

ANTS AND SOME OTHER INSECTS.

WHEN discussing the ant-mind, we must consider that these small animals, on the one hand, differ very widely from ourselves in organisation, but on the other hand, have come, through so-called convergence, to possess in the form of a social commonwealth a peculiar relationship to us. My subject, however, requires the discussion of so many complicated questions that I am compelled to assume acquaintance with the work of others, especially the elements of psychology, and in addition the works of P. Huber, Wasmann, von Buttel-Reepen, Darwin, Romanes, Lubbock, my Fourmis de la Sutsse, and many others. Since the functions of the sense-organs constitute the basis of comparative psychology, I must also refer to a series of articles entitled "Sensations des Insectes" which I have recently published (1900-1901) in the Rivista de Biologia Generale, edited by Dr. P. Celesia. In these papers I have defined my position with respect to various authors, especially Plateau and Bethe.

Very recently Bethe, Uexkull, and others have denied the existence of psychic powers in invertebrate animals. They explain the latter as reflex-machines, and take their stand on the ground of the so-called psycho-physical parallelism for the purpose of demonstrating our inability to recognise mental qualities in these animals. They believe, however, that they can prove the mechanical regularity of behavior, but assume unknown forces whenever they are left in the lurch in their explanations. They regard

the mind as first making its appearance in the vertebrates, whereas the old Cartesianes regarded all animals, in contradistinction to man, as mindless (unconscious) machines.

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The Jesuit father E. Wasmann and von Buttel-Reepen are willing, on the other hand, to accept the inductive inference from

analogy as a valid scientific method. Like Lubbock, the lecturer
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. and others, they advocate a comparative psychology of the invertebrates and convincingly demonstrate the existence of psychic faculties in these animals. Wasmann, however, puts a very low estimate on the mental powers of the higher vertebrates and, in my opinion, improperly, denies to them any ability of drawing inferences from experience when in the presence of new conditions (this alone he designates as intelligence); he believes that man alone possesses an immortal soul (independent of natural laws?) in addition to the animal mind.

It is necessary, first of all, to arrive at some common understanding concerning the obscure notion "psychic" in order that we may avoid logomachy, and carrying on theology in the sense of Goethe's Mephistopheles. Two concepts are confounded in an obscure manner in the word "psychic" : first, the abstract concept

of introspection, or subjectivism, i. e. , observation from within, which every person knows only, and can know only, in and by himself. For this let us reserve the term "consciousness." Second, the "activity" of the mind or that which determines the contents of the field of consciousness. This has been included without further ado with consciousness in the wider sense, and thence has arisen the confusion of regarding consciousness as an attribute of the mind. In another place I have designated the molecular wave of activity of the neural elements as "neurocyme."

We cannot speak of the consciousness of human beings other than ourselves without drawing an inference from analogy ; quite as little ought we to speak of a consciousness of forgotten things. The field of our consciousness is constantly changing. Things appear in it and disappear from it. Memory, through association, enables us to recall, more or less directly and with more or less difficulty, things which appear to be momentarily absent from consciousness. Moreover, both the experience of self-observation and the phenomena of hypnotism teach us experimentally that many things of which we seem to be unconscious, are nevertheless pres-

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ent in consciousness or have been. Indeed, certain sense-impressions remain, at the moment of their occurrence, unconscious so far as our ordinary consciousness or superconsciousness is con-

cerned, although they can be subsequently recalled into conscious-ness by suggestion. Whole chains of brain-activities, (dreams, somnambulism, or secondary consciousness) seem ordinarily to be excluded from the superconsciousness, but may subsequently be associated by suggestion with the remembered contents of consciousness. In all these cases, therefore, what seems to be unconscious is after all proved to be conscious. The above-mentioned phenomena have frequently led to mystical interpretations, but they are explainable on a very simple assumption. Let us assume and this is quite in harmony with observation that the fields of the introspectively conscious brain-activities are limited by so-called association or dissociation processes, i. e., that we are unable actively to bring them all into connection at the same time, and that therefore all that seems to us unconscious has also in reality a consciousness, in other words, a subjective reflex, then the following results : Our ordinary waking consciousness or superconsciousness is merely an inner subjective reflex of those activities of attention which are most intimately connected with one another, i. e., of the more intensively concentrated maxima of our cerebral activities during waking. There exist, however, other consciousnesses, partly forgotten, partly only loosely or indirectly connected with the contents of the superconsciousness, in contradistinction to which these may be designated as subconsciousness. They correspond to other less concentrated or otherwise associated cerebral activities. We are bound to assume the existence of still more

remotely intercon-
nected subconsciousnesses for the infra-cortical
(lower) brain-
centers, and so on.

