

GAINING AND LOSING POWER

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A man goes into a gymnasium and takes up physical training. The first day he gets tired very quickly. The second day is the same, and the third day and the fourth day. But if he continues, there soon comes a day when he can exercise longer and harder without becoming so tired. And if he keeps on day after day, and month after month, he finds he continually gains in his capability of withstanding severe exercise without weariness.

When a man who has been leading an active life changes to a sedentary one he finds, after a few months, that he has lost something of that energy, vim, pep, which he had before, and that he tires more quickly than when he was active. If his sedentary life continues year after year, he finds that his physical powers continually decline.

What is this thing which is gained by exercise and lost by idleness? What are the conditions under which there is a change from gain to loss or the reverse? How long will gain in powers continue to follow exercise and loss of powers follow idleness? What are the limits of gain and loss? Can an animal by continual exercise become more powerful than any ancestor? To how many different organs does this kind of gain or loss apply?

The object here is to bring together some of the facts which will help to furnish answers to these questions. The facts bearing upon this matter are to be found in many and diverse places, but we will consider only such as lend themselves most readily to scientific exactness, or are most convenient for illustration.

Of all animals, the trotting horse has been more regularly and continuously trained for the purpose of producing physical development than any other, and the mile track and stop watch furnish scientifically exact means for measuring the gain coming from exercise. It is universally recognized that powers continue to develop during growth, but it is generally believed, and sometimes stated, that such development ceases when the ani-

mal becomes full grown, or soon thereafter. The horse is full grown at three or four years of age, consequently we will look at what occurs under continuous training after full growth.

HIGHEST SPEED OF FLORA TEMPLE AT DIFFERENT AGES

ONE MILE

Five years old.....	2:49
Seven years old.....	2:36
Eight years old.....	2:27
Eleven years old.....	2:24½
Fourteen years old.....	2:19¾

Flora Temple was not raced as a six-year-old, but was trained and raced every other year up to sixteen years of age. She continued to gain in trotting power under continued training up to fourteen years of age, though the gain was not uniform. At sixteen she nearly equalled her best previous record, but her racing career was suddenly terminated by Government action. That was in 1861.

By continually exercising the powers she had, Flora Temple acquired powers she did not have before, and powers which never existed in any ancestor. By her own efforts she acquired powers beyond her inheritance, because no previous horse was capable of trotting as fast as she trotted, and she could not inherit from ancestors a power which the ancestors did not have. As an eleven-year-old she trotted faster than any previous horse had trotted, and as a fourteen-year-old she broke the world's record four times in succession. Whenever a horse becomes a champion trotter, the fact that he does become a champion is of itself positive evidence that he has greater trotting power than he inherited—greater power than existed in any ancestor, or in any relative of any ancestor. During the past seventy-five years there have been more than twenty such horses to become champions, and no matter how good a horse may be, he can become a champion only as the result of many years of strenuous efforts. He must acquire by his own efforts that which he did not have, and that which never before existed.

HIGHEST SPEED OF GOLDSMITH MAID AT DIFFERENT AGES

ONE MILE

Eight years old.....	2:36
Nine years old.....	2:30
Ten years old.....	2:24½
Eleven years old.....	2:22½
Twelve years old.....	2:19½
Fourteen years old.....	2:17
Fifteen years old.....	2:16¾
Sixteen years old.....	2:16
Seventeen years old.....	2:14

When Goldsmith Maid trotted a mile in 2:17 as a fourteen-year-old she broke the world's record, and thus demonstrated that she had developed more trotting power than ever existed in any previous horse. As a fifteen-year-old she broke the record again, and then once more as a sixteen-year-old. As a seventeen-year-old she broke the record four times in succession. By continually exercising the powers she had, she continued to gain in trotting power from youth to old age, and made the most striking gains in the evening of life. The powers she developed in that way greatly exceeded anything which ever existed in any ancestor.

It is not often that horses are trained continuously for so many years as were Flora Temple and Goldsmith Maid, but for the purpose of showing that the results obtained were not due to something peculiar in the inheritance of those animals, note the fact that during 1917 more than one hundred trotters, ranging from ten to fifteen years of age, made faster records on the race tracks of the United States than they ever made before.

HOLSTEIN-FRIESIAN MILK PRODUCTION

SEVEN-DAY OFFICIAL TESTS

Average Age.	Pounds of Milk
Two years and two months.....	322.7
Three years and two months.....	400.3
Four years and two months.....	446.8
Six years and six months.....	450.7
Seven years and seven months.....	472.6
Eight years and three months.....	499.8
Nine years and seven months.....	564.8

The first part of this table is just as it is furnished by the Holstein-Friesian Association for 1913. The second part is a tabulation made from the records of 1906. The reason why it was necessary to make this tabulation is because the association does not classify cows over five years of age, but lumps them all together.

The cow reproduces before two years of age, and is full grown at three. As further evidence that milk-producing power continues to develop under milk-producing exercise long after full growth, take note of the average amount of milk produced by the 1,497 Jersey cows of all ages tested during 1916.

