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Third Pisa Colloquium in Logic, Language and Epistemology

Essays in Honour of Mauro Mariani and Carlo Marletti

Edited by
Luca Bellotti, Luca Gili, Enrico Moriconi, Giacomo Turbanti

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PREFACE

ENRICO MORICONI

In the fall of 1969, I moved to Pisa to start my undergraduate studies and there I met Mauro Mariani and Carlo Marletti. They were in their second year of university and we were all enrolled in the Scuola Normale Superiore. The atmosphere of the Scuola is special in that students live in residences and spend most of their time together, thereby learning from each other and forming lasting friendships. Carlo and Mauro made an immediate impression on me. Already then Carlo was insightful and brilliant and Mauro was a bibliophile, I daresay he was a bookworm. Despite their capabilities and broad knowledge, they were down to earth and eager to help those who approached them with a philosophical question.

Mauro and Carlo were studying logic, epistemology and philosophy of language and they were finding their research paths in these fields. At the beginning of my second university year, when I was looking for a study topic in the same broad domain of all things logical, I naturally spent more time with them, benefitting from their insights and suggestions. Thanks to their inputs, I was prompted to widen my research interests and they provided me with answers to the many doubts I had while I was studying logic, philosophy of mathematics and, more generally, philosophy. At that time, they were focusing on W. V. O. Quine's philosophy. Later, Carlo developed an interest in *nominalism* and Mauro in *modal logics*. They eventually broadened their research topics to include Aristotle's logic, philosophy of language, linguistics, and Kripke's semantics for modal logics.

Years passing, thanks to the special atmosphere of the Scuola Normale, our friendship became ever deeper and together with Lello Frascolla, Ernesto Napoli, and the late Paolo Casalegno we formed a close group that shared a common research agenda. In the 1980s, Carlo, Mauro and I landed jobs at the Department of Philosophy of the University of Pisa, where our mentors Francesco Barone and Vittorio Sainati were the already established scholars working on logic, philosophy of science, and Aristotle. More recently, we were joined by the much younger Luca Bellotti, who is co-editing this volume.

Carlo and Mauro were excellent teachers and their classes included innovative approaches that went beyond the traditional syllabus. Yes, the students had to overcome some difficulties of communication, and not only those raised by the complexities of the philosophical topics treated: Mauro's teaching style was cir-

cuitous and Carlo's was concise, at times elliptical. But they were effective and many of their former students have since secured academic positions all over the world.

Two of their former students, Luca Gili and Giacomo Turbanti, together with Luca Bellotti and me, are editing this volume in honor of Carlo and Mauro. It is our pleasure to present this collection of essays in this year 2019 as Carlo and Mauro are turning 70. We thank friends and former students who contributed papers on the favourite research topics of the two *honorandi*. This volume contains essays originally written for this celebration, and eleven of them are by former students of Carlo and Mauro.

I thank all the people who enthusiastically contributed to the project. I thank Valentina Morotti for her precious help in drafting Carlo's and Mauro's bibliographies and Laura Tesconi for editing and type-setting the volume. This *Festschrift* is a token of friendship and gratitude from us all.

Cari Carlo e Mauro, buon compleanno!

ON FALSE ANTECEDENT IN DIALETHEIC ENTAILMENT

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Abstract: Aim of the paper is to analyze Priest's dialetheic solution to Curry's paradox. It has been shown that a solution refuting ABS, accepting MPP and consequently refuting CP meets some difficulties. Here I just concentrate on one difficulty: one obtains the validity of MPP just using FA in the metalanguage, an invalid rule for a dialetheist.

1 *Introduction*

Consider a paradigmatic case of self-reference paradox, the *strengthened liar*, having the form:

(a): (a) is untrue.

A solution to the *strengthened liar* is notoriously hard to find. If we admit, by the law of excluded middle, that (a) is determinately true or untrue it is immediately inferred that it is true if and only if it is untrue. Moreover, the *strengthened liar*, differently from the simple one, is a paradox also for those who argue for the so-called *gap* solutions to the paradox: contrary to the law of excluded middle there are some sentences that are neither true nor false.[1] If you assume (a) as neither true nor false one can conclude that, it is, in particular untrue, what the paradoxical sentence says, being so true.

