Human Aging: Usual and Successful

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Research in aging has emphasized average age-related losses and neglected the substantial heterogeneity of older persons. The effects of the aging process itself have been exaggerated, and the modifying effects of diet, exercise, personal habits, and psychosocial factors underestimated. Within the category of normal aging, a distinction can be made between usual aging, in which extrinsic factors heighten the effects of aging alone, and successful aging, in which extrinsic factors play a neutral or positive role. Research on the risks associated with usual aging and strategies to modify them should help elucidate how a transition from usual to successful aging can be facilitated.

RESEARCH ON AGING HAS EMPHASIZED LOSSES. IN THE absence of identifiable pathology, gerontologists and geriatricians have tended to interpret age-associated cognitive and physiologic deficits as age-determined. We believe that the role of aging per se in these losses has often been overstated and that a major component of many age-associated declines can be explained in terms of life style, habits, diet, and an array of psychosocial factors extrinsic to the aging process.

Research on aging has also emphasized differences between age groups. The substantial heterogeneity within age groups has been either ignored or attributed to differences in genetic endowment. That perspective neglects the important impact of extrinsic factors and the interaction between psychosocial and physiologic variables. In this article we offer our perspective on the place of extrinsic factors in the aging process, the long-term consequences of extrinsically initiated changes, and the implications of our views for gerontological research.

The Concept of Normality in Studies of Aging

In recent decades, increasing interest in the medical problems of older people and in the process of aging itself has stimulated substantial growth in physiologic, psychologic, and sociologic research on aging in human populations. Investigators involved in such studies have from the beginning recognized the importance of separating pathologic changes from those that could be attributed to aging per se. Thus, for physiologic studies careful guidelines have been developed to exclude individuals whose age-determined responses and behaviors might be contaminated by specific disease processes (1, 2). Results on the population remaining after such exclusions have then been interpreted as representing "normal" aging, especially when the data came from longitudinal studies

rather than cross-sectional comparisons of different age groups and were thus less confounded with cohort effects.

The concept of normality, explicit or implied, has served well in such research. During the past 30 years, numerous cross-sectional and longitudinal studies on populations carefully screened for disease have demonstrated major effects of age on such clinically relevant variables as hearing, vision, renal function, glucose tolerance, systolic blood pressure, bone density, pulmonary function, immune function, and sympathetic nervous system activity. More recently, related research has revealed characteristic changes with respect to cognitive and behavioral functions. Such nonpathologic changes are important not only as reflections of the aging process but also, in many cases, as precursors of pathology. They constitute the physiologic substrate for the influence of age on the subsequent presentation of disease, and perhaps on probable response to treatment and likelihood of complications.

Nevertheless, the division of populations into diseased versus normal and the division of research findings into disease-related and age-determined have serious limitations. Chief among these is the neglect of heterogeneity among older people in the nondiseased group with respect to many physiologic and cognitive characteristics, a heterogeneity that is important both within cultures and between cultures. A second limitation of the emphasis on normality is the implication of harmlessness or lack of risk. And a third limitation is the related implication that, risky or not, what is normal is somehow natural and therefore is or should be beyond purposeful modification. In short, the emphasis on "normal" aging focuses attention on learning what most older people do and do not do, what physiologic and psychologic states are typical. It tends to create a gerontology of the usual.

Successful and Usual Aging

Each of the foregoing limitations urges the development of an additional conceptual distinction within the normal category, which can be approximated by the contrast between usual on the one hand, and successful on the other. For example, while many important physiologic variables show substantial losses with advancing age on the average, an important characteristic of such age-grouped data is the substantial variability within groups (1–3). In many data sets that show substantial average decline with age, one can find older persons with minimal physiologic loss, or none at all, when

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compared to the average of their younger counterparts. These people might be viewed as having aged successfully with regard to the particular variable under study, and people who demonstrate little or no loss in a constellation of physiologic functions would be regarded as more broadly successful in physiologic terms. They, in combination with people who show the typical nonpathologic age-linked losses that we propose to designate usual, constitute the heterogeneous category of the normal (that is, nondiseased) in any age group.