JERSEY COW MILK PRODUCTION

YEAR RECORDS. OFFICIAL TESTS. 1916.

	Pounds of Milk
Ages at Calving	
Under two years.....	6242.2
Two years to three years.....	6710.0
Three years to four years.....	7317.1
Four years to five years.....	8040.2
Five years to six years.....	8255.0
Six years to seven years.....	8340.2
Seven years to eight years.....	8702.2
Eight years to nine years.....	8667.0
Nine years to ten years.....	8643.3
Over ten years.....	8900.0

The Binet system recognizes the continued development of mental power in human beings during the growing period, but let us go beyond that into the older life. It requires mental power to learn anything, and to retain it in memory while learning a second thing. It requires more power to remember two things while learning a third; still more to remember three things while learning a fourth; more yet to remember four things while learning a fifth; and so indefinitely. As a matter of fact we carry more and more in our memory as the years go by, and the increasing load we carry is a measure of our increasing mental power. Even those persons designated as feeble-minded carry more and more in their memories as they grow older, and that fact is conclusive evidence

that they do increase in mental power, statements to the contrary notwithstanding.

The "dope fiend" will take a quantity of poison large enough to kill several men who are not accustomed to taking it. The man who survives the taking of such large doses does not do so because he was born with greater powers of resistance to that drug than other men. He does so because he began with small doses, such as any man might take and survive, and then gradually built up his powers of resistance by continually exercising them. By exercising the powers he has, a man can build up powers he did not have before, and powers which never existed in any ancestor.

By beginning with small doses and gradually increasing them, pigeons have been made resistant to rattlesnake poison. Resistance has been built up in this way until pigeons were able to withstand a dose more than four times as powerful as that which would kill in the first place. By exercising the feeble powers which they had, these pigeons acquired powers which they did not have before, and powers which never existed in any ancestor.

Let us turn aside and consider the powers of plants, because the matter under consideration is something fundamental in living things. If we take some wild plant and attempt to reproduce it by cuttings, we are likely to find that it can be reproduced that way only with difficulty. But if we take a cutting from the first plant raised that way we find the second time it grows a little more readily. If we take a cutting from the second plant to raise a third, we again find it starts more easily, and so on time after time. By many repetitions the plant develops the power of producing roots abundantly from cuttings. By exercising the powers which it has it acquires powers which it did not have before, and powers which never existed in any ancestor.

There is no selection in this matter. No seeds are produced. The final plant is really a developed section of the original plant, but has powers which the original plant did not have. A large number of our greenhouse plants

are now produced by cuttings, but originally came from stock which would grow that way only with difficulty.

All plants raised for any considerable length of time by division, like tubers, bulbs, cuttings, buds or grafts, gain the power to produce roots abundantly, and at the same time they lose the power, sooner or later, to produce seeds. By continually exerting themselves along particular lines plants develop new powers along those lines, and by continued idleness along other lines (seed production) they lose the powers they originally had.

In a wild state plants have to fight for existence in a world covered with other plants. When man domesticated certain plants he protected them from weeds. As a consequence of not having to fight for room against other plants, our domesticated kinds have lost the power of so fighting, and are unable to maintain themselves when deserted by man. Idleness along that line caused a loss of power on that line. There is no selection in this. Man did not select plants because of their inability to protect themselves.

Plants produce seeds. To casual observation, a seed looks like a dead object, but it came from a living plant and it has life. In that life there is the power of sprouting and growing into a new plant like that from which the seed came. But let the seed lie idle for one, two, three or more years, and that power gradually declines and finally ceases to exist. The loss of power due to idleness extends to the seed stage, and continued loss of power means loss of life. In the seed, life and power are one and the same.

Flagellata are protozoa which multiply by division. Dallinger subjected these animals to heat and found them dying at 74 degrees, Fahr. But by beginning at 60 degrees and gradually increasing the temperature he finally got them to stand 158 degrees without dying. Several years were required to accomplish that result. There was no selection in this. The final animals were simply divisions from the original ones. By continually exercising the powers they had, they acquired powers they did not have before.

Corn is sensitive to climatic changes, and can endure only slight changes without suffering seriously. But by moving it a short distance northward each year, it is now fully acclimated in regions where it was impossible to raise it forty years ago. Corn goes through the seed stage; flagellata do not. But each of them by continually exerting the powers they had, acquired powers of resisting temperature changes which they did not have before. The presence or absence of a seed stage does not affect the matter except as to the rate at which the acquirement occurs. The acquirement comes as a direct result of exercising the powers in existence. When the matter extends over several generations, the seed stage simply inserts idle periods during which there is no acquirement.

The blood reaction of different animals is different. With this in mind, let us consider some phenomena relating to vaccination. If we inoculate a cow with smallpox virus we remove the germ from a place where it was able to live to a new place where it meets a new blood reaction. Only occasionally does the germ survive in this new place, but when it does survive we may pass it on from cow to cow without difficulty. If, after passing the germ through ten or more cows in series, we take this virus and inoculate a man, we find that it is cowpox and not smallpox. A man so inoculated becomes immune to smallpox.

