

The Logica Yearbook
2011

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2011

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and
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Preface

Since 1997 participants in the Logica symposia have had the opportunity of publishing their contributions in The Logica Yearbook series. Last year was no exception and so we have the pleasure of introducing the latest volume of the proceedings which contains most of the papers presented at Logica 2011.

The international symposium Logica has a long and rich tradition and, in this respect, last year was very special because we were celebrating an important anniversary. Logica 2011 was the 25th event in the series of conferences annually held in the Czech Republic.

Logica 2011, held at Hejnice Monastery (North Bohemia) from 20th to 24th June 2011, was organized by the Department of Logic in the Institute of Philosophy of the Academy of Sciences of the Czech Republic. As every year, the symposium brought together logicians from the whole world and besides the invited talks (invited speakers were Edwin Mares, Pavel Materna, Krister Segerberg and Gila Sher) about thirty other papers devoted to the various branches of logic were presented.

Both the Logica symposium and The Logica Yearbook are the result of the joint effort of many people who deserve our warmest thanks. We thank Vladimír Svoboda, the head of the Organizing Committee of Logica 2011. We are very grateful to the Institute of Philosophy and especially its director, Pavel Baran, for all their support. We would like to thank College Publications and its managing director Jane Spurr. We greatly appreciate the hard work of Karel Chvalovský, the typesetter of this volume. Special thanks go to Petra Ivaničová who provided invaluable assistance to the organizers of the conference.

We are also very grateful to the staff of Hejnice Monastery and to Bernard Family Brewery of Humpolec which has traditionally sponsored the social programme of the symposium. Neither the publication of this volume, nor the conference Logica 2011 itself would be possible without the Grant Agency of the Czech Republic which provided significant support by financing the grant project no. 401/04/0117.

Last, but not least, we would like to thank all the authors for their exemplary collaboration during the editorial process.

Prague, May 2012

Michal Peliš and Vít Punčochář

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On Dialetheic Entailment

Massimiliano Carrara Enrico Martino
Vittorio Morato

Abstract

The entailment connective is introduced by Priest (2006b). It aims to capture, in a dialetheically acceptable way, the informal notion of logical consequence. This connective does not “fall foul” of Curry’s Paradox by invalidating an inference rule called “Absorption” (or “Contraction”) and the classical logical theorem called “Assertion”. In this paper we show that the semantics of entailment, given by Priest in terms of possible worlds, is inadequate. In particular, we will argue that Priest’s counterexamples to Absorption and Assertion use in the meta-language a dialetheically unacceptable principle. Furthermore, we show that the rejection of Assertion undermines Priest’s claim that the entailment connective expresses the notion of logical consequence.

Keywords: dialetheism, entailment, possible world semantics, Curry’s paradox

1 Introduction

In *In contradiction* (2006b), G. Priest has introduced a new connective aimed to capture, in a dialetheically acceptable way, the informal notion of *entailment* or *logical consequence*.

According to Priest, any dialetheically acceptable connective for entailment must, at least, have the following two features:

- it must validate MPP;
- it must not “fall foul” of Curry’s Paradox.

An entailment connective must obey MPP because, according to Priest, it is the very meaning of the word “entailment” or “implication” to require it. It is then *analytically* true of any kind of genuine conditional that it should satisfy such a rule. “Any conditional worth its salt should satisfy the *modus ponens* principle”, Priest writes. According to Priest, the classical material conditional \rightarrow (or any conditional built on its basis, such as the strict implication, for example) cannot be used to capture the informal notion of entailment, at least in a dialethic logical context. Priest holds that the material conditional is not *genuine*. In the logical framework of Priest (1979), where the material conditional was used, MPP was labelled a *quasi-valid rule*, a rule that is valid provided that all truth-values involved are classical (i.e., solely true or solely false).

An entailment connective must not “fall foul” of Curry’s Paradox, because from Curry’s Paradox follows *trivialism*, i.e., the thesis that every formula is true, and trivialism is to be avoided by the dialetheist.

