Specification and Homogeneity in Plural Predication*

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* [Acknowledgments to be added.]

Abstract

This paper focuses on two questions in the semantics of plural predication: (i) What is the source of variation between non-distributive predicates with respect to Homogeneity? (ii) What is the nature of the distributive/collective distinction in plural predication, i.e., do we have two different meanings corresponding to collective and distributive situations or one weak underspecified meaning compatible with both? Examining question (ii), I strengthen arguments that predicates differ in whether they give rise to one weak meaning or to stronger ones. I further claim that there is a correlation between the behavior of predicates in this regard and their behavior with respect to Homogeneity, which calls for a unified perspective on questions (i)-(ii). I propose to capture this correlation by a modest modification of a standard view of Homogeneity which relies on a trivalent semantics for the pluralization operator together with a relativization of that operator to 'covers'.

Keywords: Homogeneity, Pluralization, Covers, Distributivity, Collectivity, Underspecification

1 Introduction: A new question and an old one

1.1 A new question: A surprising variation with respect to Homogeneity

Homogeneity is a name for the fact that positive and negative sentences involving plural predication do not have complementary truth conditions (Fodor 1970; Löbner 1987, 2000; Schwarzschild 1994; Krifka 1996; Gajewski 2005; Magri 2014; Križ 2015, 2016; Križ & Spector 2017; Bar-Lev 2018, a.o.). If only half of the kids laughed, we cannot truthfully utter (1a) nor can we truthfully utter (1b).[1]

(1) a. The kids laughed.
b. The 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. This presupposition requires that the *atomic* parts of the plurality

1 I will ignore throughout the paper the availability of so-called 'non-maximal' readings where, for instance, (1a) is judged true even if not all the kids laughed. Homogeneity has been argued by Križ (2015, 2016) to be connected to Non-maximality. The view I will argue for in this paper will be compatible with a variety of accounts in which the two phenomena are connected, e.g., Križ (2016); Križ & Spector (2017); Bar-Lev (2018).

predicated over will be homogeneous with respect to the predicate: in the case at hand, that either every kid laughed or no kid laughed.[2] Indeed, non-distributive predicates like *be light enough to carry* behave precisely as is expected on the standard account of Homogeneity, which we'll call a Standardly Homogeneous behavior. On their collective understandings there is apparently no Homogeneity requirement, namely (2a) and (2b) have complementary truth conditions, and on their distributive understandings both (2a) and (2b) require the individual bottles to be homogeneous with respect to *be light enough to carry*, but imply nothing about bigger pluralities.

(2) A **Standardly Homogeneous** behavior:

a. The bottles are light enough to carry.

b. The bottles aren't light enough to carry.

Križ (2015) observed however that not all predicates behave in a Standardly Homogeneous way like *be light enough to carry*. The behavior of predicates like *lift the piano* is entirely unexpected on the standard view of Homogeneity (and is thus named here Surprisingly Homogeneous): (3b) is only true if no plurality of kids, atomic or non-atomic, lifted the piano. In a situation where half of the kids lifted the piano 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 standard view is to blame: this presupposition only concerns *atomic* individuals, which in the case at hand are indeed homogeneous with respect to *lift the piano*.

(3) A **Surprisingly Homogeneous** behavior:

a. The kids lifted the piano.

b. The kids didn't lift the piano.

The existence of Homogeneity with non-distributive predication has led Križ (2015); Križ & Spector (2017) to develop alternative accounts in which Homogeneity arises independently of pluralization operations. However, no existing account provides a principled explanation for the distinction between *lift the piano* and *be light enough to carry* with respect to Homogeneity, or more generally between the Standardly Homogeneous and Surprisingly Homogeneous predicates in (4).[3] The goal of this paper is to fill this gap, emphasiz-

2 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 §A.1.

3 As Križ notes, the distinction between Surprisingly Homogeneous and Standardly Homogeneous predicates (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 §5.2. Križ attributes the behavior of Standardly Homogeneous predicates to the involvement of some sort of measurement. This however disregards predicates like *agree* (as well as *compatible* and *consistent*, see fn. 35) which don't involve measurement and are Standardly 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).

ing that the key to the analysis is having an adequate answer to an old question about the nature of the distributive/collective distinction, to which we now turn.

(4) **Typology of some predicates and their Homogeneity properties**:

a. Standardly Homogeneous predicates: *be numerous*, *be few in number*, *be heavy*, *be light enough to carry*, *cost 6 dollars*, *agree*.

b. Surprisingly Homogeneous predicates: *gather*, *lift the piano*, *perform Hamlet*, *win the lottery*.

1.2 An old question: The nature of the distributive/collective distinction

On some views, the fact that (5) can be true in both distributive and collective situations is the result of two specified readings of (5) corresponding to these two situations, as in (6) (Link 1987; Gillon 1987; Landman 1989; Schwarzschild 1996, a.o.); on other views (5) has one underspecified meaning compatible with both distributive and collective situations (as well as others, an issue we return to in §2.4), as in (7) (Higginbotham 1981; Schwarzschild 1994, a.o.).[4]

(5) The kids lifted the piano.

