Nuclear Bundles of Tropes and Ontological Dependence

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MOST DEFENDERS OF TROPE METAPHYSICS have maintained that particular objects should be reduced to bundles of tropes. Part of the attraction of a trope metaphysic is the work that tropes can do for understanding the nature of both particulars and universals. On one hand, what we call 'universals' can be conceived as resemblance classes of tropes. On the other hand, particular objects are nothing but pluralities of tropes satisfying certain conditions (*cf.* for example, Williams 1953a, 1953b; Campbell 1981, 1990; Maurin 2002; Ehring 2011). But, what are exactly those conditions that make a plurality of tropes a particular object? It has not been easy to fill in the details of a trope theory of objects and, then, it is not surprising that a variety of different proposals have been put to the fore. Some have said that objects can be understood as mereological fusions of compresent tropes. Some have said that objects can be understood as pluralities of tropes that happen to be «co–instantiated». Some have said that «co–instantiation» is just a primitive fundamental ontological fact. Some have said that it is a relational trope, albeit an especial one. For example, a relational trope that is essentially a relation between the tropes that compose an object, although the related tropes are independent from each other (*cf.* Maurin 2002, pp. 164–166). For others the co–instantiation trope is a relational trope that happens to relate all the tropes composing an object, including itself (*cf.* Ehring 2011, pp. 128–135).

In all these proposals it has been assumed that tropes —or most of them— are ontologically independent entities. Any of them can exist with or without any other. A different line of theories, though, has supposed the opposite, *i.e.* that tropes are essentially dependent entities that can only exist in clumps. This tradition goes back to Edmund Husserl in the twentieth century and it has been put to the fore since the 1990s by a series of works by Peter Simons (*cf.* 1994, 1998, 2000) and Markku Keinänen (*cf.* 2005, pp. 343–392; 2011) as the «nuclear

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theory of trope bundles». There is a lot in favor of trope bundles conceived in this way, but they require in almost all of its forms equivalence classes of mutually dependent entities. Dependencies between tropes should be reflexive, symmetric and transitive. But, it will be argued here that there are such relations of ontological dependence. Then, most forms of nuclear trope bundles are metaphysically impossible. Most, but not all. It will be argued that the best way to conceive nuclear trope bundles is with a unique nuclear trope. A theory in these lines makes the nuclear theory very close to traditional conceptions of particular objects with properties instantiated in a «bare particular», and very close also to most of the theories of tropes that have been proposed during the centuries.

This work will be divided, then, in the following sections: in section 1 the varieties of different theories of trope bundles will be presented, discussing in particular what are the main advantages for theories in which the unity of the particular object is grounded on mutual relations of ontological dependence; section 2 will be focused on the relation of ontological dependence, relying on the work of Kit Fine (*cf.* Fine 1994, 1995a, 1995b); in section 3 it will be argued that dependence is a strict order, *i.e.* it is an irreflexive, asymmetric and transitive relation; section 4 will discuss several criticisms against this theses; and, finally, section 5 will consider the consequences that these characteristics of the relation of dependence have for a sensible trope metaphysic.

§1. Varieties of trope bundles

As it has been already said above, the first philosopher that has proposed trope bundles in which the connections between the tropes composing the bundle are their mutual ontological dependencies is Edmund Husserl (*cf.* 1913, 3rd Investigation, § 21). He called those trope bundles 'pregnant wholes' (*prägnanten Begriff des Ganzen*: «wholes in the pregnant sense»). The main motivations for its postulation are the problems for explaining the unity of a bundle of tropes or «moments». A «trope», «moment» or «mode» is a particular property like the exact shape that has a particular apple in opposition to the universal shape that could, in principle, be instantiated in different objects. A trope of shape of an apple is as particular as the apple itself. A trope is also numerically different from the object that bears it. The trope of shape of an apple is not simply an «aspect» of the apple just conceptually different from it. It is not just a different way of understanding the same entity. Many have been

