III. THE UNCONSCIOUS AND DISCOVERY

Combination of Ideas. What we just observed concerning the unconscious in general will be seen again from another angle, when speaking of its relations with discovery.

We shall see a little later that the possibility of imputing discovery to pure chance is already excluded by Poincaré's observations, when more attentively considered.

On the contrary, that there is an intervention of chance but also a necessary work of unconsciousness, the latter implying and not contradicting the former, appears, as Poincaré shows, when we take account not even of the results of introspection, but of the very nature of the question.

Indeed, it is obvious that invention or discovery, be it in mathematics or anywhere else, takes place by combining ideas.[1] Now, there is an extremely great number of such combinations, most of which are devoid of interest, while, on the contrary, very few of them can be fruitful. Which ones does our mind—I mean our conscious mind—perceive? Only the fruitful ones, or exceptionally, some which could be fruitful.

However, to find these, it has been necessary to construct the very numerous possible combinations, among which the useful ones are to be found.

It cannot be avoided that this first operation take place,

[1] Max Müller observes that the Latin verb "cogito," for "to think," etymologically means "to shake together." St. Augustine had already noticed that and also observed that "intelligo" means to "select among," in a curious connection with what we say in the text.

to a certain extent, at random, so that the role of chance is hardly doubtful in this first step of the mental process. But we see that that intervention of chance occurs inside the unconscious: for most of these combinations—more exactly, all those which are useless—remain unknown to us.

Moreover, this shows us again the manifold character of the unconscious, which is necessary to construct those numerous combinations and to compare them with each other.

The Following Step. It is obvious that this first process, this building up of numerous combinations, is only the beginning of creation, even, as we should say, preliminary to it. As we just saw, and as Poincaré observes, to create consists precisely in not making useless combinations and in examining only those which are useful and which are only a small minority. Invention is discernment, choice.

To Invent Is to Choose. This very remarkable conclusion appears the more striking if we compare it with what Paul Valéry writes in the *Nouvelle Revue Française*: "It takes two to invent anything. The one makes up combinations; the other one chooses, recognizes what he wishes and what is important to him in the mass of the things which the former has imparted to him.

"What we call genius is much less the work of the first one than the readiness of the second one to grasp the value of what has been laid before him and to choose it."

We see how beautifully the mathematician and the poet agree in that fundamental view of invention consisting of a choice.

Esthetics in Invention. How can such a choice be made? The rules which must guide it "are extremely fine and delicate. It is almost impossible to state them precisely;

they are felt rather than formulated. Under these conditions, how can we imagine a sieve capable of applying them mechanically?"

Though we do not directly see this sieve at work, we can answer the question, because we are aware of the results it affords, i.e., the combinations of ideas which are perceived by our conscious mind. This result is not doubtful. "The privileged unconscious phenomena, those susceptible of becoming conscious, are those which, directly or indirectly, affect most profoundly our emotional sensibility.

"It may be surprising to see emotional sensibility invoked à propos of mathematical demonstrations which, it would seem, can interest only the intellect. This would be to forget the feeling of mathematical beauty, of the harmony of numbers and forms, of geometric elegance. This is a true esthetic feeling that all real mathematicians know, and surely it belongs to emotional sensibility."

That an affective element is an essential part in every discovery or invention is only too evident, and has been insisted upon by several thinkers; indeed, it is clear that no significant discovery or invention can take place without the *will* of finding. But with Poincaré, we see something else, the intervention of the sense of beauty playing its part as an indispensable *means* of finding. We have reached the double conclusion:

that invention is choice
that this choice is imperatively governed by the sense of scientific beauty.

Coming Back to the Unconscious. In what region—a word not to be taken in a too literal, but, so to say, in a symbolic meaning—in what region of the mind does that

sorting take place? Surely not in consciousness,[2] which, among all possible combinations, only knows of the right ones.

