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Robert J. Fogelin

Why Obey the Laws of Logic?¹

Robert J. Fogelin

A foolish consistency is the hobgoblin
of little minds, adored by little
statesman and philosophers and
divines. With consistency a great
soul has simply nothing to do.
Emerson, "Self Reliance"

Do I contradict myself?
Very well then I contradict myself
(I am large, I contain a multitude.)
Whitman, "Song of Myself"

The law of contradiction [tells us
that] the true world cannot contradict
itself, cannot change, cannot become,
has no beginning and end.
This is the greatest error that has
ever been committed.
Nietzsche, *Will to Power*²

Man is a rational animal.
Attributed to Aristotle

To the best of my knowledge (and to my surprise), Aristotle never actually says that man is a rational animal. However, he all but says it. Aristotle held that rationality is the feature that sets human beings apart from all other animals. By this he did not mean that human beings always or even usually think and act in rational ways. He knew better. Like other animals, human beings also possess desires and appetites, and these, if not properly managed by reason, can produce irrational beliefs and irrational ways of acting. Yet, for Aristotle, a rational life is the ideal life, and to the extent that we approximate such a life, just to that extent do we realize our distinctively human essence.

Aristotle's conception of rationality is complex and many-sided, but one of its central ideas is that thought, to be rational, must conform to the laws of logic. To take the primary instance of a violation of a law of logic, it is not rational to hold inconsistent or incompatible beliefs; for example, it is not rational to hold both that God is all-powerful and that God is not all-powerful. Doing so violates one of the fundamental principles of rationality: the *law of contradiction* or, as it is now more reasonably called, the law of *noncontradiction*. Traditionally, many philosophers (Aristotle among them) have considered

the law of noncontradiction to be the deepest, most fundamental, principle of rationality. To abandon that principle is to abandon reason itself and thus, if Aristotle is right, to abandon the very feature that sets human beings apart from all other animals.

Yet, as the three quotations presented above show, not everyone has treated the law of noncontradiction with respect. Both Emerson and Whitman refuse to be bound by it, and Nietzsche, in his usual over the top fashion, goes so far as to call it “the greatest error that has ever been committed.” These three figures are not alone in rejecting the law of noncontradiction. The voice of anti-rationalism can be found in fragments of some early Greek philosophers, and reappears two and a half millennia later in the writings of many contemporary post modernists. The status of the law of noncontradiction is the ultimate battleground on which the traditional forces of rationalism and anti-rationalism have met. This conflict is the topic of this essay.

First of all what is the law of noncontradiction? Stated accurately, if clumsily, it comes to this:

It is not the case that something is both the case and not the case.³

Here some elementary notation will bring out the underlying structure of the law of noncontradiction. If we let “ \sim ” mean “it is not the case that” and let “ $\&$ ” mean, as usual, “and,” then the law of noncontradiction has the following form:

$$\sim(p \ \& \ \sim p)$$

The claim is this: take any proposition you please, substitute it in both places for p , and you will always wind up with a proposition that is true. For example, if we let p equal *Lead is heavier than aluminum* (which it is), we get the truth:

(1) It is not the case that (both) lead is heavier than aluminum and lead is not heavier than aluminum.

This principle remains true even if we substitute something false for p , for example, if we let p equal *Aluminum is heavier than lead* (which it isn't), we get:

(2) It is not the case that (both) aluminum is heavier than lead and aluminum is not heavier than lead.

Since the truth of the proposition we substitute for p makes no difference to the truth of either (1) or (2), it should be clear that their truth does not depend in any way on the actual weight of these two metals. More generally, it doesn't matter *what* we are talking about when we insert propositions into this pattern: the principle holds as well for daffodils, numbers, and furniture as it does for metals. We thus have a principle that holds with perfect generality: The law of noncontradiction takes any proposition, whatever its subject matter, whether it is true or false, and generates from it a proposition that is always true. Those who think that there are no certainties, wrong, for here we have a recipe for generating endlessly many certainties.

Explaining the law of noncontradiction this way may make it seem altogether trivial. Someone might wonder what all the fuss is about since it is just obvious that every statement having the form of the law of noncontradiction will have to be true. That's absolutely right! Noting this triviality, however, has the following important consequence: If you violate the law of noncontradiction

by asserting something of the form *it is the case that p and also the case that not p* you have said something trivially (obviously, boringly, stupidly) false. Looked at this way, ultra-irrationalism turns out to be tedious.

