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ORIGINAL RESEARCH

Determinables, location, and indeterminacy

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Abstract
Discussions about determinables and determinates, on the one hand, and discussions about (formal) theories of location, on the other, have thus far proceeded without any visible interaction, in substantive mutual neglect. This paper aims to remedy this situation of neglect. It explicitly relates (theories of) determinables and (theories of) location. First, I argue that some well known principles of location turn out to be instances of principles relating determinables and determinates. Building on this I then argue that theories of location present formidable counterexamples to those principles about determinables and determinates. One such counterexample in particular is used as an argument against disjunctivism. Finally, I relate the entire discussion to yet another crucial debate in metaphysics, that of metaphysical indeterminacy.

Keywords Determinables and Determinates · Location · Disjunctivism · Metaphysical indeterminacy

1 Introduction

Discussions about determinables and determinates, on the one hand, and discussions about (formal) theories of location, on the other, have thus far proceeded without any visible interaction, in substantive mutual neglect. This paper aims to remedy this situation of neglect. It explicitly relates (theories of) determinables and (theories of) location.

First, I argue that some well known principles of location turn out to be instances of principles relating determinables and determinates. This is important: or so I contend. For theories of location then present formidable counterexamples to those principles about determinables and determinates. One such counterexample in particular provides an argument against what is arguably the most widely held reductionist account of determinables, namely disjunctivism. Finally, I relate the entire discussion to yet another crucial debate in metaphysics, that of metaphysical indeterminacy.

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2 Determinables, determinates and determination

As a first pass,[1]

> Determinables and determinates are in the first instance type-level properties that stand in a distinctive specification relation: the "determinable–determinate" relation (for short, "determination"). For example, *color* is a determinable having *red*, *blue*, and other specific shades of color as determinates; *shape* is a determinable having *rectangular*, *oval*, and other specific (including many irregular) shapes as determinates; *mass* is a determinable having specific mass values as determinates (Wilson 2017b: Introduction).

Determinables, determinates and the determination relation are usually characterized by a *list of features*.[2] Wilson (2017b) lists fourteen different such features. In what follows I will focus on two of them, namely **Requisite Determination**, and **Unique Determination**.[3] As Wilson formulates them:

Requisite Determination: If x has a determinable Q at time t, then, for every level L of determination of Q: x has some L-level determinate P of Q at t.[4]

Unique Determination: If x has a determinable Q at time t, then x has a unique—one and only one—determinate P at any given level of specification at that time.[5]

Let me introduce a simple formal notation.[6] This will prove helpful in due course. Also, let me simplify things a little. First simplification: I will omit talk about time(s). Second simplification: I will (mostly) consider two levels of specification, namely *minimally*

[1] For an introduction see Wilson (2017b) and references therein.

[2] There is no common agreed *core* list of such features, yet some are more central than others.

[3] See Wilson (2017b, §2.1).

[4] Some other formulations employ modal operators. I will not consider such a complication in the paper.

[5] This formulation might be too strong. Consider the minimally specific determinable D = *mass*. And consider the two determinates D' = *having a mass between 2 and 6 pounds*, and D'' = *having a mass between 3 and 7 pounds*. Now, suppose x has a maximally specific determinate d = *having a specific mass value = 4 pounds*. Arguably, D' and D'' are at the same level of specification of D. And x has both of them at the same time. This would constitute a counterexample to Unique Determination, as it is formulated in the text. One solution would be to restrict Unique Determination to the *maximally specific level*, i.e., to the level of *maximally specific determinates*. In what follows I focus explicitly on the maximally specific level.

[6] The formalization adopted in what follows was chosen in order to make the relation between principles about determinables and principles about location as transparent as possible. I should notice that said formalization is loosely inspired by the classic reference in the literature on determinables, that is, Johnson (1921, pp. 173–185). Johnson writes: "We propose to use a capital letter to stand for a determinable, and the corresponding small letter with various dashes to stand for its determinates" (Johnson 1921, p. 179). Semi-formal classic treatments of determinables are found in Prior (1949a, b) and Yablo (1992). Classic formalizations that are different from the one proposed here are in Denby (2001) and Funkhouser (2006). These treatments differ from mine insofar as their formalizations *entail* Requisite Determination and Unique Determination. Yet a further different formal treatment is in Fine (2011). Fine's formalization crucially depends on his notion of *state*. It would be interesting to inquire how Fine's *Directed Completeness* relates to failures of Requisite Determination and more in general to disjunctivism, which will be the focus of Sect. 4.4.

