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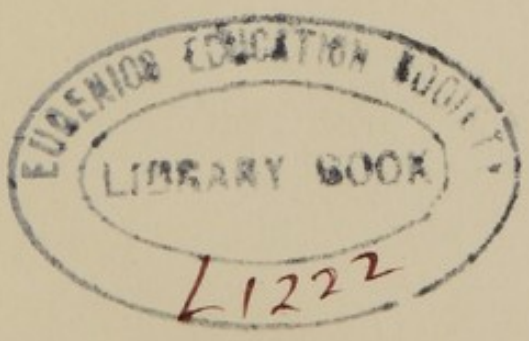

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MIND AND HEREDITY

LOUIS CLARK VANUXEM FOUNDATION

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BY VERNON L. KELLOGG

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PRINCETON UNIVERSITY

THE LOUIS CLARK VANUXEM FOUNDATION

This Foundation was established in 1912 with a bequest of $25,000 under the will of Louis Clark Vanuxem, of the Class of 1879. By direction of the executors of Mr. Vanuxem's estate, the income of the Foundation is to be used for a series of public lectures delivered in Princeton annually, at least one half of which shall be on subjects of current scientific interest. The lectures are to be published and distributed among schools and libraries generally.

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By Vito Volterra

Lectures delivered in Princeton in connection with the dedication of the Graduate College of Princeton University, by Emile Boutroux, Alois Riehl, A. D. Godley, and Arthur Shipley

Romance

By the late Sir Walter Raleigh

A Critique of the Theory of Evolution

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Platonism

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Human Efficiency and Levels of Intelligence

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By Henry A. Cotton

Nature's Simple Plan

By Chauncey B. Tinker

MIND AND HEREDITY

INTRODUCTION

We have a convenient single word to express our confession of ignorance when faced with things we do not understand. We apply this word to the unexplained things of our own body, to things in the world about us, to things of the apparently infinite universe. We call such things mysteries, and to many of us, especially the more tender-minded among us, the labeling of a thing as mystery ends discussion of it. To others, tougher-minded, it is the very incitement to discussion, and, to some, the activating stimulus to prolonged and feverish study. It is, of course, chiefly, if not entirely, by such study that we ever can and do get anywhere in the fascinating game of solving mystery.

The methods of such study are familiar; they are primarily descriptive and analytic. We call them scientific. They break up the big mystery into little ones; they sometimes succeed in reaching an immediate—although never an ultimate—rather satisfying explanation of some of these little parts of the big whole. By

these methods we re-describe, which is a form of approximate explanation, these parts of the mystery and sometimes the whole mystery. If it is a mystery of life and so-called vital forces —and no kind of mystery is more fascinating to us nor more feverishly discussed and studied than this kind—we re-describe it, or bits of it, in terms of non-life, and of forces of physics and chemistry. We analyze protoplasm, the physical basis of life, into chemical and electric elements. We re-describe the simpler vital phenomena in terms of mechanics. There is a veritable mechanistic school of scientific students of life, a most active and aggressive school. The American leader of this school writes a guide-book for his followers called "The Mechanistic Conception of Life." The strength and vogue of this school rest on the assumption that a re-description of life in terms of mechanics is an explanation of life. To be sure it carries the life mystery from one field of study into another in which we have been more successful in describing a wide variety of structures and phenomena as manifestations of a few basic structures and happenings, and a re-

description of this sort may be accepted as a welcome nearer approach toward real explanation, although, of course, it leaves ultimate causes and conditions to remain as much of a mystery as ever. Perhaps this is well, for life robbed of mystery would be drab indeed. The stimulus of mystery is a mainspring of the higher human activities.

Now all this applies precisely to our attitude toward mind, by which we usually, and perhaps unfortunately for our hope in reaching any understanding of mind, mean just human mind. But this is understandable; for human mind means more to us than all other mind and than all else human. We speak of good minds and poor minds; of minds of talent and of genius; of feeblemindedness and insanity; of the quick mind and slow mind; of the unconscious mind and the creative mind. These are kinds of mind. But we mean by all of these, kinds of human mind, and, even more limitedly, kinds and conditions of functioning of the human brain.

I wish to use the name mind in a broader, if less interesting way; a much broader way, in-

deed, so as to indicate by it both a wider occurrence of mind in Nature than in human beings alone, and a wider inclusion of seats of mind, even in human beings, than the brain alone. I want to use mind to mean almost everything that acts as control of animal or human behavior, with a recognition that other parts of the nervous system besides the brain, and even body-parts not composed of nerve tissues at all, may play a role in mind. I want to assume even that animals with no specialized nervous system whatever may have mind, that is, may respond by action in a recognizable and even predictable way to stimuli. There are, indeed, some plants, like the quickly responding sensitive plant and the diabolically effective sun-dews and Venus fly-traps which attract, imprison and digest small insects, that might fairly be considered to have a kind of mind. An Indian naturalist of some repute, Dr. Bose, writes constantly about the "mind of plants."

Someone may think that this taking all meaning out of mind. I think, rather, that it is putting new and useful meaning into it, that

to do anything less than this is to limit ourselves to an anthropocentric interpretation of mind, which may tend to obscure our understanding of what our own mind really is. Mind in Nature is surely something much wider than that special manifestation of it as a function of the human brain. Of course, we must, for practical reasons, if no others, limit somewhere our generosity in the way of a definition of mind, else we might involve ourselves in that too logical predicament of finding ourselves talking about the "consciousness of the molecule," as some of our predecessors have actually done. But we must at least be broad-minded enough in our talking about mind to escape the cry of anthropocentrism from the lower animals, such animals, say, as Ammophila, the sand-loving wasp of the salt-marshes of San Francisco Bay, about which I purpose now to give a true story. I am sure it is true, for I have seen repeatedly all the incidents of this story.

THE INSTINCT MIND OF AMMOPHILA

ALONG the western shores of the long southern arm of San Francisco Bay there stretch broad salt marshes, through which tide-channels run, but which embrace considerable areas that lie above all but the very high spring tides, and which are mostly covered by a dense growth of a low, fleshy-leaved plant called samphire or pickle-weed (*Salicornia*). Here and there, however, in these areas there are small, entirely bare, level sandy places which shine white and sparkling in the sun because of a thin incrustation of salt over them.

Each September these bare places are taken possession of by many female wasps of a species of Ammophila, which is a long, slender-bodied "solitary" or "digger" wasp, that is somewhat gregarious in habit, but is not at all a "social" wasp like the hornets and yellow-jackets, the *Vespas*, more familiar to us. Now, watching closely any one of these female Ammophilas flitting about these bare places one can see the following performance take place.

First, the Ammophila, after various flights—flights of survey, we may call them

—over the salt-encrusted ground, will settle down somewhere on it, and, with her sharp jaws, cut out a small circular bit of the salty soil crust, which she gets out unbroken, and drags off a few inches to one side. Then she digs out, by means of her jaws, bit by bit, a little vertical well about three inches deep and slightly less in diameter than the circular bit of salt crust. Each pellet of soil dug out is carried away by the wasp, flying a foot or two from the mouth of the hole in any direction, and dropped. She does not plan to have any tell-tale pile of soil near the mouth of that precious hole in the ground. In emerging from the hole she always backs upward out of it, and while digging she keeps up a low humming sound. We might imagine this to be the joyous song of the home-making mother—but as we are scientific observers we had better restrain, if not our imagination, at least our unverifiable interpretation of things. Let us be properly matter of fact.

After the hole is about three inches deep our energetic Ammophila, climbing out with the last pellet and flinging it to one side, seeks for and finds the little circular bit of salt encrustation which was so carefully removed and put to one side at the beginning of this hole-making performance. This she

now drags to the hole and with it carefully covers the hole's mouth. Then she flies away over the surrounding pickle-weed and disappears in it.

We must wait a few minutes now, sometimes only a few, sometimes as many as fifteen or twenty. If we like, we can look around us in the little bare space and we shall see other Ammophilas digging holes, going in head first and backing out, flipping pellets of soil away, humming their nest-building songs and altogether doing just what our first Ammophila did and in just the same way. But now, silence and immovability! For the first Ammophila is coming back, flying low and heavily with what seems to be a dead looper or inch-worm (larva of a Geometrid moth) about an inch and a quarter long, held in her jaws. She comes directly to the covered hole;—how does she tell where it is, with its salt-crust cover making it look like all the rest of the ground?—puts the limp inchworm down by it, carefully removes the salt-crust cover, and then drags the inchworm down into the hole, going in head first and then coming up and out backwards. Then she re-covers the hole with the salt-crust lid, and flies away again. After a while she is back with another limp inchworm which she puts into the hole,

going through just the same performance as she did the first time. And so on until she has put in five inchworms. If we watch other Ammophila mothers we shall see that they vary a little in number of inchworms put into their holes. The number runs from five to eight, or rarely, ten, but is usually five or six.

Now, what next? After taking the fifth inchworm down into the hole Ammophila does not come out as soon as she has after putting each of the others down. After several minutes, however, she does come out, but instead of flying away she now begins to fill the hole with pellets of soil which she scrapes up here and there with her sharp strong jaws. Some of the pellets are the ones she scattered a foot or two away while she was digging the hole. If they are close by she scrapes them in with her forefeet. If farther away she brings them in her jaws. She works rapidly, running and jumping about, making little buzzing leaps and flights, until she has quite filled the hole.

Then she does a clever thing. With her forefeet she paws and rakes the surface of the filled hole until it is quite smooth, and then with jaws and horny head she presses and tamps down the bits of soil on top until they are a little below the surface of the salt

crust around the hole. Finally she gets again the circular salt-crust lid and neatly puts it into the depression on top of the filled-in hole so that it fits perfectly with the hard continuous salt crust around the hole's edge! Without saying anything about intention on the part of Ammophila, it is certain that by this performance she has almost perfectly concealed the whereabouts of the hole. In fact, if we take our eyes off it we shall have difficulty in finding it again: and yet *we* know, to start with, just where it is. How about the various predaceous birds or insects who would like to find it with its store of luscious inchworms?

And now Ammophila is finished with this hole, at least. But we are not. Let us dig it up and have a look at those apparently dead inchworms, and also see if we can find out what kept Ammophila so long in the hole after taking down the fifth worm. So we dig up and examine the five inchworms. Sticking to the body of the last one put in there is a little, shining, white, seed-like thing. It is an egg which Ammophila has laid and glued on to the worm's body. And the worms themselves instead of being dead are alive but paralyzed. If we prick any one of them near head or tail it will wriggle just a little. If we prick one in the middle of the body it

does not wriggle. Ammophila has stung each inchworm in one or more of the middle tiny ganglia or body-brains which are ranged segmentally along the under side of the body; a very exact and useful surgical operation. For the worms, which are, of course, to serve as food for the Ammophila grub that will hatch from the single egg, if dead would soon decay and be useless to the grub, and if not paralyzed would promptly dig their way up and out of the hole before the egg even hatched. So down in the darkness of the filled-in hole there will soon begin the tragic eating alive of the worms by the Ammophila grub which soon hatches from the egg and which will find in the inchworms enough food to last it until time to pupate, when it takes no more food. Then, later, it will issue as a full-fledged new Ammophila, to dig its way out and find another and mate, and, if a female, go through this same performance next September. And it will do all this without ever being taught by its mother or any other Ammophila. In fact it will never see its mother or father, nor will they ever see it.

This may not be a wholly new story for those who have read Fabre or our own Peckhams and others who have watched and described the similar performances of other

kinds of solitary wasps. Many people know from reading these other stories that different varieties of solitary wasps use different kinds of insects to store their egg burrows with; some use crickets, some use flies, some use spiders, and so on, but each kind or species of wasp always uses a particular kind, or closely related kinds, of other insects or spiders to supply its never-to-be-seen children with living animal food. Even the great hairy Mygales, or tarantulas of California, are stung, paralyzed and stored in the egg-burrows of Pepsis, the glittering armored giant wasp called Tarantula-killer.