inclined to maintain that particular objects are bundles of tropes, without any substratum bearing them, as it has been said above (*cf.* Williams 1953a, 1953b; Campbell 1981, 1990; Denkel 1996; Maurin 2002; Ehring 2011). One of the problems that such a program should face is the explanation of the unity of the bundle. Our intuition is that particular objects have some kind of unity. But, how can a plurality become something unified? The first proposal has been that objects are simply mereological fusions of «comprensent» tropes. Standard extensional mereology guarantees that, for any entities x_1, x_2, …, x_n there is the fusion of x_1, x_2, …, x_n. For any condition F, there is also the fusion of all and only the Fs.[1] So, if there is the condition of «being *compresent* in a spatio–temporal region r», then those axioms guarantee that there is the fusion of all and only the tropes comprensent at r. Tropes x and y are compresent at region r if and only if, x exactly occupies r and y exactly occupies r. This proposal seems *prima facie* very simple. It only requires facts about occupation of space–time and mereology. But its simplicity is not real. It is crucial for these bundles the relations of «occupation» between tropes and spatio–temporal regions, and it is not at all obvious how such relation should be understood. It is a relational trope? It is a «primitive fact»? It is not clear how to answer these questions in a principled way. Besides, this theory makes a metaphysical truth that no different objects can be occupying the same spatio–temporal region, but it is an empirical fact that certain kinds of physical particles —like neutrinos— can occupy the same region that other particles. So, it seems that it is convenient to look for other alternative. Suppose now that the unity of a bundle of tropes is not something grounded on facts of occupation of spatio–temporal regions plus mereology, but something grounded on facts about the *co–instantiation* of the tropes composing a bundle. Here we have again a difficulty concerning this relational fact, only that now it is «co–instantiation» and not «comprensence». If «co–instantiation» is a trope like any other, then the fact that a particular co–instantiation trope happens to be composing a bundle should be grounded on another fact: the fact that this co–instantiation trope is *co–instantiated* with the other tropes with which it composes the bundle. It is easy to see that a vicious regress could ensue here. There are several strategies that have been assayed to evade it. Anna–Sofia Maurin postulated a co–instantiation trope that, essentially, is a relation connecting the tropes that compose a bundle (*cf.*

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[1] The fusion of the Fs is defined as a unique entity x such that, for any entity y, y overlaps with x if and only if y overlaps with an F. Entity x overlaps with y if and only if x and y have an improper part in common (*cf.* Simons 1987, 9–45).

Maurin 2002, pp. 164–166). Regular tropes —*i. e.* tropes that are not co–instantiation tropes— are independent entities that can exist composing a bundle, but also not composing it. Unfortunately, it is not clear what advantages could have a co–instantiation trope with a nature so different from the nature of any other trope. Douglas Ehring, on the other hand, proposed a co–instantiation trope that is independent from any other trope. A bundle is grounded on the fact that certain tropes are co–instantiated by a relational trope of co–instantiation that happens to connect itself to the other tropes composing a bundle (*cf.* Ehring 2011, pp. 128–135). But it is dubious that an arrangement in these terms is even intelligible. Of course, it is also open to the friend of tropes to appeal to a «primitive» fundamental fact of co–instantiation. The resource to «primitive» facts, though, should be made with extreme care. What is a «primitive relational fact» if not a *relation*? And, if it is a relation, why should it be different from any other relation in a trope metaphysic?

It is common to all the theories presented above that tropes are independent entities. The only exception is the co–instantiation trope postulated by Maurin —an exception postulated precisely for making sense of independent tropes conforming a bundle. But there is another tradition that conceives from the beginning the nature of topes as ontologically *dependent* entities. «Pregnant wholes» proposed by Husserl seem to offer a simple and elegant solution for the unity of the bundle.[2] It is a structure in which all the tropes composing the bundle are ontologically dependent on each other. There is no need here to postulate some further compresence or co–instantiation trope or some further primitive compresence or co–instantiation fact explaining the unity of the tropes composing the bundle. It is inscribed in the essence of each of those tropes that they cannot exist without all the other tropes composing the bundle. It is notorious that the dependence relation between tropes composing a «pregnant whole» should be reflexive, symmetric and transitive. Only under these constraints all the tropes of the bundle depend on each other and on themselves.

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[2] A pregnant whole can be understood as an integral whole with ontological dependence as characteristic relation. An *integral whole* is a collection of all and only the entities that have between them certain relation. Let *R* be a dyadic relation. A collection of entities is «closed under *R*» if and only if no entity not belonging to the collection has *R* to any entity of the collection, nor any entity of the collection has *R* to something not belonging to the collection. A collection is *connected* under a relation *R* if and only if all the entities belonging to the collection have *R* with respect to each other. Then, an integral whole is a collection of entities closed and connected under some relation *R*. In this case, *R* is said to be the *characteristic relation* of the collection (*cf.* Simons 1987, 326–335).

