ages of certain other diseases will in this case be the very cause to promote the ravages of cholera. A parallel case would be that of carefully removing the coals of fire from a building every night as a safeguard to the structure; but let a sudden gale spring up, and the embers thus removed would be scattered far and wide.

ILLUSTRATIONS OF THE LOGIC OF SCIENCE

BY C. S. PEIRCE,
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SECOND PAPER.—HOW TO MAKE OUR IDEAS CLEAR.

I.

Wbover has looked into a modern treatise on logic of a common sort, will doubtless remember the two distinctions between clear and obscure conceptions, and between distinct and confused conceptions. They have lain in the books now for many centuries, unimproved and unmodified, and are generally reckoned logicians as among the gems of their doctrine.

A clear idea is defined as one which is so apprehended that it can be recognized wherever it is met with, and so that no other will be mistaken for it. If it fails of this clearness, it is said to be obscure.

This is rather a neat bit of philosophical terminology; yet, since clearness that they were defining, I wish the logicians had made the definition a little more plain. Never to fail to recognize an idea, never under any circumstances to mistake another for it, let it come in how one form it may, would indeed imply such prodigious force as clearness of intellect as is seldom met with in this world. On the other hand, merely to have such an acquaintance with the idea as to become familiar with it, and have lost all hesitancy in recognizing it in ordinary cases, hardly seems to deserve the name of clearness of apprehension, since after all it only amounts to a subjective feeling of mastery which may be entirely subjective. I take it, however, when the logicians speak of "clearness," they mean nothing more than such a familiarity with an idea, since they regard the quality, but a small merit, which needs to be supplemented by another, which they call distinctness.

A distinct idea is defined as one which contains nothing with it is not clear. This is technical language; by the contents of an idea logicians understand whatever is contained in its definition. So an idea is distinctly apprehended, according to them, when we give a precise definition of it, in abstract terms. Here the professional logicians leave the subject; and I would not have troubled in

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reader with what they have to say, if it were not such a striking example of how they have been slumbering through ages of intellectual activity, listlessly disregarding the engineering of modern thought, and never dreaming of applying its lessons to the improvement of logic. It is easy to show that the doctrine that familiar use and abstract distinctness make the perfection of apprehension has only a true place in philosophies which have long been extinct; and it is now time to formulate the method of attaining to a more perfect clearness of thought, such as we see and admire in the thinkers of our own time.

When Descartes set about the reconstruction of philosophy, his first step was to (theoretically) permit skepticism and to discard the practice of the schoolmen of looking to authority as the ultimate source of truth. That done, he sought a more natural fountain of principles, and professed to find it in the human mind; thus passing, in the directest way, from the method of authority to that of a principle as described in my first paper. Self-consciousness was to furnish us with our fundamental truths, and to decide what was agreeable to reason. But since, evidently, not all ideas are true, he was led to note, as the first condition of infallibility, that they must be true. The distinction between an idea being clear and really being so, never occurred to him. Trusting to introspection, as he did, even for a knowledge of external things, why should he question its testimony in respect to the contents of our own minds? But then, I suppose, seeing men, who seemed to be quite clear and positive, holding opposite opinions upon fundamental principles, he was further led to say that clearness of ideas is not sufficient, but that they had also to be distinct, i. e., to have nothing unclear about them. What he probably meant by this (for he did not explain himself with precision) was that they must sustain the test of dialectical examination; that they must not only seem clear at the outset, but that discussion must never be able to bring to light points of obscurity connected with them.

Such was the distinction of Descartes, and one sees that it was precisely on the level of his philosophy. It was somewhat developed by Leibnitz. This great and singular genius was as remarkable for what he failed to see as for what he saw. That a piece of mechanism could not do work perpetually without being fed with power in some form, was a thing perfectly apparent to him; yet he did not understand that the machinery of the mind can only transform knowledge, but never originate it, unless it be fed with facts of observation. He thus missed the most essential point of the Cartesian philosophy, which is, that to accept propositions which seem perfectly evident to us is a thing which, whether it be logical or illogical, we cannot help doing. Instead of regarding the matter in this way, he sought to reduce the first principles of science to formulas which cannot be denied without self-contradiction, and was apparently unaware of the great
difference between his position and that of Descartes. So he revol-
to the old formalities of logic, and, above all, abstract definitions play
great part in his philosophy. It was quite natural, therefore, an
on observing that the method of Descartes labored under the diffic-
that we may seem to ourselves to have clear apprehensions of th
which in truth are very hazy, no better remedy occurred to him than
require an abstract definition of every important term. According
in adopting the distinction of clear and distinct notions, he describes
the latter quality as the clear apprehension of everything contained
in the definition; and the books have ever since copied his plan.
There is no danger that his chimerical scheme will ever again be val-
Nothing new can ever be learned by analyzing definitions. Nevertheless, our existing beliefs can be set in order by this process and order is an essential element of intellectual economy, as of any other. It may be acknowledged, therefore, that the books are right in making familiarity with them the first step toward clearness of apprehension, and the definition of the second. But in omitting mention of any higher perspicuity of thought, they simply mirror a philosophy which was exploded a hundred years ago. That much-admired "ornament of logic" — the doctrine of clearness and distinctness — may be pretty enough, but it is high time to relegate to our cabinet of curiosities the antique bijou, and to wear about us something better adapted to modern uses.

