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THE UNITY OF OPPOSITES: A DIALECTICAL PRINCIPLE

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INTRODUCTION

ALTHOUGH the unity of opposites and other dialectical principles have suffered various "refutations," and certain interpretations and misapplications have quite properly been laid to rest, dialectic is very much alive today. The Platonic-Aristotelian tradition continues, and both the Hegelian and the Marxian dialectic have many followers. The unity of opposites, which Lenin described as the most important of the dialectical principles,[1] states that a thing is determined by its internal oppositions.

The principle was first put forward by the Milesian philosophers of the sixth century B.C., and by their cotemporary, Heraclitus of Ephesus. It held its own through centuries of philosophical thought, though it took different forms which were seldom clearly distinguished. The purpose of the present paper is to separate various forms of the unity of opposites principle, to show that they are of unequal importance and that their consequences are very different.

The principle is not a complete method or philosophy. If one forgot all about the complementary principle that a thing is determined by its field or milieu, the result would be a one-sided distortion. It is well to emphasize at the beginning, therefore, that no attempt is to be made to describe all phases of method in one article, however desirable this might be, but to cover one phase intensively. Lack of space also precludes an investigation of the historical origin and context of the various forms of the unity of opposites. Some are still important today. We shall confine ourselves to two brief examples.

From the time of Heraclitus it has been pretty well agreed that

1 V. I. Lenin, *Collected Works*, XIII (New York, 1927), p. 321.

change involves a unity of opposites, of being and non-being. It is not true to say that the world is (being) or that it is not (non-being), said Heraclitus, but that it is becoming. "You cannot step twice into the same river, for new waters are ever flowing in upon you." The supposed contradiction involved led the Eleatics to deny the reality of change, and has been employed to disparage change, ever since. The Hegelian dialectic, on the other hand, accepted the contradiction as a real aspect of the world, which is continually overcome and continually renews itself in the process of change.

Another famous historical example of the unity of opposites is the One-Many problem. The One, Plato has Parmenides say, must be many because it has parts, and the Many must be one, i.e., one Many. This paradox became the foundation of the system of Plotinus[2] and was also essential to the Christian doctrine of the trinity. The same problem reappears in contemporary discussions of the foundations of mathematics.

Thus Bertrand Russell, in his earlier treatment of classes in *The Principles of Mathematics,* finds it necessary to distinguish the class as one from the class as many. "In the class as many," he says, "the component terms, though they have some kind of unity, have less than is required for a whole, they have in fact just so much unity as is required to make them many, and not enough to prevent them from remaining many."[3] Later on he concludes that it is more correct "to infer an ultimate distinction between a class as many and a class as one, to hold that the many are only many, and are not also one."[4] But this raises the question what we are talking about when we refer to the class as many. It seems to be *one* in some sense. Although Russell ventures an answer, he nevertheless confesses that there are "puzzles in this subject which I do not yet know how to solve."[5] This and other difficulties were avoided in *Principia Mathematica* (1910) by a solution which involved the denial of the existence of classes, and by the development of the theory of logical atomism. Russell's new position permitted statements about classes, even the null-class, though classes were interpreted as fictions. Apparently the one-many

2 Ennead VI, 9.
3 B. Russell, *Principles of Mathematics* (New York, 1903; second edition, 1938), p. 69.
4 *Ibid.,* p. 76.
5 *Ibid.,* p. 77.

problem was resolved only by translating statements about classes into statements about individuals similar to a given individual.

THE MEANING OF OPPOSITES

The meaning of the unity of opposites[6] will naturally depend on our understanding of "opposites." We shall distinguish the strict or formal sense of the term from the more concrete meanings which occur in dialectical writings and also in ordinary discourse.

(1) In this paper A and –A always stand for strict opposites, i.e., properties which cannot both be true of the same event E (except when E lies in a borderline or transitional range). Thus A and –A can stand for contradictories which cannot both be true, nor false of the same E, or for contraries which cannot both be true of the same E, but may be both false (providing that E in no case lies in a borderline or transitional range). Black and non-black, and infant and non-infant, are examples of contradictories; black and white, and infant and adult, are examples of contraries. This usage conforms to ordinary formal logic except for the parenthetical phrase: "providing that E does not lie in a borderline or transitional range." This phrase, however, is crucial, since it appears to constitute a principal difference between dialectic and formal logic. Let us take the contraries boy and man. Most boys are plainly not men, and most men are plainly not boys, though they may have some boyish features, but there are also many borderline or transitional cases in which any decision would be arbitrary and untenable. We have to say "yes and no" or "neither nor." It is to these stretches that our parenthetical phrase refers.

Our definition of "strict opposites" entails a revision of two principal laws of formal logic, viz.: the law of excluded middle and and the law of non-contradiction and all other laws of formal logic which involve negation. The laws are restricted to cases which do not fall in borderline or transitional stretches. In these cases it is not true that everything is either A or –A, and it is not false that any-

6 It should be noted that the dialectician recognizes the conflict as well as the unity of opposites, as was especially emphasized by Lenin, *Selected Works*, XI (New York, n.d.), p. 82.

thing is both A and –A. Yet our assertion that these laws do not hold for these stretches involves no contradiction, since we have defined A and –A as mutually exclusive except in transitional ranges.[7]

(2) The term "opposites" is also used with other meanings that differ from the strict sense defined above. What we describe below as "identical polar opposites," "opposite determinations," and "oppositely directed forces" are not strict opposites, though they are not, on that account, as we shall see, any less important.

FORMS OF THE PRINCIPLE

The principle of the unity of opposites has been interpreted in the following ways:

1. (a) *The conception (or perception) of anything involves the conception (or perception) of its opposite.*

To understand anything is to distinguish it from its opposite. This is recognized by non-dialectical logicians.[8] To perceive anything is to distinguish it from its background, which is necessarily different (contrary) in color or other sense-quality.

