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ECONOMICS, TIME, AND AGE

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Economics, Time, and Age

Richard A. Posner*

I Introduction

I have long wanted to visit Ireland. I majored in literature in college, and wrote my senior thesis on the late poetry of William Butler Yeats, and I find myself returning to Yeats's poetry again and again. Yeats was, among other things, the greatest poet of old age, and he was also, among the great poets, probably the only one who improved with age at least until his fifties and who wrote great poetry right up into his seventies and indeed until days before his death.

I am going to talk today about two aspects of the economics of ageing: the psychology of ageing, where I will be drawing directly on Yeats, though only in small part; and creativity and ageing, where Yeats stands as representative of people who retain their creativity at advanced ages. Neither the psychology of ageing nor creativity is a topic ordinarily associated with economics. But I have long been interested in the economics of non-market behaviour, a non-traditional but very vital and improving area of economics, and I hope to persuade you that economics can say interesting things about both these topics. I will not be talking about policy as such, which depends on details, but I will be presenting concepts that undergird intelligent thinking about such urgent issues of policy touching upon the aged as the allocation of resources to health, mandatory retirement at fixed ages, university tenure policies, and the computation of damages for wrongful death.

There are three bits of theory that I must present right off. First is the basic concept of investment in human capital, which we owe largely to Gary Becker. Human capital means earning capacity, although the earnings can be non-pecuniary as well as pecuniary. People obtain schooling or on-the-job training, at a cost in tuition or in income forgone, in order to obtain benefits in the form of a return over their working lifetime.

* This lecture is based on Chapters 5 and 7 of a forthcoming book tentatively entitled *Aging and Old Age: A New Theoretical Framework.*

Investing in human capital tends to be concentrated in one's early years, because the opportunity cost is small then and the expected return great. As the years pass and one gets deep into one's career, the opportunity cost rises because one's income from work is rising, and the benefits fall because the number of periods over which a return on one's investment can be obtained is diminishing as retirement approaches.

The second bit of theory comes from psychology and is not ordinarily discussed by economists, but for my purposes it is an essential enrichment of the human capital model. It is the distinction between fluid and crystallized intelligence and the different age profiles of these two competences. Fluid intelligence refers to problem-solving, analytical ability, and abstract intellectual competence generally, crystallized intelligence to language competence and basic knowledge. Fluid intelligence begins to decline at an early age, often in the twenties, though the decline generally is gradual until the sixties. Crystallized knowledge tends not to decline significantly until senility.

The third bit of theory is a novel aspect of the economics of information that I found in, of all places, Aristotle's treatise on rhetoric. It is closely related to the distinction between fluid and crystallized intelligence. Aristotle is discussing how to argue to young and old respectively, and he says that this depends on their outlooks on life, which are different. He lists many differences, as we are about to see, among them that the "lives [of the young] are mainly spent not in memory but in expectation; for expectation refers to the future, memory to the past, and youth has a long future before it and a short past behind it: on the first day of one's life one has nothing at all to remember, and can only look forward". The old, in contrast, "live by memory rather than by hope; for what is left to them of life is but little as compared with the long past: and hope is of the future, memory of the past". So if we think of knowledge and imagination - roughly, "crystallized" and "fluid" intelligence respectively -as the two principal components of reason, the balance is sharply different between young and old people.

The basic human capital model, enriched by the psychologists' distinction between fluid and crystallized intelligence, by the different

ageing profiles of these two competences, and by the shifting balance between forward-looking and backward-looking thinking as we age, provides the framework of my analysis.

II Psychology of the Old

Economists generally take values, preferences, and attitudes for granted and consider how, with them as givens, a rational actor can maximise his utility by the choices that he makes of where to live, what occupation to follow, whom to marry, and so forth. I take a different tack here, and consider the extent to which the psychology of the old might fruitfully be modeled as a result of rational choice. I do not suggest that all old people necessarily make *conscious* choices as to whether, for example, to talk more and listen less than when they were young, but simply that certain choices, conscious or unconscious, appear to be rational in the sense of utility-maximising, once the fundamental attributes of being old are understood. Many old people, of course, have serious mental problems which prevent rational choices, and my discussion excludes such people. Nor do I believe that all aspects of the psychology of the old can be given satisfactory economic explanations. Genetics, for example, will play a role in my analysis.