If this is correct, how do we explain the urge found among many historically important figures to reject the law of noncontradiction and find it of fundamental importance to do so? The answer, I think, is that the status of the law of noncontradiction has been persistently misunderstood. Instead of being seen as true, but trivial, it is taken as being profoundly significant, but false. The road to misunderstanding is paved by stating the law of noncontradiction in a more robust way, for example:

A fact cannot both exist and not exist (or obtain and not obtain).

Or as Aristotle put it:

The same attribute cannot at the same time belong and not belong to the same subject in the same respect.⁴

Stated in these ways, with its reference to *facts* or *attributes*, the law of noncontradiction seems to place constraints on the form that *reality itself* can take. Expressed this way, the law of noncontradiction seems to preclude certain possibilities and to do so in the strongest possible way. This can suggest that the law of noncontradiction, far from being a triviality, is the most fundamental, the most encompassing, and the most constraining law of all. The law of noncontradiction now appears to be a super law governing reality in its most fundamental aspects. As Aristotle put it, this principle is true of “being qua being.”⁵

This way of interpreting the law of noncontradiction is, I believe, altogether natural and also altogether mistaken. It is the result of a deeply misleading picture that can naturally force itself on us—a picture of various laws operating at various levels of constraint.⁶ At the lowest level of constraint, so the story goes, there are human laws or human ordinances. Being commands, these laws can be broken, though it is often considered wrong to do so, and you may be punished if caught. Above these laws in degree of constraint are physical laws, e.g., the law of gravity. Unlike human laws, these laws cannot be broken—except, perhaps, if God rescinds them in order to produce a miracle. But even if physical laws cannot be broken, they are still, as it is said, *contingent* laws. The universe is *in fact* governed by certain physical laws, but it might have been governed by other physical laws or, perhaps, been governed by no physical laws at all. It is this feature of contingency that supposedly sets physical laws below logical laws in stringency: Logical laws govern the world not contingently, but, as it is said, *necessarily*.

Perhaps we can now see why people are sometimes inclined to reject the law of noncontradiction: They think that the law of noncontradiction is tied to the picture of laws just sketched, and they refuse to believe that the world conforms to this picture. One reason, perhaps the chief reason, they reject the picture is that they hold that a world governed by the strict unchangeable laws of logic leaves no place for change (creativity, agency, action, progress, fun). For symbolic purposes, I will call those who adopt this position Heracleitians.

⁷ Heracleitians hold that radical change, not unalterable logical structure, is the fundamental characteristic of reality. For Heracleitians, nothing is stable and unchanging. Granted, certain things may *seem* stable, but, down deep, all is flux. You cannot step into the same river twice—maybe not even once.

Here, then, is a reason for rejecting the law of noncontradiction: the law of noncontradiction, it is thought, is incompatible with real change, but change is real—indeed, it represents the most fundamental aspect of reality. If this is right, then the law of noncontradiction misrepresents the world in its most fundamental aspects.⁸ More than two thousand years later Nietzsche, who in various places praises Heracleitus,⁹ adopted the Heracleitean view of the world, tying it explicitly to a rejection of the law of noncontradiction. This is the point of the passage cited at the head of this essay:

The law of contradiction [tells us that] the true world cannot contradict itself, cannot change, cannot become, has no beginning and end.

Opposed to the Heracleiteans are those who accept this picture of the law of noncontradiction as a super law and then, reasoning in the reverse direction, conclude that change is impossible. I will take Parmenides as the symbolic representative of this standpoint.¹⁰ The Parmenideans held that the real, or at least the really real, is rational and, for that reason, immutable. This supposed connection between rationality, reality and immutability is a persistent feature of western philosophy. Calling something immutable is still a laudatory thing to say about it. The Judeo-Christian God is said to be immutable. (The Greek Gods were not immutable nor are the Hindu Gods—that is why they are more entertaining.) Some still seek immutable truths as the grounds for ethics and forms of government. Unlike the Rolling Stones (paradigmatic Heracleiteans), many people are made uncomfortable with the like of Ruby Tuesday who “changed with every new day.”

