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# Link's Revenge: A Case Study in Natural Language Mereology

**Abstract:** Most philosophers are familiar with the metaphysical puzzle of the statue and the clay. A sculptor begins with some clay, eventually sculpting a statue from it. Are the clay and the statue one and the same thing? Apparently not, since they have different properties. For example, the clay could survive being squashed, but the statue could not. The statue is recently formed, though the clay is not, etc. Godehart Link 1983's highly influential analysis of the count/mass distinction recommends that English draws a distinction between uncountable "stuff" and countable "things". There are two mereological relations, related in specific ways. Our primary question here is whether an empirically adequate account of the mass/count distinction really does require distinguishing "things" from "stuff", and thus postulating two corresponding mereological relations, or if instead positing only one sort of entity and corresponding mereological relation is sufficient, as other semantic theories would have it. This question is meant to be one of what we call *natural language mereology*. We are asking about the mereological commitments of English, or perhaps competent speakers of English, and not about ultimate reality as such. There is no pretense that we will definitively solve the *metaphysical* puzzle of the statue and clay.

## 1 Introduction

Most philosophers are familiar with the metaphysical puzzle of the statue and the clay. A sculptor begins with some clay, eventually sculpting a statue from it. Are the clay and the statue one and the same thing? Apparently not, since they have different properties. For example, the clay could survive being squashed, but the statue could not. The statue is recently formed, though the clay is not, etc.

LEIBNIZ'S LAW is the thesis that identical things have the same properties. It follows from this that the statue and the clay are distinct, since they have different properties: one can survive being squashed, the other cannot; one is recently formed, the other is not, etc.

Many metaphysical puzzles then follow: When exactly does the clay become the statue? How can two co-located objects exist concurrently, etc.

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Given the persistence of this puzzle, it would be rather surprising if the relatively nascent science of natural language semantics required taking a stance on the issue. Yet that is precisely what Godehart Link 1983's highly influential analysis of THE COUNT/MASS DISTINCTION recommends. In particular, Link argues on the basis of examples like (1) that English draws a distinction between uncountable “stuff” and countable “things”.

- (1) This ring is new, but the gold in the ring is old.

Link's argument is straightforward: The ring and the gold constituting it have different properties, even though the ring is completely constituted by the gold. It follows, from Leibniz's Law, that the two are distinct. To quote Link 1983: 128 directly:<sup>1</sup>

Our guide in ontological matters has to be language itself, it seems to me. So if we have, for instance, two expressions *a* and *b* that refer to entities occupying the same place at the same time but have different sets of predicates applying to them, then the entities referred to are simply not the same. From this it follows that my ring and the gold making up my ring are different entities.

If providing an empirically adequate semantics for nouns requires postulating such a distinction, and if “our guide to ontological matters has to be language itself”, then it would appear that we have little choice but to accept that the ring and the gold are in fact different, as are the statue and the clay.

More to the point, since ‘ring’ is a count noun and ‘gold’ is a mass noun, Link infers that the denotations of the two nouns must be different *sorts* of things. Very roughly, rings are “things”, while gold is “stuff”.

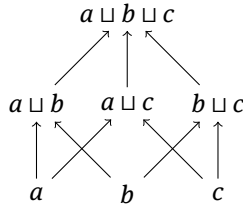
More technically, Link distinguishes between ATOMIC INDIVIDUALS and MASS QUANTITIES. Atomic individuals are countable entities serving as the denotations of singular count nouns like ‘ring’. Plural nouns like ‘rings’ then denote PLURALITIES, or mereological sums of atoms. Atoms are related to pluralities, and pluralities to other pluralities, via the INDIVIDUAL PARTHOOD relation, represented as ‘ $\sqsubseteq_i$ ’, and defined as (2), where ‘ $x \sqcup_i y$ ’ is the individual sum of *x* and *y*.

- (2)  $\forall x, y. x \sqsubseteq_i y \leftrightarrow x \sqcup_i y = y$

Ordering the atoms via individual parthood results in an atomic join semilattice structure like the following, where arrows represent  $\sqsubseteq_i$ .

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<sup>1</sup> See also Link 1998.



Call this **THE COUNT DOMAIN**.

Mass quantities, in contrast, are related via **MATERIAL PARTHOOD**, represented as ' $\sqsubseteq_m$ ', and defined similarly to (2). Ordering mass quantities via material parthood results in a different, but similarly structured, semilattice. Call this **THE MASS DOMAIN**.

The count and mass domains are related via a homomorphism, a function  $h$ , mapping pluralities to mass quantities. If  $a$  is an individual (or a sum of individuals), then  $h(a)$  is the material stuff it is (or they are) made of. So if  $a$  is the notorious ring, then  $h(a)$  is the gold constituting it. Since  $h$  is a homomorphism, it preserves the material constitution of atomic individuals: if  $a \sqsubseteq_i b$ , then  $h(a) \sqsubseteq_m h(b)$ . For example, if Link's ring  $a$  is an individual part of his collection of rings  $b$ , then the gold constituting Link's ring is a material part of that collection.

If Link's ring and the gold constituting are located in different, though related, domains, then it is hardly surprising that they have different properties. After all, they would be *different entities*. As Link acknowledges, the resulting ontology is anything but parsimonious, from a purely metaphysical perspective.

[L]et  $a$  and  $b$  denote two atoms in  $A$ . Then there are two more individuals to be called below  $a + b$  and  $a \oplus b$ ,  $a + b$  is still a singular object in  $A$ , the *material fusion of  $a$  and  $b$* ;  $a \oplus b$  is the *individual sum or plural object of  $a$  and  $b$* . The theory is such that  $a + b$  constitutes, but is not identical with,  $a \oplus b$ . This looks like a wild Platonistic caprice strongly calling for Occam's Razor. Language, however, seems to function that way. Take for  $a, b$  two rings recently made out of some old Egyptian gold. Then *the rings,  $a \oplus b$* , are new, *the stuff,  $a + b$* , is old.

There are two ways of interpreting Link's proposal concerning ontology. On the first, ontologies which attempt to reduce "things" to "stuff", or vice versa, by appeal to, say, basic facts about physics are making some kind of methodological mistake—the guide to reality is language, not science.

On the second, more plausible, interpretation, Link's semantics is not meant to be an account of ultimate reality as such. Rather, it is intended to be of a piece with what Strawson 1959 calls **DESCRIPTIVE METAPHYSICS**, or what Bach 1986 calls **NATURAL LANGUAGE METAPHYSICS**, if those are different (see Pelletier 2011). On this approach, Link's semantics exposes the ontological commitments of English itself,

or perhaps of competent English speakers. The language functions *as if* “things” and “stuff” are different. Whether or not one sort of entity is “really” reducible to the other, in some metaphysically loaded sense, is a separate matter.

Our primary question here is whether an empirically adequate account of the mass/count distinction really does require distinguishing “things” from “stuff”, and thus postulating two corresponding mereological relations, or if instead positing only one sort of entity and corresponding mereological relation is sufficient, as other semantic theories would have it.

This question is meant to be one of what we call NATURAL LANGUAGE MEREOL-OGY. We are asking about the mereological commitments of English, or perhaps competent speakers of English, and not about ultimate reality as such. Thus, to return to our original example, there is no pretense that we will definitively solve the *metaphysical* puzzle of the statue and clay.

Nevertheless, our question is important because, as we will see, Link’s argument for distinguishing “things” from “stuff” leads to an apparent dilemma. On the one hand, it is easy to generate examples similar to Link’s, but which do not involve a mixture of count nouns and mass nouns. For example, consider (3), due originally to Susan Rothstein 2010, Rothstein 2017.

(3) The bricks of the wall are old, but the wall is new.

Here we have a singular count noun (‘wall’) and a plural noun (‘bricks’). We may assume that the bricks completely constitute the wall, and yet they have different properties.

Now consider another example due to Rothstein, which involves only mass nouns.

(4) The gold in the jewelry is old, but the jewelry is new.

Again, we may assume that the gold in the jewelry completely constitutes the jewelry, and yet they have different properties.

The operative general principle, which we dub LINK’S MORAL, appears to be that if something completely constitutes something else but the two have different properties, then they must be different sorts of things, belonging to completely different domains. Link’s original argument would not only justify positing distinct domains and corresponding mereological relations for count and mass nouns, but also corresponding distinctions between singular and plural nouns, and also mass nouns like ‘gold’ and so-called “object mass nouns” like ‘jewelry’. In fact, we will argue in §3 that it vindicates postulating *indefinitely many* sorts of entities, not just “things” and “stuff”.

This might be reasonably taken to show that we should instead adopt what we call a ONE-DOMAIN ANALYSIS, as opposed a TWO-DOMAIN ANALYSIS such as Link's. One-domain analyses postulate only one sort of entity and one corresponding mereological relation in capturing the characteristic semantic differences between count and mass nouns.