Poincaré, at first, sets forth the idea that the unconscious itself should exclusively perceive the interesting combinations. He does not insist on that first hypothesis and, indeed, I cannot consider it as deserving further examination. It is, as it seems, nothing but recording before making a second jump and would be only a verbal question, a question of definition: we should have to find in what "region" uninteresting combinations could be eliminated, and there would be no reason not to call that other region, if existing, another part of the unconscious.

So there remains only Poincaré's final conclusion, viz., that to the unconscious belongs not only the complicated task of constructing the bulk of various combinations of ideas, but also the most delicate and essential one of selecting those which satisfy our sense of beauty and, consequently, are likely to be useful.

Other Views on Incubation. These a priori reasons would be by themselves sufficient to justify Poincaré's conclusion. However, that conclusion has been assailed by various authors, some of whom[3] again seem to be moved by that same

[2] Mozart's letter (see p. 16) suggests that, in his mind, choice is partly conscious, though probably, as we should think, preceded by a preliminary unconscious one: otherwise we should be re-conducted to the hypothesis of pure chance.

[3] Rossman (*Psychology of the Inventor*, VI, p. 86) writes: "The assumption that the subconscious is responsible for the final condition is no answer to the problem. It merely amounts to giving a name to a thing which puzzles and mystifies us." Now, unconscious phenomena are not mere names, but realities. Though they are less easy to observe directly, they exist, as we have seen, whether they are the cause of illumination or not. To invoke "physiological and chemical conditions in the body," as the author does—without trying, of course, to specify

fear of the unconscious which we met with in the preceding section. Let us see how they endeavor to account for the striking fact of illumination.

It is not necessary to speak again of the doctrine of pure chance, which we have discussed in Section I and at the beginning of this one. Therefore, we consider it as granted that incubation generally precedes illumination.[4] In this period of incubation, no work of the mind is consciously perceived; but, instead of admitting that there is an unconscious work, could we not admit that nothing at all occurs? Two chief hypotheses have been set forth.[5]

A. It has been supposed that an explanation for the new state of mind which makes illumination possible could lie in a *freshness* or lack of brain fatigue. This is what we can call the *rest-hypothesis*. Poincaré, though not adopting it, has thought of it but (see below) in a special case.

B. It can be admitted that an essential cause of illumination may be the *absence of interferences* which block progress during the preparation stage. "When, as must often happen, the thinker makes a false start, he slides insensibly into a groove and may not be able to escape at the moment. . . . Incubation would consist in getting rid of false leads and hampering assumptions so as to approach the problem with an 'open mind.' " We can call this the *forgetting-hypothesis*.

what they are—incurs, at least as much, the same objection of merely giving a name to our ignorance. That statement of Rossman, if it means anything, merely gives another name for the rest-hypothesis.

[4] Exceptions seem to occur in cases such as Mozart's and, as Catherine Patrick observes in the work mentioned below in footnote 10, in A. E. Housman's (Cf. p. 37). For the reason given in the text, it seems to me certain that these exceptions must be apparent ones, due to a special rapidity of incubation.

[5] See Woodworth's *Experimental Psychology*, p. 823.

Discussion of These Ideas. Helmholtz's testimony has been invoked in favor of the rest-hypothesis. Helmholtz says that "happy ideas" (his word for illumination) never come to him when his mind is fatigued or when he is seated at his work table;[6] and, mentioning his preparatory study of the question investigated, adds that "Then, after the fatigue resulting from this labor has passed away, there must come an hour of complete physical freshness before the good ideas arrive"—a statement which perhaps doubtfully supports the hypothesis in question, as illumination is not said to occur the moment mind is rested, but about an hour later.

