Homogeneity, underspecification, and ambiguity in plural predication*

Moshe E. Bar-Lev
Tel Aviv University
moshebl@tauex.tau.ac.il

June 26, 2024

Abstract

A prominent view of homogeneity takes it to be the result of a trivalent distributivity operator. Križ (2015) challenged this view by pointing out the existence of non-distributive plural predication which is nonetheless homogeneous. In this paper I argue that this challenge disappears once a trivalent cumulativity operator (based on Link's star operator), which derives meanings that are underspecified for distributivity and collectivity, is taken to be responsible for homogeneity instead. I further point out that when this view is combined with a solution offered by Schwarzschild and Heim for the challenge of deriving both underspecified and ambiguous meanings (using 'covers'), the variation observed by Križ with respect to homogeneity falls out.

Keywords: Homogeneity, Pluralization, Covers, Distributivity, Collectivity, Underspecification, Context-snsitivity

1 Introduction

Positive and negative sentences involving plural predication do not have complementary truth conditions, a puzzling fact which goes by the name homogeneity (Fodor 1970; Löbner 1987, 2000; Schwarzschild 1994; Krifka 1996; Gajewski 2005; Magri 2014; Križ 2015, 2016; Križ and Spector 2017; Bar-Lev 2018, 2021; Chatain 2021; Wehbe 2022, a.o.). For example, if only half of the kids laughed, we cannot truthfully utter (1a) nor can we truthfully utter (1b).[1]

(1) a. The four kids laughed.

*For helpful discussions and comments I would like to thank Luka Crnič, Diego Feinmann, Danny Fox, Manuel Križ, Fred Landman, Viola Schmitt, Roger Schwarzschild, Benjamin Spector, and audiences at Tel Aviv University, The Hebrew University of Jerusalem, the LINGUAE seminar in Paris, and the first Homogeneity and Non-maximality workshop.

1 I will ignore throughout the paper the availability of so-called 'non-maximal' readings where, for instance, *the kids laughed* is judged true even if not all the kids laughed. To avoid possible interference from non-maximal readings, I will use definite plurals with numerals (when it makes sense), as in (1), since they are known to block non-maximality. Homogeneity has been argued by Križ (2015, 2016) to be connected to non-maximality, and the view I will argue for in this paper is compatible with his account of the connection between the two phenomena. As I will mention in section 5, the core of my proposal can be implemented in other theories of homogeneity such as Križ and Spector (2017) and Bar-Lev (2018, 2021), and will then be compatible with their views on the connection between homogeneity and non-maximality. As a reviewer points out, the variation with respect to homogeneity which we will be concerned with in this paper reflects a similar variation with respect to non-maximality; this connection is predicted by all the theories mentioned above which assume a direct connection between homogeneity and non-maxmiality.

b. The four kids didn't laugh.

A prominent view in the literature (originating from work by Löbner and developed mainly by Schwarzschild 1994; Gajewski 2005) attributes homogeneity to a presupposition of a pluralization operator.[2] This presupposition requires that the *atomic* parts of the plurality predicated over be homogeneous with respect to the predicate: in the case at hand, that either every kid laughed or no kid laughed; let us call this the Homogeneity-from-Distributivity view.[3] Indeed, (2) looks precisely as is expected on this account of homogeneity, which we'll call a distributively homogeneous behavior (what Križ calls 'non-homogeneous'). On the collective understanding of the sentences in (2) there is apparently no homogeneity, namely (2a) and (2b) have complementary truth conditions: If the people together weigh exactly 250 lbs we judge (2a) as true, otherwise we judge (2b) as true; and on their distributive understandings both (2a) and (2b) require the individual people to be homogeneous with respect to *weigh (exactly) 250 lbs*, but imply nothing about bigger pluralities.

(2) A **distributively homogeneous** behavior:

a. These four people weigh (exactly) 250 lbs.

b. These four people don't weigh (exactly) 250 lbs.

Križ (2015) observed however that, on top of cases like (2) which show the expected pattern of behavior on the Homogeneity-from-Distributivity view, there are also cases which behave in a way that is surprising on that view and which I will call totally homogeneous (what Križ 2015 simply calls 'homogeneous'): (3b) is only true if no plurality of kids, atomic or non-atomic, lifted the table. In a situation where half of the kids lifted the table together and the other half did nothing, we cannot truthfully utter (3a) nor can we truthfully utter (3b). Homogeneity is then not restricted to distributive predication, a fact which isn't explained if the presupposition assumed by the Homogeneity-from-Distributivity view is to blame: this presupposition only concerns *atomic* individuals, which in the case at hand are indeed homogeneous with respect to *lift the table* (since no individual kid lifted the table).

(3) A **totally homogeneous** behavior:

a. The four kids lifted the table.

b. The four kids didn't lift the table.

Any theory of homogeneity then must be flexible enough to allow for deriving both the distributively homogeneous behavior in cases like (2) and the totally homogeneous behavior in cases like (3):

(4) **A challenge for theories of homogeneity**:

a. Derive total homogeneity.

b. Derive distributive homogeneity.

The existence of total homogeneity has led Križ (2015); Križ and Spector (2017) to develop alternative

2 Whether homogeneity behaves like presupposition, vagueness or implicature is a debate which I will not be concerned with in this paper (see Spector 2013; Križ 2015; Križ and Spector 2017; Feinmann 2021; Wehbe 2022; Guerrini and Wehbe 2024). While my own proposal will assume that it is a presupposition, the core of my proposal can be implemented in other theories of homogeneity, as I will mention in section 5.

3 This way of describing the presupposition follows Gajewski's implementation. Schwarzschild's presupposition is in fact stronger, a fact which I ignore here for simplification; I discuss his system in detail in section A.1.

accounts in which homogeneity arises independently of pluralization operations such as a distributivity operator.[4,5] On these accounts, homogeneity is divorced from distributivity, and more generally from pluralization operators. One still needs pluralization operators for the usual reasons, that is, in order to make sentences with plurals true in distributive situations. Both Križ (2015) and Križ and Spector (2017) assume then that there is a distributivity operator which is responsible for deriving homogeneity with respect to atomic parts on distributive readings. Note that, as a result, homogeneity effectively has two different sources for them: On top of whatever it is that explains homogeneity in the case of (3) (which is different for Križ and for Križ and Spector), there is homogeneity which is introduced by a distributivity operator; this operator is responsible for homogeneity on distributive readings of predicates which are otherwise considered 'non-homogeneous', as in the case of (2) (as well as on distributive readings of (3)). In other words, these accounts offer a split view of homogeneity, where pluralization operators are still responsible for homogeneity in some cases, but on top of it there is another source for homogeneity. This raises the question whether one could come up with a unified account after all, where pluralization is the only source for homogeneity.

My main goal in this paper is to propose such an account.[6] I will consider the challenge of deriving both distributively homogeneous readings as well as totally homogeneous readings in light of a decades-old debate about the nature of plural predication. I will go back to arguments showing that a proper theory of plural predication must be flexible enough to derive both ambiguous (collective or distributive) readings, as well as readings which are underspecified for distributivity and collectivity (following the footsteps of Schwarzschild 1994 and Heim 1994). We will have then two challenges for theories of plural semantics: one challenge is deriving both totally homogeneous and distributively homogeneous readings (as in (4)), and the other is deriving both underspecified and ambiguous readings (as in (5)).

(5) **A challenge for theories of plural predication**:

4 Their views make the distributively homogeneous behavior one finds in examples like (2) an exception to the general rule of homogeneity. This is particularly clear on Križ's view, where all simple lexical predicates are born homogeneous, and any predicate which diverges from this behavior must be taken to be complex. Furthermore, he attributes the behavior of distributively homogeneous predicates to the involvement of measurement. This however disregards predicates like *agree* (as well as *compatible* and *consistent*, see fn. 38) which don't involve measurement and behave as distributively homogeneous: *the kids don't agree* doesn't entail that there are as many different opinions as there are kids (which is what we would expect to get if its truth required that no plurality of kids agree). In section 7.2.2 I will follow Križ in suggesting that measurement plays a role in the explanation of why certain predicates show distributive homogeneity, but this will not be the only possible reason for distributive homogeneity; see section 7.2.1 and particularly fn. 36.

5 As Križ notes, the distinction between totally homogeneous and distributively homogeneous predication (which he calls 'homogeneous' and 'non-homogeneous', respectively) seems to have interesting connections with other typologies of predicates (Winter 2001, 2002; Champollion 2017). While this issue will not play an important role in this paper, I will return to discuss it in section 7.3.

6 The only other attempt to provide a unified account of homogeneity based on pluralization which I am aware of is Kalomoiros (2022) who relies on a claim due to Brisson (2003) according to which only certain predicates can host a distributivity operator in their structure, based on their aktionsart. This account however faces several problems. First, it ends up stipulating that a distributivity operator must outscope negation; as Spector (2013); Križ (2015) have shown, however, a scope theory of homogeneity is untenable given homogeneity in examples like (i):

(i) No boy found his presents.

Second, by making the application of a distributivity operator optional (with predicates which allow it), it makes it possible to derive readings which are not homogeneous in examples like (3). Third, and perhaps most importantly, if a distributivity operator is responsible for homogeneity throughout, it is entirely unclear how one could explain the contrast between the total homogeneity in (3) and the homogeneity with respect to atomic parts on a distributive reading of (2).

Another attempt to explain the contrast between total and distributive homogeneity is found in Amiraz (2020), who aims to account for the distinction between totally homogeneous and distributively homogeneous readings in analogy with distinctions found between absolute adjectives. His account however does not extend to distributive predication, and is more generally silent about the connection between homogeneity and pluralization which I focus on.

a. Derive underspecified readings.

b. Derive ambiguous (distributive/collective) readings.

Many theories of plural predication are unable to derive both underspecified and ambiguous readings, and, more generally, no current theory is able to meet both the challenge in (4) and the challenge in (5). Importantly for us, theories which assume an optional distributivity operator (without also assuming a cumulativity operator), such as Gajewski (2005); Križ (2015); Križ and Spector (2017), cannot derive such readings. What I aim to show is that the challenge Križ brought up for theories where homogeneity is due to distributivity (like Gajewski's) is directly related to the fact that these theories can only derive distributive and collective readings but not underspecified ones; and once we have pluralization which can derive both, we can also derive both total homogeneity and distributive homogeneity from pluralization.

I will demonstrate how a view where homogeneity is the result of cumulativity can resolve both challenges in (4) and (5) in two steps: First, I will show that within a theory which can derive underspecified readings, one where rather than an optional distributivity operator we have an obligatory cumulativity operator (Link's star operator), we can derive totally homogeneous readings by defining the cumulativity operator so that it introduces homogeneity. Second, I will show that once this theory is combined with a resolution of the challenge of deriving both ambiguous and underspecified meanings in (5) (once again following Schwarzschild 1994; Heim 1994; what I will call the S/H view), we immediately also get a resolution of the challenge of deriving both totally homogeneous and distributively homogeneous readings in (4).

In section 2 I will focus on the first of those two steps and propose a minimal modification of the Homogeneity-from-Distributivity view where what's responsible for homogeneity is a trivalent cumulativity operator, following Schwarzschild in taking star to be responsible for homogeneity, but implementing it in a way that's more similar to Gajewski's implementation of homogeneity in the semantics of the distributivity operator. This will derive underspecified and totally homogeneous readings, but will fail to derive ambiguous and distributively homogeneous readings. Sections 3–5 are concerned with the second step: In section 3 I will present old arguments that a proper theory of plural predication should derive both underspecified readings as well as ambiguous (distributive/collective) readings, and in section 4 I will present the S/H view where distributive and collective readings can be derived (on top of underspecified ones) by relativizing the cumulativity operator to specific 'covers', that is, by domain restriction. In section 5 I will show that distributive homogeneity falls out when we relativize the trivalent star operator defined in section 2 to the covers needed in order to get distributive and collective readings on the S/H view. Section 6 discusses some extensions of the theory to homogeneity with two-place predicates and to 'upward homogeneity', section 7 is concerned with whether what governs the readings we get is lexical semantics or context, and section 8 concludes. Appendix A provides a more in-depth comparison between my proposal and some previous accounts of homogeneity.

