

HUMAN VARIABILITY:
A Discussion of Life-Span and Longevity

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It has often been said that the only certainty in life is death. We are all going to die sometime, so it just remains a question of when and how. Because death is something we are all faced with, there seems to be a universal interest in it. Our conceptions of death are intricately related to our ideas about life, including our attitudes toward old age. Alex Comfort has suggested that, "Our reaction in this culture to old age, as to death, is one of anger and outrage, in a way that hasn't been true in previous cultures." (Comfort:1970). Reflections of this may be seen daily in our dress, our language, and even in our physical appearances. It is not uncommon for women, or for men either, to dye their graying hair, to wear youthful styles of clothing, and to utilize words and phrases common in the conversation of the young in order to disguise the fact of their aging. This has even been carried to the point that face lifts, to remove the wrinkles of age, are not viewed as being particularly extreme.

The reasons for these reactions are tied to both our own cultural background and also to apparent universal ideas about life. We are definitely a youth-oriented culture. This is in part, no doubt, due to our basic acceptance of the Protestant work ethic, and the belief that to be useful we must work. Those who don't work don't command the respect of much of the remainder of society. Inability to work is associated with the physical results of aging, so perhaps denial of aging is a defense against the prospects of the forthcoming loss of status.

On a broader scale these reactions may be attributed to the fact that all societies value life and seek to prolong it

(Cowgill & Holmes: 1972). But it should be noted that we seek to prolong the period of our active lives and not our period of disability.

Interest in long life is also cross culturally evident in the form of legends and folklore. There seems to be two common themes: the "antediluvian" theme and the "hyperborean" theme (Cowgill & Holmes: 1972). The former suggests that in the past people lived much longer. A good example of this may be seen in the Judeo-Christian religions. The Old Testament writings of the Bible often make reference to the extreme ages of some of its characters. This is sometimes referred to as the Methuselah theme. The second assumes that in some remote area of the world there are contemporary people who hold the secret of long life. There are many people today who do not hesitate to accept this as fact. To support their arguments they point to the numerous newspaper and magazine articles that picture the elderly inhabitants of Vilcabamba, Ecuador; Hunza, West Pakistan; and the highlands of Georgia in the Soviet Caucasus. The validity of this theme as well as the reports cited to support it will be discussed later in this paper.

Prior to this, it might be helpful to explain the use of several terms. Cross-cultural comparisons have revealed variations in both life expectancy and longevity. Changes have been noted within the same culture with the passing of time, often leading people to conclude that man is living longer now than he did in the past. This is correct, to some extent, but there is a tendency to confuse the issue here. For example, the fact that life expectancy in the United States has increased by 24

years since 1900 does not mean that people are living that many years longer, but that more people in the population are living to old age thus raising the mean or average for the entire population. The life-span of man then has not increased, but his expectancy has. Life-span as defined by Louis Dublin is the limit beyond which human life does not extend even in the most favorable circumstances (Dublin: 1952: In: Lansing). This limit represents man's biological potential, which is considered to be somewhere around 100 years.

The importance of recognizing these differences is apparent when considering the implications of a change in either. The change in life expectancy in the United States has resulted from a combination of factors. Both the decline in birthrate, and the improvement of health care, decreasing the number of premature deaths, has brought an increase in the proportion of elderly in our population to 11% (Leaf: 1973). A change in life-span will only be brought about by the manipulation of the biological mechanisms of aging.

Cross-cultural differences in life expectancy and reported longevity have prompted questions concerning the existence of populations with a longer than average life expectancy and life-span ("hyperborean" theme). The Wichita Eagle recently ran a picture of a woman and her son who claim to be 140 and 100 years old, respectively (1974). In the last few years there have been numerous articles, both popular and scientific, reporting cases of extreme longevity. These reports prompted the implementation of intensive research methods in order that the secret of the longevity of these groups of people might be learned. Consideration was given to the possibility that their diet, the altitude,

their level of physical activity, or their heredity might play a role in their extreme longevity. Few would question that these aspects of culture have some degree of influence on longevity but there is doubt that these could bring about such a large increase.

