The Paradox of Decrease and Dependent Parts

Alex Moran
Queens' College, University of Cambridge

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ABSTRACT: This paper is concerned with the paradox of decrease. Its aim is to defend the answer to this puzzle that was propounded by its originator, namely, the Stoic philosopher Chrysippus. The main trouble with this answer to the paradox is that it has the seemingly problematic implication that a material thing could perish due merely to extrinsic change. (For, intuitively, it is not possible for a mere extrinsic change to cause a material thing to cease to be.) It follows that in order to defend Chrysippus' answer to the paradox, one has to explain how it could be that Theon is destroyed by the amputation without changing intrinsically. In this paper, I shall answer this challenge by appealing to the broadly Aristotelian idea that at least some of the proper parts of a material substance are ontologically dependent on that substance. I will also appeal to this idea in order to offer a new solution to the structurally similar paradox of increase. In this way, we will end up with a unified solution to two structurally similar paradoxes.

Key Words: Paradox of Decrease; Paradox of Increase; Dependent Parts; Mereology; neo-Aristotelian Metaphysics.

> …the semicircle is defined by the circle; and so is the finger by the whole body, for a finger is such and such a part of a man.
>
> — Aristotle, *Metaphysics*, 7: 1035b9—11

1 Introduction

This paper is concerned with an ancient puzzle: the paradox of decrease. Consider Dion, a human being, and Theon, one of Dion's large proper parts, identical to all of Dion besides his left foot. Suppose that Dion's left foot is amputated, and that Dion survives. (Suppose also that Dion undergoes no further mereological change.) Intui-

tively, Theon survives in this scenario as well as Dion; after all, Theon only undergoes extrinsic change. However, if this is right, it follows that post-amputation, Dion and Theon end up composed of the very same matter, whilst occupying exactly the same region of space. Intuitively, however, it is not possible for two material objects to occupy precisely the same spatial region, or be composed of the very same matter, at once.[1]

In general, the paradox of decrease arises because, across a range of cases, it seems possible for an object to lose a proper part and thereby become coincident with (what once was) the complement of that part. Yet at the same time, it does not seem possible for distinct material objects to come to be related in this way. The case of Dion and Theon is an instance of this more general problem. To solve it, we must either find a way to make palatable the claim that an object and (what once was) one of its proper parts might come to coincide spatially and materially, or else resist the reasoning which implies that this could happen. That is, we need either to explain how it could be that Dion and Theon end up being coincident, or else find some way of denying that this is the situation that the amputation would engender.

Many philosophers pursue the former strategy. However, aside from the intuitive case against coincident objects, this response faces two further problems. First, there is a worry concerning how a single set of material parts could possibly compose two distinct material things at once. For prima facie, at least, it is not possible for this to happen (cf. Lewis: 1986, p. 252; Noonan: 1988, p. 222). Second, and perhaps more

[1]. Interestingly, the intuitive ban on material coincidence is echoed throughout the entire history of philosophy (cf. Betegh: 2016). Of course, some philosophers do believe that material coincidence is possible. However, it seems to me that the intuition against the possibility of material coincidence is sufficiently strong to make it so that the Dion/Theon story constitutes a genuine paradox.

seriously, there is the so-called 'grounding problem'. To illustrate, suppose for instance that both Dion and Theon survive the amputation, and thus end up being coincident. Then notice that after the amputation (as before), Dion and Theon differ in certain salient ways. For exam- ple, after the amputation, Dion is a person, whilst Theon is not (cf. Burke: 1994a). The trouble is that it seems hard to see what could possibly ground the difference in personhood between Dion and Theon at this time, given that they are composed of the same matter, and hence have precisely the same microphysical properties. The proponent of the coincidence view thus seems forced to maintain (as Bennett: 2004 puts it) that there can be brute differences in 'sortalish' properties (such as personhood) between distinct material things. Yet this commitment seems implausible, as several philosophers have noted (see e.g. Burke: 1992, Fine: 2008, and Olson: 2001).[2]

In light of these problems, it seems worthwhile to pursue an alternative strategy. There are several options that might be considered here, but in this paper, my goal is to defend the position advocated by the originator of the puzzle, namely, the Stoic philosopher Chrysippus.[3] What Chrysippus contends, essential, is that whilst *Dion* survives the amputation, *Theon* does not. Philo of Alexandria summarises Chrysippus' position thus:

> The question arises which one has perished, and [Chrysippus'] claim is that Theon is the stronger candidate…[But] how can it be that Theon, who has had no part chopped

[2] There is in fact an extensive body of literature concerned with this problem. Some of the key texts here include: Burke (1992), Bennett (2004), deRossett (2011), Fine (2008), Moyer (2006), Olson (2001), Sider (2008), Wasserman (2002), and Zimmerman (1995).