specific determinables, and *maximally specific determinates*. The thought here is that determinables admit of different levels of specification, so that the characterization of a property as determinable and determinate is relative to levels. The paradigmatic case is that of color. But it will be more helpful for what follows to focus on another case Wilson mentions explicitly, namely mass: *Having a mass between 34 and 43 pounds* is a determinate of *mass*, but a determinable of *having a specific mass value = 37.73 pounds*. Minimally specific determinables are roughly properties that are not determinates of any other determinable. Conversely, maximally specific determinates are properties that are not determinables of any other determinate. The reader can convince herself that these simplifications are harmless.

For any minimally specific determinable D, let $D^* = \{d_1, ..., d_n\}$ be the (possibly infinite)[7] set of maximally specific determinates of D, and let $D(x)$ and $d_i(x)$ abbreviate "x has (minimally specific) determinable D", and "x has (maximally specific) determinate d_i" respectively.[8] Then, we can write—in higher-orderese—Requisite Determination, and Unique Determination as follows:

$$\textbf{Requisite Determination} \qquad (\forall D)(D(x) \rightarrow (\exists d_i \in D^*)(d_i(x)) \tag{1}$$

$$\textbf{Unique Determination} \qquad (\forall d_i, d_j \in D^*)(d_i(x) \wedge d_j(x) \rightarrow d_i = d_j) \tag{2}$$

3 Location

Theories of location attempt to give a precise characterization of different locative notions—capturing different ways an object can be located at a region of space (at a given time)—and their relations. One can use different primitive notions and then go on to define other locative notions in terms of such primitives and standard mereology (or set-theory).[9] One option is to take *exact location* (@) as primitive.[10] The following is the somewhat orthodox gloss on @:

> "[A]n entity x is exactly located at a region y if and only if x has (or has-at-y) exactly the same shape and size as y and stands (or stands-at y) in all the same spatial or spatiotemporal relations to other entities as does y" (Gilmore 2018, §2.1).

Another option is to start from *weak location* ($@_\circ$) instead.[11] Weak Location is location in "the weakest possible sense", as Parsons (2007) puts it: x counts as weakly located at a spatial region r iff r is not completely free of x. It captures the weakest sense in which an object x is *in* a region r.

[7] As a matter of fact, I will focus on *finite* cases for the sake of simplicity, but D^* can be an infinite, even uncountable set. Details about the cardinality of D^* will play a role in the argument in Sect. 4.4.

[8] Slightly abusing formal notation.

[9] For an introduction see Varzi (2016). Following Varzi I take parthood as a primitive, and write $x \sqsubseteq y$ for "x is part of y". Other mereological notions I will use include *proper parthood*—$x \sqsubset y = x \sqsubseteq y \wedge x \neq y$—, and *overlap*—$x \circ y = (\exists z)(z \sqsubseteq x \wedge z \sqsubseteq y)$.

[10] See e.g. Casati and Varzi (1999), Hudson (2001), Sattig (2006), Hawthorne (2008) and Donnelly (2010).

[11] See Parsons (2007) and Eagle (2010).

These two notions are enough to introduce the two locative principles that take center stage in the rest of the paper, namely *Exactness* and *Functionality*,[12] respectively (3) and (4) below:[13]

$$\textbf{Exactness} \qquad (\exists r_1)(x @_{\circ} r_1) \rightarrow (\exists r_2)(x @ r_2) \tag{3}$$

$$\textbf{Functionality} \qquad x @ r_1 \wedge x @ r_2 \rightarrow r_1 = r_2 \tag{4}$$

Exactness claims that something that has a weak location also has an exact location, whereas Functionality claims that everything has a unique exact location.[14]

4 Determinables and location

In this section, I first put forth the background that is used in the rest of the paper (Sect. 4.1). Then, I argue that Exactness and Functionality are instances of Requisite Determination and Unique Determination (Sect. 4.2). I go on to discuss known failures of both. (Sect. 4.3). Building on one such failure, I give an argument against a particular reductive account of determinables, namely disjunctivism. (Sect. 4.4).