The psychology of the old is the subject of a vast, ambivalent, but on the whole rather a pitiless, literature, though Dickens is a conspicuous exception (remember the Aged P in *Great Expectations*) and not an isolated one. We recall from *As You Like It* man's "second childishness, and mere oblivion,/ Sans teeth, sans eyes, sans taste, sans everything", and from *Hamlet* the ridicule heaped on old age in the person of Polonius. We recall the senescent Lear - a magnificent ruin, but a ruin nevertheless - the Struldbruggs of *Gulliver's Travels*; Keats's "few, sad, last grey hairs" shaken by palsy; T. S. Eliot's catalogue of the gifts reserved to age, such as the "cold friction of expiring sense" and the "rending pain of re-enactment/ Of all that you have done, and been," and Yeats's fulminations against old age ("this absurdity ... this caricature,/ Decrepit age that has been tied to me/ As to a dog's tail"). Elsewhere in this great poem ("The

Tower"), Yeats describes old age as "the wreck of body,/ Slow decay of blood,/ Testy delirium/ Or dull decrepitude,/ Or what worse evil come -/ The death of friends, or death/ Of every brilliant eye/ That made a catch in the breath".

Even the defiant cry of Tennyson's aged Ulysses has a certain bleakness:

> Though much is taken, much abides; and though
> We are not now that strength which in old days
> Moved earth and heaven, that which we are, we are:
> One equal temper of heroic hearts,
> Made weak by time and fate, but strong in will
> To strive, to seek, to find, and not to yield,

And Tennyson wrote a downbeat poem about Tithonus, cursed by immortality without an accompanying gift of eternal youth.

Aristotle's *Rhetoric* has a remarkable description of "the character of elderly men - men who are past their prime". Writing more than two millennia before the term "political correctness" entered the lexicon, he minces no words. His discussion is frankly stereotypical; it is - as befits a treatise on rhetoric, which must point the reader to characteristic features of its subject, features that the speaker's audience will recognise - a discussion of central tendencies rather than of individual variations. It is not the complete truth about the old, but it is part of the truth.

Because elderly men have lived a long time, "they have often been taken in, and often made mistakes; and life on the whole is a bad business". As a result, "they are sure about nothing ... They 'Think', but they never 'know'". Experience has made them "cynical; that is, they tend to put the worse construction on everything", and distrustful. They are also "small-minded, because they have been humbled by life: their desires are set upon nothing more exalted or unusual than what will help them to keep alive". This focus on keeping alive, together with bitter experience about how hard it is to get money and how easy it is to lose it, makes them ungenerous and cowardly, "always anticipating danger". They are self-centred, too, guiding their lives too much by what is useful for them rather than by what is "noble", that is "what is good absolutely". Stated differ-

ently, "they guide their lives by reasoning more than by character; reasoning being directed to utility and character to excellence". "They are not shy, but shameless", feeling only "contempt for what people may think of them". "They lack confidence in the future; partly through experience - for most things go wrong, or anyhow turn out worse than one expects; and partly because of their cowardice". They are loquacious, "continually talking of the past, because they enjoy remembering it". "Their fits of anger are sudden but feeble". It is a mistake to suppose them "to have a self-controlled character; the fact is that their passions have slackened, and they are slaves to the love of gain". When they feel pity, they do so "out of weakness, imagining that anything that befalls anyone else might easily happen to them ... Hence they are querulous, and not disposed to jesting or laughter".

The aim of this harrowing account is not, however, to make us side with youth. Young men are hot-tempered and fickle, lack self-control, are preoccupied with honour and victory, are naively optimistic. "They look at the good side rather than the bad, not having yet witnessed many instances of wickedness. They trust others readily, because they have not yet often been cheated. They are sanguine ... [because] they have as yet met with few disappointments". Their sanguine disposition makes them easily cheated, and together with their hot tempers makes them courageous: "the hot temper prevents fear, and the hopeful disposition creates confidence". And "they have exalted notions". "They think they know everything, and are always quite sure about it".

We can see where this is leading: to a typically Aristotelian celebration of the mean, that is, of men in their prime:

> They have neither that excess of confidence which amounts to rashness, nor too much timidity, but the right amount of each. They neither trust everybody nor distrust everybody, but judge people correctly. Their lives will be guided not by the sole consideration either of what is noble or of what is useful, but by both; neither by parsimony nor by prodigality, but by what is

> fit and proper ... They will be brave as well as temperate, and temperate as well as brave.

Aristotle concludes by observing that "the body is in its prime from thirty to thirty-five; the mind about forty-nine".

The essential differences that Aristotle discerns between young and old are two. The young are optimistic and the old pessimistic. And the old are more self-centred than the young. They are cowardly, putting their own safety above other goods. They are greedier than young people. And they are "shameless" - they don't care whether people have a good opinion of them.