Husserlian pregnant wholes have the problem that all the properties of an object are essential. If a bundle is actually integrated, for example, by a trope of length of 1 meter, then the object in question —the object that is identical to the pregnant whole— could not have had a length of 1,0000001 meters.[3] The nuclear theory of trope bundles seem to deal with this problem maintaining the advantages of Husserlian pregnant wholes (*cf.* Simons 1994, 1998, 2000; also Keinänen 2011). In the nuclear theory, objects are bundles of tropes, but there are two different ontological layers composing the bundle. A first layer is the *nucleus* or *kernel* that is composed by tropes that depend on each other, just as in the Husserlian pregnant wholes. Besides the nuclear layer, there is a *periphery* or *halo* composed by tropes that depend on the tropes of the nucleus, although the tropes of the nucleus does not depend on the tropes of the periphery.[4] It results, then, that the nuclear tropes are the essential properties of the object — and, collectively, the nuclear bundle is the individual essence— and the tropes of the periphery are the accidental properties of the object. As in the case of the Husserlian tropes, it is not necessary to postulate a further compresence trope or primitive compresence fact. Relations of ontological dependence —inscribed in the essence of the tropes composing the bundle— are all that is required for the unity of the object.

It is not necessary to discuss at this point the relative merits and costs of these different alternatives. There are some theoretical functions that they can fulfill better than the traditional trope bundle theories. It is, of course, desirable to preserve these advantages as far as possible. The problem is that it relies on a dubious view of the relation of ontological dependence.

§2. Ontological Dependence

More precision about the nature of ontological dependence is crucial for the intelligibility of the nuclear theory. The very idea of a nuclear trope bundle requires a reflexive, symmetric and transitive relation of dependence. In the last

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[3] Of course, there are some usual maneuvers that one can use here. It can be said that the truth conditions of *de re* modal attributions are given by counterparts of the objects in other possible worlds that, although not strictly identical, are sufficiently similar. So, although strictly it is metaphysically impossible for an object *x* that is actually *F* not to be *F*, in a sense, it is true to assert that «*x* might have been *F*».

[4] Nuclear tropes can be, on the other hand *generically* dependent on peripheral tropes of certain types (*cf.* Simons, 1994, 567). For example, a material object should have some location and some momentum. It is not essential for a material object to have a determinate location and to have a determinate momentum, but to have some location and some momentum under the respective determinables (*cf.* also, Denkel 1996, pp. 188–194).

years a lot of attention has been given to the notion of «dependence» and to other close notions like «grounding». Even in some cases, both terms 'dependence' and 'grounding' have been taken to be synonyms. There is considerable more clarity about these relations than some decades ago. It is a notorious trait of these developments that the relation of dependence has been described as a strict order, that is, as an irreflexive, asymmetric and transitive relation. Even more, it has been considered obvious that dependence is so. Most philosophers treating the question have not feel it necessary to argue for it (*cf.* for example, Lowe 2005, § 3; Koslicki 2012, pp. 187–188). Some recent works have accused that these treatments have been overhasty and not well thought through. Before considering with more care those allegations, it is important to make some precisions here about «dependence» and «grounding».

At some moment, it was supposed that the resources of quantified modal logic could be sufficient to analyze the concept of ontological dependence. The dependence of x on y is just the fact that $[\Box((x \text{ exists}) \to (y \text{ exists}))]$. Since the work of Fine (*cf.* 1994, 1995a), nonetheless, it has been realized that this purported analysis is insufficient. Socrates, for example, results to be ontologically dependent on the singleton {Socrates} under the analysis, but it is obvious that it is the other way around. It is the singleton {Socrates} that depends on Socrates. Quantified modal logic can only describe modal co–variations between entities, but it is incapable of describing asymmetric dependence relations, or asymmetric grounding relations between entities that are modally covariant. In any possible world in which Socrates exists, {Socrates} exists also, and in any possible world in which {Socrates} exists, Socrates also exists, but it is the singleton {Socrates} that depends on Socrates. It is also perturbing that under the modal analysis everything turns out to be ontologically dependent on any necessary object. Dependence, then, transcends what boxes, diamonds or quantification across possible worlds can capture. These limitations of quantified modal logic does not prevent, nonetheless, that the dependence of x on y entails that $[\Box((x \text{ exists}) \to (y \text{ exists}))]$. Dependence is stronger than modal co–variation.