It is easy to establish the fact that the maximum of
our psychic
activity, namely, attention, passes every moment from
one percep-
tion or thought to another. These objects of attention,
as visual
or auditory images, will-impulses, feelings or abstract
thoughts,
come into play and of this there is no doubt in
different brain-
regions or neuron-complexes. We can therefore compare
attention

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to a functional macula lutea wandering in the brain, or
with a wan-
dering maximal intensity of neurocymic activity. But it
is quite as
satisfactorily established that other psychic phenomena
external to
attention are likewise present in consciousness, though
in a feebler
condition. Finally, it is well known that all that has
been in con-
sciousness even that which is now more, now less,
forgotten is
included in the psychic, i. e., in the contents of
consciousness. On
superficial consideration this appears to satisfy
theoretical require-
ments. But in fact and in truth there are innumerable
processes
of which we are feebly conscious for only a scarcely
appreciable
instant and which anon disappear from consciousness.
Here and
not in the strong and repeated "psychomes" I beg your
indul-
gence for this word, with which I would for the sake of
brevity
designate each and every psychic unit are we to seek

the transi-
tion from the conscious to the apparently unconscious.
Even in
this case, however, the feeble condition of
consciousness is only
apparent, because the inner reflex of these processes
can merely
echo faintly in the field of a strongly diverted
attention. This,
therefore, in no wise proves that such half conscious
processes are
in and for themselves so feebly represented in
consciousness, since
a flash of attention is sufficient subsequently to give
them definite
shape in consciousness. Only in consequence of the
diversion of
the attention do they lose more and more their
connection with the
chain of intensity-maxima which, under ordinary
circumstances,
constitute the remembered contents of our
superconsciousness.
The more feebly, however, they are bound to the latter,
with the
more difficulty are such half-conscious processes later
associated
anew through memory with the dominant chain. Of such a
nature
are all dreams, all the subordinate circumstances of
our lives, all
automatised habits, all instincts. But if there exists
between the
clearly conscious and the unconscious, a half-conscious
brain-life,
whose consciousness appears to us so feeble merely on
account of
the deviation of our ordinary train of memories, this
is an unequiv-
ocal indication that a step further on the remaining
connection
would be completely severed, so that we should no
longer have the
right to say that the brain-activities thus fading away
nebulously

from our superconsciousness do not have consciousness in and for themselves. For the sake of brevity and simplicity we will ascribe subconsciousness to these so-called unconscious brain - processes.

If this assumption is correct and all things point in this direction we are not further concerned with consciousness. It does not at all exist as such, but only through the brain-activity of which it is the inner reflex. With the disappearance of this activity, consciousness disappears. When the one is complicated, the other, too, is complicated. When the one is simple, the other is correspondingly simple. If the brain-activity be dissociated, consciousness also becomes dissociated. Consciousness is only an abstract concept, which loses all its substance with the falling away of "conscious" brain-activity. The brain-activity reflected in the mirror of consciousness appears therein subjectively as a summary synthesis, and the synthetical summation grows with the higher complications and abstractions acquired through habit and practice, so that details previously conscious (e. g., those involved in the act of reading) later become subconscious, and the whole takes on the semblance of a psychical unit.

Psychology, therefore, cannot restrict itself merely to a study of the phenomena of our superconsciousness by means of introspection, for the science would be impossible under such circumstances. Everybody would have only his own subjective psychology, after the manner of the old scholastic

spiritualists, and would therefore be compelled to doubt the very existence of the external world and his fellow-men. Inference from analogy, scientific induction, the comparison of the experiences of our five senses, prove to us the existence of the outer world, our fellow-men and the psychology of the latter. They also prove to us that there is such a thing as comparative psychology, a psychology of animals. Finally our own psychology, without reference to our brain-activity, is an incomprehensible patchwork full of contradictions, a patchwork which above all things seems to contradict the law of the conservation of energy.

It follows, furthermore, from these really very simple reflections that a psychology that would ignore brain-activity, is a monstrous

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impossibility. The contents of our superconsciousness are continually influenced and conditioned by subconscious brain-activities. Without these latter it can never be understood. On the other hand, we understand the full value and the ground of the complex organisation of our brain only when we observe it in the inner light of consciousness, and when this observation is supplemented by a comparison of the consciousness of our fellow-men as this is rendered possible for us through spoken and written language by means of very detailed inferences from analogy. The mind must therefore be studied simultaneously from

within and
from without. Outside ourselves the mind can, to be
sure, be
studied only through analogy, but we are compelled to
make use of
this the only method which we possess.

