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Mereological Essentialism and Mereological Inessentialism

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Mereological essentialists argue that mereological summations cannot change their parts. Mereological inessentialists argue that mereological summations can change some or all of their parts. In this paper I articulate and defend a position called Moderate Mereological Inessentialism, according to which certain mereological summations can change some, but not all, of their parts. Persistent mereological summations occur when the functional parts of mereological summations persist through alterations to its spatial parts.

Keywords: Mereology, mereological sum, mereological essentialism, mereological inessentialism.

Hansel and Gretel eat a piece of the candy from which the witch's house is constructed. Is the house the same house before and after this incident? Debate rages between mereological essentialists, who answer in the negative, since mereological summations cannot change their parts (Chisholm 1973; Van Cleve 1986), and mereological inessentialists, who answer in the positive, since mereological summations can change some or all of their parts (Thomson 1983; Van Inwagen 2006). In this paper I articulate and defend a position called Moderate Mereological Inessentialism, according to which certain mereological summations can change some, but not all, of their parts.

This paper is divided into seven sections. First, I outline the relevant principles of classical mereology which give rise to the difficulties associated with mereological essentialism (§ 1). I then outline, and ultimately judge incomplete, two contemporary versions of mereological inessentialism: the first (§ 2), what I call the Weak Sum Identity view of Peter Van Inwagen (2006); the second (§ 3), what I call the Moderate Sum Identity and Strong Sum Identity proposals of David Sanford (2011). I then define several varieties of mereological summations

(§ 4), arguing that mereological essentialism is true for unstructured mereological summations, but there is a class of persistent mereological summations (§ 5), where moderate mereological inessentialism is true for this class (§6). I then demonstrate how moderate mereological inessentialism overcomes the difficulties that Van Inwagen and Sanford face (§ 7).

1. *Mereological Commitments*

Mereology, from the Greek *méros* = part, is the study of the relation between parts and wholes. Classical mereology is that tradition within the twentieth century study of mereology that attempts to formalize mereological theory. Pioneers of this enterprise include Lésniewski (1916) and Leonard and Goodman (1940), while contemporary proponents include Simons (1987) and Casati and Varzi (1999), of whom my notation follows the latter. In these works, formal mereological principles and definitions are established, several of which are relevant to the material discussed below. First, the principle of transitivity:

Transitivity $=_{df} (Pxy \wedge Pyz) \rightarrow Pxz$

Transitivity states that if x is a part of an object y that is itself part of a larger object z, then x must be part of that larger object z. For example, if the banana stem is part of the banana peel, and the banana peel is part of the banana, then the banana stem is part of the banana. Second, when two (or more) individuals, in some way, combine:

Overlap: $Oxy =_{df} \exists z(Pzx \wedge Pzy)$
Underlap: $Uxy =_{df} \exists z(Pxz \wedge Pyz)$

According to these definitions, x overlaps y if z exists such that z is part of x and z is part of y. Imagine that two distinct roads (King St. and Weber St.) intersect at a junction. In this case, King St. and Weber St. overlap, where the overlapping portion is the individual called junction. The junction exists, and this junction is a part of King St. and a part of Weber St. And, x underlaps y if z exists such that x is part of z and y is part of z. To return to the example of the banana, the peel and the fruit-flesh underlap the banana, or, they are both parts of the banana. These two definitions help to define the summation operation:

Sum: $z = [x + y] =_{df} \exists z \forall w(Owz \leftrightarrow (Owx \vee Owy))$

That is, there is a z that exists which is the sum, and for every w, w overlaps z iff w overlaps x or w overlaps y. The banana, for example, is the sum of the peel and the fruit-flesh, so only if the stem overlaps the banana, the stem overlaps the peel or the fruit-flesh. In this case, the stem overlaps the peel. Similarly, only if the stem overlaps the peel, the stem overlaps the banana.

2. *Van Inwagen on Mereological Essentialism*

Strong Mereological Essentialism is the view that mereological sum $y_1 = [x_1 + x_2]$ necessarily has all and only the parts x_1 and x_2. Strong mereological essentialism implies that mereological sum $y_1 = [x_1 + x_2]$ cannot change any parts. That is, if mereological sum $y_1 = [x_1 + x_2]$, and mereological sum $y_2 = [x_1 + x_3]$, then $y_1 \neq y_2$. According to this view, the witch's house can be composed of all and only the candy originally composing it. Roderick Chisholm (1973) points to Leibniz and Moore as historical advocates, while Chisholm and Van Cleave (1986) can be included as adherents as well.

Strong Mereological Inessentialism is the view that mereological sum $y_1 = [x_1 + x_2]$ can have any part, such as distinct hypothetical parts f_4 and/or u_7. Strong mereological inessentialism implies that mereological sum $y_1 = [x_1 + x_2]$ can, without caveat, change any and all its parts. That is, if mereological sum $y_1 = [x_1 +x_2]$, and mereological sum $y_2 = [f_4 + u_7]$, then it may be that $y_1 = y_2$. According to this view, the house can be composed of a pebble on Mars and the Eiffel Tower (cp. Chisholm 1973: 584). Strong mereological inessentialism is an extreme position that, so far as I know, currently lacks adherents.