1. (b) *The existence of a thing involves the existence of an opposite.*

The existence of a thing depends upon the existence of certain other things, bound to it by a necessary relation: Thus no employer without employee. This principle does not hold universally for con-

7 In Hegelian and Marxist literature the term "contradiction" is used in a very broad sense, to include conflicts and opposing forces (see, for example, Henri Lefebvre, *A la Lumière du Materialisme Dialectique, I, Logique formelle, Logique dialectique* (Paris, 1948), p. 174 and *passim*), but also in the sense of formal or logical contradiction, which is much narrower. In the first sense, the state of the world or a segment of it is always contradictory, though the contradiction is also being overcome. Contradiction thus represents a stage of truth and reality, often of a very high order. In the second sense, on the other hand, contradiction is an unfortunate impasse of thought arising from mistake or ignorance. Anyone who falls into contradiction must give up his position. He has not got the truth at all, though the contradiction may help him to find it. To avoid this double use of "contradiction," the present authors have used the term only in the latter sense (though modified to take account of the "fringe").

8 J. N. Keynes, *Studies and Exercises in Formal Logic*, 4th ed. (London, 1928), p. 58. "The thinking of anything as *A* involves its being distinguished from that which is not *A*."

traries or contradictories. Thus the existence of fallible men does not imply the existence of infallible men, though the existence of men does (biologically) imply the existence of non-men, e.g., plants or animals.

2. *Polar opposites are identical.*

3. *A concrete thing or process is a unity of opposite determinations.*

4. *A concrete system or process is simultaneously determined by oppositely directed forces, movements, tendencies, i.e., directed toward A and –A.*

5. *In any concrete continuum, whether temporal or non-temporal, there is a middle ground between two contiguous opposite properties A and –A, i.e., a stretch of the continuum where it is not true that everything is either A or –A.*

6. *In any concrete continuum, there is a stretch where something is both A and –A.*

Of these six senses of the unity of opposites, the first four do not run counter to traditional formal logic. Forms 5 and 6, on the other hand, clearly involve a revision of formal logic. Sense 4 does not assert that something is both A and –A, but only that it contains oppositely directed forces. Forms 2 and 3 appear to involve logical contradiction, but they really do not, as we shall see below.

THE IDENTITY OF OPPOSITES

The unity of opposites is sometimes equated with the identity or coincidence of opposites. But there may be unity, even interpenetration, without complete coincidence or identity. Thus One and Many may be conceived as forming an inseparable unity of some sort, which would in fact specifically exclude identity. In general, *unity* of opposites seems to imply diversity, and to exclude identity in the strict sense.

There are, however, two cases at least in which it is possible to speak of the identity of opposites, though even here "identity" can not be taken in a strict sense. The first is the "fringe" phenomenon, to be discussed later. The other is the so-called identity of polar opposites. In any ordinary sense, polar opposites, or contraries, such as black and white, hot and cold, cannot be identical. But when you

abstract sufficiently from circumstances, contraries such as "positive" and "negative" are interchangeable and indistinguishable. Of course, if you specify that the positive is, for example, positive electricity, and the negative, negative electricity, a distinction can be made. In arithmetic and logic there are also systems in which each of a set of symbols may be interchanged for another of the set (or itself) according to a certain rule, without affecting the truth of any proposition.[9] This identity of opposites occurs only on levels of high abstraction, and the terms are not really opposites, but *forms* of opposition, related to opposites as propositional forms are related to propositions.[10] (The *unity* of polar opposites, on the other hand, is commonplace. For example, pure white and pure black are hypothetical end-terms of a continuum of intensities, and can be understood only in terms of it.)

Hegel made a great contribution, in spite of his exaggerations, by exhibiting the identity of opposites on certain levels of abstraction. Modern theory of axiom-sets confronts the same problem in a different form. It becomes the problem of interpretation. The abstract system may be "meaningless," but if it can be interpreted as a meaningful system, its usefulness is demonstrated.

OPPOSITE DETERMINATIONS

A concrete thing or process is a unity of opposite determinations (Form 3). Thus everything, it is said, is both abstract and concrete, both universal and particular. A man, for example, is always a concrete particular which can occupy only one space-time track. Yet all of his characteristics seem to be abstract, capable of occurring in many places simultaneously. We say that a man is an electrician, a broker, that he is silent, wise or foolish. Since such adjectives describe a man's nature, this nature must be regarded as abstract and universal. This contradiction is accepted, and embodied in the so-called theory of the concrete universal. A judgment such as "Jones

9 There is, for instance, the well-known duality of Boolean algebra.

10 A propositional form (or propositional function) is an expression such as "x is a philosopher" or "2 R 3," which becomes a proposition when an appropriate substitution is made.

is wise," it is said, is expressible in abstract terms as: "The individual is the universal."[11] But here a distinction must be made. "Jones is wise" does not mean that Jones is identical with wisdom, but that Jones *has* wisdom. The apparent contradiction is resolved by recognizing different meanings of "is."

Actuality and potentiality are also opposite determinations, for what is actual cannot be merely potential, nor vice versa, yet everything is both actual and potential. But the contradiction again is only apparent. The actual characteristics of a man, for example, are those which are manifest at a particular time, whereas the potential characteristics, or "dispositional" traits, are those which would be manifest if appropriate stimuli were presented. It is clear, therefore, that (except for the borderline cases to be discussed later) nothing is both actual and potential in the same respect at the same time, and that there is accordingly no contradiction (except that involved in all transitions).

Another important example of opposite determinations is the unity of structure and function in tissues, organs and organisms. Structure and function are demonstrably interdependent, and neither could exist without the other. They are inseparable, but also distinguishable, like the convex and concave sides of a curve. Still another example, already mentioned, is the unity of one and many. Though what is one cannot be many, a class appears to be both. To dispel the contradiction, it is sufficient to specify what is one, and what is many, e.g., 12 disciples, and one class of 12 disciples. The difficulty arises only on levels of abstraction where logic, evidently, has resources to cope with it.

In Aristotle's philosophy, form and matter, and act and potency, were fundamental, and the tradition has continued with modifications to the present day. The unities of opposite determinations are forms of common experience, and furnish a conceptual framework presupposed by scientific inquiries. The precise interdependence of the determinations in concrete cases sets problems for the special sciences.

11 See Hegel, *The Logic of Hegel* (from the *Encyclopaedia*), tr. by Wallace, 2nd edition (Oxford, 1892) Section 166, p. 297.