What, within a rational-choice framework, might explain such differences? (If nothing, we may be led to wonder whether the description is adequate, or whether Aristotle isn't just too preoccupied with finding means between undesirable extremes.) Why for example would the fact that the young rely more on imagination or expectation in making judgments and the old more on experience or retrospection make the young optimistic and the old pessimistic? The key to the answer may be that people are *naturally* optimistic. As the great American philosopher Charles Sanders Peirce once noted,

> We seem to be so constituted that in the absence of any facts to go upon we are happy and self-satisfied; so that the effect of experience is continually to contract our hopes and aspirations. Yet a lifetime of the application of this corrective does not usually eradicate our sanguine disposition. Where hope is unchecked by any experience, it is likely that our optimism is extravagant. Logicality in regard to practical matters ... is the most useful quality an animal can possess, and might, therefore, result from the operation of natural selection; but outside of these it is probably of more advantage to the animal to have his mind filled with pleasing and encouraging visions, independently of their truth; and

thus, upon unpractical subjects, natural selection
might occasion a fallacious tendency of thought.

If Peirce is right that a limited tendency to view the world through rose-tinted glasses has survival characteristics (beyond some point, of course, such a tendency would be a disaster) and is therefore part of our genetic endowment, we would expect the tendency to be blunted by experience (which is correlated with age), since experience would demonstrate that our optimism was excessive. The effect of experience in grinding down natural but exaggerated optimism would be to make the old more pessimistic than the young, though not necessarily as pessimistic as Aristotle believed. Pessimism in turn would imply a reluctance to take risks, financial or otherwise, because the old will have learned that it is silly to think oneself "lucky". (This implies that in areas in which mistakes of optimism impose heavier social costs than mistakes of pessimism, responsibility should be entrusted to old rather than to young people.) More broadly, we can expect the old to be more "realistic" than the young, more aware of human limitation, and therefore "wiser" in the sense that contrasts wisdom with brilliance. Wisdom may in fact require little more than extensive experience combined with emotional maturity and detachment.

Since the old were once young, their pessimism entails disillusionment, including disillusionment about schemes for human betterment, schemes usually founded more on hope than on experience. The young may have read about the failure of such schemes, but the old have lived the failure, and in many areas of human activity, as I shall argue in the second half of this lecture, book learning is not a perfect substitute for lived experience. Being pessimistic, disillusioned, and cynical, the old, however "wise", tend naturally to become preoccupied with their own survival and happiness, these being the only goods of certain goodness to them. From that obsession avarice and shamelessness can spring.

We can give an economic twist to the idea that the old are more self-centred than the young with the help of the "last period" concept that has received much attention in economics in recent years. The social virtues, including fair dealing, trustworthiness, being a good listener, generosity, and forbearance or self-control, are oriented towards transacting

and, what is closely related, towards the acquisition of new human capital that will enable even more valuable transactions to be obtained in the future. Being a good listener illustrates both points. The good listener is polite, thus reducing the costs to other people of transacting with him, and by attending carefully to what other people say he increases his own stock of useful information. In addition, the good listener, by limiting his own speaking, reduces the risk that he will make "revealing" disclosures about himself that may repel potential transaction partners. The closer the horizon of one's transactional activity is, the fewer will be the benefits from adhering to virtues that increase the expected value of transacting. We might thus expect the old not only to be more loquacious, unrestrained, blunt and even tactless in speech but also to indulge in fewer regrets than the young (after correction for the fact that the old will have a larger stock of regretted actions), since from a functional standpoint the utility of regret is in reducing the likelihood of repeating what has turned out to be a mistaken action. The old have more experience, but also less to gain from learning from experience.

The most puzzling thing about the suggestion that old people are more self-centred than the young is the inordinate fear of death that Aristotle ascribes to old people. "They love life", he says, "all the more when their last day has come". How can this be, when the old have so many fewer years to lose by dying than the young do, and when those years may confer less utility, because of poor health?

Most people report that as they get older, time seems to go by faster. Perhaps this is because the young are looking forward and, being generally optimistic, with hope. They are therefore impatient; and we know that the "watched pot does not boil". At all events, the effect is to bring the future closer to the present than would be the case with a younger person. This might explain, without our having to posit that young people are naturally reckless or heedless, why the discount rate (which is of course the rate at which a future value or cost is equated to a present one) tends to decline over the life cycle. An alternative explanation is that people who have low discount rates will invest more in their long-term health and will therefore be disproportionately represented

among persons who survive into old age. Either way, a low discount rate implies being future-regarding. But this cannot explain the inordinate dread of death that Aristotle attributes to the old. Death is much more imminent for the old, and the probability within a given interval greater; yet, confront old and young with the same risk of death, and the old will dread the prospect not much less, and sometimes more, than the young do.