The very first lesson that we have a right to demand that logic should teach us is, how to make our ideas clear; and a most important one is, that they should be comprehended by minds who stand in need of it. To know, as we see, to be masters of our own meaning, will make a solid foundation for greater and weightier thought. It is most easily learned by those whose ideas are meagre and restricted; and far happier than such as wallow helplessly in a rich mud of conceit. In fact, it is true, may, in the course of generations, overcome the disadvantage of an excessive wealth of language and its natural co-mitante, a vast, unfathomable depth of ideas. We may see it in history, slowly perfecting its literary forms, sloughing off at length its metaphysics, and, by virtue of the unfaible patience which is often compensation, attaining great excellence in every branch of mental acquirement. The page of history is not yet unrolled which shall tell us whether such a people will or will not in the long run prevail; or one whose ideas (like the words of their language) are few, but which possesses a wonderful mastery over which it has. For an individual, however, there can be no question that a few clear ideas are worth much more than many confused ones. A young man would hardly be persuaded to sacrifice the greater part of his thoughts to save the rest; and the muddled head is the least apt to see the necessity of such a sacrifice. Him we can usually commiserate, as a person with a congenital defect. Time will help him, but intellectual

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The principles set forth in the first of these papers lead, at once, to a method of reaching a clearness of thought of a far higher grade than the "distinctness" of the logicians. We have there found that the action of thought is excited by the irritation of doubt, and ceases when that belief is attained, so that the production of belief is the sole function of thought. All these words, however, are too strong for my purpose. It is as if I had described the phenomena as they appear under a mental microscope. Doubt and Belief, as the words are commonly employed, relate to religious or other grave discussions. But here it is said that "the first and last "to designate the starting of any question, no matter how small or how great, and the resolution of it. If, for instance, in a horse-car, I pull out my purse and find a five-cent nickel and five coppers, I decide, while my hand is going to the purse, in which way I will pay my fare. To call such a question Doubt, and my decision Belief, is certainly to use words very disproportionate to the occasion, for in the act of paying such a doubt as causing an irritation which needs to be appeased, suggests a temper which is uncomfortable to the verge of insanity. Yet, looking at the matter minutely, it must be admitted that, if there is the least hesitation as to whether I shall pay the five coppers or the nickel (as there will be sure to be, unless I act from some previously contracted habit in the matter), though irritation is too strong a word, yet I am excited to such small mental activity as may be necessary to deciding how I shall act. Most frequentl
doubts arise from some indecision, however momentary, in our own minds. Sometimes it is not so. I have, for example, to wait in a railway station, and to pass the advertisements on the walls. I compare the advantages of different trains and different routes, and I never expect to take, merely fancying myself to be in a state of hesitancy, because I am bored with nothing to trouble me. Feigned hesitancy, whether feigned for mere amusement or with lofty purpose, plays a great part in the production of scientific inquiry. However the doubt may originate, it stimulates the mind to an activity which may be slight or energetic, calm or turbulent. Images pass rapidly through consciousness, one incessantly yielding to another, until at last, when all is over—it may be in a fraction of a second, in an hour, or after long years—we find ourselves determined in a way we should act under such circumstances as those which occasioned our hesitation. In other words, we have attained belief.

In this process we observe two sorts of elements of consciousness, the distinction between which may best be made clear by means of an illustration. In a piece of music there are the separate notes, and there is the air. A single tone may be prolonged for an hour or a day, and it exists as perfectly in each second of that time as in the whole taken together; so that, as long as it is sounding, it might be present to a sense from which everything in the past was as completely absent as the future itself. But it is different with the air, the performance of which occupies a certain time, during which only portions of it are present. It consists in a sort of orderliness in the succession of sounds which strike the ear at different times; and to perceive it there must be some continuity of consciousness which makes the events of a lapse of time present to us. We certainly only perceive the air by hearing the separate notes; yet we cannot be said to directly hear it, for we hear only what is present at the instant, and an orderliness of succession cannot exist without an instant. These two sorts of objects, what we are immediately conscious of, and what we are merely conscious of, are found in the air.