Zhores A. Medvedev, a Russian scientist currently working in London, will not accept the implications of these studies. He proposes that the basis for the superlongevity is not attributable to biological differences, but to a complex social problem which has developed for social, cultural and political reasons (Medvedev: 1974). The similarities of factors between the societies in which the centenarians live does not seem close enough that their longevity should be ascribed to these. Furthermore, there are inconsistencies between the patterns of longevity in the three populations previously mentioned and those of the general population. Medvedev cites the following points as cause for suspicion:

1. These villages have more people in progressively older age brackets;
2. They showed a decrease in the percentage dying with each higher age bracket, contrary to the expected increase;
3. There were more superold men than women; and
4. The biochemical studies conducted showed that the function and metabolism of the 100 to 110-year-olds was on the same level as is normal for 55 to 60-year-olds.

Cowgill and Holmes report that the status of the aged is higher in less complex societies (Cowgill and Holmes: 1972). This could account for many of the claims and is proposed by Medvedev to be one of the probable reasons. Further, at least in the Caucasus, the fact that the Moslem calendar year is ten months long must also be noted. Political factors come

into focus when the emphasis the Soviets place upon these people, as examples of their social achievement, is evaluated.

The lack of adequate documentation of any of the super-old has been one of the primary causes for dissatisfaction with the studies. At present, the greatest authenticated report of old age in this country is 120 years (Comfort: 1964).

Medvedev's use of statistics to criticize the authenticity of the reports may not be valid, should a race genotype with twice the normal potential life-span exist. Comfort suggests that this would not be evident unless the distribution of ages is continuous.

When what is currently known about the processes of aging is considered, it becomes increasingly difficult for me to accept these and other reports of extreme age as having any biological basis. As is certainly apparent by now, any study dealing with longevity and life-span is inherently involved with studies in the processes of aging. Although when a person is considered old is largely determined by culture, the fact of biological aging assures that in each society there will be individuals who are considered aged. This state is generally accompanied by a decrease in strenuous physical activity, the acceptance of new roles, and change in the treatment accorded them by the remainder of the society (Cowgill and Holmes: 1972). These social changes result most often as a consequence of the changes in the ability of the individual to adapt due to decreasing physiological adaptability. In modernized societies, however, old age is signalled by chronological age despite physical condition.

E. W. Busse makes a distinction between two aging pro-

cesses: 1. Primary Aging, that is, those inborn and inevitable detrimental changes that are time-related but independent of stress, trauma or disease; and 2. Secondary Aging, or disabilities resulting from trauma and chronic disease (Busse: 1969). It will be seen later that these concepts determine the focus of the efforts being made to prolong life.

Most of the studies concerned with process are oriented toward primary aging, while studies of secondary aging are focused on the elimination of disease.

The following is a basic outline of some of the theories of aging as described by E. W. Busse (Busse: 1969).

1. Exhaustion Theory: An early theory based upon the assumption that all organisms contain a limited amount of energy which is gradually expended.

2. Accumulation of Deleterious Material: The assumption here is that pigments and other material accumulate in some of the cells, reducing their ability to function.

3. Deliberate Biological Programming: This involves the idea of built-in obsolescence. Accordingly, the life-span of the organism is limited by the durability of its parts; that is, the cells, tissues and organs.

4. Accumulation of Copying Errors: According to this model, life is terminated because cells develop copying errors which reduce the metabolic efficiency and interfere with their capacity for repair.

5. Cross-linkage or Eversion Theory: Cross-linkage between polypeptide strands results in a change in the structure of the collagen molecule, as well as a decrease in its elasticity.

6. Autoimmune Mechanisms: This proposes that with advancing age there is an accumulation of faults in the somatic cells, in the form of mutations. These mutations produce changes in the proteins, making them unrecognizable as a part of the organism and the body mounts an immune reaction to destroy what it mistakes as foreign matter. These are only a few of the many theories or models that have been developed. Even a quick glance at these reveals that investigations are being carried out at the cellular level. There are hopes that an understanding at this level will shed light on the mechanisms operating at higher levels in the aging process.

The basis for these studies lies in the work of Leonard Hayflick. Dr. Hayflick demonstrated that normal human and animal cells in vitro have a finite lifetime of 50 population doublings, taking about 10 months (Hayflick: 1974). Although these were in vitro studies, and no finite doubling process has yet been observed in vivo, the implications are interesting. He concludes that this finite lifetime of cells is a manifestation of biological aging at the cellular level.

