

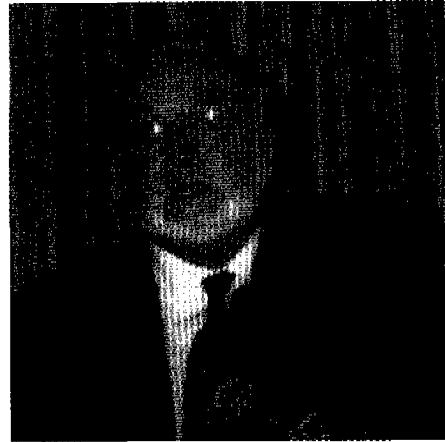
## ALFRED KORZYBSKI MEMORIAL LECTURE 1996

### Creativity and the Evolution of Culture

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Creativity is the process that describes the cultural evolution of humankind. It involves the making of new *memes*, or units of knowledge that become part of our cultural heritage. Memes provide instructions for what to do, like the notes of a song that tell us how to sing, or the recipe for a cake that tells us what ingredients to mix and how long to bake. But whereas genetic instructions are transmitted in the chemical codes we inherit on our chromosomes, the instructions contained in memes are transmitted through learning. By and large we learn memes and reproduce them without change. But when a new song or a new recipe is invented, then we have creativity.



Memes seem to have changed very slowly in human history. One of the earliest memes, for instance, was the shape that our ancestors gave to the stone tools they used for chopping, carving, scraping, and pounding. The shape of flint blades remained almost unchanged during the Paleolithic, for close to a million years. It was not until about 50,000 years ago, during the upper Paleolithic, that humans began to use new tools – blades specialized for performing specific functions, and even tools for making other tools. The first change in the meme of the tool took almost a million years to develop. Once this first step was taken, however, new shapes followed each other in increasingly rapid succession. For thousands of generations, men looked at the stone blades they held in their hands, and then reproduced ones exactly like it, which they passed on to their children. The shape of the tool contained instruction for its own replication.

But then someone discovered a more efficient way of chipping stone blades, and a new meme appeared and it started reproducing itself in the minds of men, and generating offspring, that is, new tools that had not existed before, which were increasingly different from their parents. The meme of a flint scraper or flint axe is part of the domain of technology which includes all the artifacts humans used to achieve control over the material environment. Other early domains were those of language, dance, visual representation, music, religion – each of which included a set of memes related to each other by a grammar of rules. Since the recession of the last Ice Age about 15,000 years ago, memes and corresponding domains have of course proliferated to an extent it would have been impossible to foresee only a few seconds earlier in evolutionary time. Now the single domain of technology is subdivided into so many sub-domains that no single individual can master even a minute fraction of it.

Whatever makes us uniquely human is the result of creativity. In terms of biology we are not that different from our cousins the great apes, with whom we share over 95% of genetic instructions. But our memes – language, art, religion, and science – make the reality we experience very different from that of a chimp or gorilla. This is why understanding creativity is such a fascinating and important task.

Creativity was the topic of the first scholarly study that I did over 35 years ago, when I started following a group of young artists in Chicago to see how they made works of art and how they developed as artists over time. And earlier this year I published a new book on creativity which summarized my previous work, and in addition contained a recent study in which I interviewed a number of creative artists, scientists, political and business leaders. In fact Professor Klein is one of the 90 individuals that I interviewed for that book. So what I'm going to talk about tonight are some of the things that came out of that research with these people, fifteen of whom had Nobel prizes. The others were about the same caliber, even if they did not win the prize.

Well, let me go through these issues systematically, otherwise I will be spending more time than I have. So I will be reading part of the talk tonight. First of all, I would like to start with the central idea that when we think about creativity, we tend to think of it as a mental process that takes place inside the mind of individuals. What I would like to propose tonight, and develop a little bit, is that such an approach to thinking of creativity as a personal, individual process cannot do justice to the phenomenon of creativity, which, I will argue, is as much cultural and social as it is a psychological event. And to develop this perspective, I will use a systems model of the creative process that takes into account its essential features. First of all, let me say that by creativity I mean an idea or action that changes the way we see, or think, or act. In other words, I don't mean by creativity just any idea that a person may feel is creative. I am using the term in its original meaning, as something which changes the culture, that changes the way we see, think, or act.