Similarly, strong mereological essentialism is, even to the minds of its adherents, an "extreme principle" (Chisholm 1973: 586). Many have attempted to weaken the doctrine (Chisholm 1973; Plantinga 1975). Here is one such weakening: Moderate Mereological Inessentialism is the view that mereological sum $y_1 = [x_1 + x_2]$ may, within certain parameters, have x_1 and x_3, rather than x_1 and x_2, as parts. Moderate mereological inessentialism implies that mereological sum $y_1 = [x_1 + x_2]$ may, within certain parameters, change some of its parts. That is, if mereological sum $y_1 = [x_1 + x_2]$, and mereological sum $y_2 = [x_1 + x_3]$, then, possibly, $y_1 = y_2$. According to this view, the same house can be composed of different candy. Moderate mereological inessentialism has a number of adherents (Plantinga 1975; Thomson 1983: 204; Van Inwagen 2006), though they do not label themselves as such, nor do they agree on the conditions requisite for summation alteration. Of course, moderate mereological inessentialism is heavily dependent upon outlining and legitimating the conditions under which summation modification is plausible. In this section, and the next, I evaluate, and ultimately judge incomplete, two sets of conditions placed upon mereological summations according to which they may be capable of changing some of their parts.

In this section I consider Peter Van Inwagen's (2006) argument that sums can change their parts. Central to his argument is his view that a mereological sum is actually a mereological summation *of parts*. This means that a mereological sum is an object that is distinct from its parts (Van Inwagen 2006: 616–617). In other words, Van Inwagen accepts the Principle of Ontological Generosity:

> *Ontological Generosity*: When x_1 and x_2 underlap, a new individual y_1 exists, which is the mereological sum of $[x_1 + x_2]$, but is not only x_1 and x_2.[1]

A straightforward reading of classical mereology indicates that whenever x_1 and x_2 underlap a mereological summation of these two parts, the mereological summation is a new individual y_1, or a singular term y_1 (cp. Simons 1987: 13; Casati and Varzi 1999: 43–44, 51). To use a common example, Tibbles is an individual cat, Tib is the cat's body minus the tail, and Tail is the cat's tail (Wiggins 1979: 309–310; Noonan 1980: 23; Simons 1987: 191). In this case, Tibbles ≠ [Tib + Tail].

The principle of ontological generosity has its share of detractors (Lewis 1991: 81; Armstrong 1978: 36; Baxter 1988). Those detractors argue that mereology is ontologically innocent:

> *Ontological Innocence*: When x_1 and x_2 underlap, the new individual y_1, which is the mereological sum of $[x_1 + x_2]$, is only x_1 and x_2.

According to ontological innocence the mereological sum y_1 is nothing over and above the parts x_1 and x_2. The mereological sum is, as it were, a transparent container, leaving only the parts as content: "The fusion [of several cats] is nothing over and above the cats that compose it. It just *is* them. They just *are* it. Take them together or take them separately, the cats are the same portion of Reality either way" (Lewis 1991: 81).[2]

The Principle of Ontological Innocence faces several trenchant difficulties, one of which is highlighted by Van Inwagen himself. Namely, the mereological summation has the property of being singular, while the parts have the property of being a plurality, so, by Leibniz' Law, the mereological summation ≠ the parts (cp. Van Inwagen 2006: 614; Sider 2007: 55; Yi 1999; McDaniel 2008). Even Lewis is cognizant of this difficulty: "What is true of the many is not exactly what's true of the one. After all, they are many while it is one" (Lewis 1991: 87; cp. Sider 2007).

If the mereological summation were identical to its parts, then a change in the parts would necessitate a change in the mereological summation. But, given that mereological summations are distinct from their parts, a change in the parts does not necessitate a change to the mereological summation. In other words, the distinction between mereological sums and their parts, as implied by ontological generos-

[1] Ontological generosity is also evident in cases of the product operation of closure mereology as well. In this case, when x_1 and x_2 overlap, a new individual y_1 exists, which is the intersection of x_1 and x_2, which is not only x_1 and x_2.

[2] Casati and Varzi support Lewis' intuition by saying "Imagine bargaining over two cats in a pet store. Can you buy the cats without buying their sum? Can you buy the sum but not the individual cats" (Casati and Varzi, 1999: 43–44)? Not all intuitions support mereological innocence however: imagine buying a Toyota and it is shipped to you in a box of pieces. You have all the parts, but you do not have the car.

ity, renders it possible for the parts to change without the summation changing. Van Inwagen exploits this opening:

> There is an object x [i.e., a house] such that for a certain interval before t, x was a mereological sum of the Tuesday Bricks and, for a certain interval after t, x was a mereological sum of 'the Tuesday Bricks minus the Lost Brick'. 'But the Brick House was not the same mereological sum before and after the Lost Brick ceased to be a part of it.' Well, it was not a mereological sum of the same things. But that does not mean that it 'wasn't the same mereological sum' (Van Inwagen 2006: 626).

Since the mereological sum (i.e., the house) is a distinct object from its parts (i.e., the bricks in his example), it is possible for the same mereological sum to have different parts at different times. In other words, Van Inwagen endorses a Weak Sum Identity Condition:

> *Weak Sum Identity Condition*: sum y_1 of $[x_1 + x_2]$ = sum y_2 of $[x_3 + x_4]$ iff $y_1 = y_2$.

Van Inwagen frames weak sum identity as follows: "x is the same mereological sum as $y =_{\text{df}} x$ is a mereological sum and y is a mereological sum and $x = y$" (Van Inwagen 2006: 626). Since y_1 is a distinct object from x_1 and x_2, and y_1 is an object capable of persisting through changing parts, y_1 can remain the same sum through changes to its parts.