There are different solutions to the paradox. Just to mention two of them one can consider Tarski's solution based on the difference between language and metalanguage and Kripke's notion of semantic foundation.[2]

Aim of this paper is to discuss the dialetheic solution to the paradox, a solution proposed by Priest, for example in (Priest, 1979, 2002a,b, 2006a,b). The dialetheic solution simply consists in accepting the conclusion that (a) is both true and untrue. It is a dialetheia, i.e., a sentence having the form $(A \wedge \neg A)$.[3]

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* I would like to thank Enrico Martino for useful discussions on this paper. Parts of it are in (Carrara and Martino, 2014b).

[1] For a discussion on gap theories solutions to the *strengthened liar* see (Field, 2008).

[2] Tarski's solution is in (Tarski, 1956), Kripke's solution is in (Kripke, 1975).

[3] G. Priest uses the terms 'dialetheiae' and 'true contradictions' to indicate 'gluts', which in turn is a term coined by K. Fine in (Fine, 1975).

In classical logic, the presence of dialetheiae entails *trivialism* and – from a deductive point of view – *explosion*. Explosion is produced using the rule *ex contradictione quodlibet* (ECQ). The classical justification for ECQ rests on the alleged evidence that no contradiction can be true, which is rejected by dialetheists. Observe that in standard natural deduction ECQ can be derived using *reductio ad absurdum* (RAA) and other apparently non-problematic rules. And RAA is indeed rejected by a dialetheist.

However, the banish of RAA is insufficient to avoid trivialism: Curry's paradox, from which trivialism follows, can be generated without the help of RAA.

In the *Logic of Paradox* (LP)[4] Priest observes that, in a semantically closed theory, using *modus ponens* (MPP) and *absorption* (ABS), i.e.:

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

a version of Curry's paradox is derivable.[5]

In LP, $(A \to B)$ is defined as $(\neg A \vee B)$ (the material conditional), which suffices to establish that MPP can't in general be valid: if A is a dialetheia, $(\neg A \vee B)$ is true even if B is not. MPP is labeled in LP as a *quasi-valid* rule, a rule that is valid provided that all truth-values involved are classical (i.e., solely true or solely false).

However, Priest realizes that the material conditional, just because it invalidates MPP, is not a genuine conditional. He emphasizes that "any conditional worth its salt should satisfy the *modus ponens* principle" (Priest, 2006b, p. 83).

So, in subsequent works, for example in (Priest, 2006b, 2008), he introduces a new conditional satisfying MPP, the *entailment connective*, and tries to escape Curry's paradox by rejecting ABS. Since in natural deduction ABS is derived from CP and MPP to reject ABS and accept MPP implies to reject CP.

The above strategy should be compatible with the following two general claims Priest also makes:

1. the presence of dialetheias does not entail trivialism;

2. the meaning of logical constants should be dialethically acceptable both in the object language and in the metalanguage.

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[4] For a general introduction to LP see (Asenjo, 1966; Asenjo and Tamburino, 1975; Routley, 1979; Beall, 2009). For an introduction to dialetheism see (Berto, 2007, Ch. 8).

[5] Formulations of Curry's paradox that do not rely on ABS typically make an appeal to the *structural* version of the rule, Structural Contraction, viz. that if $\Gamma, A, A \vdash B$, then $\Gamma, A \vdash B$. On this, see, e.g., (Beall and Murzi, 2013).

In the rest of this paper, I critically assess the foregoing approach to Curry's Paradox. I just focalize on a single difficulty: Priest's strategy for recovering a genuine conditional, the *entailment connective* or *conditional* $(A \Rightarrow B)$ – one that allows him to recover MPP – is such at the cost of a use of the conditional rule of *false antecedent* FA in the metalanguage. This use is highly problematic, however, because of Priest's requirement that the inference rules used in the metalanguage should be dialetheically acceptable.

2   *Curry's paradox and its arithmetical formalization*

Curry's paradox[6] is derived in natural language from sentences like the following:

> (b): If sentence (b) is true, then Santa Claus exists.

Suppose the antecedent of the conditional in (b) is true, i.e., sentence (b) is true. Then, by MPP, Santa Claus exists. So, we have proved the consequent of (b) under the assumption of its antecedent. By CP, we have then proved (b), i.e., sentence (b) is true. We can now apply MPP once more, and conclude that Santa Claus exists. Of course, we could substitute any arbitrary sentence for 'Santa Claus exists'. As a result, every sentence can be proved and trivialism follows.

I reconstruct Curry's argument in the language of first order arithmetic with a truth predicate.