4.1 Preliminaries

Theories of location usually start from a particular locative *relation*. Metaphysicians working in theories of determinables are more familiar with another terminology, that of an object having the determinable *position*. And in fact position has usually been thought to display a determinable–determinate structure, parallel to that of *mass*. *Having (the determinable) position*—like having (the determinable) mass—is supposed to be the minimally specific determinable property, whereas having *a specific position*—like having a specific mass value—is supposed to be the maximally determinate property.

Having (the determinable) position simply means *being somewhere* in space. Given what I said so far about locative relations, this translates in *being weakly located* somewhere.

12 The names, especially Functionality, might strike as not particularly explanatory. The thought behind it is that, as Parsons (2007) puts it, Functionality makes location a *function*. As a matter of fact, if assumed together with Exactness, it makes location a *total* function over the domain of spatial entities, that is, those entities that are weakly located in space. A perhaps more immediately transparent name for Functionality would be **Uniqueness of Exact Location**. This would also signal its intimate relation with Unique Determination, which will be explored in what follows. Given that Functionality has become the somewhat standard term in the literature on formal theories of location though, I will stick to it.

13 Interestingly enough, if we take @ as primitive and define $@_{\circ}$ as: $x @_{\circ} r \equiv_{df} (\exists s)(x @ s \wedge r \circ s)$, then Exactness follows. One might press the point that this is problematic, given the discussion in Sect. 4. As I pointed out, Parsons (2007) and Eagle (2010) take $@_{\circ}$ as a primitive and go on to define @ in its terms. Their definitions are however substantially different. It turns out that, given Parsons' definition Functionality follows, whereas this is not true for Eagle's definition. Thus, Eagle's theory admits the possibility of *multilocation*. I believe that the theory of location Eagle presents faces independent problems, but clearly such a discussion goes beyond the scope of this paper.

14 The picture I just sketched is *substantivalist* insofar as it does not attempt to *reduce* spacetime regions to something else.

Here is a passage from Alisa Bokulich that clearly reflects what I set forth. She is interested in particular quantum systems, the so-called *entangled systems*. I am choosing this particular passage, because it will play a role later on:[15]

> In quantum theory it is more typically the case that the degree to which the particle's momentum is specified allows us to say, for example, that the particles is located *somewhere in this room*, although it is not possible to say that is located in any particular point in the room. In other words, while it makes sense to talk about the particle *having the property of position* (that is to say the particles are in the room), that property cannot be ascribed a definite (precise) value (Bokulich 2014, p. 467, italics added).

So I shall *assume* that x has the *determinable position* P iff it is weakly located somewhere, that is at a region of space, given that every region is part of space. Letting $P^* = \{p_1, \ldots, p_n\}$ be the set of maximally specific determinates of P for a particular object x, the claim that x has P iff it is weakly located somewhere translates into:

$$P(x) \leftrightarrow (\exists r)(x @_\circ r) \tag{5}$$

The biconditional above is enough for the purpose of the paper. However one might want to explore stronger views, for instance one according to which having a weak location *just is* having position. Using λ-abstraction we can write this as:

$$P = \lambda x (\exists r)(x @_\circ r) \tag{6}$$

Given that the biconditional in (5) may fall short of being a *definition*, I take it that (6) entails (5) but the converse does not hold.[16]

Let me move on to the maximal determinate property of *having a specific position*. This translates into the property of having an exact location $p_i \in P^*$. Consider point-particles, for the sake of simplicity. The candidate exact locations of the point-particles, assuming a realist understanding of space, will be the (set of) spatial points. Having a maximally specific position boils down to being exactly located at one of these spatial points p_i':[17]

$$(\exists p_i \in P^*)(p_i(x) \leftrightarrow x @ p_i') \tag{7}$$

Analogously to the case of weak location we can strengthen (7) into (8):[18]

$$p_i = \lambda x (\exists p_i')(x @ p_i') \tag{8}$$

[15] See Sect. 4.3.

[16] Another way to express it is to use *generalized identity* ($\equiv_x$). The claim would then be "to have position *just is* to be weakly located at a region", formalized as: $P(x) \equiv_x (\exists r)(x @_\circ r)$. I am not taking a stand here, nor I need to. For generalized identity see Dorr (2016) and Correia and Skiles (2019).

