Gerontology

DISCUSSION GROUP

The following are authors' abstracts of presentations to the gerontology discussion group at the National Institutes of Health, Public Health Service, during the first 6 months of 1958.

The planning of this series originated in the gerontology discussion group at the National Institutes of Health. In 1954 a group of about 20 staff members from various fields at the Institutes decided to meet once a month for informal discussion of some selected aspect of gerontology. The meetings have continued to this date with a de-emphasis on formality. The first chairman was Dr. Paul Stevenson of the National Institute of Mental Health, who served, until his retirement at the beginning of 1955, in arranging for speakers in response to suggestions of the group and of scheduling the meetings at appropriate times. In 1957, the discussion group was sponsored by the newly formed Center for Aging Research, under the direction of Dr. G. Halsey Hunt, to encourage the free exchange of information on aging.

Apart from the specific content of the presentations, other facts have emerged about gerontology in this 4-year period. Interests are clustered about certain foci: the molecular level; the general biology of the whole organism; the disease processes; the psychological aspects of aging; and the sociological or societal aspects. These seemed to be the respective interests of the gerontologists themselves at the lectures. It also became apparent in the discussions that it is impossible to compress gerontology into the confines of a single discipline, profession, or dogma.

—JAMES E. BIRREN, PH.D., CHAIRMAN, *chief of Section on Aging, National Institute of Mental Health, Public Health Service.*

Age Changes in Cells

When an animal grows old, cells in various parts of the body deteriorate so that they are no longer able to fulfill their various functions as efficiently as they did when the animal was younger. Why is this true? We should like very much to find out, for if we knew perhaps we could find some way of delaying the aging process.

For many years, cytologists have tried to discover in what ways an aging cell differs from a young cell. The results of their painstaking studies have not been impressive, and even though an occasional morphological change has been described, we know nothing about the why and wherefore of such change. Perhaps the main reason is that cytologists, both those using ordinary light microscopes and those using electron microscopes, have compared the appear-

ance of dead old cells with the appearance of dead young cells. And the methods used in killing cells so that they may be sectioned and stained could easily destroy any evidence of age changes in the protoplasm.

Physically, the cell is a colloidal engine, and it is proper to look for changes in the colloids of which this engine is composed. In order to appreciate the types of changes that may occur, we need to know the nature of the protoplasmic colloid. The work of many years has shown that the interior protoplasm in the cell is fluid surrounded by a stiff cortex.

This protoplasmic fluid does not behave like an ordinary protein or an admixture of such protein and lipid; it is strangely sensitive and can suddenly change from a fluid (sol) state to a more or less stiff gel. This reaction is similar to that occurring when the blood of vertebrates clots. The reaction is dependent on the presence of calcium and also on the activation of a clotting, proteolytic enzyme. Work on the nature and reactions of the protoplasmic colloid has been summarized in two books by the author, the Dynamics of Living Protoplasm, published in 1956, and the Viscosity of Protoplasm, which appeared in 1958.

According to E. Gunther's article in *Protoplasma* in 1957, when plant cells age the outer cortical layer becomes less rigid and the interior protoplasm becomes decidedly more viscous. This is exactly what I found in 1956 for aging egg cells of the marine worm *Chaetopterus*, as reported in *Protoplasma*. The loss of rigidity in the cortex of a cell is generally due to a loss of calcium from this region. The cortex normally behaves as a semipermeable membrane and offers resistance to the passage of ions into a cell. As is well known, the permeability of a cell membrane increases as the presence of calcium in it declines; as the cortex loses calcium, the cell becomes more permeable to calcium ions. The result is that calcium enters aging cells more readily than it does young cells. This is presumably why so many aged cells and tissues have been found to have a higher calcium content than young ones.

Because the protoplasm in the cell interior is so sensitive to calcium, entrance of calcium in increased amounts can cause a clotting reaction, as already noted. For this reason old cells may show increased viscosity of their interior protoplasm or may even become vacuolated, for pronounced clotting often causes vacuolization. Moreover, aging cells tend to suck more and more calcium out of the blood; this tends to lower the calcium content of the blood. Such a lowering of calcium concentration in the blood is known to result in a loss of calcium from the bones, hence the diseases of osteoporosis and osteomalacia, so common in old people.