(6) a. Distributive meaning: 'Each kid lifted the piano individually'
b. Collective meaning: 'All the kids together lifted the piano'

(7) Underspecified meaning: 'Every kid participated in a lifting of the piano by a plurality of kids (= a group[5] of one or more kids)'

What is then the nature of the distributive/collective distinction? While a lot of ink has been spilled over this question, the debate hasn't been settled. This paper aims to provide new support for an answer to this question due to Schwarzschild (1994); Heim (1994), according to which both specified and underspecified meanings are needed; furthermore, it aims to demonstrate that this answer enables a relatively simple perspective on the issue discussed in the previous section along the lines of the standard view of Homogeneity. In a nutshell, the upshot will be that what's special about Surprisingly Homogeneous predicates is that they have no collective/distributive meanings but rather only underspecified ones. Based on our characterization of the underspecified meaning as 'distributing participation' down to the atomic individuals as in (7), we will explain the judgments in (3) as resulting from a requirement from the atomic kids to be homogeneous with respect to the property of *participating in a lifting of the piano by a plurality of kids*.

4 I will not be able to do justice in this paper to all the arguments that have been brought up for each view. See Nouwen (2016); Champollion (to appear) for recent reviews. 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).

5 The use of *group* here should not be confused with the notion of groups familiar from Landman (1989); I will use pluralities and groups interchangeably.

I will proceed as follows: in §2 I will strengthen and elaborate on arguments that predicates differ in their Specification properties, i.e., whether they give rise to underspecified meanings (US-predicates) or to specified (distributive or collective) ones (S-predicates). I will further point out that this distinction tracks the distinction between Surprisingly Homogeneous and Standardly Homogeneous predicates. In §3 I present my proposal which adopts a cover-based view of the difference between underspecified and specified meanings (Schwarzschild 1994; Heim 1994) and which allows the difference between US- and S-predicates to be characterized in terms of association with different cover-types; I then show that the different Homogeneity properties of US- and S-predicates fall out when we combine this characterization with a modest modification of the prominent view which ties Homogeneity to pluralization. Extensions of the proposal to Homogeneity with two-place predicates and to Upward Homogeneity are provided in §4, and §5 summarizes and discusses some remaining issues. Appendix A compares the proposal with previous accounts of Homogeneity, and specifically focuses on whether they can be modified to capture the connection between Homogeneity and Specification.

2 Connecting the old question and the new question

Schwarzschild (1994); Heim (1994) argued that we need both specified and underspecified meanings. My goal in this section is twofold: (i) Providing more arguments for this claim, and further claiming that some predicates only give rise to underspecified meanings and others only to specified ones (I will call these two kinds of predicates US- and S-predicates, respectively); and (ii) putting forward the following novel claim about the connection between the Homogeneity and Specification properties of predicates:

(8) **The Homogeneity-Specification correlation**:

a. Standardly Homogeneous predicates are S-predicates.

b. Surprisingly Homogeneous predicates are US-predicates.

To establish this correlation I will use three tests that distinguish between specification and underspecification and apply them to predicates from the two categories in (4): based on embedding under negation (§2.1), on possible objections to utterances (§2.2), and on embedding in the scope of a universal quantifier (§2.3). To facilitate the discussion, I will intentionally use for these tests predicates which can be verified by both distributive and collective situations, such as *lift the piano*, *be heavy*, and *be light enough to carry*.[6] As a

6 Once the inability of predicates like *gather* and *be numerous* to be true of atomic individuals is taken into account, the tests can be applied to them by considering 'intermediate situations' instead of distributive ones, i.e., distribution to appropriately large pluralities. This however requires making intermediate readings available, for example by mentioning the relevant pluralities (see §2.4 and fn. 9). For instance, applying the negation test in §2.1: *the girls and the boys aren't numerous* has an intermediate reading which is true if neither the boys nor the girls are numerous but together they are. But *the girls and the boys didn't gather* is false if they did together.

baseline I will use the typical examples in (9) to distinguish between cases of specification and underspecification: while both sentences can be made true by at least two different situations—if Mary went to the financial institution or to the river bank in (9a) and if she has a sister or a brother in (9b)—for (9a) this results from two specified meanings (i.e., due to *bank* being ambiguous) while for (9b) it results from one meaning which is true in both situations.

(9) a. Mary went to the bank. A typical case of specification
b. Mary has a sibling. A typical case of underspecification

In §2.4 I will further argue for the correlation in (8) based on cumulative inferences with different predicates.

2.1 Test #1: Negation

One way to distinguish cases of specification from cases of underspecification is by adding negation. Negating a sentence with two specified meanings such as (9a) does not exclude both possible situations: on a financial institution-understanding of (10a) there is no implication as to whether Mary went to the river bank. In contrast, negating an underspecified sentence such as (9b) excludes every situation which verifies (9b): it has no reading compatible with Mary having a brother, for example.

(10) a. Mary didn't go to the bank.
b. Mary doesn't have a sibling.

