Is Impossible Worlds Semantics Compositional?

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Abstract

The aim of the present article is to investigate the tenability of the principle of compositionality within an impossible worlds framework. To understand how this question is raised, the first section will be devoted to explaining what the principle of compositionality is and how it is compatile with a possible worlds semantics. In the following section, some arguments from hyperintentionality will be provided against such semantics. The third section will introduce the notion of impossible worlds as adequate tools to accommodate such arguments, with particular attention to Berto and Jago's account (2019). In the fourth section a solution to the compositionality objection towards an impossible worlds semantics will be presented. Finally, the paper will conclude with a possile objection towards such solution.

Keywords: principle of compositionality, hyperintensionality, impossible worlds.

1 Compositionality and Possible Worlds

According to the standard view, the principle of compositionality states that the meaning of a complex expression is fully determined by its structure and the meanings of its constituents. This principle is considered a fundamental presupposition of most contemporary works in semantics and it is argued to be perfectly suited to explain various phenomena such as:

i) the ability to understand new sentences never encountered before (Frege 1914).
ii) the ability to systematically understand sentences such that if one understands aRb, than one is also able to understand bRa (Fodor 1987).

iii) the ability to learn natural languages without knowing all the sentences contained in them (Davidson 1965).[1]

As competent speakers of a language, we are indeed capable of grasping the meanings of an ideally infinite number of sentences. However, having apprehended the meaning of a limited number of words, this is only possible if the meanings of complex sentences are obtainable recursively from the meanings of their parts.

As one can see in Pagin and Westerståhl (2010), there are many arguments to justify the need for a principle of compositionality, as well as many formulations of it. In this paper, we will adopt the version of the principle that best suits our purposes:

(PC) The meaning of a complex expression is a function of the meanings of its component expressions.

It should be noted that the principle of compositionality fits perfectly with a possible world semantics. Let's see why. First, in a possible world semantics a proposition is identified as the appropriate intension of a sentence, where the intension is a function from possible worlds to appropriate extensions, namely truth conditions. The core idea of a semantics based on the notion of intension (differently from a merely extensional semantics) is to assign to expressions intensions as meanings. Unlike extensional semantics, within an intension-based framework i) it is possible to understand what is the meaning of a sencence without being limited to its truth value in our actual world and ii) it is not the case that two sentences have the same meaning if and only if they have the same truth value. On the contrary, sameness of meaning is spelled out in terms of an intension-function that associates those sentences with the same proposition.

Moreover, compositionality is apt to work for notions such as those of content and truth conditions since the content of a complex expression is a function of the contents of its constituents. This means that, intuitively, the content of a conjunction $A \wedge B$ must be a function from the contents of A and B, and the content of the disjunction $A \vee B$ will be another function from the contents of A and B. This can be formulated within a set theoretic framework: if the contents of A and B are sets of possible worlds, then the content of their conjunction $A \wedge B$ is the intersection between these sets; and the content of their disjunction $A \vee B$ is their union. For the same reason, under this respect, given that '$\wedge$' requires the truth of both its conjuncts, in a possible world

[1] I agree with Pagin (2019) when he says that no person can learn all meaninfgul sentences, one at a time in any finite time, regardless their mortality (which Davidson considered as the real limit). I would add that admitting the possibility that there exists a person with no biological (cognitive and temporal) limits who is able to learn all the expressions of a language (even more than one at a time) would be challenging on another level. In fact, that would mean conceding that there exists a finite T1....Tn time frame in which the person learns all the expressions. That is, it would mean admitting the possibility to perform an infinite number of operations in a finite amount of time; and this is problematic. The limit here is computational, not related to human nature.

framework the content of A∧B must be all those worlds where both A and B are true.

It follows intuitively from the notion of intersection and union that, given a pair of sets, there is only one intersection and one union between them. This possible world account of content (at least for the Boolean connectives) is fully compositional.