Naturally, we are far more interested in the age changes that occur in higher animals than in those in plants or in the egg cells of invertebrates. Recently an attempt has been made to study the colloidal changes that occur in the course of the aging process in the cells of cats. Such studies are far more difficult to make and various technical difficulties have to be overcome. However, it is possible to study living muscle fibers of kittens and mature cats, and such studies have commenced. Also attempts are being made to study the colloidal properties of liver cells from cats of various ages.

—L. V. HEILBRUNN, PH.D., *professor of general physiology, University of Pennsylvania, Philadelphia, Pa.*

Aging in Insects

Although not a guarantee of expected results, the wise choice of a suitable animal for laboratory research may often prove to be the basis for the slim margin of difference between success and failure of an experiment.

For studies in aging, members of the largest of all animal phyla, the Arthropoda, appear to be ideal because of their small size, low cost of maintenance, relatively small space requirements for large numbers of animals, and high reproductive potential. Most of all this high reproductive potential is linked to a relatively short life history, as few as 29 days on the average for female houseflies (17.4 for males) and 33 days for adult worker honey bees.

These two species of insects have been the subjects of structural, biochemical, and biological studies from the moment of emergence

through old age. In an early study on the adult worker honey bee, the brain (like that of mammals, including humans) showed a slow but steady fall in number of the original cells from the first day of adult life to a total loss of 35 percent of that number by extreme old age. In the honey bee, enzyme studies of the brain (cholinesterase) and of muscle (phosphatases) related to energy buildup and release failed to show any corresponding changes with age. However, the quantitative relationships among these enzyme systems appear to be concerned with development and maintenance of flight ability, which is well developed in advanced old age. In the male housefly, on the other hand, which loses its ability to fly by the 10th day of adulthood, the wings are frayed, and both the acid phosphatase and the magnesium-activated adenosinetriphosphatase show pronounced drops in activity to a minimum by the 10th day.

During the course of this biochemical study, moreover, it became apparent that male houseflies had a considerably shorter average as well as shorter maximum longevity. By a series of studies involving constant humidity, temperature, and conditions of maintenance and rearing, longevities of male and female flies were compared in offspring from hundreds of generations of breeding of a standard laboratory strain of houseflies. Data accumulated for more than 4,000 pairs of flies of both sexes confirm the presence of an aging factor in the male which results in a longevity that is almost 70 percent higher for the female than the male. Experiments with reduced and enriched diet for the aging adult show that the average longevity of the male is not altered by such dietary variations; the female longevity, on the other hand, can be increased by inclusion of powdered whole milk in a sugar and water diet fed to the aging adult.

In a current study, the possible presence of a "Lansing" factor in the aging of houseflies is being investigated. Eggs, usually collected at a very young parental age, were collected at later and later parental ages; offspring from these collections were isolated and allowed to age under controlled conditions of temperature, humidity, and complete diet. First results clearly indicate that longevity of the male offspring is the same, regardless of the parental age at which the egg has been laid. In the case of the female offspring, after the sixth day of adult life, the older the parents at oviposition, the shorter the average longevity of the offspring. The 30-day mortality of female offspring hatched from eggs collected from parents 27 days old, for example, was 90 percent, exactly equal to that of males from eggs laid at all ages. A mortality of 50 percent was found for female offspring of young parents, on the other hand.

Thus, for the housefly, it appears that there is a relatively immutable aging factor in the male as opposed to an aging or longevity factor in the female which is labile to the extent that a limited diet as well as advanced parental age at the time of oviposition markedly reduces the average and maximum longevities of such females.

Studies are being continued on the relative roles of the male and female parents in the curtailment of the longevity of female offspring hatched from eggs collected at an advanced parental age.