[3] For a useful account of the full range of options for interpreting the Dion and Theon paradox see Burke (1994a). For further discussion of the paradox see Burke (1994a, 2004), Carter (1997), Olson (1997), Sidelle (2002), Sider (2001), Stone (2002), Parsons (2004), and van Inwagen (1981).

> off, has been snatched away, while Dion, whose foot has been amputated, has not perished? 'Necessarily', says Chrysippus, 'For Dion, the one whose foot has been cut off, has collapsed into the defective substance of Theon…Therefore it is necessary that Dion remains whilst Theon has perished' (Long & Sedley: 1987, pp. 171—172)

An important problem with this answer to the paradox, as Philo himself points out, is its implication that a material thing could be destroyed by a mere extrinsic change. For, intuitively, no extrinsic or 'mere Cambridge' change could cause a material thing to cease to be (cf. van Inwagen: 1981, p. 78). Accordingly, in order to defend the view that Theon perishes, one has to explain how it is possible for the amputation to destroy Theon, despite changing Theon only extrinsically.

An important problem with this answer to the paradox, as Philo himself points out, is its implication that a material thing could be caused to perish by a merely extrinsic change. For, intuitively, no mere extrinsic change could cause a material thing to cease to be (cf. van Inwagen: 1981, p. 78). Accordingly, in order to defend the view that Theon perishes, one has to explain how it is possible for the amputation to destroy Theon, despite changing Theon only extrinsically.

In this paper, I develop a novel answer to this challenge, which appeals to a broadly neo-Aristotelian mereological framework. The result, I contend, is a novel and attractive account of the paradox of decrease.[4]

[4] The Chrysippian view that Theon perishes has also been defended by Burke (1994a, 1996, 2004). In this paper, I do not engage with Burke's view directly. (But for critical discussion see: Carter: 1997 Stone: 2002 Olson: 1997a, and Sider: 2001. See also Moran: manuscript.) I do in fact believe that my account of the paradox is preferable to Burke's. However, I do not argue for that here.

At the heart of my proposal is that idea at least some of the parts of material substances are dependent parts, which ontologically depend upon their proper wholes. The central claim is that since Theon is a dependent part of Dion, it follows that for Theon to exist, it is necessary for Dion to exist and have a certain structure. Given this view, I claim, we can explain why the amputation destroys Theon, despite changing Theon only extrinsically. In particular, we will be able to explain why this is so in terms of the *intrinsic,* structural change that Dion undergoes. The core idea is that because Theon is a dependent part of Dion, Theon is unable to survive the change in structure that the amputation constitutes for *Dion*, Theon's proper whole.

As we will see, this proposed answer also suggests a parallel solution to a related puzzle, known as the paradox of increase. (For contemporary discussion of this puzzle see Chisholm: 1967, p. 175ff and Olson: 2006; 2007, Ch. 7.3.) This puzzle turns on a variant case, in which Dion is born without a left foot, before having one surgically attached later on. Now, intuitively, once the new foot is attached, Dion should end up with a large proper part comprising all of Dion minus the new foot. Let us again refer to this part as 'Theon'. The question is whether or not Theon exists prior to the surgery. If Theon is already there, then we again have to make sense of coincident objects. Furthermore, we face the difficulty of explaining why it is that Dion grows when the new foot is attached whilst Theon does not. However, it is equally hard to see how Theon could be brought into being when the new foot is attached. How could attaching a foot thereby *create* the corresponding foot-complement? Attaching

a foot to something seems like a strange way to create a further object, of which the foot is not even a part.[5]

What I will argue is that this puzzle can be adequately resolved once we conceive of Theon as a dependent part of Dion. In particular, I shall argue that once we think of Theon as ontologically dependent on Dion in the relevant way, we will be able to make perfect sense of how, in this variant case, attaching a new foot to Dion brings Theon into being.

The paper is structured as follows. In the next section, I set out my proposed view of the paradox of decrease, which aims to vindicate Chrysippus' claim that Theon perishes despite undergoing only extrinsic change (§2). In the following section, I then explain how my proposed account of the paradox of decrease can be extended to the related paradox of increase (§3). The final section of the paper concludes (§4).

2 Dependent Parts

In this section, my aim is to offer an explanation as to how it could be that Theon gets destroyed by a mere extrinsic change. As we will see, this view depends upon a background mereological framework, which is broadly Aristotelian in character, according to which material substances may have both independent and dependent parts.

Broadly speaking, the independent parts of a substance are those which can exist regardless of whether or not the substance that they are contingently part of exists. For example, the particles that now compose me are among my independent parts.

[5] Cf. Olson (2006, pp. 401—402); 'If conjoining two objects adds anything to the furniture of the earth, it ought to be something made up of those two objects. We don't expect it to create a new thing that is just like one of the original things was before the attachment.'