One reason for this is that there appears to be no genetic programme for old age; so few people survived to old age in the evolutionary era of human existence that it is most unlikely that there were enough old people for natural selection to operate on, picking out those whose attributes maximised the survival probabilities of their descendants. All human beings of minimal mental competence fear death. This fear, which religious, political, and military leaders have devoted endless ingenious thought to overcoming, is instinctual, programmed. Its contribution to inclusive fitness (the survival of a person's genes over future generations) is obvious, since a rational creature that has such a fear is likely to survive long enough to maximise his reproductive potential. In fact the survival of the very old contributes little to inclusive fitness, and may detract from it by putting them in competition with the younger members of their own families for scarce supplies of food and other resources. But if selection pressures have not produced a distinctive genetic programme for the old, because so few people survived to old age during the evolutionary period, there is no reason to expect them to have lost the instinctual dread of death, and this dread, like other phobias, may defy being reasoned away.

There is an economic as well as a biological reason why the old should dread death as much as the young. The economic literature on damages in tort cases points out that for a person who derives a positive utility from living and does not have a very powerful bequest motive, no amount of money will compensate him for giving up his life on the spot. For he will derive no utility from the money. By the same token, again setting aside the case of negative utility from life or of a strong bequest motive, a person should be willing to expend all his resources, if necessary, on avoiding an immediate death, because those resources will have zero value to him if he dies immediately; they have no opportunity cost.

Hence (subject to the individual's budget constraint), when faced with the prospect of imminent death a person will behave at all ages as if the value of his life were "infinite" to him. This behaviour will be encountered *more* commonly among old people than among young ones because the old are more likely to encounter substantial risks of imminent death.

None of this explains why the old should dread death more than the young, however. Nor is it clear that they do (in fact it is clear that not all do, for the suicide rate is highest among elderly people); but here are some reasons why they might, or might at least so appear to an observer:

First, the sacrifice of an old person is likely to confer a smaller expected gain on other people. A warrior who sacrifices himself in combat may, by assuming the risk that has led to his death, have contributed to the survival of his nation, comrades, family, and way of life. The risking of life by one too old to be effective in combat is less likely to produce a compensating gain.

Second, as between two persons, one old, one young, facing the "same" danger (maybe both are equidistant from a drowning child), the risk of death or serious injury is apt to be much greater to the old person because of his physical frailty.

Third, as suggested by the first two points, it is rare that the issue is life versus certain death. Cowardice is unwillingness to *risk* one's life, not (in our culture anyway) unwillingness to commit suicide. If the young are more optimistic about risky choices than the old, this would make the disutility of the same risk of death greater to an old person than to a young one.

Fourth, as the end of life approaches, other sources of utility besides continuing to live may disappear or diminish. As the marginal value of competing goods (such as sex, travel, rich food and drink, strenuous exercise, and so forth) falls, the rational old person will reallocate resources to life-extending investments in medical care and in safety. He will become more cautious than a young person because what he gives up in alternative consumption by being cautious is worth less to him. Equivalently, he has less to gain from taking risks than a young person would.

Finally, it is arbitrary to suppose that the only thing to be lost through death is future living. Another consequence is the destruction of the complex of memories that constitutes a person. Until senility begins to destroy those memories, the old person has a richer stock of them than a young person.

Taken together, these points show how in expected-utility terms life-endangering risk-taking by the old might be at once less beneficial (points 1 and 4) and more costly (points 2, 3, and 5) than such risk-taking by the young, provided that the expected utility of the remaining years of life does not play too large a role in the fear of death. But we must not go overboard. The higher suicide rates of old than of young people is evidence that some old people, at least, set a lower value on continued life than young people.

It is noteworthy that decline does not play a large role in Aristotle's depiction of the psychology of old age. He attributes almost all the distinctive traits of the old to the changing balance between imagination and experience. This both explains and is explained by his choice of age 50 as the onset of old age. By then a person has seen enough of life to have lost his youthful optimism; and it is doubtful that the typical 50 year old in the citizen population of fourth-century BC Athens was mentally or physically decrepit. But decline must not be ignored in considering the distinctive psychology of the old, once the threshold of old age is raised to a more realistic level. Age-related decline helps to explain not only the "cowardice" of the old (point 2 above), but also their hesitation and tentativeness. One way to compensate for diminished physical or mental capability is by investing more time in doing tasks. So old people walk more slowly, drive more slowly, and make decisions more slowly. The point is not that they are incapable of walking fast, and so on, but that taking more time is a rational adaptation to diminished capability. An old person has a greater risk of falling than a young person does, because the old person has poorer balance and eyesight and slower reflexes, and being more frail is also more likely to be injured if he falls. The benefits of using more inputs of time are therefore greater to him, so he makes a deliberate choice to walk and drive more slowly than he is capable of doing. In addition the

cost of time is likely to be less to him than to a young person, and this will increase the tendency of the old to substitute time inputs into their activities for other inputs.