Let $\mathscr{L}$ be the language of first order arithmetic and $\mathscr{N}$ its standard model. Now extend $\mathscr{L}$ to $\mathscr{L}^*$ by introducing a new predicate T.

Assume a codification of the syntax of $\mathscr{L}^*$ by natural numbers and extend $\mathscr{N}$ to a model $\mathscr{N}^*$ of $\mathscr{L}^*$ by interpreting T as the truth predicate of $\mathscr{L}^*$. So, for all $n \in \mathscr{N}$, $T(\underline{n})$ is true *if and only if* n is the code of a true sentence A of $\mathscr{L}^*$, in symbols $n = \ulcorner A \urcorner$.

To be sure, classically such an interpretation is impossible, since the theory obtained by adding to Peano arithmetic the truth predicate for the extended language $\mathscr{L}^*$ (with Tarski's shema) is inconsistent. This is not so for a dialetheist, however, who accepts inconsistent models.

At this point one can show that, if one uses the classical rules of the conditional in natural deduction and Tarski's scheme

$$T(\ulcorner A \urcorner) \leftrightarrow A,$$

the model $\mathscr{N}^*$ turns out to be trivial. In fact, let A be any sentence of $\mathscr{L}^*$. By diagonalization, there is a natural number k such that

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[6] Curry's original paper in which the paradox was introduced is (Curry, 1942).

$$k = \lceil T(\underline{k}) \rightarrow A \rceil.$$

We can now prove *A* using natural deduction as follows:

1	(1)	$T(\underline{k}) \leftrightarrow (T(\underline{k}) \rightarrow A)$	Tarski's schema
2	(2)	$T(\underline{k})$	Assumption
1, 2	(3)	$T(\underline{k}) \rightarrow A$	1, 2 MPP
1, 2	(4)	A	2, 3 MPP
1	(5)	$T(\underline{k}) \rightarrow A$	2, 4 CP
1	(6)	$T(\underline{k})$	1, 5 MPP
1	(7)	A	5, 6 MPP

The LP logic doesn't validate MPP: as we have already observed in §1, if *A* is a dialetheia, $(\neg A \vee B)$ is true even if *B* is solely false. In this way *Curry's paradox* is blocked.

3   *Entailment: logic and semantics*

As said, Priest is aware that the material conditional is inadequate to capture the intended meaning of the genuine conditional. If, following Priest, it is thought that MPP is constitutive of the meaning of 'if', one natural reaction to Curry's Paradox, then, is to define a conditional which validates MPP but not CP. For this reason in (Priest, 2006b, Ch. 6) Priest introduces a more sophisticated conditional ($\Rightarrow$) which he takes to be an *entailment connective*.

Priest suggests to read

$$(A \Rightarrow B)$$

as

"*B* follows logically from *A*".

The main feature of the entailment connective, $\Rightarrow$, is that it is a *modal* connective invalidating ABS, preserving MPP while avoiding Curry's paradox. . The modal force of $\Rightarrow$, however, is quite different from the force of other modal conditionals, such as the strict conditional, or even the counterfactual conditional. Both, in fact, validate ABS.

An interpretation *I* for a language $\mathscr{L}$ of propositional logic with $\Rightarrow$ is 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 is an evaluation 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". Similarly for a first order language.

The semantic clauses 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 false in w if, and only if, for some world w' such that $R(w,w')$, $1 \in v_{w'}(\phi)$ and $0 \in v_{w'}(\psi)$.

In short: $\phi \Rightarrow \psi$ is 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 is ϕ. $\phi \Rightarrow \psi$ is false at a world w if and only if there is at least one accessible world w' where ϕ is true and ψ is false.[7] He defines *semantic consequence* and *logical truth* as follows.

(SC) $\Gamma \models \alpha$ if$_{df.}$ for all I, if, for every $\beta \in \Gamma$, $1 \in v_G(\beta)$, then $1 \in v_G(\alpha)$, and if $0 \in v_G(\alpha)$ then $0 \in v_G(\beta)$ for some $\beta \in \Gamma$.

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

Counterexamples to ABS are obtained 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 $\neg R(w,w)$.

Consider now the following interpretation where the two above mentioned properties are at work:

- $W = \{G,w\}$

- $R(G,w), \neg R(w,w), R(G,G), R(w,G)$

- $v_G(\phi) = \{0\}; v_G(\psi) = \{0\}; v_w(\phi) = \{1\}; v_w(\psi) = \{0\}$

In the above interpretation, we have that $v_G(\phi \Rightarrow (\phi \Rightarrow \psi)) = \{1\}$, at least in the classical metalanguage. However, $v_G(\phi \Rightarrow \psi) = \{0\}$, since in w, which accessible from G, ϕ is true and ψ is false.