I have described the smoothing off and tamping down by Ammophila, with jaws and head, of the filled-in hole. But Williston in Kansas and the Peckhams in Wisconsin have seen other Ammophilas hunt about for and find and pick up in their forefeet a smooth little pebble and use it as a tool for this smoothing and tamping. This may seem incredible to many humans—so sure are we that we are the only tool-users. But doth Williston and Peckham pass among biologists as truth-tellers. Williston, indeed, was afraid to tell of his observations for some time after making them. It was soon after the time of Theodore Roosevelt's valiant charge on the nature fakers!

We have spent a good deal of time with Ammophila, but I want to make one story of instinct do as an example of the stories of all instinct-minds. Hence I have told the story in some detail. We have now only to note certain particular conditions that pertain to the animals that have, and live successfully by exercising, such instinct-minds.

In the first place, although Ammophila's egg-laying and food-providing performance is very elaborate and seems very clever, it is about the only elaborate performance she does in her whole life. Most of the rest of Ammophila's activity in life is to avoid as well as she can by good flying, and a use of her sting, the various predaceous birds, lizards, toads, or large insects that would like to catch and eat her, and to hunt about for some food for herself, which isn't difficult, as she, and all other wasps, are almost omnivorous; practically anything in the way of animal food as well as various kinds of vegetable food will do. In the second place, we can find by a little experimenting that even in the accomplishment of her elaborate and wonder-compelling egg-laying and food-providing performance there is a quickly-reached limit to her cleverness.

Suppose we interrupt Ammophila in her clever performance and give her a few diffi-

culties, very slight difficulties, to overcome. That happens to us almost every day. It is, indeed, under such conditions especially that our mind shows its capacities. Of course, there are, as declared at the very beginning of this discussion, different kinds of human minds, and so we respond to the calls put on our minds with different degrees of success, or even with no success at all. We may be feeble-minded or moron or we may have an average mind or a mind of much talent or even of genius. We shall have later to discuss these differences. But we need only recognize now that unless we are really feeble-minded or moron, the introduction of interruptions or special difficulties in our undertakings only gives our mind a special chance to win new triumphs.

But not so with Ammophila. Interrupt her chain of activities in the nest making and provisioning performance and she is lost. If, for example, we quietly remove one of the inchworms, after she has brought it and laid it on the ground near the nest, and place it a few inches farther away while she is engaged in getting the salt-crust cover off of the hole, what happens? When she turns about to seize the worm to drag it down into the hole and does not find it just where she placed it, she is nonplussed. She moves

about distractedly. She doesn't search. She simply flutters about, perhaps happening by chance on the worm; perhaps not. She doesn't seem to use her powers of sight and smell, which she has certainly used in finding the same inchworm in the pickle-weed, to find the nearby worm now on the ground in plain sight or smell of her. So if she doesn't happen to find it promptly by chance she simply gives up further work on this burrow. If she goes on with her nest-making at all she starts a new hole. In other words, she starts the chain of performance all over again from the beginning. Fabre found in the case of another kind of solitary wasp which stores its burrow with individuals of a certain kind of wingless ground cricket, that if he merely turned around one of these crickets brought by the wasp to the side of the hole, and which she deposited with the long hind legs nearest the hole so that she always seized the cricket by these legs preparatory to dragging it down, that the wasp failed to put the cricket in the hole although the antennae projecting from the head, which was now nearest the hole, were about as good handles to seize it by as the legs.

We get an enlightening idea from this. This wonderful and apparently most sensible and even reasoned performance of bur-

row-building and provisioning is obviously a series of separate but connected successive performances, each single act being the necessary stimulus for the next in the chain, the whole chain being started by the stimulus of egg-production in the body and all of it possible to the Ammophila by inherited endowment without any learning. And it is as possible to any one female Ammophila as to another. There seems to be no, or at best but little, possibility of variation in the performance. We humans go about making our nests and caring for our young in a great variety of ways, all alike in general, but almost all specifically different. Not so with Ammophila. All the mothers of this kind or species of solitary wasp do their nest-building in almost exactly the same way. Similarly with each other kind of solitary wasp. The performance must go on uninterruptedly and uniformly. There is no adaptability, no meeting of emergencies, no choice of ways. Fabre stresses especially this lack of variation in performance. The Peckhams, quite as reliable observers—although not such gifted writers and hence not so well known—do find some variation in the behavior of individual wasps of the same species, enough, at least, to offer bases for a progressive modification of the whole be-

havior if these variations can in some way be selected and established as a general species endowment. But these variations are slight.

Now, we are at once led to ask, what are the particular influences that have determined the separate identical acts that go to make up this chain of performance carried out so nearly uniformly by all Ammophila females of the same species? I know of no analysis aimed at elucidating this in the case of Ammophila's nest-making performance, but I have attempted such an analysis, by experimentation, in the case of two other important instinctive performances by insects; first, that of the swarming of honey bees from their hive, and, second, that of mating and egg-laying by silkworm moths. Let me briefly refer to these observations by way of introducing a brief discussion of another type of "mind" that may be looked on perhaps as a simpler type than the instinct mind, but which may even better be looked on as the instinct mind in a formative stage. This is the mind, or behavior control, which depends on obvious and inevitable mechanical reactions to specific physico-chemical stimuli either internal or external to the body of the organism. These reactions have, however, been observed chiefly as responses to external stimuli.

REFLEXES OF HONEY-BEES AND SILKWORM MOTHS

One of the many striking performances in the instinctive behavior of honey-bees is that of the "swarming" out of the hive, after a new queen has emerged from her special pear-shaped cell, of either the new queen, or the old one, together with a large number, running up to ten thousand or even more, of the workers of the hive. This performance accomplishes two things; first, it relieves the hive of congestion, for it occurs usually at times of abundant food supply and when the old queen is laying eggs and new workers and drones are being produced in largest numbers; and, second, it distributes the species, as new honey-bee communities, unlike new social wasp or bumble-bee communities, are founded only in this way, (except of course by certain artificial methods of bee-handlers).

When it is time for the new queen to be born, that is, to issue full-fledged from the cell in which she has until now passed all her developing life as egg, larva and pupa, there is great excitement in the hive. The varied tasks of the worker bees of pollen- and nectar-gathering, comb-building, larva-feeding, cleaning, ventilating, etc., mostly cease, and

a great crowd of bees gathers about the queen cell, from which is heard the challenging piping of the new queen ready to issue, answered by loud trumpeting from the old queen outside. Then the slender-bodied virgin new queen emerges. Sometimes the workers—following, we may say as long as we know no better explanation, Maeterlinck's "spirit of the hive"—prevent her issuance for some time, or, allowing her to issue, suffocate her by imprisoning her in a dense mass of bees, "balling" as it is called. More usually, however, they permit her to issue, unhindered and unharmed, and then she and the old queen fight to the death for the queenship of the hive, or one of them emerges from the hive exit accompanied by a great number of excited workers. This is "swarming."

Over a glass-sided and glass-topped observation hive in my laboratory, with its exit leading by a short glass-covered tunnel to a hole cut in a window casing, I kept a black cloth cover which could be easily and quickly removed whenever I wanted to see what was going on in the hive. At a time of the birth of a new queen, readily indicated to me, although the black cloth cover was on the hive, by the sounds of the royal trumpetings and the loud buzzing of the excited

workers, I suddenly lifted the black cloth just as the swarm was on the point of issuing from the hive. Strangely enough the swarming out was immediately arrested, and those bees about to issue all turned and made rapidly for the top of the hive. They simply flowed up the glass sides in an amber stream to jam themselves tight against the glass top. And there they remained excitedly as long as the cloth cover was off. But when I replaced the cover, slipping it on slowly from above down, this stream of bees promptly flowed back down the sides and when the cover was all on, started flowing out to the exit through the short glass-topped tunnel. Again I lifted the cover off and again the excited bees turned and flowed upward.

Now, let us realize that the only light which entered the hive when the black cloth cover was on came in through the small entrance-exit opening, but when the cover was off much more light came in through the glass top, the hive being at the bottom of the window. With this in mind, some further experimenting clearly revealed that although the bees in normal times went uninterruptedly on their foraging trips out and in through the entrance exit opening, whether the black cloth cover was on the hive or

off of it, that is, whether the light came from below or above, at the special time of swarming the bees went in that direction, whatever it was, from which came the most light. They became at this time, to use the technical language of the mechanist explainers of animal behavior on a physico-chemical basis, strongly positively phototropic. (There is one weak point in this explanation, that probably may have been already noted. Why do not *all* of the bees in the hive, instead of only ten thousand or so, issue from the hive, if a strong positive phototropism develops among all of them at the time of the appearance of a new queen. And if not among all of them, why or how among a particular ten thousand?)

Swarming may be called an instinct; we usually so call it. But certainly it is true that I could permit or prevent this swarming, not by any such brutal proceeding as opening or closing the exit of the hive, but merely by determining the direction from which came the strongest light. The positive and essential act of swarming thus resolves itself into a simple reflex or mere tropism, a direct and inevitable reaction to an external physico-chemical stimulus, namely, light.

The Chinese silkworm moths issue from

their cocoon-covered, pupal cases as full-fledged insects, sexually mature. They have four wings, but cannot fly, or can only in exceptional cases, and then for but a few feet or yards. They take no food; indeed they cannot feed, for their mouth-parts are atropied. They have done their eating, and plenty of it, as larvæ (silkworms). They take enough food then, not only to provide energy for their six or seven weeks of active larval life, but to store up food in the body, mostly as fat, to provide for their inactive pupal life of twelve to fourteen days and their active life as moths, which lasts, however, only a few days, usually not more than a week. Having no need, or even means, of feeding; having no bird or toad or lizard or insect enemies to avoid, because they are entirely protected, as their ancestors have been for the past five thousand years, by the silk-growers; and the males not having to search widely for their female mates which issue from cocoons within a few inches of them; and these females, once mated, not needing to search for a particular food-plant on which to deposit their eggs, as most moths and butterflies do, so that the hatching larvæ will find proper food ready to mouth; without having, thus, to do any of these various things usually necessary for

moths to do, the silkworm moths have just two essential activities to achieve, namely, mating and egg-laying.

Here, then, we have a highly developed insect, of different order, but of little less structural specialization than the solitary wasps and honey-bees, whose behavior, however, is extremely limited and very simple, although no less important to the persistence of its own species than the elaborate behavior of the bees and wasps is to the maintenance of theirs. Under these advantageous circumstances perhaps we can discover, as we did in the case of the swarming of the honey-bees, an explanation, or better put, a description, of the behavior of the silkworm moths in terms of definitive response to physico-chemical stimuli; in other words, a mechanistic explanation or description.

After the female moths issue from their cocoons, with bodies already heavy and swollen because of the mass of eggs in them, they move about but little and only slowly. The males, on the other hand, of more slender and lighter body, are active and restless in their movements, which soon culminate in bringing them to the females. Now, these movements might be described as resulting from an intention to find the females, if we

cared to ascribe the power of conscious intention to these creatures; or as an instinctive search for their mates, if we preferred to explain their behavior as controlled by unconscious instinct. But if we go further in our observation, and add a little experimentation to it, we shall find basis for a third kind of description.

The females bear, in the posterior end of the abdomen, a pair of scent glands which are occasionally, and in some cases continuously, protruded from the body. The males have organs of smell—many minute pits with a free nerve-ending at the base of each—on their antennæ. They smell the odor from the female scent-glands; or, put as the mechanists would put it, the scent particles proceeding through the air from these glands strike and stimulate these nerve-endings; which in turn results in a positive stimulation of the males to move in the direction of the source of the scent particles. This brings them to the females. They do not find the females by sight, for they find them in darkness as well as in day time and with their eyes totally blinded as well as with their eyes untreated. If one antenna of a male moth standing near a female is removed, the movements of this male will constitute a series of circles, or a spiral, turning

always toward that side on which the intact antenna lies, this devious movement, however, also usually bringing it finally to the female. Finally, if the scent-glands be cut from a female, and a male, with eyes and antennæ intact, be put equidistant between the female moth and the removed glands, or even much nearer the female than the glands, the male will inevitably move toward the glands and reaching them remain there and go through the motions of an attempt at mating. It doesn't distinguish the difference between the cut-out glands and the female moth, and it thus doesn't mate at all. The male silkworm moth is, say the mechanists, positively chemo-tropic: its movements are simply a positive and inevitable physical reaction to a chemical stimulus. That accounts for practically all of the behavior of a male silkworm moth through all of its adult life.