2 Hyperintensionality

A consequence of the fully reducibility of this account to a set theoretic framework is that, as precisely pointed out by Stalnaker (1976), necessarily equivalent propositions are one and the same proposition. Logical equivalence precisely means being true at exaclty the same worlds. That is, there is no possible world at which one is true and the other is false. Logical equivalence can be represented as a biconditional in the form "if A is true, B is true and if B is true, then A is true".

Despite this bringing great benefits on many respects, it also generates problem on some others.

1. *Aboutness Objection.*
   If we take propositions (the meanings of sentences) as sets of possible worlds, then necessarily equivalent propositions are one and the same proposition.
   Tautological sentences such as "if Mario Draghi is a human, then Mario Draghi is a human" or "it is raining or not" are true precisely at the same possible worlds: all of them. Thus, according to possible worlds semantics, they all express the same proposition, that is, the total set of worlds. Following Yablo (2014), however, this is arguably problematic, since intuitively these sentences should have different meanings: for instance, only one is about Mario Draghi. The other side of the coin concerns sentences that cannot be true like "Mario Draghi is both a human and a dragon" and "it's raining and it's not raining". Within a possible worlds framework, they express the same proposition (the empy set) precisely because they are true at the same worlds: none. Although it is obvious that these sentences refer to different things, possible worlds semantics cannot differenciate among necessary equivalent sentences; the result is that they are processed as if they were one and the same.

2. *Truthmaker Objection.*
   Another related argument underlining the coarseness of the possible world grain is offered by Jago (2018). Consider the following propositions.[2]

   (a) Michela exists.

[2]Pagin (2001) in "A Quinean Definition of Synonymy" offers a similar argument considering the relation between synonymy and necessary equivalent expressions.

(b) Michela exists$\wedge$5 exists.

Surely there is no world where one is true and the other is false, therefore these would be treated as the same proposition. However, there is at least one difference between them, namely the fact that Michela is a *full* truthmaker for (a) and not for (b). This is crearly a contraddiction.

3. *Logical omniscience*
The problem of logical omniscience comes from the modal treatment of epistemic and doxastic concepts. In order to understand the problem one might start from Hintikka (1962) where, proposing his own possible worlds accountd, he offers a cluster of clousure conditions on knowledge and belief. Significant closure effects of Hintikka's clauses are:

(C1) *If KA and A entails B, then KB* (where 'KA' is 'knowledge of A' and 'KB' is 'knowledge of 'B').
That is, one knows all the logical consequences of what one knows. Label it as fully omniscience condition.

(C2) *If A is valid, then KA.*
This condition claims that one knows all logical truths.

(C3) *It is not the case that KA and K$\neg$A.*
This means that one can never have inconsistent knowledge.

It's intuitive to see, for instance, why (C1) holds once we understand A's entailing B as the claim that B is true at all possible worlds (of all models of the epistemic logic at issue) where A is true. Then, if A is known (believed), it holds at all the epistemically accessible possible worlds. But if A entails B, then B holds at all those worlds too, and so B is known (believed) as well. That is, if A entails B and A is known (namely, A holds at all epistemically possible worlds) then there is no possible world in which A is known and B is not. (C2) holds when we understand the logical validity of A as its holding in all possible worlds (of all models, etc.). Then, in particular, a valid A holds at all the epistemically accessible worlds, and so it is automatically known (believed). (C3) simply states that it cannot be the case that one has the knowledge of A and not-A at the same time, namely one cannot have inconsistent knowledge.

As highlighted by Berto and Jago (2019) these conditions follow directly from interpreting the relevant epistemic notions as resticted quantifiers over possible worlds.

It seems, however, that this conception of knowledge does not adequately mirror how human cognition works. For instance, we know basic arithmetic's truths like Peano's postulates, which entail (let be suppose) the Goldbach's Conjecure. However, we do not know whether Goldbach's Conjecture is true. This is a clear case of failure of (C1).

What has just been remarked is that some concepts, when analyzed under a possible worlds framework, are not adequately distinguished. This happens

precisely in virtue of the fact that possible worlds fail to draw a distinction between concepts that are logically equivalent to each other.

