Old age - Research

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AGING AND THE AGED

Aging is a phenomenon both personal and public, both evident and elusive. Time passes: as an experience within, as a dimension without. New forces quilt disturbing as well as satisfying patterns into the later years. Yet ancient mysteries remain tightly woven into the fabric of the aging process. The University of Chicago tradition of fundamental inquiry and interdisciplinary approach has guided its scholars and scientists to examine the aging enigma at its most basic levels. They seek information and insight to help an older society act with wisdom about age. This account by no means embraces all of their efforts, but it may provide an introduction to the vitality and variety of the research, experiments, and theoretical work being conducted at The University of Chicago on aging and the aged.

THE ROLELESS ROLE

The stereotypes are only too familiar: the rocking chair, the empty hands, the unwanted look, the passive posture. Are these the meaning of being old? Too long, says an elder statesman of modern sociology, have these myths persisted. These illusory cobwebs have ensnared the elderly in a "roleless role" without a vital function to perform. Ernest Watson Burgess would sweep away the cobwebs. Only with a fresh start, says the 75-year-old Professor Emeritus of Sociology at the University of Chicago, can the private task and public responsibility of understanding aging and the aged begin.

An obvious exception to the ravages of rolelessness, Burgess has just edited *Aging in Western Societies*, the last of a massive three-volume series on aging published by the University of Chicago Press. With the same sensitivity he brought to his classic earlier studies of engagement, marriage, and the family, Burgess perceives that the stereotypes and myths sanctioning the "roleless role" have burgeoned into "the greatest obstacle to progress by society and by the older person himself." From the vantage point of his survey of American and European problems and solutions, Burgess warns:

"The American way of life, if it is to be preserved for both older persons and all of us, is not merely to help older persons, but to help them to help themselves.

"Up to the present time nearly all programs in behalf of the aging in the United States as well as in Europe are the product of the welfare mood, of [so called] expert opinion, and of uncritical adoption of untested projects.

"The time has come for critical evaluation of policies, programs, and projects, and for reliance on basic research for the scientific knowledge of the capacities, needs, and potentialities of older people."

One of the designers of the 1960 Census, Philip M. Hauser, provides some of the statistical dimensions of the aging problem. An international authority on demography, Hauser is Professor and Chairman of the Department of Sociology and Director of the University's Population Research Center. He reports:

"Americans were younger on the average than in 1950; the median age of the population declined for the first time in 170 years. But the population was also older, as measured by the proportion of men and women 65 years old or more.

"During the decade 1950–60 the number of people 65 years old and older increased by about 35 per cent, a growth rate almost twice that of the nation as a whole.

"This group grew from 3 million in 1900 to 15.8 million in 1960, more than a fivefold increase.

"As a consequence, the proportion of older people in the population more than doubled, going from 4 to 8.7 per cent, over the same period."

Expressed in another way—the United States has been transformed from a "young" to a "mature" society. Before 1900, only 1 of every 25 citizens was over 65. By 1960, 1 of every 11 people was over 65.

Hauser predicts: "By 1980, the number of persons 65–69 will probably exceed 8.5 million, while those 70 or over will number almost 16 million. This would be nearly a 50 per cent increase in the older population over the next 20 years."

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Like Burgess, Hauser finds that an urgent challenge to understand the aging process arises from his area of inquiry.

"The free world, of which the United States is the leader, is made up in the main of the relatively old countries; the Communist world, of which the U.S.S.R. is the leader, includes only mature and young countries, and the neutral or uncommitted world, of which India is probably the key nation, is virtually all young," Hauser said. "If youth means vigor and age debility, the Western and free nations may be handicapped in the intense competition—economic, social, political, and perhaps military—which lies ahead. But youth has not always triumphed over age, and age has many virtues and strengths not possessed by youth. The relation of age to the political question, while exciting and portentous, is, in the present state of knowledge, not known. But posing the political question perhaps makes more clear and also more dramatic the need to learn about the consequences of the aging of populations."

A New Subculture

On the American scene, the future may bring a new "subculture of persons in later maturity." This possible development was sketched in a working paper prepared by a University of Chicago team for the recent White House Conference on Aging. The authors were Associate Professor Bernice L. Neugarten and Professor Robert J. Havighurst, members of the Committee on Human Development at the University of Chicago, and Professor Hauser.

Although there is little evidence now of group solidarity among older people, the document pointed out that in numbers there is more than strength: "It is a reasonable inference that membership in a group growing in number and power gives a person higher morale and tends to keep him active and reaching out for new experience. In brief, it tends to keep him 'young.' "

The report speculated that over the next few decades older people in general will be better able to compensate for the social, economic, and psychological losses they might experience with age:

"The growing economic and political influence of older persons as a group, improved health, greater freedom, and greater amounts of free time at their disposal are encouraging a growing proportion of older persons to select a more active style of life.

"As this proportion grows, it may produce a subculture of persons in later maturity . . . whose pattern of life is different from society as a whole. In such a subculture, there would be a high premium on leisure, on freedom of movement, and on reduced family responsibilities, and perhaps also on spending rather than saving. The subculture would be made up of persons with time, energy, and money at their disposal, who have sought out their age peers and who work out new patterns of shared activities with these people. This style of life is most clearly seen today in the retirement communities of the South and Southwest, but it is not limited to these areas."