These labels —“one-domain analysis” and “two-domain analysis”— are borrowed from Chierchia 1998 and Rothstein 2010, Rothstein 2017. To quote Rothstein 2017: 91f. directly:

Link (1983) proposes that homogeneous and non-homogeneous singular predicates have their denotations in different domains, reflecting the fact that they denote different kinds of entities. [Mass nouns] have their denotations in a non-atomic domain, and denote non-atomic Boolean semilattices. [Singular count nouns] have their denotation in an atomic domain and denote sets of atoms ...

Link's model captures the distinction between objects and stuff as an ontological distinction between two different kinds of things. It posits two different semantic domains representing two different kinds of entities related by ... material constitution.

Thus, the intended effect of Link's Moral is that if  $x$  completely constitutes  $y$  despite  $x$  and  $y$  having different properties, then  $x$  and  $y$  are in different (but related) “domains”, with different corresponding mereological relations, in precisely this sense.

As we will see in §2, both one-domain analyses and two-domain analyses purport to capture the key semantic differences between count nouns and mass terms. So the primary argument for two-domain analyses cannot be that postulating a sortal distinction between “things” and “stuff” does a better job at that. Nor can it be that two-domain analyses better track a brute metaphysical intuition that “things” and “stuff” are *fundamentally* different, in some metaphysically loaded sense, at least not if “our guide to ontological matters has to be language itself”.

Now, one-domain analyses typically assume that the nominal domain consists of “stuff” which may or may not be “packaged” into countable bits—the *atoms*—in context. Hence, on such analyses, Link's ring and the gold constituting it stand in the *same* parthood-relation to each other. They are, to put it bluntly, *the same stuff*. In other words, ‘the ring’ and ‘the gold in the ring’ are coextensional, in which case it would appear that they cannot have different properties, after all.

And the same holds of the wall and the bricks constituting it, the jewelry and the gold constituting it, and many more pairs, in fact. In essence, if we reject Link's Moral in favor of a one-domain theory, then we are immediately saddled with explaining the observation which led Link to postulate separate domains in the first place. We call this predicament LINK'S REVENGE.

The goal of §4 is to survey two seemingly plausible responses to Link's Revenge on behalf of one-domain analyses. In particular, we will attempt to fill in the missing details of two suggestions from Rothstein 2010. On both suggestions, what examples like (1), (3), and (4) reveal is not that natural language sortally distinguishes "things" from "stuff", but rather that there is some kind of *intentionality* associated with the accompanying noun phrases in those examples, thus explaining why there is a failure of substitutivity. And though both explications appear initially very plausible, we will ultimately see that neither is acceptable without significant challenges.

Ultimately, our goal in this paper is not to adjudicate between one-domain and two-domain analyses, or between the two possibilities sketched in §4. Rather, it is to raise the apparent dilemma already sketched, and to survey some possible resolutions, assuming that Link's Moral is rejected. The challenges facing the two suggestions sketched here are only intended to illustrate the difficulty of adequately addressing Link's Revenge.

Nevertheless, finding a potential resolution to Link's Revenge is important, for two reasons. First, with the exception of Link, the predominant theories of the count/mass distinction within linguistic semantics are one-domain analyses. Examples include Krifka 1989, Gillon 1992, Chierchia 1998, Chierchia 2010, and Rothstein 2010, Rothstein 2017. Thus, *some* plausible response to Link's Revenge is in order. Secondly, the question of how many mereological relations are needed to account for the count/mass distinction is, we take it, of primary importance to natural language mereology. Thus, finding a plausible resolution to Link's Revenge would go some way towards giving a definitive answer to that question, namely 'one'.

The rest of the paper is laid out as follows. In §2, we sketch the characteristic differences between count and mass nouns, and show how both one-domain and two-domain analyses purport to account for those differences. In §3, we look closer at Link's original argument for a two-domain analysis, and show how it seemingly leads to an explosion of nominal domains and corresponding mereological relations, thus leading to the adoption of a one-domain analysis. We then sketch two particularly natural responses to Link's Revenge, along with their difficulties, in §4. We conclude the paper in §5, where we summarize the paper and suggest some alternative ways out of Link's Revenge not considered here.

## 2 Single-Domain and Double-Domain Theories

The count/mass distinction is typically presented as a series of characteristic contrasts.<sup>2</sup> For example, whereas count nouns can occur with cardinality modifiers such as ‘two’, mass nouns (usually) cannot.

(5) Mary bought two {rings/??golds}.

Similarly, whereas count nouns cannot usually occur in the singular with classifiers like ‘piece of’ or ‘kilo of’, mass nouns usually can.

(6) Mary bought three pieces of {??ring/gold}.

Also, while count nouns can occur with distributive determiners like ‘every’, mass nouns (usually) cannot.

(7) Mary bought every {ring/??gold}.

Similarly, whereas mass nouns are typically acceptable with modifiers like ‘little’ or ‘much’, count nouns are instead typically acceptable only with modifiers like ‘several’ or ‘many’.

(8) a. Mary bought several {rings/??gold(s)}  
 b. Mary bought little {??ring/gold}.

Finally, and relatedly, whereas count nouns are typically acceptable with reciprocal distributive predicates like ‘stacked on top of each other’, mass nouns typically are not.

(9) The {rings were/??gold was} stacked on top of each other.

Both single domain and double domain theories purport to explain contrasts like (5)–(9), but they do so in different ways. Link explains these differences in terms of the semantic properties of the nouns involved. Specifically, whereas mass nouns are CUMULATIVE, singular count nouns are not.

(10) **Cumulativity:**  $\forall P. \forall x, y. P(x) \wedge P(y) \rightarrow P(x \sqcup y)$

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<sup>2</sup> See Rothstein 2017.

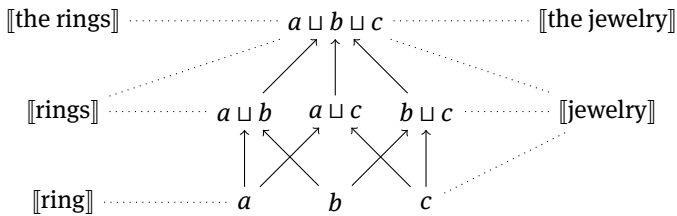
For example, if  $x$  and  $y$  are both quantities of water, then the sum of  $x$  and  $y$  is also a quantity of water. In contrast, if  $x$  is a chair  $y$  is a chair, the sum of  $x$  and  $y$  is not a chair.

Furthermore, whereas some mass nouns are (apparently) *DIVISIVE*, count nouns are not.

(11) **Divisiveness:**  $\forall P. \forall x. \exists y, z. P(x) \rightarrow [P(y) \wedge P(z) \wedge y \sqsubseteq x \wedge z \sqsubseteq x \wedge \neg y \circ z]$

In other words, entities satisfying divisive predicates can always be “split” into smaller, non-overlapping parts which also satisfy that predicate. This implies that not only do the denotations of count nouns and mass nouns belong to different domains, those domains are structurally different: whereas count nouns form an *atomic* semilattice structure, mass nouns instead form an *atomless*, or *GUNKY*, semilattice structure.<sup>3</sup> Assuming cardinality modifiers count atoms, and that distributive expressions “distribute” down to atoms, it’s little wonder we see contrasts like (5)–(9).

In contrast, Chierchia 1998’s highly influential single-domain analysis explains contrasts like (5)–(9) through the nature of the proposed denotations for count and mass nouns. Specifically, count and mass nouns both denote sets of atoms forming semilattice structures like the following:



Thus, singular count nouns such as ‘ring’ denote atoms, plural nouns such as ‘rings’ denote proper sums of atoms, and mass nouns such as ‘jewelry’ denote the closure of the atoms under sum-formation. Moreover, as on Link’s analysis, ‘the’ is a maximality operator, and so ‘the rings’ and ‘the jewelry’ will denote the same maximal sum, namely the rings, assuming (for simplicity) that they are the only pieces of jewelry. Incidentally, this will also be the denotation of ‘the gold in the rings’, given that the rings are completely constituted by gold.

<sup>3</sup> We are following the exegesis of Rothstein 2017 and others (like Landman 2012) here. In fact, Link 1983: 131 appears to be neutral on the atomicity of mass nouns: “In addition to the domain of individuals,  $E$ , there is a set  $D$  which is endowed with a join operator “ $\sqcup$ ” making  $D$  into a complete, but *not necessarily atomic*, join-semilattice” (emphasis added).