OPPOSITELY DIRECTED FORCES

Form four of the unity of opposites principle states: A concrete system or process is simultaneously determined by oppositely directed forces, movements, tendencies. Thus a planetary orbit is determined at every point by oppositely directed forces. Similarly, a society, or its development, may be determined (say) by conflict between productive forces and property relations ("relations of production"). In the psychobiological organism the phenomenon is always in evidence. The opposite forces acting upon the organism, however, are typically expressed by means of antagonistic skeletal muscles—flexors and extensors; or by smooth muscles—radial and circular fibers. In all such examples, forces operate in different directions. The flexor pulls in, the extensor out. The employers' aim is reducing labor costs, the employees' is higher wages. Gravity in case of a planet induces movement toward the center of the sun, whereas inertia determines movement in a straight line.

The term "force" does not retain the same meaning when applied in different fields. The reduction of social forces to physical, or mechanical forces, is mechanism, whereas the reduction of physical forces to social or psychological forces is teleology (vitalism), and neither form of reductionism has proved successful. Psychological goals and motivations, social movements and tendencies, cannot be profitably treated as *mere* movements, differing only in direction and acceleration. On the other hand, psychological and social forces or movements do always *involve* directed and accelerated motion. This is the common denominator of "force" as employed in these different fields. In all examples of the unity of opposites, in form 4, there is a system acted upon by two forces in such a way that, if one of these forces grew weaker the whole system would veer in the direction of A, whereas, if the other force grew weaker, the whole system would veer in the contrary direction, –A. Thus if the gravitational pull of the sun decreased sufficiently, the earth's motion would approximate to a straight line; if the earth lost sufficient momentum, it would be deflected toward the sun. Similarly, when employer groups become much stronger, compared to the employee organizations, wages tend to fall, or prices to rise, and a whole series of changes commonly results; if conversely, the employee organizations become comparatively stronger, wages tend to rise, and a whole train of oppositely di-

rected motions will ensue. Instead of silent submission, withdrawal and disunity, there is now vocal protest, demand of rights and labor solidarity. Instead of prudent retirement from shop windows, the employee goes on and purchases needed commodities. Instead of stopping at home, the family goes out for entertainment. On the psychobiological level, we may also find oppositely directed motions, although of course we also find a great deal more. In any rhythmic activity, such as walking, both flexors and extensors are pulling simultaneously, in opposite directions, though when one is contracted, the other is only partially contracted. The character of the activity is basically determined by the relative strength of the contractions of these antagonistic muscles. If in walking the contraction of the extensors is extraordinarily greater than that of the flexors, acceleration and direction of movement is shifted upward.

If the law of the unity of opposites is to be applied to the subject matter of physics, sociology and psychology, *in the same sense,* then the common denominator, so far as one can see, would have to be: *Oppositely directed forces or movements within a system determine the movement of that system.* But as our discussion has suggested, this interpretation of the law is somewhat artificial. It might direct the scientist, investigating the behavior of a system, to the opposition movements within it, but since the movements referred to are mechanical, they would have to be reinterpreted if the system were psychological or sociological. The oppositely directed forces could only be understood when sufficient facts about the organism or society were known. While if the system were physical, the competent physicist would have the relevant data anyhow, and the law, it might be argued, would be of little use to him.

It is obvious that the law of the unity of opposites is not a law of physics, or of any other science, but a philosophical generalization of findings in various sciences. Its identical meaning in various kinds of systems is: Oppositely directed forces or movements within a system determine the movement of that system. In its more important interpretation, however, the law is systematically ambiguous, i.e., "forces" and "movements" are reinterpreted for every new kind of system investigated.

The problem is how such a philosophical generalization can be usefully employed. There is little doubt that philosophical generali-

zations and perspectives do sometimes give guidance to scientific work. Long before the evidence for organic evolution had accumulated, there was a philosophy of evolution based upon a certain amount of scientific knowledge which is supposed to have given impetus to investigations that finally established the importance of evolution in many fields of science. And similarly, before Newtonian physics came the Cartesian philosophy of a world machine, which is supposed to have supplied problems, direction and inspiration.

The question is how the law of the unity of opposites, in the fourth form, *can* give useful guidance to scientific work. That it actually does so in particular cases, would be a historical question which lies beyond the compass of this brief paper. The law could provide desirable correction wherever scientific method overemphasizes the effect of external forces acting upon systems, and neglects their internal dynamics. Sometimes the spontaneity of organisms is not suffiently recognized. The internal stimuli arising from complicated needs acquired by adult human beings, for example, are not adequately considered, and efforts are even made to explain complicated learning by blind or random trial and error, or by field forces acting entirely from outside the organism. Early behaviorists seemed to have assumed that given sufficient repetitions learning one thing is as easy as another, that conditioned responses can always be established, the organism being completely plastic and neutral. In sociology, similarly, the attempt has been made to explain basic human behavior by climate, terrain, technology or institutions of one kind or another, with little attention given to the needs and reaction patterns of the individual. Societies are often compared with respect to more or less external traits, such as population, geographical extent, or duration in time, without much acknowledgment of the crucial differences of internal structures. In anthropology an example that comes to mind is the extreme theory that civilizations and cultures develop mainly by a process of "diffusion." All such tendencies, and many more, illustrate the danger of neglecting those contrary forces internal to systems. The principle of the unity of opposites may therefore be said to express methodological experience, and revised judgments, in several fields of science.

The complementary principle, meanwhile, is not forgotten in dialectical literature. If the motion of a system is determined by the

contrary forces or movements internal to it, it is also determined by the motions of other systems external to it, and by the system of systems to which it belongs. But the latter principle falls outside the scope of the present article.

THE FRINGE

The fifth form of the unity of opposites is: *In any concrete continuum, whether temporal or non-temporal, there is a middle ground between any two contiguous, opposite qualities A and –A,* i.e., a certain stretch S of the continuum where it is not true that everything is either A or –A. Thus the law of excluded middle, which states that S is always either A or –A is restricted.[12] This fifth form of the unity of opposites applies to all contradictory properties, e.g., child and non-child, but also to contiguous *contrary* qualities, such as infant and child. Although most cases are either infants or children, there is an intermediate fringe in which this cannot be said. Non-contiguous contrary qualities, however, such as infant and old man, would have a middle ground in any case.

The dichotomy between child and adult is crude and unsatisfactory. There is a long stretch of the continuum S which is neither A nor –A. By applying the law of excluded middle as a kind of ideal or norm of thought we can reduce the size of S. We can distinguish between the neonate (two days or less) and the infant (more than two days and less than two years) and the child (at least two years but not more than sixteen), etc. By introducing intermediate terms, by use of the microscope, telescope and other analytic methods, it is possible to diminish S but not to eliminate it. The dichotomies established in accordance with the law of excluded middle prove periodically unsatisfactory, and are replaced by new dichotomies. The law of excluded middle, as Dewey says, specifies a condition *to be* satisfied,[13] which however, in certain stretches of a continuum, never *is* satisfied.