The here-and-now problems of money and illness were studied under a Health Information Foundation grant in a nation-wide survey by the National Opinion Research Center on campus, which is affiliated with the University and directed by Peter H. Rossi, Professor of Sociology. The findings reported by Ethel Shanas, a senior study director of the center and a research associate (Associate Professor) in sociology, include:

1. Of men 65 years of age and older, 28 per cent received less than $1,000 income per year, 34 per cent received between $1,000 and $2,000, and 38 per cent received $2,000 or more. The median money income for this group was $1,575, compared with the median of $4,190 for men 55–64 years old. Families headed by men 65 or older had a median income of $2,831, compared with $5,417 for all families in the United States.

2. Three out of four older people appear to believe that an older person cannot save enough during his working life to take care of him during retirement. The majority of older people and of the American public feel that, if the older person has not been able to save enough to be financially independent, the government should assume the financial responsibility for his care through income-maintenance programs. On the other hand, the children and relatives of older people are less likely than older people themselves to say that the government should assume financial responsibility; about two of every five children of the elderly feel that "it's a child's duty" to support his aged parents, yet circumstances may make it impossible for them to provide the financial support.

3. The overwhelming consensus of medical practitioners, hospital administrators, visiting nurses, and family social workers is that older people are very sick. But the 15 million people 65 years of age and over in the United States—and those relatives and friends to whom they turn in a health crisis—give a different answer. Most older people, as many as eight or nine of every ten, would say, "I've a lot of things wrong with me, but I'm not really very sick!" The NORC findings indicate that the very sick among the older population comprise about 10 per cent of all persons interviewed; if those too sick to be interviewed are added to this

group, the proportion rises to 14 per cent. The rest of the older population, some 13 million persons, may suffer from substantial illness and impairment, but nevertheless three out of every four agree: "The way things are now people can expect to feel pretty good when they're 70."

Medical Needs

The contributions of medical progress to longevity bear a closer look. In the view of Dr. Lowell T. Coggeshall, Vice-President of the University, "It is correct, in a sense, to assume that by checking the great 'killers' of the past—the infectious diseases —we have created old age and its concomitant afflictions. . . . Life-expectancy has been increased because the miracle drugs, new techniques, preventive medicine, and other public health measures have decreased the infant mortality. The improvement in the early years has pushed the average longevity up to unprecedented levels."

However, Dr. Coggeshall points out that, once an individual reaches the age of 50, his life-expectancy is only two years greater than a 50-year-old had a century ago. And, for a man of 60, the life-expectancy is only slightly better than it was in 1850. In Dr. Coggeshall's words, "Since various studies have shown that above the age of 60, two of five people have some form of chronic disease, we can clearly see what the pattern of the needs for medical science are and will be: it clearly lies within the degenerative field. The high death rates from heart disease and cancer today do not stem from better diagnosis or increased susceptibility. It is simply that there are more persons living in those ages where these diseases are most prevalent."

According to Ray E. Brown, former superintendent of the University of Chicago hospitals and the University's Vice-President for Administration, "This country is simply not prepared for the accelerating number of chronic, long-term patients with which it is being confronted as a result of increased longevity. This is by far the greatest problem facing the hospital and health field." A former president of the American Hospitals Association, Brown has been named chairman of the United States Public Health Service's National Committee on Planning for Facilities for Long-Term Patient Care.

On the campus, the newest unit of the University's vast medical facilities is the Chronic Diseases Hospital. Dedicated on July 12, 1961, "to the study and understanding of chronic disease, to its prevention, and to the amelioration of its ravages," the new $2,920,000 hospital is oriented toward research on such chronic ailments as heart disease, cancer, psychiatric disorders, metabolic and genetic diseases, and changes attendant upon the aging process.

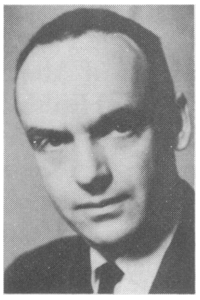
As the Dean of the Division of the Biological Sciences, Dr. H. Stanley Bennett, puts it, "Aging itself is not a disease."

"There are many important questions we need to answer in relation to chronic disease," Dean Bennett explains. "For example, we need to know more about how genetic deficiencies existing since conception can produce disability in advanced age. We need to know more about the factors leading to hardening of the arteries, and how to save the lives of people who have lost their kidney function."

Dean Bennett, an anatomist and one of the world's foremost authorities on the use of the electron microscope, pointed out that the deeper the scientist goes in penetrating the mysteries of aging, the more the realization grows that answers will be found in investigations of the basic biological process of the living cell.

BURGESS

HAUSER



BENNETT

"Fundamental research into the process of life itself will bring us better understanding of aging and death," Dean Bennett observes. "The aging process is a terminal manifestation of a chain of events starting early in life. Thus by studying how life begins we may learn more about how it ends. Every advance in fundamental biology can lead to an improvement in our knowledge of life and death and to greater effectiveness of our efforts to ameliorate the ills of mankind."

THE MIRROR AS CALENDAR

A man who works with his brain for a living does not consider himself "old" until 70. A man who works with his hands thinks he is "old" at 60.

An upper-class woman thinks she is "good-looking" at 35. Her lower-class sister feels she reaches the full flowering of beauty at 25.

These are some of the views reflected from the inner mirror, when people are asked emotionally charged questions about growing old.

An extensive University of Chicago study has shown how the image changes as the vantage point shifts and as the years pass.

The mirror tells a different story for men and for women.

The first detailed profile of the attitudes of

"middle age" and "old age" toward aging has come from the Kansas City Study of Adult Life, a large-scale study by the University's Committee on Human Development.