Some elements (the sensations) are completely present at every instant, so long as they last, while others (like thoughts) are actions having beginning, middle, and end, and consist in a change of consciousness in the succession of sensations which flow through the mind. They cannot be immediately present to us, but must cover some portion of the past or future. Thought is a thread of melody running through the succession of our sensations.

"We may add that just as a piece of music may be written in parts, each part having its own air, so various systems of relationship of succession subsist together beneath the same sensations. These different systems are distinguished by having different motives, ideas, or functions. Thought is only one such system, for its subjective, idea, and function, is to produce belief, and whatever does not concern that purpose belongs to some other system of relations. The action of thinking may incidentally have other results; it may serve to amuse us, for example, and among dilettanti it is not rare to find those who have so perverted thought to the purposes of pleasure that it seems to vex them to think that the questions upon which they delight to exercise it may ever get finally settled; and a positive discovery which takes a favorite subject out of the arena of literary debate is met with ill-concealed dislike. This disposition is the very bane of many of our intellectual discussions. But the soul and meaning of thought, abstracted from the other elements which accompany it, though it may be voluntarily thwarted, can never be made to direct itself toward anything but the production of belief. Thought in itself has as its only possible motive the attainment of thought at rest; and whatever does not refer to belief is no part of the thought itself. And what, then, is belief? It is the demi-endurance which closes a musical phrase in the symphony of our intellectual life. We have seen that it has just three properties: First, it is something that we are aware of; second, it appears the irritation of doubt; and, third, it involves the establishment in our nature of a rule of action, or, in short, a habit. As it appears the irritation of doubt, which is the motive for thinking, thought relaxes, and comes to rest for a moment when belief is reached. But, since belief is a rule for action, the application of which involves further doubt and further thought, at the same time that it is a stopping-place, it is also a new starting-place for thought. That is why I have permitted myself to call it thought at rest, although thought is essentially an action. The final act of thinking is the exercise of volition, and of this thought no longer forms a part; but belief is only a stadium of mental action, as it is upon our nature due to thought, which will influence future thinking."

The essence of belief is the establishment of a habit, and different beliefs are distinguished by the different modes of action to which they give rise. If beliefs do not differ in this respect, if they appear to be of the same doubt by producing the same rule of action, then no more differences in the manner of consciousness of them can make them different beliefs, any more than playing a tune in different keys is playing different tunes. Imaginary distinctions are often drawn between beliefs which differ only in their mode of expression; the singing which ensues is real enough, however. To believe that any objects are arranged as in Fig. 1, and to believe that they are arranged in Fig. 2, are one and the same belief; yet it is conceivable that a man should assert one proposition and deny the other. Such false distinctions do as much harm as the confusion of beliefs really different, and are among the pitfalls of which we ought constantly to beware, especially when we are upon metaphysical ground. One singular exception of this sort, which often occurs, is to mistake the satisfaction
produced by our own unlearnedness of thought for a character of the object we are thinking. Instead of perceiving that the object is purely subjective, we fancy that we contemplate a quality of the object which is essentially mysterious; and if our conception be the word presented to us, we do not recognize it and same, owing to the absence of the feeling of unlearnedness, &c.

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occasion, no matter how improbable they may be. What the habit is depends on when and how it causes us to act. As for the when, every stimulus to action is derived from perception; as for the how, every execute of action is to produce some sensible effect. Thus, we come back to what is tangible and practical, as the root of every real distinction of thought, no matter how subtle it may be; and there is no distinction of meaning so fine as to consist in anything but a possible difference of practice.

To see what this principle leads to, consider in the light of it such a doctrine as that of transubstantiation. The Protestant churches generally hold that the elements of the sacrament are flesh and blood only in a symbolic sense; they nourish our souls as meat and the juice of it would nourish our bodies. But the Catholics maintain that they are literally just that; although they possess all the sensible qualities of red-ripe and diluted wine. But we can have no conception of wine except what may enter into a belief, either—