Age-related decline also helps explain another common observation about old professionals and academics, and points me towards my second topic: they generally do not keep up with the literature in their fields as assiduously as the young do. If the cost of absorbing new information is higher to the old than to the young because of diminution of fluid intelligence, and the benefit lower because the old have fewer periods remaining in which to earn a return on any human capital they acquire, the observation is consistent with what one would expect. The broader point is that the old are less receptive to new ideas than the young. This is the kernel of validity to the cruel aphorism (the "smoking gun" of age discrimination cases) that "you can't teach an old dog new tricks". The old dog is rational in not wanting to take the time to learn new tricks, as the cost will be greater and the benefit smaller than in the case of a young dog.

This analysis adds a further dimension to the aversion of the old to risk-taking activity. One thing that often makes a proposed course of action risky in the sense of quite likely to fail is that it involves doing something new. If it were merely the repetition of an old action the estimation of its likelihood of succeeding would be more accurate; there would be a track record to rely upon; the risk of failure would be minimised. So if because of decay of fluid intelligence or the cost of breaking old habits the old have trouble absorbing new ideas, this may make it difficult for them to evaluate risky choices.

We should not be surprised to find that old people are on average more religious than young (in belief, not practices, since the incapacities associated with old age may limit church attendance). The afterlife, being more imminent for the old, has a greater weight in their thoughts and decisions. A slightly subtler prediction is that among the old religiosity will be negatively related to health, because the unhealthy old have a shorter life expectancy.

We might expect old people to be on average selfish, single-issue voters. Like politicians with short terms of office, the old have truncated

horizons and therefore would be irrational to take the long view. This point is in only superficial tension with the point about religiosity, which extends the horizons of many old people but does so in a way that affects their perceived self-interest; it need not make them altruistic voters. But the point disregards disinterest. To the extent that the aged are in the process of disengaging from the world, they have less stake in redistributive policies than younger persons do. In this respect old people resemble judges (many of them old), whom we assume to be more impartial than other decision-makers because the rules of judicial ethics require that they have no family or financial stake in the cases that they judge.

From Nestor to Polonius and beyond, a frequently observed characteristic of old people is loquacity. I suggest that this can be explained by reference to the lesser value of privacy, consideration, and new information to the old than to the young. Another factor is the difficulty of interpersonal transfer of lived experience. If the knowledge that comes through experience were easy to transfer through books or conversation (and some of it is easy to transfer that way), there would be no socially useful age-related attribute called "experience" or "judgement". The young would pick these things up by reading about them. To the extent that lived experience is imperfectly transferable, we should expect older people to resort to elaborate, protracted speech in an effort to overcome the obstacles to communication.

III Age and Creativity

Under the general heading of age and creativity, I want to discuss both age-related changes from one kind of work to another and age-related changes in the quality of work, and to contrast creativity with another important area of human activity, leadership.

As an example of the first point, one observes that, as they get older, academics at research universities often reallocate working time from producing scholarship to assisting in the administration of the university. Because the opposite pattern, in which an academic begins his career heavily involved in academic administration and later reallocates

time from administration to scholarship, is almost never observed, it is unlikely that the age-related substitution of leadership activity for creative activity is a matter of sorting. If it were merely the case that when an academic was starting his career no one could tell whether he was better at scholarship or at administration - that it took several years of observation to determine which type of work he was better at - there would be as many cases in which an academic started in administration and later switched to scholarship as the reverse.

It is more plausible to suppose that what is going on is a decline in creative output caused by reduced investment in human capital over the life cycle, as predicted in the economics of human capital pioneered by Gary Becker and others. This cannot be the entire explanation, however. The simple life-cycle model does not explain why the investment profile for *leadership* human capital should be different from that for *creativity* human capital. And the extensive literature on peak ages of creativity identifies in fields such as mathematics and theoretical physics average peak ages that are too low - in the thirties or even twenties - to be explained by the reduction in investment in human capital that is induced by proximity to death. If we ignore age-related decline, as the simple life-cycle model does, a 35-year-old particle physicist would have an expected payback period of roughly 40 years for any new investment that he made in his human capital.