2 A trivalent star operator and total homogeneity

2.1 Homogeneity-from-Distributivity

Since Link (1987); Roberts (1987), it is common to assume that a distributivity operator is needed in order to make a sentence like *the kids read a book* true in situations where each of the kids read a different book. We can characterize what the distributivity operator ^{D} does as in (6).

(6) ^{D}P is **true** of x *iff* **every** atomic part of x satisfies P.

The Homogeneity-from-Distributivity view, as implemented in Gajewski (2005), relies on the idea that a trivalent distributivity operator (which I will call ^{D_t}) presupposes that the atomic parts of the plurality predicated over are homogeneous with respect to the predicate. We can then characterize what the distributivity operator does following Gajewski (2005) as follows:

(7) a. ^{D_t}P is **true** of x *iff* **every** atomic part of x satisfies P.
b. ^{D_t}P is **false** of x *iff* **no** atomic part of x satisfies P.

When applied to a predicate like *lifted the table*, the result is that *the four kids* ^{D_t}*(lifted the table)* is true if every kid lifted the table, and false if no kid lifted the table. On a view where distributive understandings result from the application of a distributivity operator, of course, one should assume a different ^{D_t}-less parse in order to get a collective reading. Since the idea in the Homogeneity-from-Distributivity view is that ^{D_t} is responsible for homogeneity, on the collective reading there should be no homogeneity: it would be true if the kids together lifted the table and false otherwise. The problem brought up by Križ for that view is that in situations where some but not all the kids lifted the table together, *the four kids didn't lift the table* is not judged true, which is unexpected on the Homogeneity-from-Distributivity view. This view predicts that the sentence should be true on both distributive and collective readings: the collective reading of *the four kids lifted the table* is false because the kids didn't lift the table together (so its negation should be true), and the distributive reading of *the four kids* ^{D_t}*(lifted the table)* is false because no single kid lifted the table alone (so its negation should be true).

2.2 Homogeneity-from-Cumulativity

Pluralizing predicates with a distributivity operator is not the only option on the table. As we will see in section 3, there are reasons to think that, at least in some cases, the distributivity operator provides meanings which are too strong. An alternative to ^{D} which avoids this problem is Link's star operator which takes a predicate and, rather than return a predicate true of pluralities whose *atomic* parts satisfy the original predicate, returns instead a predicate which is true of a plurality if that plurality can be composed by summing (atomic or non-atomic) parts which satisfy the original predicate. In other words, the star operator takes a set and closes it under sum formation:

(8) $[\![\star]\!](P)(x) = 1$ *iff* $\exists P' \subseteq \{x' : P(x') = 1\}[\bigsqcup P' = x]$

It is often assumed, following Link (1983), that the star operator is what's responsible for pluralization, so that pluralizing the nominal predicate *kid* with * ends up denoting the (characteristic function of) the set of all sums of members of the denotation of *kid* (individual kids), sums of sums of those members, etc., and the result is pronounced as *kids*.[7] One can then let * also pluralize verbal predicates, such as *lift the table*, so that the result is the (characteristic function of) the set of all sums of members of the denotation of *lift the table* (individuals or pluralities which lifted the table), sums of sums of those members, etc.

For expository reasons, it will be useful for us to characterize what the * operator does in a way that makes it clear what the difference between ^{D} and * is. As it turns out, when we focus on domains which have atomic members (which is what's relevant for the purposes of this paper), we can characterize what the * operator does as follows:[8]

(9) $^{\star}P$ is **true** of x *iff* **every** atomic part of x is part of some part of x which satisfies P.

As should be immediately clear when considering the relationship between our characterizations of ^{D}P and $^{\star}P$ in (6) and (9), $^{\star}P$ is logically weaker than ^{D}P: Whenever ^{D}P is true of x, namely whenever every atomic part of x satisfies P, $^{\star}P$ must be true, that is, every atomic part of x must be part of some part of x which satisfies P, for the trivial reason that everything is part of itself. We can think of * then as a distributivity operator of participation: **(lifted the table)* is true of x if every atomic part of x participated in a lifting of the table by some (potentially atomic) part of x.

This weakness of the * operator leads to readings which are underspecified with respect to distributivity and collectivity, since it's true in both distributive and collective situations (as well as many other, so-called intermediate situations, which we will discuss in section 3). In a collective situation where all the kids lifted the table together, *the four kids* **(lifted the table)* is true because every kid participated in a lifting of the table by a plurality of kids, namely the plurality consisting of all the kids; and in a distributive situation where each of the kids lifted the table it is also true because every kid participated in a lifting of the table by a plurality of kids, namely themselves (since a single kid is also technically a plurality of kids).

The * operator then derives readings which are underspecified for distributivity and collectivity, in contrast with the distributivity operator which only derives distributive readings. In the next section we will discuss arguments that have been brought up for and against underspecified meanings derived by applying * to predicates. In this section I focus on a benefit of the underspecified nature of *, which is that it provides us with a simple way to explain total homogeneity, along the same lines of Gajewski's (2005) implementation of homogeneity into the definition of ^{D}. On the Homogeneity-from-Distributivity view, we quantify universally over the atoms in the truth conditions of ^{D_t}, but we have the negation of existential quantification in the falsity conditions (as indicated in boldface in (7)). We can apply the same recipe to our characterization of * as distributing participation in (9), which gives us the trivalent characterization in (10) of a trivalent star operator (which I will call ^{*_t}; I will reserve * for the standard bivalent definition of * in (8)):[9]

(10) a. $^{\star_t}P$ is **true** of x *iff* **every** atomic part of x is part of some part of x which satisfies P.

7 For ease of exposition, my LFs throughout the paper will not show the application of star operators within the DP.

8 A more adequate characterization of * in terms of universal quantification but with no regard to atomicity would be as follows (cf. Champollion 2016: ex. 32; two pluralities overlap *iff* they have a part in common):

(i) $^{\star}P$ is true of x *iff* every part of x overlaps with some part of x which satisfies P.

9 In making the star operator trivalent I follow Schwarzschild (1994); he however implements trivalence differently, in a way that does not allow for deriving total homogeneity; see Appendix A.

b. $\star_t P$ is **false** of x *iff* **no** atomic part of x is part of some part of x which satisfies P.

The falsity conditions in (10b) turn out to be equivalent to the following (as long as we only consider domains which have atomic elements):

(11) $\star_t P$ is **false** of x *iff* **no** part of x satisfies P.

Let us now see how this definition of $\star_t$ predicts total homogeneity when $\star_t$ applies to a predicate like *lifted the table*. As we established, *the four kids* $\star_t$ *(lifted the table)* is true whenever every kid participated in a lifting of the table by a plurality of kids. The trivalent characterization of $\star_t$ we just outlined predicts it to be false when no plurality of kids lifted the table. This gives us total homogeneity: In any situation in which not all the kids participated in a lifting of the table but at least one plurality of kids did lift the table (whether this plurality is a single kid or not), *the four kids* $\star_t$ *(lifted the table)* is neither true nor false. As a result, one would expect its negation to also be neither true nor false, precisely as one observes with total homogeneity (as we have seen in (3)).

Note that for total homogeneity to be predicted, we should not only assume that $\star_t$ *can* apply when a plurality-denoting expression is taken by a predicate, but rather that it *must* apply, or, in other words, that there is no purely collective reading. For if there was another parse of *the four kids lifted the table*, one where $\star_t$ does not apply, there should have been a reading of the sentence where it's simply false as long as the kids did not all lift the table together, which is not the case. The assumption that plural predication obligatorily involves an application of the star operator has been made by Schwarzschild (1994) (for reasons we will see in the next section), as well as Kratzer (2007).[10]

Going back from our characterization of the star operator in terms of distribution of participation (which as mentioned above doesn't extend to mereological structures with no atomic elements) to the more familiar definition in (8), we can define the trivalent $\star_t$ operator as follows, where a starred predicate is true of a plurality when the plurality can be composed by summing members of the unstarred predicate, and false of a plurality when there is no part of the plurality which can be composed by summing members of the unstarred predicate.[11] The crucial part of this definition is replacing '=' in the truth conditions with '$\sqsubseteq$' in the falsity conditions.[12]

(12) $$[\![\star_t]\!](P)(x) = \begin{cases} 1 & \textit{iff} \quad \exists P' \subseteq \{x' : P(x') = 1\}[\bigsqcup P' = x] \\ 0 & \textit{iff} \neg\exists P' \subseteq \{x' : P(x') = 1\}[\bigsqcup P' \sqsubseteq x] \\ \# & \text{otherwise} \end{cases}$$

We have then a Homogeneity-from-Cumulativity account of total homogeneity which falls out from a modification of the Homogeneity-from-Distributivity view: Rather than implementing homogeneity

10 This assumption is not shared with Heim (1994) who allows for $\star$-less LFs.

11 As long as the domain of pluralities one assumes does not have a bottom element which is part of every plurality, the falsity conditions can be equivalently defined as in (i). If one wishes to admit a bottom element (see Landman 2011; Bylinina and Nouwen 2018 for reasons to do so), the two definitions are no longer equivalent; specifically, the falsity conditions in (12) will never be met since $\varnothing \subseteq P$ for any P, and (assuming a bottom element) $\bigsqcup\varnothing \sqsubseteq x$ for any x, hence any statement of the form $\exists P' \subseteq P[\bigsqcup P' \sqsubseteq x]$ will be trivially true. That is, if one assumes a bottom element the alternative definition in (i) should be preferred.

(i) $\ldots 0$ *iff* $\neg\exists x' \in \{x' : P(x') \neq 0\}[x' \sqsubseteq x]$

12 Moving from '= 1' in the truth conditions to '$\neq$ 0' in the falsity conditions is designed to avoid making $\star_t$ a filter for presuppositions. This is inconsequential for the purposes of this paper.

in the definition of the distributivity operator (^{D_t}), we implement it in the definition of the cumulativity operator (^{*_t}).

Our work here is however not done, as we now account for total homogeneity (and underspecification) but lose an account of distributive homogeneity (and ambiguity). Recall from our discussion of (2) that a sentence like *these four people weigh (exactly) 250 lbs* shows homogeneity only on its distributive reading, and even then it shows homogeneity only with respect to the individual people. Specifically, suppose two of the four people together weigh 250 lbs (suppose each weighs 125 lbs), and the two others weigh less each (suppose each weighs 100 lbs). In this situation it is entirely natural to say that *these four people don't weigh (exactly) 250 lbs*, even though *these four people* ^{*_t}*(weigh 250 lbs)* isn't false (so its negation isn't true), because there is a plurality which is part of the four people which weighs 250 lbs, i.e., the plurality consisting of the first two people.[13]

In other words, the Homogeneity-from-Distributivity view predicts distributive homogeneity (along with a distributive/collective ambiguity) but fails to account for total homogeneity (along with underspecification), whereas the Homogeneity-from-Cumulativity view proposed in this section predicts total homogeneity (along with underspecification) but fails to account for distributive homogeneity (along with a distributive/collective ambiguity). My goal in the next three sections is then to show that distributive homogeneity falls out from the Homogeneity-from-Cumulativity view once this view is equipped with a way to derive distributive and collective readings and not only underspecified ones. In the next section I will present arguments due to Schwarzschild (1994) and Heim (1994) that a proper theory of plural predication should be able to derive both cases where there is an ambiguity between distributive and collective readings (as expected by proponents of predication with an optional ^{D}) as well as cases where there are only underspecified readings (as expected by proponents of predication with *). In section 4 I will then present their *-based theory which provides such an account (what I call the S/H view). In section 5 I will return to homogeneity and show that the S/H view, when coupled with the Homogeneity-from-Cumulativity view I proposed in this section, accounts for both distributive homogeneity and total homogeneity.

3 Underspecification, distributivity and collectivity

The choice between * and ^{D}, and more generally between underspecified readings and ambiguous distributive/collective readings for plural predication has been subject to much debate. While many advocate for a distributive/collective ambiguity (Link 1987; Gillon 1987; Landman 1989; Schwarzschild 1996, a.o.), others argue for an underspecified meaning compatible with both distributive and collective situations (as well as others, as we will see shortly; Higginbotham 1981; Schwarzschild 1994, a.o.).[14]

What is then the nature of the distributive/collective distinction? Schwarzschild (1994); Heim (1994) argue that a proper theory of plural predication should be able to derive both underspecified and ambiguous predication. We can make the case for an underspecified reading by replicating an

13 In fact, as Heim (1994) notes, one may expect *these four people* **(weigh 250 lbs)* to be true here, because when a plurality weighs more than 250 lbs, there must be (potentially-overlapping) parts of that plurality, each of which weighs exactly 250 lbs, which sum up to the whole plurality.