As a result, only one mereological relation is needed on Chierchia's analysis. Moreover, the explanation of contrasts like (5)–(9) falls out from the nature of the denotations assumed. Specifically, mass nouns literally neutralize the singular/plural contrast, in virtue of denoting *both* atoms and pluralities. As such, they cannot be pluralized, since they are already plural. Further, because their denotations do not include just atoms, they cannot be counted or occur acceptably with distributive expressions. Lastly, they require classifiers like 'piece of' or 'quantity of' to be counted, as the latter partition mass entities into countable atoms (see §4.1.2).

But why think that count and mass nouns should be analyzed homogeneously in this manner? Chierchia 1998: 348 explains:

The main argument in favor of the present view of mass nouns is one of economy. The structure revealed by plurals suffices to account for the properties of mass nouns. Why hypothesize two different domains when all that is needed to account for mass nouns can be found in the familiar atomic domain of count objects? The intuition that a mass noun like *furniture* means something subtly but deeply different from a count counterpart like *pieces of furniture* is an optical illusion, a gestalt effect due to the different groupings of their denotations.

In other words, if it is possible to explain the characteristic contrasts between count and mass nouns without positing distinct domains of "things" and "stuff", then one ought to do so, all else being equal.

Hence, the argument for double-domain theories such as Link's cannot simply be a metaphysical hunch that "things" and "stuff" are by their very nature different sorts of things, and that the count/mass distinction is tracking this difference.<sup>4</sup> At least that cannot be the argument if we are engaged in *natural language mereology*, in which case positing distinct domains would be legitimate only if providing an empirically adequate account of that distinction required doing so. Yet this is precisely what *both* single and double-domain analyses purport to do.

To be clear, Link's argument for two domains does *not* rely on antecedent metaphysical intuitions. Rather, it relies only on the observation that a ring and the gold constituting it can have different properties, in which case it would appear that single-domain theories such as Chierchia's are empirically inadequate. After all, if 'the ring' and 'the gold in the ring' both denote *the same maximal sum*, then shouldn't they have the same properties?

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<sup>4</sup> See Pelletier 1975 for relevant discussion here.

### 3 Link's Moral

Let's return to Link's argument for double-domains. Assuming (1) is true, the referent of 'this ring' and the referent of 'the gold in the ring' must have different properties.

(1) This ring is new, but the gold in the ring is old.

Specifically, on Link's semantics, the denotations of 'the ring' and 'the gold in the ring' are given in (12a,b), where ' $\sigma$ ' is Link's maximality-operation, and  $A$  and  $Q$  range over atomic entities and mass quantities, respectively.

- (12) a.  $\llbracket \text{the ring} \rrbracket = \sigma x \in A : \text{ring}(x)$   
 b.  $\llbracket \text{the gold in the ring} \rrbracket = \sigma x \in Q : \text{gold}(x) \wedge x \sqsubseteq_m \text{the-ring}$

Thus, 'the ring' refers to some unique atomic ring, while 'the gold in the ring' refers to the maximal quantity of gold which stands in the material-part of relation to that ring. Assuming that the ring is completely constituted by the gold, both are the same "stuff". So, if 'the ring' and 'the gold in the ring' both referenced that "stuff", their referents would be identical, thus violating Leibniz's Law. Upholding the latter, we conclude that atoms and mass quantities constitute different domains altogether.

Link's argument seemingly relies on a more general principle, which we call *Link's Moral*:

(13) If  $x$  and  $y$  have different properties, yet one completely constitutes the other, then  $x$  and  $y$  are different sorts of things. That is,  $x$  and  $y$  belong to different domains.

While this would certainly justify Link's double-domain analysis, it would also appear to justify even more domains and corresponding mereological relations. For example, consider again (3).

(3) The bricks of the wall are old, but the wall is new.

Here we have two count nouns: 'the bricks of the wall' and 'the wall'. On Link's analysis, 'the wall' denotes a specific atom, while 'the bricks of the wall' denotes the maximal sum of atomic bricks which stand in the individual-part of relation to the wall ('\*' is Link's pluralization operator, where '\* $P$ ' denotes the closure of the  $P$ -atoms under sum-formation).

- (14) a.  $\llbracket \text{the wall} \rrbracket = \sigma x \in A : \text{wall}(x)$   
 b.  $\llbracket \text{the bricks of the wall} \rrbracket = \sigma x \in A : * \text{brick}(x) \wedge x \sqsubseteq_i \text{the-wall}$

Now, suppose that the wall is completely constituted by the bricks. Since these have different properties, they must be different sorts of things, and thus constitute different domains, by Link's Moral. The trouble, of course, is that the bricks and the wall are supposed to be located in the *same* domain, namely that of atomic entities.

Now reconsider (4).

- (4) The gold in the jewelry is old, but the jewelry is new.

Here we have two mass nouns, 'the gold in the jewelry' and 'the jewelry'. On Link's analysis, these too can be coextensional.

- (15) a.  $\llbracket \text{the jewelry} \rrbracket = \sigma x \in Q : \text{jewelry}(x)$   
 b.  $\llbracket \text{the gold in the jewelry} \rrbracket = \sigma x \in Q : \text{gold}(x) \wedge x \sqsubseteq_m \text{the-jewelry}$

In particular, assuming the jewelry is completely constituted by the gold in it, we are led to conclude that the jewelry and the gold form different domains, by Link's Moral. The trouble, once again, is that the denotations of mass nouns are supposed to be located in the *same* domain, namely that of mass quantities.

In the next section, we consider certain responses available to Link in light of these two examples. To anticipate, it might be reasonably thought that Link 1984, Link 1998's theory of *groups* could be used to explain how the wall and the bricks, and the jewelry and the gold, do in fact constitute separate domains. Thus, groups represent a seemingly plausible way of retaining Link's Moral in light of Rothstein's examples.

Despite this possibility, maintaining Link's Moral in full generality would appear to *massively* overgenerate domains and corresponding mereological relations. Consider (16), due to Oliver & Smiley 2001.

- (16) a. Russell and Whitehead were logicians.  
 b. The molecules of Russell and Whitehead were logicians.

'Be logicians' is a DISTRIBUTIVE PREDICATE, meaning that it applies to all parts of a given plurality. In Link's semantics, 'Russell and Whitehead' denotes the sum of Russell and Whitehead, while 'the molecules of Russell and Whitehead' denote atoms which are individual parts of the aforementioned sum. Since parthood is transitive, Link's semantics would thus appear to predict that (16a) entails (16b), contrary to fact. Intuitively, the problem is that because mereological sums do not

have unique decompositions, we cannot semantically distinguish the plurality of Russell and Whitehead from its proper parts.<sup>5</sup>

According to Oliver and Smiley,<sup>6</sup> examples like this reveal that mereological analyses of plurals, such as Link's, are fundamentally misguided. However, this objection neglects an important property of atoms, as they appear in various semantic treatments, namely that they are *property-relative*. In other words, when doing semantics, it never makes sense to talk about atoms *full-stop*, but only atoms of a certain kind, atoms of a given property *P*.

Here, for example, is the definition of ATOMICITY in (17a) from Krifka 1989, along with the accompanying definitions of ATOMIC PREDICATE in (17b) and ATOMIC PARTHOOD in (17c), where *S* restricts the *P*-atoms to a certain sort.

- (17) a.  $\forall x. \forall P. \text{ATOM}_S(x, P) \leftrightarrow P(x) \wedge \neg \exists y. y \sqsubset_S x \wedge P(y)$   
 b.  $\forall P. \text{ATOMIC}_S(P) \leftrightarrow \forall x. P(x) \rightarrow \text{ATOM}_S(x, P)$   
 c.  $\forall x, y. x \sqsubseteq_{At, S} y \leftrightarrow x \sqsubseteq_S y \wedge \text{ATOM}_S(x, S)$

Thus, *x* is an atomic-*P* relative to sort *S* just in case it has no proper parts which are also *P*s; *P* is an atomic predicate relative to *S* just in case every member of its extension is a *P*-atom in *S*; and *x* is an atomic part of *y* relative *S* just in case *x* is an *S*-part of *y* and *x* is atomic in *S*.

In a Link-style semantics, singular count nouns are atomic predicates in this sense, and distributive predicates apply to atomic parts as defined in (17c). In both (16a,b), the relevant *P*-atoms will be individual logicians, including both Russell and Whitehead. Relative to the property of being a molecule of Russell or Whitehead, on the other hand, the relevant *P*-atoms will be the molecules belonging to either Russell or Whitehead. Hence, neither Russell nor Whitehead are atoms relative to this property, and none of the atomic-molecules have the property of being logicians. In other words, it simply does not follow on Link's analysis that (16a) entails (16b).