It is, I think, possible to read the history of philosophy as a series of conflicts and accommodations between the Parmenidean vision and the Heracleitean vision. At the moment, Heracleitus seems to be getting more press than Parmenides—at least among advanced thinkers. Historically, Parmenides has fared better. Fashions change. It is important, however, to see that, despite their deep differences, these primal opponents share a fundamental dogma:

If the law of noncontradiction is true, then change (real change) is not possible.

Anyone who accepts this conditional will be forced to choose between the law of noncontradiction and the reality of change. Opting for the law of noncontradiction, the Parmenideans reject change. Opting for change, the Heracleiteans reject the law of noncontradiction. Notice, by the way, that both views share equally in the charm of being utterly outrageous. Contrary to what Parmenides’ student Zeno says, Achilles can catch the tortoise. Contrary to Heracleitus, you can step in the same river twice—three or four times, if you like. Somehow, such plain facts get demoted to apparent facts, and then dismissed altogether.

My suggestion, then, is that the perennial dispute between the Heracleiteans

and the Parmenideans is driven by the shared view that the law of noncontradiction is incompatible with change. How are we to break the spell of this idea? As noted, this cannot be done by citing plain facts. Running will not move a Parmenidean; standing still will not stop a Heracleitean. Instead it has to be shown that the analogy between physical laws and logical laws (as super-physical laws) is wholly misguided. This will be our next topic.

We can now go more deeply into the law of noncontradiction which, as we saw, correctly stated, has the following form:

It is not the case that it is both the case that p and not the case that p .

Or, symbolically:

$\sim(p \ \& \ \sim p)$

This expression, as we saw, provides a pattern or schema for endlessly many propositions all of which turn out to be true for whatever proposition we substitute for the variable p . Since, as we saw, the content of p can vary endlessly without affecting the truth of the resulting statement, it seems reasonable to suppose that the work of guaranteeing the truth of propositions that conform to this pattern must be done by the two words that do not vary, namely the words “and” and “not.” But what do these words *mean*—what do they *stand for*? Early in the twentieth century, Ludwig Wittgenstein had the remarkable idea that these words, though meaningful, do not stand for anything at all. They do not stand for anything in the world or in the mind or anywhere else. They are non-referring terms.

The idea that the meaning of a word is the thing that it stands for is so deeply ingrained that it strikes many people as simply obvious that a word that does not stand for or represent something must be a dead symbol—a mere mark on paper—hence meaningless.¹¹ However deeply ingrained or natural this view might seem, Wittgenstein came to think that it was a prejudice—a prejudice that has been the source of endless confusion. In effect, Wittgenstein arrived at this result by setting aside the question, “What do words like “and” and “not” stand for?” and asking a better question: “How do these terms contribute to the meaning of the total sentences in which they occur?”

We can start with “not”—negation. We can become utterly baffled if we ask what this word stands for. Does it stand for *nothing*, *nothingness*, *non-being*? If so, what sorts of things are they? Does nothing really exist, and if it does exist, is it really nothing? Questions of this kind can sound deep or silly depending on your philosophical mood or temperament. The air clears at once if we set aside the question, what does this word stand for, and ask quite a different kind of question:

Starting with some proposition p , what happens if we construct its denial using the word “not”?

The negation of a proposition can be constructed in a variety of ways, for example, by putting the word “not” in the appropriate place in front of its main verb. If you want to sound like a logician, you can put the expression “It is not the case” in front of the whole sentence. There are other ways of negating a

sentence as well, but, however negation is achieved, we get the following result:

If a proposition is true, then the proposition that results from negating it is false, and if a proposition is false, then the proposition that results from negating it is true.

Wittgenstein captured this idea by introducing what came to be known as a *truth-table* definition of negation. Using the symbol for negation introduced earlier, the truth-table definition looks like this:

p	~p
T	F
F	T

It is important to see that nothing esoteric (or sly) is going on here. The left-hand column indicates the two truth-values that a proposition can have: It can be true or it can be false. The second column indicates what happens when a proposition is negated, i.e., when its truth-value is reversed. Negation, we might say, is a truth-value flip-flopper. Why should we have such a word in our language? Well, among other things, it provides a convenient way of expressing denials.