Curry’s paradox can be proved using self-reference devices, T-schemas, MPP, conditional proof and an inference rule called “absorption” or “contraction”:

$$\text{ABS} \frac{\phi \rightarrow (\phi \rightarrow \psi)}{\phi \rightarrow \psi}$$

A dialethic logic with entailment can avoid Curry’s paradox, and thus trivialism, by invalidating ABS. This is in fact the strategy chosen by Priest.

It is to be noted, however, that there are other, quite standard, formulations of Curry’s paradox that do not rely explicitly (i.e., at the level of the object language) on ABS. In some formulations, they rely on another related principle called “assertion” or even “pseudo *modus ponens*”:

$$(\text{Assertion}) \quad \phi \wedge (\phi \rightarrow \psi) \rightarrow \psi$$

As we will see, formulations of Curry’s paradox with (Assertion) are blocked in Priest’s approach in the same way in which formulations with ABS are blocked.

Formulations of Curry’s paradox that do not rely on ABS at the level of the object language, however, typically make an appeal to

such a rule at the level of the meta-language; in such cases, ABS is a *structural rule* governing the consequence relation.¹

In Carrara, Gaio, and Martino (2010), criticisms to the entailment connective were done in the larger framework of criticizing the various attempts made by Priest to avoid trivialism generated by Curry's Paradox.

This article is a sequel of that work and will be squarely devoted to dialetheic entailment and its problems.

We are going to show that there is a tension between the logical rules used in the object language and those used in the meta-language.

2 The semantics of entailment

The characteristic feature of the entailment connective, that we will indicate from now on with the symbol \Rightarrow , is that of being a *modal* connective: its truth-conditions are in fact given in terms of a quantification over a set of possible worlds. Having a modal force is what distinguishes \Rightarrow from the material conditional of classical logic. The modal force of \Rightarrow , however, is quite different from the force of other well-known modal conditionals, such as the strict conditional, or even the counterfactual conditional. Both conditionals, in fact, validate ABS and (Assertion).

An interpretation I for a language \mathcal{L} with \Rightarrow is given by a quadruple $\langle W, R, G, v \rangle$, where W is, as usual, an arbitrary set of objects ("possible worlds"), R is a dyadic relation between members of W ("the accessibility relation"), G is a designated member of W ("the actual world") and v a valuation function that assigns to each propositional atom and world w a non-empty subset of $\{0, 1\}$, where 1 is the value "true", 0 is the value "false".

The semantic clauses that define the truth-conditions for a formula like $\phi \Rightarrow \psi$ are the following:

$\phi \Rightarrow \psi$ is true in w if, and only if, for every world w' such that $R(w, w')$, if $1 \in v_{w'}(\phi)$, then $1 \in v_{w'}(\psi)$ and if $0 \in v_{w'}(\psi)$, then $0 \in v_{w'}(\phi)$

$\phi \Rightarrow \psi$ is then true in a world w if and only if, for every world w' accessible from w , if ϕ is true in w' , so is ψ and if ψ is false in w' , so

¹Cfr. Beall and Murzi (in press).

is ϕ . From the clause above, it follows that a formula like $\phi \Rightarrow \psi$ is false at a world w if and only if there is at least one accessible world w' such that in w' ϕ is solely true and ψ is false or ϕ is true and ψ is solely false.

The definitions, respectively, of *semantic consequence* and *logical truth* are the following:

(SC) $\Gamma \models \alpha$ if and only if for all I , if, for every $\beta \in \Gamma$, $1 \in v_G(\beta)$, then $1 \in v_G(\alpha)$

(LC) $\models \alpha$ if and only if, for every I , $1 \in v_G(\alpha)$.

Note that the definitions of logical truth as truth in each actual world of every interpretation and of logical consequence as truth preservation in every actual world of every interpretation are in accordance with the standard Kripkean definitions of logical truth and of semantic consequence.