A distinction between usual and successful is urged similarly by recent discoveries with respect to risk factors for specific diseases. We are learning, for example, that age-linked increases in blood pressure, body weight, and serum cholesterol levels, while they may be usual in the populations that have been most frequently studied, are risk factors for cardiovascular disease. Moreover, such changes, which had been interpreted as age-intrinsic, are turning out to be usual in prosperous industrial countries but not in pastoral and traditional agricultural societies (4).

It is at least a reasonable hypothesis, given such cross-cultural differences, that attributions of change to age per se may often be exaggerated and that factors of diet, exercise, nutrition, and the like may have been underestimated or ignored as potential moderators of the aging process. If so, the prospects for avoidance or even reversal of functional loss with age are vastly improved, and thus the risk of adverse health outcomes reduced.

The concept of successful aging does not, of course, replace the necessary concern with explicit diseases and their causes nor the need to know what the dominant patterns of aging are in our society, by whatever name (usual, average, or even normal) we designate them. The concept of successful aging, however, adds to these a focus on heterogeneity within age groups and on the elucidation of factors that explain success. We turn now to the research evidence that bears on the distinction between usual and successful aging, first for physiologic and then for psychosocial characteristics.

Aging and Carbohydrate Metabolism

It has been known for over 60 years that advancing age is associated with progressive impairments in the capacity to metabolize a glucose load (5). After exclusion of individuals with fasting hyperglycemia, which is indicative of diabetes mellitus, as well as those treated with medications known to alter glucose tolerance and those noted to have become diabetic during the course of longitudinal studies, results of oral or intravenous glucose tolerance tests show a remarkable increase in the mean 2-hour blood sugar level with advancing age. There is a substantial increase in the variability of results in successive age groups, however, with many older individuals metabolizing glucose as well as their average younger counterparts. Resistance to the effect of insulin on peripheral tissues appears to play a major role in the genesis of glucose intolerance among nondiabetic older people. As with other insulin-resistant states, the insulin resistance of aging is associated with progressive increases in postprandial insulin levels (6).

The carbohydrate intolerance of aging may carry substantial risk, even in the absence of disease. A recent report from the Honolulu Heart Program evaluated the 12-year risk of stroke in 690 diabetics and 6908 nondiabetics free of stroke at study entry (7). Diabetes was clearly associated with increased risk of stroke, as expected. Additionally, among nondiabetics the risk of stroke was markedly age-related and was significantly higher for those at the 80th percentile of serum glucose than for those at the 20th percentile.

Findings on the carbohydrate intolerance of aging as a risk factor in coronary heart disease are mixed. While some epidemiological studies suggested an increase in coronary heart disease risk with hyperglycemia in nondiabetics, an international collaborative group conducting a thorough review of the 15 available studies on this issue did not find consistent evidence for that effect (8). On the other hand, studies focusing on post-prandial hyperinsulinemia, a cardinal feature of the insulin resistance of aging, have shown increases in insulin levels to be a significant independent contributor to the incidence of coronary heart disease death (9–11). In addition to these direct effects, increases in insulin level are associated with increases in triglyceride levels and decreases in high density lipoprotein–cholesterol levels, both of which are known risk factors for heart disease (12–14).

Attempts have been made to determine which components of the age-associated alterations in carbohydrate intolerance are related to aging per se and which components might be related to factors such as diet, exercise, medications, and body composition. For example, in Italian factory workers aged 22 to 73 years, Zavaroni et al. (15) evaluated the relative contributions of obesity, physical activity, family history of diabetes, and the use of diabetogenic drugs to age-related increases in glucose and insulin levels after an oral glucose tolerance test. The initial strong statistical correlation between age and both post-prandial glucose and insulin levels became much weaker when the effects of exercise, diet, and drugs were taken into account, so that the correlation between glucose and age was limited to marginal statistical significance and there was no longer an effect of age on insulin levels. Hollenbeck et al. (16) showed a direct and statistically significant relation between physical fitness as reflected in maximal oxygen consumption and insulin-stimulated glucose metabolism in nonobese healthy older men. Seals and co-workers found the performance of older physically trained men on oral glucose tolerance tests was identical to that of young athletes and significantly better than that of untrained older men (17).