Nevertheless, (16) does seemingly represent a problem for *Link's Moral*. Again, Russell and Whitehead are completely constituted by their molecules, presumably. In other words, the correct denotations for 'Russell and Whitehead' and 'the molecules of Russell and Whitehead' are presumably those in (18).

- (18) a.  $\llbracket \text{Russell and Whitehead} \rrbracket = r \sqcup w$   
 b.  $\llbracket \text{the molecules of Russell and Whitehead} \rrbracket = \sigma x \in A : *_{\text{molecule}}(x) \wedge x \sqsubseteq_i r \sqcup w$

<sup>5</sup> For similar arguments, see Rayo 2002 and McKay 2006.

<sup>6</sup> See also Oliver & Smiley 2013.

There are two issues. First, because ‘molecule’ is a count noun, ‘the molecules of Russell and Whitehead’ must be located in the domain of atomic entities. Likewise with Russell and Whitehead, of course. Hence, the mereological relation holding between the molecules and the sum of Russell and Whitehead should be that of individual-part of. On the other hand, any physical mass quantities standing in the material-part of relation to Russell and Whitehead – their blood, their hair, etc – will also be constituted by those molecules. And these too can have different properties.

(19) The molecules of Russell’s hair are old, but Russell’s hair is (comparatively) new.

This should not be surprising on Link’s analysis, given that molecules belong to the count domain, and Russell’s hair to the mass domain. What is surprising, however, is that the former *constitutes* the latter.

- (20) a.  $[[\text{Russell's hair}]] = \sigma x \in Q : \text{hair-belonging-to-Russell}(x)$   
 b.  $[[\text{the molecules of Russell's hair}]] = \sigma x \in A : * \text{molecule}(x) \wedge x \sqsubseteq_{?} \text{Russell's-hair}$

But then it is hard to see what this constitution-relation could be. It cannot be that of individual-part of, since Russell’s hair would then be in the atomic domain, and thus countable. Conversely, it cannot be that of material-part of, since the molecules constituting it would be mass quantities, and thus non-countable.

Perhaps one can set this aside. A more pressing issue is that since the molecules and the sum consisting of Russell and Whitehead have different properties, they must constitute completely different domains by Link’s Moral. We can reproduce this argument for practically *any* atomic entity or sum of atomic entities. That is, for any atom or sum of atoms referenced by a definite noun phrase like ‘Mary’, ‘that chair’, or ‘these people’, the molecules constituting them will have different properties than the things referenced. Thus, if Link’s Moral held in full generality, we would have *indefinitely many* domains and corresponding mereological relations, not just the two Link hypothesizes.

To be clear, the problem isn’t merely that this would require positing more domains than just the two Link originally hypothesizes. Semanticists regularly posit a variety of different sorts of entities, including, for example, events, kinds, degrees, numbers, times, and locations. A seemingly plausible justification is that natural language regularly makes category distinctions corresponding to these, as witnessed in the distinction between various kinds of predicates, nouns and verbs, measure phrases, tenses, locatives, ... And something similar might be said

with respect to the count/mass distinction, perhaps. But nothing remotely similar can be said for the sorts of additional sortal distinctions that would be required to maintain Link's Moral in light of examples like (16) and (19).

In short, while Link's Moral would certainly vindicate his two domain analysis, it also appears to massively overgenerate domains and corresponding mereological relations. Thus, unless some principled reason can be given for restricting Link's Moral to just the count and mass domains, or unless some other general background principle can be found which would have the same effect, the right response would appear to be rejecting Link's Moral. In that case, however, we would have no obvious reason for adopting a double-domain analysis, opting instead for a single-domain analysis.

But now we have come full circle. Again, if all there is, at least with respect to the nominal domain, is "stuff" which is "packaged" in context into countable "things", as one-domain theories suggest, then how can it be that that Link's ring and the gold constituting it can have different properties? Likewise for the wall and the bricks constituting it, the jewelry and the gold constituting it, Russell and Whitehead and the molecules constituting them, etc.

If a single domain and corresponding mereological relation is all that is needed to adequately model the count/mass distinction, then clearly some response to Link's Revenge is in order. But what?

## 4 Two Avenues of Response

From here on, we assume that some kind of one-domain analysis is correct. The question, then, is how to make sense of examples like (1), (3), and (4) if the pairs of definite noun phrases in those examples refer to the same "stuff", and so are coextensional.

- (1) This ring is new, but the gold in the ring is old.
- (3) The bricks of the wall are old, but the wall is new.
- (4) The gold in the jewelry is old, but the jewelry is new.

Commenting on these examples in a footnote, Rothstein 2010: 365, fn. 10 suggests a possible way out:

One possible solution is to treat *wall* analogously to *deck* [as in *deck of cards*], justifying this by the plausible assumption that walls are greater than the sums of bricks that compose them ... [This] is a version of the problem that occurs in the mass domain too ... *This jewelry is new, but the gold it is made of is old.* The mass entity in jewelry cannot be equated with

the mass entity in gold since they have different properties, even though they are apparently identical. This implies that generally ‘artefact’ predicates like *jewelry* involve a packaging or perspective function as part of their lexical meaning, so that [*gold*] and [*jewelry*] can be identified as the same spatiotemporal entity but presented under different perspectives or guises and with different properties.

Because Rothstein’s comments here are only meant to be suggestive, she does not elaborate on how exactly this suggestion should be carried out, or indeed how might be used in response to Link’s Revenge. Thus, our task will be to fill in these missing details.

We will do so by appealing to two theories which appear particularly well suited to implement Rothstein’s proposal. On both, the truth of examples like (1), (3), and (4) is to be explained through some kind of *intensionality* associated with the noun phrases involved in those examples: ‘the ring’ and ‘the gold in the ring’, ‘the wall’ and ‘the bricks of the wall’, and ‘the jewelry’ and ‘the gold in the jewelry’. Where they differ is the *source* of that intensionality, corresponding to different views of the semantic function of those noun phrases.

On the first suggestion, the noun phrases are *referential* expressions (type *e*) referring to *groups* in the sense of Link 1984, Link 1998. Just as a deck of cards can consist completely of cards but have its own identity in virtue of representing the cards as a unified whole, likewise the wall and the jewelry have their own identity beyond the bricks or the gold in virtue of representing them as unified wholes. Assuming with Link that groups are intensional, and so cannot be identified by their members, it would be hardly surprising if the wall qua group of bricks and the bricks qua sums of atoms can have different properties despite consisting of the same atomic constituents, namely bricks. Likewise for Link’s ring, the jewelry, and the gold constituting them. This is this THE GROUP-FORMING STRATEGY.

On the second suggestion, inspired by Landman 1989b, the noun phrases involved are not referential expressions. Rather, they are intensional generalized quantifiers (of hyperintensional type  $\langle\langle e, p \rangle, p\rangle$ , where *p* is the type of propositions), expressing properties of restricted properties. These restricted properties can be thought of as representing the bricks, the wall, etc. through different aspectual “guises”. They are given either explicitly through aspectual phrases like ‘as a group of bricks’ and ‘qua sums of atoms’, or else contextually when no overt aspectual phrases are available. This guarantees that the different noun phrases involved will express different second-order properties in different contexts, thus explaining how (1), (3), and (4) can be true. This is THE ASPECT-RESTRICTION STRATEGY.

On both strategies, then, the moral of Link’s original example (1), and others like it, is that the meanings of definite noun phrases like ‘the ring’, ‘the gold in the ring’, etc. cannot be identified with the “stuff” they denote.

We will consider both strategies in what follows, while pointing out their apparent challenges. Though we will conclude these challenges are substantial, this should not be taken as an indictment on Rothstein's suggestion, as there could be alternatives to those considered here which do not face those problems. Rather, the challenges considered here are only intended to illustrate how difficult answering Link's Revenge really is.

## 4.1 The Group-Forming Strategy

Consider (21), due originally to Link 1984, Link 1998.

(21) The red cards and the blue cards are shuffled.

As Link observes, (21) is ambiguous between COLLECTIVE INTERPRETATION according to which the red cards and the blue cards are shuffled together, and a DISTRIBUTIVE INTERPRETATION on which each deck of cards is individually shuffled. Now, given Link 1983's original analysis, 'the red cards' and 'the blue cards' should both denote maximal sums of atomic cards.