Counterexamples to ABS are obtained, as we will see, by means of interpretations with the following two features:

- G is *omniscient*: for every $w \in W$, $R(G, w)$
- R is non-reflexive: there is at least one $w \in W$ such that $\neg R(w, w)$

The omniscience of G means that G “sees” all other possible worlds; this implies that, for G , it holds that $R(G, G)$.

These kind of interpretations invalidate ABS. To prove that ABS is not a valid inference rule we must show that $\phi \Rightarrow \psi$ is not a semantic consequence of $\phi \Rightarrow (\phi \Rightarrow \psi)$. To do this, we have to show that there is at least one interpretation I such that $\phi \Rightarrow (\phi \Rightarrow \psi)$ is true at the actual world, while $\phi \Rightarrow \psi$ is false. Consider the following interpretation:

- $W = \{G, w\}$
- $R(G, w), \neg R(w, w), R(G, G), R(w, G)$
- $v_G(\phi) = v_G(\psi) = v_w(\phi) = \{1\}, v_w(\psi) = \{0\}$

In such an interpretation, $v_G(\phi \Rightarrow (\phi \Rightarrow \psi)) = \{1\}$: since ϕ and ψ are true at G , the unique world accessible from w , $\phi \Rightarrow \psi$ is true in w . So

in every world accessible from G , namely G and w , if ϕ is true, then $\phi \Rightarrow \psi$ is true.

In such an interpretation, however, $v_G(\phi \Rightarrow \psi) = \{0\}$, because there exists at least one world accessible from G (namely, w) where ϕ is true and ψ is false. Note that the use of $=$ instead of \in for the evaluation function v signals that in such interpretation no dialetheia is involved. Counterexamples to ABS then have nothing to do with dialetheiae.

The very same interpretation can be used to show that (Assertion) is not valid. (Assertion) is invalid if, in some actual world, $\phi \wedge (\phi \Rightarrow \psi) \Rightarrow \psi$ is false in it. In the interpretation presented above, $v_G(\phi \wedge (\phi \Rightarrow \psi) \Rightarrow \psi) = \{0\}$, because there is at least one world accessible from G , namely w , where $v_w(\phi \wedge (\phi \Rightarrow \psi)) = \{1\}$ and $v_w(\psi) = \{0\}$.

The non-reflexivity of R and the omniscience of the actual worlds are essential for Priest's purposes. On the one hand, as we have just seen, if the R of the interpretations for \Rightarrow were reflexive, ABS and (Assertion) would be valid. If, on the other hand, some G s were not reflexive, then MPP would fail for \Rightarrow . Remind that failure of MPP for \Rightarrow means that there is some actual world where ϕ and $\phi \Rightarrow \psi$ are true and ψ is false. Consider the following interpretation:

- $W = \{G, w\}$
- $\neg R(G, G), R(G, w), R(w, G), R(w, w)$
- $v_G(\phi) = v_w(\phi) = v_w(\psi) = \{1\}, v_G(\psi) = \{0\}$

In this interpretation ψ is false in G , but ϕ and $\phi \Rightarrow \psi$ are true in G ; in particular, $\phi \Rightarrow \psi$ is true in G because it is true in every world accessible to G , namely w .

The failure of (Assertion) shows that Priest's entailment fails to express logical consequence: while ψ is a semantic consequence of $\phi \wedge (\phi \Rightarrow \psi)$, this conjunction does not entail ψ .

The countermodels to ABS might be used to reveal other interesting characteristics of the language containing \Rightarrow and, in particular, its interactions with the necessity operator \Box .

The fact that there is a non necessary formula where \Rightarrow is the main connective, means that there is some formula that "logically follows" from another formula, but such that does not necessarily follows from it. This separation of logical necessity from logical consequence might

be taken as undesirable: it is quite strange that α logically follows from β , but only contingently.

The contingency of entailment has consequences at the level of rules. As we already know, MPP is a valid rule in the logic of \Rightarrow . That MPP is a valid rule means that ψ is a semantic consequence of ϕ and $\phi \Rightarrow \psi$ and this means that in every actual world of every interpretation if $1 \in v_G(\phi)$ and $1 \in v_G(\phi \Rightarrow \psi)$, then $1 \in v_G(\psi)$. As our countermodel to ABS reveals, however, MPP “fails” in w , where $1 \in v_w(\phi)$ and $1 \in v_w(\phi \Rightarrow \psi)$ but $1 \notin v_w(\psi)$.