Van Inwagen's solution is of significant worth, and will be substantially incorporated into the final solution below, but it is incomplete in at least one respect. While Van Inwagen is correct in demonstrating the distinction between the mereological sum and the parts, his solution fails to meet the following plausible condition on sum identity:

> *Overlap Condition*: sum y_1 of $[x_1 + x_2]$ = sum y_2 of $[x_3 + x_4]$ iff $[x_1 + x_2] = [x_3 + x_4]$.

Here is some motivation for the overlap condition: according to the definition given in the discussion on classical mereology, only those things (w) that overlap some part ($x_1 \vee x_2$) of the summation (y_1), overlap, or, are included in, the summation. For example, only those things w that overlap some part ($\text{candy}_1 \vee \text{candy}_2$...) of the Tuesday House, are included in the Tuesday House. In this case, w overlaps candy_1, which is a candy on the western wall of Tuesday House, so w is included in the Tuesday House. Also, candy_{1b}, which is a candy on some store shelf on Tuesday, does not overlap any part of the Tuesday House, so candy_{1b} does not overlap, or, is not included in, the Tuesday House. Imagine that Hansel and Gretel eat candy_1 on Wednesday, so the witch replaces candy_1 with candy_{1b}. Now again, only (and all) those things w that overlap some part ($\text{candy}_{1b} \vee \text{candy}_2$...) of the Friday House, are included in the Friday House. Since w overlaps candy_{1b}, candy_{1b} is included in the Friday House. But, since w does not overlap candy_1, which has been digested, candy_1 is not part of the Friday House. Now the question: is Tuesday House = Friday House? The answer is no. Why is that? It is already established that candy$_{1b}$ is not included in Tuesday House, so if Tuesday House = Friday House, then candy$_{1b}$ is not included in Friday House. But, it is established that candy$_{1b}$ is included in Friday House, so a contradiction arises if Tuesday House = Friday House. At the same time, it is established that candy$_1$ is included in Tuesday House, so if Tuesday House = Friday House, candy$_1$ is included in Friday House. But, it is established that candy$_1$ is not included in Friday House, so a contradiction arises if Tuesday House = Friday House. For both reasons, it cannot be the case that Tuesday House = Friday House. So, a difference in the parts of the houses on Tuesday and Friday implies that Tuesday House ≠ Friday House (cp. Meirav 2009: 185ff; McDaniel 2010: 419ff; Johannson 2006: 8–9).

What is needed is a principled account of how the Tuesday House = the Friday House while candy$_1$ of the Tuesday House ≠ candy$_{1b}$ of the Friday House. Van Inwagen assumes, without adequately demonstrating, this is possible. Below I sketch a model that meets this Overlap Condition.

3. *Sanford on Mereological Essentialism*

In a recent paper, David Sanford (2011) offers two other possible identity conditions for sums. According to Sanford, the first condition, call it the Strong Sum Identity Condition, entails mereological essentialism. Meanwhile, the second condition, call it the Moderate Sum Identity Condition, offers more hope in permitting sums to change their parts. I argue that the second substantially reduces to the first, thus neither models permit sums to change their parts. I will begin with the first condition:

> *Strong Sum Identity Condition*: sum y_1 of $[x_1 + x_2]$ = sum y_2 of $[x_3 + x_4]$ if $[x_1 + x_2] = [x_3 + x_4]$, and the parts $[w_1 + w_2 + w_3 + w_4]$ of the parts $[x_1 + x_2]$ = the parts $[w_5 + w_6 + w_7 + w_8]$ of the parts $[x_3 + x_4]$ (cp. Sanford 2011: 235–236).

Strong sum identity says that $y_1 = y_2$ if y_1 has all the same parts, and the same parts of parts, as y_2. Sanford explains it as follows, where the ys are parts of the mereological sum x: “Every part of every y shares a part with some z, and every part of every z shares a part with some y” (Sanford 2011: 235). To return to the example of the house: the house on Tuesday has four walls, a roof and a floor, where these parts are each composed of candy. On Wednesday one gummy bear is removed from the western wall. The Friday house has the same parts as the Tuesday house (i.e., four walls, roof and floor), but the parts of these parts are not the same (i.e., one of the gummy bears on the western wall is gone). So, according to strong sum identity, the Tuesday House ≠ the Friday House. Sanford, therefore, is correct in arguing that this strong identity condition entails strong mereological essentialism.

Sanford’s second sum identity condition, the Moderate Sum Identity Condition, more plausibly enables sums to change their parts:

> *Moderate Sum Identity Condition*: sum y_1 of $[x_1 + x_2]$ = sum y_2 of $[x_3 + x_4]$ if $[x_1 + x_2] = [x_3 + x_4]$ (cp. Sanford, 2011, 237).

According to this condition, the Tuesday house (i.e., *wall* with all the candy) has the same *wall* as the Friday house (i.e., *wall* with the missing gummy bear), so the sum identity appears to go through. Sanford argues that the moderate sum identity condition is "logically independent" (Sanford 2011: 237) from the strong sum identity condition. This is because, among other things, it is possible to imagine a scenario whereby the Strong Sum Identity Condition renders two sums identical while the Moderate Sum Identity Condition renders the same two sums distinct. Here is his example:

> Four brick walls constitute a brick house. *A* is the sum of the walls on Tuesday. *B* is the sum of the walls on Friday. This time a brick is removed from one of the walls without destroying the wall. It is the same wall with one less brick. Because the removed brick is a part of one of the walls on Tuesday that is not a part of any wall on Friday, $A =_1 B$. Because the walls on Tuesday and Friday are the same walls, $A \neq_2 B$ for the same reason as before (Sanford 2011: 238).