The Committee, first organized in 1930 as the Committee on Child Development, took its present name in 1940. It brings to problems in human behavior, such as aging, a broad interdisciplinary perspective that cuts across traditional departmental boundaries. Current chairman is Robert D. Hess, Associate Professor in the Committee and the Department of Education.

The Kansas City project, which began in the midwestern metropolitan area in 1950 with a cross-sectional survey of adults 40–70 years old, has since been broadened into a full social-psychological investigation of aging. A "panel" of older adults, ranging in age from 40 to 85, is interviewed twice yearly. The research, supported initially by the Carnegie Foundation and now by the National Institute of Mental Health, under the United States Public Health Service, is directed by three members within the Committee on Human Development: Professor Robert J. Havighurst, who also holds an appointment in the Department of Education; Professor William E. Henry, also in the Department of Psychology; and Associate Professor Bernice L. Neugarten, who serves as Executive Secretary of the Committee.

In the Kansas City survey, respondents were separated into four social classes: upper middle, lower middle, upper lower, and lower lower.

In general, the upper-class man sees a slow period of arriving at maturity, followed by a relatively short period which he defines as "old age."

The lower-class man, on the other hand, sees life speeded up. The first phases of adulthood appear to pass quickly, followed by a long "old age."

These social class differences are reflected, too, in defining the period when a man thinks he is "mature," at "the prime of life," with the utmost confidence in himself. This table tells the story:

TABLE 1

MEN LOOK AT AGING

When is a man . . . ?	Upper Middle	Lower Middle	Upper Lower	Lower Lower
"Mature," "at the prime of life," "most confident"	40	35	30	25
"Middle-aged"	47	45	40	40
"Old"	70	70	60	60

For women, the Kansas City data bears out the same trend—moving down the social ladder, aging seems to occur earlier. This is the woman's view:

TABLE 2

WOMEN LOOK AT AGING

When is a woman . . . ?	Upper Middle	Lower Middle	Upper Lower	Lower Lower
"Good Looking"	35	30	27	25
"Most Confident"	38	35	30	35
"In Her Prime"	40	40	38	35
"Old"	70	70	67	65

Both men and women tend to divide adulthood and old age into four periods—young adulthood, maturity, middle age, and old age.

Men seem to be most in agreement on the age of 30 as the significant dividing point in life, but they gave several other major divisions as well. Their image of the life-line seems to be one punctuated by several turning points; yet they see a relatively gradual progression from one period to the next.

Women, by contrast, emphasized the age of 40 as the major turning point in the life-span. Rather than a gradual progression from one period to another, they seemed to be describing two somewhat disconnected lives.

All groups of women reported this dramatic division of life at 40. But for different reasons.

Upper-status women felt the "second life" after 40 was an opportunity to engage in civic activities and to become more of a career woman. Lower-status women were more inclined to view the after-40 period as one of social withdrawal and preparation for the afterlife.

Mrs. Neugarten found that social class lines affect not only the timing of periods in life but the dominant moods or "themes" associated with each period as well.

Upper-middle-class respondents, for example, see young adulthood (from about 20 to 30) as a time of exploration and groping, of feeling one's way and getting adjusted to marriage, one's self, and adulthood. It is a time for experimentation. For this class, maturity (30–40) is the time of progressive achievement, developing autonomy and gaining self-confidence. Middle age (40–60) is the peak period of productivity and of major rewards in life. This view of middle age as a period of prime activity and reward is shared by upper-class women. As one put it: "You really enjoy life; you're comfortable with yourself and the world, and you're no longer adjusting as you were before." Old age, for this group, is the period of relaxation, leisure, security, partial retirement and withdrawal, with emphasis on contentment and resting on one's laurels.

But the lower-status group views adult life much differently. The buoyant note fades, and an undertone of resignation, if not pessimism, clouds the advancing years. The lower-status man views young adulthood as the time when one takes over the serious business of life—job, marriage, children, responsibilities—with a certain note of finality. Some take this change hard and describe it in pessimistic tones—"when responsibility is hung on you." Others greet this phase with a certain pride that "now I am a man." Maturity is described by both men and women of this social class as the period of being "settled, established, sensible." This is the plateau period. One meets increased responsibilities, one gets older, wiser, quieter. This is not, as for upper-status respondents, the period when one is building up and progressing but the period when one has leveled off. Middle age is described by the majority of men of this group in terms of decline—"slowing down," "physical weakening," and "a has-been." Lower-status women also stress decline. Old age, for this group, is the time of full retirement, withdrawal, and progressive physical decline, with undertones of pessimism; the regression, senility, second-childhood syndrome; the "old age—it's a pity" theme. For the women, the most frequent theme is that of slowdown and withdrawal, and again some mentions of physical decline, regression, and senility.

THE PRODUCTIVITY PUZZLE

Aging is full of paradox and contradiction.

One man looks old at 40, another young at 70. The work load of an "old man" staggers a young person many years his junior. Retirement cannot come soon enough for one worker—for another, it comes too early.

A number of University of Chicago studies have wrestled with these apparent conflicts, seeking "objective criteria" of aging—yardsticks more accurate than calendar or chronological age.

The University of Chicago Industrial Relations Center, under a grant from the National Institute of Mental Health, brought together a team of scientists representing medicine, biology, psychology, sociology, and economics to examine 166 production workers in order:

1. To determine whether *objective* measures of aging could take the place of chronological age as a determinant of retirement;
2. To analyze the extent of differences in productivity between older and younger employees.