There have been two main ways to analyze the concept of ontological dependence. One resorts to a primitive sentential operator 'because' (*cf.* Schnieder 2006, pp. 402–411; 2011), *i. e.*: $[(x \text{ depends on } y) =_{df} \exists F (x \text{ exists},$ because y is $F)]$. Other resorts to a primitive notion of «essence» (*cf.* Fine

1995a, 1995b). The latter will be preferred here. The analysis proposed by Schnieder treats dependence as a form of explanation. But there is always a risk of suffusing ontology with pragmatic and epistemic factors that seem to be relevant for an explanation —or a «good explanation» if you prefer. Pragmatic and epistemic factors seem extraneous to the objective ontological structure of reality. Schnieder is well aware of this risk (*cf.* Schnieder 2006, pp. 405–406) and he is careful to distinguish between subjective and objective notions of explanation. Only objective explanations are relevant for the elucidation of ontological dependence. But how do you distinguish «subjective» from «objective» explanations? One suspects that ontological dependencies or causal connections are relevant for this distinction. But then, «explanation» does not seem to be the appropriate notion to analyze «dependence» at all. It seems to be the other way around.[5]

Fine analyzes the notion of dependence in terms of «essence». That is, *x* depends on *y* if and only if it is included in the essence of *x* that if *x* exists, then *y* should also exist (*cf.* Fine 1995a, pp. 272–273). The «essence of *x*» is not defined using quantified modal logic, as the properties *F* of *x* such that: $[\Box((x$ exists$) \to Fx)]$. An analysis of essence in these terms has the same problems that an analysis of ontological dependence as a strict implication has in quantified modal logic (*cf.* Fine 1994, pp. 5–8). In the analysis envisaged here, it is just a primitive fact that there are some properties integrating the essence of something. Those properties conform the «identity» of the entity in question. Of course, there are also some things that are entailed by the fact that the essence of something includes certain properties. This is called by Fine «consequentialist essence» (*cf.* Fine 1995a, pp. 275–277), but what is relevant here is «constitutive essence», the base from which consequentialist essence follows. In the notation used in Fine (1995b) $[\Box_x Fx]$ says that it is true in virtue of the identity of *x* that *Fx* or that it is included in the essence —constitutive essence— of *x* that *x* is *F*. The ontological dependence of *x* on *y*, then, can be analyzed as:

Dependence $(x \text{ depends on } y) =_{df} [\Box_x((x \text{ exists}) \to (y \text{ exists}))]$.

Defined as in *Dependence,* ontological dependence is not asymmetric (*cf.* Fine 1995a, pp. 282–287), but this won't be important, because there are positive reasons for asymmetry that will be presented later that are not necessary to presuppose now. An analysis of asymmetric ontological dependence in terms of «essence» should be:

Dependence'   (x depends on y) $=_{df}$ $[\Box_x((x \text{ exists}) \rightarrow (y \text{ exists})) \wedge \Diamond_y((y \text{ exists}) \wedge \neg(x \text{ exists}))]$

The view defended by Lowe can also be included here. The relevant notion of dependence described by Lowe is analyzed in terms of the conditions of identity of something, that is, x depends on y if and only if it is part of the conditions of identity of x that y exists (*cf.* Lowe 2005, § 4):

> Identity–dependence as defined by (ID [an analysis like the indicated above]) is simply a species of *essential* dependence, that is, a way in which «the very being» of a certain thing is determined by a relation in which it stands to another thing.

There are important differences between dependence and grounding. Grounding is not related to essence in the way that dependence is (*cf.* Fine 2012, pp. 74–80). A ground for a fact is something sufficient for the obtaining of that fact. This is what typically happens with truth–makers for a given truth. The truth of the proposition <There are cats> is grounded on the fact that Tom exists, because the existence of Tom necessitates that <There are cats> is true. But it is not part of the essence of the truth of the proposition <There are cats> that Tom exists. The proposition could be true also if there existed another individual cat instead of Tom. Consider also the state of affairs of x having the universal property U. This state of affairs depends on the existence of x and the existence of U, but it is not grounded on the existence of x and U. The existence of x and U is not sufficient for the existence of the state of affairs, because x could instantiate other properties instead of U, and U could be instantiated in some other object instead of x.