According to Moderate Sum Identity, Tuesday House = Friday house, since all their parts are the same, including Tuesday Wall = Friday Wall. According to Strong Sum Identity, however, Tuesday House ≠ Friday House, since not all the parts of the parts are the same. Specifically, candy_1 in Tuesday Wall ≠ candy_0 in Friday Wall.

As it turns out, at least in this regard, the moderate sum identity condition reduces to the strong sum identity condition, thereby entailing that the Tuesday House ≠ Friday house on the moderate sum identity condition. There are two different ways to show this. First, the moderate sum identity condition assumes that Tuesday Wall = Friday Wall, so Tuesday House = Friday House. But Tuesday Wall does not have the same parts as Friday Wall, so, due to the overlap condition, Tuesday Wall ≠ Friday Wall. Since Tuesday Wall ≠ Friday Wall, the house composed of four walls, including Tuesday Wall, is not the same sum as the house composed of four walls, including Friday Wall.

Secondly, as outlined in Section One, one of the basic principles of classical mereology is the principle of transitivity: if *x* is a part of an object *y* that is itself part of a larger object *z*, then *x* must be part of that larger object *z*. While the transitivity principle has been questioned (Lyons 1977: 313; Cruse 1979), it is widely accepted. And, plausibly, the transitivity principle is symmetrical, so it entails the transitivity of summation:

> *Transitivity of Summation*: if *z* has part *y*, and *y* has part *x*, then *z* has part *x*.

So, the Tuesday House has Western Wall as part, and the Western Wall has all of its candy as parts. The Friday House has Western Wall as part, and the Western Wall has all but one of its candies as parts. Since Western Wall does not have the same parts on Tuesday and Friday, Tuesday House ≠ Friday House.

One way to overcome this difficulty is to find a principled reason for why the house may have only four walls, a roof and a floor as essential parts, without also having the parts of these parts as essential parts. In other words, the principle of transitivity of summation can be rejected if the following principle is true:

> *Principle of Parthood Immediacy*: if z has y as part, and y has x as part, it is not necessarily the case that z has x as parts.

Sanford, in arguing that the Friday House = Tuesday House since Tuesday Wall = Friday Wall, despite the fact that Tuesday Wall has a part that Friday Wall lacks, appears to suggest such a move. His reason is that the Friday Wall is the same *object* as the Tuesday Wall, where objects can change parts and *sums* cannot change parts (Sanford 2011: 238–239). In other words, the Tuesday Wall Sum ≠ Friday Wall Sum, but the Tuesday Wall Object = Friday Wall Object, and the Friday House is composed of the Friday Wall Object, not the Friday Wall Sum. But now the question arises, and this is similar to the question that arises in the discussion on Van Inwagen: how does Tuesday Wall Object = Friday Wall Object despite the fact that Tuesday Wall Sum ≠ Friday Wall Sum? What is needed, and what I shall outline below, is an explanation of how the wall can remain the same wall, despite changes to some of its parts.

4. *Varieties of Mereological Summations*

According to classical mereology, mereological summation is unstructured. That is, the only existence condition on mereological sum y_1 is that it must have x_1 and x_2 as proper parts. Thus, since spatial proximity and/or ordering are omitted, it is plausible that my left arm and a pebble on Mars compose a mereological sum. And, since temporal proximity and/or ordering are omitted, it is plausible that Socrates and the first teleportation devise compose a mereological sum.[3] Unstructured mereological summations are often called aggregates (Burge 1977; Elder 2004: 60), but I shall call them the cumbersome but more precise title of Maximally Unstructured Mereological Summations. As before, I symbolize these as $y_1 = [x_1 + x_2]$, but I intend this to indicate that no other conditions or relations need obtain.

Many agree that mereological summations have structure, though agreement on gradations of structure is not universal (cp. Fine 1994: 139; Burge 1977; Donnelly and Bittner 2009). I shall provide some argumentation for the claim that mereological summations have structure,

[3] Moreover, since modal considerations are left out, it is plausible that a billion grains of sand compose the mereological sum of the beach, even though this is an unusual result when conceiving of them as scattered throughout the universe.

but first I will provide a non-exhaustive list of some relevant structured mereological summations.[4] First, there is a category of mereological summations that includes the requirement for summations to be spatially proximate. A forest, for example, is a summation of trees that stand in spatially proximate relations.[5] Rivers and lakes are likewise summations of water that essentially stand in spatially proximate relations to each other. These sorts of mereological summations are sometimes called collections or groupings, but I shall call them Spatially Proximate Mereological Summations, where the mereological sum has requisite spatial proximity among the parts (cp. Whitehead 1920: 76; Van Inwagen 1990; Barnett 2004: 90). Hence, if the same parts do not stand in spatially proximate relations, then the spatially proximate mereological summation no longer exists (Wiggins 1980: 27; Thomson 1983: 201; Sanford 2003). I leave the condition of sufficient spatial proximity open to slight variation (so long as it conforms to the conditions outlined below). After all, the requisite proximity of the planets in the solar system may be different from the requisite proximity of the water molecules in a puddle (cp. Laan 2010: 137). I also leave the strength of the bond between grouped parts open: the group can be strongly bonded (i.e., a cemented brick wall, covalently bonded molecules), or loosely bonded (i.e., pebbles on a beach).