True, the opportunity costs of investment in human capital tend to grow with age because income, which one would have to give up if one devoted substantial time to such investing, tends to grow with age. But low age peaks imply that the investment in human capital required in the particular activity is low, so a diminished incentive to re-invest in one's human capital is unlikely to explain declines from the peak. The less human capital is required to perform a particular activity, and hence the lower the cost of acquiring the necessary human capital, the less sensitive will investment in it be to the proximity of death. Even an octogenarian might invest in the knowledge required to play poker or bingo - though the payback period for his investment would be severely truncated by his age.

If we are to explain peak ages of productivity, therefore, we must

move beyond the simplest human capital model. The first thing to note is that the very concept of a peak age of productivity is misleading in suggesting that all careers have a pronounced inverted U-shaped age profile. There are careers that have early peaks and careers that have late peaks, but also careers in which the peak, whenever attained, is sustained without a significant decline virtually until death. Let me call these "sustained peak" careers, as distinct from "early peak" careers and "late peak careers". Sustained-peak careers can in turn be divided into "early peak, sustained" and "late peak, sustained", thus giving us a fourfold division: early peak; early peak, sustained; late peak; late peak, sustained. Examples of the first category are most fields of professional athletics, along with mathematics, theoretical physics - and heavy manual labour. Examples of the second category are literature, economics (other than the severely mathematical), musical composition, and musical performance. An important example of the third category (late peak) is the senior management of large firms, where the peak age will often be in the late fifties, followed by retirement in the early sixties; perhaps most leadership is in this category. An example of the fourth category (late peak, sustained) is judging. History, theology, literary criticism and scholarship, and philosophy appear to straddle the second (early peak, sustained) and fourth (late peak, sustained) categories.

Peak age may be low in an activity because minimum capability is very close to peak capability, as in professional athletics or in mathematics. Such proximity marks an activity as an elite one. Elite activities are more challenging; that is, they draw on more of a person's ability than routine ones do. If an elite activity does not require a large investment in human capital and if the biological abilities on which it draws peak at an early age, the decline in capability can come very early, as in the case of many sports. In academic fields in which these conditions obtain, we can expect substitution into administration early in a scholar's career - provided of course that administration does not have the same age profile. It does not. Why not? Here are three mutually compatible possibilities. First, the ratio of fluid to crystallized intelligence is higher in creative tasks. Although leadership usually requires some problem-solving abilities,

much of it consists of assessing, motivating, and monitoring other people, interpersonal skills that are not strongly correlated with problem-solving ability. Second, experience is an important input into most forms of leadership. Experience is the knowledge that accrues from living and working, as opposed to reading or studying, and it therefore grows with age, though in some activities only up to a point: after a point early reached in living or working, one does not become better at tying one's shoe laces or tightening a bolt on an assembly line. If experience is more valuable in leadership than in creative activity, it is easy to see why the peak age for leaders might be much later than that for scientists or poets. Third, leadership implies responsibility. If an academic is a flop as teacher or scholar, he can be fired (unless he has tenure), and little harm has been done; even if he has tenure and cannot be fired, his ineptitude will do relatively little harm. But a leader who is a flop may cause serious harm to many other people, so it is natural to require that he demonstrate his competence in advance by success at the next lower rung of the administrative ladder, and the necessity of climbing the ladder makes it likely that senior leaders will be of mature age. To put this differently, the costs of failed leadership tend to be greater than those of failed creativity, implying a more careful screening of leaders than of creative workers; and careful screening of leaders may require many years of observation.

But there is a big puzzle here. Why does one have to learn some things by doing rather than by studying, given that study takes so much less time? In the case of "physical" tasks (using the word loosely) such as riding a bicycle, or mixed physical-mental tasks such as driving a car, or even such "purely" mental tasks as learning to speak a foreign language, the answer is that the task, to be done right, requires a degree of speed in responding to stimuli which can be achieved only by habit-inducing drill. But this does not explain why long experience should be a condition of effective leadership any more than of effective research in theoretical physics. The reason that physicists peak early is not that they operate without a substantial knowledge base, but that they can absorb the essential parts of the base by a relatively brief course of reading, practice, and being instructed. Why could not a social scientist, through careful study of polit-

ical and management theorists, psychologists, politicians, and business leaders, assemble a course of readings that would impart to students all the principles of effective leadership, so that after a brief course of study the student would know everything that seasoned politicians and managers knew? It is only a partial answer that institutions differ in significant detail. That just implies having to supplement the general course of instruction in the principles of leadership with a handbook applying the principles to the particular institution (university, business firm, nation, or whatever) in which the student wanted to make his career of leadership.