A concept or operator, more fine-grained than an intensional or modal one, which succeeds in marking a distinction invisible to the latter, is called hyperintensional. In Cresswell (1975) hyperintensionality is originally defined to account for logically equivalent sentences that cannot be intersubstituted *salva veritate*.[3]

The framework of possible worlds still seems to be the dominant conceptual framework of contemporary philosophical theorizing. However, it is not sufficient to analyze and understand the concepts of what Nolan (2014) calls the "hyperintensional revolution" that has been occurring since the 'beginning of the 21st century. Therefore, different kinds of tools are needed and among the available ones we find impossible worlds.[4]

3 Introducing impossible Worlds

Before further elaborating, we shall explain what we mean by impossible worlds. Definying what impossible worlds are is not an easy task; and at the current state of affairs there is no unilateral accepted definition. Let us show a few examples of attempted definitions.

Impossible ways: if the notion of possible worlds mirrors the human intuition that "things could have been/gone differently", that of impossible worlds reflects another human idea according to which not everything is possible. In this sense, the most intuitive way to deal with impossible worlds is to consider them as ways in which things could not have been. Thanks to its simplicity, this approach can count on various supporters.[5]

An alternative view is that of Priest (1997/2008) who regards an impossible world as a world where the laws of logic fail. Given the plurality of logical accounts, this second approach presupposes a choice. That is, we first adopt a specific kind of logic with its laws and then we define as impossible worlds all worlds where such principles do not hold. Under this conception, for example, even a world backed up by intuitionistic logic would be considered as an impossible one at our actual world, assuming that here classical logic holds.

A narrower definition that does not leave room for the choice of a logical account but is strictly grounded on law of non contraddiction as the mark of possibility has it that an impossible world is one where sentences of the form A and ¬A hold together. (Lycan 1994).

It is not necessary to list all the alternative definitions of an impossible world for a fundamental question to arise spontaneously. Which is the best

[3]Nolan (2014) prefers to use the expression "necessary equivalence" instead of logical equivalence, so that he has the possibility to include not only logical necessity but also mathematical and metaphysical necessity in the discourse.

[4]Alternative theoretical tools to deal with hyperintentionality that have been offered are the structured propositions approach of King (1995, 1996, 2007), Soames (1985, 1987), and others. Recent approaches include Fine's truthmaker semantics (Fine 2012, 2014) and Yablo (2014)'s work on aboutness.

[5]See Restall (1997), Salmond (1984), Yagisawa (1988), Beall (2003).

candidate? What are the principles under which to individuate an impossible world? Not to be too constrained by arbitrary choices about which type of logic to adopt and what logical principles to apply, a suggestion is to place ourselves in the situation of not having too many options to choose from. What principles to save? Only those that are strictly necessary. What to give up? Trivially, all the others. Referring to Berto and Jago (2019) the idea is to consider the notion of *open world* as the most suitable candidate.

An open world is one that obeys no logical closure principle other than A⊨A. The consequence of adopting such a notion is the rejection of some usual rules. In an open world, for example, it is no longer the case that A∧B is true iff A and B are both true as it is usual in possible worlds. Here we have an intuitive violation of the principle of compositionality. Furthermore, from a set theoretical perspective we do not get the content of A∧B by taking the intersection of world A with world B. Under these terms, if the truth of A is independent on the truth of A and B in an open world, there seems to be no function that has as input the open worlds A and B, and as output the content of A∧B. The strong connection between compositionality-content-truth conditions no longer holds for open worlds.

Following again Berto and Jago (2019), in order to have open worlds I will refer to the fortified version of Nolan's principle,[6] according to which:

(NP+) *If it is impossible that A1, A2... but not C, then there is an impossible world that represents A1, A2... but not C.*

In other words, for any logical principle (other that A⊨A) there is an impossible world that breaks such principle.