When I started studying creativity over 30 years ago, like most psychologists I was convinced that it consisted of a purely intrapsychic process. I assumed that one could understand it with reference to the thought processes, emotions, and motivations of individuals who produce novelty. But each year the task became more frustrating. In my longitudinal study of artists, for instance, it became increasingly clear that some of the potentially most creative persons stopped doing art and pursued ordinary occupations, while others who seemed to lack creative personal attributes persevered and eventually produced works of art that were hailed as important creative achievements. To use just a single example, young women in art schools showed as much or more creative potential than their male colleagues. Yet 20 years later not one of the cohort of women had achieved outstanding recognition, whereas several of the males did. Clearly some external factors were inhibiting the expression of creativity in women.

Thus starting from a strictly individual perspective, I was forced by the evidence to develop a model of creativity that encompasses the environment in which the individual operates. This environment, I will argue, has two separate aspects: a cultural or symbolic aspect, which here I will call the *domain*; and a social aspect which I will call the *field*. Creativity is a process that can be observed only at the intersection where individuals and domains and fields interact. The domain, which is part of the culture, is a necessary component of creativity because it is impossible to introduce a novelty without reference to an already existing pattern of information. New is meaningful only in reference to the old. Original thought does not exist in a vacuum. It must operate on a set of already existing objects, rules, representations, or notations. One can be a creative carpenter, cook, composer, chemist, or clergyman because the domains of woodworking, gastronomy, music, chemistry, and religion exist. And one can evaluate performance by reference to their traditions. Without rules, there cannot be exceptions, and without tradition, there cannot be novelty.

Creativity occurs when a person makes a change in a domain – a change that will be transmitted through time. Some individuals are more likely to make changes either because of personal qualities or because they have the good fortune to be well positioned with respect to the domain. They have

better access to it, or their social circumstances allow them free time to experiment. For example, until quite recently the majority of scientific advances were made by men who had the means and the leisure; clergymen like Copernicus, tax collectors like Lavoisier, or physicians like Galvani – men who could afford to build their own laboratories and concentrate on their own thoughts. And, of course, all of these individuals lived in cultures with traditions of systematic observation of nature, and with a tradition of record keeping and mathematical symbolization which made it possible for their insights to be shared and evaluated by others who had equivalent training.

But most novel ideas are quickly forgotten. Changes are not adopted unless they are sanctioned by some group entitled to make decisions as to what should or should not be included in the domain. These gatekeepers are what we call here the field. In physics the opinion of a very small number of leading university professors was enough to certify that Einstein's ideas were creative. Hundreds of millions of people accepted the judgment of this tiny field and marveled at Einstein's creativity without understanding what it was all about. It has been said that in the United States 10,000 people in Manhattan constitute the field of modern art. They decide which new paintings or sculptures deserve to be seen, bought, included in collections, and, therefore, added to the domain.

The system model presented here is analogous to the model that scholars have used to describe the process of biological evolution. Evolution occurs when an individual organism produces a variation which is selected by the environment and transmitted to the next generation. The variation which occurs on the individual's chromosome corresponds to the contribution that a person makes to creativity. Environmental selection corresponds to the contribution of the field, and what in biological evolution is accomplished by genetic transmission in the creative process is accomplished by the domain. Thus, creativity can be seen as a special case of evolution. Specifically, it is to cultural evolution as the mutation, selection, and transmission of genetic variation is to biological evolution.

Just to make this more concrete, during the last census over half a million Americans reported their occupation as being "artist". Thus half a million individuals are producing novelties, that is new paintings – probably several million of them each year. And yet during a recent national survey which asked a cross-section of Americans how many living artists they knew, the average response was less than two. And most of these respondents mentioned Picasso, who had been dead for several decades. This is just to show the tremendous selection that occurs in artistic creativity. You have 500,000 people trying to produce novel variations, but the field can select only a very small number to be included in the domain of art; very few of the millions of paintings will be preserved and few of the artists will be remembered.

As mentioned earlier, it is useful to think about creativity as involving a change in *memes*. These refer to the units of imitation that Richard Dawkins, the British biologist, suggested were the building blocks of culture. Memes are similar to genes in that they carry instructions for action. But they are different from each other in the way that they store information. For instance, as long as memes are recorded orally and can be transmitted only from the mind of one person to that of another, traditions must be strictly observed so as not to lose information. Therefore creativity in such a culture is not likely to be prized, and it would be difficult to determine in any case. Development of new media of storage and transmission, like books or computers, have a tremendous impact on the rates of novelty production and its acceptance.