Why does that seem a quixotic suggestion? Evidently some types of knowledge are extremely difficult to transfer from one person to another. A lifetime's experience can be summarised, but the summary will not provide much in the way of useful guidance to another person, who is at an earlier point in his own life cycle. Why there should be such a tremendous loss in transmission - why some forms of knowledge should depend on the knower's own experience rather than on that of his predecessors - is a puzzle. It is not enough to say that leadership is one of those activities about which we do not know enough to lay down rules and are therefore left to grope our way as best we can by employing analogies to past experiences; for why could not all the potential analogies be neatly laid out in a book for the young leader to consult when he came upon a new problem? I offer two suggestions. First, for reasons that are not well understood it is difficult to learn how to deal with people effectively from books, and the essence of leadership is dealing with people effectively. Second, leadership like warfare is a strategic activity in the game-theoretic sense: every move invites a countermove, so the leader who merely repeats the moves of previous leaders is easily thwarted because predictable.

Even within the class of creative fields, as the examples I gave earlier should have made clear, there are large differences in the age profile of productivity. Some of these differences can be explained in terms of the different rate at which fluid and crystallized intelligence decline with age, or of different levels of required investment in human capital, or both. Mathematics and physics (especially theoretical physics) involve

both high ratios of fluid to crystallized intelligence and low levels of human-capital investment, because the stock of knowledge that they employ can be conveyed through books and instruction economically, with relatively little "learning by doing" required. It is no surprise that they are early-peak fields. Nor that experimental scientists have a later peak than theoretical ones; not only are the demands on fluid intelligence somewhat less, but experimentation involves team work, hence some people have skills and therefore "leadership" in a broad sense. Most modern economics entails formal modeling skills that draw heavily on fluid intelligence, but experience of social life is important too, and it accrues with age. History and literary criticism are fields which traditionally have required large investments in human capital because of the need to master large bodies of text or information that cannot be reduced to a handful of principles, and in which aspects of crystallized intelligence, and in particular skills of exposition, play a much larger role relative to fluid intelligence than in the case of scientific and social scientific fields. Expository skills - not only writing skills narrowly conceived but also the organising skills required to write books as distinct from articles - tend to improve with experience.

Lyric poetry has been found to be an early-peak field, which may seem surprising since it is of course a branch of writing, although it involves less organisation, and therefore less experience, than scholarly writing or fiction because the unit of composition is so much smaller. But probably the reason for the early peak is simply that poetic ability is positively correlated with psychiatric illness, which is likely to disable the poet at an early age. And so many lyric poets have *not* suffered a creative decline with age (familiar examples are Yeats, Stevens, Whitman, and Frost) that the field should probably be placed in the category of fields in which early peaks are achieved and sustained. This description is consistent with the centrality of writing skill to poetic achievement *and* the dispensability of substantial life experience to the writing of poetry, as distinct from the writing of novels, where we would expect the peak to be reached later but, again, sustained indefinitely.

Musical creativity, both in composition and in performance, fol-

lows a pattern similar to that of poetry - early peak, sustained - but in the case of performance, at least, this is puzzling. A concert pianist or violinist is engaged in an elite activity, that is, one in which required capability is close to peak capability; and his capability has a physical dimension. It might seem therefore that even if the age-related decline in the requisite physical skills is slight, ageing concert performers would be quickly supplanted by equally able youngsters; yet there are innumerable examples of pianists and violinists who continue to perform with immense distinction to a very old age. I conjecture that life experience can compensate for the relatively slight physical decline. Music has a rich emotional content, and age may enable the performer to discover and express emotional dimensions invisible to the young.

The sustained peak in philosophy may seem a mystery since the ratio of fluid to crystallized intelligence in the activity of philosophers is, or at least might seem to be, very high. Although the peak age of achievement is early for philosophers whose work borders on science or mathematics (Bertrand Russell, for example), Wittgenstein had peaks in his twenties (when he was doing logic) and in his fifties, and many philosophers, ranging from Plato and Kant to Dewey and Sartre, and, among the living, Quine, Davidson, Rawls, Putnam, Richard Rorty, and a number of others, have remained highly creative in their sixties or even later. I suggest two explanations. The first is that literary skills are far more important in philosophy than in, say, mathematics. The distinction of many philosophers, including Plato, Wittgenstein, Nietzsche, James, and Rorty, is owed in no small part to those skills. Metaphors ("language game", "veil of ignorance", "cash value", etc.) and other striking turns of phrase (such as Thomas Kuhn's "normal science" and "paradigm"), neologisms ("grue"), parables (Plato's cave, Neurath's boat, "turtles all the way down"), dialogues (Plato again), and even poetry (Lucretius) have been employed in philosophy to striking effect.