If we now ask what gives negation the power to reverse truth-values in this way, Wittgenstein (in effect) says that the question is ill-conceived. For him, the meaning of the word “not” consists in its capacity to reverse truth-values. This is its job—hence its meaning—in our language.¹² It took the insight of a genius to see that the definition of negation should take this form, for this truth-table definition looks nothing like the definitions we commonly offer for nouns, verbs, and so on. This difference in form reflects the special role that logical words play in our language.¹³

Having given a truth-table definition of negation, we can turn next to conjunction. A conjunction of two propositions is true just in case both of the conjoined propositions are true, false otherwise. Thus, the truth-table definition of conjunction looks like this:

p	q	p & q
T	T	T
T	F	F
F	T	F
F	F	F

Again, the novelty of this definition does not lie in the particular values we have assigned to conjunction in this truth table—that should seem trivial. (“Of course, a conjunction is false if at least one of its conjuncts is false; you don’t need a logician to tell you that.”) The importance lies in taking this truth table as a *definition* of conjunction.

Having given truth-table definitions of negation and conjunction, we are now in a position to look at the law of noncontradiction with new (let’s hope scale-free) eyes. Specifically, we are now in a position to address the question, “What makes the law of noncontradiction true?” or “In virtue of what is it true?” The appropriate truth table for the law of noncontradiction looks like this:

A	B	C	D
p	$\sim p$	$p \ \& \ \sim p$	$\sim(p \ \& \ \sim p)$
T	F	F	T
F	T	F	T

Again, nothing esoteric is going on. Moving through three stages, we have constructed a truth table for the law of noncontradiction. Column A gives the two possible truth values for p . In column B, we have constructed $\sim p$ by reversing truth-values of p . In column C we have conjoined p and $\sim p$. Given the truth-table definition of conjunction, we know that this conjunction has to be false no matter what truth-value is assigned to p . (Thus, in column C, we have constructed the pattern for an explicit self-contradiction.) In column D we have simply negated the formula in column C, thereby producing the pattern for the law of noncontradiction. Given the truth table for negation, the result is that the truth-values under column C are reversed—where originally they were all false, they are now all true.

We now have something quite simple to say to the Heraclitean who finds nothing wrong in affirming an explicit contradiction. As column C indicates, whatever the subject matter of his remark, he must be saying something false. To think otherwise is to suffer from a curious form of linguistic amnesia concerning the meaning of the words “not” and “and.”¹⁴ But even if this embarrasses the Heraclitean, it gives little aid or comfort to the Parmenidean, for now the law of noncontradiction (represented in column D) emerges as a barren tautology—a purely empty or formal truth. To vary one of Wittgenstein’s examples, to be told that it is not the case that it is both raining and not raining is not to be told anything about the weather—or about anything else.

If this account is correct, then the picture of the law of noncontradiction as a super law of reality has been undermined. The law of noncontradiction, rather than placing ultimate constraints on reality, places *no* constraints on reality at all. Furthermore, we now see that the view *shared* by the Heracliteans and the Parmenideans, *that change is incompatible with the law of noncontradiction*, rests on a misunderstanding. The Heraclitean is wrong in thinking that we must deny the law of noncontradiction in order to affirm the existence of change. The Parmenidean is wrong in thinking that we must deny the existence of change in order to preserve the law of noncontradiction. They are both wrong and wrong for the same reason. They share the view that change and the law of noncontradiction are incompatible when, in fact, the law of noncontradiction has no bearing on the possibility of change one way or the other.

It’s time to slow down, for it may now seem that we have managed to do something that Aristotle (in agreement with a great many other philosophers) thought could not be done, namely, we seem to have *proved* or *demonstrated* the truth of the law of noncontradiction. Since the law of noncontradiction lies at the basis of all demonstration, it was not, Aristotle thought, capable of demonstration.¹⁵ I think that Aristotle is fundamentally right in this. Though truth-table definitions may help us *understand* the status of the law

of noncontradiction, they cannot be used to prove it. The difficulty is this: In constructing these truth-table definitions, we seem to be taking the law of noncontradiction (or something very close to it) for granted. To see the problem, we can look again at the truth table for negation:

P	~P
T	F
F	T

But why not add a third possibility, namely that p might be both true and false:

P	~P
T	F
F	T
T-F	?