Another way cultural differences affect the rate of creativity is the accessibility of information. Often people who benefit from the ability to control memes develop protective boundaries around their knowledge so that only a few initiates at any given time will have access to it. Priestly castes around

the world have been known to keep their knowledge esoteric and out of reach of the masses. Until recently, in Europe knowledge of Latin and Greek was used as a barrier to prevent the admittance of the masses to professional training. The more such barriers, the less likely it becomes that potentially creative individuals will be able to contribute to the domain. Similarly, how available memes are also bears on the rates of creativity. When knowledge is concentrated in a few centers, libraries, or laboratories, or when books and schools are rare, most potentially creative individuals will be effectively prevented from learning enough to make a contribution to existing knowledge.

Cultures differ in the number of domains they recognize, and in the hierarchical relationship among them. For example, in Western cultures philosophy developed out of religion, and then the other scholarly disciplines separated out of philosophy. For a long time religion was the queen of disciplines and it dictated which memes could be included in differing domains. Now scholarly domains have much more autonomy, although it could be claimed that mathematics has become the benchmark by which other domains are judged.

The multiplication and gradual emancipation of domains has been one of the features of human history across the planet. For a long time, almost every aspect of thought and expression was unified in what we would call a single religious domain. Art, music, dance, narrative, proto-philosophy, and proto-science were a part of an amalgam of supernatural beliefs and rituals. Now every domain strives to achieve independence from the rest and to establish its own rules and legitimate spheres of authority. Cultures in which the separate domains are clearly related to each other – and these tend to be the simpler cultures – are likely to resist novelty in any one area, since it would involve a readjustment of the entire culture. On the other hand, once a change is accepted in one domain of such a culture, the effect of that change is likely to reverberate across the entire system.

New memes most often arise in cultures that, either because of geographical location or economic practices, are exposed to different ideas and beliefs. The Greek traders collected information from Egypt, the Middle East, the north coast of Africa, the Black Sea, Persia, and even from Scandinavia, and this disparate information was amalgamated in the crucible of the Greek city-states. In the Middle Ages the Sicilian court welcomed techniques and knowledge from China and Arabia as well as from Normandy. Florence in the Renaissance was a center of trade and manufacturing and so was Venice. Later the maritime trade of the Iberian Peninsula, the Netherlands, and Great Britain resulted in those countries becoming centers of information exchange. Even now, when the diffusion of information is almost instantaneous, useful new ideas are likely to arise from centers where people from different cultural backgrounds are able to interact and exchange ideas.

Cultures are made up of a variety of domains: music, mathematics, religion, various technologies, and so on. Innovations that result in creative contributions do not take place directly in the culture, but in one of such domains. Creativity is the engine that drives cultural evolution.

It is important to realize that the notion of evolution does not imply that cultural changes necessarily follow some single direction, or that cultures are getting any better as a result of the changes brought about by creativity. Following its uses in biology, evolution in this context means increasing complexity over time. In turn complexity is defined in terms of two complementary processes: First, it means that cultures tend to become differentiated over time. They develop increasingly independent and autonomous domains. Second, the domain within a culture becomes increasingly integrated; that is, related to each other and usually supporting of each other's goals, in an analogy to the differentiated organs of the physical body that help each other's functioning.

This is what the domain and the culture contribute to the actualization of creativity. I would turn now to the social context, and even the most individually oriented observer must agree that, in order to be called creative, a new meme must be socially valued. Without some form of social valuation, it would be impossible to distinguish ideas that are simply bizarre from those that are genuinely creative. But this social validation is usually seen as something that follows the individual's creative act and can be at least conceptually separated from it. The stronger claim I am making is that there is no way, even in principle, to separate the reaction of society from the person's contribution. The two are inseparable. As long as the idea or product has not been validated, we might have originality but not creativity.

Nowadays everyone agrees that Van Gogh's paintings showed that he was a very creative artist. It is also fashionable to sneer at the ignorant bourgeoisie of his period for failing to recognize Van Gogh's genius and letting him die alone and penniless. The implication, of course, is that we are much smarter and if we had been in their place, we would have loved Van Gogh's paintings. But we should remember that 100 years ago those canvasses were just the hallucinatingly original works of a sociopathic recluse. They became creative only after a number of other artists, critics, and collectors, who lived in a different historical epoch, interpreted them in terms of new aesthetic criteria and so transformed them from substandard efforts into masterpieces. Without this change in the climate of evaluation, Van Gogh would not be considered creative even now. But would he have been creative anyway, even if we didn't know it? In my opinion, such a question is too metaphysical to be considered part of a scientific approach. If the question is unanswerable in principle, why ask it? The better strategy is to recognize that, in the sciences as well as in the arts, creativity is as much the result of changing standards and new criteria of assessment as it is of novel individual achievement. So the second main element of the systems model is society, or the sum of all the fields that operate within a time-space frame.