This allows us to have a very accommodating definition of impossible worlds by admitting the presence of many violations and allowing us to include various conceptions of impossible worlds under the same category, but each of them characterized by their own specifics. Notably, it does not follow that one single world breaks all closure principles. In fact, it might be that each closure principle is broken by some world, although no world breaks them all.

Now, in order to adequately reflect the wide variety of worlds that can be included under the label 'open', the simplest suitable semantics is one that mirrors this variety. That is, a semantics that allows us to build models, on the one hand, in a very general way (by involving only worlds which meet a certain condition) and, on the other hand, models that contain worlds which do not necessarily meet this or that condition. Therefore, we need a world-representation that, regardless of the specific characteristics (or conditions) that the worlds taken under analysis have each time, reflects the only requirement that open worlds demand for: namely, that A⊨A.

To maintain this versatility, the way in which these open worlds respresent must be very fine-grained. Ultimately, we need a world-representation to be at

[6] 'if it is impossible that A, then there is an impossible world which represents that A.' Nolan (1997).

least as fine-grained as the sentences of the object language. For otherwise, as stated by Berto and Jago:[7]

> *"there would be distinct object-language sentences A, B such that a world represents that A iff it represents that B. But this gives us a closure principle $A \dashv\models B$ which all worlds must obey, contrary to what we established above."*

Linguistic ersatzism is the most suitable canditate to complete the task.[8] This choice is motivated by Berto and Jago (2019) for at least a twofold reason:

The first reason concerns precisely the requirements of fineness of grain mentioned above. Linguistic ersatzism is compatible with the view according to which impossible worlds are sets of sentences and any set of sentences counts as a world. If that is case, then the world representation will be as fine-grained as the worldmaking language itself. In other words, for any pair A and B of worldmaking sentences there is a world which represents that A but not B.

The second reason, more generally, concerns how ertsatz represent. According to Lewis (Chapter 3 'On the Plurality of Worlds' 1986) ersatz possible worlds (as opposed to 'genuine worlds') are representations, and the way they represent possibilities is similar to the way in which language does. In particular, they represent possibilities without having to resemble them, but only in virtue of the structural features of the representation.

Where does this opposition between genuine and ersatz worlds reside? Genuine realism says that there exist non-actual worlds very much like ours. Genuineness is just a matter of how a world represents itself; it is not, therefore, per sé related to the concreteness or abstractness of the things represented. Genuine worlds represent (de dicto) possibilities and impossibilities directly, having them as parts. Non-genuine worlds do not. Worlds that do not genuinely represent are ersatz worlds. Ersatzists typically take their worlds to be abstract entities: maximal properties, or sets of sentences, or propositions.

This means that by accepting ersatzism as properly modelling impossible worlds, we account for the fact that an impossible world w, in this account, can consistently represent inconsistencies, such as that x is both F and not-F, without implying the reality of any such x.

To summarize, under the linguistic version of ersatzism worlds can be considered as sets of sentences, and worldmaking is nothing more than the specified language to which the sentences belong. For instance, suppose that we select Latin to be our worldmaking language; then the world w represents that A iff it contains the Latin sentence 'A'. Most significantly, then, it is possible that A iff there's a possible world which contains the Latin sentence 'A'. In light of all this, having satisfied all the fundamental requirements – despite not being immune to problems[9] -, Berto and Jago's choice is to adopt a form of linguistic etsatzism as the basis for developing an appropriate semantics for impossible worlds. In their view one of the applications that we can have of

[7] See 'Impossible Worlds'(2019) p. 177.
[8] Linguistic forms of ersatzism date back to Carnap (1947).
[9] See the problem of Alien Entities in Lewis (1986), Chapter 3.

linguistic ersatzism lies in its ability not to fall under *"the compositionality objection."*

4 The Compositionality Objection

Compositionality, as previously mentioned, is the principle according to which the meaning or content of a complex expression is a function of the meanings of its constituent expressions.

As pointed out in the first section, the principle of compositionality is commonly considered as a mandatory feature of any adequate theory of meaning. Hence, it directly follows that there cannot be semantics without compositionality.