- (22) a.  $\llbracket \text{the red cards} \rrbracket = \sigma x \in A : \text{red}(x) \wedge * \text{card}(x)$   
 b.  $\llbracket \text{the blue cards} \rrbracket = \sigma x \in A : \text{blue}(x) \wedge * \text{card}(x)$   
 c.  $\llbracket \text{the red cards and the blue cards} \rrbracket = [\sigma x \in A : \text{red}(x) \wedge * \text{card}(x)] \sqcup [\sigma x \in A : \text{blue}(x) \wedge * \text{card}(x)]$

Since 'and' denotes the join-operation, 'the red cards and the blue cards' will thus denote the maximal sum consisting of the red cards and the blue cards. Moreover, since cumulative predicates apply to sums, while distributive predicates apply to all parts of sums, including their atomic parts, the prediction is that the collective interpretation should be true if the maximal sum in (22c) has the property of being shuffled, while the distributive interpretation should be true if each atomic card within that maximal sum has the same property, i.e. each individual card is *itself* shuffled. Clearly, that is not the intended interpretation, and, it seems, we cannot get the one on which the red cards are shuffled and the blue cards are shuffled separately.

To overcome this difficulty, Link develops a theory of *groups*. Groups are like pluralities (sums) in that they are inherently plural, (typically) having more than



one atomic constituent.<sup>7</sup> Linguistically, however, they are canonically referenced by different sorts of phrases. Whereas pluralities are prototypically referenced by conjunctive noun phrases like ‘John and Mary’, groups are prototypically referenced by GROUP NOUNS like ‘deck’ in ‘deck of cards’. Both can be referenced, however, by definite plurals such as ‘the red cards’, as evidenced by examples like (21).

However, the crucial difference between pluralities and groups, on Link’s analysis, is that whereas pluralities are inherently extensional, and so are identified by their atomic parts, groups are inherently intensional, and hence cannot be so identified. Consider (23), due to Landman 1989a.

- (23) a. The judges are on strike.  
 b. The hangmen are on strike.

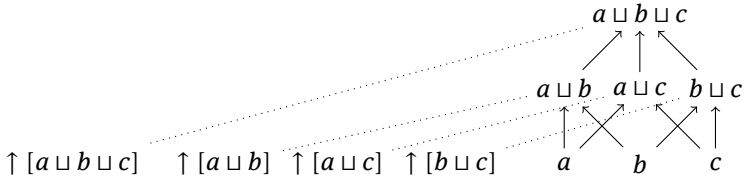
Suppose we happen to live in a small town where the judges moonlight as the hangmen. As Landman observes, a prisoner sentenced to die would be ill-advised to infer (23b) from (23a) in such a situation. After all, it could be that the judges *qua* judges are on strike, while the judges *qua* hangmen are not.

Link models this sort of intensionality by introducing a distinction between PURE ATOMS and IMPURE ATOMS. Pure atoms are ordinary atomic entities like John, Mary, that table, etc. They are the sorts of things which when summed together form pluralities. Impure atoms, on the other hand, are groups formed from pluralities in the following manner. There are two operations,  $\uparrow$  (GROUP-FORMATION) mapping pluralities to impure atoms, and a converse operation  $\downarrow$  (MEMBER-SPECIFICATION) mapping impure atoms to the pluralities from which they are formed.  $\uparrow$  is one-to-one but not onto, whereas  $\downarrow$  is onto but not one-to-one. Thus, whereas every plurality forms a group, it needn’t follow that every group corresponds to a unique plurality. In the case of (23), for instance, the judges and the hangmen form different groups, despite being formed from the same plurality.

Crucially, impure atoms are sortally distinct from pure atoms, i.e. they form a separate domain. The picture is roughly as follows, where dots represent group-formation.

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<sup>7</sup> We say “typically” here because it is in principle possible to have a group having only one member, thanks to the idempotency of  $\sqcup$  (Krifka 1989), i.e.  $x \sqcup x = x$  for any  $x$ .



We begin with some pure atoms,  $a, b, c$ , and form pluralities from them through the sum-operation. We then form groups from these pluralities through the  $\uparrow$ -operation, and these now serve as atomic entities within a new semilattice structure consisting only of impure atoms. These can then be summed to form pluralities of groups, and the process can be iterated to form groups of groups, groups of groups of groups, etc.<sup>8</sup>

With groups in hand, it is easy to see how (21) can have both a collective and distributive interpretation. On the cumulative interpretation, ‘be shuffled’ applies to the plurality consisting of the two maximal sums, and thus the totality of red and blue cards. The distributive interpretation arises instead if ‘be shuffled’ applies to the two decks as groups:

- (24) a.  $\text{shuffled}([\sigma x \in A : \text{red}(x) \wedge * \text{card}(x)] \sqcup [\sigma x \in A : \text{blue}(x) \wedge * \text{card}(x)])$   
(collective)
- b.  $\text{shuffled}(\uparrow [\sigma x \in A : \text{red}(x) \wedge * \text{card}(x)] \sqcup \uparrow [\sigma x \in A : \text{blue}(x) \wedge * \text{card}(x)])$   
(distributive)

Since groups are atoms, the distributive interpretation will be true just in case each deck is shuffled, as desired.

### 4.1.1 Extending Groups

The question here is whether Link’s theory of groups can be extended so as to capture the truth of (3) and (4), and without multiplying domains unnecessarily.

- (3) The bricks of the wall are old, but the wall is new.
- (4) The gold in the jewelry is old, but the jewelry is new.

<sup>8</sup> See Landman 1989a. We’d want the process to be cumulative, in the sense that, for example, there is a group consisting of some groups plus some individuals.

The basic idea is simple enough: if we allow that the wall is a group whose members are the bricks constituting it, and that the jewelry is similarly a group whose members are the rings, bracelets, etc. constituting it, then since groups have different properties from the pluralities forming them, it's hardly surprising that (3) and (4) can be true. What's more, because groups are presumably needed to model semantic phenomena like (21) anyway, even for one-domain analyses, this postulation of separate domains is independently justified. This is *the Group-Forming Strategy*.

Let's begin with (3). Again, the basic idea is to analyze 'the wall' as referencing a group formed from a sum of pure atomic bricks, as suggested in (25), where 'IA' is the domain of impure atoms, or groups, at a given level.<sup>9</sup>

- (25) a.  $\llbracket \text{the wall} \rrbracket = \sigma x \in IA : \text{wall}(x)$   
 b.  $\llbracket \text{the bricks of the wall} \rrbracket = \sigma x \in A : *brick(x) \wedge x \sqsubseteq \downarrow \llbracket \text{the-wall} \rrbracket$

Thus, 'the wall' will refer to the unique impure atom whose only constituents are pure bricks, while 'the bricks of the wall' will refer to the maximal plurality of pure bricks. The mereological relation holding between them is that of *member-specification*: the pure bricks are group-members of the wall. Nevertheless, they are distinct, just as the deck of red cards is distinct from the maximal sum of red cards. And just as decks of cards and the pluralities of cards constituting them can have different properties, e.g. (26) can only be true of the plurality and not the group,

(26) The red cards are stacked on top of each other.

likewise the wall qua group of bricks may have properties different from the bricks qua components of the wall, as revealed by e.g. (3).

Something similar can be said about (4), it seems. So-called OBJECT MASS NOUNS such as 'jewelry', 'silverware', and 'furniture' serve as major motivations for one-domain analyses.<sup>10</sup> That's because, unlike e.g. 'gold' or 'water', 'jewelry', 'silverware', and 'furniture' denote collections of apparently *countable* entities, e.g. rings and bracelets, forks and knives, and chairs and sofas.<sup>11</sup> Hence, to recall the quote from Chierchia 1998 in §2: "The intuition that a mass noun like *furniture* means something subtly but deeply different from a count counterpart like *pieces of furniture* is an optical illusion, a gestalt effect due to the different groupings of

<sup>9</sup> The fact that groups iterate in way resembling sets means that we are flirting with (Russell's) paradox. See Snyder & Shapiro (ms.) for details plus a possible solution.

<sup>10</sup> The label 'object mass nouns' comes from Rothstein 2010, Rothstein 2017.

<sup>11</sup> See Barner & Snedeker 2005.

their denotations.” According to Chierchia, this suggests that we ought view the denotations of mass nouns and count nouns alike: both denote atoms, though the atoms of non-object mass nouns such as ‘gold’ and ‘water’ are typically “vague”, and thus far less easily identifiable than those of e.g. ‘furniture’.

Suppose Chierchia is right. Then the analogy between the bricks of the wall and the gold in the jewelry becomes apparent: just as we can view the wall as an impure atom whose sub-constituents are pure atomic bricks, we can likewise view the jewelry as an impure atom whose pure atomic sub-constituents are pieces of jewelry such as rings and bracelets. And as before, these may have different properties, even if the jewelry is completely constituted by the rings and the bracelets:

(27) The rings and the bracelets of the jewelry are stacked on top of each other, but the jewelry itself is not.