With Standardly Homogeneous predicates like *be heavy* and *be light enough to carry*, adding negation doesn't exclude both distributive and collective scenarios: for example, (11a) has a distributive understanding which can be true even if the bottles taken together are heavy.

(11) a. The bottles aren't heavy (but taken together they are).
b. The bottles aren't light enough to carry (but individually they are).

With Surprisingly Homogeneous predicates such as *lift the piano*, adding negation excludes both distributive and collective scenarios: (12) is simply false if the kids lifted the piano, no matter whether this was done individually or together (this is a replication of an argument for underspecification made by Schwarzschild 1994: ex. 72 using the predicate *win the lottery*).[7]

7 As will be discussed in appendix A, this issue does not entirely disappear even on accounts geared towards explaining Homogeneity with non-distributive predicates: for both Križ (2015) and Križ & Spector (2017) a distributibity operator ^{D} is available and distributive readings are predicted on which (12) is at best neither-true nor-false if the kids only lifted the piano together. Since we won't assume the existence of ^{D} we won't face this problem.

(12) The kids didn't lift the piano (# but they did together/individually).

2.2 Test #2: Objections

Another way to distinguish specification from underspecification is by using objections:

(13) a. [Context: B thinks that Mary went to the river bank but not to the financial institution.]
   A: Mary went to the bank.
   B: What? That's not true! (Oh, you mean the river bank.)
  b. [Context: B thinks that Mary has a brother but not a sister.]
   A: Mary has a sibling.
   B: #What? That's not true! (Oh, you mean she has a brother.)

With Standardly Homogeneous predicates such as *be light enough to carry* and *be heavy*, one can object to an utterance based on a collective understanding, (14), or based on a distributive one, (15):

(14) [Context: B thinks that each of these 6 bottles is light enough to carry but taken together they are heavy.]
  A: These 6 bottles are light enough to carry.
  B: What? That's not true! (Oh, you mean individually.)

(15) [Same context as in (14).]
  A: These 6 bottles are heavy.
  B: What? That's not true! (Oh, you mean together.)

With Surprisingly Homogeneous predicates such as *lift the piano*, one can't object to an utterance based on a putative collective understanding, (16), or based on a putative distributive one, (17):

(16) [Context: B thinks that each of the kids lifted the piano, and they didn't do it together.]
  A: The kids lifted the piano.
  B: #What? That's not true! (Oh, you mean individually.)

(17) [Context: B thinks that the kids lifted the piano together, but not individually.]
  A: The kids lifted the piano.
  B: #What? That's not true! (Oh, you mean together.)

The distributive/collective distinction then looks like a case of specification with the Standardly Homogeneous predicates *be light enough to carry* and *be heavy*, but as a case of underspecification with the Surprisingly Homogeneous predicate *lift the piano*.

2.3 Test #3: Universal quantification

Finally, we can utilize embedding in the scope of universal quantification to distinguish between cases of specification and underspecification: it's difficult to conceive of (18a) as true in the context described, presumably since the meaning of *bank* cannot vary with different assignments. In contrast, (18b) is simply true in the given context.

(18) a. [Context: Mary went to the river bank and John to the financial institution.]
#Both Mary and John went to the bank.
b. [Context: Mary has a brother and John has a sister.]
Both Mary and John have a sibling.

With Standardly Homogeneous predicates such as *cost 6 dollars*, we get an odd sentence when we quantify universally in a context where the truth of the sentence depends on different resolutions of the distributive/collective distinction with different assignments:[8]

(19) [Context: Last week at the store there were 3 toys which cost 6 dollars each. Yesterday they were sold together for 6 dollars.]
#On both occasions the toys cost 6 dollars.

With Surprisingly Homogeneous predicates there is no similar problem, thus an underspecified meaning seems to be what we have when embedding under universal quantification:

(20) [Context: Last week each of the kids at my kid's school lifted the piano alone, yesterday they did it together.]
On both occasions the kids lifted the piano.

2.4 Evidence from cumulative inferences

Since we focused on distributive and collective scenarios (with the exception of fn. 6), our arguments up to now do not fully justify an underspecified meaning for Surprisingly Homogeneous predicates such as the one in (7), and are rather compatible with a stronger reading which is the disjunction of the distributive and collective meanings. To justify underspecified meanings we have to consider other situations in which such meanings are made true; these are the so-called 'intermediate' situations, 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.