Going back to what we have learned about power being developed by exercise and lost by idleness, and applying that information to the facts just given about smallpox and cowpox, we can get some new light on the phenomena relating to vaccination. When smallpox virus is inoculated into a cow it will "take" only when it comes to some cow more susceptible than others. The germ in fighting for its own existence in a new blood reaction develops its powers of meeting that kind of blood reaction so that when it later is passed on to another cow it finds no difficulty in surviving in a place where before it could not have survived. In passing along from cow to cow these germs continue to develop their powers of meeting the blood reaction of cows. But while they are doing

this they are removed from the blood reaction of human beings, and because they are not fighting this particular blood reaction they gradually lose the power of fighting it. As a consequence, when they are later removed from the cow to the man they have only the powers of cowpox.

From these facts it will be seen that cowpox and smallpox are two strains of the same thing. One strain has its powers developed to meet the blood reaction of cows but not that of man, while the other has its powers developed to meet the blood reaction of man but not that of cows. Also, that either can be transformed into the other by a course of training designed to develop one form of power and not the other.

About 1880 Pasteur discovered that the anthrax bacillus cultivated in chicken broth at blood temperature lost its virulence after a few generations and ceased to kill even the mouse. Since then it has been learned that the virulence of many organisms became diminished when they are grown on artificial media. Let us consider what these facts mean.

When bacteria in small numbers get into the blood they are rapidly killed off. As far as we are at present concerned we need not stop to inquire whether this is by phagocytosis, chemiotaxis, or other means, or several means combined. The point here is that animal powers of some kind attack the bacteria, and for these bacteria to withstand these powers and make headway against them, the bacterial powers must be developed by exercise.

Now, when bacteria are raised on some nonliving substance, as chicken broth, they do not have to struggle for existence against a blood reaction and consequently they lose the power of meeting such reaction. A stalled bacterium may be as fat as any other, but he does not develop individual powers any more than does a stalled steer.

When a person exerts himself by physical efforts, he does certain foot-pounds of work, and foot-pounds of work is something well known in physical science. It is properly called "energy", but is referred to as "power" when we wish to indicate energy as being expended, or

capable of being expended. This energy which is expended by efforts comes out of the body of the person who exerts himself, and as we cannot get something out of nothing, the energy must be stored in the body of the person before he can do foot-pounds of work. If the efforts which a person makes are moderate, within the ordinary meaning of that term, then the foot-pounds of energy withdrawn by exercise are soon replaced by other foot-pounds of energy derived from food. The condition under which this results in a building process is one in which the amount of energy withdrawn from the system, in some unit of time, as a day, week or month, shall be a little less, but not much less, than the system can replenish in the same time from the food supply.

But it is known that by great efforts long continued a man may cause his own death as a result of nothing else than his own exertions. This means that death is caused by withdrawing from the system more than a certain amount of energy, and that in turn means that life itself is a form of energy. We identify electricity as being a form of energy, even though we do not know precisely what this form is. In the same way we can identify life as being a form of energy, even though we are unable to determine the essential nature of this form as distinguished from other forms.

We have identified life as being a form of energy by showing that life may be withdrawn from an individual by withdrawing foot-pounds of energy, and not withdrawing anything else. Likewise, life may be withdrawn from an individual by exposure to cold which results in withdrawing heat units, and not withdrawing anything else. As heat units are a form of energy, we again identify life as being nothing else than a form of common mechanical energy.

By the examples given it has been shown that powers are developed by exercising them, and the powers so developed are nothing else than stores of energy which are transformable into foot-pounds of work. By referring to the records of the trotting horse it is learned that those horses which had their powers developed (stores of en-

ergy increased) by training and racing live longer than do their untrained brothers and sisters who did not have their stores of energy augmented by special exercise. Here is a third identification of life itself being a form of common mechanical energy. Those horses live longest which have stored in their systems by acquirement the greatest number of foot-pounds of energy.

Women produce children, and in doing so they exercise many bodily organs not exercised by women who produce no children. Such exercise builds up energy in the exercised organs just the same as other exercise builds up energy in other organs. Statistics gathered by Cattell and by Bell show that those women who build the greatest amount of energy into their systems by this process before they are forty-five, are the ones who live the greatest number of years after they are forty-five. Here again we identify life as being a form of energy by showing that increase of energy means increase of life, and that we may build onto our inheritance by our own efforts.

Longevity is that power within the organism which prolongs life, and is known to be an inherited thing. In trotters, the offspring of those horses which have their powers developed by training and racing live longer than do the offspring of their untrained relatives. In human beings, when healthy women develop their bodily powers by producing many children, the later born children live longer than do the earlier born ones. The first of these items is taken from records published in *The Horse World of Buffalo*. The second is from statistics I gathered from genealogies. Both identify life as being energy; both make it clear that we can add to our lives by our own efforts; and both show that what is built up in that way is carried over by heredity to the next generation.