As pointed out by Reaven and Reaven (18), these findings clearly suggest that much of the observed carbohydrate intolerance of older people may be caused by factors other than biological aging per se, and that dietary or exercise modifications may substantially blunt the emergence with age of carbohydrate intolerance and insulin resistance. The latter view is supported by earlier studies demonstrating improvements in glucose tolerance in young adults and diabetics after exercise regimens (17, 19, 20), as well as recent studies suggesting that exercise programs also improve the glucose intolerance and insulin resistance of older people (21, 22).

Aging and Osteoporosis

Aging is associated with a progressive decline in bone density in both males and females after maturity. Losses in bone density so severe as to result in fractures after minimal trauma define the "disease" osteoporosis, which accounts for more than 1 million fractures in the United States each year. Osteoporosis is of staggering importance in the elderly—by age 65 one-third of women will have vertebral fractures and by age 81 one-third of women and one-sixth of men will have suffered a hip fracture, often a catastrophic, if not terminal, event (23).

Although it has long been recognized that osteoporosis is a process that has multiple possible causes and that varies a great deal among older people, aging itself has generally been considered a major factor in the loss of skeletal integrity. In their recent review of current information regarding involutional osteoporosis, Riggs and Melton (23) indicate that three separate components contribute to age-related bone loss. The first component—the effect of intrinsic aging—represents a decline in bone mass with advancing age in both men and women beginning in the 20s and 30s, and includes several

identifiable physiologic processes. In women this bone loss occurs despite regular periods and intact ovarian function. The second component—a more rapid decline in bone mass in women after middle age—is accountable to the prominent effects of menopause. The third component, which is of major clinical importance, represents the net effect of "extrinsic" factors present to a variable degree in the population that contribute to the remarkable variance in bone density among the elderly. These preventable risk factors include cigarette smoking, heavy alcohol intake, and inadequate calcium intake (24–27).

In addition to identifying several potentially modifiable factors contributing to the emergence of osteoporosis, a number of studies suggest that bone loss can be blunted in advanced age by institution of moderate exercise programs (28–30). Thus, emergence of osteoporosis, a common, crippling, and expensive disorder previously considered to represent the "normal" aging process, is variable and influenced by aging and nonaging factors. The marked reductions in bone density associated with "usual" aging may be in large part preventable or modifiable.

Aging and Cognitive Function

Apparent age-related changes that further study suggests are not intrinsic to the aging process and may be modifiable have been found in cognitive domains as well (31). Schaie and his colleagues conducted an instructive series of cross-sequential studies on successive cohorts of individuals across the adult age range, thus permitting a comparison of cross-sectional and longitudinal data from the same study populations (32). Cross-sectional comparisons between age groups for subjects tested in 1963 showed significantly lower scores in many cognitive capacities for the older groups, a finding commonly interpreted as reflecting performance declines with advancing age. However, when the same subjects were retested 7 years later, they did not show the age-related declines that would have been predicted on the basis of the earlier cross-sectional comparisons. The longitudinal data suggested that declines in both verbal test scores (crystallized intelligence) and scores on reasoning and spatial tests (fluid intelligence) occurred at substantially later ages than the cross-sectional comparisons had implied. Such differences between cross-sectional and longitudinal comparisons exemplify a cohort effect, in which successive age cohorts score differently at the same chronological age. Differences of this kind cannot be explained in terms of factors intrinsic to the aging process, which are presumably constant from one age cohort to another. The explanation of cohort differences must be sought elsewhere—for example, in nutritional or educational differences between cohorts.

A clear demonstration of the influence of education on test performance commonly considered age-determined can be seen in Green's analysis of scores on the Wechsler Adult Intelligence Scale (33). Comparisons across age groups in a stratified random sample showed large age-related differences, of the kind usually interpreted as decrements caused by age. However, when similar comparisons were made between age groups limited to people of equal education, the "age effect" became insignificant.