The production workers were matched up in every respect—race, sex, occupation, place of work, and job stability—but one: age. One member of each of the 83 pairs was between 40 and 45 years old and the other between 60 and 65.

The specialists reported their findings, soon to be published as a book, on physical, mental, and emotional characteristics at a research seminar on objective criteria of aging. Here are highlights from their observations:

Physical Comparisons

Dr. Emmett B. Bay, Professor in the Department of Medicine, who gave medical examinations that included an elaborate medical history and a complete physical examination, reported that "the majority of the workers were physiologically able to continue on the job past 65." There was "some doubt" about whether one-fourth of the group should continue working after 65. These men were split about evenly between the younger and the older age groups. The small number who "probably should stop work at 65" were mostly in the upper age group.

Dr. Bertha A. Klien, Professor in the Department of Surgery of the School of Medicine, examined the arteries in the retina of the eye, for evidence of arteriosclerotic and cardiovascular disease. She reported, "The group of older employees, 60–65, had only one-fifth the percentage of normal artery condition found in the younger employees."

Robert Kleemeier, industrial and experimental psychologist at Washington University in St. Louis, participated in the University of Chicago study with tests designed to measure psychomotor performance.

He reported: "With but one exception, the tests showed statistically significant decrements in performance over the age range from 40 to 65."

Mental Capacities

Ward Halstead, Professor of Psychology and Medicine, gave the workers a battery of non-verbal performance tests to measure higher brain functioning. He was able to give an unqualified "No" to the question: "Does (creative) brain power reside equally in the younger and older groups?" Said Halstead: "Relatively more of the younger workers (than the older group) fall in the zone of normal functioning on my index."

Halstead went on to compare these data on production workers with similar data gathered earlier on business executives. He reported "a considerably higher incidence of impairment of higher brain function (among the production workers) than in our executives." Halstead said the majority of production workers tested, both younger and older, were in the "impaired" zone of performance on these tests. But among a group of executives only

one in five showed "impairment." Halstead pointed out: "It is clear that there can be no simple answer. In terms of the standards applied to mental work, the majority of our production workers are old at 50. In sharp contrast, almost half of our executive group is young at 50. In short, they appeared—on this scale of measurement—to be aging at a slower rate than production workers."

Job Attitudes

Leonard Z. Breen, Purdue University sociologist who was responsible for the design of the study, found in his area of investigation that "the younger men, for the most part, wish to retire by age 65, while the older men do not. If an older man does not conceive of himself as 'old' and is committed to his work, he wishes to continue working; on the other hand, if he does think of himself as 'old' and is not attached to his job, he wants to retire. The younger men want to retire by age 65, whether or not they think they will be old by that age, and whether or not they like their jobs. But this may be partly explained by the fact that the retirement decision is too remote to be real to them."

Thus, the research has shown no physical difference between the age groups significant enough to take most of the older workers off the production lines; that arteries in the eye deteriorate markedly with age; that psychomotor performance falls off significantly with age; that mental reserve abilities favored the younger group; and that job attitudes and motivations differed sharply between the older and younger men.

Work Output

How did their work output compare?

The answer to this critical question created an unexpected puzzle.

Age, it was found, had very little to do with productivity.

Robert K. Burns, Professor and Associate Dean of the Graduate School of Business and Executive Officer of the Industrial Relations Center, who directed the research in Chicago-area plants on the actual productivity of employees in the two age groups, drew this conclusion:

"On these jobs there was no difference in productivity between men aged 40–45 and men aged 60–65."

Thus the common belief that output declines with age had to be ruled out. And no ready explanation could be offered.

True, individuals did vary a great deal in their ability to produce. But the variation was not tied to chronological age.

The other factors gave slim, if any, clues to the differences in productive ability.

Physical fitness, psychomotor performance, high-level functioning of the brain, job attitude, self-perceptions—all these approaches added up to a pattern of apparent paradoxes and contradictions.

"None of these factors," said Burns in reviewing the data from the comprehensive series of tests, "was a major determinant of productivity for the sample of workers."

He concluded: "It seems evident that certain older employees are able to maintain, under existing work practices, and with incentive stimulation, a level of productivity equal to that of workers 20 years younger.

"This finding throws us back on our alternative explanations: that productivity may be determined by work-group norms or that our sample of older workers had been pre-selected by their ability to continue in their present jobs."

TESTS OF SUCCESS

Successful aging can be measured.

The problem is to decide what to measure.

If successful aging can be defined in "inner" terms, then feelings of happiness and satisfaction can be reported. This approach assumes that the individual is the proper judge of his well-being and, perhaps more important, that it is not necessarily appropriate to measure well-being in old age by the same standards that apply in middle age or by the outward style of life.

Havighurst and Mrs. Neugarten worked out measures for "inner" satisfaction and applied them to the Kansas City study population of people aged 40–85.

Five different components of morale and mental health were defined. Then, using data obtained from interviews, each person was rated on the extent he:

—takes pleasure from the round of activities that constitutes his everyday life (zest versus apathy);

—regards life as meaningful and accepts resolutely what life has been (resolution and fortitude);

—feels he has succeeded in achieving his major life-goals (correlation between desired and achieved goals);

—holds a positive self-image (confidence); and

—maintains happy and optimistic attitudes (mood tone).

The separate ratings were then summed to get an over-all score entitled the "Life Satisfaction Rating" (LSR).