14 I will not be able to do justice in this paper to all the arguments that have been brought up for each view. See Frazier et al. (1999); Nouwen (2016); Champollion (2019, 2020) for some relevant discussion. Underspecified meanings in the context of plural predication have been discussed under various terms in the literature, for instance as *general* meanings by Gillon (1987) and as *neutral* meanings by van der Does (1993).

argument due to Schwarzschild (1994: ex. 72), which shows that adding negation excludes both distributive and collective scenarios: (13) is simply false if the kids lifted the table, no matter whether this was done individually or together, which is presumably why the continuation in brackets sounds contradictory.[15]

(13) The four kids didn't lift the table (# but they did together/individually).

We can add to this the observation that B's objection in (14) and (15) looks strange, which is surprising if A's utterance can have a collective reading (for (14)) or a distributive reading (for (15)), but entirely expected if it only has an underspecified reading.

(14) [Context: B thinks that each of the kids lifted the table, and they didn't do it together.]

A: The four kids lifted the table.

B: #What? That's not true! (Oh, you mean individually.)

(15) [Context: B thinks that the kids lifted the table together, but not individually.]

A: The four kids lifted the table.

B: #What? That's not true! (Oh, you mean together.)

One may wonder though whether the infelicity in (13)-(15) is the result of homogeneity, given that negation is involved in all of these examples, thus undermining the argument for underspecification.[16] Moreover, even if we ignore homogeneity, these arguments do not fully justify an underspecified meaning of the sort we get with the * operator, and are rather compatible with a stronger reading which is the disjunction of the distributive and collective meanings.

To justify underspecified meanings in a way that is independent of homogeneity we can then consider situations in which underspecified meanings are made true and which are not expected to be true on an ambiguity account; these are the so-called 'intermediate' situations (see Gillon 1987, 1990; Lasersohn 1989; Schwarzschild 1996, a.o.), i.e., situations in which the predicate doesn't hold either distributively or collectively of the plurality predicated over, but that plurality can still be divided into parts each of which satisfies the predicate. As Heim notes, in some cases intermediate situations are enough to make the predicate true of the plurality predicated over. Suppose half of the kids lifted the table together, and the other half did too. In this context, it seems appropriate to say that the kids

15 Schwarzschild's original example is, as one may expect, much better:

> "Consider the following demand made by the head mobster on one of his flunkies:
>
> (i) Beasly, better make sure those guys don't win the lottery this week!
>
> I would say that Beasly's goose is cooked if those guys win the lottery, whether as a group or as individuals. His skin will not be saved by claiming that he understood the boss on only one reading of the sentence, distributive or non-distributive."

16 Even accounts geared towards explaining homogeneity with non-distributive predicates aren't entirely free of problems here once a distributivity operator is available: For both Križ (2015) and Križ and Spector (2017) ^{D} is available and distributive readings are predicted on which (13) is at best neither-true-nor-false if the kids only lifted the table together, whereas the intuition seems to be that the sentence is simply false in this scenario; the judgment does not look the same as what one has when just half of the kids lifted the table (see also Appendix A). This may not be a very serious issue for these accounts because intuitions about the distinction between falsity and neither-truth-nor-falsity can be misleading. But the contrast we will see between (13) and (17) is difficult to reconcile with their view: Both are predicted to have a reading where a distributivity operator applies below negation, and as a result the source of contrast between them remains mysterious. Since I don't assume the existence of a distributivity operator my account does not face this problem.

lifted the table. In other words, cumulative inferences seem to hold with *lift the table*; if we divide the kids into two groups, call them A and B, the inference in (16) seems valid. This is precisely what is expected if * applies to *lifted the table* (see Heim 1994, as well as Schwarzschild 1996: pp. 11–13, both showing that predicates differ in validating cumulative inferences).

(16) a. A lifted the table
b. B lifted the table
c. ∴ The four kids lifted the table

We have evidence then that for the case of *the four kids lifted the table* an underspecified reading is needed. An underspecified reading is however overly weak in many cases. Consider the following example, modified from Heim (1994):

(17) These two people don't weigh (exactly) 250 lbs (but they do together/individually)

This sentence can be uttered by a speaker who believes that these two people weigh 125 lbs each (i.e., 250 lbs together) or by a speaker who believes that they weigh 250 lbs each (i.e., 500 lbs together). In order for the negation of *these two people weigh 250 lbs* to be true in these situations, it must have a collective reading and a distributive reading, since on a putative underspecified reading *these two people weigh 250 lbs* should be true in both situations, so its negation can't possibly be true. Note that this is exactly the opposite conclusion than the one we reached for (13).

Considering objections with *these two people weigh 250 lbs*, it looks like both collective readings and distributive ones are possible: It is possible for B to object to A's utterance because it's false on a distributive (/collective) understanding, even though they think it's true on a collective (/distributive) understanding, as in (18) and (19).

(18) [Context: B thinks that together, these two people weigh 500 lbs (250 lbs each).]
A: These two people weigh (exactly) 250 lbs.
B: What? That's not true! (Oh, you mean individually.)

(19) [Context: B thinks that each of these two people weighs 125 lbs (250 lbs together).]
A: These two people weigh (exactly) 250 lbs.
B: What? That's not true! (Oh, you mean together.)

Turning to cumulative inferences, *weigh 250 lbs* behaves differently than *lift the table* in this respect as well, as Heim points out. If we divide a group of people into two different groups, A and B, we do not easily take the following inference to be a valid one:[17]

(20) a. A weigh 250 lbs
b. B weigh 250 lbs
c. $\not\therefore$ These people weigh 250 lbs

The upshot of all this is that we now have arguments (which are independent of considerations of homogeneity) for a theory of plural predication where both ambiguous (distributive/collective)

17 Predicates like *weigh 250 lbs* can be made true of a plurality in an intermediate situation given a special context (see Schwarzschild 1996 following the debate in Gillon 1987, 1990; Lasersohn 1989). The point here is essentially that while *weigh 250 lbs* requires a special context in order to be judged true in an intermediate situation, with *lift the table* no special context is needed.

readings and underpsceified readings are derivable, as in (21) (repeated from (5)):

(21) **A challenge for theories of plural predication**:

a. Derive underspecified readings.

b. Derive ambiguous (distributive/collective) readings.

Recall that Križ's (2015) observations have shown us that we also need to account for both total and distributive homogeneity, as in (22) (repeated from (4)):

(22) **A challenge for theories of homogeneity**:

a. Derive total homogeneity.

b. Derive distributive homogeneity.

As we have seen in the previous section, however, accounts where ^{*_t} is the only pluralization operator can only derive underspecified readings and total homogeneity from pluralization, and accounts where ^{D_t} is the only pluralization operator can only derive ambiguous readings and distributive homogeneity from pluralization. One may entertain then the possibility that we need both ^{*_t} and ^{D_t}. Note however that this will require a series of stipulations concerning when ^{D_t} and ^{*_t} can or must apply, in order to avoid getting, for instance, distributive homogeneity for sentences like (3).

In the next section I will present the S/H view which offers an alternative to having both a star operator and a distributivity operator and which is still able to meet the challenge in (21). According to this view, plural predication is carried out by Link's (1983) * operator, which (as we have seen in the previous section) yields underspecified readings; ambiguous readings are derived once * is relativized to 'covers' which contain only some of the parts of the plurality predicated over. In section 5 I will show that the combination of this view with the trivalent definition of ^{*_t} proposed in section 2 derives both total homogeneity and distributive homogeneity, and hence provides a resolution for the challenge in (22) as well.

4 The S/H view of underspecification vs. ambiguity

On the S/H view, the crucial ingredient which allows deriving different meaning-types is relativizing plural predication to a contextually provided *cover*: a set of individuals which represents a way of dividing the plurality predicated over into parts (Higginbotham 1981; Gillon 1987; Schwarzschild 1994, 1996, a.o.). Given different types of covers, we will derive effectively different types of meaning. Intuitively, we can think of a cover in terms of what parts of the plurality are 'important' in a context. Formally:[18]

(23) P covers x *iff* $\exists P' \subseteq P[\bigsqcup P' = x]$

Covers can come in many shapes and forms. Here I will focus on three cover-types, which will end up responsible for the three meaning-types we are after: a power cover (which will derive an underspecified meaning), and two minimal covers—minimal-singleton (which will derive a collective meaning) and

18 Note the similarity between the definition of covers and the definition of * in (8). See Vaillette 2001; Champollion 2017.

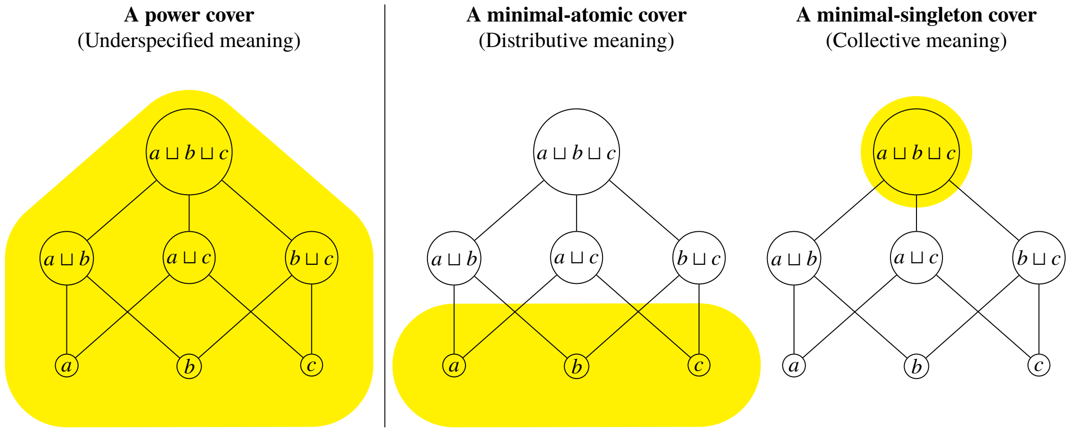

Figure 1 Three types of covers of the plurality $a \sqcup b \sqcup c$ and the meanings they will correspond to. The members of the cover are the highlighted pluralities.

minimal-atomic (which will derive a distributive meaning); see figure 1 for illustration.[19,20]

(24) a. A **power** cover ('all parts are important'): P power covers x *iff* $\forall y \sqsubseteq x[y \in P]$

b. **Minimal** covers:
P minimally covers x *iff* P covers x and $\neg\exists P' \subset P[P'$ covers $x]$

(i) A **minimal-atomic** cover ('only atomic parts are important'):
P is a minimal-atomic cover of x *iff*
P minimally covers x and $\{y : y \sqsubseteq_{AT} x\} \subseteq P$

(ii) A **minimal-singleton** cover ('only the plurality itself is important'):
P is a minimal-singleton cover of x *iff* P minimally covers x and $x \in P$

Suppose now that plural predication with the $\star$ operator involves domain restriction by a cover. This can be technically done in various ways; here I will follow the implementation in Heim (1994); Beck (2001) and assume that the sister of $\star$ is headed by a cover variable Cov which combines with the predicate by predicate modification, and is assigned by the context (the characteristic function of) a cover (Cov^c) which is assumed to cover the sum of individuals in the domain of discourse, $\bigsqcup D$. I follow Schwarzschild (1996) in assuming that for pragmatic reasons the cover will also cover the plurality predicated over, even though this is not a formal requirement.[21] Plural predication hence takes the schematic shape and meaning in (25). Since we focus on the S/H view of underspecification

19 Covers are sometimes restricted to minimal ones (see, e.g., Nouwen 2016). This is presumably since covers are mostly utilized to restrict the domain of the distributivity operator ^{D}, in which case non-minimal covers give rise to arguably unattested readings. Since we will be using $\star^t$ instead, this problem won't arise. More importantly, we need non-minimal covers (specifically power covers) to derive underspecified meanings. It is worth noting that by allowing power covers I follow Heim (1994) but diverge from Schwarzschild (1994) whose Single-Partition Constraint on Plural Domains blocks such covers and consequently any reading weaker than the disjunction of distributive and collective ones.