Some summations have temporal structure as well. Imagine, for example, that on some African plain a tree grows and dies, and then another tree grows immediately after and immediately beside where the first tree dies, and so on for thousands of years. The result is that, without consideration of temporal structure, these trees are spatially proximate, and yet they do not compose a forest. Or, imagine that Mario makes a salad. The maximally unstructured summation of [lettuce + tomatoes + bacon + olive oil] in various fields scattered across the planet over a variety of times is different from the salad, which Mario *makes* by bringing these ingredients into spatial proximity at a time (cp. Fine 1999: 62). Mario's salad is not only a spatially proximate mereological summation, but also a Temporally Proximate Mereological Summation, where the mereological sum is temporally proximate if the parts stand in a synchronous relation with the other parts.

[4] As examples, in addition to the structured mereological summations listed here, Donnelly and Bittner (2009) distinguish between maximally unstructured mereological summations and 'portions of stuff', which are summations of the same stuff, and Fine (1994) distinguishes between maximally unstructured mereological summations and compounds, which are summations of more than one thing.

[5] It is possible to object that mereological summations are exhaustively composed of their parts, so spatial, temporal or other relations should be excluded from mereological summations. In response, it is worth pointing out that mereological summations are, longwindedly, mereological summation relations between parts. So, (summation) relations are already included within mereological summations, so spatial and/or temporal relations are not anathema.

Spatially proximate mereological summations lack requisite spatial ordering relations among the parts. This is to say that they are commutative (x + y = y + x). Other mereological summations have parts that stand in requisite spatial ordering relations. A bicycle is a mereological summation whose parts are essentially spatially arranged. The bicycle spokes necessarily stand in an inside-of relation to the bicycle wheels, the bicycle frame necessarily stands in an on-top-of relation to the bicycle wheels, *etc*... Chairs, tables, and pizzas are similar examples. Call these Spatially Ordered Mereological Summations, where the mereological summation is spatially ordered because the parts stand in sufficiently spatially arranged relations to one another. That is to say, they are not commutative. Examples include mechanisms as well as words and sentences: "dog" ≠ "god", and "the sky is blue" ≠ "the blue is sky".

Similarly, temporally proximate mereological summations do not have parts that necessarily stand in any temporally ordered relation with the other parts. This is to say they are associative [x + (y + z) = (x + y) + z]. Other mereological sums have requisite temporal ordering. A car is a mereological summation with essentially temporally arranged parts. The car's pedal is depressed before the car's gas rushes into the car's engine, the car's gas rushes into the car's engine before the car's wheel turns, *etc*... Call these Temporally Ordered Mereological Summations, where the mereological summation is temporally ordered when the parts necessarily stand in ordered temporal relations with the other parts. That is to say, they are not associative. Examples include the car and mathematical equations involving various operations, such as [2 + (4 × 8) ≠ (2 + 4) × 8].

There is a further condition that can be placed on mereological summations, which allows mereological summations to survive alterations to their parts and/or spatial/temporal ordering over time. Some argumentation for this type of summation (§ 5), and explanation of how this type of summation persists (§6), will be provided below, but for now it is sufficient to register the category. First, some mereological summations appear capable of changing some parts: a salad is still the same salad, even if one leaf of lettuce is replaced by another before the meal begins; the car is still the same car, even if one wheel is replaced by another wheel. Second, some mereological summations appear capable of persisting through some change to some of the spatially ordered relations: the house persists even if the western wall is moved in/out a foot. Third, with respect to changes to some of the temporally ordered relations: an amoeba moves around over time and performs its functions with different temporal sequencing, indicating contortion to its temporal (and spatial) structure, but the amoeba continues to persist as the same individual. Some call these continuants (Simons 1987), but I shall call them Persistent Mereological Summations, where mereological summations are persistent when the mereological summation remains the same despite alterations to some of its parts and/or spatial/temporal proximity/ordering relations.

5. *Arguments for Persistent Mereological Summations*

The existence of persistent mereological summations is, without a doubt, controversial. Indeed, it lies at the centre of our controversy, with mereological essentialists denying their existence and mereological inessentialists granting their existence. In this section I motivate the existence of the category by providing four arguments in support of the view that persistent mereological summations exist.

First, there is a common sense argument: a stingy restaurant owner charges Sally 400$ for eating seventy salads at the restaurant—a different salad for every bite. Few will agree that the owner's tactics are plausible. Or, with respect to spatial ordering: Benji barks at the stranger, which causes the stranger to walk over to the owner and threaten him. The owner replies that his dog did not bark at the stranger. After all, the dog that was barking had a different spatial ordering than his current dog has. Few will agree with this line of reasoning, and this is because it is pre-theoretically intuitive to endorse the view that persistent mereological summations exist (cp. Meirav 2009: 176).

There is also a linguistic argument: language often captures constancy through part replacement and alterations to spatial/temporal relations. The Amazon rainforest has been called the same name for many years, though the trees composing the rainforest, and the spatial boundaries of the rainforest constantly shift. There are three options here. One, agree that the rainforest stays the same through changes, thereby rendering our language accurate. Two, argue that the rainforest does not stay the same through changes, so, in order to keep our descriptions accurate, we must re-label the rainforest with every changing tree. This move, while preserving linguistic accuracy, is unlivable. Third, argue that the rainforest does not stay the same through changes, but, rather than re-labeling the forest with every change, admit that human labeling is inaccurate but convenient. This move, while livable, sacrifices accurate reference. All things being equal, the first option appears most palatable (cp. Turner 2013: 313–315).