Some one has said that language was given to man not so
much for the expression as for the concealment of his
thoughts. It
is also well known that different men in all honesty
attribute very
different meanings to the same words. A savant, an
artist, a
peasant, a woman, a wild Wedda from Ceylon, interpret
the same
words very differently. Even the same individual
interprets them
differently according to his moods and their context.
Hence it
follows that to the psychologist and especially to the
psychiatrist
and as such I am here speaking the mimetic expression,
glances
and acts of a man often betray his true inner being
better than his
spoken language. Hence also the attitudes and behavior
of ani-
mals have for us the value of a "language," the
psychological im-
portance of which must not be underestimated. Moreover,
the
anatomy, physiology and pathology of the animal and
human brain
have yielded irrefutable proof that our mental
faculties depend on
the quality, quantity, and integrity of the living
brain and are one
with the same. It is just as impossible that there
should exist a
human brain without a mind, as a mind without a brain,
and to
every normal or pathological change in the mental
activity, there
corresponds a normal or pathological change of the
neurocyclic ac-
tivity of the brain, i. e., of its nervous elements.
Hence what we
perceive introspectively in consciousness is cerebral

activity.

As regards the relation of pure psychology (introspection") to

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the physiology of the brain (observation of brain-activity from without), we shall take the theory of identity for granted so long as it is in harmony with the facts. The word identity, or monism, implies that every psychic phenomenon is the same real thing as the molecular or neurocymic activity of the brain-cortex coinciding with it, but that this may be viewed from two standpoints. The phenomenon alone is dualistic, the thing itself is monistic. If this were otherwise there would result from the accession of the purely psychical to the physical, or cerebral, an excess of energy which would necessarily contradict the law of the conservation of energy. Such a contradiction, however, has never been demonstrated and would hold up to derision all scientific experience. In the manifestations of our brain-life, wonderful as they undoubtedly are, there is absolutely nothing which contradicts natural laws and justifies us in postulating the existence of a mythical, supernatural ".psyche."

On this account I speak of monistic identity and not of psycho-physical parallelism. A thing cannot be parallel with itself. Of course, psychologists of the modern school, when they make use of this term, desire merely to designate a supposed parallelism of

phenomena without prejudice either to monism or dualism. Since, however, many central nervous processes are accessible neither to physiological nor to psychological observation, the phenomena accessible to us through these two methods of investigation are not in the least parallel, but separated from one another very unequally by intermediate processes. Moreover, inasmuch as the dualistic hypothesis is scientifically untenable, it is altogether proper to start out from the hypothesis of identity.

It is as clear as day that the same activity in the nervous system of an animal, or even in my own nervous system, observed by myself, first by means of physiological methods from without, and second, as reflecting itself in my consciousness, must appear to me to be totally different, and it would indeed be labor lost to try to convert the physiological into psychological qualities or vice versa. We cannot even convert one psychological quality into another, so far as the reality symbolised by both is concerned ; e. g., the tone,

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the visual and tactile sensation, which a uniform, low, tuning-fork vibration produces on our three corresponding senses. Nevertheless, we may infer inductively that it is the same reality, the same vibration which is symbolised for us in these three qualitatively and totally different modes; i. e., produces in us these three different psychical impressions which cannot be transformed into one

another. These impressions depend on activities in different parts of the brain and are, of course, as such actually different from one another in the brain. We speak of psycho-physiological identity only when we mean, on the one hand, the cortical neurocyme which directly conditions the-conscious phenomena known to us, on the other hand, the corresponding phenomena of consciousness.

And, in fact, a mind conceived as dualistic could only be devoid of energy or energy-containing. If it be conceived as devoid of energy (Wasmann), i. e., independent of the laws of energy, we have arrived at a belief in the miraculous, a belief which countenances the interference with and arbitrary suspension of the laws of nature. If it be conceived as energy-containing, one is merely playing upon words, for a mind which obeys the law of energy is only a portion of the cerebral activities arbitrarily severed from its connections and dubbed "psychic essence," only that this maybe forthwith discredited. Energy can only be transformed qualitatively, not quantitatively. A mind conceived as dualistic, if supposed to obey the law of energy, would have to be transformed completely into some other form of energy. But then it would no longer be dualistic, i. e., no longer essentially different from the brain-activities.

Bethe, Uexkull, and others would require us to hold fast to the physiological method, because it alone is exact and restricts itself to what can be weighed and measured. This, too, is an error

which has been refuted from time immemorial. Only pure mathe-
matics is exact, because in its operations it makes use solely of
equations of abstract numbers. The concrete natural sciences can
never be exact and are as unable to subsist without the inductive
method of inference from analogy as a tree without its roots. Bethe
and Uexkull do not seem to know that knowledge is merely rela-

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tive. They demand absolute exactitude and cannot understand
that such a thing is impossible. Besides, physiology has no reason
to pride itself upon the peculiar exactitude of its methods and re-
sults.