These studies of Schaie and Green, taken together with similar findings by other investigators (31), indicate that much of the cognitive loss in late middle life that has been considered intrinsic to aging is caused in part by extrinsic factors and may therefore be preventable. That such losses may even be reversible once they occur is suggested by the recent studies of Schaie and Willis (34). These investigators divided participants in a longitudinal study into those with a clear pattern of decline in fluid intelligence (inductive reasoning and spatial orientation) with aging and those whose

performance was stable. After five training sessions there was substantial and retained improvement among the individuals who were previously declining in cognitive function.

Psychosocial Factors in Health and Disease Among Older People

In the rest of this article we will focus on psychosocial factors, which constitute one category of the extrinsic variables that influence patterns of aging, both usual and successful. Most health-relevant psychosocial research on older people, however, has been concentrated on morbidity and mortality as the outcomes of interest with few if any distinctions made within the residual category of the nondiseased elderly. Despite this neglect of nonpathologic aspects of aging, this research provides a valuable backdrop for the research we call for, since it identifies extrinsic psychosocial properties that influence the well-being of older men and women. Psychosocial factors should be studied in their full range, not only in their negative aspects. Doing so is especially important to reveal their contributions to successful aging. Two dimensions that have been sufficiently studied to serve as examples of our views are autonomy (or control) and social support (or connectedness).

Autonomy and Control

A great deal of research has been done in the broad area of control or autonomy—that is, the extent to which individuals are able to make decisions regarding choice of activity, method and manner of engagement, timing, pace, and the like. Despite a discouraging scatter of measures, the research results show a remarkable convergence: lack of control has adverse effects—on emotional states, performance, subjective well-being, and on physiologic indicators.

The potential relevance of research on control, animal and human, for understanding the circumstances and well-being of older people was observed promptly by gerontological research workers. Older people commonly encounter reductions in autonomy and control for a variety of reasons—physical impairments, reduced economic capability as wages are replaced by retirement stipends, residential moves from separate households to combined or institutional living arrangements, and the like (35). In recent years a number of studies have been done on the effects, or at least the concomitants, of autonomy limitations of various kinds on older people. This considerable literature has been the subject of two recent summaries (36, 37), and we therefore limit ourselves to major examples.

The bulk of control-oriented research with older human populations is nonexperimental and more often cross-sectional than longitudinal, both of which facts urge caution in causal interpretation. Nevertheless, the substantive findings are encouraging in their consistency. For example, Wolk (38) compared the residents of two retirement settings, a low constraint retirement village and a relatively high constraint retirement home. Residents in the former setting were observed to be more in control of their own activities, they so perceived themselves, and they also scored higher in life satisfaction and adjustment.

Shupe (36) cites preliminary data from a longitudinal study of psychosocial events and health status (39) that provides a stronger basis for causal inference. Undesirable events over which the individual had full control did not correlate with the index of strain, whereas undesirable events over which the individual had no control were strongly correlated with strain. When the individual had partial control, the correlation with strain depended on a third variable, the predictability of the aversive stimuli, with low predictability height-

ening the relation between lack of control and strain, and high predictability suppressing the relation.

Perhaps the most persuasive data on the effects of control among older people come from the small number of field experiments in which the control of individuals over their own daily lives was systematically increased. These experiments have been done almost entirely with populations already in residential retirement facilities or nursing homes, or among people facing imminent relocation to such facilities.

Krantz and Schulz (40), following an earlier nonexperimental study (41) in which the negative health changes after admission to a nursing home were found to be moderated by the amount of individual control over the move, conducted an experiment in which prospective patients were given a choice about the timing of the move, which of several institutions they would move to, and some of the living arrangements after the move. Under these experimental conditions, there was little decline from the level of health and psychological well-being as assessed before the move.

Langer and Rodin (42) conducted an experiment in a nursing home in which residents on one floor were given a treatment that enhanced control consisting of a lecture from the nursing-home administrator about decisions that they could and should make for themselves. A comparison group, on another floor, heard a lecture of similar length that emphasized what the staff would do in taking care of such matters. During the first 3 weeks after the experimental treatment, people in the experimental group were happier and more active according to self-report and spent more time in social activities as reported by nurses, who also judged them to be generally more improved than those in the control group. These changes persisted and the differences between groups increased over an 18-month period.