—MORRIS ROCKSTEIN, PH.D., *associate professor of physiology, New York University College of Medicine, New York City.*

Aging and Longevity in Rats Under Favorable Conditions

In 1945, a special rat colony for research on aging and longevity was set up in an old building at the Columbia-Presbyterian Medical Center. We attempted to produce conditions as ideal as possible in the belief that, for satisfactory results, the colony had to be maintained under uniform conditions for a long period, with freedom from noise and other disturbances and with the elimination of infectious diseases.

To this end, we installed an air conditioning system with temperature and humidity control. We adopted a uniform diet, which has been used for the last 13 years. All outside light was closed off. Indirect fluorescent lights were installed on a time switch to give 12 hours of light

and 12 hours of darkness each 24 hours, and special cages and shelves were designed for our purposes. In addition, we have endeavored to avoid unnecessary noises and rough handling.

Our stock of animals came originally from the Sprague-Dawley Laboratories. From these original animals we have bred our own with 2 closed lines of random-bred animals and 2 lines of brother-sister meetings.

In the beginning, as in other rat colonies, there was a high incidence of respiratory disease, which now has practically been eliminated. This was done by Dr. Benjamin N. Berg, who destroyed all obviously infected animals and all suspected of having respiratory infection, as well as those which failed to gain weight in a normal manner. Thereafter, with a colony nearly free from respiratory disease, we have been able to study the onset of lesions of other diseases without the complication of pulmonary infection.

As our animals become older and reach a moribund state, they are killed and given complete autopsies. The data obtained are carefully tabulated so that we have been able to determine the relationship between age and the onset of lesions of various types and to study the development of these lesions from early to severe stages.

We have recently published a study of the data on five major diseases in male rats (Simms and Berg, in the *Journal of Gerontology* 12: 244–252, 1957). Findings show that for each of these diseases the onset of the early lesion gives a sigmoid curve when plotted against age, but the shape of the sigmoid curve depends upon the type of lesion. For example, myocardial degeneration has a relatively flat curve. This disease is first seen in some of the animals as early as 200 days of age, but a period of 900 more days elapses before the curve levels off with no further incidence. On the other hand, degeneration of voluntary muscle is not seen until 550 days of age, but the curve rises so sharply that there is a 100 percent incidence after only 550 more days.

With some diseases, such as periarteritis, only a portion of the animals are susceptible. The remainder are apparently immune to this disease, with the result that the sigmoid curve levels off at 60 percent incidence. Similarly, adenoma of the pituitary is found in less than 25 percent of the older animals, but all those susceptible acquire this tumor before 900 days.

The logarithmic increase in the human death rate with advancing age, first reported by Gompertz in 1825, has been a matter of concern for many years. The reason for the logarithmic increase has not previously been explained. Our data on rats show that their mortality follows a similar but very much steeper logarithmic curve. We have been able to show that this is not due to a change with age in the duration of the diseases from early to late stages but rather because the mortality parallels the onset of the major diseases that contribute to the death of these animals. As was stated above, the onset of these major diseases has a typical sigmoid curve. We have found, furthermore, that the probability of onset of new lesions of each disease when plotted against age gives a curve with a definite peak suggestive of a normal distribution curve. In other words, for each disease there is an age of maximum probability of acquiring a new lesion of this disease, and the resulting mortality follows a logarithmic curve, like the human mortality curves with which we are familiar.

—Henry S. Simms, Ph.D., *Columbia University College of Physicians and Surgeons, New York City.* (*This study was carried out on grants from the Josiah Macy, Jr. Foundation and the Albert and Mary Lasker Foundation, and grant H–945 from the Public Health Service.*)

Evaluation and Treatment of Older Persons in Need of Psychiatric Care in a Metropolitan Area

By current standards, mental disorder is common, and emotional ills, by some definition, affect everyone. However, circumstances often dictate that treatment be reserved for disturbed and disturbing persons who need specialized care for their welfare or that of society. Even for them there may be limited resources. Obviously, not all psychiatrically ill older persons reach points of medical care. Of those

who do, not all are equally afflicted; many who receive good care may require it less than some who receive little or none.