Fields are made up of individuals who practice a given domain and have the power to change it. For example, all the accountants who practice by the same rules comprise the field of accountancy, and it is they who have to endorse a new way of keeping books if it is to be accepted as a creative improvement. And society can then be defined as the sum of its interrelated fields, from architects to zookeepers, from nuclear physicists to beer-bottle collectors.

We may now consider some of the ways society can influence the frequency with which new memes are produced and accepted. All things being equal, a society that enjoys a material surplus is in a better position to help the creative process. A wealthier society is able to make information more readily available, allows for a greater variety of specialization and experimentation, and is better equipped to reward and implement new ideas. Subsistence societies have fewer opportunities to encourage and reward novelty, especially if it is expensive to produce. Only societies with ample material reserves can afford to build great cathedrals, great universities, great scientific laboratories. Even composing music, writing poetry, or painting a canvas require an economy where subsistence needs are not primary.

But it is not enough to have the material resources to implement new ideas. It is also important to be interested in them. There have been societies with great resources where new ideas were shunned. In Egypt, for example, after a unique burst of creativity that resulted in astonishing accomplishments in architecture, engineering, art, technology, religion, and civic administration, the leaders of society apparently agreed that the best policy was to leave well enough alone. Thus, most of Egyptian art for thousands of years was produced in a few central workshops supervised by priests and bureaucrats, and was done by relying on conventional rules, common models, and uniform methods. The sociologist Arnold Hauser writes that "originality of subject matter was never very much appreciated in Egypt, in

fact was generally tabooed, the whole ambition of the artist being concentrated on thoroughness and precision of execution.”

Whether a society is open to novelty or not depends also on its social organization. A society with a stable feudal structure, for instance, would be one where tradition counts more than novelty. Societies based on commerce with a strong bourgeois class trying to be accepted by the aristocracy usually provide a favorable environment for the production of novelty. Whenever the central authority tends towards absolutism it is less likely that experimentation will be encouraged.

External threats often mobilize society to recognize creative ideas that otherwise might not have attracted much attention. Florence in the 15th century spent so many resources on the arts in part because the leaders of the city were competing against their enemies in Siena, Lucca, and Pisa, and tried to outdo them in the beauty of their churches and public architecture. The reason high energy physics became so important after World War II is that practically every nation wished to have the technology to build its own nuclear arsenal.

Well, I will now cut to the chase. Being late, I would like to jump to the part that most people are interested in, and that is the individual in this equation. We talked about the necessity to have the culture with its domains, society with its fields, being able to stimulate and recognize creative achievements. But the question that probably you would ask is: So where is the person, where is the individual in all of this? Let me turn to that topic now.

After all, the great majority of psychological research assumes the creativity is an individual trait to be understood by studying individuals. So we must look at what makes a person potentially creative, provided we remember that as far as I can tell none of these personal characteristics are sufficient and probably not even necessary. Conservative and unimaginative scientists have made great contributions to science by stumbling on important new phenomena, and primitive painters, like Rousseau le Douanier or Grandma Moses, who were trying to be traditional but could not quite paint realistically enough, have contributed to the history of art. At the same time, it is probably true that the person who can master a domain and want to change it will have a better chance to be recognized as creative. So now we shall review briefly what the characteristics of such persons are, starting with consideration of the background factors that have a bearing on the production of novelty.

One of the first issues to consider is whether an individual is born in an environment that has enough surplus energy to encourage the development of curiosity and interest for its own sake. Despite the saying that necessity is the mother of invention, too much necessity, that is too much deprivation, does not seem to lead to innovative thinking. When survival is precarious, as it has been and still is in most of the world, there is little energy left for learning and experimenting. The lack of books, schooling, intellectual stimulation will have obvious detrimental effects. It is not impossible for a talented person to emerge from a ghetto or a third world country, but much potential is lost for want of access to the basic tools of a domain. Ethnic groups and families within them differ in the amount of importance they place on different domains. Jewish tradition has emphasized the importance of learning, Asian-American families have instilled strong economic and artistic motivation in their children. Some cultural groups emphasize musical abilities, others prize engineering, or medicine, or technology. Such traditions help to focus a child's interest in a particular domain, thus providing the preconditions for further innovation.

Cultural capital consists in the educational aspirations of one's parents, the non-academic knowledge one absorbs in the home, then the formal learning that one picks up from home and

community. Moreover, it involves the learning opportunities which include schooling, the availability of mentors, exposure to books, computers, museums, musical instruments, and so forth. Even in very poor families, when the parents read books to children, this seems to help the latter to become involved in intellectual pursuits and to break away from their destitute conditions. Parental expectations for educational attainment are also an important component of a child's cultural capital.