The knowledge gained through the study of the aging process at the cellular level is being expanded in research and aimed at prolonging life. As I stated before, research is being carried out, focusing on both primary and secondary aging. Those interested in primary aging suggest that the increase in life-span that may be realized by curing the major diseases causing death, is not large enough to have any profound effect. Those interested in secondary aging, on the other hand, doubt that research in primary aging will come

up with any breakthroughs in the near future, but, if they should, they suggest that if implemented, its cost would be prohibitive for the average person.

I shall first consider the work of the researchers concerned with secondary aging. Alexander Leaf proposed that if science could prevent arteriosclerosis, hypertension and cancer, the life-span would be pushed closer to the biological limits (Leaf: 1973). There is little doubt about this, but its significance may be questioned. The effect of such a breakthrough would be a healthier old age, but it could hardly set back the limits of our life-span. Once again the primary effect would be upon life-expectancy rather than life-span. Hayflick produced the following table which illustrates how the elimination of ten of the causes of death would affect life expectancy at birth and at age 65 in the United States.

Table 1. Gain in Expectation of Life at Birth and at Age 65
Due to Elimination of Various Causes of Death

<u>CAUSE OF DEATH</u>	<u>Gain in Years in Expectation of Life if Cause was Eliminated</u>	
	<u>At Birth</u>	<u>At Age 65</u>
Major Cardiovascular-Renal Diseases	10.9	10.0
Heart Diseases	5.9	4.9
Vascular Diseases affecting the central nervous systems	1.3	1.2
Malignant neoplasms	2.3	1.2
Accidents excluding those caused by motor vehicles	0.6	0.1
Motor vehicle accidents	0.6	0.1
Influenza and Pneumonia	0.5	0.2
Infectious diseases (excluding tuberculosis)	0.2	0.1
Diabetes mellitus	0.2	0.2
Tuberculosis	0.1	0.0

A quick glance at this table shows that the elimination of all of these causes of death would result in an increase in

life-expectancy by 22.6 years at birth and 18.0 years at age 65.

Research is currently going on also which is primarily concerned with finding ways of slowing down the rate of aging. Experiments in this area have included attempts to increase longevity by lowering body temperature, by introducing antioxidants and immuno-suppressive drugs, and by restricting caloric intake.

Leonard Hayflick's discovery that cell cultures could be frozen for apparently indefinite periods in liquid nitrogen, and then thawed without altering the doubling process, has prompted study in the area of cryobiology. Although the preservation of whole tissues, organs or animals, through this process, has not yet been achieved because of problems related to crystalization. There are a few people, twenty as a matter of fact, who have chosen not to accept death (Kowet: 1974). These twenty people made arrangements that after their death, their bodies were to be chemically treated and frozen, in the hopes that at some time in the future a discovery would be made, in whatever the field pertaining to their causes of death, and they might then be thawed and their lives restored.

The problem with this, thus far, on the cellular level, has been related to the damaging effects of freezing (Chemistry: 1974). Fast freezing increases the chances of ice forming within the cells, causing cell membranes to burst. Slow freezing results in the formation of ice outside rather than inside the cell. When this happens, salt concentrations outside of the cell increase and the cell releases water in order to maintain osmotic equilibrium, thus resulting in the buildup

of lethal levels of salt within the cell. The emphasis now is to find cryoprotectants, solvents that are virtually unfreezable, that will prevent cell damage caused by crystallization. Those presently available are not able to penetrate large cell masses (Hayflick: 1974).

Another problem has arisen due to the fact that different types of cells have different rates of survival at the different freezing rates (Chemistry: 1974). This makes successful freezing of the entire organism doubtful at this time.

If Hayflick's statement that manifestations of age and death are due to a loss of cell function rather than cell division then perhaps some of the damage caused in freezing the organism might be repaired (Hayflick: 1974). This, of course, would not be true for non-reproducing cells, as are found in the brain. It has been reported that a cat's brain was frozen six months, thawed and tested for electrical activity. The fact that such activity was observed suggested to some that organs could be frozen and thawed with little damage to them. Dr. King has pointed out however, that the enzymes in frozen tissue may be unaffected and will produce electrical activity in a thawed brain when the vital cells are dead (King: 1974: In: Kowet). In fact, Peter Mazur of Oak Ridge National Laboratory has said that whole organs, which thus far have been subjected to freezing and thawing have been nonfunctional or have shortly become so (Mazur:1974: In: Kowet). Successful reviving then seems to be quite a way off in the future.