20 There are many more cover-types than the ones we consider here; other types have however been argued to require special contexts. See especially Gillon (1990) and Schwarzschild (1996), as well as fn. 17.

21 Note that if Cov^c is a minimal/power cover of $\bigsqcup D$ and it covers x, then it is also a minimal/power cover of x. Based on the assumption that the subject of predication is always covered by Cov I then allow myself to switch between talking about minimal/power covers of $\bigsqcup D$ and minimal/power covers of the subject of predication. This assumption further means that I ignore the possibility of 'ill-fitting covers'—contextually provided covers which cover $\bigsqcup D$ but not the plurality predicated over (cf. Brisson 1998, 2003). It should however be noted that while for Brisson ill-fitting covers are utilized to weaken the overall meaning in positive sentences, admitting them given (25) would only lead to strengthening it; this is since the output will necessarily be 0 if Cov^c in (25) doesn't cover $[\![\text{DP}]\!]$. The only weakening effect of ill-fitting covers would be achieved in Downward Entailing contexts.

vs. ambiguity in this section, we ignore the falsity conditions of $\star_\iota$ that we assumed in section 2 and focus on the bivalent meaning of $\star$ that the S/H view assumes. We will plug in the falsity conditions in the next section, where we will return to the issue of homogeneity.

(25) a. LF: [DP [$\star$ [Cov VP]]]
b. $[\![(25a)]\!]^c = 1$ *iff* $\exists P' \subseteq \{x' : [\![\mathrm{VP}]\!](x') = 1 \wedge Cov^c(x') = 1\}[\bigsqcup P' = [\![\mathrm{DP}]\!]]$

Using our paraphrase of $\star$ in terms of distribution of participation, we can paraphrase the truth conditions $\star$ derives when relativized to a cover as follows (where a cover-part of x is a part of x which is also in the contextually provided cover denoted by Cov):

(26) $\star[Cov$ P] is **true** of x *iff* **every** atomic part of x is part of some **cover-part** of x which satisfies P.

Let us now see how with these assumptions power covers derive underspecified meanings, miminal-singleton covers derive collective readings, and minimal-atomic covers derive distributive readings. First, if the cover is a power cover, that is, it contains all parts of the plurality predicated over, (26) boils down to the same result we got without relativization to covers, that is, what we have seen in (9).[22]

(27) If Cov denotes a **power** cover of x the meaning is **underspecified**:
$\star[Cov$ P] is **true** of x *iff* **every** atomic part of x is part of some part of x which satisfies P.

If the cover is instead a minimal-atomic cover of the plurality predicated over, the result is a distributive reading, because the only cover-parts of the plurality are atomic (and, of course, the only way for an atomic part of x to be part of an atomic part of x which satistfies P is for it to satisfy P):

(28) If Cov denotes a **minimal-atomic** cover of x the meaning is **distributive**:
$\star[Cov$ P] is **true** of x *iff* **every** atomic part of x satisfies P.

Finally, if the cover is a minimal-singleton cover of the plurality predicated over, the result is a collective reading, because the only cover-part of the plurality is the plurality itself:

(29) If Cov denotes a **minimal-singleton** cover of x the meaning is **collective**:
$\star[Cov$ P] is **true** of x *iff* x satisfies P.

On the S/H view of plural predication, then, plural predication is not LF-ambiguous: It always involves application of a $\star$ operator; the difference between underspecified, distributive, and collective readings is a context-dependent ambiguity which results from having different covers. The S/H view leaves open the question of what governs the choice of a cover given a context, which to my understanding is still ill-understood. A natural question to ask at this point is why specific predicates tend to have underspecified meanings (in the case of *lift the table*) or ambiguous meanings (in the case of *weigh*

22 Considering the equivalence between starring with a power cover and starring with no cover at all suggests a slightly different way to think about how the three readings come about, which is to assume that an underspecified reading arises when $\star$ applies directly to the predicate, with no Cov variable, that is, with the structure *DP* $\star$ *VP*. In contrast, distributive and collective readings are derived by applying $\star$ to the result of combining the VP with a cover variable. On this option, nothing changes in our predictions if we assume that the Cov variable can only denote minimal covers (see fn. 19). I have nothing to say against this option, but for ease of exposition choose to stick to a structure with a Cov variable throughout.

(exactly) 250 lbs), if the difference between underspecified and ambiguous readings is in the choice of cover (power cover vs. minimal covers) which is ultimately context dependent. In other words, if cover choice depends on the context, then how come it looks like it depends on the predicate? In section 7 I will go back to this question and try to provide a preliminary answer. For now, we will simply stipulate that the predicate *lift the table* comes with a power cover, and the predicate *weigh (exactly) 250 lbs* comes with minimal covers.

Now that we have seen the S/H view of underspecification vs. ambiguity, we are ready to examine the results of combining this theory with the Homogeneity-from-Cumulativity view from section 2.

5 Deriving two types of homogeneity with covers

In the previous section we have seen that, on the S/H view, underspecified readings are the result of a power cover, whereas ambiguous (distributive or collective) readings are the result of minimal covers (atomic or singleton). We can now show that when we combine the S/H view with the Homogeneity-from-Cumulativity view from section 2, the result is that a power cover derives total homogeneity, while minimal covers derive distributive homogeneity.

The combination of the two accounts gives us the following schematic shape and meaning: According to the S/H view the structure of a sentence of the form *DP VP* is as in (30a) where a star operator applies to the VP, and given the assumption that the star operator is the trivalent $\star^t$ defined in (12), the sentence has the semantics in (30b).

(30) a. LF: [DP [$\star^t$ [Cov VP]]]

b. $$[\![\text{(30a)}]\!]^c = \begin{cases} 1 & \textit{iff} \;\; \exists P' \subseteq \{x' : [\![\text{VP}]\!](x') = 1 \wedge Cov^c(x') = 1\}[\bigsqcup P' = [\![\text{DP}]\!]] \\ 0 & \textit{iff} \, \neg\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') \neq 0 \wedge Cov^c(x') \neq 0\}[\bigsqcup P' \sqsubseteq [\![\text{DP}]\!]] \\ \# & \text{otherwise} \end{cases}$$

Using our 'distribution of participation' paraphrase once again, we have the following:

(31) a. $\star^t$ [Cov P] is **true** of x *iff* **every** atomic part of x is part of some **cover-part** of x which satisfies P.

b. $\star^t$ [Cov P] is **false** of x *iff* **no** atomic part of x is part of some **cover-part** of x which satisfies P.

Let us first look at what happens with power covers. As mentioned in the previous section, having a power cover is like having no cover at all, so it should be no surprise that $\star^t$ with a power cover derives total homogeneity, for the same reasons that $\star^t$ with no cover at all derived it in section 2. If we have a sentence with *lift the table* (which as we stipulated comes with a power cover), we expect an underspecified meaning with total homogeneity, as in (32) (recall (10) and (11)).

(32) If Cov denotes a **power** cover of x the meaning is **underspecified** and there is **total homogeneity**:

a. $\star^t$ [Cov P] is **true** of x *iff* **every** atomic part of x is part of some part of x which satisfies P.

b. $\star^t$ [Cov P] is **false** of x *iff* **no** part of x satisfies P.

	lift the table	*weigh (exactly) 250 lbs*	
Cover-type	Power	Minimal-atomic	Minimal-singleton
	↓	↓	↓
Meaning-type	Underspecified	Distributive	Collective
Homogeneity	Total homogeneity	Atomic homogeneity	No homogeneity

Table 1 Summary of the results of Homogeneity-from-Cumulativity together with th S/H view: Cover types determine both the type of meaning and the kind of homogeneity.

Recall that the Homogeneity-from-Cumulativity view alone could not account for distributive homogeneity of the sort we saw in (2) for the predicate *weigh (exactly) 250 lbs*. However, with the aid of the S/H view which explains how this sentence can get a (context-dependent) ambiguous meaning, we can now show that we predict distributive homogeneity.

Consider first what happens when there is a minimal-atomic cover (again, *weigh (exactly) 250 lbs* comes with minimal covers by stipulation). We have already seen in the previous section that the result is a distributive reading. But because the cover is restricted to atomic members of the plurality, we get falsity only if no *atomic* part of the plurality predicated over weighs 250 lbs. This is indeed the type of homogeneity we observed for the distributive reading of (2), where there is homogeneity but only with respect to the atomic individuals.

(33) If Cov denotes a **minimal-atomic** cover of x the meaning is **distributive** and there is **atomic homogeneity**:

a. $\star^{\iota}\,[Cov\ \mathrm{P}]$ is **true** of x *iff* **every** atomic part of x satisfies P.

b. $\star^{\iota}\,[Cov\ \mathrm{P}]$ is **false** of x *iff* **no** atomic part of x satisfies P.

Finally, if the cover is minimal-singleton, we get a collective reading, as established in the previous section. But since the cover contains only one part of the plurality, namely the plurality itself, there is no homogeneity at all: Either the predicate holds of that plurality or not; there is no third option. We then get no homogeneity at all.

(34) If Cov denotes a **singleton-atomic** cover of x the meaning is **collective** and there is **no homogeneity**:

a. $\star^{\iota}\,[Cov\ \mathrm{P}]$ is **true** of x *iff* x satisfies P.

b. $\star^{\iota}\,[Cov\ \mathrm{P}]$ is **false** of x *iff* x does not satisfy P.

This is indeed the distributive homogeneity behavior we observed for *weigh (exactly) 250 lbs*: Homogeneity on a distributive reading but only with respect to the atomic parts, and no homogeneity on the collective reading. Table 1 summarizes the theoretical picture that emerghes once we combine the S/H view with Homogeneity-from-Cumulativity.

We have then a theory which can derive both underspecified readings which are totally homogeneous, as well as ambiguous readings which are distributively homogeneous, that is, showing homogeneity with respect to atomic individuals on a distributive reading and no homogeneity on a collective reading. This theory then meets both challenges for theories of plural predication and homogeneity in (21) and (22). As I hope is clear, the novelty in my proposal is relatively minor: all I did was combine the general recipe for deriving homogeneity based on Gajewski (2005) together with the idea that Link's (1983) star operator is responsible for homogeneity from Schwarzschild (1994) and with the S/H view of underspecification vs. ambiguity. The view proposed here however differs from these accounts by being able to derive total homogeneity. Since Gajewski relies on the distributivity operator as the source of homogeneity he cannot explain such facts; while Schwarzschild's implementation relies on the star operator, it still fails to account for it (see Appendix A.1 for details).

A crucial aspect of the theory is adhering to the view which ties homogeneity to pluralization. The ability of such a view to account for both distributive and total homogeneity undermines the arguments made by Križ (2015) in favor of untying homogeneity from pluralization operations based on total homogeneity. Far from consisting an argument for departure from that view of homogeneity, total homogeneity turns out to support a modest modification of it. Having said that, the connection between underspecification and homogeneity at the heart of my proposal can be implemented within different views of homogeneity, as long as they take pluralization to be responsible for homogeneity: In appendix A I will sketch an implementation within a view due to Krifka (1996); Križ and Spector (2017) which relies on filtering multiple (bivalent) readings, and an implementation within an implicature-based view of homogeneity can be found in Bar-Lev (2018: section 5) and Bar-Lev (2021).

Finally, the current work provides further support for the S/H cover-based view of pluralization with the star operator. This theory, initially developed for entirely different reasons, has proven adequate when plugged into the relatively simple view of Homogeneity-from-Cumualtivity proposed here. In the next section I will focus on two extensions of the theory designed to deal with homogeneity with two-place predicates and with the phenomenon of 'upward homogeneity'.

6 Extensions

6.1 Homogeneity with co-distributive predication

Explaining the homogeneous behavior found with two-place predicates having definite plurals in both argument positions has proven a difficult task for previous accounts of homogeneity (see appendix A, Gajewski 2005: pp. 142–149, and Križ 2015: pp. 58–61).

(35) a. The four girls danced with the four boys.
≈ 'Every girl danced with a boy and every boy danced with a girl'.
b. The four girls didn't dance with the four boys.
≈ 'No girl danced with any boy'.