A near replication of the Rodin and Langer experiment was conducted by Mercer and Kane (43). The experimental treatment was extended to include individual visits by the nursing-home administrator in which patients were invited to join a council of residents. The comparison group in this experiment came from a second nursing home. Again the experimental group showed increased activity, improvement in staff-rated patterns of eating and sleeping, and decreases in self-reported hopelessness.

A third field experiment in a nursing-home setting, similar in some respects, was conducted by Schulz and his colleagues (44, 45). Again the experimental treatment involved increased control, in this case over the timing and duration of student visits, and again enhanced control produced gains in positive affect, activity level, and general health status. The differences between the experimental group (enhanced control) and two comparison groups, one of which received no student visits and one of which received visits on a random and unpredictable basis, were unambiguous. However, a fourth group, which had no control over the timing of the visits but was given advance information about their scheduling, showed improvements comparable to those of the enhanced control group. These findings suggest that the positive effects of enhanced control may be due at least in part to its making life more predictable; control confers predictability.

A more recent nursing-home experiment by Avorn and Langer (46) extends this line of work by comparing two experimental treatments, one of which is control-enhancing and the other control-reducing. Experimental subjects, a total of 72 with an average age of 78 years, were randomly assigned to three groups and given the task of completing individually a simple jigsaw puzzle. All subjects then had four 20-minute practice sessions. Subjects in the first group were given verbal encouragement during practice; subjects in the second group were given direct assistance, and subjects in the third group received no assistance or encouragement beyond the initial instruction. All subjects were rated for proficiency and speed both before and after the experimental treatments. The results showed significant improvement for subjects who had been encouraged, significant deterioration for subjects who had been directly assisted, and no change for subjects who had had no experimental treatment. The authors argue that the direct-assistance treatment is typical of approaches to older people that do for them what they could do or learn to do for themselves. The effect is infantilizing; the lesson is learned helplessness. We concur, and add that the essential difference between the two experimental studies is one of control: encouragement in this situation is control enhancing; assistance is control reducing.

On balance, these studies, all published within the past 10 years, represent an important line of field-experimental research. Their results reinforce earlier nonexperimental findings that suggested the importance of control for the well-being of older people. In our opinion, the extent to which autonomy and control are encouraged or denied may be a major determinant of whether aging is usual or successful on a number of physiologic and behavioral dimensions.

Aging and Social Support

Several lines of research on psychosocial factors and health converge around the concept of social support. Moreover, in spite of the definitional imprecision of the concept and the variety of measures that claim to assess it, empirical research has produced consistent if not often large associations between social support and various indicators of health and well-being (47). Some of this research has involved attempts to measure support directly, usually by report of the recipient but occasionally by report of the provider as well (48). Some has inferred support from less subjective data—marital status and household composition, for example, or proximity of family members. Most such research has neglected the variable of age and none shows systematically differentiated findings across the entire life course. A significant number of studies, however, are specific to older people or control appropriately for age, and it is those on which we rely for this review. We will consider first the evidence that social networks and support as persisting conditions affect mortality and morbidity among older people and next that support-disrupting life events have specific negative effects on both mortality and morbidity. Finally, we will consider some of the ramifications of this work for successful aging, including the relation to autonomy and control among older people.

Three epidemiological studies show that membership in a network of family and friends is associated with lesser mortality risk. In the Alameda County Study, Berkman (49) developed a social network index that included marital status, contacts with extended family and close friends, church group membership, and other group affiliations. Analyses based on this index showed age-adjusted relative risks of 2.3 for men and 2.8 for women over the 9-year period of the study, where relative risk refers to the likelihood of death among people at the bottom of the social network index in comparison with those at the top. The Tecumseh (Michigan) study (50), in similar multiple logistic analyses of social connectedness, found significant relationships to mortality over a 10-year period for both men and women, with age controlled. And the Durham County study (51), which included perceptions of social support as well as reported connectedness, and in contrast to the Alameda and Tecumseh studies was limited to men and women aged 65 years or more, showed relative mortality risks of 3.40 for impaired social support (self-perceived), 2.04 for impaired roles and attachments, and 1.88 for low frequency of social interaction.