Heim's (1994) original motivation for deriving both specified and underspecified meanings comes from a difference in the behavior of different predicates in such situations: she points out that an intermediate situation seems enough to make the predicate true of the

8 Of course, this oddity relies on interpreting *6 dollars* as *exactly 6 dollars*. Under an *at least 6 dollars* interpretation (19) has a true reading in the given context.

plurality predicated over with *lift the piano* but not with *weigh 250 lbs*. This contrast receives a simple explanation if we assume that *lift the piano* gives rise to an underspecified meaning while *weigh 250 lbs* only gives rise to specified ones: underspecified meanings are made true by intermediate situations, but distributive and collective meanings are not.[9]

To put the issue in slightly different terms, we can ask whether cumulative inferences hold. Suppose there are two arbitrary groups we refer to as A and B, such that they both satisfy the predicate and the sum of their denotation is all the kids (i.e., $[\![A]\!] \sqcup [\![B]\!] = [\![\text{the kids}]\!]$). Does it follow that the kids satisfy the predicate? Given an underspecified meaning the answer should be yes; given a distributive or collective one the answer should be not necessarily. We can show now that for Surprisingly Homogeneous predicates this reasoning seems valid, as in (21), supporting the claim that they give rise to underspecified meanings. For Standardly Homogeneous predicates on the other hand it doesn't necessarily seem valid,[10] as in (22), supporting the claim that they give rise to specified ones.[11]

(21) a. A lifted the piano/gathered/performed Hamlet/won the lottery
  b. B lifted the piano/gathered/performed Hamlet/won the lottery
  c. $\therefore$ The kids lifted the piano/gathered/performed Hamlet/won the lottery

(22) a. A weigh 250 lbs/are few in number/agree
  b. B weigh 250 lbs/are few in number/agree
  c. $\not\therefore$ The kids weigh 250 lbs/are few in number/agree

2.5 Towards a proposal: Degrees of Homogeneity

I have argued based on 3 tests for distinguishing between cases of specification and underspecification and based on the (in)validity of cumulative inferences that Surprisingly Homogeneous predicates give rise to underspecified meanings, i.e., they are US-predicates; and that Standardly Homogeneous ones give rise to specified meanings, i.e., they are S-predicates. The correlation between Specification and Homogeneity properties of predicates calls for a principled explanation, and presents itself as a desideratum for any theory of Homogeneity. Before presenting my proposal which aims to capture this correlation, let me first provide a more detailed description of the facts which will take us a step closer to understanding why such a correlation might transpire. First, US-predicates have one meaning on both positive and negative sentences, an underspecified one. The meaning of the negative sentences excludes that any part of the plurality satisfies the predicate. As a result, if half of the kids lifted the piano and the other half did nothing, both (23a) and

9 As has been discussed extensively in the literature, 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, as well as fn. 6). The point here is essentially that with *lift the piano* no special context is needed for making the sentence true in intermediate situations.

10 Of course, predicates like *be numerous* and *be heavy* validate cumulative inferences by virtue of their meaning, and are hence ignored here.

11 See Schwarzschild (1996: pp. 11–13) for data showing that predicates differ in validating cumulative inferences.

(23b) will end up as not true. This explains the judgments in (3).

(23) **Underspecification** (**Surprising Homogeneity**):

a. The kids lifted the piano.
≈ 'Every kid participated in a lifting of the piano by a plurality of kids'.

b. The kids didn't lift the piano.
≈ 'No plurality of kids lifted the piano'.

Second, S-predicates have two meanings—distributive and collective—on both positive and negative sentences. On distributive meanings, negative sentences excludes that any atomic part of the plurality satisfies the predicate. On collective meanings they exclude that the plurality satisfies the predicate. Note that (24b-ii) is compatible with half the bottles being light, explaining the judgments in (2).

(24) **Specification** (**Standard Homogeneity**):

a. Distributive meanings:
   (i) The bottles are heavy.
   ≈ 'Every individual bottle is heavy'.
   (ii) The bottles aren't heavy.
   ≈ 'No individual bottle is heavy'.

b. Collective meanings:
   (i) The bottles are light enough to carry.
   ≈ 'The plurality consisting of all the bottles together is light enough to carry'.
   (ii) The bottles aren't light enough to carry.
   ≈ 'The plurality consisting of all the bottles together isn't light enough to carry'.

Departing from our previous distinction between Surprisingly and Standardly Homogeneous predicates, we can characterize a different pattern of Homogeneity for each meaning type, based on the following question: Which parts of the plurality predicated over matter for Homogeneity, i.e., can give rise to a situation where both positive and negative sentences aren't true? In the case of underspecified meanings, we get Homogeneity with respect to every proper part: Every group of kids which doesn't consist of all of them is such that if only that group lifted the piano, both (23a) and (23b) would end up not true. For distributive meanings, we get Homogeneity with respect to every atomic part: every bottle is such that if it's the only heavy bottle both (24a-i) and (24a-ii) would end up not true. For collective meanings, we get no Homogeneity at all: the truth conditions of (24b-i) and (24b-ii) are complementary.

(25) a. **Underspecified** meanings give rise to Homogeneity with respect to **every**

proper part.

b. **Distributive** meanings give rise to Homogeneity with respect to **every atomic part**.

c. **Collective** meanings give rise to **no Homogeneity at all**.

What's needed now is a theory which (i) leaves room for all three meaning-types, (ii) can make sense of the distinction between US- and S-predicates, and (iii) can account for the connection between meaning-types and Homogeneity patterns. In the next section I will spell out a view of the three meaning-types following Schwarzschild (1994); Heim (1994) and connect it to our distinction between US- and S-predicates. I will then provide a novel view of Homogeneity which modifies the view according to which Homogeneity is tied to pluralization, and show that combining these two components predicts the description in (25), hence accounts for the Homogeneity-Specification correlation.