12 This restriction of the law of excluded middle may not appear to be a case of the unity of opposites because there is separation of opposites here rather than unity. However, as we shall see, the denial of this law is normally equivalent to the denial of the law of non-contradiction, and hence to form 6 of the principle.

13 John Dewey, *Logic, The Theory of Inquiry* (New York, 1938), p. 346.

The sixth form of the principle is: *In any concrete continuum* there is a stretch where something is both A and –A. When the assumptions common to almost all logical systems are made, the law of non-contradiction is equivalent to the law of excluded middle.[14] But then the denial that the law of excluded middle holds universally is equivalent to the denial that the law of non-contradiction holds universally. And this is equivalent to the assertion that there is something for which the law fails. We may therefore infer from form 5 above that in any concrete continuum there is a stretch S where something is both A and –A. (The continuum, of course, may be temporal, as in growth or developmental processes, or static, as in the color spectrum.)

The same conclusion may be reached with the aid of Dr. M. Black's analysis,[15] by a direct approach. Suppose we have a series of colors and that we divide them into ten segments which are then numbered successively from 1 to 10. Now suppose that the colors in segments 1 to 4 are red, whereas those in segments 5 to 6 are doubtful, and those in segments 7 to 10 are not-red. Red therefore is excluded only from the range 7 to 10, while not-red is excluded only from the range 1 to 4. There is a sense, therefore, in which the ranges of application of red and non-red overlap, and the law of non-contradiction does not hold.[16]

14 There is, to be sure, the system of intuitionist logic of A. Heyting (see his "Die formalen Regeln der intuitionistischen Logik," *Sitzungsberichte der Preussischen Akademie der Wissenschaften,* Physikalisch-Mathematische Klasse, 1930, p. 47-58), which asserts the law of non-contradiction while omitting the law of excluded middle; but this result is obtained by eliminating the law of double negation: (not not A is equivalent to A), and thus altering the usual meaning of negation. Such a system involves a revision of traditional logic, different from that which we propose, and may be disregarded for the present.

15 Max Black, "Vagueness," *Philosophy of Science,* IV, no. 4 (Oct., 1937), p. 435 f.

16 The argument, in Dr. Black's generalized form, is as follows: If Lx means L is true of x and $-Lx$ means L is false of x, we may say that Lx is only definitely false for the range 7 to 10, whereas $-Lx$ is only definitely false for the range 1 to 4. The "inability to find a logical interpretation of *doubtful* and *perhaps* in terms of the two truth values, truth and falsehood, forces us to admit that the ranges of application of Lx, 1 to 6, and of $-Lx$, 5 to 10, overlap in the fringe, 5, 6" (p. 436). "Whether the number of terms in the field of reference is finite or infinite," Dr. Black goes on to argue, "denial of the existence of a unique boundary between the domains of Lx and $-Lx$ leads to contradiction" (p. 437).

THE UNITY OF OPPOSITES AND FORMAL LOGIC

The program of denying the unrestricted validity of formal logic is difficult, since our thinking has been molded by formal logic and it is embedded in our language. We shall go on thinking in terms of it anyhow, but the dialectician will always be mindful that the dichotomies he sets up are only approximate and can be improved. That is, the stretch S can be made smaller and more definite.

Another reason why denial of the unrestricted application of the law of non-contradiction and the law of excluded middle is difficult, is that these laws are confirmed by experience in innumerable instances. Usually, when one says, this is a chair, a goat, or a human being, the contradictories are manifestly impossible. We see at once that what we have before us could not be a non-chair, a non-goat or a non-human being. Either-or is also obviously valid throughout vast ranges of human experience. It is only in borderline cases that there is doubt. It is only in these cases that there could be any justification in saying that a certain thing is neither a chair nor a non-chair, or that it is both. There is no question that these laws have strong inductive support though the exceptions are also richly confirmed.

The main tradition of logic in the past, overlooking the exceptions, held that logical laws are universal and necessary truths, and hence impossible to establish by induction. The view taken was that they are intuitive certainties or, with Kant, *a priori* principles of the Understanding. A certain difficulty always attached to such interpretations, however. A great deal of experience of the oppositions in the world seemed necessary to the intuition, or to the operation of the Understanding. Neither was really *a priori* or *de novo*. Instantaneous logical convictions, like other convictions, now appear to have a history. Since the formation of logical concepts has been studied in children and variations of logical habits have been noted in different societies, it has become evident that the learning of logical laws is a protracted, cumulative process, which had its beginning perhaps in those first discriminations where figure is distinguished from its opposing ground, and in the first denials and frustrations—the "you can't have that" experience. Indeed, striving, success and frustration would seem necessary to any comprehension of negation.

The main stream of modern logic has veered away from intui-

tionism, and few logicians today would talk about intuitive or transcendental necessities. The primitive propositions, or axioms, from which contemporary logic deduces its theorems are not affirmed to be self-evident, but are described as assumptions. When this course is taken, however, the usefulness of logic when applied to the concrete world remains mysterious. Why one set of assumptions should yield a system having important interpretations, another not, receives no answer.

This difficulty, which is often cited, can be avoided by an inductive approach. Since in the obvious ranges of experience, the formulae of formal logic are always confirmed, we may say that they have a probability of 1 or certainty in these ranges. Thus there are countless areas (which, however, need have no sharp boundaries) where the formula "not both A and –A" always holds. But in the transitional ranges, as we have seen, the general formula breaks down. In passing along the continuum from blue to green, the probability that colors will not be both blue and not-blue, runs from 1 to 0. In this sense we may say that the probability of a logical formula (i.e., where the quantifier is omitted) is determined by the ratio of favorable to the total number of cases. Favorable cases abound in the learning process. We are always discovering that different discriminations, interpretations, needs and objectives, which we had supposed to be jointly possible, are really incompatible. We have to learn in innumerable cases that ends without certain means are impossible, and that certain means, which seemed to conduce to an objective, are really inconsistent with it. Either A or –A, but not both, is richly confirmed in experience, and learning is a process of discovering what concrete properties exemplify A and –A. Each such discovery is a favorable case.