As for the egg-laying. Very soon after mating the female begins to lay its eggs, in small batches, until all of the 300 or more in its body have been deposited. This is of course a very useful performance; it is a necessary one for the persistence of the species. Does the female moth know of this usefulness, this necessity? Or is egg-laying an unconscious performance due to an in-

herited instinct? Or can it, too, be seen as a positive and inevitable result of a mechanical reaction to a certain specific and immediate physico-chemical stimulus? If the abdomen, or even just that posterior part of it containing the eggs, is cut off from a female moth, thus leaving the head, with brain, eyes and sense-organs on the antennæ, and the thorax with its large mid-body ganglion, quite separated from the egg-laying organs (ovaries, ovi-ducts, muscles) with the small posterior abdominal ganglion and its nerves which run from the skin and to the muscles of the hinder part of the abdomen, this cut-off hinder fraction of the body, if its ventral side is brought in contact with the bottom of the tray in which the moths are kept, or if this fragment of the body be turned over and its ventral side is rubbed, will extrude the eggs. The performance of egg-laying will be carried on just as it would be by an unmutilated female. In other words, the interesting and useful egg-laying behavior of the adult female moth—which is practically all of its behavior in its whole adult life—is, the mechanists would say, simply an inevitable physical or mechanical reaction by a small mass of living substance to a group of physico-chemical stimuli.

OTHER REFLEXES AND TROPISMS

THESE phenomena are exhibitions of animal behavior governed by the simplest kind of mind, the mind of reflex and tropism, the mind of mechanics, of physics and chemistry, a mind, or behavior, which is merely a physico-chemical property of protoplasm. When we go lower in the animal scale, and especially when we go to the very bottom of this scale, to the simplest animals we know, the unicellular Protozoa, we find this kind of behavior being more and more nearly the only kind of behavior exhibited. We find these simple animals, and the simple motile unicellular plants, moving inevitably toward or away from light (positive or negative phototropism); toward or away from various chemicals (positive or negative chemotropism); in or opposite to the direction of the pull of gravitation (positive or negative geotropism); in contact with or avoiding contact with solid substance (positive or negative stereotropism); and so on; all inevitable physical reactions to physical or chemical stimuli, all mechanistic behavior. Or, to substitute for the word behavior the name of that which presumably governs behavior, namely, mind (in

our broad use of the word), we can say that among the lowest animals the reflex or mechanistic mind seems to be the only, or at least, principal kind of mind.

But, also, we have found that an analysis of certain examples of the instinct mind, as exhibited even among those animals, the insects, which are usually referred to as the group in which the instinct mind finds its highest development, reveals the possibility of seeing in instinct only a highly complex and coordinated chain of mechanical reflexes determined by physico-chemical stimuli. What do we find when we transfer our scrutiny from the lower animals to the higher, and even to the highest animals, our own proud selves, in our attempt to recognize behavior by reflexes or tropisms?

We readily enough find reflexes, or what we call reflexes, in the higher animals and in ourselves. Such are the unconscious movements and general behavior of our internal organs, the beating of the heart, the peristaltic movements of the alimentary canal, the secretory activities of glands, the contraction and dilation of blood-vessels. And while the particular physical or chemical stimuli that set up the behavior of these body parts are, in most cases, not recognized by us, yet modern experimental physi-

ologists have revealed some of them. The swiftly increasing knowledge that we have of the effects of the secretions of the ductless glands, these secretions so small in quantity but of such strong stimulating or inhibiting action, has opened a new way to the understanding of the physico-chemical control of much of the functioning of different body tissues and organs.

But perhaps most forms of behavior by the body or its parts in the case of the higher animals and ourselves that are called reflexes by the students of human physiology and psychology are not of the same character as the reflex and tropismic activities of the lower animals, although the mechanists list some that they claim to be the same. Some human reflexes are undoubtedly the result of long repetition of originally intentional movements, which become thus a habit of the individual and are performed unconsciously by reflex action under the reoccurring proper circumstances. But such acquired reflexes are not inherited. The reflexes, on the contrary, which we have described among the lower animals, as well as the beating of our heart, the winking of the eyes, etc., are a part of the inherited endowment of the species.

Some of the more thorough-going me-

chanists make daring claims for the tropismic control of the most complex animal bodies, even our own. Once when one of these convinced mechanists saw me, on entering a cafe in Leipzig, find a seat in a corner of the room where my body touched the wall on either side, he explained to me my behavior in this instance as an example of positive stereotropism, my action being such as to give my body as much contact as possible with solid substance—which is the same explanation he would give for the familiar behavior of a startled sand flea in burrowing into the sand. I was to him simply a positively stereotropic animal—and nothing more.

My own explanation of my interesting behavior, namely, that I had made an engagement with a friend some hours before to meet him in this particular corner at this particular time was pleasantly waved aside. Why, on the philosophic principle of Occam's Razor, should we need a more complex or specialized explanation when a simpler, more generalized one was at hand? However, I was not convinced then, nor am I yet, that the springs of my behavior are to be as easily discovered by a casual, even though a trained, observer, as those of a Paramœcium or a sand-flea. And this, if for

no other reason than a basis of our common knowledge of the power of the human being to dislocate, both in time and place, many of his reactions from his stimuli. My stimulus and my reaction may be days apart and miles away from each other.

But whether those forms of our behavior that the physiologist and human psychologist call reflex are, or are not, of the same type as the "reflexes" of the lower animals, we certainly recognize part of our behavior as instinctive and quite of the type of the instinctive behavior of Ammophila and of the myriad other instinct-controlled lower animals. Our instinctive behavior, indeed, is of so much importance to us that some of it is actually necessary to the saving and persistence of our lives.

Take the babe's act of suckling, for instance. This is a behavior common to all of us individuals of the human species—just as it is to all individuals of all mammal species—and is neither taught us nor learned from individual experience but is something of which we are just naturally capable from the moment of birth; an inherited possession of the species. That puts it in the category of instinct, simon-pure instinct.

How we came, as species, originally to possess this capacity of instinctive behav-

ior, or how Ammophila came to possess its much more complicated nest-making and food-providing instinct, is a great question, the conclusive answer to which the biologists, genetic psychologists and evolutionists—or even the mechanists—have not yet found. Some explain it by natural selection choosing among a nearly infinite host of spontaneous, fortuitous small variations. We do know that these variations occur but we do not know that they can be the basis for a life-saving or life-losing determination which, together with their heritability, must necessarily be assumed in the Darwinian natural selection explanation. In fact, we know that many of these variations can not fill the requirements thus made of them.

The mutationists assume fewer but larger spontaneous variations as heritable, and hence larger evolutionary jumps, but they cannot assume that these jumps will be in the right or in any particular direction, for the observed mutations do not bear out this assumption. Same trouble for the Mendelians.

The Lamarckians, or contenders for the simple and highly plausible explanation of evolution by the inheritance of acquired characters, face what has so far been the insuperable difficulty of proving this inheri-

tance. If this could be proved their theory would beautifully explain much of evolution, especially that phase of it called adaptation, which includes instinct. Unfortunately, it seems much easier to disprove than to prove the inheritance of acquired characters. There seems, indeed, to be no means in the mechanism of inheritance as we now so far know it, and concerning which, by the way, more has been learned in the last half century than in all time before, to make it possible. This general difficulty, or impotence, of the Lamarckians applies disastrously also to the efforts of those genetic psychologists who would explain instinct as inherited habit, that is, behavior originated under the direction of intelligence, then repeated so often as to become habit, that is, capable of being performed almost or quite unconsciously, and then finally become a matter of inheritance. But this explanation implies, first, the assumption of intelligence in very low animals, and, second, also, that fatal assumption of the inheritance of acquirements.

But whether we can find or not a reasonable and scientifically well supported explanation of the origin and development of tropisms, reflexes, and instincts, we know that they exist and that hundreds of thou-

sands of kinds of animals have minds of these kinds. Compared with the mammals, or even with all the vertebrates, to whom may be attributed minds which, in lesser or larger degree, include the elements of intelligence and reason, the animals whose minds are wholly or almost wholly tropism, reflex, and instinct minds, are as thousands to tens. The insects alone represent more than three-fourths of all the half million living kinds, or species, of animals we know. Looked at, then, from the point of view of numbers of animal kinds dominated by it, the inherited instinct mind is easily the prevailing kind of mind. What a curious impression this gives us of animal life!

INTELLIGENCE AND REASON

But it is time now to come to another general type or kind of mind, a kind which we are sure we possess, and claim to possess in much higher degree than any other animals, and of which we are very proud. It is a kind with which we are much more familiar than with any other kind, and, hence, is the kind we usually think of when we think of mind at all. It is the mind of intelligence and reason. Perhaps our whole mind includes something of that low, prosaic, mechanistic element of mind which seems alone to govern the lowest animals, and certainly it includes something of that rigorous, unadaptable, non-educable kind of mind characteristic of so many animals, that we call instinct. But the outstanding distinction of our mind, and the thing about it of which we are proud and prone to boast, is its inclusion of intelligence and reason. This kind of mind is especially characterized by varying in capacity among the different individuals of any given species possessing it.

There are, as we stated in almost our first sentence in this discussion, good human minds and poor ones, minds of talent or

genius and feeble minds, and this classification is based on the varying degrees of intelligence and reason possessed by different individuals. Even in the poorest, or nearly poorest, human mind there is some intelligence. And that seems so much better than to have only a reflex mind or an instinct mind! Perhaps, in fact almost certainly, some other animals have a mind possessing some intelligence. Almost any of us are inclined to admit this when we recall incidents of the behavior of our pet dog, cat, horse, even chicken or canary—I have a friend with a pet fish which is "so intelligent"—and the special students of animal behavior will say that many wild animals have intelligence, as will also the nature-lovers and hunters of big game by gun or camera. Mr. Hornaday, in his recent book on *The Mind and Manners of Wild Animals*, is very positive that many animals—he is thinking almost exclusively of vertebrates, and mostly of mammals—have intelligence and some of them much intelligence. Indeed he says: "Some animals have more intelligence than some men; and some have far better morals" (p. 6). Mr. Hornaday, who is a veteran naturalist and present director of the New York Zoological Gardens presents in his book an interesting collection of

examples of intelligent and reasoned behavior on the part of wild animals in field, forest and zoological gardens.

As an illustration of the intelligent and apparently reasoned behavior of an animal not usually accredited with too much intelligence, namely the jack-rabbit, I may draw on my own observations for an incident which may help recall to many of you other examples from your own observations of the intelligent behavior of other animals to add to Mr. Hornaday's already long list. I may remark in passing that one always feels surer of one's own stories about animal behavior than of those of other persons. There seems to be a general atmosphere of suspicion hanging about most "true stories about animals" whether told by the old hunter or trapper or by the literary purveyer of bed-time stories or even by the professed scientific student of animal behavior and psychology.

It was on the campus of Stanford University—an unusually generous college campus comprising, as it does, several thousand acres of valley and low foothills. I was walking leisurely across an open field on this campus given over at that time mostly to wild poppies and a few towering eucalyptus trees, when I noted the approach, at some

distance, of two slender-bodied, long and thin-legged coursing hounds, with their trainer, who was giving them an airing and some gentle exercise. It was in the old days when the brutal sport of hare-coursing was a more or less popular addition to horse racing in California as an excuse for stiff betting; and coursing hounds were almost as carefully bred and trained as race-horses. These hounds could run just a little faster than jack-rabbits, but were less adroit at dodging, their attempts at sudden stopping or change of direction, when at high speed, often resulting in violent falls or even in breaking their legs. In that advantage lay the principal hope of any jack-rabbit once seen and under pursuit by the hounds in open country. But there were not many chances for jack-rabbits to learn of this advantage by experience, for most of the coursing was done in closed fields where captured rabbits were turned loose,—but with no chance of final escape.