[17] I used the superscript because, strictly speaking p_i-s are maximally determinate properties, whereas p_i'-s are spatial regions.

[18] Naturally enough, we could use *generealized identity* here as well.

To further stress the point, let me provide an illustration. Consider a point-particle, and forget for a minute about quantum complications. In classical physics the notion *spacetime trajectory* is well-defined. Call r the region corresponding to the entire space-time trajectory of the particle in question. This is known as *the world-line* of the particle. It is a one-dimensional curve in space-time. At every instant t of its existence, the particle has the determinable position, that is, there exists a region at which it is weakly located, for instance it is weakly located at r. Not only, at every instant of its existence—given classical physics—the particle also has an exact location. In particular, at each instant t_i it will be exactly located at one particular point $p_i \in r$.

As far as I can see, what I put forth reflects orthodoxy. So I will take that the burden of the proof is on the objector, i.e., someone who does not believe that position has a determinable–determinate structure that is (somehow) reflected in (5)–(7). In any case, the following arguments can be read in *conditional* form. That is to say, they can be read as establishing what they establish if position is indeed taken to have such a structure.

4.2 Location principles and determination principles

I now shall argue that Exactness is a but an instance of Requisite Determination, and that Functionality is but an instance of Unique Determination. Given (5) and (7), we can re-write Exactness as follows:

$$\textbf{Exactness} \qquad P(x) \rightarrow (\exists p_i \in P^*)(p_i(x)) \tag{9}$$

In the same vein, we can re-write Functionality as:

$$\textbf{Functionality} \qquad (\forall p_i, p_j \in P^*)(p_i(x) \wedge p_j(x) \rightarrow p_i = p_j) \tag{10}$$

This is where the adoption of the simple formal notation I introduced pays off. Upon inspection, we immediately recognize that (9) is just an instance of (1), and (10) is just an instance of (2). This simple argument establishes what was promised: Exactness is a an instance of Requisite Determination, and Functionality is an instance of Unique Determination. One might protest that this is not surprising: after all, if position has a determinable structure, why shouldn't principles governing position be instances of principles governing determinables? There is a grain of truth here. But, first, I contend that seeing the details behind the general claim is important in and on itself. Second, what is important is that whereas Requisite Determination and Unique Determination are widely held principles of determination, failures of Exactness and Functionality are well-trodden territory in theories of location. This is crucial: theories of location might offer serious, neglected counterexamples to principles of determination. It is to those failures that I now turn to.[19]

[19] There is a worry that I want to briefly discuss. It is a general unease in picking two principles out of two broadly axiomatic systems and discuss them independently from such broader systems. As I mentioned in Sect. 2, Wilson (2017b) lists fourteen different principles relating determinables and determinates. What if they make some sort of "a package deal", so that cherry-picking some of them is not a viable option? I find

4.3 Locative failures

So far, I presented an argument to the point that Exactness is but a case of Requisite Determination, and Functionality is but a case of Unique Determination. Failures of both locative principles are indeed well-trodden territory in the literature on theories of location. It is not my purpose to take a stand here. It might turn out that some cases can be dismissed, or explained away, or handled, or what-have you. But it is undeniable that metaphysicians take them seriously. Thus, if the arguments here hold water, metaphysicians should also take them as serious counterexamples to principles of determination.

Failures of Exactness might arise as a result of the mismatch between the mereological structure of objects and space.[20] Suppose you have atomic point-particles but space is gunky, i.e., every region of space admits of further proper parts. A case in point would be Whiteheadean space.[21] These point-particles would not have any exact location. Yet they would certainly be somewhere in space, that is, they would be weakly located somewhere. Thus they would violate Exactness.