It may seem obvious that this new third row does not represent a genuine possibility, but it seems that any attempt to establish this impossibility will itself rely on the law of noncontradiction, the very thing we are trying to prove. So it seems that any attempt to prove the law of noncontradiction using truth-table definitions will presuppose the law of non-contradiction and, in that sense, be circular. This result may seem unsettling, for it may now seem that we have to accept the law of noncontradiction simply as a matter of faith. If so, it is not clear how we are to deal with people (like Emerson, Whitman, Nietzsche, *et al.*) who place their faith elsewhere.

Here, however, Aristotle comes to our rescue. Though he denied the possibility of giving a positive proof or demonstration of the law of noncontradiction, he suggested that the law of noncontradiction could be demonstrated “negatively.”¹⁶ This negative mode of demonstration proceeds as follows: Confronted with someone who wishes to reject the law of noncontradiction, we simply wait for that person to either assert or deny something, and then ask whether it makes any difference whether we interpret the remark as an assertion or a denial. If the person rejects the law of noncontradiction, it is hard to see why it should make a difference one way or the other. In effect, he is granting us the following permission:

“In interpreting what I say, you may add the phrase ‘It is not the case that’ to the front of any sentence I utter. Do this as you please, for it will in no way alter the significance of my discourse.”

One who denies the law of noncontradiction might also announce the following hermeneutical principle that he uses in interpreting the utterances of others:

“In interpreting the discourse of others, I randomly put the phrase ‘It is not the case that’ at the front of sentences that I am interpreting. Given the kind of interpretation I am engaged in, this in no way affects its significance.”

Has anyone ever accepted such mad principles of interpretation? Well, some mystics sometimes seem to. Some mystics seem to hold that the attributes of God so transcend human comprehension that it is a matter of indifference whether we apply humanly intelligible properties to him/her or not. But even mystics usually have the good sense to restrict these views to the mystical—which, they think, transcends all forms of discourse. Most people, even those

who espouse extreme post-modern views, actually reject these wild principles of interpretation—at least, when not presenting papers at conferences.

I can illustrate this last point anecdotally. I once found myself in a room of advanced thinkers where I was the sole person with a good word to say about the law of noncontradiction. As a result, I was subjected to a great deal of ridicule and abuse. I tried to explain to this audience—as I tried to explain above—that in rejecting the law of noncontradiction, they were, in all likelihood, not rejecting the law itself, but, instead, were rejecting a false picture that they mistakenly associated with it. They would have none of this—hell-bent on performing a slam-dunk against logo-phallic-western rationalism, they would accept no such temporizing compromise. In exasperation I finally employed what is called an impolite or vulgar *ad hominem*. I asked whether the organizers of the conference were applying for future funding from the National Endowment for the Humanities. When someone indicated that they were, I asked whether it would make any difference whether the answer to their request was No rather than Yes, and, if so, why? Not surprisingly, this produced a reaction of rage.

What is the point of all this? After all, people do not actually adopt the wild principles of interpretation I have laid out, even if they sometimes speak in ways that suggest that they do. If they don't really adopt them, we want to know why not. If we accept the law of noncontradiction, we then have straightforward reasons for rejecting these wild principles of interpretation. On the other hand, if we reject the law of noncontradiction—that is, really reject it, not just pretend to reject it—it is hard to think of any reason for not engaging in anything-goes interpretations in this perfectly mad way. As Aristotle saw, this does not amount to a proof of the law of noncontradiction. It merely shows that people who reject the law of noncontradiction obliterate any significant difference between the speech acts of asserting and denying. In denying the law of noncontradiction, they deprive themselves of the significant use of their own speech acts. For this reason, on their own terms, they have no claim to be listened to.¹⁷ Sincere, they are self-silencers. This is Aristotle's "negative demonstration" of the law of noncontradiction in somewhat modern guise. None of this will move anyone who genuinely opts either for silence or for madness. Since I opt for neither, I find Aristotle's negative demonstration of the law of noncontradiction entirely persuasive.¹⁸