At the moment, almost, of my seeing the approaching hounds, still some distance away, I startled a jack-rabbit from its resting place just in front of me. The rabbit began running swiftly straight away from me toward the hounds, of which it was evidently, at first, unaware. But one or both of the

dogs, which at the moment were some distance apart, jogging along on parallel courses, immediately saw the rabbit, and announcing the news to each other—and to the rabbit—by sharp barks, began converging toward the rabbit at full speed. In front, and potentially on either side were the hounds; behind was I; what was the jack-rabbit to do?

This, at any rate, is what it did. First it made, while still bearing generally forward at full speed, two or three hesitant, tentative veerings, first to one side, then the other, answered at once by responsive veerings of the hounds. And then, as the dogs drew nearer on their converging courses, the rabbit straightened out on a forward line at very top of its speed and passed directly between the amazed dogs, both of which, in endeavoring to make the nearly right-angled turn necessary to reach and seize the rabbit, lost their balance and rolled over and over before regaining their feet. In the meantime Brother Rabbit had got a good lead, and soon rabbit and re-started dogs were disappearing distantly across the field.

As I came up to the trainer, standing stock still and staring after his disappearing hounds, he expressed the amazement and the appreciation of the rabbit's perform-

ance, for both of us, by a single sufficient phrase.

"Well, I'll be damned," said he.

Along with this I may refer to an observation made on another jack-rabbit by Dr. David Starr Jordan of Stanford, which he used to recount to his students of evolution. I give the story in Dr. Jordan's own words.

"On the open plains of Merced County, California, the jack-rabbit is the prey of the bald eagle. Not long since a rabbit pursued by an eagle was seen to run among the cattle. Leaping from cow to cow, he used these animals as a shelter from the savage bird. When the pursuit was closer, the rabbit broke cover for a barbed-wire fence. When the eagle swooped down on it, the rabbit moved a few inches to the right, and the eagle could not reach him through the fence. When the eagle came down on the other side, he moved across to the first. And this was continued until the eagle gave up the chase. It is instinct that leads the eagle to swoop on the rabbit. It is instinct again for the rabbit to run away. But to run along the line of a barbed-wire fence demands some degree of reason. If the need to repeat it arose often in the lifetime of a single rabbit it would become a habit."

It is not my intention, however, to debate

or give evidence for the possession of intelligence by other creatures than man. The professional students of animal psychology, I believe, generally agree that various animals, especially the so-called higher ones, as the mammals and birds and even on down among the vertebrates through the reptiles and batrachians and fishes, do have minds which exhibit, in varying degrees, intelligence and reason. Nor is it my intention to get involved in the difficult subject of the genetic relationships of the different kinds of animal mind; that is, to attack the problem of which is genetically lowest or oldest, and which genetically highest and most recent; and, also, whether these kinds of mind can be arranged serially with regard to their evolutionary development. We shall not seriously attack such questions as, has instinct been evolved out of tropisms and reflexes and intelligence out of instinct, or do instinct and intelligence represent two branches of mental evolution from a single, early ancestral mental status, two branches or lines of mental development which have gone their independent ways, reaching present culmination in the insects on the one hand and the mammals on the other.

I am not a psychologist and these are matters primarily for the professional psy-

chologist. My excuse for daring to discuss the subject of mind at all is that there are possible special angles of approach to the consideration of mind fairly open to the general biologist and to the biologist especially interested in human life. This kind, or these kinds, of biologist, I do profess to be, and hence claim the privilege of considering the phenomena of mind from those particular angles available to such a student.

Among these is that very important one of the relative roles played by heredity and environment (including function or exercise) in determining the kind of mind in each human individual. What is it that gives me a poor mind and you a good one; that makes a genius of Einstein and a moron of Zweistein? Is nature more potent than nurture, or nurture more potent than nature, in the final determination for each of us of the mind we have? The biologist strenuously insists on discarding the too commonly held point of view of the antipathetical relation of heredity and environment. These two potent influences in the determination of our fate are complements, not antitheses. Both are necessary to our being at all; we should be nothing with either alone. But the relative complementary roles of each in making us what we are, are capable of some meas-

urable distinction. To make the distinction between, and estimate the relative potencies of, these two necessary and complementary influences is a familiar problem to all biologists in almost all biological study. In the particular case we have immediately before us this effort is essential in our feverish search for wisdom to guide us in education, in social organization, in civilization.

THE INHERITANCE OF MIND

In our scrutiny and brief discussion of the instinct mind we have had to emphasize the essentially strictly inherited basis, or, perhaps, almost inherited totality, of this kind of mind. All the individuals of a given species characterized by instinct mind have, essentially, equally capable minds, and these minds are all determined as to character and capacity at birth; little or nothing can be added by teaching or experience; all of the mind is used for all of the foreordained behavior of the individual; there is no reserve to be drawn on for emergencies. But, after all, this type is a highly successful mind from the biologist's point of view; that is, it is a mind entirely capable of carrying its owner, or enough of the owners of exactly similar minds, through life up to and through the performance, sometimes highly elaborate, of all that behavior involved in providing for the persistence of the species. And recall, please, that this all-inherited mind is that kind of mind by far the most usual in the whole animal kingdom; that is, is that kind of mind possessed by far the largest number of kinds of living animals.

Now whether we have derived our kind of mind from the instinct mind or not—and we undoubtedly have not—we have nevertheless certainly derived our body and its inherent capacities, physical and mental, by slow evolution from other early lower kinds of animals, these in turn having been themselves, body and mind, derived from other earlier and still lower ones. In climbing down this genealogical tree we do not get very far before we are looking ancestors in the face whose minds were determined for them practically exclusively by heredity. Is it surprising then that along with the determination of much of our bodily character and capacity by unquestioned biological inheritance, we should find our mind, a function chiefly of our physical nervous system, also partly, even largely, determined in its character and capacity by heredity? The wonder is, rather, that we should find our minds as responsive as they are to modification by environmental (which, of course, includes educational) influence. Anyway, we shall find it not difficult to prove the strong potency of heredity in its role of helping to determine our mental make-up.

Francis Galton, cousin of Charles Darwin, anthropologist, traveler, founder of biometry and modern eugenics and profound stu-

dent of evolution and heredity, was the first outstanding scholar to call serious attention to the biological inheritance of human mental traits and capacity. Most studies in human heredity antecedent to his—and his own studies were made less than sixty years ago—were confined almost exclusively to the inheritance of physical characteristics. Galton, himself an excellent example of the personal advantage which comes through being derived from a family stock in which unusual mental capacity has been a conspicuous hereditary feature, studied the mental ability of Oxford students and distinguished English families. He found that the correlation between Oxford brothers and Oxford fathers and sons as regards mental ability was much greater than among unrelated Oxonians. He found mental ability running for generations in English families, despite sufficient dissimilarity in environment and opportunity among successive generations to make this continuing ability not explicable by environmental advantage. He determined that the chance of a son of an eminent man to show eminent ability himself was about 500 times as great as that of a son of a man taken at random. His observations and conclusions are readily accessible in his various well-known books and papers, as

Hereditary Genius, *English Men of Science, their Nature and Nurture*, *Human Faculty and Its Development*, *Natural Inheritance*, and others. The prestige of his name, his lucid style of writing, and the ingenious and thorough character of his studies combined to give the results of his work a wide and convincing hearing. There has been no question, since his work, that human mental qualities are inherited just as are human physical qualities. There had been much question of it before him.

Galton, however, studied heredity statistically and his determinations of inheritance behavior are expressed as averages. With regard to mental inheritance he paid less attention to the inheritance of particular mental traits than to mental capacity as a whole. He formulated two principal generalizations, based on his studies of both mental and physical inheritance, which are now commonly known as "Galton's Laws." The first, known as the general law of ancestral inheritance, is to the effect that an individual derives one-half of his inheritance from his two parents, one-fourth coming from each; one-fourth of his inheritance from his four grandparents; one-eighth from his eight great grandparents; and so on by diminishing fractions until the sum of this infinite

series equals 1 or the total inheritance of the individual. Galton's second generalization, called the law of filial regression, can be summed up by saying that the children of parents who vary from the mean of the population vary similarly, but to less extent than the parents. "This law of regression," says Galton, "tells heavily against the full hereditary transmission of any gift. Only a few of many children would be likely to differ from mediocrity so widely as their mid-parent [average condition of the two parents] and still fewer would differ as widely as the more exceptional of the two parents. The more bountifully the parent is gifted by Nature, the more rare will be his good fortune if he begets a son who is as richly endowed as himself, and still more so if he has a son who is endowed yet more largely."

An excellent example of the results of this latter law may be seen in the case of Galton's collateral family, that of the Darwins. Of Charles Darwin's five sons four have shown unusual mental ability—but none has been a second Charles. But we are all familiar with examples of "filial regression." Indeed, so conspicuous in our eyes is the frequent failure of the children to equal an unusually able parent in mental capacity that we tend to overlook the equally frequent

possession by these children of mental endowment above the average of the population. But the law of filial regression calls for both these phenomena.

Galton's generalizations based on the examination and statistical treatment of many data mark a distinct step forward in the study of heredity. Especially must we be grateful to him for having brought mental inheritance into line with physical inheritance and for having determined and expressed the general or average inheritance behavior of both physical and mental heritable endowment by common generalizations. But interesting and suggestive as these generalizations may be they do not tell us what we especially wish to know, and that is something about the specific inheritance behavior of specific traits; something about what we may probably or certainly expect with regard to the presence or absence in the child or children of a given trait, physical or mental, which is included in the history of this child's ancestry. If, for example, both of the parents are feeble-minded, or one is feeble-minded and the other normal, or if both parents are normal but one or two or three or all of the grandparents are feeble-minded, or if all are normal, will the child or children be feeble-minded or

not? That is the kind of question we burn to have answered by the students of heredity. Can they answer such questions?

In the eighteen-fifties and -sixties, an Augustinian monk, Gregor Mendel, living in a cloister in Brünn, Austria, made a series of experiments in hybridizing various races of peas in the cloister garden. He published the results of his experiments, together with a theoretical explanation of them, in the obscure journal of the local natural history society of Brünn. Here they lay, practically unobserved, certainly unappreciated, until 1900, when three famous European botanists, one in Holland, one in Germany, and one in Austria, all working independently along lines tending to lead them to conclusions similar to Mendel's, all independently and practically simultaneously, discovered Mendel's work and made it known to the world. For thirty years an epoch-making discovery in science had lain hidden! Now Mendel, Mendelism, and Mendelian inheritance are names as familiar to biologists as Darwin, Darwinism, and Darwinian selection. And in time they will be as familiar to laymen.

Mendel made the beginning of the more important part of what we may call the "new heredity." Many followers have developed

this new heredity into a fascinating and imposing special science. It is already in the way of answering precisely some of those questions about inheritance that we most want answered. It deals with the inheritance behavior of specific traits of plants, animals, and man, and with the hereditary make-up of specific individuals. And it reveals much of the actual physical mechanism of heredity.

Mendel, in his own work, crossed different races of peas—he worked also with some other plants—which differed plainly and characteristically in such specific and immediately contrasted details as height of stem, character of seed coat, form of the pods, and so forth. He crossed a race with tall stem with one of low stem, a race with wrinkled seeds with one of smoothly round seeds, and so on, and noted the outcome in every one of the offspring produced by each cross-mating. He then mated these hybrids among themselves and similarly recorded the results for all of the second-generation offspring, and he did the same for still succeeding generations.

From all this intensive work Mendel arrived at several definite and surprising and important results—results not limited to garden peas but holding for other plants, for

animals and for man. One of these results is that, given a definite knowledge of the presence or absence in the germ cells of given parents of some physical or chemical determiner of a certain trait or traits—and this can be determined from a knowledge of two or three ancestral generations—definite prophecy can be made as to the outcome of the children of these parents with regard to this trait, either when the two parents are alike, or when they differ in regard to the bodily possession of this trait.