Another important aspect of personal background that has bearing on creativity is whether the child will have access to the field. In many domains it is indispensable for a young person to be trained by experts as soon as possible. To study physics or music long enough to be able to innovate in it depends in part on whether there are laboratories or conservatories in which one can practice and learn state-of-the-art knowledge. Parents have to be able to afford tutors as well as the time and expense involved in driving the child back and forth to lessons and competitions. The careers of creative individuals are often determined by chance encounters with a mentor who will open doors for them, and such encounters are more likely in places where the field is more densely represented: college towns, laboratories, or centers of artistic activity.

It has been observed that many creative individuals grew up in atypical conditions on the margins of the community. Many of them were orphaned early, had to struggle against relative poverty and prejudice, or were otherwise set apart from their peers. For example, my friend Howard Gardner recently wrote a book about the seven archetypal creative individuals in this century, and all of them, it turns out, had been marginal. Of the seven he wrote about, Einstein moved from Germany to Switzerland, Italy, and then the United States. Gandhi grew up in South Africa before going back to India. Stravinsky left Russia to live all over Europe. T. S. Eliot started in the U.S., settled in England. Martha Graham stayed in the United States, but she came from African-American background which made her, to a certain extent, marginal to the elites of the time. Freud, of course, had to leave Austria because he was Jewish. Picasso left Spain for France. It seems that a person who is comfortably settled in the bosom of society has fewer incentives to change the status quo.

Having the right background conditions is indispensable, but certainly not sufficient for a person to make a creative contribution. He or she must also have the ability and inclination to introduce novelty into the domain. These are the traits that psychologists have most often studied, and it is to these that we shall now turn. Because the individual traits of creative people have been so widely studied, I shall only touch on them briefly and without being able to do them justice.

Talent or innate ability refers to the fact that it is easier to be creative if one is born with a physical endowment that helps to master the skills required by the domain. Great musicians seem to be unusually sensitive to sounds from the earliest years, and artists seem to be sensitive to color, light, and visual shapes even before they start practicing their craft. If we extend the definition of creativity to domains such as basketball, and in principle there is no reason for not doing so, then it is clear that creative athletes like Michael Jordan benefit from unusual physical coordination.

At this point we know very little about the relationship between the organization of the brain and the ability to perform in specific domains. It would not be surprising, however, to find that interest or skill in certain domains can be inherited. Howard Gardner's postulate of seven or more separate forms of intelligence also seems to support the notion that each of us may be born with a propensity to respond to a different slice of reality and, hence, to operate more effectively in one domain rather than another. Many creative individuals display unusual early abilities that are almost on the level of the child prodigies that David Feldman described in his book, *Nature's Gambit* such as three year olds who do calculus, and speak thirteen languages, and so forth.

On the other hand, a roughly equal number of individuals who have achieved comparable creative contributions appear to have had rather undistinguished childhoods and were not recognized as exceptional until early adulthood, or even later. Clearly very little is known as yet about the relationship of central nervous system structures and creativity, although many claims have been made these days, with limited support. For instance, cerebral lateralization research has led many people to claim that left-handers or ambidextrous individuals, who are presumed to be using the right side of their brains more, are more likely to be creative. Left handers are apparently over-represented in such fields as art, architecture, and music. Many exceptional individuals from Alexander the Great to Leonardo da Vinci, Michelangelo, Raphael, Picasso, Einstein, as well as the three presidential candidates of the last elections were apparently all left handers. Suggestive as such trends might be, there is also evidence that left-handed persons are much more likely to be prone a variety of unusual pathologies. Thus whatever neurological difference handedness represents, it might not be directly linked to creativity, but rather to deviance from the norm that can take either a positive or a negative value.

Perhaps the most salient characteristic of creative individuals is a constant curiosity, and an ever renewed interest in whatever happens around them. This enthusiasm for experience is often seen as part of the childishness attributed to creative individuals. Without this interest, the person would be unlikely to become immersed deeply enough in a domain to be able to change it. Another way of describing this trait is that creative people are intrinsically motivated – they find their reward in the activity itself. And here we are going back to Professor Klein's introduction and connecting with the phenomenon of flow. Creative individuals are practically always in flow when they are involved in whatever their particular domain is. A recurring refrain among them goes something like this: "You could say that I worked every day of my life, or with equal justice you could say that I never did any work in my life." Or: "I always say, TGIF – Thank God It's Friday – because then I can go home, and for two days I can work without interruptions". So deep involvement in one's work is the constant that one can always clearly see.