Footnote 19 continued
this suggestion interesting. If it is on the right track it seems I am not allowed to discuss counter-examples to some principles without embedding them into the larger context. I am not sure how to make this worry more precise so as to turn it into a fully-fledged objection. But I think a few things can be said in response to the general strategy here. In order to do so, I will compare this situation to similar ones we encounter when dealing with other broadly axiomatic systems. The first example I have in mind is *mereology*. It is usually considered part and parcel of the notion of part that it obeys some form of *supplementation*. Different supplementation principles have been proposed: *quasi-supplementation*, *weak company*, *weak supplementation*, *strong supplementation* and the like. As a matter of fact, the philosophical discussion centers around how to pick the "right" axiom, so to speak—i.e., that axiom that captures the relevant supplementation intuition without thereby committing one to (allegedly) unwarranted consequences, such as extensionality. It is crucial to this discussion that we can discuss logically independent principles *independently* from one another. The anti-extensionalist that objects to strong supplementation by way of counter-examples does not need to bring into the discussion the partial ordering axioms for parthood. As a matter of fact, some of the arguments crucially depends on holding the partial ordering axioms *fixed*. That is to say, when it comes to mereology, *we do not look at logically independent principles as a package deal*. The second example is *identity*. There is a raging controversy about the *Identity of Indiscernable*. In the discussion about alleged counter-examples to the principle, other principles about identity such as its being an equivalence relation, or even the *Indiscernibility of Identicals* are held fixed. In this case, too, we discuss logically independent principles independently from one another. We don't look at them as a package deal. I am confident these are not the only examples: dependence and grounding come to mind as well. I admit that this falls short of an argument. Perhaps the case of determinables and determinates is relevantly different from the cases I discussed. But I think that at this stage of the argument, this is enough to *shift the burden of the proof*. The examples show that we usually do not treat broad axiomatic systems as a package deal. We *can*, and in fact *do*, discuss individual principles independently from one another, especially when considering possible counter-examples. And this is exactly the strategy I followed. It is up to the objector to make the case that the principles relating determinables and determinates are an exception to this widespread practice. Thanks to a referee for this journal for pushing this point.

[20] See e.g. Parsons (2007, §3).

[21] For an introduction see, e.g. Gruszczynski and Pietruszczak (2009). For consequences of Whitehedean space for theories of location see Leonard (2018).

Parsons (2007) discusses *omnipresent* objects in junky space as well. His own way of framing things is a little problematic in this context,[22] but just a small tweak is needed to get the example up and running. Say that an object is *omnipresent* iff it is weakly located at every region. And say that space is junky iff every region is a proper part of yet another region. Then, omnipresent objects in junky space would violate Exactness. The argument goes roughly as follows.

Suppose an omnipresent object,[23] call it *oo*, has an exact location, r. Then r is the maximal region, i.e., the fusion of all regions of space. To see this, suppose r is not the maximal region. Then there is a region s that is disjoint[24] from r, such that *oo* is not weakly located at s. But this goes against our assumption that *oo* is omnipresent. So, if *oo* has an exact location r, then r is the maximal region. On the other hand, junky space rules out the existence of such a maximal region. So *oo* does not have any exact location in junky space. Yet it has a weak location. As a matter of fact it is weakly located everywhere. This constitutes another counter-example to Exactness.

Finally, counter-examples to Exactness come from quantum mechanics.[25] In a nutshell, according to standard quantum mechanics, measuring the momentum of a given particle leaves its position *maximally indeterminate*. Let me recall part of the Bokulich's passage I already introduced:

> In other words, while it makes sense to talk about the particle having the property of position (that is to say the particles are in the room), that property cannot be ascribed a definite (precise) value (Bokulich 2014, p. 467).

The passage above suggests that quantum particles can have a weak location without thereby having an exact location, thus violating Exactness.[26]

Let us pass to failures of Functionality then. The failure of Functionality entails that something can have more than one exact location. In effect, this phenomenon (or its possibility) is most commonly referred to as *multilocation*. Literature on multilocation is literally too vast to mention.[27] There are two paradigmatic examples of multilocated entities: immanent universals, and three-dimensional objects, according

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22 Parsons takes an omnipresent object to be an object that pervades every region—where pervasion ($@_>$) is defined in terms of weak location as: $x @_> r \equiv_{df} (\forall s)(s \circ r \rightarrow x @_\circ s)$. Yet, according to his own formal system, if something pervades a region it has an exact location.

23 Some might think that there is in fact only one ominpresent object, namely God. Sometimes this view is called *panentheism*. McTaggart considers panentheism in his *Some Dogmas of Religion*. For a discussion see Geach (1979, p. 163). See also Simons (2014). Thanks to Kevin Mulligan here.

24 That is, not overlapping.

25 For some insightful remarks on location in quantum mechanics, see Pashby (2016). Disclaimer: I do not agree with everything Pashby writes about quantum location. In any event, even Pashby agrees that a physical system, say a particle, that is not confined to any bounded region—i.e., a region with finite Lebesgue measure—has a weak but not an exact location. This is enough for Exactness to fail.