Pretty much all contemporary philosophers allow that objects have independent parts (if they have parts at all). In my view, however, certain material substances also have dependent parts, which can exist so long as the substance they are a part of both exists and has a certain structure. Paradigm examples of such dependent parts are the arbitrary spatial parts of a substance, such as all of me besides my left index finger, or all of Plato besides his beard. What is distinctive of such parts, as Lowe (2002, p. 53) puts it, is that '[their] very identities are dependent upon the persisting objects to which they…belong'.[6] Unlike the independent parts of an object, then, dependent parts are in effect *abstractions from* the whole itself.[7] They are, so to speak, merely 'divided out of' the relevant whole, and in this way presuppose its existence.

In contemporary terminology, (which is itself broadly Aristotelian in flavour), the notion of a dependent part may be stated by means of the notion of 'real definition' (see Fine: 1994, 1995, Johnston: 2007, Rosen: 2015). To give the real definition of a thing is to specify *what it is* for that thing to exist—it is to specify the conditions under which we have something that is that very being. It is when these conditions are met, and *only* when these conditions are met, that the relevant item exists. The thought is that when it comes to dependent parts, their real definition has to mention

[6] The notion of a dependent part has historical precedent. Indeed Aristotle, at least in *The Metaphysics*, may be read as claiming that *all* of the parts of a material substance are dependent parts of it, which can exist only so long as they stand in certain distinctive relations to that very substance (cf. Scaltsas: 1994 and Koslicki: 2008, VI; see also Hoffman & Rosenkrantz: 1997 for a contemporary version of this Aristotelian view). However, it seems to me that this view is rather radical. After all, I am a material substance, and I am composed of various particles—but surely these particles are not dependent beings that exist only when I do, and which depend for their being upon me. Accordingly, it seems to me preferable to recognise that material substances can have both dependent and independent parts.

[7] Cf. Schaffer (2010, p. 324) who speaks of the derivative parts as *mere shards* of the whole, obtained from the whole by *abstraction*. (For Schaffer, every material thing there is, besides the cosmos itself, is a mere shard in this sense, i.e., a dependent being which is abstracted from the cosmos as a whole.)

the material substance that they are a part of. For again, if something is a dependent part, then what it is for that thing to exist is for its proper whole to exist and have a certain mereological structure.

The view that we must recognise both independent and dependent parts has recently been defended by both Lowe (2002, esp. p. 52ff) and Johnston (2002, 2006). Here I will follow Johnston's presentation. In this way, the hope is to bring the notion of a dependent part more clearly into focus.[8]

According to Johnston, each kind of substance is associated with a distinctive principle of unity (or principle of composition) by means of which it is constructed. The things to which this principle applies, moreover, are the independent parts of that substance. Specifying the real definition for a given type of substance is then a matter of specifying its principle of unity, and also the types of independent part to which that principle of unity needs to apply if the relevant substance is to exist. As an example, Johnston considers the real definition of a hydrochloride molecule. He writes:

> Consider HCl, a kind of molecule. The principle of unity for individual hydrogen chloride (HCl) molecules is the relation of *bipolar bonding*. So consider a particular HCl molecule, whose genuine parts involve a hydrogen ion (H+) and a chlorine ion (Cl-). The principle of unity holds of the ions, and its holding is the essential condition for the existence of the molecule…[W]hat it is for a given hydrogen chloride molecule to be is for there to be a hydrogen ion and a chlorine ion together in a bipolar bond…[I]t

[8] Note that while I am drawing on Johnston's mereological views, I do not claim that Johnston would accept my purported solution to the paradox of decrease. What is more likely, in fact, given his commitments elsewhere, is that Johnston would accept the 'coincidentalist' interpretation, according to which Theon and Dion both survive, and end up both spatially and materially coincident (cf. §1)

> follows that bipolar bonding is a principle of unity for hydrogen chloride molecules. (2006, p. 653)

In general, according to Johnston, when *x* is a complex whole of a certain kind, we can provide a real definition of *x*, (i.e. an account of what it is for *x* to be), in terms of (i) its characteristic principle of unity and (ii) its independent parts.

One way to think of this is as follows. Take any substantial whole, *W*. Then take the independent parts of *W*, and 'apply' to those parts the relevant principle of unity. The 'result' of doing so will be the whole itself. For, what it is for *W* to be just is for the principle of unity to apply to those parts. If the independent parts are the *Xs*, and the principle of composition is $\sum$, then what it is for *W* to be is for $\sum$ to be satisfied by the *Xs*. (What it is for $\sum$ to be satisfied by the *Xs* is, moreover, for the *Xs* to satisfy a certain complex relational condition.)