In the current view, however, two-place predicates are nothing exceptional. Defining a two-place counterpart of $\star^t$ as defined in (12) following common practice (see, e.g., Krifka 1986; Sternefeld 1998; Kratzer 2007), we get the following definition of $\star\star^t$:[23]

(36) $$[\![\star\star^t]\!](P)(x)(y) = \begin{cases} 1 & \textit{iff} \;\; \exists P' \subseteq \{\langle x', y'\rangle : P(x')(y') = 1\}[\bigsqcup P' = \langle x, y\rangle] \\ 0 & \textit{iff} \; \neg\exists P' \subseteq \{\langle x', y'\rangle : P(x')(y') \neq 0\}[\bigsqcup P' \sqsubseteq \langle x, y\rangle] \\ \# & \text{otherwise} \end{cases}$$

23 I rely on the following common assumption (see, e.g., Krifka 1986; Kratzer 2007):

(i) $\langle a, b\rangle \sqsubseteq \langle c, d\rangle$ *iff* $a \sqsubseteq c \wedge b \sqsubseteq d$

In line with our assumptions for $\star^t$, the sister of $\star\star^t$ is headed by a cover variable which is assigned a pair-cover, i.e., (the characteristic function of) a cover of the pair $\langle\bigsqcup D, \bigsqcup D\rangle$ where D is the domain of discourse. (A pair-cover is a special case of a cover where what's covered is a pair, relying on the assumption in fn. 23.) We then get for (35a) the following LF:[24]

(37) [the four girls] [[$\star\star^t$ [Cov danced]] [(with) the four boys]]

In order to get the judgements in (35b), Cov in (37) should be assigned a power pair-cover of $\langle\bigsqcup D, \bigsqcup D\rangle$. In that case, (37) will end up true as long as we can find dancing pairs the sum of which is $\langle$⟦the four girls⟧, ⟦the four boys⟧$\rangle$. It will end up false (and its negation as in (35b) will be true) as long as we can find no dancing pairs which are part of $\langle$⟦the four girls⟧, ⟦the four boys⟧$\rangle$; that is to say, as long as no girl danced with any boy.[25]

Just like with one place predicates, there are cases which require using other covers to get the right interpretation. One may consider predicates like *outnumber* and *outweigh* which behave as distributively homogeneous: *the kids don't outnumber the adults* is compatible with there being a plurality of kids which outnumbers some plurality of adults (I thank Roger Schwarzschild for pointing out these predicates). We can derive this if we use minimal covers: if Cov in (38) is assigned a minimal pair-cover of $\langle\bigsqcup D, \bigsqcup D\rangle$ which is a minimal-singleton pair-cover of $\langle$⟦the kids⟧, ⟦the adults⟧$\rangle$, we'll get truth if the plurality consisting of all kids outnumbers the plurality consisting of all adults and falsity otherwise.

(38) [the kids] [[$\star\star^t$ [Cov outnumber]] [the adults]]

I considered here rather simple cases of co-distributivity, where both arguments are definite plurals. Examples which involve a quantifier in one of the argument positions are known to present further complications which we cannot go into here (see Schein 1993, a.o.). For a recent in-depth discussion of co-distributivity and its connection to homogeneity see Chatain (2021, 2022).

6.2 Upward homogeneity and a problem of scope

On top of the totally homogeneous behavior of predicates like *lift the table*, Križ (2015) observed that these predicates give rise to a seemingly related phenomenon he calls upward homogeneity, which is the fact that positive and negative sentences both seem untrue in a situation where no part of the

24 Applying $\star\star^t$ to *danced* is obligatory since it's a sister of *the four boys*. Our assumptions require another $\star^t$ to apply to the sister of *the four girls*, which is ignored here since it's vacuous (as long as the cover variable which heads its sister is assigned a power cover). Note however that we do not exclude the availability of other structures; the following LF is possible (among others):

(i) [the four boys] $\star^t$ [Cov λ1 [the four girls] [$\star^t$ [Cov danced with t_1]]]

Interestingly (and under the assumption that all cover variables in (37) and (i) are assigned power covers), while the truth conditions of (37) and (i) aren't necessarily the same (depending on one's assumptions regarding lexical cumulativity, see Kratzer 2007), their falsity conditions are identical.

25 Beck and Sauerland (2000) claimed that a double star operator is needed based on cases of cumulativity which cannot be explained otherwise (e.g., by assuming lexical cumulativity) as in (i) (as they point out, it is possible to get co-distributive readings when there is a numeralized definite plural in object position as in (i), contra Winter 2000). My account is compatible with their view, where the double star operator applies to a predicate which is derived by movement of both definite plurals in (i).

(i) The four girls gave the four boys a flower.

plurality predicated over satisfies the predicate, but some of these pluralities are part of some plurality which does.[26] For instance, if (some or all of) the kids together with (some or all of) the adults lifted the table, both *the four kids lifted the table* and its negation do not seem true. Our system however predicts the positive sentence to be false and the negative sentence to be true.

What we'd like to have is a way to make the falsity conditions of *the four kids lifted the table* even stronger, so that they require that no kid participate in any table-lifting—not only by kids but also by kids together with non-kids. Furthermore, we would like to have an explanation for why upward homogeneity only shows up when we have total homogeneity, while cases which show distributive homogeneity show no upward homogeneity: *the five bottles don't weigh 2 lbs* is true if overall they weigh 1 lbs but their weight when taken together with something else is 2 lbs (see also section 7.2.2).

We can modify our definition of $\star_t$ in order to capture upward homogeneity. The idea is to make the falsity conditions of $\star_t$ even stronger than in (12), so that they do not only require that nothing which is *part of* the subject of predication satisfy the predicate, but rather they require that nothing which *overlaps* the subject of predication satisfy the predicate.[27] We can modify then the falsity conditions of $\star_t$ as in (39):

(39) $[\![\star_t]\!](P)(x) = 0$ *iff* $\neg\exists P' \subseteq \{x' : P(x') \neq 0\}[\bigsqcup P' \circ x]$

Let us now focus on the falsity conditions of a sentence of the form *DP VP*:

(40) a. LF: [DP [$\star_t$ [Cov VP]]]
b. $[\![(40a)]\!]^c = 0$ *iff* $\neg\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') \neq 0 \wedge Cov^c(x') \neq 0\}[\bigsqcup P' \circ [\![\text{DP}]\!]]$

Now *the four kids* $\star_t$*(*Cov *lifted the table)*, assuming Cov is assigned a power cover of $\bigsqcup D$ (see fn. 21), will no longer be false if some of the kids lifted the table together with some adults, since in this case there is a table-lifting plurality which overlaps the subject of predication ([\![the kids]\!]) and is crucially within the cover since it is a power cover of $\bigsqcup D$. So both *the four kids lifted the table* and its negation will end up neither true nor false.

Note that the fact that a power cover of $\bigsqcup D$ is used is crucial for this analysis of upward homogeneity: otherwise the table-lifting plurality could be absent from the cover and as a result we would get a defined truth value. We would then like to capitalize on this property of the theory in order to explain why there is no upward homogeneity in cases where minimal covers are needed. We can do that with the aid of a modification of an assumption we made. We have assumed that whenever we predicate of an individual x, the context provides a cover of $\bigsqcup D$ which covers x (see fn. 21). Suppose that in such a situation the cover furthermore covers x's complement, $\overline{x}$ (which we can define as the sum of all pluralities which don't overlap with x, i.e., $\bigsqcup(D \setminus \{y : y \circ x\})$). Under this assumption, whenever the cover is minimal we end up with the falsity conditions of $\star_t$ in (41) for *DP VP*, which are the same as in (30).[28] In other words, with minimal covers it doesn't matter whether we

26 My use of 'upward homogeneity' slightly differs from Križ's and covers what he calls 'sideways homogeneity'.

27 This move is greatly inspired by Križ's (2015) account of upward homogeneity.

28 This result relies on the following fact:

(i) If Cov minimally covers $\bigsqcup D$, and covers both x and $\overline{x}$, then for any $P' \subseteq Cov$: $\bigsqcup P' \circ x$ *iff* $\bigsqcup P' \sqsubseteq x$.

This is so because if Cov minimally covers $\bigsqcup D$ and covers both x and $\overline{x}$, then there can be nothing in Cov that overlaps with both x and $\overline{x}$, nor can there by anything in Cov that x (or $\overline{x}$) is a proper part of (if there were such a thing Cov would no longer be minimal). It follows then that every member of Cov which overlaps x is part of x.

assume the overlap-based falsity conditions in (39) or rely on the parthood-based falsity conditions of $\star_t$ in (12); so upward homogeneity doesn't arise when minimal covers are used in the same way that it didn't arise with our previous definition in (12).

(41) If Cov^c minimally covers $\bigsqcup D$, and covers both $[\![\text{DP}]\!]$ and $\overline{[\![\text{DP}]\!]}$, then:
$[\![(40a)]\!]^c = 0$ *iff* $\neg\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') \neq 0 \wedge Cov^c(x') \neq 0\}[\bigsqcup P' \sqsubseteq [\![\text{DP}]\!]]$

This account of upward homogeneity also provides a solution to a problem that arises once we consider different scope possibilities for the sentence *the four kids didn't lift the table*. The LF in (42) is predicted to have an extremely weak meaning given the definition of $\star_t$ in (12):[29] it will end up true as long as we can find pluralities that didn't lift the table the sum of which is $[\![$the kids$]\!]$. Note that this is compatible with there being pluralities of kids that did lift the table the sum of which is $[\![$the kids$]\!]$!

(42) [The four kids] $\star_t$ [Cov $\lambda 1$ [NEG t_1 lifted the table]]

One could try to solve the problem by requiring $\star_t$ to apply also to *lifted the table* as in (43): since the variable t_1 ranges over pluralities, it would make sense to pluralize its sister (I assume here that both cover variables are assigned a power cover of $\bigsqcup D$).

(43) [The kids] $\star_t$ [Cov $\lambda 1$ [NEG t_1 $\star_t$ [Cov [lifted the table]]]]

This alone will however not be enough: given our semantics for $\star_t$ in (12), (43) will end up true as long as no individual kid lifted the table, even if other pluralities of kids did.[30] But given our modification in (39), the truth conditions of (43) turn out to be stronger: *NEG* t_1 $\star_t$ *[Cov lifted the table]* will yield truth only if the value assigned to t_1 overlaps with no plurality that lifted the table. The whole sentence ends up true only if $[\![$the kids$]\!]$ is a sum of pluralities that don't overlap with any plurality that lifted the table. This can only be true if no plurality of kids participated in any table-lifting. Moving *the four kids* then turns out to have no effect on the interpretation, once the definition of $\star_t$ in (39) is adopted.

7 Predicates and contexts

A pressing point for the S/H view is why predicates appear to behave differently with respect to underspecification, given that what should matter is the cover which is assumed to be context dependent rather than the predicate. The obvious worry is that the S/H view blames the context where it should blame the lexical semantics of predicates instead. The same worry applies to the view of homogeneity I proposed (based on the S/H view), where the homogeneity properties of sentences are not directly determined by the predicate, but rather by the contextually provided cover. The theory proposed here raises another question concerning the relationship between underspecification and homogeneity: The connection drawn within the theory between underspecification and total homogeneity (both of which result from power covers) and between ambiguity and distributive homogeneity (both of which

29 Assuming Cov is assigned a power cover of $\bigsqcup D$. Note that the problem doesn't arise with minimal covers. If both instances of Cov in (i) are assigned the same minimal cover, the LFs in (i) end up equivalent.