There is also an argument from nature. Nature, as it so happens, contains persistent mereological summations. That is, sometimes parts group together in space and time in such a way as to allow for part replacement. The same beach exists after the wind blows a pebble away. Similarly, sometimes parts group together in space and time, with spatial and temporal order, in such a way as to allow for part replacement. The same bird exists after she loses a feather. The same bird exists if all the molecules in her heart are gradually replaced by new molecules. Since nature contains homeostatic clusters of parts, it is the philosopher's duty to, with natural submission, express them by granting the existence of persistent mereological summations of parts.[6]

[6] There are worries that this attitude leads to the overpopulation of our ontology. But such worries are benign. Including temporal/spatial proximity/ordering relations

Finally, persistent mereological summations retain their intrinsic qualities through changes to some of their parts, which is further reason to conclude that the mereological summation is the same through changes to some of its parts. Here is an example from mathematical summation: $3 + 4 = 7$. Can the mathematical summation '7' survive changes to its parts $3 + 4$? Imagine that we replace 3 in the left side of the equation with 2 at the same time we replace 4 with 5, resulting in $2 + 5 = 7$. In this case the mathematical parts on the left side of the equation have changed: $(3 + 4) \neq (2 + 5)$; but the mathematical summation on the right side of the equation remains the same: $7 = 7$. Likewise, a house retains its own intrinsic qualities through changes to many of its parts. A child could sleep through many changes to the house and wake up thinking it is the same house, since it retains its native essence. The preservation of the intrinsic qualities of the mereological summation through changes to its parts is possible because, according to ontological generosity, the mereological summation is distinct from its parts, so, a change in the parts does not necessitate a change to the mereological summation. While ontological generosity renders persistent mereological summations possible, it is nature that validates the existence of persistent mereological summations—nature contains wholes that retain their native essence and homeostatic unity throughout changes. A model explaining this phenomenon follows below (§ 6), but for now it suffices to conclude that certain mereological summations retain their intrinsic qualities through some transitioning parts. I do not take this argument, even when combined with the other three, to be decisive. I do think, however, that they shift the burden of proof on to those who deny persistent mereological summations.

6. *A Model of Persistent Mereological Summations*

Persistent mereological summations are those mereological summations that remain the same despite alterations to some of their parts and/or spatial/temporal proximity/ordering relations. In this section I provide an account of how persistent mereological summations are possible.

I begin, however, with an immediate difficulty. Namely, persistent mereological summations cannot persist through unlimited modification to their parts and/or spatial/temporal proximity/ordering relations. With respect to part replacement, imagine that the tomato in the

among parts, and persistent mereological summations, within our ontology, is innocent. By this I mean that it does nothing more than include the mundane spatial/temporal grouping/ordering relations that nature already does. There are also worries that this attitude is false, due to the atomistic truth that everything is ultimately reducible to (microphysical) parts. Atomism, however, is also problematic due to these same intuitive and linguistic arguments. That is, the view that a bee is only its parts is unintuitive, and goes against our linguistic practices of calling them 'bees', rather than calling them 'many atoms' or perhaps 'atoms arranged bee-wise'.

salad is replaced by a wrench, and the lettuce is replaced by screws, *etc*... There is no salad anymore. With respect to the modification to the spatial relations among the parts of the summation: imagine the ingredients in the salad are lined up, one by one, horizontally. This is likely not a salad anymore. Or, imagine that the house's western wall is moved such that it is pressed against the house's eastern wall. The house does not exist anymore; there is only a three sided run-in with a thick eastern wall. Thus, persistent mereological summations withstand some, but not unlimited, modification to both their parts and their requisite spatial/temporal relations.

How is the range of acceptable replacement parts determined? Here is a straightforward answer: so long as the replaced part's function continues to be adequately performed by the replacement part and/or through the altered spatial/temporal relations, then the persistent mereological summation remains intact (cp. Simons 2006: 609ff; Garbacz 2007). The western wall, for example, can be replaced by any wall that continues to function as the house's western wall. That is, it can be replaced by any substance that can function as a wall (i.e., brick, candy canes), and cannot be replaced by any substance that cannot function as a wall (i.e., oxygen, soap bubbles). Likewise, the western wall can be spatially modified in any way, so long as it continues to function like a wall (i.e., touching the house's northern wall, southern wall, roof and floor without touching the house's eastern wall), and it cannot be modified in any way that prevents it from functioning as the house's western wall (i.e., by being pressed against the eastern wall, or by being disconnected from the northern wall).

This response introduces the crucial distinction between spatial parts and functional parts of mereological summations.[7] While it is common to distinguish between several different types of parts in mereological summations (Nagel 1952; Winston, Chaffin and Herrmann 1987; Johannson 2004), only spatial parts and functional parts are important for my purposes.[8] Spatial parts are those parts of mereo-

[7] The introduction of functional parts also solves a lingering difficulty. The difficulty is that it is possible to construct mereological summations that are spatially/temporally proximate/ordered, though the parts are otherwise unrelated. For example, the mereological summation of myself and the ground is spatially and temporally proximate (so long as I am not jumping in the air), and is necessarily ordered in an on-top-of relation, but myself and the ground lack essential relatedness. The introduction of functional parts of mereological summations solves this problem. The ground plays no functional role in maintaining my existence, and I play no functional role in maintain the existence of the ground.