Now in addition to independent parts and principles of composition, we must on Johnston's view also recognise dependent parts and principles of decomposition. In general, whilst independent parts genuinely compose a substance, by means of the relevant principle of unity, the dependent parts of an item are mere arbitrary parts that are disclosed by a principle of division or decomposition. So whereas the independent parts are prior to the whole, which genuinely compose it via an appropriate principle of unity, the dependent parts are posterior to the whole, which are merely 'divided out of it' via a principle of division:

> …we have a *dependent* part of an item when we have a part of an item disclosed by a principle of division…By contrast, *non-dependent* parts of an item are those distinct items that are the relata of a…principle of unity for the item in question. An item is

> genuinely composed out of its non-dependent parts, whereas its dependent parts presuppose and are merely divided out of the item itself. (2002, p. 138)[9]

Johnston goes on to say that principles of unity and division can be thought of as associated with generative functions:

> …whereas a principle of unity can be thought of as associated with a function from given items to another item that those items make up, a principle of division is associated with a function from a given item to items that make up the given item (2006, p. 658)

Thus, whilst we move *from* the independent parts *to* the whole via a principle of unity, we move *to* the dependent parts *from* the whole via a principle of division. The whole is thus *constructed* from its independent parts, whilst the dependent parts are *abstracted* from the whole.

This way of putting things is somewhat metaphorical. There is no temporal process by means of which we move from the independent parts to the whole, or from the whole to the dependent parts. Rather, this talk of movement is supposed to indicate the order of dependence. We move *from* the independent parts *to* the whole because the independent parts are prior to the whole and genuinely compose it. Whereas we move *from* the dependent parts *to* the whole because the dependent parts are

[9] For present purposes, we need not recognise any distinction between 'non-dependent' and 'independent' parts. Rather, we can treat these terms as synonyms. (Johnston, however, in fact allows for a distinction here, in order to allow for symmetric dependence, i.e. in order to be able to claim that some parts are non-dependent without being independent, due to both depending on the whole and also being such that the whole depends on them. But we need not worry about this here.)

posterior to the whole and can exist only because the relevant whole exists and exemplifies a certain structure.

In the same way, talk of *dividing* a dependent part out of a whole is also somewhat metaphorical. The claim is not that a dependent exists only when someone literally divides a whole into those parts. Rather, talk of division is supposed to highlight the way in which the dependent parts of a substance are posterior to it. The real definition of a substance is to be given in terms of its independent parts and a principle of unity for substances of the relevant kind. Thus the whole is defined in terms of its independent parts, and not the other way around. However, the dependent parts of a substance are defined in terms of that substance itself. *What it is for a dependent part to be* is just for the relevant substance to have the relevant mereological structure. It is by virtue of having this structure that the substance satisfies the relevant principle of division, i.e. the principle of division or decomposition by means of which those dependent parts are disclosed.

An example should help to illustrate the distinction between independent and dependent parts. There is an intuitive sense in which the bricks from which a house is made are independent of the house; they existed before the house was built, and could well continue on existing without the house. (Imagine, for instance, that the house is carefully dismantled brick by brick.) Therefore, we should count the bricks as being amongst the independent parts of the house. These are a set of parts from which the house is genuinely constructed, via an appropriate principle of unity. But now consider that part of a house comprising all of it besides one arbitrary segment towards the bottom left corner of the front-facing wall. (This is a part, of course, for which we have no name in ordinary English.) Intuitively, this arbitrary part did not

pre-date the house, and, moreover, could not go on existing without it. It thus appears that we should count this arbitrary spatial part as being amongst its dependent parts.[10] On this view, the arbitrary part is not amongst a set of parts that genuinely composes the house, via an appropriate principle of composition or unity. Rather, the arbitrary part is 'divided out of' the house itself, via an appropriate principle of division. This means that *what it is* for that part to exist is for the house to exist and exemplify a certain structure. The real definition of the arbitrary part thus makes essential reference to the house itself, and to the structure it exemplifies. To specify *what it is for that part to be*, we must mention the house itself.

In fact, arbitrary parts like the part of the house just mentioned are *the* dependent parts *par excellence*. As Johnston writes:

> A paradigm of a mere principle of division is arbitrary spatial or temporal segmentation. You take a spatially extended item, say a material object, and divide it into as many fine-grained spatial slices as you like. These arbitrary undetached spatial parts of the material object typically will be mere dependent parts. (2002, p. 164)

In general, it seems, all that it takes for the arbitrary undetached parts of a substance to exist is for the relevant substance to exemplify the relevant structure. If that is so, then so long as the relevant substance exists, and remains structurally the same, the dependent part will continue to exist. With an appropriate change in structure, however, the dependent part would cease to be.

[10] In discussion, I have come across colleagues who do not share this intuition. Presumably, these philosophers will not find intuitive the more general distinction between independent and dependent parts either. To these philosophers I say that even so, this distinction might still be worth accepting. For in accepting it, we end up with a unified and attractive solution to two difficult (and related) paradoxes, namely, the paradoxes of decrease and increase.

The following serves as a general formula for providing the real definition of a dependent part. We take the proper whole, *W*, and the dependent part in question, *X,* and then we take an appropriate principle of division, Δ_X, which is to be applied to that proper whole. What it is for *X* to exist is then for Δ_X to apply to *W*. (What it is for Δ_X to apply to *W*, moreover, is for *W* to exemplify a certain shape or structure.) It follows that dependent parts always depend for their existence on the existence and structure of their proper wholes.