Where psychotherapy is regarded as a luxury, psychiatric disorders will not be identified; where the needs for physical care remain unrecognized because of socioeconomic circumstances, frank illness and associated emotional disturbance may pass for physiological decline. If we are to provide services for aged persons to match their real needs for medical care by present-day standards, the way inequalities in the distribution or receipt of care come about must be studied, especially where governmental or charitable agencies are instrumental in providing these benefits. A knowledge of the characteristics of persons now receiving different types or gradations of sociomedical treatment may permit inference or clarification of how they were selected for care or suggest preventive measures.

As part of a preliminary survey for the New York State Department of Mental Hygiene, more than 600 persons 65 years of age or over selected at random from nursing homes, old-age homes, and State hospitals were examined for comparison of their physical and mental functioning. The nursing home population was in the poorest condition from the point of view of physical function, while persons in the homes for the aged functioned best. Those in State hospitals were intermediate. About 40 percent of the aged first admissions to a hospital who survived the first 3 months required active medical care. New admissions to the State hospitals were in the poorest physical condition of all. Aged persons readmitted to the State hospitals for disorders developed in early years were generally in good physical condition.

Advanced age and physical disability tended to go hand in hand in State hospitals and in homes for the aged; nursing home residents showed the same degree of disability at all ages. Persons beyond the age of 75 appeared to have physical disability with equal frequency in all institutions. Patients in the best physical condition did best on tests of mental status as indicated by comparison of the institutional population.

Two hundred and ninety-three subjects 65 years and older selected on a random basis from the variety of nursing and old-age homes were tested by M. Pollack and R. Kahn for the capacity to perceive properly simultaneous tactile stimuli to the face and hand. About half of the subjects made persistent errors. The results exactly paralleled those of questionnaire examinations for mental status. The defects in perception were found in increasing numbers with advancing age and decreasing function but preponderantly in persons where early formal education was absent or scant.

The institutions studied were relatively homogeneous both as to the background of their residents and to the general level of alertness of the residents. There are apparently interpenetrating factors of selection which create an institutional milieu. Furthermore, these factors have a continued influence in maintaining the cultural milieu. The residents contribute to a culture which in turn acts upon them for better or worse. In this way, up to a point, the good institutions probably grow better and the poor grow worse.

The findings imply that disorders of perception related to disorientation and mental disorder in the aged are strongly influenced by cultural background and also are related to physical functional capacity. In our society good early education may act as a protection against decline of mental and physical functioning in the later years; it may help to provide special protective devices for oneself; or it may be an index for correlated protective factors. In all likelihood all these possibilities are true. The sequence may be: poor education contributes to socioeconomic deprivation, socioeconomic deprivation contributes to illness, illness to invalidism or impairment of function, impairment of function to mental disturbance, mental disturbance to disability or invalidism, and invalidism to socioeconomic deprivation.

Studies of this nature appear doomed to uncover the banal, but the manner in which the obvious is uncovered may suggest practical measures for prophylaxis and treatment. By inference, a large number of the mental disorders of the aged can be traced to economic and health problems of their preceding years. Good socioeconomic circumstances, good education

early in life, and the protection of physical health through the provision of social, public health, and general medical services promise to decrease the number of disoriented aged persons and the intensity of their disorders in the future. For those now ill, social rehabilitation techniques and good general medical treatment may mean the reclamation of a number of disoriented and maladjusted aged persons. Mutually damaging reciprocating relationships of person and institution should be interrupted; at times this requires no more than provision of the very important service for the protection of mental health: good medical care.

—ALVIN I. GOLDFARB, M.D., *office of the consultant on services for the aged, New York State Department of Mental Hygiene, Queens Village, N. Y.*

Age Differences in the Acquisition and Extinction of Conditioned Eyelid Responses

The eyeblink is difficult to condition in persons over 65 years of age, but when conditioned, is more resistant to extinction, according to a report by L. B. Gakkel and N. V. Zinina in the *Fiziologicheskii Zhurnal* (Moscow) in 1953. This report stimulated a study to provide systematic information on eyeblink conditioning and extinction among children and young and old adults under the same controlled conditions.