Havighurst and Mrs. Neugarten point out that the five components, "while positively interrelated, . . . nevertheless show a fair degree of independence, supporting the assumption that more than one dimension is involved in successful aging."

They found in analyzing the Kansas City data

that Life Satisfaction was not related to age or sex, somewhat related to socioeconomic status, and definitely related to marital status:

"Our 70-year-olds were as content with life as our 50-year-olds. This finding will probably not hold true in studies in which the sample of people 70 and 80 is a more representative group than the one we studied. Nevertheless, we conclude that, given reasonable health and financial security, advanced age does not necessarily bring with it decreased satisfaction with life.

"There was, in our data, a moderate relationship between socioeconomic status and Life Satisfaction, indicating that, just as with younger people, persons who have greater access to the economic goods of life tend to be persons who are more satisfied with life.

"There was no significant difference on LSR between sexes; but there was a relationship to marital status. Married persons were either high or low, but the unmarried (the single, divorced, or widowed) tended to be low on LSR. Again, as with younger adults, it appears that, although the married state does not guarantee satisfaction with life, it is only a hardy older person who lives alone and likes it.

"The conclusion seems warranted that the same, if not more, diversity exists among older people as among younger, with regard to the social and psychological patterns that accompany satisfaction with life. There is, in short, no one pattern of successful aging. In older age, just as in youth, what is one man's delight is another's despair."

Disadvantages of Retirement

Practically speaking, one of the stiffest tests of successful aging is retirement. Havighurst describes the hurdle in these terms:

"The greatest disadvantage of retirement is a moral and spiritual one, not an economic one.

"Retirement is a crisis in the meaningful use of time. It forces a person to shift his major activity out of the customary work role into other roles and to try to get more satisfaction in these other roles which are still open to him—the roles of homemaker, parent, spouse, citizen, friend, association member, church member, and user of leisure time. He *must* choose, or do nothing.

"If work were regarded as drudgery and as unfitting for a free man, there would be less of a problem in retirement. But very few people have this attitude toward work."

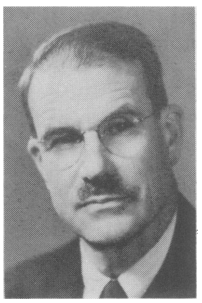
According to Havighurst, the broad moral and spiritual meanings of work which make retirement a crisis period are a basis for a sense of worth; a locus for social participation; a source of prestige; a new experience and a chance to be creative and achieve; a chance to be of service to others; and an escape from boredom, a means of getting one's self through the day.

"Ideally," says Havighurst, "a retired person should find things to do that will give him the satisfaction which he formerly got from his work. If his principal satisfaction lay in his associations with other people, he should get into clubs, social centers, church activities, and neighborhood activities that bring him into contact with old and new friends.

"If he found great satisfaction in the challenging new experience and the opportunity his job gave him for creativity, he might take up new activities such as painting or woodworking; or he might travel; or he might serve as a volunteer on civic improvement projects that deal with some pressing social problem such as urban redevelopment, juvenile delinquency, or community recreation."

HALSTEAD

NEUGARTEN



HAVIGHURST

People who make the transition from a work role to a retirement role successfully, according to Havighurst, do one or more of the following:

—decrease energy expenditure, by slowing down and doing less in a day or a month or a year than formerly;

—revise the activity budget, spending more time in non-work roles;

—spend more of their time in play, service, and new experiences; and

—increase the time they spend in contemplation.

AGING AS DISENGAGEMENT

As he grows older, man "co-operates" in disengaging himself from society—he is not just "elbowed out" by younger people, as has been assumed.

This "theory of disengagement" has been formulated by the Kansas City Study group of the Committee on Human Development.

In social psychology, where a wealth of theories exist for the processes of development and matura-

tion, there has been no general theory of aging—only the implicit assumption that "society withdraws from the older person and leaves him stranded."

However, the Kansas City study group has come up with a tentative, but explicit alternative to this implied theory of the aging process, namely, that "the individual co-operates in a process of mutual disengagement which takes place between himself and society."

The "theory of disengagement" began as the conception of Dr. Elaine Cumming, former director of the Kansas City research project, and has been explored by other members of the Committee on Human Development.

Professor William Henry and Mrs. Cumming spell out the theory in detail in a book, *Growing Old*, published by Basic Books.

Henry describes the current status of the theory in these terms:

"In overview, we see the aging individual changing gradually from a full state of engagement with the world around him (middle age) to a state of disengagement from it (old age).

"We believe we have evidence of developmental demands characteristic of old age, and qualitatively different from the developmental stages of childhood, adolescence, and adulthood. If so, the central axis of this stage is the process of disengagement—which serves as the mechanism for integrating one's life as it has been lived and the final acceptance of the reality of death."

Aging, in the theory of disengagement, involves the mutual withdrawal, beginning about age 65, of the individual from society and of society from the individual.

The process has both an inner and an outer aspect—in other words, the withdrawal of the individual from the social network is accompanied by certain inner changes in the personality.

Step-by-step symptoms of disengagement, according to Henry, are:

—measuring time by the distance from death instead of from birth

—spending more time in contemplation and introspection

—a sharpening feeling that "time is running out"

—actual curtailment of contacts with other people.

"It is at this time in the life-cycle that the aging person can for the first time since childhood afford to be carefree.

"With the thinning of ties of obligation to others, he can gratify some of his more personal desires and ignore some of the harsher strictures of social life.

"This all suggests that the very old person feels freer because he has long since withdrawn from the ongoing stream of life."