Besides, the case of Helmholtz is not a universal one and there are observations to the contrary. Professor K. Friedrichs writes to me that "creative ideas" (if any) "come mostly of a sudden, frequently after great mental exertion, in a state of mental fatigue combined with physical relaxation"; and a similar statement has been given to me by a critic of art, Dr. Sterling, who has to solve problems concerning the authenticity of pictures. Dr. Sterling tells me he has noticed that, after long conscious effort, inspiration usually comes when he is fatigued, as though it were necessary for the conscious self to be weakened in order that unconscious ideas may break through.

[6] The question whether mathematicians usually stand or sit when working is one of those asked in the questionnaire of *L'Enseignement Mathématique*. Habits of that kind are certainly among those that vary most among individuals. Helmholtz's and Poincaré's statements seem to suggest that they often used to sit at a work table. I never do so, except when I am obliged to effectuate written calculations (for which I have a certain reluctance). Except in the night when I cannot sleep, I never find anything otherwise than by pacing up and down the room. I feel exactly like the character of Emile Augier who says: "Legs are the wheels of thought."

This instance shows, and we have to bear it in mind, that rules about such matters are not necessarily invariable ones. Processes may differ not only with individuals, but even in one and the same man. Indeed, the very observations of Poincaré show us three kinds of inventive work essentially different if considered from our standpoint, viz.,

a. fully conscious work.

b. illumination preceded by incubation.

c. the quite peculiar process of his first sleepless night.[7]

Moreover, we have said that Poincaré has thought of the rest-hypothesis. He has thought of it (without being inclined to adopt it even then) in connection with a special case, even different, as it seems, from the three mentioned above and which is quite similar to Helmholtz's description, viz., a first and unsuccessful work-period, a rest—a new half-hour of work (Helmholtz speaks of one hour) after which discovery comes. As he himself says, this could be explained by the rest-hypothesis, but with the same objection as in the case of Helmholtz.

Still other processes are possible. A very curious one is reported by the chemist J. Teeple[8] who, after half an hour, realized that he had been working on a question without being aware that he was doing so, and in such an abstracted state of mind that during that time he forgot that he had already taken a bath and was taking a second one: a special case of unconscious process, as the thinker was not con-

[7] Unhappily, Poincaré, when telling us that that night was not the only one when he has been able to watch the action of his subconscious self, does not enter into further particulars. More details would have been interesting about the first night in question.

[8] See Platt and Baker, *Journ. Chemical Educ.*, Vol. VIII (1931), pp. 1969-2002.

scious of his mental work while it was going on, but perceived it when it ended.

Thus there are several possibilities, and some of them might be explained by the rest or forgetting hypotheses. I willingly admit that a "fresh" or "open" mind—that is, forgetting of some unsuccessful attempts—can account for discovery when the latter is separated from the first conscious period by a long interval, say some months. I speak, in that case, of discovery, not of illumination, because this is not, properly speaking, illumination: the solution does not appear suddenly and unexpectedly, but is given by a new work.

Also, forgetting could, perhaps, as Professor Woodworth notices,[9] explain illuminations which would reveal solutions of an especially great simplicity, it happening that such may be at first overlooked. Any other ones, in the hypotheses we are dealing with, would require a new effort of the mind in a new condition (whether on account of rest or on account of forgetting previous ideas) to resume the subject. Such explanations are, therefore, to be rejected unhesitatingly in those cases of suddenness which are reported by Poincaré and confirmed by other authors. Poincaré was not working when he boarded the omnibus of Coutances: he was chatting with a companion; the idea passed through his mind for less than one second, just the time to put his foot on the step and enter the omnibus. It cannot even be said that the idea was simple enough not to require any work. Poincaré informs us that he had to work it out for verification on his return to Caen. Though not as strictly limited in time, other illuminations reported by

[9] See the above cited p. 823 of his *Experimental Psychology.*

Poincaré occur with the same suddenness and unpreparedness which exclude the proposed explanations.