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[7] On this see also (Carrara et al., 2011, 2012; Carrara and Martino, 2014a).

Graphically, the counterexample can be characterized in the following way:

G	w
$v(\phi) = 0$	$v(\phi) = 1$
$v(\psi) = 0$	$v(\psi) = 0$
$v(\phi \Rightarrow \psi) = 0$	$v(\phi \Rightarrow \psi) = 1$
$v(\phi \Leftrightarrow (\phi \Rightarrow \psi)) = 1$	

We can, then, solve Curry's paradox by holding that, if in a semantically closed language ϕ is false only, then the Curry sentence

$$\text{(Curry) } \phi \Leftrightarrow (\phi \Rightarrow \psi)$$

is true, but both ϕ and $\phi \Rightarrow \psi$ are false only and ψ does not follow by MPP.

Observe that the presence of non reflexive worlds is essential for invalidating ABS. Suppose that all worlds are reflexive and prove ABS. Let $1 \in v_G(\phi \Rightarrow (\phi \Rightarrow \psi))$ and let w be any world. Suppose that $1 \in v_w(\phi)$. Then, $1 \in v_w(\phi \Rightarrow \psi)$ and, by reflexivity, $1 \in v_w(\psi)$; besides, if $0 \in v_w(\psi)$ then $0 \in v_w(\phi)$. Thus, $1 \in v_G(\phi \Rightarrow \psi)$.

Moreover, note that no dialetheia is involved in the above solution of the paradox. It means that the foregoing solution to the paradox is not specifically a *dialetheist* solution. Finally, it is worth emphasising that the non-reflexivity of R is *essential* for falsifying ABS.

4   *On false antecendent*

It is the aim of this section to argue that the validity of MPP for $\Rightarrow$ – as well as the above counterexample to ABS – are problematic in a dialetheic metalanguage. To see this, remember that the meaning of the logical constants should be dialethically acceptable both in the object language and in the metalanguage: claim 2 mentioned above. To prove that $\Rightarrow$ satisfies MPP one must show that, given an arbitrary model $\mathcal{M}$, the following holds:

(*) if $1 \in v_G(\phi \wedge (\phi \Rightarrow \psi))$ then $1 \in v_G(\psi)$.

Now suppose that $\mathcal{M}$ has a unique world G and consider the evaluation: $v_G(\phi) = v_G(\psi) = \{0\}$. How can we recognize that (*) holds? Since all we know from the evaluation v is that antecedent of (*) is only false, the only way to recognize the validity of (*) is to invoke the *false antecedent rule*:

(FA) Any conditional with a false antecedent is true.

Question: what kind of conditional is used in the metalanguage when proving that $\Rightarrow$ satisfies MPP?

Here is the problem. As said before, according to Priest, even the metalinguistic logical constants are to be dialetheically understood. Since, as Priest maintains, any genuine conditional must validate MPP, it does invalidate, on pain of trivialism, FA. Consider the following train of thoughts. Dialetheism rejects FA by observing that, if ϕ is a dialetheia and ψ is only false, then the conditional $\phi \rightarrow \psi$ is only false since it does not preserve truth from ϕ to ψ. So, one could think, at first sight, that – where dialetheias are not involved – FA dialetheically holds. Unfortunately, that is not the only case. Indeed, take the above countermodel to ABS:

G	w
$v(\phi) = 0$	$v(\phi) = 1$
$v(\psi) = 0$	$v(\psi) = 0$
$v(\phi \Rightarrow \psi) = 0$	$v(\phi \Rightarrow \psi) = 1$
$v(\phi \Leftrightarrow (\phi \Rightarrow \psi)) = 1$	

$\phi \Rightarrow \psi$ is only false even if ϕ is only false. Thus, following Priest's semantics, FA is rejected independently of the presence of dialetheias. For this reason the metalinguistic conditional cannot be a genuine one.

A typical non-genuine dialetheic conditional satisfying FA is the *material conditional*. If it is so, it would seem plausible to adopt the latter in the metalanguage. However, as said, the material conditional invalidates MPP in LP. Moreover, I am going to show that, if the material conditional is used in the metalanguage, the entailment connective $\phi \Rightarrow \psi$ no longer validates MPP.