The positive effects of social support have also been demonstrated

by means of intervention studies, most of them involving supportive behaviors by professional or quasi-professional persons. Criteria include rate and completeness of recovery from injuries, heart attacks, cancer, and other physical illnesses (52–54). At least four intervention studies involve the introduction of social support by one or more informal sources (relatives, friends) to increase adherence to hypertensive regimens. Three of them showed significant increases in adherence, with some evidence that the involvement of people significantly related to the patient made an independent contribution to the outcome (55–57).

Bereavement and Relocation

If the presence of social support and its experimental introduction in times of stress are conducive to well-being and recovery from illness, it is plausible that support-disrupting events should have negative effects. Two such life events are especially common among older people—bereavement and relocation, which involve, respectively, the loss of one's spouse and the loss (or at least partial loss) of friends and neighbors. Both these events have been studied for their effects on mortality and morbidity, usually with some limitations in design and measurement. For example, losses of social support are typically inferred rather than measured directly.

The gross fact of higher age-specific mortality rates among widowed than among married people has been reported in studies for many years. In 1969, Parkes, Benjamin, and Fitzgerald (58) provided more precise prospective data from a 9-year follow-up of 4486 widowers aged 55 or more. Excess mortality in this group peaked during the first 6 months of bereavement (40% excess) and declined thereafter, so that in the fifth year the mortality rate for widowers was not significantly different from that for the married men who served as controls. Causes of death varied, but in almost half the cases death certificates showed heart disease as the cause.

The finding of excess mortality has been confirmed in three other longitudinal studies (59–61), although the most recent of them (61) does not show the peaking of mortality during the first 6 months, the concentrated reporting of heart disease as the cause of death, or the gradual return to nonexcessive mortality rates within 5 years. These studies, which included women as well as men, do show a significant gender effect. For reasons not fully understood, excess mortality after the loss of a spouse is more characteristic of men than women. Tentative explanations emphasize the different roles of men and women in nutrition and meal preparation and the greater reliance of men on emotional support from their wives (62).

The effects of bereavement have been studied in terms of morbidity as well as mortality, with varying results. Higher rates of reported symptoms have commonly been found, but without change in major diagnosed disease (63), physician visits, or rates of hospitalization (64). And one study (65) of elderly men and women (average age 74) found no differences between the married and widowed on any measure of health. Post facto explanation emphasized the expectation of people in the upper age range to encounter such losses and their consequent readiness to cope with them.

Next to bereavement, residential relocation is the network-disrupting event that has been most studied in elderly populations. In a review of this research, Minkler (66) distinguishes between moves within the community of private households and moves into or between nursing homes and other institutions. Moves of the latter kind have more consistently resulted in excess mortality, especially during the early months after the move (67), although not all studies show mortality effects. Moves of the former kind have not shown excess mortality, but they have showed increases in number of physician visits and nursing home admissions, with concomitant

reductions in self-rated health (68). Kasl and Berkman (69) suggest that these differences in study results, especially those involving institutional residence, may depend on the manner of preparation and handling, as well as the relative quality of the two environments. This interpretation is consistent with findings on the effects of predictability and control described above.

Well-designed field experiments to test the effects of social support on morbidity and mortality changes after major life transitions are much needed and exceedingly rare. In one such study (70), 200 recently bereaved widows less than 60 years of age were assigned randomly to an experimental group that received support and encouragement during a 3-month period, or to a control group that received no treatment. Morbidity was significantly reduced in the experimental group during the 13-month post-intervention period. Apparently, social support can mitigate the ill effects of even this most painful relationship-disrupting event of later life. Its ability to facilitate successful aging in other ways has yet to be explored.