The unfavorable cases are also encountered in every field, though not nearly as frequently as the favorable. Unfavorable cases are those in which there is, in fact, no way of coming to a definite decision as to the application of a certain dichotomy. Subjects confronted with the continuum of colors in the spectrum will be able to distinguish two contiguous colors, such as blue and green, within the obvious ranges, but there is an intermediate range in which discrimination is impossible. Not only will subjects disagree among themselves as to which color it is, but any subject at different times

will disagree with himself and, in certain cases, will be unable to decide whether the color is blue or non-blue, or blue or green.[17]

The same is true of Engels' example of living and dying:[18] Dying is a process that takes place in time, and there is therefore a stretch of the continuum in which neither "dead" nor "living" are applicable. You may try to get around the facts by saying that when properly analyzed, "dead" and "living" do not apply to the whole organism, but to the individual cells, some of which are dead, others living, at any particular time during the dying of the organism. But this merely shifts the difficulty from the organism to the cell. The cell also takes times to die, and for a certain stretch neither "living" nor "dead" can be applied. Moreover, the death of the organism cannot be properly reduced to a mere sum of dying cells because the cells are interdependent in dying as in living. On the empirical approach we are taking, the failure of formal logic to apply in such cases has an objective basis.

IS VAGUENESS SUBJECTIVE?

Bertrand Russell, on the one occasion on which he discussed this matter in print, employed the same example. "Death," he wrote, "is also a process; even when it is what is called instantaneous, death must occupy a finite time. If you continue to apply the name to the corpse, there must gradually come a stage of decomposition when the name ceases to be attributable, but no one can say precisely when this stage has been reached."[19] "Man" is also an indefinite term since there are doubtful prehistoric cases. There is no lack of examples, but Russell attributes them, in every case, to the vagueness of language. "The law of the excluded middle is true," he says, "when precise symbols are employed but it is not true when the symbols are

17 The formal logician may say that the color is, after all, either blue or non-blue, whether or not the subject can say which. But this presupposes that the word "blue" has an absolutely definite meaning, regardless of the way it is used. Where there is inescapable indecision as to the application of the term "blue" to an object, we might as well say that it is neither blue nor non-blue, as that it is either.

18 F. Engels, *Herr Eugen Dühring's Revolution in Science* (New York, 1939), p. 132 f.

19 "Vagueness," *Australasian Journal of Philosophy*, 1 (1923), p. 88.

vague, as in fact, symbols always are." Although the article sets out to prove that the failure of the law of excluded middle results from the vagueness of language only, no real argument is offered for this subjective explanation. "There is a tendency," he says, "in those who have realized that words are vague to infer that things also are vague. . . . This seems to be precisely a case of the fallacy of verbalism —the fallacy that consists in mistaking the properties of words for the property of things."[20] And yet nowhere does he even state criteria of objectivity and subjectivity.

This defect of Russell's article was remedied by a discussion by Max Black which is, in effect, an answer to Russell's subjective resolution of the problem. Vagueness cannot be explained as the absence of scientific precision, Black points out, since "the indeterminacy which is characteristic of vagueness is present also in all scientific measurement."[21] Vagueness is not a defect of language. It is not to be identified with ambiguity, since even the most precise and unambiguous terms are vague, the difference being that the ambiguous term will have more than one "fringe," or indeterminate area. "A symbol's vagueness," he holds, consists "in the existence of objects concerning which it is intrinsically impossible to say either that the symbol in question does, or does not, apply. The set of all objects about which a decision as to the symbol's application is intrinsically impossible is defined as the "fringe" of the symbol's field of application."[22]

Black's argument for the objectivity of vagueness is interesting: If the vagueness of a symbol is subjective, he suggests, its use implies something about the speaker (psychological facts), whereas if it is objective its use implies something about the environment (physical facts). Thus an ambiguous symbol, which is clearly a subjective phenomenon, implies psychological, but not physical facts. We can appeal to less equivocal symbols and the ambiguity disappears. In the case of vague symbols this is not true. Even when discrimination and linguistic precision are at the maximum, the fringe, though perhaps reduced in extent, is still demonstrable. Confronted by the

20 *Ibid.*, p. 84.

21 "Vagueness," *Philosophy of Science* (1937), p. 429.

22 *Ibid.*, p. 430.

continuous gradations of colors in the spectrum, even the most sensitive observers, employing the utmost refinements of language, are unable to eliminate the fringe. It is therefore reasonable to conclude that the fringe is an objective feature of the series observed. The same test is usually applied to determine the objectivity of the "reports" of scientific instruments, such as the telescope, which are analagous to human discriminators, or reporters. If a telescope "reports" a certain phenomenon, its objectivity is determined by employing other telescopes, located at higher altitudes, or tilted at a different angle, for example, to allow for the rotational velocity of the earth. If the phenomenon disappears when the conditions of observation are altered, it is not regarded as an objective feature of the stars observed.[23]

The non-verbal character of the phenomenon, it might be added, is also shown by discrimination experiments, using dogs and other animals as subjects. Pavlov, for example, associated food with an illuminated circle, but no food with an ellipse of the same area. When the ellipse was of the proportion 2 to 1, the dogs readily distinguished the two figures, salivating to the circle but not to the ellipse. When the ellipse was gradually made thicker, the dogs were still able to discriminate. When the ratio of 9 to 8 was reached, however, and the ellipse was almost a circle, discrimination became impossible, and in three weeks of effort no progress was made. Evidently the limit of canine discrimination had been reached. If hu-

23 One point is not sufficiently stressed by Professor Black. The subjectivity of the "report" of a given telescope is not decided merely by its conflict with the "reports" of other instruments, for the first telescope may be a superior one in the sense that it gives more objective reports. Many facts and theories are employed to establish the superiority of scientific instruments; for example, theories and facts about lenses, and the distorting effects of the earth's atmosphere. In the case of scales, the superiority of some scales has been correlated with the type of mechanism and materials used so that the accuracy can be predicted in advance. But even the most sensitive scale which records the most minute differences of load, will demonstrate the fringe, giving slightly different recordings for the same load at different times. The fact that the fringe is not eliminated under any conditions would indicate that the phenomenon is not merely verbal, nor merely subjective, but also objective. Dr. Black's further analysis of the phenomenon distinguishes three factors: symbol, subjects (or observers), and objects. We agree with him in stressing the fundamentally objective character of the situation.

man adults were substituted for dogs, the fringe would be narrowed, and still more, if scientific instruments were used, but it would not be eliminated. The existence of the fringe does not seem, therefore, to be a wholly canine, human or instrumental fact, but also a physical one. *Even the best instrument would fail to discriminate a mathematical line dividing A from –A,* since mathematical lines cannot be discriminated, and by all accounts, do not exist in nature.