To illustrate this let me read some brief excerpts from the interviews we collected. The first one is from an inventor: "You invent for the hell of it. I don't start with the idea of what will make money. This is a rough world, and money is important, but if I have to trade between what's fun for me and what's money making, I will take what's fun." This is an 84-year-old inventor who has over 200 patents, some of which are very important, and at age 84 he has a study where he has over 2,000 folders of patents he is still working on. And he takes one out and works a little and puts it back, takes another one, and so forth.

The next one is a Nobel prize novelist who says, "I love my work more than what it produces. I am dedicated to the work, regardless of its consequences." And the reason I have it there is because this gentleman was knifed in the back just a month after this interview because of his beliefs, because of his dedication to his work. It is Naguib Mahfouz, the Egyptian writer, who has been writing his books with an eye to the reality he saw around him, regardless of the values that the traditional, fundamental religious factions of Egypt wanted to present. And eventually he paid almost with his life for trying to preserve the integrity of his vision.

Out of the 91 people I interviewed, several ended up in jail because they stood by their principles, including the Nobel-Prize winner Linus Pauling, or Dr. Benjamin Spock. So the intrinsic involvement in their work does not preclude a dedication to a belief that has social and personal consequences. The next quote is from a recent poet laureate of the United States, who describes how it feels when he writes poetry, and this is what he says: "Well, you're right in the work, you lose your sense of time, you're completely enraptured, you're completely caught up in what you are doing. The idea is to be so

saturated with it that there is no future or past. It is just an extended present in which you are making meaning, and dismantling meaning, and remaking it. You have the feeling that there is no other way of saying what you are saying.” These words describe the intense flow experience that all creative persons report when they are involved in their work.

The last quote is from a 78-year-old physicist and inventor: “Oh, I love to solve problems. If it is why a dishwasher does not work, or why the automobile does not work, or how the nerve cells works, or anything. Now I am working with an assistant on how the hair cells work and, ah, it is so very interesting. I don’t care what kind of problem it is. If I can solve it, it is fun. It is really a lot of fun to solve problems, isn’t it? Isn’t that what is interesting in life?” What all of these quotes illustrate is the constant theme of curiosity, interest, involvement with things for their own sake.

Another dimension besides motivation and curiosity is cognitive style, or the way creative individuals think. Psychologists have developed tests of divergent thinking, which include such aspects as fluency, flexibility, and originality of mental operations. These can be measured routinely, even with children. And such tests show modest correlations with original productions in laboratory settings. But whether these tests also relate to creativity in real life is not clear, although some claims have been made to that effect.

Discovery orientation is another aspect of a creative thinking style. It refers to the tendency to find and formulate problems where others have not seen any. The formulation of problems, finding problems, requires different skills from those needed to solve problems. We teach children to solve problems, all of school is about problem solving, until they get to write a thesis for a M.A. or a Ph.D. where they have to find their own problem. And at that point many brilliant students fall apart, because they never had to find and formulate a problem in their lives. As Einstein and many others have observed, the solution of problems is a much simpler affair than their formulation. Anyone who is technically proficient can solve a problem that is already formulated, but it takes true originality to formulate a problem in the first place.

What about the personality of potentially creative individuals? Psychoanalytic theory has stressed the ability to regress into the unconscious while still maintaining conscious ego controls as one of the hallmarks of creativity. Creative individuals tend to be strong in certain traits, such as introversion and self-reliance, and low in others, such as conformity and moral certainty. There is a long tradition of associating creativity with mental illness, or genius with insanity. Recent surveys have added new credence to this tradition by demonstrating rather convincingly that the rate of various pathologies such as suicide, alcoholism, drug addiction, and institutionalization for mental diseases is much higher than expected in certain creative professions, especially drama, poetry, music, and so forth. My reading of these results, however, is that some fields, which in our culture get little support, are associated with pathology either because they attract persons who are exceptionally sensitive, or because they can offer only depressing careers. They may have little or nothing to say about creativity itself.