Support and Control

Social support and control have been studied separately as psychosocial factors affecting health, but they are almost certainly related. The interpersonal behaviors that are called supportive include, among others, the providing of material assistance, information, sick care, and expressions of respect and love. Support so defined, in our view, can either increase or decrease the autonomy and control of the recipient. Teaching, encouraging, enabling are autonomy-increasing modes of support. Constraining, "doing for," warning, and the like beyond the requirements of the situation may convey caring but they teach helplessness.

Some research findings are consistent with this line of speculation, which would predict greater positive effects for supportive behavior when it is also autonomy-enhancing. We referred earlier to the nursing-home experiment in which performance at a simple cognitive task was enhanced by encouragement but reduced by direct assistance (46). Pearlin et al. found that emotional support reduced depressive symptoms by the intervening process of increasing self-esteem and mastery (71). Bulman and Wortman found that paraplegic victims of severe accidents responded best to support that emphasized their control over their own lives, even in choosing the activity that led to the accident (72).

To realize the potential contributions of support to successful aging, we must establish a causal sequence that includes the individual's need for support (objective and perceived), the kind of support required (material, informational, emotional), and the effect of that support on other psychosocial predictors of success, of which autonomy and control are an important example.

Psychosocial and Physiologic Pathways

A further step in understanding the effect of psychosocial factors on health must be the integration of psychosocial causes with a broad array of biologic outcomes, including the full functional range instead of the conventional restriction to morbidity and mortality. Moreover, we must learn the pathways by which such causes and effects are linked. Berkman (73), in a review chapter on social networks, proposes four main possibilities for investigation:

1) Providing help, care, and material assistance may be directly health protective. For example, a person who is ill may receive care from family members and friends before and beyond the requirements of professional medical service.

2) Psychosocial resources may enable people to get better and

earlier medical care. Antonucci *et al.* (74), in a study of early detection of cancer symptoms, found that the promptness with which individuals sought medical diagnosis was affected by the actions of their personal network members. Most consistent of these network factors was the direct intervention of friends or family members in making medical appointments, providing transportation, and the like.

3) Psychosocial influences may increase health-promoting and risk-reducing behaviors. For example, peer pressure may induce better nutritional practice, elimination of smoking, moderation in the use of alcohol, or adherence to medical regimens (55).

4) Psychosocial factors may also have direct physiologic effects. Research on cardiovascular disease, while by no means consistent, implies such a direct pathway, as do some animal experiments on neural, hormonal, and immunologic processes.

Epidemiological research on cardiovascular diseases suggests a direct link between psychosocial causes and physiologic effects mainly by a process of elimination: when the usual risk factors are statistically controlled, a direct physiologic pathway between supportive interpersonal relations and a specific disease is proposed as a plausible residual explanation. Interpretations of this kind have been offered to explain relations between sustained interpersonal bonds and coronary heart disease in widely diverse groups—Japanese Americans in California (75) and Hawaii (76), women clerical workers in the Framingham study (77), and Israeli civil servants (78). Such findings are intriguing but not conclusive, especially because they are inconsistent in several respects—in their generality across demographic subgroups, in their application of incidence as well as prevalence, and in their explanation of myocardial infarct as well as angina pectoris.

The direct effect of psychosocial factors on physiologic processes has been investigated more rigorously in animal research, with findings that link behavioral and environmental interventions to neural, hormonal, and immunologic processes and then to disease outcomes—alloxan diabetes in rats (79) and Marek's disease in chickens (80), for example. Studies of this kind with human populations are fewer, but increasing. Jemmott and Locke (81) describe 40 studies that link psychosocial factors, immunologic processes, and susceptibility to infectious diseases.

Few of these studies have yielded age-specific results or have been conducted with elderly populations. Two, however, have studied the effects of bereavement on lymphocyte function. Bartrop *et al.* (82) found lower lymphocyte response to mitogenic stimulation [with phytohemagglutinin (PHA) and concanavalin A (Con A)] among bereaved spouses as compared with controls matched by age, sex, and race, but no differences in T- and B-cell counts or in plasma cortisol. Schleifer *et al.* (83) reported a significant reduction in T-lymphocyte response to stimulation by one mitogen (PHA), a marginal reduction in response to another (Con A), and a significant reduction in B-lymphocyte response to pokeweed mitogen, which suggests that bereavement may affect humoral as well as cell-mediated immunity. Other studies, both animal and human, have demonstrated the effect of such stressors as novelty, unpredictability, and suspenseful anticipation on plasma cortisol secretion rates, especially among subjects with inadequate psychological defenses.