Another result is the clearing-up of the old mystery concerning the passing-on of a trait by parents not possessing it, that is, in bodily or mental manifestation. The explanation of this depends upon the fact, also first clearly indicated by Mendel's work, that the possession of the determiner of a trait in the germ cells does not necessarily assure the bodily development of the trait in the person producing, or produced from, such germ cells. For example, a normal-minded mother and father of a certain germinal character and history can produce feeble-minded children; and a feeble-minded mother of a certain germinal character and history can produce normal-minded children. The germinal and bodily possessions of an individual may differ; and it is the *ger-*

minal rather than the *bodily* character and history of a given individual that is of prime importance in understanding and prophesying the hereditary possibilities of that individual and his offspring.

INTELLIGENCE TESTS

We cannot indulge in any detailed presentation and discussion of the results of the intensive study of heredity which has been going on since the days of Galton's work, and especially since the discovery, in 1900, of Mendel's work. We may be proud that the biologists and psychologists of America have taken a particularly active and brilliant part in this study, and have made conspicuous contributions both to the knowledge of the fundamental phenomena of heredity and to the use of this knowledge in a practical way. Of special interest to us, at the moment, is that part of this work which has established the general Mendelian character of the inheritance of feeble-mindedness and certain more definitely pathologic conditions of the nervous system; as well as that part of it which has led to the extensive elaboration and growing use of those ingeniously devised tests of mental capacity commonly called intelligence tests.

Out of this work we are coming to see ever more clearly the high importance of the heredity influence in connection with the determination of our mental make-up.

The extensive studies by means of the use of these tests on school children and more recently of college students, and, during the war, on that broad sample of our population represented by the drafted soldiers, have resulted in a large and valuable contribution to our knowledge of the inherently different kinds of minds and mental levels of intelligence represented within our population. And I say this with full recognition of the unfortunate exaggeration in the claims made by some persons for this work. I should not fail to note in this connection that these exaggerated claims are not made by the competent and careful men who have actually done the work of devising and testing the tests; such men as Yerkes and Terman, Yoakum and Boring, Thorndike and Whipple, Haggerty and Brigham, and others whom I ought also to name.

It has been, indeed, the common knowledge of all of us, for all of our lives since babyhood, that our playmates and schoolmates, our college chums and our friends and acquaintances, even our brothers and sisters and parents and relatives, do have different kinds of minds; and that certain of the differences in these minds do persist, and often reveal themselves more obviously as the years pass, despite all the sameness of

tradition and education which is brought to bear on them by parental and social control.

If we can detach ourselves sufficiently to scrutinize with unprejudiced eyes our own mental capacity and behavior, we can recognize distinct and persistent modes of our mental operations and distinct limitations in our mental possibilities, and these despite all our schooling and training and opportunities. Fortunately for our complacency, Nature seems to compensate, in the case of many of us, for her meagerness of general mental gifts by a generous special gift of self-assurance, a pleasant blindness to or unawareness of our lackings. We often do not seem to know how little our knowing can be.

But if we cannot see with sufficient and useful clearness our own inherent and persistent mental peculiarities and limitations, we can abundantly see these in our companions. I often think I see what seems to be a rigid stone wall or ceiling stretching over the heads of my acquaintances up to and against which during their early years of growth and development, their heads rise, only to be stopped there for the rest of life. These dungeon ceilings are of various heights for my various friends. Occasionally one is very high, unlimitedly high, almost. I have

in mind, at this moment, one such instance. This man and the rare others like him reveal extraordinary possibilities of human mental achievement. They give us more hope of the human future. But I, and perhaps most of you, have lower dungeon ceilings. Fortunately, as I have already indicated, that we may not be too hopeless or unhappy our eyes are not in the top of our heads. We don't see the ceiling; we don't even feel the gentle jar when our heads strike it.

But this common and certain but not very definitely formulated knowledge of the variations, idiocyncrasies and limitations of the human mind as revealed by different individuals and groups of individuals, has long needed more precise formulation and arrangement on some analytic and classificatory basis. These mental differences have long needed more serious attention, more intensive study, and more definitive revelation. Especially is this needed in a country like ours with its democratic form of government, its democratic form of education, its problems of immigration and racial characteristics and race assimilation.

Well, it is precisely the chief merit of the recent work on intelligence tests and determination of levels of intelligence that it all makes for this needed classification and pre-

cision of formulation of varying mental capacity, of various kinds of mind. It all tends, also, usefully to re-concentrate our attention on the age-old, but ever pressing and still unsolved, problem of the relative influence and importance of those complementary chief factors in our individual development and racial evolution, nature and nurture, heredity and environment in its broadest sense. Therefore, it is with no apology that I purpose to give, from the point of view of the general biologist, a little special attention to this comparatively new, but, to some of you, perhaps already too hackneyed, subject of intelligence testing. It is not so much to its methodological details but to its fundamental basis and claims for consideration that I wish to ask your attention.

Because of certain implications ascribed to intelligence testing and its revelations, which incite the antagonism of the believers in that curiously persistent fiction, the equality of man, and of those who would organize society on the basis of this accepted equality, who would, to be more precise, organize society communistically, various heated efforts to discredit intelligence testing have been recently made. Also, there seems to be a fear among a considerable

number of professors of education that too much attention given to seeking to understand and measure differences in inherent intelligence or mental capacity will tend to magnify in people's minds the importance of heredity and discredit the importance of the environmental factor, education, in the determination of our mental make-up. It is important, therefore, that serious consideration be given by unprejudiced, but interested people, to this new scientific contribution to human understanding which seems, by every present indication, to have come to stay and to exert its benign or malign influence on our attitude and efforts toward the education and social organization of our people.

In the very first place we want to know just what it is that intelligence tests test and measure. We all know that any person's mental make-up consists partly of something he has inherited from, or, better, through, his parents, and partly of some things that he has acquired from his parents and others acting as teachers and preceptors and examples to imitate—or to avoid imitating—as well as from books and observation and experience and from the personal exercise or lack of exercise of his inherited mental faculties. Among those things

he has inherited are general mental capacity and certain specific mental traits, which we can group together under the name of intelligence. And there are also emotions and temperament, natural courage or cowardice, aggressiveness or retiringness, born independence or born dependency, born leadership or born following. Now of all these things inherited or acquired what are those which intelligence tests really claim to and do test? Just and only those, but those highly important ones, indicated by the name intelligence; those inherited qualities of general mental capacity and specific mental traits which compose what we call intelligence; meaning native capacity for learning by observation, experience and being taught, mental alertness and suppleness, keenness, accuracy, quickness and control. But not various other inherited mental or nervous characteristics such as temperament, emotions, courage, aggressiveness, leadership and so on. And especially not those mental possessions of acquired or learned information and knowledge, manners and methods.

Too many people jump at the wrong conclusion from the too little they read or hear, or the too hasty reading and careless hearing of what they read and hear, that the intelligence testers claim to test and evaluate

all of an individual's mental baggage. This is, of course, not true; but the denial needs to be often and loudly repeated, for on this wrong assumption much careless and unjust criticism of intelligence testing and the testers has been based. But there are less careless critics who understand better what the intelligence testers are trying to do, and who ask: Can they do it? Can they really devise tests the responses to which are based only on inherited intelligence as distinct from acquired knowledge? And if so, do these tests really enable grades or degrees of intelligence to be determined and measured with sufficient precision to warrant summary expression in terms of mental as compared with chronologic ages or in terms of numerous gradatory categories indicated by serial letters or figures? These are the questions, with their implied doubts, that the test-devising and test-applying psychologists must answer convincingly before we can accept their intelligence tests and testing as a basis for radical modification of our educational and societal administration.

The answer to the first of these questions, that which asks if the tests can be limited to inherent intelligence to the exclusion of acquired knowledge is not yet perhaps entirely definite. Some of the tests repeated on

the same children at times separated from each other by a few years receive better responses in the later times. But, of course, even the inherent capacity of a child cannot be all exhibited in babyhood. There is an unfolding of inherent mental capacity, just as there is of physical qualities, during childhood. No child is born full-fledged. Some children unfold or develop more rapidly than others. But this unfolding reaches its term, on the whole, comparatively early in life; perhaps in most cases by the age of sixteen. Not so, of course, the individual's acquirement of information, special knowledge and skill. This may go on even after the age when native intelligence begins to decline, a phenomenon that certainly occurs in most individuals although no tests have yet been devised to determine when this retrogression begins or how far it goes. We sometimes see very vividly among our friends and acquaintances the reality and the distressing extent of it. But there are many individuals whose continued acquiring of knowledge compensates in considerable degree for the loss, in their later years, of the earlier vigor and keenness of their native intelligence.

But enough has been done by way of repeated testing of children and soldiers under

differing conditions of time, physical and mental freshness or tiredness, and so on, to indicate that, on the whole, the intelligence tests of today, which have been developed, both for individual and group testing, with great ingenuity, to eliminate any advantage of literacy as compared with illiteracy, good education as compared with poor, and wide experience as compared with narrow, do call for responses which can be little influenced by acquired knowledge. They do give, on the whole, a fair picture of one's inherent intellectual possibilities.

Because of the rather startling discovery that nearly 25 per cent of the million and a half drafted men of the American army who were intelligence-tested during the World War were "found to be unable to read and understand newspapers and write letters home" it was necessary to devise special tests, the now famous Beta tests, in which no linguistic elements entered and which, presumably, made no demand whatever on educational acquirements. The Alpha tests were applied to the literate men; but many of them were also tested by the Beta tests. More than 83,000 enlisted men were given individual examinations in addition to Alpha, Beta, or both. The correspondence in scores of the same men on both the Alpha

and Beta group tests and on individuals tests was remarkably close.

With regard to the other question, there is certainly now available a sufficient body of evidence to warrant an expression in rather definite, but always *relative*, terms of different grades of intelligence as determined by the tests. These are not expressions of different grades of total native value, mentally, of an individual even apart from his acquirements, because, to repeat again the important but too often unconsidered fact, the tests do not test and do not pretend to test those various native mental and nervous possessions which we speak of as temperament, emotions, honesty and dishonesty, courage and cowardice, independence and dependence, and so on, and which play a very important role in determining our behavior and achievement. Nor are these expressions couched in absolute terms or even in relative terms indicating approximation to or distance from an ideal standard.

Dr. Yerkes, in a recent paper in the *Atlantic Monthly*, quotes from a writer in a magazine of different type and greater circulation as follows: "The army mental tests have shown that there are, roughly, forty-five million people in this country who have no

sense. . . . Besides the forty-five millions who have no sense, but a majority of votes, there are twenty-five millions who have a little sense. . . . Next there are twenty-five millions with fair-to-middling sense. They haven't much, but what there is, is good. Then lastly, there are a few over four millions who have a great deal of sense. They have the things we call 'brains'."

Dr. Yerkes, who was largely responsible for the army tests, gets pardonably vehement in referring to such statements. "Are they true?" he asks. "No," he answers. "Is there any truth in them? Just enough to make them worse than false. They discredit psychology and mislead the reader in important matters of fact."

As a matter of fact the different groups into which the army testers placed their subjects after testing them, designated by letters as A, B, C+, C, C—, D, D— and E men, who can be conveniently defined, relative to each other, as men of very superior, superior, high average, average, low average, inferior, very inferior and most inferior intelligence, indicate primarily a comparison of one individual with another with regard to the respective possession by these various individuals of native intelligence. It was, on the whole, unfortunate that this

comparison was extended, for the laudable purpose of making it more vivid, to test scores made by children of different ages in various groups. Out of this has grown the widely heralded statement that the army draft and, hence, taking it as a fair sample, our male population, has only the intelligence on the average of a thirteen-year-old child, which does not mean to the informed psychologist what it is likely to mean to you and me. In fact there has been no determination made of the average intelligence of all 13-year old children.

The child intelligence testers have adopted the custom of expressing the actual rate of mental development of a subject by a mathematical coefficient called the Intelligence Quotient, which is the percentage ratio between the chronological and the mental age of the subject. This mental age is a statement of the degree of mental retardation or advancement of a child of a given age in a given group compared with the mental condition of average normal children of the same age in the same group. Thus a child of twelve years old may be found by the tests to have a mental age of but eight years, meaning that it has a mental condition not beyond that of the average normal condition of children of eight in the group

tested. Repeated tests of the same children at intervals of one to four years have indicated that the intelligence quotient of a given child remains practically constant between the ages of ten and sixteen years.