One view that I have developed on the basis of my studies is that creative persons are characterized not so much by single traits, but rather by their ability to operate through the entire spectrum of personality dimensions. For instance, the first thing you notice is that creative individuals who really make a change in the culture tend to be extremely vibrant people. They have a lot of energy and vitality. I remember the interview with Linus Pauling at age 89 – the sharpness of his memory, his quickness, his ability to lead a conversation with great elan. Or Benjamin Spock: I went to his 85th birthday party, and he danced till two in the morning. I was collapsing on the floor as he was just waltzing around. At the same time, almost all of these people claimed that they were really very lazy, and the reason they

say they are lazy is because they have found ways to find peaceful moments during their day, during their week, during their year where they can escape distraction and rest. Some people take naps of ten minutes three times a day, others take walks at certain moments, and during those periods they recharge themselves. The Canadian novelist Robertson Davis, who passed away just last year about this time, was in his 80's but he said ever since childhood his greatest ambition had been to be able to take a nap every afternoon. I think the interesting thing is not that these people are just energetic, because a lot of people are energetic, and driven, and they burn out when they are 30, but that creative individuals can find a balance, and combine these two almost opposite traits in the same person.

Convergent thinking, that is, the ability to solve problems by following rational steps, is also there. All of these people are rational in their thinking, whether they are scientists, poets, or artists. At the same time they have this ability to think in a divergent mode, to open up, to think of new ways of seeing problems. A similar ability to combine opposite, and usually separate modalities involves their tendency to be playful and responsible at the same time. All of these people talk about not taking things very seriously, being playful, looking at the same thing from five different viewpoints, even if it's clear that one of them is supposed to be better than the others. This playfulness, though, stops at a certain point, and then discipline and concentration and responsibility take over.

All of these people have a great deal of imagination, but they also are very reality oriented. For instance, in one of the studies I used Rorschach inkblots. We gave a group of creative artists these inkblots, and asked them to tell what they saw in them. Some of the stories that people gave to the inkblots can be original, and normal people give rather few original responses, but normal people give quite a few "bizarre" responses – responses that you could never see in this particular configuration, like if it looks vaguely like a butterfly, let's say, and you say that it looks like a cigar, or vice versa. That would qualify as a bizarre response. Creative people give a lot of original responses, but they never give bizarre responses. They always tie their perception to the actual stimulus. They don't make up things that have no basis in reality.

Another characteristic of creative individuals relates to extroversion and introversion. One usually reads that creative people are very introverted, and that's true during some phases of their work. But at the same time, they are able to be very extroverted when it's needed. Every scientist says that you can't be a good scientist if you lock yourself in the laboratory. You have to talk to people all the time, you have to listen, you have to find out what others are doing. The same holds for artists. Sculptors, writers, musicians say you have to constantly talk and talk and that is as important, apparently, as the introversion, as the solitary focusing. Many of these people are very ambitious, competitive SOBs as many of their colleagues think of them. But at the same time, they are humble and the humility comes from the fact that they are aware, like Newton was aware, that they are standing on the shoulders of giants. They know what went on before in their domain and so they know that their own contribution is not that huge, but at the same time they know that they are making that contribution, and so they have the pride and ambition together with the humility.

The androgyny of creative people has often been mentioned. Almost all studies show that creative men have many characteristics usually associated with women in our culture. And many creative women have characteristics associated with men, like dominance and competitiveness, for instance. Androgyny doesn't necessarily mean bisexuality. Sometimes it does. But it doesn't have to have anything to do with sexual preferences. It's just that generally when we bring up a child, we want that child to be a good little boy or a good little girl. And that shapes what that child can experience for the rest of life as being constricted by a certain gender stereotype, and that makes it difficult to see things in new ways or to experience the whole range of human potential. So what this kind of ability to move

from masculinity to femininity means is that they can cover the whole range of human experience better than people who have been socialized into very narrow gender-stereotyped roles.

Another stereotype about creative people is that they are very rebellious and iconoclastic. That's true, but it is also true that they are usually very traditional, and they couldn't be creative without accepting and taking seriously the domain in which they work, whether it is art or music or science. And so the tradition is as important as breaking it, and the important thing about these people is that they don't get constricted by the tradition, but they hold onto enough of it to be able to change it.

These people are passionate about what they are doing, but they can step back and be critical and look at what they are doing in an objective way. Finally, the last point I want to make is that creative people are insecure and vulnerable and often suffer. But at the same time, when they are involved in what they are doing, then they tend to experience this joyful state of flow that has been alluded to before. And again, this alternation is quite frequent, especially with artists, but even with scientists. There are periods of depression, of being blocked, of not being able to accomplish, of feeling completely dried out and so forth.

So these are the dualities that creative people are able to use as necessary. When I first shared these conclusions with some of my colleagues, they said, "Oh, I see, you mean creative people are schizophrenic." But that is not the case, because schizophrenics can't choose what to be like. They move from one end of a trait to the other without control. What creative people seem to be able to do is use the potential for being both extroverted and introverted, masculine and feminine, passionate and disciplined, when and as it's needed. So personality traits do not limit the individual, but serve to advance their goals.