Although we know that our whole psychology appears as the
activity of our cerebrum in connection with the activities of more
subordinate nerve-centers, the senses and the muscles, nevertheless
for didactic purposes it may be divided into the psychology of cog-
nition, of feeling and Volition. Relatively speaking, this subdivi-
sion has an anatomico-physiological basis. Cognition depends, in
the first instance, on the elaboration of sen^e-impressions by the
brain ; the will represents the psycho- or-cerebrofugal resultants of
cognition and the feelings together with their final transmission to
the muscles. The feelings represent general conditions of excita-
tion of a central nature united with elements of cognition and with
cerebrofugal impulses, which are relatively differentiated and re-

fined by the former, but have profound hereditary and phylogenetic origins and are relatively independent. There is a continual interaction of these three groups of brain-activities upon one another. Sense-impressions arouse the attention ; this necessitates movements ; the latter produce new sense-impressions and call for an active selection among themselves. Both occasion feelings of pleasure and pain and these again call forth movements of defense, flight, or desire, and bring about fresh sense-impressions, etc. Anatomically, at least, the sensory pathways to the brain and their cortical centers are sharply separated from the centers belonging to the volitional pathways to the muscles. Further on in the cerebrum, however, all three regions merge together in many neurons of the cortex.

Within ourselves, moreover, we are able to observe in the three above-mentioned regions all varieties and degrees of so-called psychic dignity, from the simplest reflex to the highest mental manifestations. The feelings and impulses connected with self-preservation (hunger, thirst, fear) and with reproduction (sexual love and its concomitants) represent within us the region of long-inherited, profoundly phyletic, fixed, instinct-life. These instincts

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are nevertheless partially modified and partly kept within due bounds through the interference of the higher cerebral activities.

The enormous mass of brain-substance, which in man stands in no direct relation to the senses and musculature, admits not only of an enormous storing up of impressions and of an infinite variety of motor innervations, but above all, of prodigious combinations of these energies among themselves through their reciprocal activities and the awakening of old, so-called memory images through the agency of new impressions. In contradistinction to the compulsory, regular activities of the profoundly phyletic automatisms, I have used the term "plastic" to designate those combinations and individual adaptations which depend on actual interaction in the activities of the cerebrum. Its loftiest and finest expression is the plastic imagination, both in the province of cognition and in the province of feeling, or in both combined. In the province of the will the finest plastic adaptability, wedded to perseverance and firmness, and especially when united with the imagination, yields that loftiest mental condition which gradually brings to a conclusion during the course of many years decisions that have been long and carefully planned and deeply contemplated. Hence the plastic gift of combination peculiar to genius ranks much higher than any simpler plastic adaptability.

The distinction between automatism and plasticity in brain-activity is, however, only a relative one and one of degree. In the most different instincts which we are able to influence through our cerebrum, i. e., more or less voluntarily, like deglutition, respiration, eating, drinking, the sexual impulse, maternal

affection, jealousy, we observe gradations between compulsory heredity and plastic adaptability, yes, even great individual fluctuations according to the intensity of the corresponding hereditary predispositions.

Now it is indisputable that the individual Pithecanthropus or allied being, whose cerebrum was large enough gradually to construct from onomatopoeas, interjections and the like, the elements of articulate speech, must thereby have acquired a potent means of exploiting his brain. Man first fully acquired this power through written language. Both developed the abstract concept symbolised

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by words, as a higher stage in generalisation. All these things give man a colossal advantage, since he is thereby enabled to stand on the shoulders of the written encyclopaedia of his predecessors. This is lacking in all animals living at the present time. Hence, if we would compare the human mind with the animal mind, we must turn, not to the poet or the savant, but to the Wedda or at any rate to the illiterate. These people, like children and animals, are very simple and extremely concrete in their thinking. The fact that it is impossible to teach a chimpanzee brain the symbols of language proves only that it is not sufficiently developed for this purpose. But the rudiments are present nevertheless. Of course the "language" of parrots is no language, since it symbolises nothing. On

the other hand, some animals possess phyletic, i. e., hereditarily and instinctively fixed cries and gesture, which are as instinctively understood. Such instinctive animal languages are also very widely distributed and highly developed among insects, and have been fixed by heredity for each species. Finally it is possible to develop by training in higher animals a certain mimetic and acoustic conventional language-symbolism, by utilising for this purpose the peculiar dispositions of such species. Thus it is possible to teach a dog to react in a particular manner to certain sounds or signs, but it is impossible to teach a fish or an ant these things. The dog comprehends the sign, not, of course, with the reflections of human understanding, but with the capacity of a dog's brain. And it is, to be sure, even more impossible to teach its young an accomplishment so lofty for its own brain as one which had to be acquired by training, than for the Wedda or even the negro to transmit his acquired culture by his own impulse. Even the impulse to do this is entirely lacking. Nevertheless, every brain that is trained by man is capable of learning and profiting much from the experience of its own individual life. And one discovers on closer examination that even lower animals may become accustomed to some extent to one thing or another, and hence trained, although this does not amount to an understanding of conventional symbols.

In general we may say, therefore, that the central nervous system operates in two ways : automatically and plastically.

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