(i) a. NEG [The bottles] [$\star_t$ [Cov heavy]]
b. [The bottles] $\star_t$ [Cov $\lambda 1$ [NEG t_1 heavy]]

30 The problem could be solved if we stipulated that $\star_t$ only applied to *lifted the table* and not the the sister of *the four kids*, which would however be at odds with our assumptions.

result from minimal covers) may make one expect that there should be a strong correlation between the homogeneity properties of predicates and their underspecification/ambiguity properties. This expectation seems to be borne out when we focus on the predicates we used so far, that is, *lift the table* and *weigh (exactly) 250 lbs*, but whether it holds more generally is not entirely clear to me (see fn. 31). In this section I will focus mostly on these two questions: (i) whether the culprit in the variation with respect to underspecification and homogeneity is the lexical semantics of predicates or the context, and (ii) what kind of connection one should expect between homogeneity and underspecification. As I will emphasize, these two issues are interconnected: the particular predictions with respect to (ii) depend on whether we take predicates or contexts to be responsible for underspecification and homogeneity. I will not aim to resolve these questions completely here; instead, I will offer some preliminary reasons to think that contexts are indeed the underlying reason behind whether we get underspecification and homogeneity, and accordingly, the connection we should expect between homogeneity and underspecification should only arise for a given sentence in a given context.

7.1 Option 1: Lexical semantics is the culprit

One option that comes to mind is to assume that the lexical semantics of predicates can constrain the possible assignments of the cover variable which modifies them, so that the choice between covers is after all rooted in lexical semantics. When coupled with the lexical stipulations about the possible choices of covers, the theory presented here makes a rather strong prediction: It predicts a sharp distinction between predicates which show total homogeneity and predicates which show distributive homogeneity, and this distinction should not be affected by context. Moreover, it predicts that predicates which are on the totally homogeneous camp will always be underspecified and predicates which are on the distributively homogeneous camp will always be ambiguous between distributive and collective readings. As I mentioned, whether this correlation is borne out or not is not entirely clear.[31]

This lexical implementation however raises two immediate problems: (i) the same lexical item can be used to construct both predicates which have underspecified (totally homogeneous) meanings and predicates which have ambiguous (distributively homogeneous) meanings, for instance *lifted the table* and *lifted 250 lbs*; (ii) it does not seem trivial to explain how kids might learn such a meaning component.[32] Note that these two objections apply more generally to the idea that lexical semantics is the root cause of the difference between underspecification and ambiguity and between totally homogeneous and distributively homogeneous cases (as advocated for instance by Križ 2015; Kalomoiros 2022 in the context of homogeneity). Furthermore, in section 7.2.1 I will present preliminary evidence that context does affect the interpretation, which is at odds with the lexical view.

7.2 Option 2: Context is the culprit

Another option which does not face these problems is to assume, as in Schwarzschild (1994, 1996), that the context in which different predicates are uttered is the underlying reason behind cover choice.[33]

31 A previous version of this paper (Bar-Lev 2019) mistakenly took the correlation described here to be a prediction of the combination of the S/H view and the Homogeneity-from-Cumulativity view even without a lexical implementation. I thank a JoS reviewer for pointing out that this was a mistake. In a small survey I later conducted with a small number of predicates I got mixed results, potentially suggesting that the connection between predicates and underspecified/homogeneous readings is more loose than might first look, which, if correct, bolsters the context-only view I discuss in the next subsection.

32 I thank Fred Landman for bringing up the issue of learnability.

33 For discussion of whether distributivity and collectivity are determined by contextual factors or by lexical semantics see Glass (2018). Note however that the focus of our discussion here is different: Rather than the tendency to have distributive readings

On this view, the connection between predicates and cover choices is not direct, but rather mediated by contextual considerations. Note furthermore that, on this view, we no longer make any predictions concerning predicates, and particularly we do not predict predicates like *lift the table* to always be underspecified and totally homogeneous, and we don't predict predicates like *weigh 250 lbs* to always be ambiguous and distributively homogeneous. The prediction is much weaker: we predict that a given sentence in a given context should have an underspecified (/ambiguous) meaning if and only if it has a totally (/distributively) homogeneous meaning.

This view leaves open the question how context interacts with predicates and cover choices, in a way that makes us prefer a power cover for *lift the table* and a minimal cover for *weigh 250 lbs*. In what follows I will discuss two observations whose common core is that predicates differ in whether they give rise to an informative meaning on a (putative) underspecified reading. The first observation is that underspecified *truth* conditions of sentences like *these four people weigh 250 lbs* would often be too weak to be informative given reasonable questions under discussion; the second observation (which is largely in the spirit of remarks made by Križ 2015: section 1.4) is that for some predicates (those involving measurement such as *weigh 250 lbs*), the underspecified falsity conditions would end up too strong and almost unsatisfiable given upward homogeneity. The combination of these two observations, I speculate, provides a rather strong reason to avoid underspecified readings for such predicates, leading to ambiguous readings whose truth conditions are stronger and whose falsity conditions are weaker.

7.2.1 Informativity and truth conditions

A possible distinction between predicates we could rely on is the following: it is easy to conceive of an underspecified meaning of *the four kids lifted the table* as informative, that is, as a reasonable answer to a question, whereas this is more difficult to do with *these four people weigh 250 lbs*. For instance, we can be interested to know which pluralities can be divided into parts each of which lifted the table (roughly, having the question *who participated in table-lifting?*), for which an underspecified reading of *the four kids lifted the table* would be a good answer. Note that, in many contexts, we may not care about whether the table-lifting was done individually, collectively, or otherwise (we will shortly consider a context where this is not the case).

In contrast, an underspecified meaning would be in most contexts uninformative for *These four people weigh 250 lbs*: We are normally not interested to know which pluralities can be divided into parts each of which weighs 250 lbs. In most contexts where we care about people's weight, not knowing whether they weigh 250 lbs distributively, collectively, or otherwise, is not knowing much about their weight. We can then entertain the idea that by default a cover variable is assigned a power cover (i.e., by default all parts of the plurality predicated over matter), and only in contexts where this results in an uninformative meaning we use instead a minimal one.[34]

If this view is on the right track, we'd predict that contextual manipulations might affect the choice of cover-types. Let me now provide preliminary evidence that this is not an outlandish prediction. Consider a table-lifting competition where a contestant only gets a prize if they lift the table alone

on the one hand or collective readings on the other hand as in Glass (2018), what we care about is the tendency to have underspecified readings on the one hand or ambiguous (distributive or collective) readings on the other hand.

34 A different interpretation of this idea could be that the presence of the cover variable itself is optional, and is only warranted when an uninformative meaning is derived otherwise. Such an interpretation would be compatible with assuming that covers are always minimal ones (see fn. 19).

(and otherwise they get nothing). In this context, it seems possible to report the results of the contest with *the six contestants didn't lift the table so no one got a prize* even if they managed to lift it all together, or if half of them managed to lift it together, as long as none of them lifted it individually (cf. the discussion of (13)). Predicates which normally get an underspecified and totally homogeneous interpretation can then have a distributive one once the context is properly set so that we only care about whether the atomic parts of the plurality satisfy the predicate and do not care about other pluralities, as expected on the context-based view.[35]

7.2.2 Informativity and falsity conditions

The idea we outlined above, according to which underspecified readings for predicates like *weigh 250 lbs* would be uninformative, was based on the truth conditions alone, ignoring the effect of homogeneity. Here I would like to suggest, following an observation due to Križ (2015: section 1.4), that there might be another reason for some predicates not to have an underspecified reading, which has to do with homogeneity, that is, with the falsity conditions. This reason will be relevant for a subgroup of predicates which show a distributively homogeneous behavior, namely those involving measurement like *weigh 250 lbs*.[36]

Let us begin with the observation that, in some cases, the falsity conditions of an underspecified meaning are contradictory. Consider for instance the (distributively homogeneous) predicate *be light enough to carry*. The falsity conditions of a sentence like *the five boxes are light enough to carry* on an underspecified meaning would require that no part of the plurality of boxes be light enough to carry. This is however a contextual contradiction, at least assuming that we consider all parts of the boxes, including those that are smaller than individual boxes. This is the case for all predicates which are downward monotonic with respect to the parthood relation, such as *be light enough to carry* and *be few in number*: It will always be possible to find, for any plurality, parts small enough to be considered light or few in number, so the falsity conditions won't be satisfiable.

This observation does not immediately apply to other distributively homogeneous predicates, such as *weigh 250 lbs*; however, once we consider upward homogeneity, the falsity conditions of sentences containing them end up almost trivial as well on an underspecified reading. Given upward homogeneity (that is, given the definition of $\star_t$ in (39)), *these five boxes* $\star_t$ *(weigh 250 lbs)* would be false only if no part of the plurality of boxes overlaps any plurality which weighs 250 lbs. No matter how much the boxes weigh, though, it is guaranteed that they have a part which overlaps with some plurality that

35 Whether predicates which normally have ambiguous meanings may also have underspecified meanings given specific contexts seems more difficult to determine. Here is an attempt: Suppose I only get a discount in the store if I pay more than 100 dollars, and I just realized that what I am about to go to the cashier with only costs 94 dollars. Now I'm looking for something I could buy for 6 dollars in order to get the discount, and my friend notifies me that *the three bottles right there cost 6 dollars* even though they have no idea if the price tag they saw with a big 6 on it was referring to the price of individual bottles or that of pairs of bottles, etc. While this apparently shows that underspecified readings are possible with a predicate like *cost 6 dollars*, it is not clear to me how natural the sentence is even in this context, and even if it is, this could also be analyzed as my friend being ignorant about the identity of the (minimal) cover rather than using a power cover. I thank Benjamin Spector for suggesting this possibility to me. Note that, if predicates like *cost 6 dollars* which involve measurement cannot get an underspecified meaning due to the triviality of the falsity conditions, as I will suggest in section 7.2.2, one may not necessarily expect such manipulations of the context to matter with these predicates.

36 As mentioned in fn. 4, an explanation based on measurement will not be relevant for predicates like *agree*. Note however that the observation concerning the weakeness of the truth conditions from section 7.2.1 can explain why a power cover is dispreferred in this case: It is difficult to imagine a context where we care about which pluralities can be divided into pluralities that are in agreement but not care about which of those pluralities agrees with which. And in contexts where we do not care about who exactly agrees with whom, it looks like we can indeed accept an underspecified reading: If a committee of three people chooses a candidate when two committee members agree on the candidate's identity, saying *the three committee members did no agree* can be understood as entailing that no two members were in agreement. I thank Viola Schmitt for a discussion of this point.

weighs 250 lbs, as long as there are pluralities which weigh 250 lbs. Effectively, saying that $\star^t$ *(weigh 250 lbs)* is false of an object is equivalent to the claim that nothing in the universe of discourse weighs 250 lbs; this is an extremely strong requirement, and it seems reasonable to assume that we consider it a contextual contradiction in many contexts. The same observation applies to other predicates which are upward monotonic with respect to the parthood relation, such as *be heavy* and *be numerous*, which also show a distributively homogeneous behavior.

But why should we care about the falsity conditions being contradictory for (some) distributively homogeneous predicates? Here I would like to follow recent work by Wehbe (2022); Guerrini and Wehbe (2024), who argue in favor of assuming that homogeneity is a presupposition, as we assumed here following much earlier work. While Spector (2013); Križ (2015) argue against a presuppositional account of homogeneity, Wehbe (2022); Guerrini and Wehbe (2024) claim that a view of homogeneity where it is a presupposition can explain felicity conditions of homogeneous sentences, based on the independent observation that sentences are infelicitous if the sentence becomes a contextual tautology once the presupposition is accommodated. Now note that a situation where the falsity conditions are contradictory is a situation where the sentence is a contextual tautology once the presupposition (that is, the disjunction of the truth and falsity conditions) is accommodated. Consequently, if it is indeed reasonable to assume that the falsity conditions of sentences like *the five boxes are heavy/light enough to carry/weigh 250 lbs* are contextual contradictions on an underspecified reading, we should expect this reading to be unavailable due to a violation of the requirement that sentences be informative after presupposition accommodation. This violation is avoided if one has minimal covers, and as a result ambiguous readings.

7.3 Connection to previous typologies of predicates

Before concluding, we should point out a potential connection between the distinctions between predicates we focused on here, with respect to homogeneity and underspecification, and another typology of predicates (see also Kalomoiros 2022). As a first approximation, the distinction between predicates which tend to behave as totally homogeneous (underspecified) and those which tend to behave as distributively homogeneous (ambiguous) seems to correspond roughly to Winter's (2002) distinction between atom and set predicates or Champollion's (2017) distinction between *gather*-type and *numerous*-type predicates.[37] If the distinction made here indeed correlates with these distinctions,[38] one might hope to shed new light on the behavior of *all* (and other plural quantifiers) with predicates of different types which underlies them (see Dowty 1987; Winter 2002; Brisson 2003; Kuhn 2017; Champollion 2017, a.o.): While *all* with *gather*-type predicates is compatible with both distributive and collective situations, *all* with *numerous*-type predicates is only compatible with distributive situations.