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- 1 With a few stylistic changes, this is the text of a public lecture that I presented on December 4, 2001 at the Center for Philosophical Exchange at the State University of New York, College at Brockport.
- 2 Friedrich Nietzsche, , #584
- 3 The traditional Big Three of fundamental laws of logic is completed by two others: The Law of Identity. (Everything is identical with itself.)
The Law of Excluded Middle. (Something is either the case or not the case.)
Except for some asides, I will not consider these laws, but concentrate on the law of noncontradiction.
- 4 Aristotle, , IV, 3, 1005b19-20.
- 5 , IV, 3, 1005a24-25.
- 6 The notion that a false or even nonsensical philosophical conception can force itself upon us through our tendency to adopt a faulty picture of how our language functions is a one of Ludwig Wittgenstein's leading ideas. Reflecting on mistakes found in his own earlier writings, he remarks:
A picture held us captive. And we could not get outside it, for it lay in our language and language seemed to repeat it to us inexorably. (Philosophical Investigations, #115)
In this essay I am trying to describe, or at least sketch, the picture that leads people to misunderstand the status of the law of noncontradiction.
- 7 Heraclitus of Ephesus, an early Presocratic (c. 500 BC), is famous for employing the metaphor that the world is composed of fire.
- 8 Some classical scholars deny that Heraclitus rejected the law of non-contradiction. But Aristotle thought that he did, as did other ancient commentators. In any case, even if Heraclitus will not serve our symbolic purposes, his follower Cratylus, who outdid his master by saying that one cannot step in the same river even once, will. According to Aristotle, Cratylus was so deeply committed to the doctrine of endless change or universal flux, that he thought it impossible to assert anything at all, holding, as he did, that the meanings of the words at the beginning of a sentence would change before the sentence was completed. Cratylus, again according to Aristotle, was thus reduced to pointing his finger at things as they passed. (See , IV, 5,1009a7-16.)
- 9 For example, , , p. 480.
- 10 Parmenides of Elea (c. 480 BC).
- 11 There is, of course, something right about this claim that meaningful symbols are more than marks on paper or vibrations in air. What is wrong is the assumption that all words get their meanings essentially in the same way that names seem to—by referring to or standing for something.
- 12 In equating the meaning of an expression with the job it performs, some may think that I am attributing a view to Wittgenstein's early writings that is only found in his later writings. This is wrong. Wittgenstein's initial break with a purely referential conception of language occurs first in the with respect to logical terms and numbers. In his later writings, Wittgenstein expands this attack on the referential conception of language, with the result that much of the itself is rejected root and branch. I discuss these matters in Fogelin (1987) and Fogelin (1996).

- 13 Unfortunately, when writers of logic texts introduce truth-table definitions, they rarely comment on their deep philosophical significance.
- 14 Willard Quine put it this way: “[To] affirm a compound of the form ‘and not is just to have mislearned one or both [of these] particles. , p.23.
- 15 , IV, 3,1006a5-11.
- 16 , IV, 4, 1006a12-28.
- 17 Not only will the contrast between asserting and denying be undercut, but a whole range of other speech acts will be compromised as well, for example, promising to do something as opposed to promising not to, asking someone to do something as opposed to asking him not to, and so on through a very wide range of different types of speech acts.
- 18 I recently found a variation on Aristotle’s negative demonstration of the laws of logic in Daniel Dennett’s *Darwin’s Dangerous Idea*. Confronted with a theologian who holds that “faith is quite beyond reason,” Dennett suggests the following rejoinder:

The philosopher Ronald de Sousa once memorably described philosophical theology as “intellectual tennis without a net” and I readily allow that I have indeed been assuming without comment or question ... that the net of rational judgment was up. But we can lower it if you really want to. It’s your serve. Whatever you serve, suppose I return service rudely as follows: “What you say implies that God is a ham sandwich wrapped in tinfoil. That’s not much of a God to worship.” If you then volley back, demanding to know how I can logically justify my claim that your serve has such a preposterous implication, I will reply: “Oh, do you want the net up for returns, but not for your serves? Either the net stays up or it stays down. If the net is down, then there are no rules and anybody can say anything, a mug’s game if there ever was one. I have been giving you the benefit of the assumption that you would not waste your own time or mine by playing with the net down.” (Darwin’s *Dangerous Idea*, p.154)

This doesn’t, of course, refute the theologian’s claim, for various responses are open to him. There is the Zen move: “Is God a ham sandwich wrapped in tinfoil? Yes. We can say that too.” And our fideistic theologian may take absolute delight in the thought that we have to play with the net up, whereas he doesn’t. Such theologians and many so-called post-modern thinkers exist quite beyond the reach of intellectual embarrassment, except, that is, when their position carries with it personal disadvantages. It is for this reason that I prefer the cruder version of an ad hominem attack of the kind given above.

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