To the extent that older people are placed in situations where they lack control over their lives, and to the extent that the forms of support available to them are not control-enhancing, we would predict physiologic changes of the kinds reported in this research, with consequent increases in morbidity and passivity. The positive implications of such predictions are that increased predictability, control, and support that enhances both will be reflected in increased proactive behavior and resistance to disease. Research along these lines should help explain the great variability within the population of nondiseased elderly and thus increase our understanding of successful aging.

Directions for the Future

The central theme of this article is the distinction between usual and successful aging and the consequent need for interdisciplinary studies of the factors that determine the trajectory of function with advancing age. Most gerontological research, however, continues to concentrate on average tendencies within different age groups and to neglect the substantial heterogeneity within such groups. That heterogeneity, moreover, appears to increase with increasing age.

The emphasis on usual age-linked tendencies encourages an over-readiness to treat age as if it were itself a sufficient explanatory variable; the emphasis on heterogeneity within age groups compels a search for other explanations as well. Epidemiological research shows that age-extrinsic factors such as eating and exercise habits are prominent among such potential explanations. These habits are shaped and sustained by psychosocial influences—properties of the larger culture and behaviors of family members, friends, and professionals.

Our first recommendation, therefore, is that gerontological research should incorporate the distinction between usual and successful aging. That in turn means including the full functional range of the outcome variables under study. It also means undertaking the task of explaining the heterogeneity of older people with respect to those functions.

Our second recommendation is that gerontological research should concentrate on understanding transitions in later life, especially transitions that have functional significance. Some of these represent loss of function—from successful to usual, usual to diseased, diseased to impaired. But no less important and much less understood are the potentialities for transition in a positive function-expanding direction. Experimental results on the effects of exercise in increasing bone density and the effects of specialized training in improving cognitive functions demonstrate the possibility of positive reversals in older populations. To the extent that maintenance and recovery of function can be explained in terms of extrinsic factors, it becomes reasonable to think of increasing the proportion of the successful elderly.

Autonomy and social support were discussed as psychosocial factors relevant to understanding successful aging. Research on autonomy is reasonably interpreted as indicating that the role of the helpless elder is to a significant degree shaped by the immediate environment of the individual—its opportunities and constraints, and the specific behaviors of influential others who define them. Experiments with people showing extreme functional losses—residents and prospective residents of nursing homes—have shown that some of these losses are reversed by modest increases in autonomy and the encouragement to use them.

Social support, like autonomy, has positive effects on function and self-reported well-being. Support—defined to include the enhancement of material, informational, and emotional resources—seems to exert these effects both directly and by buffering the negative effects of stressors. The fact that behavior intended to be supportive has been shown in at least one situation to have negative effects on function suggests the importance of distinguishing between autonomy-enhancing and autonomy-reducing modes of support. This distinction is familiar in the field of child development but not in gerontological research, and it is only one example of a causal complexity that is almost certainly widespread.

Our third recommendation, therefore, is that extrinsic factors that

influence successful aging should be studied in interdependent combinations as well as singly.

Finally, research that links the physiologic and psychosocial levels is suggested by the fact that both are implicated in the definition and explanation of successful aging. Recent experiments showing the effect of psychosocial interventions on physiologic indicators of stress and resistance to disease illustrate both the feasibility and the importance of such interdisciplinary efforts. Scientific work on aging requires both levels of explanation for completeness, and gerontological practice requires both for the development of effective interventions. Our fourth recommendation, therefore, is for aging research that links the psychosocial and physiologic levels.

These recommendations have in common a thrust toward health promotion and disease prevention in the elderly. A revolutionary increase in life span has already occurred. A corresponding increase in health span, the maintenance of full function as nearly as possible to the end of life, should be the next gerontological goal. The focus on successful aging urges that goal for researchers, practitioners, and for older men and women themselves.

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