recording in mammalian heart	X			(T. C. West) Wash. (Seattle)	Marquette Creighton
5. Disorders of heartbeat	X			Wyeth: AHA	Albany LSU Tennessee
6. Cardiac arrhythmias	X			Ideal	Tennessee
7. Cardiac fibrillation and defibrillation			X	Jefferson	Jefferson
8. Cardiac arrest	X			AMA	Tennessee
9. Cardiac resuscitation	X			AMA	Oregon
10. External cardiac massage	X			SKF	LSU Tennessee
11. Turtle heart as a pump	X	X		Upstate-Buffalo	Upstate-Buffalo
12. Cardiac dynamics	X			Jefferson	Jefferson
13. Cardiac output in man	X			Mc-Michael ICI	Einstein Tennessee
14. Cine coronary arteriography	X			AMA	Tennessee
15. Action of human heart valves	X			AFIP	Tennessee W. Virginia
16. Heart valves and sounds	X			AHA	Oregon
17. Heart sounds and murmurs	X			Rushmer Wash. (Seattle)	Kentucky
18. Heart development	X			AMA	Oregon
19. Congenital malformation of heart	X			AHA	Georgia
20. Nervous control of turtle heart		X		Mich. State	Mich. State
Circulation					
1. Regulation of blood pressure			X		Einstein Georgia Stritch
2. Cardiovascular pressure pulses	X			(C. Wiggers) G. D. Searle	N.Y. Med. Stritch

Title	Film	Tape	Live	Producer or Distributor	Users
3. Function of carotid sinus and aortic nerves (Parts 1, 2)	X			ICI; Ind. M &C	Creighton Hahneman
4. Subcutaneous blood flow and active vasomotion	X			AMA #273	Rochester
5. Microcirculation in Hamster's Pouch	X			AHA	Georgia
6. Bloodflow in batwing	X			(Nicoll and Webb) Indiana Columbia Press	Einstein Georgia Louisville Nebraska St. Louis Stritch
7. Flow of life; microcirculation	X			ETS; Princeton	N.Y. Med.
8. Capillary circulation		X		Mich. State	Mich. State
9. Lymphatic system	X			ICI	Hahneman
10. Cerebrospinal fluid circulation			X		Jefferson
11. Respiration and circulation	X			Air Force Film Lab.	St. Louis

Renal

Title	Film	Tape	Live	Producer or Distributor	Users
1. Kidney structure			X		Mich. State
2. Physiology of kidney	X			ICI	Tennessee
3. Renal physiology			X		Oregon
*4. Kidney function in health disease (parts 1 and 2)	X			Eli Lilly (R. F. Pitts)	Albany Colorado Creighton Hahneman LSU New York Med. St. Louis Tulane Vanderbilt

Respiration

Title	Film	Tape	Live	Producer or Distributor	Users
1. Respiratory movements in man			X		Mich. State
*2. Principles of respiratory mechanics (Parts 1 and 2)	X			Natl. Found. Assoc. Films (Whittenberger) Radford, Mead McIlroy, Ferris)	Cornell Dartmouth Einstein Kentucky N. J. Oregon Pittsburgh Stritch Tennessee Tulane

Title	Film	Tape	Live	Producer or Distributor	Users
3. Respiratory resuscitation	X			Burroughs-Welcome	Tennessee
4. Respiratory resuscitation technic	X			Linde; AFI	Louisville New Jersey
5. Closed chest resuscitation		X		Mich. State	Mich. State
6. Lung scanning in pulmonary disease	X			Ideal	Tennessee
7. Chemical control of respiration		X		Mich. State	Mich. State
8. Anoxia	X			Linde	Albany
9. Respiratory acidosis	X			SKF	Illinois
10. Chemical balance through respiration	X			AMA;AFI	Oregon St. Louis
Gastrointestinal					
1. Alimentary tract	X			(Carlson-Johnson); Encycl. Brit.	Illinois
2. Development of GI tract	X			AMA	Oregon
3. Oral and pharyngeal structures	X			-	Tennessee
4. GI Motility			X		Oregon
5. Gastric function-Pavlov pouch			X		Jefferson
6. Gastric secretion	X			ICI	MCV Oklahoma Tennessee
*7. Human gastric function	X			SKF (Wolf)	Illinois LSU MCV Nebraska N. C. Tennessee
8. If I had an ulcer	X			Warner-Chilcott	Tennessee
9. Peptic ulcer	X			Robins	Tennessee
10. Nausea and vomiting	X			SKF	MCV Tennessee
11. Pancreatic secretion	X			ICI	MCV Tennessee
12. Pancreas juice secretion		X		Illinois	Illinois
Endocrinology and Reproduction					
1. Hypothyroidism	X			Warner-Chilcott	Tennessee
2. Male sex hormone	X			Schering	Tennessee
3. Ovulation in the rat	X			(R. Blandau) Washington (Seattle)	Pittsburgh