1. That this, that, or the other, is wine; or,

2. That wine possesses certain properties.

Such beliefs are nothing but self-notifications that we should, upon occasion, act in regard to such things as we believe to be wine according to the qualities which we believe wine to possess. The occasion of such action would be some sensible perception, the motive of it to produce some sensible effect. Thus our action has exclusive reference to what affects the senses, our habit has the same bearing on our action, our belief the same as our habit, our conception the same as our belief; and we can consequently mean nothing by wine but what has certain effects, direct or indirect, upon our senses; and to talk of something as having all the sensible characters of wine, yet being in milk, blood, is senseless jargon. Now, it is not my object to pursue the theological question; and having used it as a logical example I drop it, without caring to anticipate the theologian's reply. I only desire to point out how impossible it is that we should have an idea in our minds which relates to anything but conceived sensible effects of things. Our idea of anything is our idea of its sensible effects; and if we fancy that we have any other we deceive ourselves, and mistake a more sensation accompanying the thought for a part of the thought itself. It is absurd to say that thought has any meaning unrelated to its only function. It is foolish for Catholics and Protestants to fancy themselves in disagreement about the elements of the sacrament, if they agree in regard to all their sensible effects, here or beyond.

It appears, then, that the rule for attaining the third grade of degrees of apprehension is as follows: Consider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object.
III. Let us illustrate this rule by some examples; and, to begin with the simplest one possible, let us ask what we mean by calling a thing hard. Evidently that it will not be scratched by many other substances. The whole conception of this quality, as of every other in its conceived effects, is necessarily furnished by some effort. Suppose, then, that a diamond could be crystallized in the shape of a cushion of soft cotton, and should remain there until it was burned up. Would it be fair to say that that diamond was soft? This seems a foolish question, and would be so, in fact, except in the realm of logic. There such questions are often of the greatest importance as serving to bring logical principles into sharper relief than any discourse ever could. In studying logic we must not put them aside with hasty answers, but must consider them with attentive care, in order to make out the principles involved. We may, in the present case, modify our question, and ask what prevents us from saying that all hard substances remain perfectly soft until they are touched, since their hardness increases with the pressure until they are scratched. Reflection will show that the reply is this: there would be no such thing in such modes of speech. They would involve a modification of present usage of speech with regard to the words hard and soft by not of their meanings. For they represent no fact to be derived from what it is; only, they involve arrangements of facts which will be exceedingly maladroit. This leads us to remark that the question of what would occur under circumstances which do not actually exist is not a question of fact, but only of the most perspicacious arrangement of them. For example, the question of free will and fate in simplest form, stripped of verbiage, is something like this: I have done something of which I am ashamed; could I, by an effort of will, have resisted the temptation, and done otherwise? The philosophical reply is, that this is not a question of fact, but only of the arrangement of facts. Arranging them so as to exhibit what is particularly pertinent to my question—namely, that I ought to blame myself for having done wrong—it is perfectly true to say that, if I had been willing to do otherwise than I did, I should have done otherwise. On the other hand, arranging the facts so as to exhibit another important consideration, it is equally true that, when a temptation has once been allowed to work, it will, if it has a certain force, produce its effect, let me struggle how I may. There is no objection to a contradiction if what would result from a false supposition. The reductio ad absurdum consists in showing that contradictory results would follow from a hypothesis which is consequently judged to be false. Many questions are involved in the free-will discussion, and I am far from desiring to say that both sides are equally right. On the contrary, I am of opinion
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Let us now approach the subject of logic, and consider a conception which particularly concerns it, that of reality. Taking clearness

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1 Possibly the velocities also have to be taken into account.
in the sense of familiarity, no idea could be clearer than this. Each child uses it with perfect confidence, never dreaming that he does not understand it. As for clearness in its second grade, however, it is probably puzzle most men, even among those of a reflective turn of mind, to give an abstract definition of the real. Yet such a definition may perhaps be reached by considering the points of difference between reality and its opposite, fiction. A figure is a product of somebody’s imagination; it has such characters as his thought impresses upon it. That whose characters are independent of how we think is an external reality. There are, however, phenomena with our own minds, dependent upon our thought, which are at the same time real in the sense that we really think them. But though their characters depend on how we think, they do not depend on what we think those characters to be. Thus, a dream has a real existence as a mental phenomenon, if somebody has really dreamt it; that he dreamt it and so, does not depend on what anybody thinks was dreamt, but is completely independent of all opinion on the subject. On the other hand, considering, not the fact of dreaming, but the thing dreamt, it retains its peculiarities by virtue of no other fact than that it is dreamt to possess them. Thus we may define the real as that whose characters are independent of what anybody may think them to be.