This suggests the analysis in (28).<sup>12</sup>

- (28)a.  $\llbracket \text{the jewelry} \rrbracket = \sigma x \in IA : \text{jewelry}(x)$   
 b.  $\llbracket \text{the rings and the bracelets of the jewelry} \rrbracket = \sigma x \in A : \exists y, z \in A : *ring(y) \wedge *bracelet(z) \wedge x = y \sqcup z \wedge x \sqsubseteq \downarrow \llbracket \text{the-jewelry} \rrbracket$

Thus, as with the wall, the jewelry may be viewed as a group whose group-members are rings and bracelets, and so the relevant mereological relation holding between them will be that of group-membership.

Now consider the remaining examples considered above.

- (1) This ring is new, but the gold in the ring is old.  
 (4) The gold in the jewelry is old, but the jewelry is new.  
 (19) The molecules of Russell’s hair are old, but Russell’s hair is (comparatively) new.

As before, the idea would be to view the ring and the jewelry as a group whose group-members are “vague” (pure) gold-atoms, and likewise to view Russell’s hair as a group consisting of “vague” (pure) molecule-atoms. Hence, the only semantically significant difference between examples like (3) and (27) and those like (1), (4), and (19) would be that the pure atoms in latter cases are not as easily identifiable as those in the former cases.

Finally, consider (29a), modeled on an example from Pelletier 2011.

<sup>12</sup> For a similar analysis of cumulative conjunction, see Krifka 1990.

- (29) a. The snow is new, but the water constituting the snow is old, and the hydrogen and oxygen molecules constituting the water are even older.
- b. The art installation is new, though the walls of the art installation are old, and the bricks of the walls are even older.
- c. The art exhibit is new, though the jewelry of the art exhibit is old, and the gold in the jewelry is even older.

As Pelletier rightly notes, (29a) is puzzling for Link's original analysis, since it would appear to require that the hydrogen and oxygen molecules stand in a mereological relation to the water, and that the water to stands in the *same* mereological relation the snow, despite 'molecule' being count, and 'water' and 'snow' being mass. And as (29b,c) reveal, similar examples can be reproduced for the other sorts of nouns considered here.

On the present suggestion, these examples might be seen as witness to *group iteration*. As mentioned above, groups iterate in such a way that we can have groups of groups, groups of groups of groups, etc. Thus, for (29a), we might view the pure atoms as the "vague" hydrogen and oxygen molecules. These constitute the first "level" of impure atoms, namely the "vague" water-atoms. And these in turn form the second "level" of impure atoms, namely the "vague" snow atoms. And something similar can be said about (29b,c), of course. In short, it would appear that adopting a one-domain analysis along with Link's theory of groups is sufficient to explain how all of the variations on Link's original example can be true.

#### 4.1.2 Challenges for the Group-Forming Strategy

Despite its apparent advantages, the Group-Forming Strategy faces two significant challenges. The first is raised by Rothstein 2010: 365.

One possible solution is to treat *wall* analogously to *deck*, justifying this by the plausible assumption that walls are greater than the sums of bricks that compose them. However, against this is the intuition that while *deck* is defined as a set of cards, *wall* denotes a set of entities that are objects in their own right, rather than being an expression that classifies bricks ...

Expressions such as 'deck' (as in 'deck of cards') are called "group nouns" because their function, intuitively, is to combine with a noun to denote groups of things having that property. Group nouns are a subclass of English CLASSIFIERS, or expressions whose function is to combine with a noun to produce a countable or

measurable predicate. Rothstein 2017 organizes these into two kinds. The first are COUNTING CLASSIFIERS:

<i>Category</i>	<i>Example Classifier</i>	<i>Example Classifier Phrase</i>
Unit Classifier	'unit', 'item'	'item of clothing'
Apportioning Classifier	'grain', 'quantity'	'grain of rice'
Container Classifier	'box', 'cup'	'box of books'
Group Classifier	'group', 'deck'	'deck of cards'
Arrangement Classifier	'row', 'pile'	'row of cabbage'

Opposed to counting classifiers are MEASURING CLASSIFIERS.

<i>Category</i>	<i>Example Classifier</i>	<i>Example Classifier Phrase</i>
Lexical Measure	'kilo', 'liter'	'kilo of cocaine'
Container Measure	'bottle', 'glass'	'glass of water'
'-ful' Measure	'pocketful', 'busful'	'pocketful of sand'
'-worth' Measure	'dollarsworth', 'poundsworth'	'ten dollarsworth of nickels'

Thus, Rothstein's argument can be summarized as follows. If 'wall' were analogous to 'deck', it would be a classifier, specifically a counting classifier. But whereas nothing is a deck *outright*, but only a deck *of* something, something can be a wall outright, independent of whether it consists of bricks, cardboard, etc. In other words, there is hardly any plausibility to the claim that 'wall' is a classifier, and so the analogy between 'deck of cards' as denoting a group whose group-members are (pure) atomic-cards, and 'wall of bricks' as denoting a group whose (pure) atomic-bricks, collapses. And the same complaint could be leveled at the suggestion that 'the ring', 'the jewelry', and 'Russell's hair' are group-referring expressions.

One may reasonably question the apparently operative presumption here, namely that 'the wall', 'the ring', etc. are plausibly understood as a group-denoting term only if they are appropriately analogous to group classifiers. As we have seen, Link 1984, Link 1998 argues that postulating groups is necessary to account for ambiguities like (21).

(21) The red cards and the blue cards are shuffled.

Notice that group classifiers allow for the same ambiguity.

(30) The deck of red cards and the deck of blue cards are shuffled.

On Link's account, presumably, the distributive interpretation arises if the definite plurals here reference groups, while the collective interpretation arises through applying member-specification ( $\downarrow$ ) to those groups, thus returning the totality of cards in both decks. In other words, group classifiers are not required to generate these sorts of distributive/collective ambiguities. Moreover, insofar as groups are needed to explain such ambiguities, it would seem that 'the red cards' is appropriately analogous to 'the deck of red cards'. If so, then why not think that 'the wall', 'the ring', etc. are too?

Setting this aside, there appears to be a more direct, but related, challenge to the Group-Forming Strategy. Clearly, we can use group classifiers to talk about the bricks as a group; witness 'that group of bricks'. Presumably, this refers to the same group which would result through applying group-formation to 'the bricks of the wall'. But now consider (31).

(31) That group of bricks is old, but the wall is new.

In other words, we can reformulate the same kind of problematic example using the hypothesized referent of 'the bricks of the wall'. But since 'the wall' is, by hypothesis, coreferential with 'that group of bricks', it appears that appealing to groups will not help explain how (3) can be true.

Worse yet, we can easily produce similar examples for the other problem cases. Consider (32), for instance.

(32) The quantity of gold in the jewelry is old, but the jewelry is new.

Arguably, apportioning classifiers like 'quantity' serve a semantic function similar to group classifiers,<sup>13</sup> but with mass nouns. In other words, they partition uncountable "stuff" into countable, unified portions, much like how 'group of bricks' partitions pluralities of bricks into a countable, unified whole. Hence, 'the quantity of gold in the jewelry' plausibly references the same group of (pure) gold-atoms hypothesized as the referent of 'the jewelry' in (4). If so, then once again appealing to groups will not help explain how the gold in the jewelry and the jewelry itself can have different properties.

A different kind of challenge for the Group-Forming Strategy concerns the source of intensionality supposed for the examples discussed. Consider again Landman 1989a's (23).

(23a) The judges are on strike.

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<sup>13</sup> See Scontras 2014.

(23b) The hangmen are on strike.

To repeat, the proposed explanation for why (23a) does not entail (23b) is that because groups are intensional, and so cannot be identified by atomic parts of the sums from which they are formed, ‘the judges’ and ‘the hangmen’ can reference different groups despite extensionally consisting of the same individuals. Hence the failure of substitutivity in (23a,b).

As Landman notes, the trouble is that exactly similar examples can be produced using definite *singular* noun phrases like ‘the judge’ and ‘the hangmen’. Thus, consider Landman’s (33).

- (33) a. The judge is on strike.  
 b. The hangman is on strike.

As before, if John happens to moonlight as both judge and hangman in our small town, one would be ill-advised to infer (33b) from (33a): in his capacity as judge, John may have good reasons to be on strike, even if he feels compelled to carry out his duties as a hangman. Yet the claim that ‘the judge’ and ‘the hangmen’ reference a *group* seems far less intuitive.

Thus, Landman reasonably concludes that the sort of intensionality witnessed in both sorts of examples is better located in the meaning of noun phrase itself, not in the *sorts* of things referenced, i.e. groups. Thus, we are led to the same problematic conclusion: identifying the referents of the various definite plurals above with groups will not explain how the wall and the bricks constituting it, the jewelry and the gold constituting it, etc. can have different properties.