The subjects were 15 boys in the age range 8–10 years, with a mean age of 9.36 years; 15 young men aged 18–25 years (mean age 20.63 years); and 13 men aged 62–84 years (mean age 70.5 years). The old adults were noninstitutionalized and were either employed full time or part time or were retired.

The conditioned stimulus (CS) was an increase in the brightness of a 6-cm. circular milk glass disk from 1 to 1.5 apparent foot-candles. The duration of the CS on each trial was 1 second. The unconditioned stimulus (UCS) was a puff of air with an intensity of 2 pounds per square inch delivered to the right eye, with a duration of 500 milliseconds. All subjects were given 80 conditioning trials. Intertrial intervals were spaced at 10, 15, and 20 seconds according to a prearranged schedule. Following the 80th conditioning trial, 20 extinction trials were given in which the CS–UCS interval was lengthened to 1,500 milliseconds. Subjects were tested in a dark and relatively quiet room. The equipment for recording eyeblinks and presenting the CS and UCS was similar to that of K. W. Spence described in the *Journal of Experimental Psychology* in 1953.

Through the 60th conditioning trial, the conditioning curve for the children was consistently above that of the young adults, and it was above that of the elderly group throughout the entire 80 trials. The conditioning performance of the young and old adults was similar through the first 20 trials after which the young group improved markedly and the elderly group only slightly. The conditioning curve of the children was negatively accelerated, that of the young adult group was positively accelerated, while the curve of the old adults was flat. At the start of conditioning, either the performance level of the children or the rate of conditioning was relatively high or both were high. On the other hand, the performance level of the other two age groups at the beginning of conditioning was relatively low or the rate of conditioning was slow or both conditions prevailed.

Statistical evaluation of these results was made by the Mann-Whitney test. The difference between the number of conditioned responses made by the children and the old adults was significant beyond the .002 level of confidence for a two-tailed test ($U=23$). The difference between the number of conditioned responses made by the young adults and the old adults was also significant beyond the same level of confidence ($U=25$). The children and young adults did not differ significantly in the number of conditioned responses ($U=89$).

Resistance to extinction was also inversely related to age. The use of the Mann-Whitney test showed that the children made significantly more conditioned responses during extinction than the elderly adults ($U=27$; $P<.002$) as did the young adults ($U=49$, $P<.05$). The two younger groups did not differ significantly in this respect.

The main and striking finding of this study was the relative inability of the elderly sub-

jects to acquire the conditioned eyeblink response. Of the 13 subjects in this group, 4 subjects gave no conditioned responses during the 80 conditioning trials, 7 gave from 1 to 8, while 37 and 75 were given by the other 2 subjects. There were no instances of failure to condition in the two younger groups. This result confirms the report of Gakkel and Zinina although their study does not include data on the conditioning performance of younger subjects. To account for the failure of older subjects to condition, Gakkel and Zinina quote Pavlov as concluding that "liveliness of the nerve processes suffer(s) from the development of senile changes." They also invoke the construct of inertia of the stimulating process at senile age.

These results suggest the consideration of an adaptation hypothesis to account for the relative unconditionability of elder subjects. It is known that subjects who were adapted to the UCS (air puff) showed a significantly lower level of conditioned eyelid responses than subjects who were not given pre-adaptation trials. It is proposed that in the course of many years of living the eyelid response and probably other responses have been "adapted out" and thus are less susceptible to subsequent conditioning. Research is underway to study several consequences of this hypothesis: that both frequency and amplitude of blink are reduced as a function of age. The procedures employed in the present study did not provide data on these variables.

—HARRY W. BRAUN, PH.D., *professor of psychology, University of Pittsburgh.* (*This investigation was supported in part by research grant M-1365 from the National Institute of Mental Health, Public Health Service. Richard Geiselhart assisted in the study.*)

Cornell Longitudinal Study on Occupational Retirement

The Cornell study of occupational retirement is a longitudinal study of a panel of subjects, most of whom were born in 1887, 1888, or 1889. Currently, there are approximately 2,400 participants in this study; they do not constitute a representative sample in a statistical sense, but represent widely divergent backgrounds and all the geographic regions of the country, although the major concentration is from the more heavily industrialized sections. With the exception of a disproportionate number of professionals, the participants approximate the total male employed population from age 60 to 64. The investigators consider the population to represent the "normal aged."