However, taking everything we said so far into consideration, a compositional theory of meaning under an impossible worlds framework, seems to show some conceptual discrepancies. In fact, we must find a way to reconcile the following assertions:

(P1) We take impossible worlds to be open worlds.

(P2) Open worlds-based approach are not compositional.

(P3) An adequate theory of meaning must be compositional.

To avoid the following conclusion:

(C) It is not possible to build an adequate theory of meaning based on impossible worlds.

To solve this conflict, Berto and Jago's strategy focuses on attacking the second premise, trying to show that at least some open worlds based approaches are compositional.

Their idea is to understand how it is possible to move recursively between content c of a sentence A of an object language and the corresponding sentence of the worldmaking sentence A*.

Here follows their argument:

a) Let 'A ' be a sentence of the object language.
b) Let 'A*' be the translation into the worldmaking language of 'A'.
c) Let '| A |' be the content of 'A', namely the set of worlds at which A is true, that is the set of all worlds that have A* as a member (where w is any world, and W is the set of all worlds).

$$\{w \mid A^* \in w, w \in W\}$$

d) By doing so we are implicitly considering truth-at-a-world in terms of world-membership such that the object language sentence A is true at w if and only iff the sentence of the worldmaking language A* is a member of a world w.

(Tw) A is true at w iff $A^* \in$ w

e) In line with the fact that any set of worldmaking sentences is a world in W, even the set that contains only A* is a world. If we add A* to every world in W, the set we obtain, $\{w \cup \{A^*\} \mid w \in W\}$, is precisely the set of worlds that have A* as a member, namely |A|.

f) In addition, since we have recognized A* as being a world, the least common element to all worlds that have A* as a member, namely the intersection between all the worlds in |A|, is exaclty the world containing solely A* as an element; that is, $\bigcap$ |A| is $\{A*\}$.

To sum up, if we add A* to each world we obtain |A|, that is the content of 'A'. Then, by $\bigcap$ |A| we obtain $\{A*\}$. and therefore A*, namely the translation in worldmaking language of 'A'. For a more formal formulation, we can define two functions in the following way:

Let (O_1) and (O_2) be any 1- and 2-place operators, respectively.
Let $x^\frown y$ be the concatenation of the worldmaking strings x and y.
In this notation, then, $O_1^\frown A^*$ and $A^*1^\frown O_2^\frown A^*2$ are worldmaking sentences.
We define two functions f_1 and f_2. The former works for one-place operators (O_1) and one sentence. The latter for two-place operators (O_2) and two sentences.

$$f_1(o, c) = \{w \cup \{o \frown x \mid x \in \bigcap c\} \mid w \in W\}$$

Where 'o' is the operator, say for instance negation (let's write '$\neg*$' for the translation into the worldmaking language of the object language negation '$\neg$'). 'c' is the content of an object language. '$\bigcap$ c' is some singleton of the form $\{A*\}$. Under this conditions, then $f1$ ($\neg$*,|A|) returns |$\neg$A|, namely the set of worlds at which $\neg$A is true.

The same holds for f_2:

$$f_2(o, c_1, c_2) = \{w \cup \{x \frown o \frown y \mid x \in \bigcap c_1, y \in \bigcap c_2\} \mid w \in W\}$$

For example, consider A and B and their conjunction A$\wedge$B. We use f_2 on '$\wedge$*' (the worldmaking translation of '$\wedge$') and the contents of A and B.
|A$\wedge$B|, the content of A$\wedge$B, is the output of the function f_2($\wedge$*, |A|,|B|).
This means, eventually, that the semantic is compositional.

Conclusion

As pointed out by Berto and Jago, we see the concrete possibility of moving back and forth between the content c of an object language sentence A and the corresponding worldmaking sentence A*. This possibility ensures the correct construction of complex sentences due to the concatenation from simple sentences. To sum up, the compositionality objection is rejected by setting the object language and the wordmaking language in a certain intercourse such that it is always possible, by switching from one language to the other, to obtain A* from |A| and vice versa. The result, more specifically, leads us to

observe that it is possible to create complex worldmaking language sentences from basic sentences similarly to the way we do for object language sentences. This result is a sign of a clear compositional dimension in the semantics of impossible worlds, under this ersatz linguistic approach, as configured in the present paper.