Hayflick's studies may also have prompted the research currently being carried out in search of a drug which will

reduce the core body temperature. Barnett Rosenberg of Michigan State University explains that by lowering the body temperature the aging rate is also slowed (Kansas City Star: 1974). Experimentation in this area has thus far been restricted to mice. Rosenberg does suggest, however, that if these tests are successful, they might be tried on humans within the next ten years. Their effects upon life-span have projectively been attributed various levels of success. While Rosenberg states that a change by twelve degrees Fahrenheit would result in a life-span of approximately two hundred years, Strehler suggests that a change in only two degrees Centigrade will result in a twenty-year extension (Strehler: 1970). It is doubtful, taking the individual variability in core body temperature into account, that lowering the temperature two degrees will have any detrimental effects.

Other studies have focused upon other manipulations. Vitamin E is a natural anti-oxidant, which is said to perform an important role in the maintenance of cellular function (Strehler: 1970). The addition of anti-oxidants to the diets of study mice has produced an increase in longevity. Interestingly enough, one of these was BHT, which is used as a food preservative in many items available at the supermarket.

Studies with mice have shown that a diet restricted in caloric intake, during the early periods of life, will increase longevity by as much as 20% (McCay: 1952: In: Lansing). This also results in a slower rate of maturation. Figures, concerning caloric intake in the villages claiming extreme longevity, also indicate that low consumption might be preferable. Even

if the inhabitants are not as old as they claim, there is still some relevance to this issue, as they are obviously elderly.

These studies and observations have implications for our cultural practice of over-feeding children. They are reaching maturity earlier no doubt, but their acceptance of social responsibility is delayed, often until after college. The conflict between biological and social maturity has created problems for many individuals. Perhaps a return to restricted caloric intake might produce a swing back to later maturation and increased longevity.

Nevertheless, any increase in either life-expectancy or life-span will have a marked effect upon our culture. A change in life-expectancy will result from an increase in the proportion of the old aged. A large enough change might result in a shift in the general ideas of the population, as the elderly often have a conservative influence. A change in life-span, however, will likely come as a breakthrough. The aim of such research is the extension of the active middle years, not the older period of disability. An increase in life-span extending the middle years will have different social results than a comparable increase in expectancy.

Bernice Neugarten has predicted that even an increase of only five years will have a profound effect upon economic and welfare institutions (Neugarten: 1972). With people living longer and having prolonged middle years, there will be more people in the job market than can be handled, at least if our present circumstances are any indication. Some sociologists suggest that for this and other reasons there will also

be a power conflict between the young and old.

Another point of interest will be its effect on rates of change. If the life-span is sufficiently extended, then perhaps people will feel less pressured to make instant decisions, taking a little longer to think things through.

There are bound to be difficulties in implementing these programs. Richard Zeckhauser warns that the practical approach will be to consider all the effects before activating any programs, but taking a realistic view at our past, he suggests that we will go ahead whether or not the long term effects are worth the cost of transition (Zeckhauser:1974).

This raises questions of policy concerning who is to receive treatment and how it will be paid for. It has been estimated by Wheeler that costs for therapy could range from \$2000 per year per person to \$20,000 per year per person (Wheeler: 1970). If the cost must be paid by the individual, then there will be the obvious problem that treatment will be restricted to the rich. This suggests the possibility of some type of federal aid.

In the state of Kansas, the proportion of elderly in the population is 12.4%. Birren has estimated that in Kansas alone, by 1980, in order to meet the needs of the aged, 13,000 new trained personnel will be needed (Hays and Mullikin: 1975). In order to help meet these needs, Wichita State University has developed a field major in gerontology, aimed at providing an interdisciplinary training to those interested in the problems faced by this increasing population. It seems inevitable that similar programs will be developed at other institutions

in this state and others as well in the future.

It will be interesting further, to observe how the distribution of the knowledge will be handled. The effects on societies at different levels of complexity should be varied, since our concepts of who constitutes the aged population and our attitudes toward them are culturally determined. For example, the change in life-span and the proportion of the population living into old age may be very disruptive to the order of power in some societies.

It can be seen that there are cross-cultural differences largely influenced by cultural factors, and some degree of cultural difference in longevity. Considering the data, however, I doubt that there are, in fact, such wide variations in the potential life-span as claimed by isolated groups. On the contrary, there appears to be a biological basis for aging, which is much the same throughout the species, and which determines that even when all the cultural factors are at an optimum, there is a limited number of years that we can live.

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