Take Johnston's example involving the lower-half of a human being. According to Johnston, the lower half of a person is a mere dependent part. This is because all it takes for that part to exist is for the person to exist and to exhibit a certain structure. As Johnston writes: 'What it is for the…lower half of a person's flesh to exist is for the person's flesh to exist and for it to have a lower half…' (2002, p. 137). In our terminology, this view can be stated as follows. If H is the lower-half of a given person, P, then *what it is* for H to exist is for a given principle of division, Δ_H, to apply to P. What is it is for this principle of division to apply to P, moreover, is for P to have the appropriate structure. In particular, P has to be such that a lower-half of flesh can be discerned.[11]

Return now to the case of Dion and Theon. As a mere arbitrary undetached spatial part of Dion, we can maintain that Theon is a merely *dependent part,* which is 'divided out of' Dion by a principle of decomposition. On this view, *what it is for Theon to exist* is for Dion to exist and have a certain structure. For Theon just is, in its nature, that part of Dion which consists of all of Dion besides his left foot. To cap-

[11] Cf. Lowe's example involving the top inch of a wooden pole (Lowe: 2002, p. 53). As Lowe notes, it is plausible to think that for this item to exist, it is sufficient for the pole to exist and to exemplify a certain (spatial) structure.

ture this more precisely, let 'Δ_T' denote the relevant principle of division for Theon. We can then say that what it is for Theon to exist is for Δ_T to apply to Dion, Theon's proper whole.

Given this view of Theon, it is possible to explain why Theon perishes due to the amputation. The reason why Theon perishes is that Theon can no longer be divided out of Dion post-amputation. *For, when you divide a whole along its own spatial dimensions, you obtain only the whole itself*. That is, you do not obtain a dependent part of that whole. For there is, so to speak, nothing to divide that part out of. (Trying to divide Theon out of Dion post-amputation would be like to trying to divide a hemisphere out of a sphere that has already been sliced in half.) In short, whilst Dion still has his left foot, he has the kind of structure out of which Theon can be divided. After the operation, however, this is no longer so.[12]

We can put matters this way. Before the amputation, the principle of division for Theon, Δ_T, applies to Dion; that is, the conditions on Theon's existence are met. However, after the operation, Δ_T does not apply to Dion; and so the conditions on Theon's existence are not met. Accordingly, Theon does not survive the operation. For, whilst *Theon* does not undergo any intrinsic change, *Dion* does undergo such change. And it is this intrinsic change to Dion—a change which alters Dion's shape or structure—that prevents Theon from continuing to exist.

This, then, is the proposed answer to the explanatory challenge with which we started, i.e., that of explaining how a mere extrinsic change could cause Theon's de-

[12] It is common to view entities like Theon as mere aggregates or mere mereological sums, which necessarily continue to exist so long as the relevant particles from which they are composed continue to exist (and, perhaps, be arranged in the relevant way). Given this conception of Theon, it would indeed be hard to see how it could fail to survive the amputation. On my view, however, Theon is no mere aggregate or sum. Rather, it is a dependent part of Dion, which can exist only if Dion has the requisite structure. And this why Theon does not survive the amputation of Dion's left foot.

mise. The view is that the amputation, which constitutes a mere extrinsic change for Theon, also constitutes an intrinsic change to Dion, one which alters Dion's mereological structure. This intrinsic, structural change to Dion is then what brings it about that the dependent part, Theon, does not continue to exist.

The upshot is that Chrysippus' answer to the paradox can be vindicated. What we can claim is that, whilst Dion survives the amputation, the same cannot be said of Theon, given Theon's status as a dependent part. For since Theon is a dependent part of Dion, which cannot therefore survive certain intrinsic changes to its proper whole, it follows that Theon is unable to survive the amputation. And this entails the view that Chrysippus defends, namely that whilst Dion survives, Theon does not.

In the following section, I will explain how it is possible to extend this reply to a related and structurally similar puzzle, known as the paradox of increase. Before that, however, I want to address a couple of worries that one might have regarding my proposed answer to the paradox of decrease.

The first concern I want to address is whether or not my proposed interpretation of the Dion/Theon story really does furnish us with a *general* solution to the paradox of decrease. At the start of this paper (§1), I noted that the Dion/Theon case is just one instance of a more general problem, which arises across a whole range of cases. The present question, then, is whether or not my view of the Dion/Theon case will generalise, so that we end up with a general solution to the paradox of decrease, rather than a more limited solution that applies only to certain cases.

In general, the paradox of decrease arises whenever we have a material substance O with some proper part P and some larger proper part O-P (whereby O-P comprises all of O besides P), such that O could lose P without ceasing to be. The worry is

that if indeed O loses P, then since material things like O-P necessarily survive extrinsic change, both O and O-P will survive O's loss of P, so that O will come to be coincident with O-P, despite the fact that intuitively, it is not possible for distinct material things to be related in this way (cf. §1).