“Failure” of MPP in at least one non-actual world could be interpreted in two ways: on the one hand—and this would be perfectly compatible with the spirit of dialetheism—it could be taken as showing that non-actual possible worlds are deviant worlds; on the other hand—and we think that this is more problematic, even for the dialetheist—that *we*, from the standpoint of the actual world, are not able to reason about those worlds with our standard logical rules.

3 The philosophical justification of non-reflexivity and omniscience

What Priest aims to do in *In contradiction* is to give also a philosophical justification of omniscience and non-reflexivity. His views are revealed by this passage:

Now, how do we know that all the “possible worlds” in an interpretation are conceivable by people living under those conditions of G ? Simply because we are those people (by definition), and we conceive them. It is we who are theorizing, specifying what interpretations are, and we who can spell out any particular [assignment]. If we were to live under a different set of conditions, however, there would be no guarantee that we would be able to think all of this. Indeed, had we not evolved, we might have been maladapted to our environment, and might not even, therefore, have been able to conceive properly of the conditions under which we actually lived. G is omniscient, but there is no reason, therefore, why any other world should be omniscient or even reflexive. (Priest, 2006b, p. 87)

From this quoted passage we can extract the main motivations Priest uses to philosophically justify omniscience and non-reflexivity:

Omniscience of G : G is omniscient because the totality of possible worlds accessible from the actual world of an interpretation is the totality of the possible worlds conceivable by the inhabitants of G .

As we have seen, from the omniscience of G follows the reflexivity of G that Priest justifies in this way:

Reflexivity of G : G is accessible from itself because the inhabitants of G are “adapted” to their actual conditions and therefore they are able to conceive/represent them.

Finally, there is the non-reflexivity of some non-actual worlds from which it naturally follows their non-omniscience (if a non-actual world were omniscient, it would be accessible from itself).

Non-reflexivity and non-omniscience of non-actual worlds: We cannot grant inhabitants of other possible worlds the ability to conceive all possible worlds and even the ability to conceive their own situation.

There are various aspects of this philosophical picture that are problematic. We are going to mention just a few of them.

Against Omniscience, for example, it could be argued that it is generally assumed, in contemporary debates about the relations about conceivability and metaphysical possibility, that conceivability/possibility links fails in both directions;² it cannot then be assumed, or at least it cannot be assumed without argument, that a world is possible if and only if it is conceivable. We might not be able to conceive metaphysically or logically possible worlds that are accessible and thus relevant for the evaluation of sentences containing the entailment connective.

Furthermore, if omniscience of G is explained, as Priest does, via conceivability, there seems to be a clash between omniscience and non-reflexivity. Conceivability-based accounts of omniscience in fact seems to presuppose unrestricted reflexivity. Something is conceivable if it

²Cf. Gendler and Hawthorne (2002).

is conceived by us in an alternative (epistemic) situation. But to conceive something in an alternative situation we need to have access to this alternative situation. To know that we are conceiving something in another possible world (and therefore to know that something is conceivable by us in the actual world) we need to have access to the world in which we are conceiving. It could be denied that the reflexivity of a world has to be understood in terms of the capacity of its inhabitants to access this world; the quotation above reveals, however, that this is exactly what Priest had in mind.

Against non-reflexivity it could be argued that it does not fit well with the very nature of modal reasoning. The point of modal reasoning is that of reasoning in the actual situation about counterfactual situations. Without reflexivity, from knowing that ϕ is true in an accessible world w , we cannot even conclude that ϕ is possible in w (in non-reflexive frames, is false).

