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A New Look at Evolution: Modernity and Living Respectfully with Nature

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Part I. Overview

It is often assumed that human cultural achievement is the pinnacle of the evolutionary process on Earth. People think of the human brain as an intellectual endpoint in cultural development. Is it possible that other entities of a higher or different knowledge type can evolve? Some light can be thrown on this problem by looking at what exactly is knowledge.

A plant could be said to have genetic knowledge in the sense that its genes provide it with a blue print for producing structures (for example, leaves and branches) and taking actions (for example, when to grow and when to flower). The expression of the information in the genes, in combination with an adequate environment, allows the formation of the plant. The plant's offspring may vary genetically from the parent and these variations can be seen as new knowledge, even if this change in knowledge is random. Those offspring that chance to have new knowledge that allows them better functioning than their competitors will, on average, be more successful at reproducing and so more successful at passing their new knowledge on. In this way, through the differential survival of offspring, plants can adapt to changing environments.

The same applies to animals. Through the differential survival of offspring, the animals that remain will, on average, have a better knowledge of their environment. For example, insects that plague a crop may be sprayed and only a few resistant individuals survive. The resistant insects have a better genetic knowledge of their new environment; one that will periodically contain insecticide. These insects know more about their new environment than those that succumbed to the spray. A species will "learn" about its environments through the differential survival of offspring. As an environment changes, the knowledge of organisms will follow.

An organism's genetic knowledge does not change during its lifetime and so its behaviors are fixed. An organism relying only on genetic knowledge cannot learn from its experiences (although it may behave differently in different environments depending on the sensory information to which it is exposed). Given the same environment it will always react the same way.

For small animals with a short generation length this system of genetic knowledge works fairly well as new advantageous knowledge can spread quickly. But as the animals become larger and more complex and have longer generation lengths, their genetic knowledge systems become vulnerable to invasion by new knowledge systems capable of accumulating knowledge at a greater rate. An animal with such a new knowledge system could then learn about its environment during its lifetime and so out-compete one relying only on a fixed genetic knowledge. The new knowledge system that achieves this is cultural knowledge, and its existence is made possible due to a particular organ, the brain, specialising in the processing, storage and recall of sensory information from the environment. Animals with brains can out-compete others of a comparable size and occupying the same niche that rely solely on genetic knowledge.

The first cultural knowledge was gained by collecting and storing information brought in by the sensors. This first knowledge was for personal use and was not intentionally communicated to others. It had to be relearned by each generation. For example, a solitary wasp can remember its surroundings in respect to finding its nest, but this knowledge is not passed to other wasps. Later, knowledge gained was intentionally communicated - thus a bee can remember the location of nectar and it can tell others of this location through a language of dances. As communication became widespread, particularly in mammals, a long nurturing period developed where a good proportion of the parent's knowledge could be passed to offspring. This saves the offspring from learning knowledge afresh, particularly where this knowledge can only be gained through trial and error, often at considerable risk.

An animal with a brain is driven in its actions by both genetic and cultural knowledge. The human baby is born with an abundance of innate drives (genetic knowledge) within the structure of its brain for various behaviors. It will rely on these genetic drives initially and gradually this knowledge will be added to, and in many cases overridden, by cultural knowledge. For instance, say a person is asked to go swimming. Some people "take to the water" much more readily than others. But a person with an innate fear of water may decline the opportunity to swim. Here a genetic knowledge for a fear of water has played a part in the decision of whether or not to swim. This can only happen because that genetic knowledge has reached the brain and is within its structure. The brain's structure and its genetic knowledge can be considered a "landscape" in which cultural knowledge interacts. Thus the final decision on whether to or not to swim will depend on the outcome of a struggle amongst cultural and genetic units of knowledge. Similarly, other decisions that a person makes will depend, to varying extents, on the interaction of genetic and cultural knowledge.

Our cultural knowledge has become progressively more intricate and this is seen by our making of complex artefacts. One of these, the computer shows some potential for operational independence. Software (programs) written by humans is cultural knowledge. But if this software can change itself in a random way, and if some of these new variations survive differentially in an electronic environment, then this new "electronic knowledge" will be independent in its content from the cultural knowledge from which it arose (of course it is still dependent on humans for making the computer in the first place, just as humans are dependent on plants making carbohydrates - yet the content of human thought is independent of plants). Examples might be computer viruses or computer programs that generate code randomly and incorporate that code within the program. This electronic knowledge, if it develops, could be the basis for a third knowledge system.

Evolution can thus be thought of as a process that gives rise to a succession of knowledge systems. The first is the genetic knowledge of amino acids that was 'fermented' from primordial pools. The second is a system of cultural knowledge fermented from various animals' minds, with the minds "primordial pools" for this fermentation. Human made computers could also be considered as primordial pools for the fermentation of new electronic knowledge. In turn, this new electronic knowledge may create an environment that is eventually invaded by still newer knowledge systems.