All of this suggests that a different kind of explanation is in order. In the next subsection, we will consider a solution modeled from Landman’s own theory of examples like (23) and (33). On that account, the intensionality witnessed is not a function of the sorts of things referenced, but rather of the meanings of the definite noun phrases involved. In effect, substitutivity fails because we are restricting the properties expressed to different aspectual “guises”. As a result, the meanings expressed are different, even if the things referenced are extensionally the same. Hence we call it “the Aspect-Restriction Strategy”.

## 4.2 The Aspect-Restriction Strategy

Unlike the Group-Forming Strategy, the Aspect-Restriction Strategy locates the source of intensionality witnessed in examples like (3) and (4) in the meanings of the component noun phrases.



- (3) The bricks of the wall are old, but the wall is new.  
 (4) The gold in the jewelry is old, but the jewelry is new.

This is in keeping with a second suggestion of Rothstein 2010: 355, elaborated as follows:

The mass entity in *jewelery* cannot be equated with the mass entity in *gold* since they have different properties, even though they are apparently identical. This implies that generally ‘artifact’ predicates like *jewelery* involve a packaging or perspective function as part of their lexical meaning, so that [the lexical meanings of *gold* and *jewelery*] can be identified as the same spatiotemporal entity but presented under different perspectives or guises and with different properties. But if this kind of lexical packaging is needed anyway in the mass domain, then the problem of the wall and the sum of bricks that makes it up can be solved at the level of [the lexical meanings of *wall* and *brick*], in which case [the lexical meaning of *brick*] will not include the sum of bricks presented as a wall.

In other words, if the source of intensionality can be located within the lexical meanings of the component nouns, then there is no need to appeal to groups to explain the failure of substitutivity witnessed in (3) and (4).

How might this suggestion be spelled out? A natural place to look would be Landman’s analysis of groups. As mentioned, Landman argues that the kind of intensionality witnessed in (34) should be located in the meanings of the component nouns, rather than groups, precisely because it exists for both definite plural and definite singular noun phrases alike.

- (34) a. The {judge is/judges are} on strike.  
 b. The {hangman is/hangmen are} on strike.

Thus, unlike Link 1984, Link 1998, Landman models groups *extensionally*, using sets. Pluralities correspond to sets of entities, and groups correspond to sets of sets of entities—the group formed from a plurality is the singleton of the corresponding set. The same operations are available relating pluralities and groups, namely  $\downarrow$  and  $\uparrow$ , only now both are *bijective*: for every plurality there is a unique corresponding group, and vice versa

In other words, the source of intensionality witnessed in (34) is to be located in the meaning of the component noun ‘judge’. The basic idea is that we are not interpreting ‘the judge’ and ‘the hangman’ in (33a,b) as singular terms referring to the same individual, but rather as properties of that individual considered under a certain *aspect*.

Supposing that John happens to be the lone judge and hangman in our small town, (33a,b) can be respectively paraphrased as (35a,b).

- (35) a. As a judge, John is on strike.  
 b. As a hangman, John is on strike.

John's CHARACTER is the set of properties John possesses, and the semantic function of aspectual phrases like 'as a judge' is to restrict these properties to a certain aspect, corresponding to the different functional roles he plays. These may be thought of as John under different "perspectives" or "guises" in that when evaluating (35a,b), we are considering not merely the properties of John as such, but rather the properties of John *qua judge* or John *qua hangman*. Since he may have different properties when considered under different aspects of his character, substitutivity fails in (33a,b) even though, intuitively, both noun phrases describe the same individual.

To develop (or, better, to start developing) this plan, Landman adopts a hyper-intensional semantics, with two basic types:  $e$  (individuals) and  $p$  (propositions). He then introduces an aspectual-operator  $\uparrow$ , which takes an entity and a property (type  $\langle e, p \rangle$ ) and returns a property of properties (type  $\langle \langle e, p \rangle, p \rangle$ ).

Accordingly, (35a,b) can be represented as (36a,b), respectively, where 'on-strike' also expresses a property (type  $\langle e, p \rangle$ ).

- (36) a.  $j \uparrow \text{judge}(\text{on-strike})$   
 b.  $j \uparrow \text{hangman}(\text{on-strike})$

Thus, (35a) will be true if being on strike is among the properties John has in his role as judge, and similarly for (35b), in his role as hangman. The important thing to note is that (36a,b) are *not* equivalent, simply because ' $j \uparrow \text{judge}$ ' and ' $j \uparrow \text{hangman}$ ' can express different second-order properties, corresponding to different aspects of John's character.

Of course, not just *any* set of properties will represent an aspect of John's character. Certain conditions must be imposed, and Landman lays down several. The first guarantees that what we may call John's HAECCEITY—the property of being identical to John—is in the set.

- (37) a.  $j \uparrow \text{judge}(\lambda x. x = j)$   
 b. John *qua judge* is still John.

The second guarantees that the restricting property is among the set.

- (38) a.  $j \uparrow \text{judge}(\text{judge})$   
 b. John *qua judge* is a judge.

The third guarantees that restricting John's character to his haecceity does no restricting: it returns *all* of John's properties.

- (39) a.  $[j \uparrow \lambda x. x = j] = \lambda P. P(j)$   
 b. John qua John is John.

The next five govern the internal logic of property restriction.

- (40) a.  $[j \uparrow \text{judge}(P) \wedge j \uparrow \text{judge}(Q)] \rightarrow j \uparrow \text{judge}(P \wedge Q)$   
 b.  $[j \uparrow \text{judge}(P) \wedge P \rightarrow Q] \rightarrow j \uparrow \text{judge}(Q)$   
 c.  $\neg \exists P. j \uparrow \text{judge}(P \wedge \neg P)$   
 d.  $\forall P. j \uparrow \text{judge}(P \vee \neg P)$   
 e.  $j \uparrow \text{judge}(P) \rightarrow \text{judge}(j)$

Jointly, these tell us that restricted properties are ULTRAFILTERS of properties which include the haecceity of the individual whose properties are being restricted and the property doing the restricting itself.

#### 4.2.1 Extending Aspect-Restriction

It is relatively straightforward to extend Landman's theory to the examples of interest. Because noun phrases more generally are interpreted as second-order properties, we can interpret 'the bricks of the wall' in (3) and 'the gold in the jewelry' in (4) similarly as restricted terms, where these contextually-determined restrictions intuitively represent different "perspectives" or "guises".

Following Rothstein 2010's suggestion, we assume that the source of this aspectual relativity is the component nouns, e.g. 'brick' or 'gold'. This leads to a completely general, and seemingly plausible, answer to Link's Revenge.

Let's begin with (3). Suppose a wall was just constructed out of some old bricks. In such a scenario, it seems plausible that the bricks are understood under the guise of components of the wall, whereas the wall itself is understood under the guise of a unified structure. Hence, we might plausibly paraphrase (3) as (41a), formalized as (41b).<sup>14</sup>

<sup>14</sup> Following Ladusaw 1982, we have been assuming that 'of' denotes the parthood relation between entities (hyperintensional type  $\langle e, \langle e, p \rangle \rangle$ ), as suggested in (i).

(i)  $\llbracket \text{of} \rrbracket = \lambda x \lambda y. y \sqsubseteq x$

However, now that noun phrases are interpreted at the level of second-order properties, a type-mismatch arises when we combine 'of' with 'the bricks' and 'the wall'. To remedy this, one could

- (41) a. As components of the wall, the bricks of the wall are old, though as a structure, the wall is new.
- b.  $\sigma x \in A : \text{bricks-of-the-wall}(x) \uparrow \lambda y. y \sqsubseteq \text{the-wall}(\text{old}) \wedge \sigma x \in A : \text{wall}(x) \uparrow \text{structure}(\text{new})$

According to (41b), we are considering the bricks of the wall under their guise as components of the wall, whereas we are considering the wall under its guise as a unified structure, independent of its component parts. And just as John can be trustworthy under certain guises, e.g. being a judge, while being corrupt under others, e.g. being a hangman, despite still being John, similarly the bricks of the wall under the guise of components can be old, while the wall under the guise of unified structure can be new, despite both being the same material stuff.

A similar analysis is available for (4). In one plausible scenario, for instance, some jewelry was recently made from some ancient Egyptian gold. In such a scenario, (4) is plausibly true because we are considering the gold in its role as materially constituting the jewelry, while considering the jewelry itself as a unified collection, or artifact to follow Rothstein 2010, independent of its material components. Thus, we might paraphrase (4) as (42a), analyzed as (42b).

- (42) a. As the material constituting the jewelry, the gold in the jewelry is old, though as an artifact, the jewelry itself is new.
- b.  $\sigma x \in A : \text{gold-in-the-jewelry} \uparrow \lambda y. y \sqsubseteq \text{the-jewelry}(\text{old}) \wedge \sigma x \in A : \text{jewelry}(x) \uparrow \text{artifact}(\text{new})$

According to (42b), we are considering the gold in the jewelry under its guise as materially constituting the gold, and we are considering the jewelry itself as an artifact, independent of its material constitution. And as with John under his different roles and the bricks and the wall under their different roles, these too can have different properties.