Though the fringe is evidently not a mere psychological fact, the *size* of the fringe does vary with different observers, or groups of observers. Thus the size of the fringe, or the degree of vagueness of the symbol, is always respective to a class of observers. The size or degree is always *for* a given class of subjects, though the class may be a large one. The size of the fringe is a difficult conception, however, since the fringe has no distinct boundaries. No one can say with certainty exactly where it begins and where it ends. Professor Black has devised an ingenious technique for dealing with the difficulty,[24] and Professor Hempel[25] has contributed some improvements. Professor Black explains the vagueness of a symbol in terms of variations in its use by a given group of users, applying it to a given series of objects. He defines *"the consistency of application of a term"* to the members of a series. Suppose the series to be a series of chairs, running from the most obvious examples, such as a Chippendale chair, to ever more doubtful cases, and ending with a shapeless piece of wood. Almost all observers will call the first members of the series "chairs," and the last members of the series, "non-chairs." In other words, the consistency of application of the terms "chair" and "non-chair" will be highest at the beginning and end of the series respectively. Toward the middle of the series the cases become more doubtful, however, and consistency decreases. The term "fringe" is henceforth used by Dr. Black with a new meaning, viz.: the range of objects which are called "non-chairs" about as frequently as they

24 More exactly, Dr. Black's technique enables him to eliminate the idea of the fringe as a definite set of objects. This he regards as a crude untenable notion, since it leads to logical contradiction by the kind of argument presented above in the section on the fringe.

25 C. G. Hempel, "Vagueness and Logic," *Philosophy of Science,* April, 1939, p. 168.

are called "chairs." The vagueness of a symbol is to be measured by the curve on which this varying consistency is plotted.[26]

Two minor objections may be expressed. Vagueness should be defined not only by the conflicting discriminations of different observers, or of the same observer at different times, but also by the inability, or failure, of discrimination. Such failure, hesitation or blocked response is frequently met with in psychological studies of sensory discrimination. Secondly, discriminations of different observers, as of different scientific instruments, are not of equal accuracy. Such deficiencies in the formula, however, could probably be remedied. We must add that we believe (contrary to Professor Black) that the term "fringe" can be used in the original sense consistently, provided the laws of logic are stated with appropriate restrictions; and this is the practice we shall follow.

POSSIBLE LOGICS FOR DIALECTIC

The discussion so far poses the question: What alterations of formal logic are entailed by the principle of the unity of opposites in forms 5 and 6? It has been pointed out that the restriction of the law of excluded middle would mean a radical revision of logic; yet this has often been contemplated, even by Aristotle apparently. It seems still more drastic to restrict the law of non-contradiction; in fact, it has generally been considered unthinkable. The dialectician is as intent as anyone else to avoid self-contradiction, and continues to think of formal logic as prescribing an ideal for exact thought. There are several possibilities to be considered.

(a) One alternative available to the dialectician is to retain the

26 If we refer to a member of the series of objects as x, let L and –L stand for a term and its contradictory (e.g., "chair" and "non-chair"), let m be the number of discriminations of x as L, and n the number of discriminations of x as –L, then Professor Black defines *"the consistency of application of L to x* as the limit to which the ratio m/n tends when the number of [discriminations of x] and the number of observers increase indefinitely" (*loc. cit.*, p. 442). The "consistency profile" is the curve on which the consistency of application of L to x is plotted for every x in the series, from those most frequently called L to the least frequently. This curve is steep in the middle range if L is a precise symbol, and flat if it is a vague symbol. Professor Black proposes to measure vagueness by the flatness of this curve.

Professor Hempel has raised a technical objection to this method of measurement (based on the non-metric character of the series), and proposed an alternative formula which avoids this difficulty (*loc cit., p.* 166).

principles of formal logic, but to assert them universally (if they involve negation) only for cases which are not in the fringe. It is not assumed here that the fringe has sharp boundaries, nor that it is so well defined that we can always tell whether an object falls in it or not. But it is assumed that for certain things we can decide definitely that they are *not* in the fringe between a certain property and its opposite. If we write "Fringe –A" for the fringe between A and –A, the law of excluded middle would be expressed in this fashion: For all x not in Fringe –A, either x is A or x is –A.

This scheme, if it can be worked out consistently, has several advantages. It retains traditional logic for the obvious cases while acknowledging existence of doubtful cases in the fringe. It also has the merit of fitting in with the inductive approach to logic, and appears to be the system presupposed by the conceptions of opposites and the fringe adopted in this paper.[27]

(b) An alternative procedure is to adopt the quantitative technique of Professor Black. Roughly, what he says is as follows: If we replace L and –L by consistency curves, representing the consistency of observers in applying these terms to a series of items, then the law of excluded middle, L or –L, may be restated in a form that is valid.[28]

27 In addition to the statements of logical principles restricted, as above, to the non-fringe, we would also have unrestricted statements, in which, however, it would be asserted that the logical formula applies with a certain probability—a probability determined roughly by the ratio of favorable cases to the total cases in human experience. But for further refinement it must be remembered that not all observations are of equal accuracy and weight.

28 He replaces the propositional function Lx by $L(x,C)$, which means: "the symbol L applies to x with consistency C." When the consistency of application of L to x is C, then, by Black's definition, the consistency of application of –L to x is the reciprocal, $\frac{1}{C}$. Instead of the law of excluded middle in the form: "Every x is either L or –L," he has an operation which permits the transformation of $L(x,C)$ into $-L(x,\frac{1}{C})$ (*loc. cit.*, p. 451 f.).

With appropriate changes, the law could also be stated for contiguous, *contrary* qualities which together exhaust a series. If a series begins with squarish rectangles ("plates") and gradually descends to very narrow rectangles ("sticks"), and "plates" and "sticks" are the only terms to be applied, the consistency curve may be expected to be similar to that where the terms are "plate" and "non-plate." See Livingston Welch's "A Preliminary Study of the Interaction of Conflicting Concepts of Children Between the Ages of 3 and 5 Years," *The Psychological Record*, II, 20 (1938).