3 Proposal

3.1 Different types of covers

I will assume a unified underlying meaning for plural predication; the crucial ingredient which will allow deriving different meaning-types is making that underlying meaning dependent on 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. Since covers will play a central role in the theory, let me first discuss them. Intuitively, we can think of a cover in terms of what parts of the plurality are 'important' in a context. Formally:

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

We will consider three cover-types: a power cover, and two minimal covers—minimal-singleton and minimal-atomic (see figure 1 for illustration).[12,13]

(27) 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 $x]$

12 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 $\star$ 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.

13 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. 6 and 9.

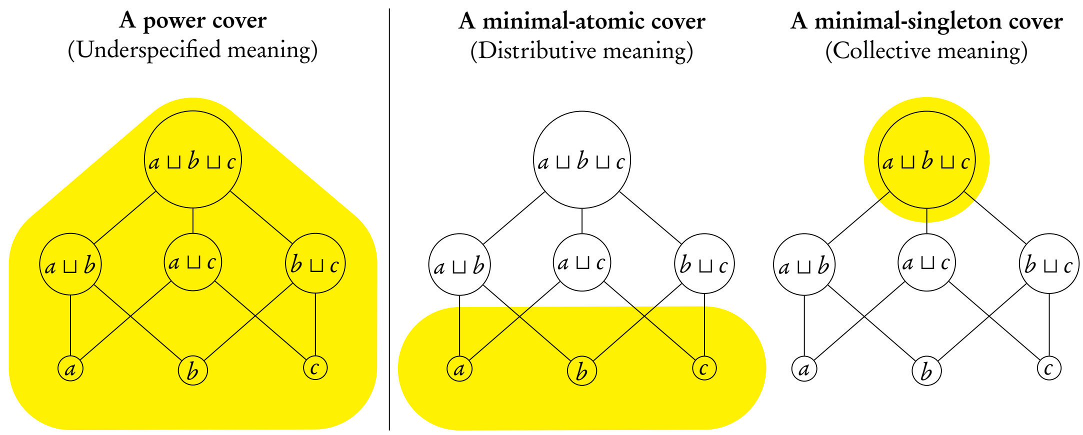

Figure 1 Three types of covers of the plurality $a \sqcup b \sqcup c$ and the meanings they will correspond to. The members of the cover are the highlighted pluralities.

(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 $x \in P$

Before getting into the specifics, let me explain how the theory is going to unfold. I will first characterize the context-dependent *truth* conditions of plural predication given which these three cover-types will yield the three meaning-types we are after (underspecified, distributive, and collective, respectively). I will then characterize the context-dependent *falsity* conditions of plural predication given which the three cover-types will yield the three patterns of Homogeneity we observed (wrt every proper part, wrt every atomic part, and none at all). The distinction between US- and S-predicates will translate into the distinction between power covers and minimal covers, and as a result we will predict the Homogeneity-Specification correlation. Table 1 summarizes the relations between predicate-types, cover-types, meaning-types and Homogeneity patterns which will fall out from the theory.

	US-predicates (e.g., *lift the piano*)	S-predicates (e.g., *be heavy*, *be light enough to carry*)	
Cover-type	Power	Minimal-atomic	Minimal-singleton
	↓	↓	↓
Meaning-type	Underspecified	Distributive	Collective
Homogeneity	wrt every proper part	wrt every atomic part	none

Table 1 Architecture of the theory.

3.2 US- vs. S-predicates as association with power covers vs. minimal covers

Keeping with our paraphrase of the underspecified meaning as 'distribution of participation' from (7), I characterize the unified truth conditions I assume for plural predication as in (28), where ${}^{\star}P$ is the result of pluralizing the predicate P. The choice of the $\star$ symbol is not accidental: (28) approximates the workings of pluralizing P using Link's (1983) $\star$ operator when it's relativized to a cover, following Schwarzschild (1994); Heim (1994) (which I will refer to as the SH system). For expository reasons I will keep using the informal characterization relying on the intuition of 'distribution of participation', and postpone a formal definition of $\star$ to §3.5.[14]

(28) ${}^{\star}P$ is true of x given a cover of x *iff*
every atomic part of x is part of a cover-part of x which satisfies P.
(where y is a cover-part of x *iff* y is a part of x and y is in the cover)

Given (28), the three cover-types correspond to the three meaning-types we are after. First, a **power cover** yields an **underspecified** meaning. Let me illustrate this by showing that it yields truth in both distributive and collective situations (though recall from §2.4 that it would yield truth in other situations as well). Suppose P holds of all the atomic parts of x (a distributive situation); since every atomic part of x is in the cover and every atomic part of x is obviously a part of itself, the truth conditions are satisfied. Suppose now P holds of x (a collective situation); since x is in the cover and every atomic part of x is obviously a part of x, the truth conditions are satisfied. Second, a **minimal-atomic cover** yields a **distributive** meaning. This is since for any atomic part of x, the only way it could be part of a cover-part of x which satisfies P (given that the cover only contains atomic pluralities) is if it satisfies P itself. Third, a **minimal-singleton** cover yields a **collective** meaning. This is since for any atomic part of x, the only way it could be part of a cover-part of x which satisfies P (given that the only cover-part of x is x) is if x satisfies P.