By reason of its relative stability, therefore, the intelligence quotient becomes a fairly reliable and useful test of intelligence. Once determined, it seems possible to predict by it, within reasonable limits, the probable relative level to which a given individual's intelligence will develop. From a rather wide experience of these specific ratings of mental age and intelligence quotient in various groups, certain general categories of mental capacity or incapacity have been established and are now commonly used by psychologists. At bottom is the category feeble-minded, then, in ascending order, border-line, dull-normal, average-normal, and superior.

These categories, like the A, B, C, D, E categories of the army testers are, as I have said, categories of relative or compared values and should not be taken usually for more than that. But we do know that some of these categories can be interpreted, in some measure, into absolute terms. For example, most feeble-minded persons are literally unable to maintain themselves un-

aided, let alone contribute to maintain others, in human society. They become a burden on the social organization. The two men out of every hundred of the army draft tested, whose scorings in the mental tests revealed them so mentally inferior that they could not safely be recommended for regular military training and duty were, until their discharge or consignment to merely manual labor groups, a load on the military organization of the American army. As Dr. Yerkes points out, had the Army rejected or discharged immediately on the basis of psychological examination the lowest 100,000 of its recruits it would have lessened by at least one-half military crime, difficulty and delay in training due to stupidity and inequalities in strength of organization.

So there is after all some indication given by intelligence tests of absolute human values. It is quite true that intelligence is but one factor in the absolute value of a man. A man might have an intelligence sufficient to make him available for use as an army officer, but if he lacked courage and some qualities of leadership this would be a poor use to make of him. But also if a man had courage and leadership and was of very inferior intelligence he would not be a very useful officer. There can certainly be no question

on the part of those of us who admit that there are, among human beings, differences in native intelligence, that a more precise knowledge of such differences can be made useful in our attempts to solve the serious problems presented to us in connection with education, military and industrial efficiency, immigration and racial assimilation and social organization generally. Such recent books as Goddard's "Human Efficiency and Levels of Intelligence" and the admirable analysis, under the title "A Study of American Intelligence," of the results of the army tests by Professor Brigham of Princeton university, show us something of where we now stand in regard to this knowledge and some of the uses we can make of it; and they show what further knowledge we can readily acquire if we set ourselves to it. The present-day situation of our schools and universities; our pressing present-day immigration problem, and the present-day widespread social unrest, demand of all of us who are interested in the fate of the nation that we overlook no least chance to inform ourselves of anything which science has to offer us that may be useful to know in connection with our efforts to solve these problems. The modern studies of intelligence do offer us something that may be useful in this way.

I have tried now to show that scientific knowledge reveals with no uncertainty the great role that heredity plays in determining kinds of mind in Nature and, of particular interest to us, in determining our own mental make-up. We have seen how large a part inherent or native intelligence takes in this. We simply must not overlook this fact. One of the major reasons for our present loud outcries about the unsatisfactoriness and waste in college and university instruction is because we do overlook it. At least by our present methods, by our clinging to tradition, and by our necessity of mass-handling the crowding groups of college students—they have increased by 100% in the last five years—we do, in effect, deliberately overlook this fact of wide native difference in minds. And this despite the sound and revealing start that our psychologists have made not only in informing us of this fact—which, of course, we knew before—but of offering us methods of classifying in some measure these varying inherent mental capacities, which is the first step toward treating them variously as their variety demands. In the face of this we go on in the universities treating all student minds as if they had been standardized by nature or previous schooling, and hence as if, for their further

best development, standardized mass methods were quite sufficient. No wonder the capable-minded students must idle, or find other activities open to them out of classroom and laboratories for the exercise of their minds. It is not their fault if they do it; it is our fault. And similarly we go on attacking those other various problems of our economic and political and social life, and futilely fussing with them, with all too much fatal disregard of that fundamental element in them all of the proved reality of varying degrees of native intelligence.

EDUCATION AND THE MIND

EMINENT educators are eminently disturbed now-a-days. One hears or reads, coming from them, rather panicky declarations about the bankruptcy of American education, the appalling spectre of an illiterate American nation, the general inefficiency of American university methods, the swamping of American colleges by incoming waves of moron students, the submergence of the humanities by the hideous Juggernaut of science, the utter vanishing of what little sweetness and light we have ever had.

Fortunately for my own peace of mind I had an opportunity recently to visit Russia and talk with Lunacharsky the Soviet Minister of Education, and I know from personal observation and much added reliable information something of the present state of affairs in such centers of educational leadership as Vienna and Berlin, and hence know that however bad is our situation theirs is worse. So I take that selfish and short-sighted comfort in regard to our own troubles that comes from seeing other peoples' troubles. I take refuge in the natural philos-

ophy of relativity. Relatively, we are not so badly off.

But after all we must not close our eyes to things that are happening in the realm of absolute values. We may be less illiterate than the Russians, but we are, a certain proportion of us, indeed illiterate. Lunacharsky has recently announced—I may interject that I do not believe everything that comes out of Moscow—that in a year and a half every Russian soldier will be able to read and write his native language. A large fraction, perhaps as high as one-fourth, of our own drafted army, which may be taken as a nearly fair sample of our male population in the time of the World War, were "unable to read and understand newspapers and write letters home," to use the interesting phraseology of the army examiners. Poland ranks its university professors, as to official status and salary, on a level with major-generals in its army. I will not undertake to estimate the social and salary status of our professors. Czecho-Slovakia is providing a library for every one of its towns of a population of four hundred and over. Even the Carnegie libraries are a little less abundant than that. A Swedish professor of education, contrasting Swedish and American schools, remarked that in his own country the word

"teacher" is not a noun feminine as it is in America. A recent Bulletin of the U. S. Bureau of Education shows, indeed, that the total percentage of men teachers in American city schools is 11 while the percentage of such teachers in the city elementary schools is 4.

One of the high schools of Washington works its pupils in shifts but its teachers all the time. American teachers' and college professors' salaries have gone up—but the cost of their food and clothing has gone up faster. The number of college students has doubled in the last five years, but the number of college instructors has been far from doubling. Presidents of universities are, some of them, on the verge, or over it, of hysterics. The intelligence testers are informing us daily by specific figures what we knew before as general facts—but these facts seem more exact and awful as they take on the manner of mathematical equations.

So much for a cursory glance at the educational status of the land. What should we do, what can we do, what are we doing, about it?

The intelligence testers, and the child psychology students generally, have made an impress on the primary and secondary

schools and on the institutions for juvenile delinquents. They have shown that they can go far in determining and classifying relatively the native intelligence of children, and that this native intelligence, this inherited kind of mind, of the child, determines in no inconsiderable measure the possibilities of that child which can be *realized*, but not materially increased, by home and school environment. Some backward children come from good homes and some forward children from bad ones even though, in the majority of cases, normal and forward children come from good homes and sub-normal children from bad homes. But this more usual condition is perhaps less because of the influence of the home environment itself on the child than because the bad homes are usually homes created by parents of low mentality and the good homes are created by parents of normal or superior mentality, the children deriving their sub-normal or normal mentality by inheritance from these parents.

But this is not to decry for a moment the high and absolute value of a careful attention to the environmental influences exerted on the developing child both in home and school. For each kind or grade of mind has its own possibilities, and to attain the

maximum of these possibilities the maximum of opportunity and help is necessary. That wonderful thin, sensitive, cellular cortex that spreads over the fore-brain of the child, blank, and inviting the parent and teacher painters to paint on it the most beautiful picture of life possible to be painted with all the experience of ages in it, all our knowledge of Nature in it, and all the stories of human goodness and sweetness in it, is the great gift of Nature to the environmentalist. So much good for the child, or so much bad for it, can be done with this opportunity that even the most convinced hereditarian must be very, very careful nev er to rob any mother or father or teacher or preacher of his or her faith in the actuality and possibility of environmental influence. But, equally important, no environmentalist should try to delude any parent with the idea that anything can be made out of any child by environment and education. I can not forget the circular I once received, which asked me the burning question if I wanted to be another Michaelangelo or Leonardo da Vinci, and suggesting that if I wanted to I should take fifty dollars' worth of advice or instruction from the author of the circular. The promised result would, I admit, be cheap at the price—if that result could be

brought about. But I happen to know that it couldn't.

There is no doubt that the intelligence testers have shown by their tests that inheritance does determine various levels of intelligence which in turn determine in some measure the learning and information-acquiring possibilities of school children. These varying mental conditions indicate the need of an educational treatment adapted to the special needs and possibilities of special categories of pupils. Indeed, they are strong arguments in favor of as nearly an individual educational treatment as can possibly be given under the circumstances of popular education, circumstances that of course preclude going far in such treatment in any but a few private schools.

But there can be, and should be, a further and more detailed grouping of pupils than our present too wholesale method of classification provides. Such more detailed classification and special educational treatment of pupils is not a retrogression in democracy of education. On the contrary it is an advance in it. For the old or widely present method of treating every child like every other is based on the unwarranted assumption of human equality, and actually negatives the real aim of democratic education

which is to give every child an opportunity to make the most of its inherent possibilities. It is equality of opportunity to become the most you can that a successful democracy must be based on.

All this applies to college and university education as well as to primary and secondary education. The intelligence testers have invaded the examination rooms of the candidates for college entrance. They have received here and there a reluctant permission to use a few minutes of the valuable time now devoted, according to the accepted ritual, to finding out how many dates or names of kings or rules of grammar and diction, or description of natural objects, the candidates have committed to memory. The intelligence testers have been permitted here and there to try their tests for mental capacity, that is, capacity to learn and do things mentally, on the huddled groups of would-be Freshmen. On the basis of these tests they have made predictions as to how long certain students would last in the college they enter, that is, whether they would be dropped at the end of the first semester, or the second or third, or would stick on to sheepskin day by virtue of professorial charity, or would go on triumphantly through the four years clamoring for more and hard-

er work and impatiently marking time as the instructors held them back while they slowly nursed the mentally average and inferior along to semester's end after semester's end. And the testers have seen their predictions come true.

If the intelligence testers can do this, what a waste of time and energy and money our colleges are tolerating in their efforts to find out during a semester or year or more what students cannot keep up with even the moderate—to be restrained in expression—mental achievement necessary to making grades in the college courses. The fact, and it is a fact, that the American univeristy—curious hybrid of gymnasium or lycée and real university—is now giving more attention and effort to the less capable, the uninterested and the non-attaining students than to the more capable, the interested and the attaining students, is a menace to the highest usefulness of the institution if it is to exercise effectively its much-needed true university function, which is the development of thinkers and leaders for the country. We may be all equal in our right to receive service from the state, but we are not all equal in our capacity to give service back to it. The state, which is simply all of us, needs the benefit of the best

use of the best brains, and to get it we must see that these best brains have the best of training, and the opportunity to go as rapidly and as far as they can. The problem of what to do with the gifted university student should be looked on as a problem equally as important as that problem to which we now give most of our attention, namely, of what to do with the inherently mentally incapable student.

SOCIETAL ORGANIZATION AND MENTAL CAPACITY

We can do best what we are best fitted to do. This sounds like an axiom, a "proposition that it is necessary to take for granted," as Webster says. We may accept it as such, but do we govern our behavior and our education according to it? The answer is, as they say in the House of Commons, in the negative. At least, it is too largely and generally in the negative.

"Vocational guidance" is a name that, like "eugenics," has come into some disrepute by being overworked by cranks. But each is the name for a good idea and for something that all those interested in the advancement of individual and social capacity and happiness should not turn away from simply because the name has some unfortunate connotations.

Vocational guidance does not mean merely, or mostly, finding jobs for jobless veterans or young persons with high school or college diplomas. Nor should or does it mean modifying our school system so that the curriculum is to be mostly given over to courses in currying horses, baking bread or double entry bookkeeping. It means a little

of these and a good deal of several other things.