Evolution, then, is a process that generates a series of nested knowledge systems, each independent in content from, but dependent for their existence on all previous knowledge systems. Human cultural knowledge may well be a stepping stone for new knowledge systems. If this is the case, and a third knowledge system is just beginning (after all, there is some 5 billion years of evolution to go on Earth), it is not likely that human cultural knowledge will be the pinnacle of the evolutionary process.

Part II. The Evolution of Medical Information

The information we inherit in our genes and the cultural information that accumulates in our society, both contain instructions for fighting disease. In many cases today, where the body is unable to fight a disease due to incorrect or insufficient genetic information, the disease can now be cured through cultural information. Cultural information is becoming a major factor in health.

During our cave days, the human body relied on genetic information to correct mishaps and conquer diseases. Bones mended themselves, cuts healed, and infections were fought with antibodies and phagocytes. This information could be called genetic medical information (GMI). Those animals with poor or insufficient GMI were selected against by their environments (everything surrounding an organism).

Since then there has been an accumulation of cultural information to assist this GMI. The antibodies of the blood can be assisted with antibiotics such as penicillin, cuts cleaned with disinfectants and bones set in casts. This additional information is not genetic; rather it is cultural, information that is passed from generation to generation not via the germ cell but through the senses. It could be called cultural medical information (CMI).

The first CMI was folk medicine. A particular herbal cure may have originated something like this: a person(s) may notice a herb aid with the cure of some illness, possibly by accidental ingestion, later someone may cook it, thereby causing a greater effect, while still later it is mixed with other herbs and so on, often taking hundreds of years to evolve to the current recipe. This new information has occurred through a series of chance events being noticed and retained. As the plant has a certain effect that is deemed useful, this information will be retained in the community and so this plant enters a system of inherited CMI. Herbal and other folk cures have evolved from the differential retention of information from the environment, with this retention driven by the desire to live and avoid pain.

A second path for new CMI is through scientific experimentation. New ideas are thought up in the mind and then tested in the environment. These two origins of new CMI, from the environment or from the mind, could be seen as the two extreme ends of a continuum with any particular medical cure having components of each and so being a node on this continuum. For Western medicine, most new information is from the mind although a significant part still comes from chance events being noticed and investigated. For folk medicine there is also no doubt many cures that have been thought up and tested and so have a large mental component.

Organisms coevolve with their environments: each changes the other. A desert environment selects for water retentive features. Plants change the desert through the accumulation of wind blown soil, by providing shelter and food for animals, and so on. The physical environment moulds the form of the organisms living in it, and these organisms in turn, change that environment. This should also occur from CMI which is part of the environment of humans and should therefore mold the human to its form. That is, the cultural environments of humans (as well as the physical environments) are a selection pressure upon the genes.

To illustrate this, say there exists an external disease "A" which, if contracted, kills those members of the population who have no genetic resistance to it. As this disease is part of the human environment, it is a selection pressure for the removal of individuals without the resistant gene(s). The resistant gene(s) will be maintained in the population through this selection pressure. A scientific or folk medical cure for this disease will remove this pressure. Individuals without this gene(s) are now free to increase in number within the population. These people are now resistant to A, not through a genetic resistance, but through a cultural resistance. Whether protection comes through GMI or CMI, as long as that information remains in place, an individual will survive and reproduce.

There are thousands of genetic errors of metabolism (I will use various examples from McKusick, 1990 below). In chronic granulomatus disease, which is usually inherited as an X-linked recessive trait, the ability to fend off infection is reduced allowing recurrent bacterial and fungal infections. Other examples include genes that resist the polio virus while still others resist the toxins that are a by-product from the diphtheria bacillus. An individual is susceptible to these diseases should their GMI be insufficient. These infections could be our "disease A" that is a directional selection pressure for the retention of resistant genes. For these diseases, an insufficient GMI or the wrong type of GMI results in missing or inappropriate enzymes, proteins or other assorted products, necessary for resistance to external diseases. Vulnerability depends on existing GMI. The treatment of individuals through CMI, where treatment leads to an increased success in reproduction and/or an increased ability to care for existing children, results in these genetic disorders becoming more prevalent.

A similar argument can be made for a gene(s) that causes a particular disease (rather than prevents a disease, as in the case above). Here the wrong GMI causes a malfunctioning of the body. If CMI now alleviates this disease so that a normal life is possible, including reproduction, the frequency of this wrong GMI will increase. I will list a few examples.