(29) a. **Underspecification**: ${}^{\star}P$ is true of x given a **power cover** of x *iff*
every atomic part of x is part of some part of x which satisfies P.

b. **Specification**:

(i) **Distributive**: ${}^{\star}P$ is true of x given a **minimal-atomic cover** of x *iff*
every atomic part of x satisfies P.

(ii) **Collective**: ${}^{\star}P$ is true of x given a **minimal-singleton cover** of x *iff*

14 The characterization in (28) is not entirely faithful to the way $\star$ works in the SH system and the system in §3.5, but it yields the same result for any x which has atomic parts the sum of which is x. Since this is a reasonable assumption for all the cases we discuss, (28) suffices for our discussion. A more adequate characterization 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 given a cover of x *iff* every part of x overlaps with a cover-part of x which satisfies P.

x satisfies P.

Given this characterization of covers as the source of meaning-types, our distinction between US- and S-predicates boils down to the distinction between power and minimal covers. To capture it I then stipulate an association between predicates and cover-types:

(30) **Association between predicates and cover-types**:

  a. **US-predicates** associate with **power** covers.
  b. **S-predicates** associate with **minimal** covers.

Of course, one would like to have a better understanding of why certain covers are systematically used when pluralizing certain types of predicates. For if covers are contextually supplied, how come the choice of predicate determines the type of cover? I leave this as an open question. It suffices for now that we have an adequate descriptive theory; an answer to the 'why' question is not crucial for our argumentation, and I defer its discussion to §5.1.

3.3 Homogeneity: An old approach in new clothing

Recall our description of the facts from (25), according to which the three patterns of Homogeneity result from the three meaning-types. Since we now view these three meaning-types as resulting from choosing three different covers, the facts will be explained if the Homogeneity pattern could be determined solely by the choice of cover:

(31) a. **Power covers** lead to Homogeneity with respect to **every proper part**.
  b. **Minimal-atomic covers** lead to Homogeneity with respect to **every atomic part**.
  c. **Minimal-singleton covers** lead to **no Homogeneity at all**.

Let me now show that achieving this is within reach. The standard view of Homogeneity as it's implemented in Gajewski (2005) relies on the idea that a distributivity operator ^{D} presupposes that the atomic parts of the plurality predicated over are homogeneous with respect to the predicate. We can characterize this idea as follows:

(32) a. ^DP is **true** of x *iff* **every** atomic part of x satisfies P.
  b. ^DP is **false** of x *iff* **no** atomic part of x satisfies P.

In order to capture (31), I propose a modest modification of this view according to which plural predication presupposes that the atomic parts of the plurality predicated over are homogeneous with respect to the property of *being a part of a cover-part of the plurality predicated over which satisfies the predicate*. Put differently, we rely on the general recipe for deriving Homogeneity based on (32), i.e., replacing *true* with *false* on the left hand-side and *every* with *no* on the right hand-side, together with the idea that $\star$ is responsible for Homogeneity from Schwarzschild (1994) and our characterization of ⋆ as 'distributing participation' in (28). This yields the characterization of the falsity conditions of plural predication in (33b).

(33) a. $^\star P$ is **true** of x given a cover of x *iff* [=(28)]
every atomic part of x is part of a cover-part of x which satisfies P.
b. $^\star P$ is **false** of x given a cover of x *iff*
no atomic part of x is part of a cover-part of x which satisfies P.

(33b) can be stated more simply as follows:[15]

(34) $^\star P$ is **false** of x given a cover of x *iff* **no** cover-part of x satisfies P.

3.4 Putting the pieces together: predicting the Homogeneity-Specification correlation

Let us now see that the characterizations of the truth and falsity conditions in (28) and (34) yield the desired result and predict the descriptions of the facts in (25) and (31). First, **power covers** lead to **underspecified** meanings and to Homogeneity with respect to **every proper part**. Since *lift the piano* is a US-predicate it associates with a power cover by assumption. As we have seen, a power cover gives rise to underspecified truth conditions, hence the truth conditions of *the kids lifted the piano* will be underspecified. To satisfy its falsity conditions, and the truth conditions of *the kids didn't lift the piano*, we must find no plurality of kids in the cover which lifted the piano. Since every plurality of kids is within a power cover of *the kids*, it follows that no plurality of kids lifted the piano. This result matches our description in (23), and yields Homogeneity with respect to every proper part: every plurality of kids which doesn't consist of all of them will lead to both sentences not being true, if that plurality lifted the piano and no other plurality did. More generally:

(35) a. $^\star P$ is true of x given a power cover of x *iff*
every atomic part of x is part of some part of x which satisfies P.
b. $^\star P$ is false of x given a power cover of x *iff* **no part of** x satisfies P.