§3. Dependence is a strict order

Dependence is a strict order. It is irreflexive, asymmetric and transitive. Suppose, in effect, that there were nothing wrong with reflexive dependencies, then *independent* entities should be metaphysically impossible, because, everything should be —at least— dependent on itself.[6] Of course, nothing hangs on a terminological convention. There shouldn't be any difficulty of establishing a semantic convention in virtue of which everything is trivially dependent on itself. Even more, why don't accept an especial meaning of 'dependence' —let's call it 'dependence*'— under which everything is ontologically dependent* on itself? Anyone has the right to talk that way if he likes and if it suits better his purposes. But, by the same reasons, there shouldn't be anything amiss with a more austere terminology if there are important theoretical uses for it, and also important conceptual precision that might be otherwise lost. And there is, indeed, such a loss at stake here. For example, there has been a long philosophical tradition in which the concept of «substance» has been analyzed in terms of «independence» (*cf.* for some contemporary representatives, Lowe 1999, pp. 136–153; Simons 1994, 1998; Schnieder 2006; for an historical discussion, *cf.* Pasnau 2011, pp. 97–175). Of course, many have pointed out several problems with that project and some have proposed a radical change in the sense of «independence» for a correct analysis (*cf.* Hoffman and Rosenkrantz 1994). In any case, all that long tradition of philosophical discussion turns out to be just silly if there is nothing wrong with a reflexive ontological dependence, because, trivially, there couldn't be any substances under the proposed analysis. It would be a matter of conceptual necessity that there are no independent entities.

So, one can be extremely tolerant in lexicographic matters and allow a more relaxed sense of ontological dependence* that is trivially reflexive. It could even happen that for some formal purposes that notion comes to be more useful than dependence, just as in mereology the notion of «improper part» is sometimes more useful than «proper part».[7] But the same tolerance should be exercised in allowing for a more strict notion of dependence that is at stake, for example, in the discussions about an «independence» concept of substance.

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[6] Please note here that what is required for the intelligibility of nuclear trope bundles in their traditional forms is a reflexive relation of dependence. Non–reflexivity or non–irreflexivity won't be adequate for an equivalence relation.

[7] The same happens in some recent formal treatments of ontological grounding. «Strict grounding» is irreflexive, but «weak grounding» is trivially reflexive (*cf.* Fine 2012, 51–53).

And this notion of dependence is irreflexive and seems more basic than dependence*. In effect, dependence* can be very naturally be analyzed as:

[*Dependence**] x depends* on $y =_{df} ((x$ depends on $y) \lor (x = y))$

So dependence* just is dependence or identity. What is theoretically important about dependence* is dependence. Not the other way around.[8]

In recent works it has been complained, as it has been shown above, that there aren't arguments for the asymmetry of dependence (*cf.* Barnes 2014), but here is an argument: dependence is asymmetric because it is irreflexive and transitive.[9] Why is dependence transitive? Using our analysis above x is dependent on y if and only if it is inscribed in the essence of x that, if x exists, then y exists. Suppose now that y is dependent on z. By the same analysis, it is inscribed in the essence of y that, if y exists, then z exists. How on earth could now x be independent on z? If it is part of the essence of x that y should exist, and part of the essence of y that z should exist, then it is part of the essence of x that z should exist. Suppose that dependence were non–transitive, that is, x depends on y, y depends on z, but it is not the case that x depends on z. Hence, following the analysis, it is not part of the essence of x that, if x exists, then z exists. Then, it could be metaphysically possible that x exists but z doesn't. But y is dependent on z. Then in the situation envisaged, y couldn't exist. But, by hypothesis, x is dependent on y. Hence, if in the situation envisaged y doesn't exist, neither does x. Then, it is not metaphysically possible that x exists, but z doesn't. Dependence, then, is obviously transitive.

In previous works it has been just assumed that dependence is a strict order. It wasn't due simply to uncritical hastiness. The intuitions behind those treatments were correct. A closer inspection on the relation of dependence shows that, indeed, it is a strict order.

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[8] It is true that —formally— «dependence» can also be defined by «dependence*» in the following way: [(x depends on y) $=_{df}$ ((x depends* on y) $\land \neg(y$ depends* on x))]. But the cases in which there is no dependence are cases of identity, because «dependence*» is antisymmetric. However one defines «dependence*», it is just dependence or identity.

[9] Let R be a dyadic relation irreflexive and transitive. Suppose for *reductio* that R is also symmetric. Let x has R to y. By symmetry, y has R to x. Then, by transitivity, x has R to x. But, by hypothesis, R is irreflexive.

§4. Reasons for doubting dependence is a strict order

Several recent works have put into question the common view about grounding and dependence. Schaffer, for example, has argued that grounding is not transitive (*cf.* 2012). Jenkins has argued that it is not clear that dependence is irreflexive (*cf.* 2011; a general view also in Bliss 2012, 2014). More relevant for the view that is going to be defended here are the works of Barnes (2014) and Rodriguez–Pereyra (2015). Barnes maintains that there are no sufficient reasons to reject symmetric dependencies. Rodriguez–Pereyra present counter–examples to the irreflexivity, asymmetry and transitivity of grounding, but his examples against irreflexivity and asymmetry seem to be also applicable against the irreflexivity and asymmetry of dependence.