Title	Film	Tape	Live	Producer or Distributor	Users
4. Ovulation and egg transport	X			AMA	Tennessee
5. Menstrual cycle	X			MCV Film Library; AMA	MCV
6. Physiology of normal menstruation	X			Schering	Louisville Oregon
7. Physiology of normal menstruation	X			Indiana	Tennessee
8. Reproduction		X		Mich. State	Mich. State
9. Partuition	X			Ortho	MCV
10. Menopause-Significance and management	X			-	Tennessee
<u>Nervous System</u>					
1. Basic mechanisms in Neurophysiology	X			(J. P. Schadé) Netherlands	Albany Colorado Indiana-B Marquette Oregon Stritch Tennessee Tulane
2. Reflexes: principles and changes in health and disease	X			AMA	Oregon
3. Spinal cat	X			(Asher Treat) CCNY	Georgia
4. Decerbrate rigidity		X		(L. M. N. Bach) Tulane	Tulane
5. Autonomic nervous system	X			Natl. Found.	Nebraska
6. Autonomic nervous system	X		X	Jefferson	Jefferson
7. Abnormal gait-neurological changes	X			AMA;ICI	Oregon Tennessee
8. Cerebral cortex of monkey	X			ICI	Hahneman Oregon Tennessee
9. Modern concepts of epilepsy	X			Ayerst Labs.	Louisville
10. Behavioral changes following paleocortical injury	X			AFIP	Tennessee
11. Function of nervous system			X		Mich. State
12. CNS in laboratory animals		X		Utah	Utah
13. Nervous system of man	X			Indiana	Tennessee
14. Demonstration in perception	X			U. S. Navy Film Ctr.	Tennessee

Title	Film	Tape	Live	Producer or Distributor	Users
15. Conditioned reflexes	X			Ideal	Tennessee
16. Brain and Behavior	X			Penn. State	N. C.
Receptors and Muscle					
1. Special Senses			X		Mich. State
2. Inner ear	X			(Kobrack) Med. Film Guild	Nebraska Tennessee Tulane
*3. Structure and function of vestibular apparatus	X			Penn State AMA (Everett & Blandau)	Oregon Tulane
4. Excitation-contraction coupling in muscle	X			A. H. Huxley	Mississippi New Mexico
5. Muscular contraction under microscope	X			Yeshiva	Hahneman
6. Skeletal muscle contraction			X		Mich. State
7. Muscle physiology			X		Oregon
Special Subjects, Purpose, Technics					
1. Biological transport			X	(Lifson, Grim Johnson) Minnesota	Mayo
2. Tissue sensitivity			X		Mich. State
3. BMR determination			X		Mich. State
4. Demonstration of exhaustion	X			Natl. Naval Med. Ctr.	Tennessee
5. "How to" demonstrations prior to laboratory	X		X	Pittsburgh	Pittsburgh
6. Special for laboratory needs	X			Mississippi	Mississippi
7. Several laboratory demonstrations	X			Columbia	Columbia
8. Various for own use	X	X	X	Chicago Med.	Chicago Med.
9. Dissection technic		X		Illinois	Illinois
10. Difficult surgery		X		Utah	Utah
11. Surgical exposures: neck and sciatic nerve	X			AV-TV Lab. Western Res.	N. Y. Med. New Mexico
12. Computer-assisted instruction via TV	X			UCI	UCI
13. Various graduate engineering courses			X	EE Dept. Minnesota	Mayo

SECOND INTERNATIONAL SYMPOSIUM ON CALCITONIN AND THE C CELLS

London, July 21-24, 1969

A Symposium on Calcitonin and the "C" Cells will be held at the Royal Postgraduate Medical School in London from July 21 to July 24, 1969. The programme will include clinical, chemical, physiological and histological aspects of this field. Recent research, both mammalian and non-mammalian, will be discussed. Further information and registration forms are available on application to the Symposium Secretary, Dr. Giraud Foster, Royal Postgraduate Medical School, Ducane Road, London W. 12, England.

FIRST INTERNATIONAL SYMPOSIUM ON CELL BIOLOGY AND CYTOPHARMACOLOGY

The First International Symposium on Cell Biology and Cytopharmacology will be held in Venice, Italy, July 7-11, 1969. For further information write Francesco Clementi, M.D., Instituto di Farmacologia, Universita di Milano, 32 via Vanvitelli, 20129 Milano, Italy.