Vocational guidance means, or must mean, if it is to win much and permanent favor, trying to find out just how men naturally differ from each other in intelligence and temperament, strong inclinations and special capacities, and what these differences indicate as to kind of work and social activities naturally differing kinds of men can best fit themselves to do, and what the methods and manner of this fitting can best be. Vocational guidance is a natural and needed consequence of recognizing different grades of mind and of rallying to the winning slogan, equality of human opportunity. Equality of opportunity for all men means opportunity to reach the most and happiest and hence the best possible to each; and the achievement of this is obviously the way in which human society and civilization will profit most from human effort, which of course is the way to an ever higher civilization. To repeat our axiom, with some extension, we can do best what we are best fitted to do and be happiest in doing it, and what is possible and best for the most of us individually is best and most promising for us as a social group.

The world has had for some time now an

impressive illustration before it, of the re-results of a vigorous and wholesale attempt to put into effect the logical interpretation as to practise of the slogan, "equality of men." At the same time that an important member of the present American government issues a vigorously worded little book on "American Individualism" whose text is the slogan, "equality of opportunity for men," we still hear, although ever more faintly, the shouting of the old slogan, "equality of all men," from the present Russian government. We have seen clearly in Russia the results of a deliberate and forced policy of non-vocational guidance, of an attempt to act on the assumption of the reality of the equality of all men, of a disregard of the natural phenomenon of kinds of mind. Every man in Russia was assumed to be the potential equal of any other man; any man can do or be, with similar opportunity, what any other man can do or be.

I have already referred to my opportunity of a little more than a year ago to see personally some of the results of this attempt in Russia to act on these assumptions, and to talk with some of the men responsible for the attempt. I had an especially interesting talk with Kalinin, the peasant president of

the Soviet Republic, about the theories and practise of the Government, and the results of its undertaking to develop concretely a rigidly communistic social organization.

Kalinin is a man of much native intelligence, of apparent honesty and frankness, and a good debater. He has had a limited education, and speaks in a peasant patois. My interpreter, a Moscow university man, said, after the interview, that he had never had a more difficult task of interpreting.

Our talk occurred just at the time that the NEP, a new economic policy of the government, was being formulated and beginning to be put into effect. Before this no private trading had been permitted and all surplus of the peasants' grain production over the amount actually needed as food for the peasant families and their stock was requisitioned by the state to go into the common pot for government distribution. Also no industrial establishments could be privately controlled nor could there be any private banking or general commerce. Nationals of other countries in Russia were subject to the same regulations, and hence no foreign capital or industrial aid was coming in from the outside. Everything was to be undertaken and controlled by the whole people as represented by the various com-

missars who formed the government. There was a tremendous civil list of functionaries who were to direct all the people's activities, work the railways and mines, cut the forests, collect and distribute the grain, manufacture the needed cloth and clothing, hats and shoes, manage the hotels now become "Soviet guest-houses," conduct the public schools and universities, and do all the rest that needed doing in Russia for the comfort and happiness and even mere existence of the people. These functionaries were selected by no competitive method. There was no trace of vocational guidance in connection with their assumption of special tasks. Any man was held to be as capable as any other, or if he were proletarian or peasant perhaps a little more capable.

Well, as a result of this a few Americans had to go to Russia to carry on a program of food relief to save several millions of men, women and children from starving to death, or from death by simply controllable epidemic disease. There had been a tremendous falling off in food production all over the land (only partially accounted for by drouth in the Volga basin); there was no industry; there were no medicines and no hospital equipment; there was no coal to warm the houses; there was no money to buy food

or medicines or coal or manufactured clothing from outside countries. The people were starving, freezing, fleeing in panic, dying.

"Yes," said Kalinin, seriously, "we have been disappointed. We have made mistakes; we have been unable to do it. The government and the people are in great difficulties, in sore straits. We thought we could jump at once from a state of capitalism and competition to a communistic millennium. Well, we haven't been able to do it.

"We know now that it is a matter of evolution. We must go through a series of stages. So we are now going back to enter the first of these. It may be called the stage of state capitalism. Such large enterprises as the railways, mines, a state bank, all heavy industry, all export and import trade, we shall keep entirely in the hands of the state. But in agriculture and light industry the peasants and small manufacturers may carry on their affairs with only such state control as is necessary to collect a tax in kind from the grain producers and a share of the profits from the little factories. This is the basis of our new economic policy."

By a few decrees NEP was put into effect. The peasants have undisturbed possession of their land, although they do not yet own it in fee simple. They retain ownership and

control of their surplus production, and may sell it. Private trading is restored. The small industrials may have their factories back, on a sort of easy lease system—this to save the face of nationalization—and may manage these factories themselves.

The result is an immediate bettering of grain production. There is also a beginning in the rehabilitation of light industry. Heavy industry, still in the hands of the government, and managed by men selected on the principle of any man being as good as any other, still languishes.

I have given so much detailed attention to the Russian situation because it is a brilliant illustration of the results of social organization based on a nearly complete disregard of natural differences in men and minds.

Such differences do exist, and not only in Russia but in all the other countries of Europe and of the world, for that matter. And this fact may well be kept in mind when we indulge ourselves in thinking or talking or acting about the building up, the consolidation and the future of the American nation. And just now is a time for all good men to indulge themselves seriously in just this sort of thinking, discussing and acting.

RACIAL TRAITS AND IMMIGRATION

We have before us the pressing problem of the so-called Americanization of the people of America. A part of this problem is that of analyzing and classifying, on various bases, and, of course in no formal way, our present population, to the end of taking action educationally and socially to try to fit each individual to be a useful and contented citizen. Another part of this problem is that produced by the constant immigration of new would-be Americans. Perhaps some of these newcomers think less about becoming Americans than about mere escape to America from other at present less comfortable countries; or than about just finding jobs paid for in money that doesn't require reckoning in terms of astronomical figures. Perhaps some of these newcomers simply wish to follow the flow of gold, arguing to themselves that no one can get gold, the *summum bonum* in their understanding of life, where there is no gold, and that any one can probably get some gold where gold is.

But for whatever reasons our immigrants come, we feel pretty strongly, and certainly

wisely, that these immigrants must be Americanized both as extensively and as intensively as possible. By the very nature of our political organization we are a congeries of political groups rather than a single large unit group, which is a condition that of itself creates enough serious problems. We do not want to add even more serious ones by permitting the development in America of a kind of social organization, or, better, disorganization, based on racial differences. An important question, therefore, in connection with immigration is that touching the reality, and if real, the character of inherent racial differences, both physical and mental, but especially mental. Have different races different inherent mental levels? Or, as different mental levels undoubtedly do exist inside of any racial or national group—they certainly exist here in America—do some races or nations send us, not fair samples of all their mental levels, but only or preponderatingly representatives of their lower levels alone? Some recently obtained data throw much light on the occurrence and distribution of these levels in our population, both in that part of it that may be comparatively called native and in that part of it composed of recent additions from various foreign races and nationalities.

But before giving a brief special consideration to these data I want to discuss for a moment the question of the reality of inherent racial differences in mental traits. Most of us, I take it, would declare, at first blush, that there is no question at all about it: races do differ in their mental manners, as we may call them. But in saying this are we not looking at the whole mental make-up of the usual specimens we meet representing different races or nationalities? Are we not failing to distinguish between the inherent (inherited) mental traits and general capacity of these specimens and those traits and manners acquired by environmental influences, the influences of tradition and imitation, of kinds of education and politics and religion characteristic of different races or peoples? Of course these acquired characteristics have a real importance in determining the susceptibility of these people to being more or less quickly made over into American-mannered American citizens; to being brought to look at social organization and government from an American point of view. But as these traditional or acquired ways are really only acquirements, they may be modified or supplanted more or less easily and quickly by other acquirements resulting from education in and by Ameri-

can methods. They need not necessarily be handed down to their children, as their inherent mental qualities surely will, in some rather definite measure, be passed on to these children by heredity. We are all used to seeing the marked difference in mental point of view and in individual and social behavior of these immigrants, from our own point of view and manners, but we are also all used to seeing the marked differences in point of view and behavior of the first and second American generations of immigrant foreigners from those of their immigrant parents. Some of the loudest eagle-shriekers and most declarative boosters of all things American are Germans, Poles or Serbians only one generation removed. I recall a very large sign in my small college town in the middle West which indicated the place of business of "A. Urbansky, American tailor."

We may have some confidence, then, that through association and education we can modify or replace foreign acquirements by home-made ones, just as we see the incoming foreign languages replaced by our own. But we can have no such confidence with regard to inherent or truly racial mental traits. If there really are racial differences in mental traits our immigrants are not only going to bring them with them but they are

going to hold them—that is, they can't get rid of them—through all their lives. And then they are going to hand them on, little or not at all modified, to their children and their children's children. Therefore we have in these conditions a much harder nut to crack in the Americanizing, in our sense of making like us, of these people.

In a most enlightening paper, published twelve years ago, Professor R. S. Woodworth of Columbia University pointed out that what studies of racial differences in mental traits had been made up to that time, failed to reveal any pronounced or even any very readily definable differences of this character among the races studied. More recent studies seem to confirm this conclusion. In the various special senses these differences are slight, and as to general mental capacity as distinguished from mental culture it is much less easy to say, with any of that confidence so often displayed by superficial observers, that racial differences in innate intelligence of serious degree really obtain, at least among the races of Europe and those other countries which most of our immigrants represent. Perhaps it is true that the so-called primitive living peoples, like the Bushmen and Veddahs and native Australians, are truly biologically primitive, but

they need not concern us; they don't emigrate.

But there does after all seem to be fairly good evidence that although there is much overlapping of races with regard to mental traits and capacity, so that it is hard to set up differential criteria on the basis of differences in such traits, some races may be declared to differ rather definitely in their average or modal mental endowment. The total range of variation in mental character may be fairly similar in two races, but one race may have a proportionally larger number of individuals below the mean of the range than the other so that the weighted average of this race or nation may be said to be below that of another. There is more chance, then, of our receiving, if we receive a fairly distributed sample of each race, a mentally poorer contribution from one race than from another. Of course, we rarely do receive a fairly distributed sample of a given race. We almost always get a sample determined by economic or political or religious or what not other discriminatingly determining conditions. Sometimes this is a sample of the better individuals of the race; sometimes, and too often, of the poorer ones.

I want now to refer briefly to those recently obtained data which throw some

light—and a rather startling light, it is—not only on the existence and distribution of mental levels, or degrees of intelligence, among our present population, but, by incidence, on the mental levels of the samples of foreign population coming to our country from across the seas.

I have earlier referred to the penetrating analysis made by Professor Brigham in his recent book, called "A Study of American Intelligence," of the results of the psychological examination of a large fraction of the American army during the war period. This analysis will give any of its readers much food for serious thought. While the book is not primarily offered as a discussion of the immigration problem I quite agree with what Dr. Yerkes says of it in a foreword, namely: "It is not light or easy reading, but it is better worth re-reading and reflective pondering than any explicit discussion of immigration which I happen to know."

In the first place it is apparent that when the white contingent in the army draft is compared with the negro draft the scoring of the whites on the intelligence tests is much higher than that of the blacks. When the white draft is divided into two groups, namely white officers and white privates, the scoring of the white officers is above

that of the white privates while the white privates score higher than the black draft. The average scores on the basis of the so-called combined scale, which has a possible maximum of 25, are about 19 for the white officers, 13½ for the white privates and 10½ for the black draft. With regard to the general distribution of intelligence in the three groups, the analyzed data show that 98.87% of the white officers score above the average score of the white privates, while 99.97% score above the average of the negro draft. Of the white privates 86.31% are above the average of the negro draft, while only 13.13% of the negroes score above the average of the white privates. But these facts, concerning the relation of the scores of the whites to the blacks, interesting and important as they are, do not concern the immigration problem and may pass without further comment.

When the white draft is divided into two groups, one of native born and one of foreign born men, the data show that 74.8% of the native born exceed the average score of the foreign born. Now, when the foreign born draft is divided into five groups determined by years of residence of the individuals in the United States as from 0 years to 5, 6 to 10, 11 to 15, 16 to 20, and over 20

years, the interesting result is found that the average scores of these groups increase somewhat with length of American residence. The average score of the first or 0 to 5 year group is 11.41, of the 6 to 10 year group, 11.74, of the 11 to 15 year group, 12.47, of the 16 to 20 year group, 13.55, and of the over 20 year group, 13.82.