Another problem of non-reflexivity is revealed in the interpretations used to falsify ABS. In those interpretations, the evaluation of $\phi \Rightarrow \psi$ in w is done disregarding the truth-values of ϕ and ψ in w . For such an entailment to be true in w , what is relevant are just the truth-values of ϕ and ψ in G . This makes the evaluation of formulas containing \Rightarrow quite different from the evaluation of formulas containing the other connectives.

But it is quite strange that the truth-values of ϕ and ψ are accessible when evaluating, for example, a conjunction in w , while they are not accessible when evaluating an entailment in w . What could be the interest of knowing the truth-value of $\phi \Rightarrow \psi$ in w if the truth-values of ϕ and ψ in w are just irrelevant to evaluate $\phi \Rightarrow \psi$ in w ?

It seems therefore difficult to find an independent motivation for Omniscience and Non-reflexivity for the interpretation of \Rightarrow . These features seems to be specifically designed just to avoid ABS and therefore Curry's paradox.

In the next section we will show that, even from a logical point of view, the counterexamples to ABS are problematic.

4 Rejection and entailment

In *Doubt Truth to be a Liar* (2006a), Priest introduces the notion of *rejection*. The rejection of a certain proposition ϕ , according to

Priest, is a cognitive state consisting in the refusal of believing ϕ . To refuse to believe ϕ is having positive reasons to keep ϕ out of one's own belief box. The linguistic expression of rejection is *denial*. According to Priest, *in most contexts*, the assertion of a formula like $\phi \Rightarrow \perp$ constitutes the act of denial of ϕ .³ In “normal conditions”, writes Priest (2006a, p. 105), the rejection of ϕ could be expressed by the denial of ϕ , namely $\phi \Rightarrow \perp$.

What Priest intends by “most contexts” and “normal conditions” is explained by the following quotation:

In most contexts, an assertion of [...] $\alpha \Rightarrow \perp$ would constitute an act of denial. Assuming that the person is normal, they will reject \perp , and so, by implication, α . The qualifier “in most contexts” is there because if one were ever to come across a trivialist who accepts \perp , this would not be the case. For such a person an assertion of [$\alpha \Rightarrow \perp$] would not constitute a denial: nothing would. (Priest, 2006a, pp. 105–106)

From this it follows that the dialetheist is “normal”, since he is not a trivialist; then he must accept that the rejection of ϕ could be expressed by $\phi \Rightarrow \perp$.

Now consider the Curry's sentence relative to \perp :

(Curry) $\phi \Leftrightarrow (\phi \Rightarrow \perp)$

If ϕ were true (possibly a dialetheia) then also $(\phi \Rightarrow \perp)$ would be true, due to the equivalence between the two; but then, by MPP, it would be possible to derive \perp . The dialetheist is thus forced, on pain of trivialism, to reject ϕ . If ϕ is rejected, however, also $(\phi \Rightarrow \perp)$ should be rejected. But then $(\phi \Rightarrow \perp)$ cannot be used to express the rejection of ϕ : in order to express the rejection of ϕ , $(\phi \Rightarrow \perp)$ must be true.

Furthermore, given that the rejection of ϕ implies the rejection of $(\phi \Rightarrow \perp)$, we must deny that $(\phi \Rightarrow \perp)$ is true, in spite of the falsity of the antecedent ϕ . In terms of the possible world semantics given for entailment, the falsity of $(\phi \Rightarrow \perp)$ implies the existence of a possible world w , accessible from the actual, where ϕ is true and \perp is false.

³ \perp is a logical constant (*falsum*) such that it is a logical truth that $\perp \Rightarrow \alpha$, (for every α). \perp is basically the symbol for an explosive sentence (i.e., a sentence implying all the others). \perp must be solely false for the dialetheist, because if it were true, trivialism would follow.

Given that (Curry) is true in G , $(\phi \Rightarrow \perp)$ is true in w ; but, for this entailment to be true in w , in every world w' , accessible from w , it must happen that if ϕ is true, then \perp is true. To define an interpretation where all these conditions obtain, we need to assign to ϕ the value 0 in every w' accessible to w ; this in order to conclude that if ϕ is true then \perp is true. But in order to justify this metalinguistic conclusion we need to accept, *in the metalanguage*, the derived rule of False Antecedent. It is only on the basis of the mere falsity of the antecedent “ ϕ is true” that we can conclude that our metalinguistic statement is true.