"The result of the disengaging process," Mrs. Cumming says, "is a more self-centered and idiosyncratic style of behavior."

A Natural Stage

Elaborating the theory, Henry suggests that we often fail to conceive of old age as a potential developmental stage in its own right, different from middle age.

"We seem to imply that old age is not a state toward which we move, a state possibly having its own unique attributes, but, rather, that it is a period moving *away* from some previous and more desirable period—the 'prime of life' or the 'years of usefulness.' From this we can only infer that the middle-aged state is usually seen as preferable to the old-age state, and that to retain its features indefinitely constitutes successful aging.

"Disengagement theory takes into account the possibility of old age attributes different from those of the middle years, and, in particular, that one special 'behavioral' feature of age, the inevitability of death."

Although the social process of disengagement is not usually evident until age 65, the beginning of the process may be found 25 years earlier, around the age of 40. Mrs. Neugarten points out:

"The biological organism shows unmistakable signs of aging during the age period 40–65, as does the psychological organism. And both seem to remain relatively independent of social performance or personal satisfaction with life.

"Accordingly, we are suggesting here that just as biological maturation is primary for the development of an adequately functioning ego in the early years of life, it may be that biological factors again take precedence in maintenance of ego functions in the aging individual. Decreased efficiency in these personality functions may be closely related to decreased efficiency in biological functions.

"It has been pointed out that, until at least the mid-60's, the average individual maintains social competence in the face of considerable biological change. Our present work indicates a somewhat parallel phenomenon—that persons maintain social competence in the face of considerable personality change.

"Only when there is gross biological disfunction or illness is the independence between biological and social functions destroyed.

"This may be true of personality processes, too. Only a marked distortion or gross breakdown of the ego will cause a visible effect on everyday behavior."

THE BROAD BIOLOGICAL THEORIES

Two conflicting theories of the fundamental biology of the aging process have arisen at the University of Chicago.

One says literally that death is inherited—the product of the genetic makeup of the individual.

This is the conception of pioneer atomic scientist Leo Szilard, Professor of Biophysics at the University of Chicago Enrico Fermi Institute for Nuclear Studies.

The other theory contends that both hereditary and environmental factors are joined in the processes of aging and death.

This idea has been formulated by George Sacher, radiobiologist at the Argonne National Laboratory, which is operated by the University of Chicago for the United States Atomic Energy Commission.

In Szilard's theory, the time of death is precisely determined by an immutable progression of "aging hits," added to an original, inherited load of "faults" of a genetic nature.

In Sacher's, the time of death must necessarily contain "an irreducible element of uncertainty" due to the chance fluctuation both in the inner physiological condition of every human being and in the external stresses and strains on him.

Both tentative theories of aging and death give mathematical expression to the fact that the death rate increases, at an accelerated rate, with age.

But why mathematics to explain a biological process?

The answer is found in the very complexity of the aging process. A bewildering array of variables confronts the investigator. Many are obscure, for the present, because they take place deep within the living cell. Just as Einstein's abstruse mathematics laid bare the threshold of modern physics, so mathematical tools are providing the biologist with a theoretical framework and a new perspective from which to view the problems of aging.

At the University of Chicago the first center in the world for research in mathematical biology was established in 1934, by Professor Nicolas Rashevsky. It now is known as the Committee on Mathematical Biology, and one of its members, Professor Herbert Landahl, explains the use of mathematics in this field to gain fresh hypotheses and new approaches in these terms:

"Simple mathematical models help us to understand and interpret observed events. They give us a tentative system to disturb and manipulate, a system built from broad parameters whose change may explain several effects at once. They help us to discover the underlying relations that would be obscure if one looked at single effects rather than multiple interactions. For this undertaking [understanding aging], mathematics is an ideal tool."

Landahl, who has built mathematical models to describe many biological processes related to aging, builds this systematic symbolic formula by depending heavily on the dimension of time as the organizing principle which harnesses mathematical precision to the unknown and slightly known forces of aging. In his words, "Time is inseparable from aging. Many processes are clocklike in their rhythm, while others have a characteristic duration. Most are modified appreciably by aging."

Death, the end-effect of aging, is the starting point for the wide-ranging imaginative theories of Szilard and Sacher.

The rate of human mortality is a simple statistic, which obeys a well-known mathematical law. It is documented by excellent records for most modern societies. It is a "known" among a vast number of "unknowns" that relate to aging.

"Aging Hits"

Leo Szilard, one of the University of Chicago scientists who helped to achieve on the campus mankind's first sustained nuclear reaction in 1942 and since has taken a prominent role as a scientist and philosopher of the atomic age, advanced his controversial aging theory in the National Academy of Sciences.

To begin with, he said, the theory is in no sense anchored to reality as presently understood. He termed it an "attempt to describe a hypothetical biological process that could conceivably account for the phenomenon of aging."

The cornerstone of the theory is the "aging hit." The "hit" itself is pure guesswork. Its sense comes from its power to explain mortality statistics.

Szilard postulates that "aging hits" knock cells out of commission. And he suggests that death occurs when the surviving fraction of cells falls below a critical value.

The nucleus of every human cell—except sperm and egg cells—contains 23 pairs of chromosomes. The chromosomes are the "executive directors" of the complex chemical factory that is the cell. Each chromosome, in turn, is composed of thousands of genes which determine such traits as nose length or hair color by directing the manufacture of such basic substances as protein. When a single chromosome is knocked out of commission, Szilard suggests its mate can assume its functions. But when both chromosomes of a pair are neutralized, the cell dies.