This procedure differs from that of alternative (a) in denying the existence of the fringe as originally defined, i.e., as a class of objects qualitatively distinguished from the non-fringe. Any object that is L may be, so to speak, a little bit –L, if some people judge it so. The term "fringe" may still be used, but redefined (as explained above); and it is not required for the definition of "vagueness." This alternative is similar to the first, however, in involving an inductive approach.

(c) For the dialectician who wants logic to recognize the fringe, or borderline cases, there is a third alternative. He may adopt provisionally a three-value logic. Instead of the two values, true and false, the Lukasiewicz-Tarski logic (or rather one of these logics) introduces three truth values: 1, ½ and 0, or "certainly true," "doubtful," and "certainly false," as Lewis and Langford interpret them.[29] The middle term between true and false in this system is ½ or doubtful, and its application to the problem of the fringe is clear. There is a middle range of blue on the color spectrum which nearly all observers would call blue, and there is a middle range of green which almost no observers would call blue, and finally there is between blue and green a fringe which many observers would call blue, and many, non-blue. These latter judgments could be interpreted as ½ or doubtful, whereas the former attributions would be true and false, or 1 and 0, respectively. This logic therefore seems to be consistent with both the fifth and sixth forms of the principle of the unity of opposites. It is significant that neither the law of excluded middle nor the law of non-contradiction appears in this logic.

(d) The Heyting logic, to which we have already referred, also seems to allow for a fringe between A and –A, because it fails to assert the law of excluded middle and the law of double negation, $--A = A$. On the other hand the law of non-contradiction is asserted, which would exclude the sixth form of the principle of the unity of opposites.

It is not our purpose here to pass on the merits of these new logical developments, but only to point out that the dialectician who insists upon the importance of the fringe has a choice among several possible systems of logic.

29 C. I. Lewis and C. H. Langford, *Symbolic Logic* (New York, 1932) p. 214.

DOES LOGIC APPLY TO THE WORLD?

Dialectic differs from formal logic in at least one important respect. It reformulates logical principles so as to allow for the existence of the fringe. Its empirical confirmation is therefore much stronger than that of formal logic. The latter is confirmed throughout the range of obvious cases, but fails for the fringe, whereas dialectic holds for both. The probability of dialectical principles is determined, in a manner already explained, by the ratio of favorable to the total number of cases. Is such empirical evidence the only type available? There has been a persistent conviction that logical principles are self-evident and intuitively necessary. We do not deny the occurrence of intuitive certainties, but only insist that they be tested against the facts, and their origin traced in the learning process. Too many self-evident truths have turned out false to warrant any other course.

The view that logical laws are self-evident and immutable is to be rejected. So also the current conventionalism. The latter states that formal logic does not *describe* general features of the objective world, but *prescribes* verbal conventions. It is simply a set of rules for regulating scientific communication, those rules being preferable which best accomplish certain human ideals, such as precision and inclusiveness. Professor Nagel, who defends this view, interprets the principle of non-contradiction as requiring "that in a given context a term must not be applied to a given thing and also denied to it; and the principle of excluded middle is formulated in a corresponding way."[30] But he acknowledges that everyday language, and even the specialized languages of the sciences, do not entirely conform to these requirements.

There is no objection to formulating the laws of logic as rules for using language. But the fact that the laws can be interpreted ethi-

30 Ernest Nagel, "Logic without Ontology," *Naturalism and the Human Spirit*, edited by Y. H. Krikorian (New York, 1944), p. 225. Of course, if the principle were formulated in the *same* way, it would say that in a given context a term must either be applied to a given thing or denied to it; which would oblige us to be omniscient. If weakened to a command to apply the compound term "either A or non-A" to any given thing, it would have the unfortunate consequence of making silence impossible. Perhaps the principle is to be formulated as a prohibition against denying both the terms A and non-A to a given thing.

cally, as linguistic prescriptions, does not imply that they have no reference to the objective world. The materialist will want to know why some rules are more successful than others in regulating communication, organizing our knowledge—in achieving human ideals. He cannot escape the conviction that the success of an instrument depends upon properties of the object to which it is applied, as well as of the instrument itself and its user. He will also be curious about the ideals themselves. Do they vary from one society to another? Under what conditions are they learned? Such questions are relevant to the objective import of logic, and cannot be dismissed merely because our knowledge is still insufficient to furnish definitive answers.

Professor Nagel admits that the ideal of precision

> is not arbitrary, because communication and inquiry are directed to the achievement of certain objectives. . . . The assertion that this is so requires support by empirical evidence—evidence which it is possible to produce. But the available evidence is drawn from the study of the behavior of men engaged in inquiry; it does not come from a consideration of structural invariants found in other domains.[31]

It will be observed that on this view logical laws are instruments for the attainment of certain human objectives, and empirical evidence is admittedly required to show that they do in fact serve these purposes. It is regrettable that Dr. Nagel does not produce some of this evidence. Had he done so, we could perhaps discover whether it is his intention to admit as evidence only the behavior of men conducting an inquiry, or whether he would also include the facts of the world with which their inquiry deals. Dr. Nagel's position implies, in any case, that since logical laws are relative to human ideals and objectives, they may change with a change in these objectives; and secondly, that since particular logical laws are justified by empirical evidence, the weight of evidence might conceivably shift with circumstances in favor of other laws.

Professor Nagel, nevertheless, will not allow that logical principles can ever be established by empirical induction. His main argument is that logical principles cannot be refuted by negative

31 *Ibid.*, p. 226.

instances. If there appears to be a negative instance, in any particular case, we always re-examine the empirical data to bring them into harmony with the logical principle. We never reject the principles themselves; for if we did not regard them as necessarily true, we would run counter to the established usage of the expressions they involve, such as "and" and "if . . . then."[32] He concludes that there is no clear sense in which logic can be experimentally verified.