It is easy to see that similar analyses are available for the other examples discussed above. What's more, the present analysis does not share the problems mentioned in §4.1.2 for the Group-Forming-Strategy. For example, because 'that group of bricks' is also a definite noun phrase, Landman's theory implies that it

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raise the type of 'of' accordingly. Alternatively, one could define a hyperintensional analog of Partee 1986's LOWER type-shifting operation, as in (i).

- (ii)  $\text{LOWER}^* = \lambda \Omega_{\langle (e,p), p \rangle}. \sigma x \in A [\forall P_{\langle (e,p), p \rangle}. P(x) \leftrightarrow \Omega(P)]$

We will remain neutral on this issue in what follows, largely ignoring the semantic contribution of 'of' in the noun phrases of interest.

too should be contextually restricted to a certain guise, presumably one similar to that suggested in (41a).

(31) That group of bricks is old, but the wall is new.

Likewise for (32), of course.

(32) The quantity of gold in the jewelry is old, but the jewelry is new.

In short, extending Landman's analysis of group-like phenomena to the cases of interest affords a completely general, and independently motivated, response to Link's Revenge.

#### 4.2.2 Challenges to Aspect-Restriction

Despite these apparent advantages over the Group-Forming Strategy, the Aspect-Restriction Strategy faces its own challenges. We will consider two of them here.

First, because the Strategy relies crucially on Landman's analysis of groups, it is only as adequate as Landman's analysis itself. However, it has been charged that Landman's principles governing aspectual restriction, though initially plausible, lead to inconsistency.<sup>15</sup>

Suppose that John has two jobs: he works as a judge during the day, and as a hangman at night. Also, suppose that being a hangman implies being a non-judge. Now, by (38) John qua judge is a judge.

(38a)  $j \uparrow \text{judge}(\text{judge})$

Also, by (40e), this implies that John is a judge.

(40e)  $j \uparrow \text{judge}(P) \rightarrow \text{judge}(j)$

Finally, by (40b), if John qua judge is John and if this implies that John is a judge, then in fact John is a judge.

(40b)  $[j \uparrow \text{judge}(P) \wedge P \rightarrow Q] \rightarrow j \uparrow \text{judge}(Q)$

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<sup>15</sup> See Szabo 2003 and Asher 2011.

But by exactly similar reasoning, if John qua non-judge (i.e. hangman) is not a judge and this implies that John is not a judge, then he is indeed not a judge. Thus, we have that John is both a judge and not a judge, which is obviously inconsistent.

There are different potential responses available here. Most obviously, one could deny that being a hangman implies being a non-judge. After all, one wouldn't normally infer from the fact that John is both a judge and a hangman that John has contradictory properties. Furthermore, the argument will not go through if we instead adopt the seemingly more plausible assumption that, *as a hangman*, John is not a judge. In that case, it does not follow by (40e) that John qua hangman is a non-judge, but only that he is a hangman. Hence the need to assume that being a judge and being a hangman are mutually exclusive properties. And there are doubtless other potential responses available.<sup>16</sup>

Nevertheless, there is a related, but more pressing, concern for present purposes: the proposed extension of Landman's analysis does not appear capable of actually solving our original puzzle. Consider (43a), which is intuitively true.

43. a. As bricks, the bricks of the wall are old, but as a wall, the wall itself is new.  
 b.  $\sigma x \in A : \text{bricks-of-the-wall}(x) \uparrow \text{bricks}(\text{old}) \wedge$   
 $\sigma x \in A : \text{wall}(z) \uparrow \text{wall}(\text{new})$

This makes sense on the semantics under consideration since, after all, we are considering the bricks and the wall under different aspectual guises.

But now consider (44), which is also seemingly true.

- (44)a. As the bricks of the wall, the bricks of the wall are old, but as the wall, the wall itself is new.  
 b.  $\sigma x \in A : \text{bricks-of-the-wall}(x) \uparrow \lambda y. y = \text{the-bricks-of-the-wall}(\text{old})$   
 $\wedge \sigma x \in A : \text{wall}(z) \uparrow \lambda w. w = \text{the-wall}(\text{new})$

Recall that by (39a), restricting entities to their haecceities returns all *unrestricted* properties of the entity in question.

$$(39a) [j \uparrow \lambda x. x = j] = \lambda P. P(j)$$

For example, restricting the bricks of the wall to their haecceity returns the set of their unrestricted properties.

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<sup>16</sup> For example, Szabo 2003 considers a weaker formulation of Landman's principles. Alternatively, one might consider a stronger interpretation of the conditional.

$$(45) \sigma x \in A : \text{bricks-of-the-wall}(x) \uparrow \lambda y. y = \text{the-bricks-of-the-wall} \\ = \lambda P_{(e,p)}. P(\text{the-bricks-of-the-wall})$$

But now the problem should be apparent: (44b), and thus (44a), is equivalent to (3) but *without* any aspectual restrictions. Since (44a) seems true, it seems that aspectually restricting the offending noun phrases will not explain how the bricks and the wall can have different properties.

Worse, similar examples are easily formulated for the other examples considered above.

- (46)a. As the gold in the jewelry, the gold in the jewelry is old, but as the jewelry itself, the jewelry is new.
- b. As the gold in the ring, the gold in the ring is old, but as the ring itself, the ring is new.

As with (44a), (46a,b) are plausibly true, despite being equivalent to (4) and (1) *without* aspectual restrictions. One potential moral here is that restricting properties to a haecceity should not return a set of unrestricted properties. After all, as Landman 1989b: 733 observes, (39a) “is not absolutely necessary, but very convenient”. Still, (39a) does seem a particularly natural constraint on aspectual restriction: being John is a property John has, no matter how we view him, presumably. How, then, could restricting John’s properties to that of being John return anything other than John under *no* aspectual guises?

## 5 Conclusion

We began with Link 1983’s claim that because Link’s ring and the gold constituting it have different properties despite existing in the same place and time, they must be different sorts of things, constituting different domains with different corresponding mereological relations. We then observed that the general underlying principle supporting Link’s contention would appear to massively overgenerate domains and corresponding mereological relations. This led to adopting a single-domain analysis, which in turn required an explanation of Link’s original observation. We then considered two initially plausible explanations, inspired by Rothstein 2010, concluding that neither is without significant challenges.

What should we conclude from all of this? Perhaps the upshot is that we ought to adopt a different theory of aspectual restriction. Other available theories include those of Jäger 2003, Szabo 2003, and Asher 2011. An altogether different

option would be to view the culprit noun phrases as referring to different sorts of intensional, aspectually anchored objects, perhaps along the lines of Fine 1982's *QUA OBJECTS*. And a third option would be to analyze them as referring instead to *INDIVIDUAL CONCEPTS*, i.e. functions from worlds to entities, perhaps restricted to what Aloni 2001 calls *CONCEPTUAL COVERS*. We will not pursue these alternatives further here. Suffice it to say that though numerous possibilities exist, determining which is most suitable for the various examples considered here constitutes an important, but arguably at least book-long, project.

Nevertheless, *if* some such analysis could be made to work, and so we had a satisfactory response to Link's Revenge, the upshot would be that one-domain analyses are adequate to explain the count/mass distinction. Hence, given the methodological orientation of natural language mereology assumed here, we would conclude that only one domain is needed to account for that phenomena, and thus that natural language presupposes just one mereological relation, at least with regard to that phenomena.

This is not to say that natural language presupposes only one mereological relation *more generally*, however. There are still further domains or sorts to take into consideration, including kinds, events, numbers, degrees, etc. Assuming that at least some of these are genuinely distinct, the question remains whether we should view the mereological relations ordering entities within them as distinct, or whether instead we should view natural language as committed to a single mereological relation operating over different sorts.

On the one hand, if these different domains are just that—domains of a certain relation—then it would appear true merely by definition of 'relation' that we have different mereological relations. On the other hand, consider again Krifka 1989's definition of atomic parthood in (17c), where 'S' ranges over sorts.

$$(17c) \quad \forall x, y. x \sqsubseteq_{At,S} y \leftrightarrow x \sqsubseteq_S y \wedge ATOM_S(x, S)$$

This suggests that we have just one domain, subdivided into different sorts, each of which is ordered by a *single* mereological relation  $\sqsubseteq$ . Indeed, this is how Krifka himself captures various well known similarities between the meanings of nouns and verbs. However, whether these are really just notational variants, or whether they instead represent substantially different empirical claims, is something else we must leave for future research.



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