26 Kleinschmidt (2016) presents yet another violation of Exactness. Her example—the almond in the void—is a little more cumbersome. Take @ as a primitive and define weak location as follows: $x @_\circ r \equiv (\exists y)(y \sqsubseteq x) \wedge (\exists r_1)(x @ r_1 \rightarrow r \circ r_1)$. Now imagine an extended simple region r that contains an almond a and its parts. a is smaller than r. In this case, Kleinschmidt argues, a does not have any exact location, yet it is weakly located at r. This constitutes a violation of Exactness.

27 See e.g. Hudson (2001), Barker and Dowe (2003), Beebee and Rush (2003), McDaniel (2003), Calosi and Costa (2015), Eagle (2016) to mention a few.

to some versions of an endurance theory in the metaphysics of persistence, namely what Gilmore (2018) calls "Locational Endurance". For the first case, here is a quote from a contemporary classic:

> Suppose we begin by helping ourselves to a respectable posit of speculative metaphysics—immanent universals. Immanent universals, by contrast with Platonic universals, are as fully present in space and time as their bearers. Moreover, they are capable of being *fully present in many places at the same time*; if two spheres are red, then the single immanent universal redness is in each of the spheres (O'Leary Hawthorne and Cover 1998, p. 205, italics added).

As for the second case, here is Gilmore:

> **Locational endurance**: there are persisting material objects, and each of them has *many different exact locations*, each such location being instantaneous (…) *Locational endurance entails multilocation*: it says that some material objects are exactly located at many different regions (Gilmore 2018, §6.3.2, italics added).

As I said already, I think that all this is of crucial importance. Requisite Determination and Unique Determination are widely held principles of determination. If the arguments I set forth are on the right track, the literature on theories of location provides serious counterexamples to such principles,[28] counterexamples that should not be neglected, as they have been so far.

Naturally enough the arguments can be turned on its head. Those who believe that Requisite Determination and Unique Determination are (some sort of) metaphysical laws[29] could construct an argument against the possible failures of Exactness and against the possibility of multilocation that are significantly different from the extant ones in the literature.

4.4 Against disjunctivism

The argument from Exactness in Sect. 4.3 deserves further exploration, in view of different accounts of determinables. Wilson (2017b) distinguishes three broad camps, namely *Anti-Realism*, *Reductive Realism*, and *Non-Reductive Realism*. According to Anti-Realism determinables do not exist.[30] According to Reductive Anti-Realism determinables exist, but they are *reducible* to construction of determinates. Finally, according to Anti-Reductive Realism determinables exist, and they are not reducible to

[28] One might also argue that multilocation theorists should reject the claim that having a precise exact location is a maximally determinate property. Instead, they could claim that there are multiple ways to have a particular exact location. An object can have it uniquely, an object can have it as one of many exact locations, and so on. This would arguably undermine the argument from failures of Functionality to failures of Unique Determination. I am not sure I completely understand the suggestion, and how to spell it out precisely. As I pointed out already, orthodoxy has it that position (location) is relevantly similar to, say, mass. Should we say that there are multiple ways of having mass, rather than having particular mass values as maximally determinate properties? At this juncture, it is simply fair to shift the burden of the proof. It is multilocation theorists that owe us a clear, fleshed-out account of this controversial suggestion.

[29] Whatever that might mean.

[30] See e.g. Heil (2003).

any construction of determinates.[31] The most common variant of Reductive Realism is *disjunctivism*, roughly the view that determinables are *identical* to (perhaps infinite) disjunctions of determinates. Disjunctivists include Bigelow and Pargetter (1990), Clapp (2001), Rodriguez-Peryera (2002), and Massin (2013).[32] Building on (some of) the considerations in the previous sections, we can set forth an argument against disjunctivism. Or so I believe. The argument is as follows.