Again, the Dion/Theon story is one instance of this more general puzzle. What I maintain is that since Theon is a dependent part of Theon (in the relevant sense), we can plausibly claim that Theon *is* in fact destroyed by the amputation, despite only undergoing extrinsic change, which means that we do not end up with coincident things. It should be clear, however, that if this answer to the Dion/Theon puzzle is going to generalise, then it has to be plausible to maintain that in *all* the relevant cases, we can plausibly view the large proper part, O-P, (whatever exactly it is) as a dependent part of O (whatever exactly *it* is), which can exist only so long as O has a certain structure. One might, however, worry whether it really will be plausible to say this of O-P across the whole range of relevant cases.

As it turns out, it can be argued that my solution does indeed generalise. To do this, we must appeal to two ideas. The first idea we've already encountered. This is the thought that the arbitrary undetached spatial parts of a substance are *paradigmatic* cases of dependent parts (cf. again Johnston: 2002, p. 161) The second idea is that whenever we have an instance of the paradox of decrease—i.e., a case wherein some material substance O has a proper part P and a proper part O-P, whereby O can lose P without ceasing to exist—it will invariably turn out that O-P is an arbitrary undetached spatial part of P. The point is that once we put these two ideas together, then we end up with a principled reason for thinking that across all the relevant cases, we can conceive of the large proper part O-P as being a dependent part of the relevant

material substance, O. But if that is right, then my answer to the Dion/Theon cases does indeed generalise.

There is one further point that is worth making here. This is that the Dion/Theon story (at least as I am thinking about matters) is a *paradigmatic*, and thus *representative*, instance of the paradox of decrease. For what this seems to show is that it is, at the very least, a plausible working hypothesis that any successful account of the Dion/Theon case can be extended to the other instances of the paradox. My present point is that if this is right, then this constitutes further reason for thinking that my proposed solution constitutes a fully general response to the paradox, rather than being a more limited response that only deals with one specific case. The burden of proof, therefore, I think lies squarely with the objector, to locate an instance of the paradox that cannot be resolved by claiming that O-P is a dependent part of O.[13]

I want now to consider a second, related worry about my proposed account. This concerns whether, even granting everything I say about the Dion/Theon story, we might still be able to generate instances of the paradox. Let us focus on one specific instance of this worry.

To capture the claim that Theon is a dependent part of Dion, which is the kind of thing that can exist only when Dion has a certain structure, I have claimed that we can think of Theon as the output of a certain decomposition function Δ_T (as applied to Dion). The core idea is that since this function fails to yield any entity after the

[13] A final point is worth making here is this. Suppose we grant that in at least certain cases, we cannot to claim that O-P is a dependent part of O. It seems to me that even if this were the case (though I deny that we must grant it is), we could remain confident that there is at least a large class of cases, which are all putative instances of the puzzle, wherein we can plausibly view O-P as a mere dependent part of O. If that is right, however, then my response to the Dion/Theon case can at the least be generalised across this class of cases. But this already seems like genuine progress, even if it does turn out that there are some instances of the paradox that we have yet to adequately resolve.

amputation (due to the fact that Dion has the wrong structure), we can explain why Theon perishes. One might worry, however, that there is nothing to stop us from recognising a more lenient decomposition function 'Ω_X', which, like the original function, delivers an entity that occupies Theon's location before the amputation, but which also, *unlike* the original function, still delivers an entity even after the amputation has taken place. The trouble is that if there is an entity whose real definition can be given in terms of this more lenient function, then will still end up facing an instance of the original paradox, the claim that Theon is a dependent part of Dion notwithstanding. For *this* entity will exist before the amputation, and will moreover continue to exist afterwards, and so will end up coincident Dion.

The problem with this objection, it seems to me, is this. For the objection to succeed, it would have to be the case that we must recognise an entity whose real definition can be given in terms of the new decomposition function Ω_X. For it is only if there is such an entity, call it 'X', that we once more end up with the threat of coincidence post-amputation. It seems to me, however, that there is no good motivation for believing that any such entity exists.

To see why this seems right, note that if X exists at all, it is distinct from Theon. This is because Theon and X have different properties: X can survive the amputation whilst Theon cannot. It follows that if we believe that X exists, then this is tantamount to holding that *in addition* to Theon, there is another entity with which Theon is coincident, even before the amputation, whereby this entity is defined by the more lenient function Ω_X, and hence will continue to exist after the amputation. But why should we believe in any such being? There is, it seems to me, some pressure to

think that Theon exists.[14] However, once we have recognised this much, what reason is there for thinking that there is also a further entity, X, which is really defined by the more lenient function Ω_X (and which, therefore, is distinct from but coincident with Theon)?