§4.1. *Reasons for doubting the irreflexivity of dependence*

Jenkins (2011) has presented some cases in which it may seem that there are reflexive dependencies. There is a previous problem with Jenkins' treatment because she considers the relation of dependence as it were just the same as the relation of ontological grounding. This is the kind of case that Jenkins has in mind:

> Suppose I say that S's pain is metaphysically dependent upon some brain state. What happens if I then go on to *identify* the pain state with the brain state? Am I forced to go back and reject the dependence claim? (Jenkins 2011, p. 268).

Other case considered by Jenkins is the case of mereological fusions:

> It's pretty plausible that fusions depend metaphysically on their parts; but if that's true then the irreflexivity of dependence entails that I am not identical to the fusion of myself, since I am part of that fusion (albeit an improper one). It's pretty plausible that statues depend metaphysically on the matter of which they are composed; but if that's true then the irreflexivity of dependence entails that no statue is identical to its matter. (Jenkins 2011, pp. 269–270).

Jenkins suggests that there should be nothing amiss with the identity of pain–states with brain–states for the thesis of dependence. The identification of both kinds of states should be seen simply as a confirmation of the dependence thesis. But there are several things amiss with a situation like this. In the first place, a thesis of ontological dependence of pain–states on brain–states is

extremely moderate, at least for a committed naturalist. It just says that it is part of the essence of the pain–state that there are specific brain–states. A dualist could accept that dependence and insist that pain–states are numerically different from the brain–states and, even more, that they are not grounded on those brain–states. There is a big contrast between maintaining that certain brain–states necessitate the occurrence of pain–states and maintaining that certain brain–states are necessary for pain–states. It is obvious that the first is much more close to the outright identification of pain–states and brain–states. The case presented by Jenkins, then, carries more conviction against grounding than against dependence. This is something that one should expect due to the conflation that Jenkins made of dependence with grounding. Nevertheless, whatever the force of her argument against the irreflexivity of grounding, what is relevant here is its eventual force against the irreflexivity of dependence. It seems to me that if one were in a situation where certain entities x and y —that appeared previously as being such that x depends on y— are really identical, one could be in a situation in which one no longer would be entitled to say that x depends on y. The cases proposed by Jenkins are simply cases in which one could be inclined to say that there is dependence*, but if one is considering the more strict notion that is working in serious ontological issues like the correct analysis of substance, or the ontological structure of reality, then the case where pain–states are identified with certain brain–states is *not* a case of dependence.

Gonzalo Rodriguez–Pereyra has presented a battery of arguments against the transitivity, the asymmetry and the irreflexivity of grounding (*cf.* 2015). His arguments against asymmetry will be considered in the next section. The case he presents against the irreflexivity of grounding is also applicable to ontological dependence. The relation of truth–making is a case of grounding. Rodriguez–Pereyra presents a case where a proposition is a truth–maker for itself. Let the proposition <A> be:

<A>   <A> exists.

Proposition <A> is a truth–maker for itself, hence it is a ground for itself. If <A> is a ground for itself, then there are cases of reflexive grounding. Something similar can be argued against the irreflexivity of dependence. A proposition one of whose components is x, is dependent on x. That is, if x doesn't exist, the

proposition that has *x* as a component doesn't exist either.[10] The proposition <<A> exists> has as a component <A>. Then, <<A> exists> is ontologically dependent on <A>. But <A> = <<A> exists>. Then <A> is dependent on itself. Hence, the counter–example presented by Rodriguez–Pereyra is also a counter–example for the irreflexivity of dependence. He points out that proposition <A> is not paradoxical. It can be assigned the value truth consistently. In some theories of truth, semantic facts about the truth–value of propositions should be grounded on non–semantic facts. But <A> is not grounded on semantic facts. The *truth* of <A> is a semantic fact, but <A> just depends —and is grounded on— the mere existence of <A> that is not a semantic fact.

As a counter–example to the irreflexivity of dependence there is an immediate answer to this case. Identity is not dependence —you could call it dependence* if you wish, but that is another issue, as it has been explained above. Proposition <A> is identical to the proposition <<A> is true>. Then, it is not really a case of reflexivity of ontological dependence. The problems that proposition <A> pose for the irreflexivity of grounding is another question. Even in this case, the irreflexivity of grounding seems to be sufficient reason for rejecting <A>. What seems wrong with the truth of <A> is that it is ungrounded, not that it is paradoxical —in fact, it is not paradoxical. In principle, it is just as legitimate to think that grounding is not irreflexive because of <A> than to think that <A> is not true because it is ungrounded. But it seems that something is seriously wrong with admitting a truth like <A>. Precisely the thesis that truth should be grounded explains what is wrong with <A>. It is not a problem of incoherence. It is a problem of grounding.