In stating the theory, he elaborated the effect of the hypothetical "hits" on the intricate inner chemistry of the cell.

"We know that a gene can be responsible for the

synthesis of a specific protein molecule, which in many cases has a known enzymatic activity. When we speak of a mutant, or 'incompetent' form of a gene, we mean an altered form of the gene which cannot synthesize the specific protein molecule in its chemically active form.

"Our theory assumes that the elementary step in the process of aging is an 'aging hit' which 'destroys' a chromosome of the somatic cell, in the sense that it renders all genes carried by that chromosome inactive. The 'hit' need not destroy the chromosome in a physical sense.

"We assume that the 'aging hits' are random events and that the probability that a chromosome of a somatic cell suffers such a 'hit' per unit time remains constant through life.

"We further assume that the rate at which chromosomes of a somatic cell suffer such 'hits' is a characteristic of the species and does not vary appreciably from individual to individual.

"As a result of an aging process of this nature, the number of somatic cells in an individual organism which have survived up to a given age (in the sense of remaining able to fulfil their function in the organism) decreases with age.

"On the basis of our assumptions, the 'surviving' fraction of cells decreases with age at an accelerating rate.

"Our theory, then, postulates that when the surviving faction of the somatic cells of an individual approaches a critical value, then the probability that that individual may die within a period of one year will come close to 1.

"On this basis, the theory establishes a relationship between the surviving fraction of the somatic cells and the age of death of an individual.

"We shall assume that the surviving fraction of the somatic cells of an individual may fall substantially, before the organism loses its capacity to live, perhaps to a value somewhere between one-third and one-twelfth.

"Thus, in its crudest form, the theory postulates that the age at death is uniquely determined by the genetic makeup of the individual.

"According to the views adopted here, the main reason why some adults live shorter lives and others live long is the difference in the number of faults they inherit."

In Szilard's conception, life might be compared to an individual on a tightrope. All the time, inner forces ("aging hits") are lessening his sense of balance.

He falls when his capacity to keep balance decreases to a critical value.

The length of time he stays on the tightrope, then, depends on his condition at the start and on the rate at which his capacity is destroyed.

Since the rate at which aging hits take place varies little from individual to individual, the main determinant of death is the initial condition (or genetic makeup) of the individual.

Uncertainty the Keynote

But for Sacher, a different analogy comes to mind.

The process of aging, in Sacher's theory, might be likened to an erratic walk along a path that moves closer and closer to the edge of a steep precipice—death.

The approaching cliff edge symbolizes the progressive decline in physical vigor as a person gets older; the zigzag walk marks the constant fluctuations which all physiological functions undergo.

A sharp zig or zag near the beginning of the walk is not likely to carry the individual over the edge. But, as he gets closer to the edge, the swings to one side or the other become more pronounced due to lessened control in old age.

As a result, the likelihood of tumbling over the edge increases, and the mortality rate pyramids as time goes on.

Uncertainty is the keynote in this conception of aging and death. Sacher says:

"Certainly genetic factors play a part. But we believe a full explanation of the mortality rate must take into consideration both heredity and the possibility of chance failure in the organism, due both to inner physiological condition and factors in the external environment."

A person's blood pressure, for example—one factor in over-all physiological condition—fluctuates around an average value.

Should a chance event—such as sudden exertion—occur when the blood pressure is at its highest or lowest rating, death might result.

"In any system, whether living or man-made, there are limits to how far performance can depart from normal without failure," according to Sacher.

"We think the real meaning of aging is the increased probability of failure with age."

He explains:

". . . Fluctuations arise in part from the constantly changing demands of our environment, and, in part, from limitations on the ability of organisms to adapt to these demands. Another limiting factor is the accuracy with which organisms can measure their own internal state.

"In other words, an organism never knows exactly what state it is in, even in the absence of outside disturbances. This ignorance leads to an essential uncertainty in physiological performance and limits the precision of physiological adaptations.

"Given such a limit and a knowledge of the fluctuating characteristics, it is possible to calculate the probability that a failure will occur in a given span of time.

"In a living system, death (as well as non-fatal disease) is a form of failure. The failure rate per unit time is called the death rate. Thus the first step is to link the death rate with the fluctuating nature of physiological performance."

Sacher's theory, then, is a mathematical expression of the probability of failure somewhere in the human system.

Sacher acknowledges that his theory raises real problems of direct experimental tests for two reasons: "Because we know little of the physiological nature of any disease, and also because measurement, especially of fluctuating characteristics, is difficult."

Indirect lines of evidence have been established, however, which he says support his general theoretical position. Most of this evidence comes from the analysis of the effects of atomic radiations on animals.

Radiation "Aging" as a Model

Radiation injury "mimics" natural aging in many ways.

The primary effect is a shortening of the life-span. In addition, it causes premature development of cataracts, graying hair, slowing of reaction times, increasing incidence of tumors, and a wasting-away of the iris of the eye.

All are well-known indicators of age.

One of the scientists whose theoretical explanations of aging are based on its parallel character with radiation injury is Gioacchino Failla, who became intrigued with "the apparent acceleration of the aging process by chronic exposure to atomic radiations."

Failla, Emeritus Professor of Radiology (Physics) at Columbia University, is now Senior Physicist Emeritus in Argonne's Radiological Physics Division. His theories penetrate the exterior evidences of radiation "aging" to speculate about effects deep within the living cell.