Various explanations have been offered for this interesting state of affairs. One is that residence in the United States conduces to an improvement in native intelligence, a flattering explanation but one not in line with the assumption of the intelligence testers that the native or inherent intelligence of an individual is fixed some years before attaining the minimum age of army service, and that the intelligence tests do test this inherent mental capacity. Another is that the more intelligent immigrants succeed and therefore remain in this country, an explanation which is weakened by the fact that we know that many of the most successful immigrants return to Europe to spend their saved money.

Both of these hypotheses have been taken into account by Professor Brigham and tested by him through ingenious analysis of the wealth of data at his command, and are found incapable of explaining the fact of

this difference of intelligence among the foreign-born who have been resident in the country for shorter or longer periods. But another hypothesis is left, which seems really to be the true solution of the riddle, and that is that the immigrants that have been more recently coming to us are of a lower grade of intelligence than the incomers of former years. This in turn indicates a change in the character of recent as compared with earlier immigration. An analysis of the available data shows, indeed, that this latter assumption of a change in character of immigration is correct.

In the years from 1887 to 1897 the immigrants, who are the ones composing now the "over 20 years in residence" group of the foreign-born army draft, included considerable numbers from England, Scotland, Ireland, Holland, Denmark, Norway, Sweden and Germany, but these numbers decreased materially after 1897 and in recent years have been comparatively small. On the other hand the immigration in recent years has included large contingents from Russia, Italy, and Greece. Austria has sent over large contingents through all of the past twenty-five years. An analysis of the intelligence scores of the foreign-born recruits representing the various European countries in the

army draft shows a marked variation in these scores with the English, Scots, Dutch, German and Scandinavian groups ranking much higher than the Russian, Greek, Italian and Polish groups. For example, of the recruits born in England, 19% were ranked in the A and B intelligence groups; of those born in Scotland, 13.1%; in Holland, 12.4%; in Germany, 10%; in Denmark, 7%; in Sweden, 5.9%; in Norway, 5.3%; while only 3.3% of those born in Russia ranked in these groups, 2.2% of those born in Greece, 1.5% of the Italians and 1.1% of the Polish. On the other hand, 63.8% of the Polish-born recruits were in the D and E (lowest) groups, 60.5% of the Italians, 55.7% of the Russians, 44.6% of the Greeks, 23.2% of the Swedes, 17% of the Danes, 16.2% of the Germans, 13.5% of the Scotch, 12% of the Dutch, and 8.8% of the English.

If we group these nationalities—they can hardly be called races—according to a racial classification, now in much favor, as Nordics, Alpines and Mediterraneans, it becomes apparent that of the immigration from 1840 to 1890 from 40% to 50% was of so-called Nordic blood, the rest being about equally divided between Alpine and Mediterranean blood. Since 1890, however, the Nordic blood has dropped to 20% or 25%,

the Alpine stock has increased to about 50%, and the Mediterranean has remained at about 25%. And with this change, from earlier years to later ones, of the proportions in the various racial stocks coming to America from Europe there has been also a change for the worse in the average intelligence of the immigrants coming to merge into our population.

But it is to be noted that while the marked change in proportion of Nordic blood to Alpine-Mediterranean began about 1890 the marked drop in immigrant intelligence came only in 1902 and later. Which indicates that it was not alone, or even perhaps principally, the change in proportion of racial stocks that produced the change in average intelligence, but that there was a change in character of the incoming samples of all the stocks as between earlier and later years. The natural conclusion of Professor Brigham is, then, that the obvious decline in intelligence of the immigrants of later years as compared with that of those of earlier years is due to two factors; first, a change in the proportion of races migrating to this country, and, second, a change for the worse in the incoming samples of each race.

One hastens to say that neither Professor Brigham nor anyone else would necessarily

conclude from an analysis of the intelligence status of the European immigrants to this country in the last half century anything definitively with regard to the average intelligence of the different nationalities or racial stocks represented by these immigrants—although one might strongly suspect something. But what one does conclude definitively is that the samples of the different European nationalities and races making up this total immigration do reveal marked differences in average intelligence and that, unfortunately, the recent samples of all the races have been poorer than the earlier ones, and the samples of the Southern and Eastern European peoples, have been poorer than the samples of the Northern and Western peoples.

It is quite certain that we have received from Europe since the beginning of this century millions of immigrants with an average intelligence markedly below that of our native-born population. A considerable fraction of this immigrant population has an average intelligence even distinctly below that of our negro population. To the extent that this foreign population mixes by marriage with our native population, there is going on through the positive influence of heredity a lowering in the average mental

capacity of the American nation. If there is any immediate political advantage in such a blending of blood, so that these foreigners may become less foreign and more American, or be Americanized, as we say, there is on the other hand a biological or evolutionary disadvantage in this happening, for the general biological results of a blood-mixing of higher and lower orders of intelligence must be an approximation of a mean between these orders. While, then, political or immediate economic expediency may suggest one course of action, science suggests another. Politics and economics may suggest a free inflow of unselected immigrants to meet the needs for labor, especially mere manual labor, and an "Americanization" of this inflow through assimilation into the native population by education and intermarriage. Science suggests a checking of this inflow, or at least a strongly selective control of it.

HEREDITY AND ENVIRONMENT IN MIND DETERMINATION

ALTHOUGH it is obvious, I hope, that the first intention of this discussion of mind is especially to call attention to the reality and significance of the heredity factor in the determination of the character and capacity of mind, I hope my emphasis of the fact of direct inheritance of mental traits and capacity comparable in manner and degree with the inheritance of physical traits, will lead no one to believe that I overlook the reality and importance of other factors in mind determination. There are, of course, other important factors. Some of these also have a strong heredity element in them: others are almost strictly environmental factors.

Our new knowledge of the extraordinary influence of the secretions of the ductless glands on the growth, development and general metabolism of the animal (including the human) body, affecting various organs of the body in very positive ways both as to structure and functioning, includes a revelation of the immense importance of these secretions in relation to our mental and general nervous make-up. We have for long

been accustomed to think of the nervous system as the general manager of the body. We must now recognize the secretions of the ductless glands as, in some degree, general manager of the nervous system. Although these secretions, called hormones ("excitants"), are produced in comparatively very small quantities, yet, like the equally small quantities of vitamines and enzymes, they have very powerful effects.

Nearly three tons of fresh thyroid gland tissue have to be used to get one ounce of thyroxin, the hormone secreted by the thyroid. But if there is too little thyroxin secreted into the blood by the thyroid gland of a child, this whole gland weighing hardly more than an ounce, that child may become a *cretin* with not only dreadful physical deformity but with the deformed or incomplete mind of an idiot. If there is a little too much the child may have a goiter, protruding eye-balls, a too rapid heart, and a restless, irritable brain. The pituitary gland weighs one-sixtieth of an ounce, but if it is removed death ensues. If its secretions are too small in amount during childhood, growth is inhibited and a dwarf is produced, usually with psychic derangements; if too large in amount giantism occurs often with accompanying imbecility. The secretions

(called adrēnaline) of the adrēnal glands, two small bodies lying near the kidneys and weighing about one-seventh of an ounce each, have, almost certainly, a marked effect on our nervous system, revealed by strong emotional responses to the variation in the amount of the secretions. Crile declares that "apparently adrēnaline alone can cause the brain greatly to increase its work." And Professor Cushing, in an article suggestively entitled, "Psychic Disturbances Associated with Disorders of the Ductless Glands," says, "it is quite probable that the psycho-pathology of everyday life hinges largely upon the effect of ductless gland discharges upon the nervous system." Thus psycho-analysis with its explanations of dreams, symbolisms, etc., may come to the necessity of basing itself on study of the hormones.

The reference to emotional reactions introduces us conveniently to a word about the part that the emotions, as contrasted with intelligence and reason, play in determining our mental make-up and our activities.

Hugh Elliott in a recent book, called "Human Character," presents a strong brief for what he calls "the all-importance of the emotional states in the determination of be-

havior. . . . Emotions are the representation in consciousness, the subjective side, of the complex series of automatic reactions which in animals we call instincts, and which, in their case, we only occasionally endow with emotional attributes. Thus the quest for food, flight from an enemy, pursuit of a mate, are all automatic reactions which are shared by man with the lower animals, but in the case of man we say they are due to the emotions of hunger, fear and love. . . . Man's life thus becomes," says Elliot, "a series of instinctive reactions differing from those of the lower animals only in their greater complexity and in the extent to which they are varied as the result of individual training or education. Reason does not dictate behavior. . . . It is but the instrument for the safer and more successful carrying out of a reaction which will satisfy the prevailing emotion."

We need not follow these rather dogmatic assertions any farther than we please, but most of us will see some element of truth in them. Without undertaking in any least degree a scientific study of the relation of emotions, temperament, disposition, the affective qualities in general, to behavior, most of us will recognize and admit this relation to be an intimate one. We see illustrations of it

in ourselves, in the different members of our family, in our friends and acquaintances. We know how we and they will react to various stimuli because we know the character of these qualities in them. We distinguish readily these temperamental differences even among strangers whom we meet for the first time at dinner, in clubs, in public meetings, in traveling. We find some minds distinctly congenial and some antipathetic without regard to the acquirements of information or the polish of education or its lack.

And most of us will also recognize the essentially inherent or native character of these qualities. They show themselves early in childhood; they persist until death or senility. They are not acquirements. Environment or education does not create them; it only gives them opportunity or tries to inhibit them.

This brings us finally to the matter—truly an immensely important matter—of the environmental and educational factors in the determination of mental make-up, of kinds of minds. With direct inheritance of mental capacity, with the inheritance of emotions and temperament, and with the inheritance of differences in the functioning of the ductless glands whose secretions pow-

erfully affect both emotions and intelligence, we have an imposing array of inherited factors in mental and nervous make-up, in a word, in mind. How imposing and important are the environmental and educational factors? Can we nullify or ameliorate bad mental inheritance by good environment and education? How far can we compensate for inherited weakness by acquired strength? Can good teachers make Class A minds out of Class B brains? Can we put a thousand dollar education into a hundred dollar boy?

I am not going to try to answer these questions. I am not going to discuss the values and methods of education. I am presenting the unpopular side of the problem of kinds and grades of mind; the side especially unpopular in a political democracy committed to democratic education. I may express, though, in order not to be too unpopular, my conviction that nothing that our knowledge of mental inheritance teaches us prevents us from putting a large faith and hence a large effort in education, and in democratic education at that. Only my idea of a democratic education is not gained from shouting the slogan of the equality of all men but from shouting the slogan of the equality of opportunity for all men. I was a university teacher for twenty years and

more. And I tried to do my utmost for my students. But I do not remember that I ever outfought nature with my weapon of nurture. I do remember, however, helping a variety of young minds toward the attainment of a variety of possibilities open to these minds. That is my idea of true democracy in education. Nature without nurture can make nothing out of us; nor can nurture without nature make anything out of us. With either alone we are nothing. We must have both to be anything, and there is a special right kind of nurture for each especial kind of nature. Heredity and environment are complements, not antitheses, in all development.

The chief concern of our universities is education, and education seems to be at an experimental stage. Many universities in recent years have been swinging back and forth between fixed courses and elective ones; between encouraging the classics and encouraging the sciences; between an especial devotion to the inferior students and a special attention to the superior ones; between general education and vocational education. Perhaps we educators have devoted more time to the trial and error method of learning our business than to the method of finding out fundamental

facts about human make-up and possibilities.

In Russia they assume that anyone can do anything, the only problem being to define the different things needing to be done and to assign by lot each person to a specified task. We do not believe in quite so simple a solution of the problem of social organization. I have tried to show one of the reasons why it isn't so simple. This reason is the influence of heredity in determining mental make-up. It remains for someone to determine the character and potency of the environmental and educational factors in the determination of mental make-up; in the levelling up—or down—of mind, or in the amelioration of bad heredity and the reinforcement of good heredity.