(44) a. All the kids lifted the table ✓distributive situation, ✓collective situation
b. All the bottles are heavy ✓distributive situation, ✗collective situation

This can perhaps be made sense of based on the view argued for in this paper if *all* is compatible with underspecified and distributive meanings but not with purely collective meanings, a view which is very close in spirit to existing accounts in the literature (Dowty 1987; Champollion 2017). Of course,

37 Putting aside distributive predicates, which weren't discussed in this paper, the two distinctions are identical.
38 Preliminary reason to suspect it doesn't comes from predicates like *be consistent* and *be compatible* which behave as distributively homogeneous but have been argued to be *gather*-type by Kuhn (2017). The same can be said of *agree*.

much more needs to be done in order to understand the proper connection between these typologies of predicates, both theoretically and empirically.[39]

To sum up, in this section I discussed the connection between predicates and contexts on the S/H view and the Homogeneity-from-Cumulativity view, and provided preliminary reasons to think that the variation between predicates with respect to homogeneity and underspecification is due to contextual factors rather than lexical semantics. Clearly, more work is needed in order to provide a satisfactory theory of what governs the choice of covers, which I cannot further pursue here.

8 Conclusion

I proposed a modification of the view in which homogeneity is the result of pluralization, where rather than taking a distributivity operator (^{D_t}) to be responsible for homogeneity, a cumulativity operator (^{*_t}) is instead taken to be responsible for it. I have shown that once this view is combined with the S/H view of underspecification and ambiguity in which covers determine the interpretation, one derives both total homogeneity and distributive homogeneity. This theory then satisfies all requirements we have seen for theories of plural predication and homogeneity: Deriving underspecified and ambiguous meanings, and deriving total and distributive homogeneity.

A Appendix: Comparison with previous approaches

A main goal of this paper has been to come up with a theory which can derive underspecified and ambiguous readings as well as total and distributive homogeneity. As mentioned at the very beginning, no existing theory does. In this section I provide a discussion of several approaches to homogeneity, focusing mainly on why they fail to satisfy these requirements. I will also briefly remark on a way to amend an account due to Krifka (1996) (and more recently Križ and Spector 2017) in order to capture them.

A.1 Schwarzschild (1994)

Schwarzschild builds his system based on Cooper (1983). He assumes that (some) predicates have positive and negative extensions (the system is originally intensional, which I ignore here), so that if John laughed and Mary didn't (and assuming that the basic predicate *laughed* cannot be true or false of non-atomic individuals), then:

(45) a. $[\![\text{laughed}]\!]_+ = \{\text{John}\}$
b. $[\![\text{laughed}]\!]_- = \{\text{Mary}\}$

An application of the star operator is obligatory by assumption, and it is defined as follows:

(46) a. $[\![{}^\star\text{P}]\!]_+ = \{x : \exists P' \subseteq [\![\text{P}]\!]_+[\bigsqcup P' = x]\}$
b. $[\![{}^\star\text{P}]\!]_- = \{x : \exists P' \subseteq [\![\text{P}]\!]_-[\bigsqcup P' = x]\}$

39 Interestingly, context has been argued to play a role with the distinction between *gather*-type and *numerous*-type predicates as well; see Champollion (2017: p. 244).

In our case, the plurality John $\sqcup$ Mary won't be in either the positive or the negative extension of **laughed*:

(47) a. $[\![{}^{\star}\text{laughed}]\!] = [\![\text{laughed}]\!]_{+} = \{\text{John}\}$
b. $[\![{}^{\star}\text{laughed}]\!] = [\![\text{laughed}]\!]_{-} = \{\text{Mary}\}$

Finally, a predicate P is true of an individual x if $x \in [\![\text{P}]\!]_{+}$, and false of it if $x \in [\![\text{P}]\!]_{-}$. By assumption, if both $x \in [\![\text{P}]\!]_{+}$ and $x \in [\![\text{P}]\!]_{-}$ hold or neither of them does, we get a presupposition failure. Since John $\sqcup$ Mary is in neither the positive nor the negative extension of **laughed*, we get a presupposition failure, i.e., a homogeneity violation, for *John and Mary laughed*.

The main problem with this view is that it overgenerates presupposition failures once we move beyond simple distributive predication. For instance, if John $\sqcup$ Mary lifted the table but neither John nor Mary lifted it alone, we have the following situation:

(48) a. $[\![\text{lifted the table}]\!]_{+} = \{\text{John} \sqcup \text{Mary}\}$
b. $[\![\text{lifted the table}]\!]_{-} = \{\text{John, Mary}\}$

When we apply *, we get:

(49) a. $[\![{}^{\star}\text{lifted the table}]\!]_{+} = \{\text{John} \sqcup \text{Mary}\}$
b. $[\![{}^{\star}\text{lifted the table}]\!]_{-} = \{\text{John, Mary, John} \sqcup \text{Mary}\}$

Since John $\sqcup$ Mary ends up in both the positive and the negative extensions of **lifted the table*, we get a presupposition failure when we apply **lifted the table* to John $\sqcup$ Mary. This is undesired of course, given that *John and Mary lifted the table* is intuitively true.[40]

A very similar issue (brought up by Gajewski 2005) arises with co-distributivity, which is normally captured by generalizing * to n-place predicates. A natural extension of * to two-place predicates on this view will look as follows:

(50) a. $[\![{}^{\star\star}\text{P}]\!]_{+} = \{< x, y >: \exists P' \subseteq [\![\text{P}]\!]_{+}[\bigsqcup P' = \langle x, y\rangle]\}$
b. $[\![{}^{\star\star}\text{P}]\!]_{-} = \{< x, y >: \exists P' \subseteq [\![\text{P}]\!]_{-}[\bigsqcup P' = \langle x, y\rangle]\}$

Now suppose we are in a situation in which John danced with Bill and Mary danced with Sue, and no one else danced with anyone else.

(51) a. $[\![\text{danced}]\!]_{+} = \{\langle\text{John, Bill}\rangle, \langle\text{Mary, Sue}\rangle\}$
b. $[\![\text{danced}]\!]_{-} = \{\langle\text{John, Sue}\rangle, \langle\text{Mary, Bill}\rangle, \ldots\}$

When we apply * we get:

(52) a. $[\![{}^{\star}\text{danced}]\!]_{+} = \{\langle\text{John, Bill}\rangle, \langle\text{Mary, Sue}\rangle, \langle\text{John} \sqcup \text{Mary, Bill} \sqcup \text{Sue}\rangle\}$
b. $[\![{}^{\star}\text{danced}]\!]_{-} = \{\langle\text{John, Sue}\rangle, \langle\text{Mary, Bill}\rangle, \langle\text{John} \sqcup \text{Mary, Bill} \sqcup \text{Sue}\rangle, \ldots\}$

Once again we find ourselves in a situation where an object is found in both the positive and the negative extensions of a pluralized predicate, leading to a presupposition failure in a situation where

40 This problem could be solved by dropping the assumption that applying * is obligatory. But this will have repercussions elsewhere: *the kids didn't lift the table* will end up true given a *-less LF if each kid lifted the table alone.

the corresponding sentence (*John and Mary danced with Bill and Sue*) is intuitively true.[41] Since Schwarzschild's (1994) view cannot account for homogeneity beyond the distributive case (as pointed out by Križ 2015), it seems to stand no chance in capturing the total homogeneity.

A.2 Gajewski (2005)

Gajewski takes a more standard route and does not assume positive and negative extensions. Instead, he takes Schwarzschild's idea that homogeneity has to do with a pluralization operator and applies it to a distributivity operator ^{D}, defined as follows (though Gajewski defines it a bit differently), which implements an excluded middle presupposition:

(53) $$[\![^D]\!](P)(x) = \begin{cases} 1 & \textit{iff } \forall x' \sqsubseteq_{AT} x[P(x') = 1] \\ 0 & \textit{iff } \forall x' \sqsubseteq_{AT} x[P(x') = 0] \\ \# & \text{otherwise} \end{cases}$$

Križ's (2015) objection to this view is that homogeneity with non-distributive predication of the sort we see with *lift the table* cannot possibly be attributed to ^{D}, and hence it fares no better in this regard than Schwarzschild. Furthermore, Gajewski (2005) struggles with defining a two-place counterpart to ^{D} which both accounts for homogeneity and allows co-distributive interpretations, and leaves it as an open issue.[42]

A.3 Križ (2015)

Based on the homogeneity pattern found with *lift the table*, Križ departs from the Schwarzschild-Gajewski view according to which a pluralization operator is to blame. He proposes instead that there is a general constraint on the extensions of lexical predicates in natural language, which is that they have to be homogeneous. Being a homogeneous predicate is defined as follows:

(54) **Generalised homogeneity**
A homogeneous predicate P is undefined of a plurality a if it is not true but there is a plurality b that overlaps with a such that P is true of b.

While this simple constraint goes a long way in explaining homogeneity with predicates like *lift the table*, it rules out the existence of lexical predicates like *heavy* which are non-homogeneous on this definition of homogeneity: if there are heavy and non-heavy things in the world, we will be able to find for any non-heavy plurality a plurality it's part of which is heavy (bearing in mind that parthood is a special case of overlap). Križ thus claims that non-homogeneous predicates aren't lexical. On top of being a stipulation (for instance, what makes *agree*, which behaves as distributively homogeneous,

41 One might wonder whether we can get rid of the assumptions that *lift the table* and *dance* have both positive and negative extensions. Crucially, accounting for homogeneity in this system depends on having such extensions, and as we have seen these predicates give rise to homogeneity.

42 One could come up with such a definition, as Beck (2001: ex. 228) did, but it is not clear whether this could be taken to be a natural generalization of ^{D}:

(i) $$[\![^{D\,D}]\!](P)(x)(y) = \begin{cases} 1 & \textit{iff } \forall x' \sqsubseteq_{AT} x[\exists y' \sqsubseteq_{AT} y[P(x')(y') = 1]] \wedge \forall y' \sqsubseteq_{AT} y[\exists x' \sqsubseteq_{AT} x[P(x')(y') = 1]] \\ 0 & \textit{iff } \forall x' \sqsubseteq_{AT} x[\forall y' \sqsubseteq_{AT} y[P(x')(y') = 0]] \\ \# & \text{otherwise} \end{cases}$$

a non-lexical predicate, in contrast with *gather*, which behaves as totally homogeneous?), his use of a distributivity operator leads to the prediction that a sentence like *the kids didn't lift the table* would have a reading on which it is undefined rather than false in a collective situation (see fn. 16), and more generally, does not allow for deriving underspecified readings.

Finally, he also faces a problem with co-distributive predication which is in a sense similar to the problem discussed in section A.1 for Schwarzschild (I will present a simplified version of the problem and the solution; see Križ 2015: section 2.4.1 for details). In the co-distributive situation we can say that *John and Mary danced with Bill and Sue* and that *John didn't dance with Sue*. The problem is that *dance* is not homogeneous if it's true of $\langle$John $\sqcup$ Mary, Bill $\sqcup$ Sue$\rangle$ and false of $\langle$John, Sue$\rangle$ (under the common assumption that the latter pair is part of the former). His solution to this problem, again greatly simplified, is to assume that the lexical (homogeneous) predicate *dance* ends up non-homogeneous as the result of closure under sum (i.e., pluralization). So *dance*, before it's closed under sum, is true of $\langle$John, Bill$\rangle$ and $\langle$Mary, Sue$\rangle$ and false of any other pair of individuals. Then we close it under sum, resulting in a predicate which is true of $\langle$John $\sqcup$ Mary, Bill $\sqcup$ Sue$\rangle$, and is non-homogeneous.

To see how this view relates to the one argued for here, it is useful to think about the difference in procedural terms: For Križ, we first have a homogeneous predicate and then we may remove homogeneity by pluralization. For us, the order is reversed: we begin with a lexical predicate which may or may not be homogeneous (allowing for lexical predicates like *heavy* and *agree*), and homogeneity only kicks in when we pluralize, which results in homogeneous predicates (though of course the term 'homogeneous' receives a different meaning within the two views). Furthermore, it's been crucial for me that contextual restriction (for which I utilized covers) happens before homogeneity enters into the picture, which cannot be done on Križ's view. Due to this major architectural difference, I cannot see a way to reconcile Križ's view with mine.