§4.2. *Reasons for doubting the asymmetry of dependence*
Elizabeth Barnes has argued that there are no reasons for taking dependence as asymmetric (*cf.* 2014). She presents various cases in which —supposedly— there are symmetric dependencies. Actually, one of those cases is the case of Husserlian pregnant wholes (*cf.* Barnes 2014, pp. 12–13), but it cannot be used here as an argument to defend the intelligibility of pregnant wholes. It is clear that Husserlian pregnant wholes and nuclear trope bundles rely on symmetric

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[10] This is the standard position about «singular propositions» that have as a component a singular object. There are several different ways to conceive the ontological structure of propositions and the way in which an object can enter as a component in a proposition, that are not relevant here. *Cf.* for example, King 2007; Soames 2010, pp. 69–98.

dependencies. But that is what is under question here. The other cases she presents are (*cf.* 2014, pp. 9–16): the mutual dependence between immanent universals and its instantiations in particulars that have them essentially, Armstrongian states of affairs, the case of structuralist ontologies in mathematics and the ontology of events. Barnes points out that admitting the symmetry of dependencies allows for holistic explanations in which certain entities explain each other jointly. The reason why many people have been inclined to think of dependence as asymmetric —she suggests— is that they have been inclined to identify the ontologically dependent with the non–fundamental. But fundamentality is one thing, and dependence is another. Fundamentality is asymmetric, dependence need not be.[11]

But the cases presented by Barnes are not very convincing. In fact, the most convincing of them is the case of Husserlian pregnant wholes. First, immanent universals are *generically* dependent on some instantiation or other. But generic dependence is a different concept from the notion of ontological dependence that has been discussed.[12] So, it isn't a case of mutual dependence *in the same sense* of universals and its instantiations. Second, Armstrongian states of affairs are clearly dependent on its constituents, universals and particular objects. What Barnes describes as the «dependence» of universals and objects on states of affairs is the fact that states of affairs are not *grounded* on its constituents. If you define as «fundamental» something that isn't grounded on anything, states of affairs are fundamental. This is compatible with their being dependent.[13] One could only be inclined to see this case as one of symmetric dependence if one conflates dependence and grounding. The third case of symmetric dependence is that of structural ontologies. For example, in a structuralist view of mathematical entities, a natural number appears to be dependent on its relations to all the others. Number 2, for example, is a position or node in the structure defined by the Peano axioms. But here also there is a clear direction of dependencies. Nodes are dependent on structures, and structures are dependent on its constituents —either universals or tropes.[14] Finally, in the case

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[11] In fact, Barnes has argued in (2012) that the concept of «emergence» can be captured precisely as something that is ontologically dependent *and* fundamental.

[12] Of course, there is some systematic similitude between dependence —sometimes called «rigid dependence»— and generic dependence. Generic dependence between x and a F can be defined, following the analysis of Fine (*cf.* 1995a) as: $[\Box_x((x \text{ exists}) \rightarrow \exists y \, Fy)]$.

[13] In fact, in accordance with the view defended by Barnes about emergent entities (*cf.* Barnes 2012), *all* states of affairs are emergent entities.

[14] A «mathematical structure» is a set of universals that can be multiply instantiated. Sometimes a «physical

of events, it is argued that larger events are dependent on its event–parts, and the event–parts are what they are because they integrate certain big events. Then, part–events seem to be dependent on big events. But, again, like in the previous cases considered, if big events are mereological fusions of their part–events, there is a clear direction of dependence: fusion events are dependent on their part–events. If one accepts necessity of origin, events are also dependent on its causal antecedents, but even in this case, it isn't that the conditions of identity of an event are integrated by the big events of which it may be a part. For example, World War II wouldn't be the event it is if there were no Operation Barbarossa. But if the war had ended at the beginning of 1942, it is not the case that Operation Barbarossa wouldn't have been Operation Barbarossa. It is not part of the conditions of identity of Operation Barbarossa that the war ended in 1945 and not in 1942.