In this preliminary analysis of findings from the study, the major independent variable is occupational status or the change in that status from worker to retiree. The dependent variables, adjustment, subjective health, and economic deprivation, approximate the Guttman scalar pattern. Emphasis is upon the incidence of changes among the persons who retire and those who continue in gainful employment.

Our data have not supported the hypothesis that, in general, retirement leads to a decline in adjustment. We have found that continued employment for some older persons may result in a decline in certain measures of adjustment equal to or greater than changes experienced by persons who retire. This general finding was confirmed by data from the two periods under analysis: 1952–54 and 1954–56.

Age identification as a measure of adjustment was also examined; the data suggest clearly that retirement does not result in a deterioration in age identification. The retired are no more likely to experience a decline in age identification than the gainfully employed.

We also examined the data on the relationship between the forms of retirement and adjustment and we noted that a person's attitude before retirement is a more influential factor affecting a person's adjustment than the circumstances surrounding retirement, that is, whether the decision was made by the person himself or his employer. Persons who have negative attitudes toward retirement are more likely to evidence inadequate adjustment in retirement than are those with positive attitudes before retirement.

By means of the longitudinal analysis, it was shown that the association between retirement and health is largely explained by the fact that people in poor health tend to retire and not that retirement affects health negatively. This

part of the analysis is based primarily upon self-appraisals of health; but the findings are substantiated by the analysis of objective changes in health, that is, ratings by examining physicians. As in other studies, we do find a higher incidence of relatively poor health among persons who have retired, but it would seem that this correlation can be understood in terms of poor health leading to retirement and not the reverse.

One of the most obvious and objective effects of retirement is economic, for it is the rare retiree who is able to maintain his preretirement income. However, it seems agreed by a number of students of retirement that objective income must be interpreted in terms of the needs and wants of the persons. The researcher studying retirement must be aware of the subjective aspects of income. In the Cornell study we developed a measure of what we call economic deprivation in order to determine changes in attitude regarding objective changes in economic status. The panel analysis shows clearly that retirement contributes to the development of economic deprivation. However, the data also indicate a perhaps more striking finding: a high proportion of retirees possess a sufficient "role flexibility" that enables them to adapt to a greatly reduced income.

One general conclusion from this study, of which a fuller report appears in a forthcoming issue of the *Journal of Social Issues*, is that longitudinal surveys of retirement can point to the need for reexamining some stereotyped ideas about the effects of retirement. There appears to be a wider range of adaptability and adjustment than is commonly thought.

—GORDON F. STREIB, PH.D., *professor of sociology, Cornell University.* *(Initially supported by funds from the Lilly Endowment, Inc., the study now continues through grants from the National Institute of Mental Health, Public Health Service. Contributions to the analysis were made by Dr. Wayne E. Thompson, assistant professor in Cornell's sociology and anthropology department.)*

New Sections of Excerpta Medica

Two new sections of *Excerpta Medica,* Rehabilitation (Section 19) and Gerontology and Geriatrics (Section 20) were begun in July 1958. Each is published monthly by the Excerpta Medica Foundation.

With the objective of "opening another avenue to aid the medical professions in this 20th century challenge, the conquest of disability," the Rehabilitation Section is devoted to experimental, clinical, and program aspects. The first issue contains 314 abstracts, arranged according to a preestablished classification system to facilitate reference. Publication of this section is aided by a grant from the Office of Vocational Rehabilitation, Department of Health, Education, and Welfare.

The new Gerontology and Geriatrics Section, aided by a grant from the Public Health Service, covers the whole field of aging and the aging process. Recognizing that the subject is of social as well as medical concern, it includes such topics as social behavior, social welfare, economics, and politics in addition to purely medical problems.