I am not entirely comfortable with this point. Although metaphor is unquestionably a verbal skill, it is also, or at least it seems to be, closely related to analogy. Analogy plays an important part in scientific discovery and seems - this power to find the similar in the dissimilar - work

for the fluid intelligence. The explanation for the difference in the age correlations of metaphor and of scientific analogy may be that while both draw on fluid intelligence, metaphor being a verbal phenomenon also draws on verbal skills that tend not to decline with age and may even improve.

A second reason for the sustained peaking of philosophers but not of the highly mathematised sciences is that philosophy is less progressive than the scientific disciplines. Because the problems addressed by philosophers and the analytic tools used to solve them change much less rapidly than in the case of physics or mathematics, philosophers' human capital depreciates less rapidly than scientists' and hence requires less new investment to maintain. Likewise, the decline of their fluid intelligence is less hampering if they do not have to address new problems but can continue worrying the old ones, for the ratio of fluid to crystallized intelligence employed is higher the newer the problem being addressed is to the person addressing it. The rate of depreciation of human capital becomes decisive for age-related productivity if the cost of acquiring new human capital relative to the expected return is a sharply increasing function of age: which is plausible since age both reduces the payback period and, through its effect on fluid intelligence, increases the cost of acquiring human capital.

How might scholars in early-peak fields respond to the decline of their powers? I have mentioned the substitution of administration for research. Here is another possibility. Suppose that the best journals in some scientific field will not publish articles that reflect a capability of less than 90 per cent of the peak capability of average practitioners, and Dr *Y* is average. Then when his capability falls below 90 per cent of his peak, he will no longer be able to publish in such journals. He may respond by publishing in lower-quality journals. Since there is some substitutability between quality and quantity, maybe he will write more articles for such journals than he previously wrote for the best journals. Or (borrowing a leaf from the philosopher's book) he may decide to concentrate his research efforts on old problems rather than on new ones or to become a populariser rather than a creator of science, in either case mak-

ing less use of his fluid intelligence and incurring a lower (possibly zero) depreciation rate of his existing knowledge.

Another reason for the ageing scientist to adopt a conservative research agenda is that a bold agenda might bring into question the validity of his earlier work, the work on which his reputation is based. A young scientist by challenging received wisdom threatens the reputation of other scientists, not his own reputation, for he has none. It is otherwise for the older scientist. But I doubt that this is an important influence on the research of older scientists. If one's earlier research is unsound this is bound to be discovered sooner or later, and if you are your own unmasker you will get credit for courage as well as for intelligence. Reputation protecting should be distinguished from resistance to new ideas that results from decline of fluid intelligence and from failure to invest in new human capital.

I want finally to consider age-related but *quality-independent* changes in the character of creative work. In fields such as painting and sculpture, musical composition, and law in which age-related quality declines tend to be slight, zero, or even negative, as well as in the careers of exceptional poets, such as Yeats, who remained unabatedly productive until his death, there is nevertheless a tendency towards boldness, clarity, and directness, and away from artifice. Yeats, Verdi, and Holmes all illustrate this tendency in their different fields. What might explain it? Economics suggests two possibilities. First, the diminishing value of transactions as the end of life nears reduces the cost of outraging an audience's expectations. Second, fame may confer licence: if a person has done valued work in the past, this increases the probability that his current work is also valuable and induces the audience to suspend its disbelief. He can thumb his nose at the crowd (the obverse of the "shamelessness" of the old, of which Aristotle wrote). This point suggests, incidentally, that it is a mistake for scholarly journals to use blind refereeing, as it may cause them to turn down unconventional work to which they would have rightly given the benefit of the doubt had they known that the author was not a neophyte or an eccentric. Finally, as fluid intelligence declines, the cost of complexity rises, inducing the creative worker to substitute towards less

complex forms of creation and expression. It might seem that if there is value in simple works, the younger creative worker would produce them even though he was capable of more complex works. But it may be difficult to make simple works that are of high quality, so that the worker economises by producing complex works until no longer capable of doing so.

Yeats, as always, put it well in his poem "The Coming of Wisdom with Time":

> Through all the lying days of my youth
> I swayed my leaves and flowers in the sun;
> Now I may wither into the truth.