But, however satisfactory such a definition may be found, it will be a great mistake to suppose that it makes the idea of reality perfectly clear. Here, then, let us apply our rules. According to the reality, like every other quality, consists in the peculiar sensible effect which things partaking of it produce. The only effect which all things have is to cause belief, for all the sensations which they excite emerge into consciousness in the form of beliefs. The question therefore is, how is true belief (or belief in the real) distinguished from false belief (or belief in fiction). Now, as we have seen in the former paper, the ideas of truth and falsehood, in their full development, pertain exclusively to the scientific method of settling opinion. A person who arbitrarily chooses the propositions which he will adopt, can use the word truth only to emphasize the expression of his determination to hold on to his choice. Of course, the method of truth never prevailed exclusively; reason is too natural to men for that. But in the literature of the dark ages we find some fine examples of it. When Scotus Erigena is commenting upon a poetical passage in which Hellebore is spoken of as having caused the death of Socrates, he does not hesitate to inform the inquiring reader that Helleboreus and Socrates were two eminent Greek philosophers, and that the latter being overcome in argument by the former took the matter to heart and died of it! What sort of an idea of truth could a man have who could adopt and teach, without the qualification of a perhaps, no opinion taken so entirely at random? The real spirit of Socrates, who I hope would have been delighted to have been “overcome in argu-
results will move steadily together toward a destined centre. And all scientific research. Different minds may set out with the same antagonistic views, but the progress of investigation carries them on a force outside of themselves to one and the same conclusion. The activity of thought by which we are carried out, not where we wish, to a foreordained goal, is like the operation of destiny. No modification of the point of view taken, no selection of other facts for any natural beat of mind even, can enable a man to escape the finite opinion. This great law is embodied in the conception of mind and reality. It is known as the Principle of Reality. But the opinion which is extended to be ultimate agreed in by all who investigate, is what we mean by the truth, and the idea represented in the opinion is the real. That is the way it would explain reality.

But it may be said that this view is directly opposed to the view of the definition of reality which we have given of reality, inasmuch as it makes the character of the real to depend on what is ultimately thought about. No answer to this is to say, on the one hand, reality is independent, not necessarily of thought in general, but only of that part of it or in any finite number of men may think about it; and that, on the other hand, though the object of the final opinion depends on what opinion is, yet what that opinion is does not depend on what the part of it or in any man thinks. Our perverseness and that of others may indefinitely postpone the settlement of opinion; it might even conceivably cause an arbitrary proposition to be universally accepted as true as the human race should last. Yet even that would not change the nature of the belief, which alone could be the result of investigation carried sufficiently far; and if, after the extinction of our race, another should arise with faculties and disposition for investigation that true opinion must be the one which they would ultimately come to. "Truth crushed to earth shall rise again," and the opinion that would finally result from investigation does not depend on how many bodies may actually think. But the reality of that which is real and depends on the real fact that investigation is destined to fail, at least if continued long enough, to a belief in it.

But I may be asked what I have to say to all the courts of history, forgotten never to be recovered, to the lost books of the ancients, to the buried secrets.

"Fall many a gem of purest ray serene
The dark, unthought of coves of ocean bear;
Fall many a flower is born to blush unseen,
And waste its sweetness on the desert air."

Do these things not really exist because they are hopelessly beyond

1 Fate means merely that which is sure to come true, and can follow be avoided, it is a superstition to suppose that a certain sort of events are ever fatal, and it is useless to suppose that the word fate can ever be freed from its superstitious taint. We are all fated to die.
THE ARCHER-FISHES.¹

By E. Sauvage.

In the elegance and variety of their colors, in the splendor and brilliancy of the tints with which they have been adorned, Nature, marine animals have no reason to envy the inhabitants of the air; and if in the tropical regions of Africa and America the forests are embellished by the presence of innumerable birds of gorgeous plumage, the Indian Ocean and the Antilles Sea possess in legions of fishes that are more beautiful still, whose scales reflect all the colors of the metals and precious stones, while in varied ornamentations are traced in vivid colors on the gills.

The animals known to our colonists on the Antilles islands, the names of Demoiselles, Portugais, Bandoulières, are, in respect, not inferior to the most richly-adorned of fishes. As to their beauty, amid the rocks and in shallow waters, miming swiftly and ever moving, they are constantly revealing splendid colors with which they are decorated. Rose, azure, velvety-black, milk-white, are gorgeously displayed over the surface, in the form of bands, streaks, curved lines running in different directions, rings, oculated spots. These colors stand out on the surface of the body, which furnishes a background of nacreous tints of gold and silver, or of polished steel.

In all of these fishes the body is compressed, and the ventral fins are covered with scales, whence the name Squamipinnis, by which they are known to naturalists. The shape of the body is peculiar, and the buffalo or cow fish of the Malays is one of them.

¹ Translated from the French, by J. Fitzgerald, A. M.