Second, **minimal-atomic covers** lead to **distributive** meanings and to Homogeneity with respect to **every atomic part**. Let's take for example *be heavy* which is an S-predicate and hence associates with minimal covers, again by assumption. As we have seen, a minimal-atomic cover gives rise to distributive truth conditions, hence the truth conditions of *the bottles are heavy* will be distributive when a minimal-atomic cover is contextually supplied. To satisfy its falsity conditions, and the truth conditions of *the bottles aren't heavy* given such a cover, we must find no plurality of bottles in the cover which is heavy. Since the

15 Note that (33b) and (34) are only equivalent if x is a sum of atomic parts of x. See fn. 14.

only pluralities of bottles within a minimal-atomic cover of *the bottles* are the atomic ones, it follows that no bottle is heavy. This result matches our description in (24a), and yields Homogeneity with respect to every atomic part: every bottle will lead to both sentences not being true if that bottle is heavy and no other bottle is; but the weight of bigger pluralities is immaterial for determining the truth and falsity of both sentences. More generally:

(36) a. $^{\star}P$ is true of x given a minimal-atomic cover of x *iff* **every atomic part** of x satisfies P.
b. $^{\star}P$ is false of x given a minimal-atomic cover of x *iff* **no atomic part** of x satisfies P.

Finally, **minimal-singleton covers** lead to **collective** meanings and to **no Homogeneity at all**. Let's take for example *be light enough to carry* which is an S-predicate and hence associates with minimal covers, again by assumption. As we have seen, a minimal-singleton cover gives rise to collective truth conditions, hence the truth conditions of *the bottles are light enough to carry* will be collective when a minimal-singleton cover is contextually supplied. To satisfy its falsity conditions, and the truth conditions of *the bottles aren't light enough to carry* given such a cover, we must find no plurality of bottles in the cover which is light enough to carry. Since within a minimal-singleton cover of *the bottles* the only plurality of bottles in the cover is the plurality consisting of all the bottles together, it follows that that plurality is light enough to carry. This result matches our description in (24b), and yields no Homogeneity at all: either that plurality is light enough to carry, in which case the positive sentence is true, or it's not, in which case the negative sentence is true; under no circumstances are both sentences not true. More generally:

(37) a. $^{\star}P$ is true of x given a minimal-singleton cover of x *iff* x **satisfies** P.
b. $^{\star}P$ is false of x given a minimal-singleton cover of x *iff* x **doesn't satisfy** P.

3.5 Formal implementation and discussion

We can now take the characterization of the truth and falsity conditions of plural predication from (28) and (34) and give a theory that delivers them. Since one of my goals here is to claim that Surprising Homogeneity does not warrant a departure from the standard view of Homogeneity as tied to pluralization, I will present an implementation which minimally modifies the familiar and relatively simple view according to which Homogeneity follows from a presupposition the pluralization operator gives rise to. This is not to say that there aren't orthogonal issues with such a view, for instance the fact that Homogeneity projects differently from standard presuppositions (Spector 2013; Križ & Spector 2017)[16] or the existence of asymmetries between positive and negative sentences (Bar-Lev 2018: §3). Rather

16 Note that this is only an issue if Homogeneity is taken to be a presupposition, but it doesn't rule out utilizing a trivalent semantics to capture it (see Križ 2015).

than providing a full theory of Homogeneity which takes into account all these issues, my goal here is more modest: I would like to show that a minor modification of the standard theory has several benefits. Some other accounts can be amended to deliver (28) and (34): In appendix A I will sketch an implementation within a view due to Krifka (1996); Križ & Spector (2017) which relies on filtering multiple (bivalent) readings, and Bar-Lev (2018: §5) proposes an implementation within an implicature-based view of Homogeneity.

I first define a trivalent semantics for $\star$ as in (38).[17] The crucial part of this definition is replacing '=' in the truth conditions with '$\sqsubseteq$' in the falsity conditions.[18]

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

I further assume following Schwarzschild (1994) that plural predication obligatorily involves an application of $\star$, or as Kratzer (2007) puts it, "sister constituents of plural DPs are pluralized".[19] Following Heim (1994); Beck (2001), I 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.[20] Plural predication hence takes the schematic shape and meaning in (39). The truth and falsity conditions in (39b) capture

17 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 (but less elegantly) defined as in (i). If one wishes to admit a bottom element (see Landman 2011; Bylinina & Nouwen 2018 for reasons to do so), the two definitions are no longer equivalent; specifically, the falsity conditions in (38) 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) $\ldots 0 \; \textit{iff} \; \neg\exists x' \in \{x' : P(x') \neq 0\}[x' \sqsubseteq x]$

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

19 This assumption is not shared with Heim (1994) who allows for $\star$-less LFs. It is however motivated by our arguments (following Schwarzschild, see (12)) that US-predicates do not give rise to purely collective meanings.