One of the advantages for Barnes of symmetric dependencies is allowing for ontological holistic explanations. I don't quite understand what could be an «holistic explanation». Any example I can imagine of appears to be a case in which there is a regular asymmetric explanation of an entire structure. They are not cases in which two or more items explain each other, but cases in which items are explained by their position in a structure that, in its turn, has an explanation. These explanations don't appear to be symmetric. But even if one admits «holistic explanations», it is very obscure in what way that could carry any consequence for our ontology of dependencies. Explanations —or «good explanations» if you prefer— have an epistemic a pragmatic component. When these epistemic and pragmatic elements are «factored out» what is left, as 'objective explanation', is dependence, grounding and causality. So, it is not the best policy to try to illuminate ontological dependence by the notion of «explanation». It is the other way around.

A much more difficult challenge against asymmetry of dependence is that presented by Rodriguez–Pereyra (*cf.* 2015). As in the argument presented against irreflexivity, this is an argument directed against the asymmetry of grounding, but the counter–example presented can also be turned against the asymmetry of dependence. Let the following propositions <B> and <C> be:

structure» designates also a set of universals. But sometimes a physical structure is a concrete bundle of tropes, relational and non–relational.

<B>   <C> exists

<C>   <B> exists

Like in the case of proposition <A> above, propositions <B> and <C> have as components propositions <C> and <B>, respectively. Then, <B> is ontologically dependent on <C> and <C> is ontologically dependent on <B>. It seems to be a case, then, of symmetric ontological dependence. The set {<B>, <C>} is consistent. Both <B> and <C> can be assigned the value truth. Like in the case of proposition <A>, nevertheless, there seems to be something seriously wrong with <B> and <C>. Jointly, they are a truth for free. There is no paradox in {<B>, <C>} —like there is no paradox in <A>— but that is not enough. They seem to be ungrounded truths. Considering the question in abstract, it is as legitimate to assume <B> and <C> to be a counter–example to the asymmetry of grounding, as to assume <B> and <C> impossible because they could be jointly ungrounded truths. But assuming the second gives us an explanation about why <B> and <C> seem to be wrong. Jointly, they are ungrounded. The case, then, presented by Rodriguez–Pereyra instead of showing symmetric grounding, might be taken as showing why there couldn't be cycles of propositions like <B> and <C>.[15]

If there are reasons to reject the intelligibility of the cycle of <B> and <C>, then it should not bother us. If it is not a counter–example to the asymmetry of grounding, it isn't either a counter–example to the asymmetry of dependence. If there were a cycle of propositions like <B> and <C>, then there would be an ungrounded truth. But that is impossible. Then, there are no propositions <B> and <C>. Then, there is no counter–example to the asymmetry of dependence.

§5. Consequences for the nuclear theory

It results, then, that we have every reason to think that dependence is a strict order. It is obviously transitive. It is irreflexive. So, it is also asymmetric. All the reasons that have been presented to doubt these characteristics have not been

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[15] Another objection proposed to me by Manuel Pérez–Otero against the truth of <B> and <C> is the fact that in any hyperintensional conception of propositions, there seems to be no way to construct them. In effect, it has been usual in those conceptions to understand the nature of propositions as some sort of set–theoretic constructions, or mathematical constructions given by certain operators. In standard set theory —*i. e.* ZF or NBG— any construction by which {<B>, <C>} might be built will fail to accommodate the requirements of the axiom of foundation. Unfortunately, these issues cannot be discussed properly in this paper.

found convincing. The problem now is that what has been supposed to be nuclear trope bundles are bundles in which at least the nuclear tropes must be mutually dependent on each other. And in the «pregnant wholes» proposed by Husserl all tropes are mutually dependent. These bundles turn out to be unintelligible because there are no mutual dependencies with the characteristics required. The more relaxed relation of dependence*, on the other hand, is of no avail, because it is anti–symmetric, *i. e.*, if *x* depends* on *y* and *y* depends* on *x,* then *x = y.* So, the hypothesis that the tropes of the nucleus are mutually dependent* is the hypothesis of there being just one nuclear trope.

The idea of a nuclear trope bundle only makes sense if the nucleus is just a single trope on which all peripheral tropes depend. It is not possible to defend a trope metaphysic in these lines here, but it is worth noting how surprising is this fact. It turns out that, to preserve the advantages of a trope ontology in which objects are trope bundles, it is necessary to suppose that the unity of an object is grounded on the dependence of peripheral tropes to a unique nuclear trope. And a nuclear theory with only one nuclear trope looks extremely close to the traditional theory of *substrata* that instantiate properties. Somehow it results that the form of nuclear theory that seems to be coherent with our best justified view about the relation of ontological dependence, makes the ontology of tropes something that does not seem far away from ontologies that traditionally have been considered the opposite to it. A nuclear theory of trope bundles with a unique nuclear trope, then, deserves close attention.[16]

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