The dialethic justification for rejecting False Antecedent is that it would immediately lead to trivialism. Assume that α is a dialetheia and consider an arbitrary formula β , or better \perp . In such a case α would be true (because a dialetheia is also true), but by False Antecedent also $\alpha \Rightarrow \perp$ would be true (because α is also false), but from this, by MPP, \perp would be true and trivialism would follow.

In the case of (Curry), however, the dialetheist could defend the legitimacy of using False Antecedent for the metalinguistic proposition “if ϕ is true, then \perp is true” because ϕ is not a dialetheia. But as we have seen above, Priest’s solution to Curry’s Paradox requires that, *in the object language*, $\phi \Rightarrow \perp$ be false in G even if ϕ is solely false. We have therefore a case where the sole falsity of an antecedent fails to guarantee the truth of the corresponding conditional. The falsity of $\phi \Rightarrow \perp$ is justified by Priest by the existence of a world accessible from the actual where ϕ is true and \perp is false. But as we have seen above, in order to justify this, the rule of False Antecedent needs to be used in the metalanguage.

In the next section, we will argue that the use of False Antecedent in the metalanguage and the failure of False Antecedent in the object language conflicts with one of the main tenets of dialetheism, namely that the principles used in the metalanguage should be dialethetically acceptable.

5 Concluding remarks

Unlike the dialethic solution to the Liar Paradox, Priest’s solution to Curry’s Paradox does not make use of dialetheias. The paradox is solved by postulating a genuine conditional, the entailment connec-

tive, that invalidates ABS, (Assertion) and solves Curry's Paradox.

The entailment connective is a modal one and its semantic is given in terms of possible worlds.

As we have already observed, failure of (Assertion) is in conflict with Priest's requirement that the entailment connective expresses the informal notion of logical consequence. This failure is essential to avoiding the paradox: trivialism is in fact a semantic consequence of (Curry) and (Assertion). For assume $\phi \Leftrightarrow (\phi \Rightarrow \perp)$ and $\phi \wedge (\phi \Rightarrow \perp) \Rightarrow \perp$ are true in G . Since $\phi \Rightarrow \perp$ is false in G , for the truth-conditions of entailment, there exists a possible, non trivial, world w where ϕ is true and \perp is solely false. But in this world, the truth of ϕ implies the truth of $\phi \Rightarrow \perp$ (by (Curry)) and thus the truth of their conjunction $\phi \wedge (\phi \Rightarrow \perp)$, which is the antecedent of (Assertion). Therefore, \perp must be true in w .

Counterexamples to ABS and Curry's Paradox, given in terms of such semantics, presuppose that a rule like False Antecedent be false for the entailment used in the object language, but true for the conditional used in the meta-language.

What kind of conditional is then used in the meta-language?

A dialetheically acceptable metalinguistic conditional, for which False Antecedent is correct, is the material conditional. But this, as we know, is not a genuine conditional (it invalidates MPP) and its use in the metalanguage would invalidate MPP also for \Rightarrow , on pain of trivialism, as the following interpretation shows:

- $W = \{G, w\}$
- no constraint on R
- $\{0, 1\} = v_G(\phi), 0 \in v_w(\phi)$

According to this interpretation, ϕ and $\phi \Rightarrow \perp$ are true in G , because in every world accessible to G , the meta-linguistic conditional "if ϕ is true, then \perp is true" is true. Indeed, this proposition amounts to the disjunction " ϕ is false or \perp is true", that is true in every world because ϕ is false; but then, by MPP, we obtain, in the object language, \perp .

On the other hand, if the metalinguistic conditional is a genuine conditional, it seems that, according to Priest, it should not satisfy False Antecedent. Thus it remains highly problematic for the dialetheist how to interpret the conditional used in the meta-language.

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