If we admitted any one of them, illuminations ought to come as a result of a new work of the same kind as the preliminary one, from which it could differ only by elimination of the result—paradoxically, an exclusively harmful one (be it fatigue or a misleading idea)—of that preliminary work. Now, observation shows that the illumination process is *not* of the same nature as the previous conscious work. The latter is really work, implying a more or less severe tenseness of mind and often multiplied attempts; the former occurs at once, without any perceptible effort.

Besides, if we should accept the forgetting hypothesis, that is, that several previous and inappropriate ideas precede and for a while block the right one, we ought to be aware of them (as these theories precisely claim to exclude any role of the unconscious). On the contrary, most often, instead of seeing several ways supposedly likely to lead to the solution, we conceive no such ideas at all.

To sum it up, we see that such explanations as the rest or the forgetting hypotheses can be admitted in some cases, but that in other instances, especially typical illuminations as noted by Poincaré and others, they are contradicted by facts.[10]

[10] Catherine Patrick (*Archives of Psychology*, Vol. 26, 1935, No. 178) has carried out an experimental study of poetical invention: she has asked several persons—some being professional poets, others not—to write a poem suggested by a picture shown them. Contrary to her opinion, I cannot consider the process she observed as being comparable to those we investigate. The time of the experiment—hardly more than twenty minutes—shows that she deals with a quite different question; and her so-called incubation, where subjects are required to relate aloud the course of their thoughts during their attempt to do the required work, has nothing to do with incubation as Helmholtz or Poincaré consider it,

Other Views on Illumination. An Intimation Stage. An objection of another kind, one less essential, has been raised[11] against Helmholtz's and Poincaré's descriptions of the phenomenon of illumination. Does not a part of it take place in what we have previously called the fringe-consciousness?

Now, fringe-consciousness and proper consciousness are so close to each other, exchanges between them are so continuous and so rapid, that it seems hardly possible to see how they divide their roles in that sudden lightninglike phenomenon of illumination. However, in consequence of what we shall find in Section VI, we shall be led to some probable views on that subject.

Another most curious circumstance has been noted. For some thinkers, while engaged in creative work, illumination may be preceded by a kind of warning by which they are made aware that something of that nature is imminent without knowing exactly what it will be. Wallas has given the name of "intimation" to that peculiar phenomenon. I never experienced any such sensation and Poincaré does not speak of it, which he certainly would have done if it had happened to him. An inquiry on that point among scientists would be useful.

A last objection against Poincaré's ideas has been raised by Wallas. This author admits that Poincaré may be right in saying "that without a rather high degree of this aesthetic instinct no man will ever be a great mathematical discoverer," but adds that "it is extremely unlikely that the

in which that course of thought, inasmuch as it refers to the research, may remain totally unknown to the subject.

[11] Graham Wallas, *The Art of Thought*, p. 96.

aesthetic instinct alone was the 'power' driving the 'machine' of his thought."

I can but reproduce textually that passage of Wallas, because I hardly understand it. It seems to me to rest on an evident confusion between two things which must be distinguished[12] from each other: the "drive" (i.e., "what to do") and the "mechanism"[13] ("how to do it"). We shall speak of "drive" in Section IX (and again find that the sense of beauty *is* the moving power): for the time being, we deal with mechanism; and what that mechanism is, I can hardly doubt. Wallas suspects Poincaré of thinking thus because he was a friend of Boutroux, who was a friend of William James, or because he was influenced by the ideas of the "Mechanist" school. Not only is Poincaré's statement the result of his own observations and not anybody else's suggestions; but personally, I feel exactly as he does, not because of having been a special friend of Boutroux or William James, or having studied the Mechanist school (which I have not) or any other one, but on account of my own auto-observation—because the ideas chosen by my unconscious are those which reach my consciousness, and I see that they are those which agree with my aesthetic sense.

As a matter of fact, I consider that every mathematician, if not every scientist, would agree to that opinion. I may add that actually some of them, writing to me on the general subject of this work, spontaneously (i.e., without a question from me on that special point) expressed themselves in the same sense, in the most positive way.

