Logical Contexts of the Raven Paradox

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An abiding interest in traditional logic has led me to think of how the Aristotelians might handle such modern tantalizers as the raven paradox, so when Professor Peter Hutcheson's paper, "Hempel and the Raven Paradox," sketched C. Hempel's treatment of the paradox in Vol. VII of this journal I decided to let his article suffice for the general problem of confirmation and confine this essay to developing modern and traditional logical contexts for the raven hypothesis.

Hempel provides part of the context for modern logic by expressing the hypothesis in the conditional sentence, S1: '(X)(Raven x > Black x)', and by noting that S1 is confirmed by three of the following observation reports: (1) *a* is a black raven, (2) *b* is a raven but not black, (3) *c* is black but not a raven, and (4) *d* is neither black nor a raven. The second report would disconfirm S1 if it were true; but by including it, reports (1) - (4) cover everything in the universe so completely that whatever fails to disconfirm the hyopthesis, confirms it. The sense of paradox is a direct result of this plethora of evidence. For example, Hempel asks us to focus on the fourth report in order to savor the absurdity that red pencils, yellow cows and the like are evidence that ravens are black. Even if we balk at this, he thinks that we must agree that the object *d satisfies* both antecedent and consequent of a second sentence, S2: '(X) (-Black x > -Raven x)' which is equivalent to the first sentence. And if an ***equivalence condition*** is allowed, viz., that whatever confirms or disconfirms a sentence does so for each equivalence of the sentence, then as *d* is the material evidence for S2 it must be the same for S1. But this use of the equivalence condition is somewhat idle because S1 and S2 really have no such need, since both are confirmed by the three reports through a third and far more significant equivalence: '(X) (-Raven x v Black x)'. This disjunction is disconfirmed, of course, by the second report (if true), but its left member is confirmed by (3) and (4) and its right by (1). Thus the positive and negative domains are subsumed under one universal by the principle of logical addition, something that the categorical universal, 'All ravens are black' can never do.

But this wealth of evidence has the undesirable consequence of confirming unwanted, often unreasonable hypotheses. Each report, e.g., confirms the antecedent and consequent of a statement and its converse. For instance, (4) confirms '(x) (-Raven > -Black x)' along with S2, and (1) confirms '(x) (Black x > Raven x)' as well as S1, etc. N. Goodman, W.V.O. Quine, H. Reichenbach and

others have cautioned against such excesses. Reichenbach, in particular, was keenly interested in finding an expression of scientific laws in the predicate calculus that is strictly in accord with our norms of rationality. It is in support of this thesis that the following table of oppositions for the simple predicate calculus is proposed.

i.	ii.	iii.	iv.
(x) (Fx > Gx)	(x) Fx > Gx)	(x) (-Fx > Gx)	(x) (-Fx > -Gx)
(Ex) (Fx.Gx)	(Ex) (Fx.-Gx)	(Ex) (-Fx.Gx)	(Ex) (-Fx.-Gx)
v.	vi.	vii.	viii.

Students of Reinchenbach will note immediately that v, vii, and viii are the "T-cases" of the nomological statement at i. It is also at these places that Hempel's observation sentences must be inserted. S1 belongs at i, its "contrary": '(x) (Raven x > -Black x)' at ii, and its contradictory--Hempel's second report--at vi. The hypothesis, '(x) (-Raven x > Black x)' and '(x) (-Raven x > -Black x)', complete the table at iii and iv. The diagonal lines indicate contradictories; hence S1 is the only hypothesis sentence that fails to be disconfirmed. Therefore the available evidence points to its truth. Moreover, S2 does not appear on the table, although it can be adventitiously inserted at iv. An inspection of the table will also show that the fundamental function of the observation reports is not so much that of confirmation as it is of disconfirmation, although they confirm as well as disconfirm. However, it is the combined disconfirmative power of each of the confirmative reports that allows the table in some poor measure to reflect the discriminative power displayed by scientific inquiry in hypothesis selection.