The disease cystic fibrosis is a lethal autosomal recessive disorder. This disease, which increases the tendency to lung disease and poor intestinal absorption, can be treated with antibiotics and pancreatic enzymes. Heterozygous offspring are healthy and able to live normal lives. By treating the homozygote, and so possibly allowing reproduction, the disease may increase in frequency. Another genetic disease, phenylketonuria, if detected in the newborn can be treated with phenylalanine reducing drugs. It can also be treated with a diet adjusted to a low phenylalanine intake. Galactosemia, a disease caused by a deficiency in a sugar regulating enzyme, can be treated in the infant by a specially formulated milk free of galactose. Other treatments involve replacement of the necessary components that are not being manufactured. Diabetes mellitus results from a faulty sugar metabolism and sufferers require lifelong insulin injections. A milder form of this disease can be treated by dietary adjustment. Another genetic disease, hemophilia, can be treated by taking the missing blood clotting factor. The treatment of these diseases such that reproduction is possible will increase the chances of offspring having the disease or becoming carriers. The proportion of people with faulty GMI will increase. In recognition of this problem, some pregnancies are terminated upon a positive diagnosis of genetic errors within developing fetuses.

In general, where CMI is used for a cure, the usual environmental selection pressures against faulty genes is removed. A person with insufficient or wrong GMI who would have otherwise died, now relies on CMI for survival. The result is a transfer of the reliance on cures from GMI to CMI.

A similar argument can be made for medical practices such as caesarean births. This alternative way of delivery modifies the environment of the pregnant mother: a mother who might have otherwise died in delivery in cave times, might now survive. If this operation is needed due to inappropriate GMI resulting from an inability for the mother to succeed in natural birth, then the child, that has now survived, could well be a carrier of this faulty GMI. Say a caesarean birth is necessary because the mother's hips are too narrow and this narrowness is the result of a genetic variation. Genes for narrow hips will then spread in the population as this mother has now reproduced. From this increase of narrow hipped women, one would expect caesarean births to become even more frequent. There may well come a time when few women are capable of a natural birth. In general, CMI that effectively annuls an inborn genetic error will remove the selection pressure that had previously eliminated these errors from the population.

This idea can be extended to include any medical cure that increases the chances of survival and reproduction of an individual. A person may break a leg in a football game. One could argue that this is just a random event, just bad luck. While there may be a random component to this breakage, those people with an optimum bone strength (too many of the body's resources can not be put into making bones) will, on average, fare best (at least in respect to bone breakages). A person might survive this break today through CMI providing such things as splints, casts and antibiotics, where s/he might not have in cave times, relying only on GMI. Should a break be due to a slightly weaker bone that is from inappropriate or insufficient GMI, and where this person goes on to reproduce, this flawed GMI is passed to others and so becomes more frequent. The long term affect will be an increasing reliance on CMI for the healing of broken legs.

The same reasoning could apply to an infection. CMI that helps cure infections will result in higher survival rates than might otherwise be expected in our cave times. Of two people who get this infection, one may need the cultural cure due to insufficient GMI while the other, who has sufficient GMI, will not need it. Yet both survive and will go on to reproduce. This difference in survival from cave times reflects the selection pressure that is now acting on the population due to CMI. Certain GMI is no longer so critical as in our cave times. Where a medical cure exists, there is no longer a pressure to remove individuals with insufficient or incorrect GMI.

GMI and CMI can compete for the possession of information. From the examples above, the higher rate of change in CMI gives this system an advantage over GMI. A succession of successful offspring have learnt about the new CMI genetically (there has been a change in GMI to accommodate the CMI - that is, a transfer of GMI to CMI). There are also a few instances of CMI becoming GMI, although it is not very common. An example is our current attempts to introduce missing genes into the body's cells. One method that may be promising is by viral vectors; genes can be attached to viruses such as the common cold. No doubt these gene therapies will become more prevalent in the future. Another method is the screening of embryos for genetic errors and the elimination of those with faulty GMI (mentioned earlier). Far more common is cultural information transferred to domestic organisms. Rust resistant genes from wild grasses have been transferred to wheat, and human genes have been inserted into E. coli for the production of insulin. In both these cases human cultural information has changed the genetic information of another species. Cultural information can also be transferred indirectly by selective breeding.

A consequence of the rise of CMI is the increasing ratio of doctors (agents of CMI) to members of the public. CMI is concentrated in the minds of a few. Where a person has to rely on CMI in order just to survive, then that person has handed over control of his/her body to an outside agent. If a person is able to provide substantially his/her own cures (through GMI and some folk medicine), that person retains control of his/her body.

In tandem with the growth of CMI is a steady increase of human resources consumed by medicine. The unrestricted pursuit and application of CMI might well prove to be as damaging to human development in the long term as the many other forms of environmental degradation that are slowly changing our physical environment.

Reference

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