[12] See Woodworth's *Dynamic Psychology.*

[13] I am obliged to use almost simultaneously both words "mechanism" and (see below) "mechanist," the meanings of which are quite different and independent. I hope this will not make any confusion in the reader's mind.

Further Theories on the Unconscious. Certainly, our above conclusions are, to a certain extent, surprising. They raised for Poincaré a disconcerting question. The unconscious is usually said to be automatic and, in a certain sense, it undoubtedly is so, as it is not subjected to our will, at least not to the direct action of our will, and even is subtracted from our knowledge. But now we find an opposite conclusion. The unconscious self "is not purely automatic; it is capable of discernment; it has tact, delicacy; it knows how to choose, to divine. What do I say? It knows better how to divine than the conscious self, since it succeeds where that has failed.

"In a word, is not the subliminal self superior to the conscious self?"[14]

Now, such an idea has been in favor among metaphysicians in recent times and even in more ancient ones. The very fact that unconsciousness, though manifesting itself from time to time, is not really known to us, has given it a mysterious character and, on account of that mysterious character, it has often been endowed with superior powers.[15] That unconsciousness may be something not exclusively originating in ourselves and even participating in Divinity seems already to have been admitted by Aristotle. In Leibniz's opinion, it sets the man in communication with the whole universe, in which nothing could occur without its repercussion in each of us; and something analogous is to

[14] Here Poincaré alludes to Emile Boutroux, whose influence on him certainly existed in this case.

[15] Similar cases obviously occur as concerns dreams, which, since the world exists, have been supposed to enjoy a kind of prophetic value. But it would be too disrespectful to compare metaphysical theories of the unconscious with the popular "Clue to Dreams" books.

be found in Schelling; again, Divinity is invoked by Fichte; etc.

Even more recently, a whole philosophical doctrine has been built on that principle in the first place by Myers, then by William James himself (although the great philosopher, in an earlier work, his *Principles of Psychology*, expresses himself, at times, as though doubting the very existence of unconsciousness). According to that doctrine, the unconscious would set man in connection with a world other than the one which is accessible to our senses and with some kinds of spiritual beings.

Meanwhile, unconsciousness appears to other authors as being the trace of prior existence; and others again suggest the possibility that it is due to the action of disembodied spirits.

Since celestial causes are thus set forth, we must not wonder too much at hearing that infernal ones can be invoked; and that is what has actually happened. An audacious philosopher, the German von Hartmann, considers the unconscious as a universal force, specifically an evil one, which influences things and beings in a constantly harmful way; and such is the pessimism generated in him by the fear of that terrible unconscious that he advises not individual suicide, which he considers as insufficient, but "cosmic suicide," hoping that powerful forces of destruction will be devised by mankind, enabling it to destroy at once the whole planet: a kind of foresight of what is taking place as these lines are written.

We have seen how some authors had a kind of fear of the unconscious and were even unwilling to admit its very existence. Perhaps this unwillingness is a kind of reaction against the flights of imagination which some others have

indulged in about it. The same mysterious character imputed to it seems to have repelled some and overexcited others.

The question is whether there is any mystery, or more exactly, any special mystery. The true mystery lies in the existence of any thoughts, of any mental processes whatever, those mental processes being connected—in a way about which we hardly know anything more than mankind did thousands of years ago—with the functioning of some of our brain cells. The existence of several kinds of such processes is hardly more mysterious than the existence of one kind of them.

As to the unconscious mind being "superior" or "inferior" to the conscious one, I should deny any meaning to such a question and consider that no question of "superiority" or "inferiority" is a scientific one. When you ride a horse, is he inferior or superior to you? He is stronger than you are and can run more quickly than you can; however, you make him do what you want him to do. I do not know what would be meant by saying that oxygen is superior or inferior to hydrogen; nor is the right leg superior or inferior to the left one: they cooperate for walking. So do the conscious and the unconscious, a cooperation which we shall consider presently.