[8] Strictly speaking, spatial/temporal proximity/ordering relations among the parts of the mereological summation are important as well, but these relations are included within the functional parts. That is, functional parts are defined in such a way as to include these relations. For example, the functional part of being a western wall is any wall-like spatial part that is spatially ordered in a connecting-the-western-edges-of-northern-and-southern-walls way, and is temporally synchronous relation.

logical summations that occupy a region of space (at a time). While functional parts have been variously defined (Rescher and Oppenheim 1955; Simons 2006; Garbacz 2007; Johannson 2006), for my purposes, functional parts are those parts of mereological summations that define an essential function of the mereological summation. A house, by definition, has four walls, a roof and a floor. So, these are the functional parts of the house. The functional parts are defined in terms of the relations they bear to the rest of the parts of the house. Thus, the western wall is defined as that wall with appropriate spatial parts and is temporally proximate to the other parts, and is spatially ordered such that it touches the house's floor, roof, northern and southern walls, without touching the house's eastern wall. These functions are necessary for a house—without a western wall, there is no house. These functions are also definitional, or abstract, which implies that they are not essentially tied to a particular spatial part or spatial/temporal relation. This is what renders it plausible for persistent mereological summations to change some parts. If the house's functional part of being the Western Wall was performed by Tuesday Wall, and continues to be performed by Friday Wall, then the house continues to exist through this modification since the western wall function was still being realized. Or, if the house's functional part of being a western wall continues to be performed through alternating spatial relations, such as the wall moving in six inches, then the house remains the same since there was still something acting as the western wall.[9]

Having established that persistent mereological summations have functional parts and spatial parts and spatial/temporal proximity/ordering, the pieces are now in place to demonstrate how persistent mereological summations can remain the same through some alterations to some of their parts. Before beginning, it is worth noting that mereological essentialism is the doctrine that the parts of a mereological sum are essential to, or necessary for, their mereological sum. Essential and necessary parts are parts that the mereological sum cannot exist without. So, my strategy is to study which parts are essential to a mereological sum, in order to shed light on whether mereological essentialism is true or not.

[9] Here is an important objection: since functional parts are definitional, or abstract, it may be tempting to imagine the functional parts of the mereological summation without some spatial parts performing the function. The house, in the architect's mind, before anything construction, has four walls, a roof and a floor. To avoid this possibility, persistent mereological summations have been defined in such a way as to include some spatial part as a necessary realizer of the function. That is, according to the definition outlined above, if persistent mereological summation y_1's functional part y_{f1}, which was performed by spatial part x_1, continues to be performed by spatial parts x_{1b}, then the mereological summation y_1 continues to exist. Or, to return to the example, if the house's western wall is realized by Tuesday Wall and then by Friday Wall, which both function as the house's western wall, then the house continues to persist across changes to its spatial parts.

Consider the mereological sum y_1, which is the maximally unstructured mereological summation of my dinner plate and the moon. Can this aggregation change its parts? Intuitively, the answer is no. Imagine that I replace my dinner plate with another one. This appears to be a different aggregation y_2. This is because there is nothing preserving their identity, since maximally unstructured mereological summations are composed of just their spatial parts, and the spatial parts are not the same. Or, due to the overlap condition, since y_1 has parts plate_1 and moon, while y_2 has plate_2 and moon as parts, y_1 does not have the same parts as y_2, so $y_1 \neq y_2$.

Matters grow murkier when considering persistent mereological summations. Consider, for example, a finicky chef who, in preparation for the grand opening, makes a salad on Tuesday. On Wednesday he replaces a leaf of lettuce, since it is slightly wilted. On Thursday he replaces the cucumber for a green pepper, and re-tosses it. Is the Tuesday salad the same as the Thursday salad? Intuitively, the answer is yes. This is unsurprising, since the replaced parts were functionally equivalent, and the alterations to the spatial relations among the parts were within acceptable functional parameters. But now on Friday the chef replaces the lettuce with screws and the other vegetables with hammers and wrenches. Moreover, he also lines up all the ingredients one by one. Is the Tuesday salad the same as the Friday salad? Intuitively, the answer is no. This is unsurprising, since the replaced parts were not functionally equivalent, and the alterations to the spatial relation among the parts was not within accepted functional parameters. There are several lessons here: (1) the salad persists when the particular spatial parts are replaced, so the particular spatial parts are unnecessary for the salad; (2) the salad persists when the particular spatial relations among the parts are altered, so the particular spatial relations are unnecessary for the salad; (3) the salad does not persist when the functional parts perish (that is, when there are no longer any salad-like parts and/or no salad-wise spatial/temporal relation, there is no salad), so the functional parts are necessary for the salad. Necessity, as mentioned above, indicates essentiality, so specific spatial parts, and specific spatial/temporal proximity/ordering are unnecessary for persistent mereological summations, but functional parts are necessary. Or, in other words, since specific spatial parts and specific spatial/temporal relations are unnecessary for, or inessential to, persistent mereological summations, persistent mereological summations can change some spatial parts and spatial/temporal relations without perishing. Thus, moderate mereological inessentialism is true for persistent mereological summations.

7. *The Overlap Condition and the Transitivity Condition*

In this section I further unpack this model by demonstrating how it can accommodate both the overlap condition that Van Inwagen's model did not, and overcome the transitivity condition, which Sanford's model did not.