Since it is known that persistent exposure to low-dose radiation produces mutations of essentially the same types that occur spontaneously in living organisms, Failla reasoned that both aging and generalized radiation damage to an organism could be interpreted in terms of the accumulation of somatic mutations in body cells. Genetic experiments, he noted, indicate that the spontaneous mutation rate of different species is approximately inversely proportional to the life-span; that is, the greater the mutation rate, the shorter the life-span. This, of course, refers to mutations that occur in germ (sperm or egg) cells. Failla went on to assume that the same thing probably applies to mutation in all body cells.

He visualizes "the following simple process by which the life-span is controlled in nature:

"The constitution of the genetic system in the germ cells determines the inherent stability of the genetic system of the body cells in a given species. The spontaneous mutation rate is determined by the stability of the genetic system, being lower the higher the inherent stability. The rate of aging is determined by the spontaneous mutation rate. Aging increases the mortality rate . . . and sets a limit to the life span."

SZILARD

FAILLA

SACHER

In the mathematical expression of Failla's theory of aging, "vitality" (ability to survive, not ability to do work) decreases at a constant rate after middle age. He assumes that vitality at any age over 35 is proportional to the number of cells that have *not* been "hit," the hit being a spontaneous mutation.

The "hit" concept, though different mathematically from Szilard's "aging hit," again represents the loss of normal function in cells. Failla says:

"Loss of vitality with age may be attributed to the deterioration in function of the cell, brought about by multiple hits (or hits in a number of targets) in the cell. It is obvious that the loss of vitality cannot be attributed to actual loss of cells, because the number of cells at age 60 would have to be about 2.5 per cent of the number at age 20, and it is known that in old people the cell population in a tissue is not very different from that in young subjects. Hence we must assume that the cell population is affected in function rather than in number."

The reason a human being lives longer than a mouse, Failla explains, is that "the genetic system in all cells of the human body is more stable than that of the cells of a mouse." By "more stable" he means that the system is less apt to undergo spontaneous mutations in a given time interval.

Sacher, too, is interested in radiation "aging." His laboratory studies at Argonne on the physiological effects of radiation exposure complement his broad theoretical views of the aging process. Sacher says:

"Radiation injury seems to be one form of aging —there may be other kinds, too.

"The chances of death at a particular time after a radiation dose can be accounted for reasonably well in terms of the intensity of physiological injury at, and shortly before, that time.

"Though progress is slow, it has at least been established that the chances of death can be subjected to intensive study by comparing the normal and pathological physiology of animals and man."

Of Mice and Men

In Sacher's laboratory, and at the United States Air Force Radiation Laboratory on the University of Chicago campus, these comparisons are under way with laboratory animals.

One possible indicator of the extent of radiation "aging" is how fast a mouse can swim.

Aquatic competition between young and old mice can be used to establish a "base-line" scale of physiological age by relating over-all physical vigor (swim time) to age.

John Doull, Associate Professor in the Department of Pharmacology and Assistant Director of the Air Force Radiation Laboratory, proposes to go one step further, using the age scale based on swimming performance to evaluate radiation-induced "aging."

Here again, as often is true in basic biological research, the insight into the mechanisms of aging is only a scientific by-product; however, the main concern of studies in the Air Force Laboratory is to find antidotes for radiation injury and drugs to immunize against it. And in Sacher's laboratory at Argonne, the primary object is to discover the effects of atomic radiations at the most fundamental levels of physiological functioning.

What implications does Sacher see in his theory?

"One would think," he says, "that species with superior capacities to regulate their physiological performances should experience lower death rates and, therefore, live longer than other less well-endowed species.

"To test this, we made a study of the relation of maximum length of life to body size and brain size of a number of species of mammals.

"It was found that the species with relatively larger brains lived relatively longer, other things being equal. Thus intelligence operates to the benefit of physiological behavior just as it does for psychological behavior.

"This is good supporting evidence for our fluctuation theory of mortality and aging.

"The same comparative investigation confirmed that there is a component of aging that is independent of brain size and depends only on the amount of energy that is used by the body. Small animals use much more energy per unit body weight and have shorter lives in consequence.

"Thus it would seem there are at least two components that contribute to the over-all rate of aging. These are 'dissipative' aging, governed by the rate at which the members of a species dissipate energy; and 'facultative' aging, arising from inadequacies of physiological controls.

"The first decreases as animals get larger, and the second decreases as they get smarter."

Sacher contends that the "smartness" of human species has roughly doubled or tripled the human life-span, on the basis of comparing our life-expectancy with that of carnivores and herbivores of comparable body size, but with smaller brains.

Possible, though unproved, Sacher says, is the idea that "our intellect can be used to achieve a retardation of the human rate of aging.

"Thus far, human efforts to reduce disease have been directed toward control of man's environment. This has achieved a great reduction in the probability of contracting 'preventable' diseases, such as those due to infection or to dietary deficiency.

"However, as is well known, it has not yet been possible to bring about a retardation of the major systemic diseases to reduce the rate of aging or to increase the maximum duration of life materially.

"If a decreased rate of aging, and consequent real increase in the span of life is to be attained, it must be by a learning process, whereby each individual learns to attain a better-regulated, more harmonious internal life."

In raising consideration of a harmonious inner life, radiobiologist Sacher makes contact with the far different kind of inquiry that began in the field studies of the social scientists.

Such filaments of relationship among the disciplines stir the hope that someday a "general field theory of aging" will emerge to encompass the efforts of the social, biological, and physical scientists in understanding the process of aging and the problems of the aged.

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