A preliminar observation. Consider that, though Priest does not identify falsity with untruth, however he holds that certain sentences are both true and untrue, the *strengthened liar*, for example, is one of these. Now, consider a model $\mathcal{M}$ with a unique world G, where ϕ is both true and untrue and ψ is only false.

Since ϕ is untrue at G, the metalinguistic material conditionals:

(**) If ϕ is true at G, then so is ψ

If ψ is false at G, then so is ϕ

are true. It follows that $(\phi \Rightarrow \psi)$ is true. So, ϕ and $(\phi \Rightarrow \psi)$ are true but ψ is only false; hence MPP does not hold. It follows, then, that $\Rightarrow$ fails to satisfy MPP.

How to reply? A dialetheist may perhaps object to our use of FA in establishing the first conditional in (**) as follows:

- "ϕ is true" is expressed by $1 \in v(\phi)$, and hence $1 \in v(T(\lceil \phi \rceil))$, while "$\phi$ is untrue" is expressed by $1 \in v(\neg T(\lceil \phi \rceil))$ i.e., $0 \in v(T(\lceil \phi \rceil))$.

And since, according to Priest, untruth implies falsity, $0 \in v(\phi)$. Summing up, "ϕ is tue and untrue" is expressed by

$$v(\phi) = v(T(\lceil \phi \rceil)) = \{0,1\}.$$

That is, both ϕ and $T(\lceil \phi \rceil)$ are dialetheias. So the appropriate truth-conditions of $(\phi \Rightarrow \psi)$ are:

(***) If $1 \in v(\phi)$ then $1 \in v(\psi)$; if $0 \in v(\psi)$ then $0 \in v(\phi)$.

With (***) in place, we can no longer resort to FA to establish the truth of the *first conditional* in (***). If ϕ is a dialetheia the $v(\phi) = \{0,1\}$ and the conditionals are so interpreted:

(***) If $1 \in \{0,1\}$ then $1 \in \{0\}$; if $0 \in \{0\}$ then $0 \in \{0,1\}$.

To apply FA to the first conditional we have to negate its antecedent, but the negation of the antecedent is $1 \notin v(\phi)$ i.e., $1 \notin \{0,1\}$ which is false. Notice, however that, the argument shows that the semantics at issue is inadequate to express the metalinguistic notion of untruth and hence to a dialetheic solution of the *strengthened liar*. In fact, if $1 \in v(\phi)$ means that ϕ is true, the untruth of ϕ is properly expressed by $1 \notin v(\phi)$, while the truth of $\neg(T(\lceil \phi \rceil))$ is expressed by

$$1 \in v(\neg(T(\lceil \phi \rceil))), \text{ i.e., } 0 \in v(T(\lceil \phi \rceil));$$

and from the latter $1 \notin v(\phi)$ does not follow.

In a reply to a criticism developed by Littman and Simmons (2004), Priest observes that the treatment of functions in a dialetheic framework is a "sensitive matter" (Priest, 2006b, p. 288). He suggests – a suggestion later used many times – to employ relations instead of functions. In particular, in the case of semantic values, instead of an evaluation function, one can take an evaluation relation R from the set of sentences to $\{0, 1\}$, such that, for any sentence $\phi, R(\phi,0)$ or $R(\phi,1)$. Moreover, he insists claiming that even the metalanguage may be inconsistent, so that R may both correlate and not correlate a sentence with a certain truth value. If we follow this suggestion, the evaluation of an untrue sentence ϕ must satisfy the condition $\neg R(\phi,1)$; and if T must express metalinguistic truth $R((T(\lceil \phi \rceil)),0)$ is to be equivalent to $\neg R(\phi,1)$.

However, Priest's suggestion does not help him circumvent the problem To see this, consider again our model $\mathcal{M}$, this time using R instead of v. Then, the appropriate evaluation of a true and untrue sentence ϕ is

$$R(\phi, 1) \text{ and } \neg R(\phi, 1).$$

Hence, the first metalinguistic material conditional

$$\text{if } R(\phi, 1) \text{ then } R(\psi, 1)$$

is true by FA and the proposed conclusion follows.

5   *Conclusions*

Priest's strategy of having a "true" conditional implies a counterintuitive modal semantics, which allows it to recover MPP at the cost of using the FA rule in metalanguage, a rule that it is not admitted by a dialectist.

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