Consider position. According to disjunctivism we have that:

$$P(x) = p_1(x) \vee \ldots \vee p_n(x) \tag{11}$$

where $p_1(x) \vee \ldots \vee p_n(x)$ is a disjunction of maximally precise determinates of P. Consider the case in which, as (11) above suggests, one has a *finite* number of possible positions for a particular object. Then the disjunction above is equivalent to the following:[33]

$$(\exists p_i)(p_i(x)) \tag{12}$$

This entails that, according to disjunctivism, Exactness is not just a locative *principle*, it is in fact a *theorem*. To see this, just note that it follows from the above discussion that $P(x) = (\exists p_i)(p_i(x))$, and $P(x) = (\exists p_i)(p_i(x))$ entails $P(x) \rightarrow (\exists p_i)(p_i(x))$, which is Exactness.[34] As a matter of fact, disjunctivism entails—more generally—Requisite Determination, of which, I argued, Exactness is but an instance. If so, the previous arguments have wide-ranging, profound consequences.

For at the bottom, what counterexamples to Exactness show is that position (at least)[35] is not a disjunct of its determinates. Given that disjunctivism is a general thesis about determinables, failures of Exactness count as a general argument against disjunctivism.

To phrase things differently: Disjunctivism about position entails Exactness. Thus, counterexamples to Exactness count as arguments against Disjunctivism.

5 Metaphysical indeterminacy

Interestingly enough, Jessica Wilson has recently proposed an account of *genuine metaphysical indeterminacy* (MI) in terms of determinables and determinates that goes hand in hand with failures of Requisite Determination and Unique Determination.[36] The basic idea of the **Determinable-based** account of **MI** is that MI involves the obtaining of an indeterminate state of affairs (SOA), that is, a SOA where a constituent object x has a determinable D, but no *unique* determinate $d_i \in D^*$:

31 See e.g. Wilson (2013), and French (2014).

32 For a discussion see Wilson (2017a, pp. 32–34).

33 The case of infinite disjunction is more complicated for infinite disjunction are not equivalent to existential statements. However, one counterexample is enough.

34 Compare this with the remark in footnote 11.

35 It would be more hazardous to generalize from position to every determinable D.

36 See Wilson (2013). For other accounts of metaphysical indeterminacy see Akiba (2004), Barnes (2010), and Barnes and Williams (2011).

> **Determinable-based MI**: What it is for a state of affairs to be MI in a given respect R at a time t is for the state of affairs to constitutively involve an object (more generally, entity) O such that (i) O has a determinable property P at t, and (ii) for some level L of determination of P, O does not have a unique level-L determinate of P at t (Wilson 2013, p. 366).

Let us restrict our attention once again to minimally specific determinables and maximally specific determinates. There are basically *two* ways an object x that has a minimally specific determinable D can fail to have a *unique* maximally specific determinate $d_i \in D^*$: either it has *none*, or it has *more than one*. Wilson (2013) calls *gappy* MI the former case, and *glutty* MI the latter. In other words, cases of *gappy* MI correspond to a violation of (1)—Requisite Determination, whereas cases of *glutty* MI correspond to a violation of (2)—Unique Determination.[37]

6 Location and metaphysical indeterminacy

I claimed that cases of *gappy* MI correspond to failures of Requisite Determination, and cases of *glutty* MI correspond to failures of Unique Determination. In effect, *gappy* cases of MI *entail* the failure of Requisite Determination, and *glutty* cases of MI *entail* the failure of Unique Determination. What about the converse claims? Does every failure of Requisite Determination entail *gappy* MI? Does every failure of Unique Determination entail *glutty* MI? These are substantive questions that lie beyond the scope of the paper. As a matter of fact, I would rather stay agnostic as to whether there is a perfectly general, principled answer to these questions. Perhaps the best we could do is to address them on a case-by-case basis. This is what I shall do in what follows.

I argued that Exactness is a case of Requisite Determination, and I discussed different counterexamples to Exactness. Given that I did not endorse that every failure of Requisite Determination entails cases of *gappy* MI, it does not follow by *sheer logic* that counterexamples to Exactness give rise to cases of genuine MI. But there is a case to be made that they do in fact, in the examples at hand. All the counterexamples of Exactness I discussed in Sect. 4.3 are exactly cases in which the relevant objects lack a *determinate* location/position. They are cases in which the location/position of such objects is indeed *indeterminate*. Also, they are clearly cases in which this