One would of course have to accept this if one held the *for every available essence, there is an actual object that has it*, so that we end up with a plenitude of objects.[15] For given this view of matters, then just as there is an entity (Theon) whose real definition is given by the more stringent decomposition function Δ_T, so too there must be a further entity (X) whose real definition is given by the more lenient decomposition function Ω_X. It is unclear, however, where exactly this gets us. For the idea that for every essence, there is an actual object that has it, is a radical view, with various paradoxical consequences.[16] It seems therefore far from incumbent on us to accept it. (There may even be positive reason for rejecting it.) However, if we do not accept this view, then we appear to lack adequate reason to think that X exists. But this means that the present objection does not get off the ground.[17]

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[14] What exactly is the pressure to believe that Theon exists? This seems to me to derive from two ideas. First, that everyday ontology recognises entities such as hands and feet, etc. Second, that it would be intolerably arbitrary to believe in hands and feet but not in the complements thereof. It follows that if we are to hold on to the commitments of ordinary ontology (and I assume that there is good reason to do this), then must recognise entities such as Theon exist (cf. here Olson: 1995; van Inwagen: 1981). As this brings out, the pressure to believe in Theon does not derive from the doctrine that any for set of parts whatever, that set of parts has an arbitrary mereological sum. For in my view this doctrine is implausible, and there are good reasons to be suspicious of it, cf. fn. 12 above.)

[15] For recent defenses of this kind of plenitudinous ontology see for example Hawthorne (2006), Johnston (2006), and Yablo (1987), amongst several others. (For an account as to how we can avoid having to accept this view in the face of arguments from arbitrariness and the like see Korman: 2016.)

[16] For instance, as Sosa (1987) notes, this view implies that there is an 'explosion of reality', i.e., that there are vastly more entities in existence than commonsense supposes. In addition, this view gives rise to the problem of many persons (see Chihara: 1994), and, relatedly, the problem of personites (see Johnston: 2016). We therefore seem to have good reason to avoid accepting this position.

[17] N.b. also that there is something dialectically off about appealing to this plenitudinous ontology in the present context. As I mentioned at the outset of the paper (§1), my aim here is to offer a solu-

I conclude, then, that we can plausibly take my proposed response to the Dion/Theon puzzle as illustrative of a more general approach to solving the paradox of decrease. Moreover, I conclude that we can plausibly claim that if we adopt the advertised mereological framework, then instances of the paradox are not going to arise.[18]

3 The Paradox of Increase

The answer to the paradox of decrease that I defend in this paper (§2) appeals to the idea that material wholes have both independent and dependent parts. In this section

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tion to the paradox of decrease that does not require us to believe in material coincidence. But anyone who believes that every available essence is realised must be a believer in coincidence—indeed she has to hold that every matter-filled spatial region is literally packed with distinct material things (cf. Bennett: 2004). So insofar as we feel the need to offer a solution to the paradox of decrease that does not appeal to material coincidence, we should also be disinclined to hold that for every available essence, there is an actual object that has it. Thus, it does not seem dialectically effective in the present context to appeal to a theory which entails that material coincidence is indeed possible (due to being actual).

[18] There is one final worry I want to deal with. Theon is a mereologically complex object. And indeed it is presumably composed out of a sub-set of the particles that compose Dion (this is pre-amputation). Moreover, I am prepared to grant that the particles composing Theon are independent parts of Dion. The question is: if Theon is composed of these independent particles, then it looks like Theon is the product of a generative composition function running from the particles to Theon itself; yet this in turn seems to make Theon look like an independent part of Dion. But I claim that Theon is a dependent part of Dion. (There is also the worry that Theon is now generated as it were in two different ways: once in an 'upwards manner' from certain particles via a principle of composition, and then again in a 'downwards manner' from its proper whole, Dion, via a principle of decomposition. But this looks problematic too.) My reply here is essentially this. Theon is indeed composed from the relevant particles and has those particles as proper parts. However, its real definition is not given by any composition function moving from those particles to Theon. Rather, its real definition is given by a decomposition function taking us from Dion, Theon's proper whole, to Theon itself. And this is what makes Theon an dependent part of Dion. In short: Theon's status as a dependent part depends on which composition/decomposition functions enters into the real definition of Theon, and not simply on which composition/decomposition that happens generate Theon. Thus, whether Theon is dependent or else independent is not just a matter of which generative functions apply to it, but rather a matter which generative functions (and how they are to be applied) enter into its real definition. (As for Theon being 'generated' in two ways: I see this as unproblematic given that it doesn't make Theon both an independent and a dependent part of Dion at once. For all it boils down to is this: Theon is both composed from certain particles and also decomposed from a particular substance. But where's the problem here> So long as we distinguish between the composition/decomposition functions that happen to apply to a given item from those that enter into or even partly (if not fully) constitute its real definition on the other, there is arguably no trouble. (Thanks to Ralf Bader for discussion here.)

of the paper, I shall argue that by appealing once again to this idea, we can offer a parallel solution to the related and structurally similar paradox of increase.