A.4 Krifka (1996); Križ and Spector (2017)

Križ and Spector develop an account based on Krifka according to which plural predication gives rise to two candidate meanings (as well as many others which are ignored here together with much of the details of their proposal), as follows:

(55) Candidate readings for *DP VP*:

a. $[\![\mathrm{VP}]\!]([\![\mathrm{DP}]\!]) = 1$

b. $\exists y \sqsubseteq [\![\mathrm{DP}]\!][[\![\mathrm{VP}]\!](y) = 1]$

The sentence *DP VP* is judged (super-)true if all of its candidate meanings are true (i.e., if (55a) is true), and (super-)false if all of them are false (i.e., if (55b) is false). In other words, the (super-)truth conditions are only satisfied in a collective situation, and the (super-)falsity conditions are only satisfied if the predicate holds of no part of the plurality predicated over. We can characterize the result using our terms as a view where a collective meaning leads to total homogeneity. But what we have seen in (2) in fact is that a collective meaning of the sort we have seen with *weigh 250 lbs* leads to no homogeneity at all, and total homogeneity of the sort we have seen with *lift the table* goes hand in hand with underspecification.

Furthermore, to account for the fact that *the four kids lifted the table* can be true in a distributive situation, they posit a distributivity operator ^{D}:

(56) $[\![^D]\!](P)(x) = 1$ *iff* $\forall x' \sqsubseteq_{AT} x[P(x') = 1]$

We can compute the candidate readings for *DP* ^{D} *VP* based on (55):

(57) Candidate readings for *DP* ^{D} *VP*:

a. $\forall x' \sqsubseteq_{AT} [\![\text{DP}]\!][[\![\text{VP}]\!](x') = 1]$

b. $\exists y \sqsubseteq_{AT} [\![\text{DP}]\!][[\![\text{VP}]\!](y) = 1]$

The (super-)truth conditions are only satisfied in a distributive situation and the (super-)falsity conditions are only satisfied if no atomic part of the plurality predicated over satisfies the predicate. But this means that *the four kids didn't lift the table* will have a distributive reading on which it's true in a collective situation if no kid lifted the table alone, contrary to fact.

Unlike Križ, however, the general architecture of Krifka (1996); Križ and Spector (2017) can be reconciled with our view. Let me sketch a simplistic way to do it.[43] Suppose we have two pluralization operators: $\star^s$ (for strong star) which has the standard semantics in (58a), and another pluralization operator $\star^w$ (for weak star) which has the semantics in (58b) (compare to the truth and falsity conditions of $\star$ in (12)).

(58) a. $[\![\star^s]\!](P)(x) = 1$ *iff* $\exists P' \subseteq \{x' : P(x') = 1\}[\bigsqcup P' = x]$

b. $[\![\star^w]\!](P)(x) = 1$ *iff* $\exists P' \subseteq \{x' : P(x') = 1\}[\bigsqcup P' \sqsubseteq x]$

Suppose furthermore that applying one of these $\star$ operators is obligatory, and that a cover variable heads its sister. We get two readings for *DP VP*:

(59) Candidate readings for *DP VP*:

a. $[\![\text{DP } [\star^s\ [Cov\ \text{VP}]]]\!]^c = 1$ *iff* $\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') = 1 \wedge Cov^c(x') = 1\}[\bigsqcup P' = x]$

b. $[\![\text{DP } [\star^w\ [Cov\ \text{VP}]]]\!]^c = 1$ *iff* $\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') = 1 \wedge Cov^c(x') = 1\}[\bigsqcup P' \sqsubseteq x]$

The sentence *DP VP* is then judged (super-)true if both its candidate meanings are true (i.e., if (59a) is true), and (super-)false if both are false (i.e., if (59b) is false). This provides a different way to derive the connection between homogeneity and underspecification outlined in Table 1.

References

Amiraz, O. (2020). Non-maximality and homogeneity: Parallels between collective predicates and absolute adjectives. In *Proceedings of Sinn und Bedeutung*, Volume 24, pp. 66–83.

Bar-Lev, M. E. (2018). *Free Choice, Homogeneity, and Innocent Inclusion*. Ph. D. thesis, Hebrew University of Jerusalem.

Bar-Lev, M. E. (2019). Specification and homogeneity in plural predication. Manuscript.

43 The details of the formal implementation in Križ and Spector (2017), motivated by many issues I have not discussed in this paper, make the integration of the view I argued for here more complex. For the reader familiar with their work, I provide here a redefinition of their set of candidate denotations for an individual $Cand_x$ (here replaced with a context-dependent $Cand_x^c$ to allow for the integration of covers) designed to make their system compatible with our view. I will not attempt to demonstrate that it delivers the desired result here.

(i) $Cand_x^c = \{\bigvee S : S \in \{S' : S' \text{ is a maximal subset of } Cov^c \cap \{y : y \sqsubseteq x\} \text{ s.t. } \forall y, z \in S'[y \circ z]\}\}^{\vee\wedge}$

Bar-Lev, M. E. (2021). An implicature account of homogeneity and non-maximality. *Linguistics and Philosophy 44*, 1045–1097.

Beck, S. (2001). Reciprocals are definites. *Natural language semantics 9*(1), 69–138.

Beck, S. and U. Sauerland (2000). Cumulation is needed: A reply to winter (2000). *Natural language semantics 8*(4), 349–371.

Brisson, C. (2003). Plurals, all, and the nonuniformity of collective predication. *Linguistics and philosophy 26*(2), 129–184.

Brisson, C. M. (1998). *Distributivity, maximality, and floating quantifiers*. Ph. D. thesis, Rutgers.

Bylinina, L. and R. Nouwen (2018). On "zero" and semantic plurality. To appear in Glossa.

Champollion, L. (2016). Covert distributivity in algebraic event semantics. *Semantics and Pragmatics 9*, 15–1.

Champollion, L. (2017). *Parts of a whole: Distributivity as a bridge between aspect and measurement*, Volume 66. Oxford University Press.

Champollion, L. (2019). Distributivity in formal semantics. *Annual Review of Linguistics 5*(Volume 5, 2019), 289–308.

Champollion, L. (2020). Distributivity, collectivity and cumulativity. In L. Mathewson, C. Meier, H. Rullmann, and T. E. Zimmermann (Eds.), *The Wiley Blackwell Companion to Semantics*. Wiley.

Chatain, K. (2021). *Cumulativity from Homogeneity*. Ph. D. thesis, Massachusetts Institute of Technology.

Chatain, K. (2022). Cumulativity from the perspective of homogeneity. Ms.

Cooper, R. (1983). *Quantification and Syntactic Theory*. D. Reidel, Dordrecht.

van der Does, J. (1993). Sums and quantifiers. *Linguistics and Philosophy 16*(5), 509–550.

Dowty, D. (1987). Collective predicates, distributive predicates and *all*. In *Proceedings of the 3rd ESCOL*, pp. 97–115.

Feinmann, D. (2021, 12). Distinguishing Homogeneity From Vagueness. *Journal of Semantics 38*(4), 667–679.

Fodor, J. D. (1970). *The linguistic description of opaque contents.* Ph. D. thesis, Massachusetts Institute of Technology.

Frazier, L., J. M. Pacht, and K. Rayner (1999). Taking on semantic commitments, ii: collective versus distributive readings. *Cognition 70*(1), 87–104.

Gajewski, J. R. (2005). *Neg-raising: Polarity and presupposition*. Ph. D. thesis, Massachusetts Institute of Technology.

Gillon, B. S. (1987). The readings of plural noun phrases in english. *Linguistics and philosophy 10*(2), 199–219.

Gillon, B. S. (1990). Plural noun phrases and their readings: A reply to lasersohn. *Linguistics and Philosophy 13*(4), 477–485.

Glass, L. (2018). *Distributivity, lexical semantics, and world knowledge*. Ph. D. thesis, Stanford University.

Guerrini, J. and J. Wehbe (2024). Homogeneity as presuppositional exhaustification. manuscript.

Heim, I. (1994). Plurals. Lecture notes.

Higginbotham, J. (1981). Reciprocal interpretation. *Journal of linguistic research 1*(3), 97–117.

Kalomoiros, A. (2022). Reducing homogeneity to distributivity. In *Proceedings of the ESSLLI &*

WeSSLLI Student Session 2020, pp. 113–124.

Kratzer, A. (2007). On the plurality of verbs. *Event structures in linguistic form and interpretation*, 269–300.

Krifka, M. (1986). *Nominalreferenz und Zeitkonstitution: Zur Semantik von Massentermen, Pluraltermen und Aspektklassen*. Ph. D. thesis, University of Munich.

Krifka, M. (1996). Pragmatic strengthening in plural predications and donkey sentences. In *Semantics and Linguistic Theory*, Volume 6, pp. 136–153.

Križ, M. (2015). *Aspects of Homogeneity in the Semantics of Natural Language*. Ph. D. thesis, University of Vienna.

Križ, M. (2016). Homogeneity, non-maximality, and all. *Journal of Semantics 33*, 1–47.

Križ, M. and B. Spector (2017). Interpreting plural predication: Homogeneity and non-maximality. Ms., Institut Jean Nicod.

Kuhn, J. (2017). Gather/numerous as a mass/count opposition. Ms., Institut Jean Nicod.

Landman, F. (1989). Groups, I. *Linguistics and philosophy 12*(5), 559–605.

Landman, F. (2011). Boolean pragmatics. Unpublished manuscript.

Lasersohn, P. (1989). On the readings of plural noun phrases. *Linguistic Inquiry 20*(1), 130–134.

Link, G. (1983). The logical analysis of plurals and mass terms: A lattice theoretical approach. In R. Bäuerle, C. Schwarze, and A. von Stechow (Eds.), *Meaning, use, and interpretation of language*, pp. 127–144. Walter de Gruyter.

Link, G. (1987). *Generalized quantifiers and plurals*. Springer.

Löbner, S. (1987). The conceptual nature of natural language quantification. In I. Rusza and A. Szabolcsi (Eds.), *Proceedings of the 1987 Debrecen symposium on logic and language*, pp. 81–94.

Löbner, S. (2000). Polarity in natural language: predication, quantification and negation in particular and characterizing sentences. *Linguistics and Philosophy 23*(3), 213–308.

Magri, G. (2014). An account for the homogeneity effects triggered by plural definites and conjunction based on double strengthening. In *Pragmatics, Semantics and the Case of Scalar Implicatures*, pp. 99–145. Palgrave Macmillan.

Nouwen, R. (2016). Plurality. In M. Aloni and P. Dekker (Eds.), *The Cambridge Handbook of Formal Semantics*, pp. 267–284. Cambridge University Press.

Roberts, C. (1987). *Modal subordination, anaphora, and distributivity*. Ph. D. thesis, University of Massachusetts Amherst.

Schein, B. (1993). Plurals and events.

Schwarzschild, R. (1994). Plurals, presuppositions and the sources of distributivity. *Natural Language Semantics 2*(3), 201–248.

Schwarzschild, R. (1996). *Pluralities*. Springer Science & Business Media.

Spector, B. (2013). Homogeneity and plurals: From the strongest meaning hypothesis to supervaluations. Talk presented at Sinn und Bedeutung 18.

Sternefeld, W. (1998). Reciprocity and cumulative predication. *Natural language semantics 6*(3), 303–337.

Vaillette, N. (2001). Flexible summativity: A type-logical approach to plural semantics. In *OSU Working Papers in Linguistics 56*, pp. 133–157. Ohio State University.

Wehbe, J. (2022). Revisiting presuppositional accounts of homogeneity. In *Amsterdam Colloquium*.

Winter, Y. (2000). Distributivity and dependency. *Natural language semantics 8*(1), 27–69.

Winter, Y. (2001). *Flexibility principles in Boolean semantics: The interpretation of coordination, plurality, and scope in natural language*. MIT press Cambridge, MA.

Winter, Y. (2002). Atoms and sets: A characterization of semantic number. *Linguistic Inquiry 33*(3), 493–505.