> Logical principles [he contends] are compatible with any order which the flux of events may exhibit; they could not be in disagreement with anything which inquiry may disclose, and if they should ever require revision, the grounds for such alterations must lie elsewhere than in the subject matter of the natural sciences.[33]

But this passage is contradicted by a later one, in which he calls attention to a recent suggestion

> that in order to develop the theory of subatomic phenomena in a manner conforming both to *experimental evidence* and to certain ideals of economy and elegance, a "logic" different from those normally employed may have to be instituted. The suggestion . . . calls attention to the fact in a striking way that under the pressure of *factual observation* and norms of convenience familiar language habits may come to be revised; and it indicates that the acceptance of logical principles as canonical need be neither on arbitrary grounds nor on grounds of their allegedly inherent authority, but on the ground that they effectively achieve certain postulated ends.[34]

It appears, then, that Dr. Nagel's denial of the relevance of empirical evidence to logic, which he makes a great deal of in his paper, is difficult to carry out consistently.

It is true that when a logical principle appears to be violated, we *usually* re-examine and revise the other data. The same thing is true of the principles of physics. In every field we attempt to save the general principles—whenever, that is, they are better established than the data to which they are applied. But sometimes it is the principle which is revised. Such revisions have occurred more than once in the history of logic. For example, Kant corrected Aristotle's for-

32 *Ibid.*, p. 219.
33 *Ibid.*, p. 220.
34 *Ibid.*, p. 232; italics ours. The reference is to a paper by Birkhoff and von Neumann.

mulation of the law of contradiction, omitting the reference to time, and the superfluous expression of certainty.[35]

Many other examples could be given to show that logical principles, like other scientific principles, are not sacrosanct prescriptions, but modifiable to suit the purposes of logic, mathematics and other sciences. Thus Brouwer and other mathematical logicians have revised logical formulations to fit the needs of mathematics.

It is true that logical principles seem to be intuitively true and even self-evident. This is because (apart from the fringe) there appear to be no exceptions in our experience, and in the overwhelming majority of cases one is unable to *imagine* any. But fringe phenomena, as we have seen, have to be accepted. They oblige us to admit ranges of exceptions to formal logic, in every continuum. These exceptions, which dialectic incorporates into the statements of logical principles, are objective and important. As Dr. Black says, ". . . deviations from logical or mathematical standards of precision are all pervasive in symbolism; . . . to label them as subjective aberrations sets an impassable gulf between formal laws and experience and leaves the *usefulness* of the formal sciences an insoluble mystery."[36]

In general, the main objection to the view that logic has no objective import, but is merely a system of rules for organizing our knowledge, is that it fails to explain the enormous utility of this science. The conventionalism we have discussed admits the utility but makes a mystery of it.

CONCLUSION

We have not attempted in this paper to give new and interesting examples of the unity of opposites, but rather to distinguish six different forms this principle has taken in dialectical literature. It was found that some of these forms are subjective, having to do with conception and abstraction, others concrete and objective; that the

35 Cf. P. Popov, "The Logic of Aristotle and Formal Logic," *Philosophy and Phenomenological Research,* VIII, p. 8 f. In the same way, modern logicians have been obliged to deny the existential import of universal propositions.

36 Max Black in *Philosophy of Science, loc. cit.,* p. 429.

last two forms required a revision of customary logic while the others did not. Naturally, an illustration of one form of the principle need not be an illustration of the others.

The same state of affairs, however, might illustrate various forms of the principle in different ways. A developing strike situation, for example, is determined by oppositely directed movements or tendencies (form 4). There is a tendency to strike but also an impulse to cautious withdrawal, and the outcome is determined by the composition of these tendencies and by the preponderance of one of them. Fringe phenomena (5, 6) could also have some significance. In the periphery there are employees who are neither clearly in (with) the union, nor outside (against) it. The outcome may depend, in part, upon the extent of this indeterminate or hybrid fringe. Another factor plays a part in such a situation. The language of the strike organizers may be too abstract, consisting of general slogans and appeals which take little account of the concrete realities, ignoring the circumstances and hazards of the employees or the specific dispositions of the employer. The organizers have failed, in the specific situation, to achieve an effective integration of abstract and concrete, potential and actual (3).

It is well to emphasize that dialectical principles never by themselves provide any solution to concrete problems, afford no predictions. They describe only the most general determinations of processes or systems and cannot, of course, specify the outcome of any particular case. What the principle of the unity of opposites (forms 3, 4, 5 and 6) states is that in any system there is a unity of opposites of some kind appropriate to it, and that the specific interaction of the opposites determines the momentary character of the system, but also future states. The test of the principles, in this general form, would be: Does a change in the interrelation of the opposites bring about a change in the system? To revert to a previous example: Would the introduction of more specific and factual material into the union organizers' language, in place of purely abstract appeals and slogans, be apt to change the developing strike situation? Would a preponderance of one of the opposing forces change the system? Or finally, would the narrowing of the fringe of doubtful employees who are neither clearly in, nor out of the union, or neither clearly with nor against it, have any appreciable effect on the system? The

principle of the unity of opposites would enable you to predict that some change would result, but not what change.

The principle is therefore a standing invitation to acquire sufficient concrete knowledge to apply it successfully, to replace the variables of the general formula with concrete values. Hegel's whole philosophy is an insistence on this point, but it was Engels who gave the deeper materialist emphasis. It is clear that dialectic should not be compared to science, for it is not intended as a substitute for it, but as a framework for scientific inquiry. Its possible advantages are to be seen, rather, in comparison with the framework for inquiry provided by other philosophical traditions. What does the usual tradition of formal logic say? We have seen that it makes no provision for the fringe, and is obliged to overlook, for example, the mesoforms or intermediate forms which occur in the continuity of evolutionary development. And this tradition has also overemphasized the importance of propositions of the form *all A is B* and *at least one A is B,* usually ignoring the intermediate range of quantifiers which are practically most important. There has also been a strong tendency to restrict belief to certainty and outright rejection, as if the intermediate degrees of belief were not obviously the more significant. Along with this has gone the adulation of the syllogism, and a corresponding depreciation of the value of induction and concrete studies. The sterility of this logical tradition has been greatly remedied, but there is still much room for improvement. Other philosophical traditions have also laid down general principles of method. One emphasizes intuition; another, perception as the only test of truth; while still another insists that practice, without any commitment as to the nature of the world outside the laboratory, is a sufficient guide to inquiry. It is the obligation of the dialectician to demonstrate that his inductively grounded principles provide a better framework for inquiry than those of other schools. To do so, he would need to go far beyond the boundaries of this brief exploratory article, and in various directions. In particular, it would be necessary to exhibit the interrelation of the unity of opposites with other dialectical principles such as the transition from quantity to quality and the negation of negation.

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