The exhaustive Aristotelian table of oppositions, instead of the normal "square of opposition," has the same overall structure as the table for the predicate calculus. It is presented here by using the accepted abbreviations for standard form categorical A, E. I, and O statements in which *non-S* and *non-P* are designated by *S'* and *P'*:

(a)	(b)	(c)	(d)
SaP	SaP'(=SeP)	S'aP	S'aP'(=S'eP)
SiP	SiP'(=SoP)	S'iP	S'iP'(=S'oP)
(e)	(d)	(e)	(g)

The table is shown as having two squares of opposition with the contraries and contradictories of SaP and S'aP appearing in their affirmative and negative forms. Aristotle makes a point of representing these oppositions as affirmations and denials, but since Hempel's observation reports (which appear on this table as particular statements) are affirmative, each table entry is also stated affirmatively. It is equally relevant to point out that each of the universals is contrary to two other universals, but logically indifferent to one of them. Thus 'All ravens are black' at (a) is contrary to 'All ravens are non-black' at (b) and to 'All non-ravens are black' at (f), is indifferent to 'Some non-ravens are black' at (g), is indifferent to 'Some ravens are black' as well as 'Some non-ravens are non-black' at (e) and (h).

Here of course the shoe is on the other foot, for we are asking the subaltern to confirm the superaltern. Aristotle would find nothing strange in this because he argues that it is from the welter of particulars that universals first take their stand; but their final scientific acceptance depends upon rational intuition. Brushing aside the metaphysical flavor that suggests itself there, what is argued is not so different from saying that any candidate for admission to the body of scientific laws must either rationally conform to the body, or its credentials must be so strong that the body must adjust to it.

The establishment of scientific universals is directly relevant to the raven paradox. The universals in question arise from experience, from observation and experiment. They express a subject-predicate relationship that corresponds with thing-attribute raltionships (when true). The establishment of the contrapositive form of the empirically originated universal is not itself an empirical matter. It comes from utilizing the most archaic form of the principle of division, the split between the differentiated and the undifferentiated. To discover the truth of 'All ravens are black' is an act of discriminative experience; but to accede to 'All non-black things are non-ravens' is to take a step back into the relatively undifferentiated. The only differentiation here is to note that the opaque mass of the non-black is "contained" within the equally indiscriminate mass of "non-ravenness." And this is the only "specific-ness" that the contrapositive can ever bring to bear on (a) in the Aristotelian table. 'Some cows are yellow' or 'Some icicles are translucent' thus reduce to (h) on the same table. The problem comes down to this: so far as *confirmation* is concerned, (a) is confirmed by reports of black ravens, whereas 'All non-black things are non-ravens' has no meaning apart from (a), no constant discriminativeness apart from what (a) can offer it, can itself never *confirm* (a), but only offer evidence that (a) has not (yet) been disconfirmed. But the failure to satisfy 'Some ravens are non-black' at (f) accomplishes the same end. So it appears that the chief contribution of 'Some non-ravens are non-black' to the table is to disconfirm (c).

Finally, there is at least one instance in which (a) can be false and its contrapositive can be true, and this is where S is empty and non-S, P and non-P are not. As Aristotle's truth rules might put it, 'All S are P' says falsely that *what is not* (S) *is* (non-S). Contradiction is avoided because non-S is now the universe class. The truth functional tautologies, '-p > (p > q)' insure the truth of S1 and S2 when the vacuity occurs in modern logic.

Perhaps the chief value, if any, of this study consists in showing that 'All ravens are black' at (a) differs from '(x) (Raven x > Black x)' at i. Hempel recognizes that (a) presupposes existence while i does not, but he interprets 'Every P

is a Q' to mean '(x) (-Px v Qx)'; i.e., whatever fails to disconfirm it, confirms it. Since (a) and i *can* differ in truth value and *do* differ in range of confirmation, this conflation can only enhance the sense of paradox in so far as the strictures of the categorical context are applied to the conditional statement. This is probably why logicians tend to use the disjunctive form when trying to "resolve" the paradox. But a categorical sentence is not disjunctive and does not tolerate "paradoxical" evidence, whereas the disjunction is built to take it. So if the distinction is maintained between (a) and i. maybe the paradox will not be.