At this point one might argue that although the account presented by Berto and Jago is compositional, it does not follow that it can be considered semantically adequate. That is, the fact that the necessary condition for good semantics is compositionality does not mean that it is a sufficient condition. Specifically, the questions one might ask are: is translating from one language to another assuring us that we are doing semantics? When we translate from an object language to a worldmaking language, what kind of operation are we conducting? Are we actually making a different operation from the one we make when we translate a sentence from i.e. Italian to English?

Let's consider two options:

1. Suppose that the act of translating from Italian to English and from object language to worldmaking language are of the same kind. However, if we were to notice, beyond superficial differences, that intimately these two translation operations are essentially of the same kind, would we really be investigating the meaning of these sentences? Would we be, ultimately, doing semantics? At the very beginning of his famous article General Semantics, David Lewis draws attention precisely to this point. His clear critique is directed to semantic theories that claim to assign meanings to sentences of a language L by translating them into an L* language. Even if L* has semantic features (such as compositionality, as in this case) in his view such a theory couls still fail to be a theory of meaning for L. The objection is that we can know the translation of a sentence without knowing its meaning: that is, the conditions under which it would be true.

   The idea is that for the same reason that the act of translating the Italian sentence "C'è il sole oggi a Torino" into the English utterance "It's sunny today in Turin" does not say anything about the conditions under which that is true, similarly the act of translating from object language into worldmaking language does not provide information on truth conditions.

   By jumping from one language to another, remaining on a linguistic level, we never touch the connection between utterances and the world. Lacking such a connection there are no truth conditions, but a semantic without truth conditions is not semantics.

2. Certainly, it is possible to respond to the objection raised by saying that translating from an object language to a worldmaking language is not the same as translating from English to Italian. It is possible to respond, moreover, that the *objectuality* of the worldmaking language ensures that we do not remain on a purely linguistic level (as it was in the previous case where we are effectively limited to just moving from one language

to another without ever actually touching the world). Instead, we do get closer, so to speak, to a world-dimension more directly. After all, as stated above, the object language sentence A is *true* at w if its translation into worldmaking language A* is a *member* of that w.

Surely this seems not to be a problem as long as we simply consider atomic sentences excluding the use of operators such as negation, conjunction, disjunction. But as soon as we enconuter something of the kind of '¬A*' we face the situation of having to explain where and how it is the case that such a state is trackable in the world.

Looking at how Berto and Jago define functions for translation from object to worldmaking language, the need to have a corresponding worldmaking language for each sentence and for each logical operator is explicit. It is to this last desiderata that we should pay attention to, namely the idea of having an equivalent in worldmaking language for each logical connective.

To put it more accurately, in the object language there are operators such as negation, conjunction, disjunction. In the worldmaking language there must be translations corresponding to those operators. It is not a problem for the object language to have operators since there operators are functions. However, this might be a worry for worldmaking language since operators in the latter are considered along the lines of components of the world. As a result, we have that w contains '¬*' as a component, which amounts to say that operators exist in the world as objects of the world.

Intuitively, at this point the advocates of this second option are in the inconvenient situation of having to answer the following: where do we find the counterpart of negation - so understood - in the world? What does '¬*' stand for in the world? If the intention is to do semantics, questions of this kind are not avoidable.

To conclude, either we admit that the translation from object language to worldmaking language is not that different from the translation of a sentence from Italian to English and therefore - if Lewis is right - we cannot speak of semantics since "a semantics without truth condition is not semantics", or we accept the consequences of recognizing the two translation cases as completely different, having to explain how to solve the objection above. Certainly the account presented by Berto and Jago has the merit of being compositional; whether there is an adequate semantics associated with it is a matter of debate.

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