Consider a variation on the original Dion and Theon puzzle (the one that we mentioned towards the end of §1.) This time, we imagine that Dion is born without a left foot. He then at some later time has a left foot surgically attached. After the surgery, it is true to say of Dion that he possesses a large proper part, which comprises all of Dion minus his newly acquired left foot. Let us refer to this part once more as 'Theon'.

The question is, did Theon exist before the surgery? If the answer is yes, then we must say that prior to the foot being grafted on, Dion and Theon were in exactly the same place at exactly the same time, composed of exactly the same matter. But this is just as problematic as saying that Dion and Theon end up coincident post-amputation in the original case. So it appears we have to say that Theon is created by the surgery, and so did not exist before it. However, this also leaves us facing a problem, *viz.*, that of explaining how attaching a new foot to Dion could bring it about that a further object, which is roughly the same size as Dion, comes into being. For is it not somewhat mysterious to suppose that in giving Dion a new left foot we thereby create a further material object, one which does not even have that foot as a part?

This puzzle—the paradox of increase—is of course structurally similar to the paradox of decrease we have been considering. Accordingly, it would be natural to think we can offer a unified solution to these problems. (Despite this, I do not know of one that has been explicitly offered in the literature.) I will now show that in light of our response to the paradox of decrease, we can indeed offer a unified solution.

Given our theory of dependent parts, we can defuse the paradox of increase in the following way. What we can say is that whilst Theon is indeed created by the act of attaching the new left foot to Dion, there is nothing mysterious about this occurrence. On the contrary, this is exactly what we would expect, given the nature of Theon. For *what it is for Theon to be* is just for Dion to exist and have a certain structure; a structure that enables Theon to be divided out of him. However, Dion only comes to have this structure after the new foot is attached. Therefore, it is only after the foot is attached that the conditions on Theon existing come to be satisfied. Hence, it is in fact totally unmysterious that Theon is created by the operation.

In the terminology of the last section, the point can be put in this way. For Theon to exist is for the principle of division Δ_T to be applicable to Dion. This principle of division, however, is *not* applicable to Dion prior to the foot being attached. On the contrary, it only comes to apply to Dion afterwards. Therefore, it is only once the foot is attached that Theon comes to be. For it is only then that the conditions on Theon's existence, as specified by Theon's real definition, are met.

If we adopt this view, then we end up with a unified solution to two structurally similar paradoxes. The key is to claim, in each instance, that Theon is a dependent part of Dion, which is destroyed in the decrease case and created in the increase case. Again, the explanation as to why this is so is that since Theon is dependent part of Dion, Theon can only exist when Dion has a certain structure. Yet Dion only has this structure pre-amputation and post-attachment, and so can exist only at those times.[19]

[19] Again, I think that this solution easily generalises. The paradox of increase arises whenever an object O gains a part P, such that we seem to end up with O having a further proper part O-P, comprising all of O besides P. The question then is whether O-P already existed before P is attached to O, or else instead only comes into being after P is attached. Initially, both options seem implausible. However, since in such cases the larger proper part O-P will typically be an arbitrary spatial part of O,

4 Conclusion

Thus, we have seen that in order to defend the interpretation of the paradox of decrease set out by Chrysippus, we can appeal to the doctrine of dependent parts. The initial trouble with Chrysippus' view is that it leaves us facing an explanatory challenge, *viz.* that of explaining how a mere extrinsic change could cause a material thing to perish. What I have argued is that by appealing to the doctrine of dependent parts, this explanatory challenge can be met. Moreover, it has been shown that by appealing to the doctrine of dependent parts, we can also offer a compelling solution to the related paradox of increase. In this way, we end up with a unified account of two structurally similar paradoxes.[20]

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and so a mere dependent part of O, we can plausibly claim that O-P will be created by the attachment of P, on the basis that it is only once P is attached to O that the conditions on O-P existing are met.

[20] I presented a version of this material at the Cambridge Serious Metaphysics Group; I would like to thank all participants for their comments on that occasion, especially Hugh Mellor and Rae Langton. I would like to sincerely thank Tim Crane and Ralph Weir, who read over the manuscript and made very helpful comments. Ralf Bader also provided very helpful comments on a penultimate draft. Lastly, I would like to thank my fiancée, Laura Franchetti, both for the philosophical help she gave me in writing this paper, and for her constant support in countless other ways. The research for this paper was completed at the universities of Oxford and |Cambridge. My time at Oxford was supported by a T. H. Green Scholarship, and I have been supported at Cambridge by an AHRC-Walker Studentship, hosted by the Faculty of Philosophy and Queens' College, as part of the AHRC Doctoral Training Partnership (grant number AH/L503897/1). I am also presently being funded for my fourth year at Cambridge by a Jacobsen Studentship and an Aristotelian Society Bursary. I wish to express my sincerest thanks to these institutions for their kind and generous support.

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