Van Inwagen's model faces difficulty supporting the overlap condition on mereological summations, according to which identical mereological summations must have the same parts. That is, returning to the example of the gummy bear that is eaten from the western wall on Wednesday: Tuesday House is underlapped by Eastern Wall, Western Wall$_1$, Northern Wall, Southern Wall, Roof, and Floor. Friday House is underlapped by Eastern Wall, Western Wall$_2$, Northern Wall, Southern Wall, Roof, and Floor. Since Tuesday House does not have the same spatial parts as Friday House, Tuesday House ≠ Friday House.

It is possible to accept the overlap condition while simultaneously arguing that persistent mereological summations remain the same through changes to some of their parts. According to the model presented above, persistent mereological summations are essentially summations of functional parts. That is, since their functional parts are necessary for their existence, persistent mereological summations are essentially summations of these parts. How does this insight help in meeting the overlap condition? The overlap condition states that sum y_1 of $[x_1 + x_2]$ = sum y_2 of $[x_3 + x_4]$ iff $[x_1 + x_2\}$ = $[x_3 + x_4]$. Since, however, the only essential parts of persistent mereological summations are functional parts, it is plausible to interpret this as saying: sum y_1 of [functional parts x_1 + functional part x_2) = sum y_2 of [functional part x_3 + functional part x_4] iff [functional parts x_1 + functional part x_2] = (functional part x_3 + functional part x_4]. Persistent mereological summations do have the same functional parts across changes, so the overlap condition is met. In fact, since the same functional parts are essential for persistent mereological summations, the overlap condition is necessarily true: the same persistent mereological summations must have all the same functional parts, or it will cease existing. For example, assume the Tuesday House necessarily has the functional parts of a western wall, an eastern wall, a southern wall, a northern wall, a roof and a floor and the Friday house necessarily has the functional parts of a western wall, an eastern wall, a southern wall, a northern wall, a roof and a floor. Since [western wall + eastern wall + southern wall + northern wall + roof + floor] = [western wall + eastern wall +southern wall + northern wall + roof + floor], Tuesday House = Friday House. The overlap condition is met since the Tuesday House has the same functional parts as the Friday House.

Here is an objection: perhaps the overlap condition does not read that in order for sum$_1$ = sum$_2$, they must both have the same *functional* parts. Rather, perhaps it says that in order for $sum_1 = sum_2$, they must have *all* the same parts. This concern leads to the transitivity problem that Sanford's Moderate Sum Identity view faces. That is, the response just given is akin to the moderate sum identity view where two sums are identical if they have the same (functional) parts, regardless of whether they have the same parts of these functional parts. The objection, then, is that because of the principle of transitivity, moderate sum identity entails strong sum identity. That is, two sums are actually only identical if they have the same (functional) parts, *and* the same parts of those functional parts. Thus, the Tuesday House with the same functional parts (i.e., four walls, roof, floor), but differing parts of functional parts (i.e., a missing candy in the western wall), are actually not the same houses.

There are two ways in which my model overcomes this transitivity difficulty facing Sanford's moderate sum identity condition. First, according to my model, persistent mereological summations require the same functional parts because they are essential to the existence of the mereological summation. And, according to my model, persistent mereological summations do not require the same spatial parts because specific spatial parts are inessential to the existence of the mereological summation. This account provides a principled and intuitive reason for endorsing the principle of parthood immediacy rather than transitivity. Namely, if z has y as part, and y has x as part, it is not essentially, or necessarily, the case that z has x as parts because there is ample evidence that persistent mereological summation z cannot continue to exist without parts y, but can continue to exist without ys specific parts $[x_1 + x_2]$.

Secondly, it is common in the literature to argue that the principle of transitivity does not apply to functional parts. Numerous examples prove this point: a handle is a (functional) part of a door, and a door is a (functional) part of a house, but a handle is not a (functional) part of a house (Cruse 1979); Simpson's finger is a (spatial) part of Simpson, and Simpson is a (functional) part of the philosophy department, but Simpson's finger is not a (spatial or functional) part of the philosophy department (Winston, Chaffin and Herrmann 1987: 431). Numerous explanations are given for this fact: transitivity applies only to spatial and temporal part-whole relations (Garbacz 2007; Pribbenow 2002), so transitivity does not apply to functional part-whole relations (Casati and Varzi 1999: 34; Varzi 2006). This would explain the example of the handle and the house—although the door requires a functioning handle, and the house requires a functioning door, a house does not require a functioning handle. Alternatively, some argue that transitivity applies to intra-categorical part-whole relations, but not to inter-categorical relations (Winston, Chaffin and Herrmann 1987). That is, if x is a spatial part of y, and y is a spatial part of z, then x must be a spatial part of z. But, if x is a spatial part of y, and y is a functional part of z, then x is not necessarily a part of z. After all, would x be a spatial part of z, or a functional part of z? Neither is intuitive. This would explain the example pertaining to Simpson—Simpson's finger is no functional part of the philosophy department, nor does the philosophy department have spatial parts like Simpson's finger.

In summary, mereological essentialism is true for maximally unstructured mereological summations, since they are composed of only and all their specific spatial parts. However, moderate mereological inessentialism is true for persistent mereological summations. This is partially a mereological essentialist view, since persistent mereological summations are necessarily composed of all their functional parts. However, it is partially a mereological inessentialist view as well, since persistent mereological summations can endure certain modifications to their spatial parts and/or spatial/temporal relations. Certain mereological summations, therefore, can, within a functional range, change certain parts.

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