In order to function well within this whole creative system, one must internalize the rules of the domain and the opinions of the field, so that one can choose the most promising ideas to work on and do so in a way that will be acceptable to one's peers. Practically all creative individuals say that one advantage they have is confidence in being able to tell which ideas are bad and thus they can forget the bad ones without investing too much energy in them. For example, Linus Pauling, who won the Nobel prize twice, was asked at his 60th birthday party how he had been able to come up with so many epochal discoveries. "It's easy," he answered, "You think of a lot of ideas and throw away the bad ones." To be able to do so, however, implies that one has a very strong internal representation of which ideas are good and which are bad – a representation that matches closely the one shared by the field. The person has to carry in his own mind the representation of what the domain is and what the field is in order to contribute a novelty that will be a real improvement on what has existed before.

An extremely lucid example of how a person internalizes the system is given by the inventor Jacob Rabinow, who has over 200 patents and a variety of very different inventions. In addition to being a prolific inventor himself, he is also a prominent member of the field, because he works for the U.S. Patent Office, and hence decides which inventions by other individuals deserve recognition. In describing what it takes to be an original thinker, Rabinow mentions first the importance of the domain. Here is what he says: "So you need three things to be an original thinker: First, you have to have a tremendous amount of information – a big data base, if you like to be fancy. If you are a musician, you should know a lot about music. That is, you have heard music, you remember music, you could repeat a song if you have to. In other words, if you were born on a desert island and never heard music, you are not likely to be a Beethoven. You might, but it's not likely. You may imitate birds, but you're not going to write a Fifth Symphony. So you are brought up in an atmosphere where you store a lot of information." Storing information is how one internalizes a domain. And that's the first part. Next, he

talks about what the person must contribute, which is mainly a question of motivation and enjoyment. This is what he says: "Then you have to be willing to pull the ideas, because you are interested. Some people could do it, but they don't bother. They are interested in doing something else. So if you ask them, they will as a favor to you say, 'Yeah, I can think of something.' But there are people, like myself, who like to do it. It's fun to come up with an idea and if nobody wants it, I don't give a damn. It's just fun to come up with something strange and different."

Finally, the third requirement he mentions is the internalization of the field: "And then you must have the ability to get rid of the trash which you think of. You cannot think only of good ideas or write only beautiful music. You must think of a lot of music, a lot of ideas, a lot of poetry, a lot of whatever. And if you are good, you must be able to throw out the junk immediately without even saying it. In other words, you get many ideas appearing and you discard them because you are well-trained, and you say, 'That's junk.' And then you see the good one and you say, 'Oops, this sounds interesting. Let me pursue it a little further.' And you start developing it. And by the way, if you are not well-trained, but you've got ideas and you don't know if they are good or bad, then you send them to the Bureau of Standards, National Institute of Standards, where I work, and we evaluate them, and we throw them out." That's a nice way of summarizing what's involved in the whole process of internalizing the workings of the entire creative system.

To conclude, it is certain that as we think about creativity, we shall continue to focus on the individual person and his or her thought processes. After all, creative geniuses are so rare that we can't curb our curiosity about them. What I have sought to point out tonight, however, is that creativity cannot be recognized except as it operates within a system of cultural rules, and it cannot bring forth anything new unless it can enlist the support of peers. If these conclusions are accepted, then it follows that the occurrence of creativity is not simply a function of how many gifted individuals there are, but also how accessible the various symbol systems are, and how responsive the social system is to novel ideas. The shape of our future depends on the quality and rate of the new memes we admit into our culture now. In this sense, creativity is the process by which we shape what humanity is to become.

But if we wish to understand and influence this process, it makes more sense to focus on the context that nurtures innovation, because in the last analysis, it is the community as a whole, and not the individual alone that allows creativity to happen. Many corporations, for instance, are using brainstorming techniques to get people to be more creative, and these techniques work as far as the individuals are concerned. So a company may encourage its 20,000 engineers to come up with original ideas, but if those ideas are ignored and not implemented, instead of creativity the result will be alienation and frustration. It is essential to realize that the selection among ideas and the implementation of ideas is as important as the production of new ideas. I think this is a very important issue, and I hope that tomorrow, when Professor Klein and I will be having a conversation in the morning, there will be enough questions and participation on the part of those of you who will be there, that we can develop these ideas further. Thank you.