[37] One might think that cases of *gappy* MI violate Unique Determination as well. The reason is roughly the following. Cases of *gappy* MI are cases in which an object x has a determinable D but does not have any determinate d_i of D. *A fortiori*, x does not have a *unique* determinate d_i of D. Therefore it violates Unique Determination as well. This is a compelling line of thought that brings to light some subtleties about how to formulate Unique Determination. It turns out that, given the formalization in (2), cases of *gappy* MI do not violate it. This is because in *gappy* cases the antecedent of (2) will be false, thus rendering (2) vacuously true. To accommodate that cases of *gappy* MI *do* violate Unique Determination, one might give a different formalization of the latter. A proposal is the following, **Unique Determination***: $(\forall D)(D(x) \rightarrow (\exists d_i \in D^*)(d_i(x)) \wedge (\forall d_j \in D^*)(d_j(x) \rightarrow d_i = d_j)$. In other words, Unique Determination* requires the object in question to have *at least* one determinate. Cases of *gappy* MI violate Unique Determination*, but not Unique Determination. At the bottom, this is because Unique Determination* *entails* Requisite Determination, whereas Unique Determination does not. This does not play any significant role in what follows insofar as our interest in cases of *gappy* MI will be restricted to violations of Requisite Determination. Thanks to a referee for this journal for pushing this point.

indeterminacy is not epistemic, much less semantic. Thus, these cases seem to fit the determinable based account of MI: they could count as cases of *gappy* MI. The sources of the aforementioned indeterminacy are clearly different in different cases: but in all of them, it is impossible to attribute a maximally determinate position—i.e., an exact location—to the relevant object.

What about failures of Functionality and Unique Determination? This case strikes me as different. There are no grounds to claim that the failure of Functionality (Unique Determination) *per se* offers an example of genuine *glutty* MI in these cases. One possible argument against the counterexamples to Functionality being cases of *glutty* MI runs as follows. Multilocation theorists claim that it is *not* indeterminate that, say, "x is exactly located at r_1", nor it is indeterminate that "x is exactly located at r_2"—with $r_1 \neq r_2$. In fact, the aforementioned sentences are both *determinately true*. In other words: x is determinately located at r_1, and it is also determinately located at r_2: where is the indeterminacy? I admit there is something to the argument. Yet, I believe, it falls short of being conclusive. For, as Wilson herself notes, on a determinable-based approach, MI does not generate any propositional indeterminacy—and so no modal indeterminacy operator is required. Rather, MI involves a certain pattern of instantiation of determinable and determinate properties; consequently, sentences expressing the obtaining of any given state of affairs (whether precise or imprecise) or the having of any given property (whether determinate or determinable) will, if meaningful, be determinately true or determinately false, as per classical semantic usual.

A more forceful consideration is the following. There seems to be a substantive difference between cases of multilocation and other cases of *glutty* MI that Wilson discusses, e.g. the case of the iridescent feather, or cases coming from quantum mechanics. In the latter cases, maximally determinate properties are *not* had *simpliciter*. Rather they are had *relative to a perspective*, an orientation, or even *to a different degree*.[38] This is *not* what happens in the multilocation case—at least at first sight. One might argue that it is exactly the fact that different determinate properties are instantiated relative to different perspectives or to different degrees, that is responsible for genuine metaphysical indeterminacy. In other words, the indeterminacy stems from the fact that the relevant different determinates are not had simpliciter, but rather in a somewhat mediated fashion. But this is not the case when it comes to multilocation. There the relevant objects have their exact locations simpliciter. If this is on the right track, multilocation theorists are *not* committed to *glutty* cases of determinable based MI. They are however still committed to violations of Unique Determination.

7 Conclusion

This paper is an attempt to prompt an interaction between discussions on determinables on the one hand, and discussions on location on the other. I showed that some principles in theories of location are instances of general principles relating determinables and determinates, and I argued that well-discussed failures of locative principles provide counterexamples to widely held principles that (allegedly) govern the determination

[38] For this particular example see Calosi and Wilson (2018).

relation. One such counterexample was pivotal in setting forth an argument against what is perhaps the most influential reductive account of determinables. Finally, I related these discussions to the issue of metaphysical indeterminacy. There, admittedly, the conclusions are more tentative. I am inclined to see at least *some* of the examples I discussed as cases of genuine metaphysical indeterminacy, but not *all* of them. I am aware these are just a *few steps* in the direction of a substantive interaction between these two areas of metaphysical inquiry. Hopefully they are steps in the *right* direction.

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