20 Our claim about association between a predicate and a minimal/power cover in (30) is then to be understood as an association between a predicate and a minimal/power cover of $\bigsqcup D$ rather than a minimal/power cover of the subject of predication. This difference doesn't matter for most of our purposes, but becomes crucial in our analysis of Upward Homogeneity in §4.2. 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 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 (39) would only lead to strengthening it; this is since the output will necessarily be 0 if Cov^c in (39) doesn't cover [\![DP]\!]. The only weakening effect of ill-fitting covers would be achieved in Downward Entailing contexts.

the characterizations in (28) and (34),[21] and thus (based on what we've seen in §3.4) predict the Homogeneity-Specification correlation given the association between predicates and cover-types in (30).

(39) a. LF: [DP [$\star$ [*Cov* VP]]]

b. $$[\![(39a)]\!]^c = \begin{cases} 1 & \textit{iff} \ \ \exists P' \subseteq \{x' : [\![\text{VP}]\!](x') = 1 \wedge Cov^c(x') = 1\}[\bigsqcup P' = [\![\text{DP}]\!]] \\ 0 & \textit{iff} \neg\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') \neq 0 \wedge Cov^c(x') \neq 0\}[\bigsqcup P' \sqsubseteq [\![\text{DP}]\!]] \\ \# & \text{otherwise} \end{cases}$$

The novelty of this proposal for Homogeneity is relatively minor: in a sense all we did is 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). The view proposed here however differs from both accounts by explaining the Surprisingly Homogeneous behavior of predicates like *lift the piano*. Since Gajewski relies on the distributivity operator ^{D} as the source of Homogeneity he cannot explain such facts; and while Schwarzschild's implementation relies on $\star$, it still fails to account for it (see §A.1 for details).

A crucial aspect of the theory is adhering to (a modification of) the standard view which ties Homogeneity to pluralization. The ability of such a view to account for the Homogeneity-Specification correlation undermines arguments made by Križ (2015) and Križ & Spector (2017) in favor of untying Homogeneity from pluralization operations base on Surprisingly Homogeneous predicates. Far from consisting an argument for departure from the standard view of Homogeneity, the behavior of such predicates turns out to support a modest modification of it. As I discuss in appendix A, however, the alternative accounts proposed by these authors differ in whether they can be modified to capture the Homogeneity-Specification correlation.

Finally, the current work provides further support for the SH cover-based view of pluralization with $\star$. This theory, initially developed for entirely different reasons, has proven adequate when plugged into the relatively simple view of Homogeneity proposed here. Before I move on to summarize the paper and discuss some remaining issues in §5, I will first focus in §4 on two extensions of the theory designed to deal with Homogeneity with two-place predicates and with the phenomenon of Upward Homogeneity.

4 Extensions

4.1 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

21 Recall however that the two formulations aren't exactly the same (see fn. 14). This is irrelevant for our purposes.

Homogeneity (see appendix A, Gajewski 2005: pp. 142–149, and Križ 2015: pp. 58–61).

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

In the current view, however, two-place predicates are nothing exceptional. Defining a two-place counterpart of * as defined in (38) following common practice (see, e.g., Krifka 1986; Sternefeld 1998; Kratzer 2007), we get the following definition of **:[22]

(41) $$[\![^{\star\star}]\!](P)(x)(y) = \begin{cases} 1 & \textit{iff}\ \ \exists P' \subseteq \{\langle x', y'\rangle : P(x')(y') = 1\}[\bigsqcup P' = \langle x, y\rangle] \\ 0 & \textit{iff}\ \neg\exists P' \subseteq \{\langle x', y'\rangle : P(x')(y') \neq 0\}[\bigsqcup P' \sqsubseteq \langle x, y\rangle] \\ \# & \text{otherwise} \end{cases}$$

In line with our assumptions for *, the sister of ** 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. Relying on the assumption in fn. 22, a pair-cover is a special case of a cover where what's covered is a pair. Like one-place predicates, two-place US-predicates associate with power (pair-)covers and two-place S-predicates associate with minimal (pair-)covers. We then get for (40a) the following LF:[23]

(42) [the girls] [[** [*Cov* danced with]] [the boys]]

Based on the judgements in (40b), I take *dance (with)* to be an instance of a two-place US-predicate (another example of a two-place US-predicate is *attack*), which means that I assume *Cov* in (42) is assigned a power pair-cover of $\langle\bigsqcup D, \bigsqcup D\rangle$. Given this and our definition of **, (42) will end up true as long as we can find dancing pairs the sum of which is ⟨⟦the girls⟧, ⟦the boys⟧⟩. It will end up false (and its negation as in (40b) will be true) as long as we can find no dancing pairs which are part of ⟨⟦the girls⟧, ⟦the boys⟧⟩; that is to say, as long as no girl danced with any boy. The judgments in (40) are then predicted.

22 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* $a \sqsubseteq c \wedge b \sqsubseteq d$

23 Applying ** to *danced with* is obligatory since it's a sister of *the boys*. Our assumptions require another * to apply to the sister of *the 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 boys] * [*Cov* $\lambda 1$ [the girls] [* [*Cov* danced with t_1]]]

Interestingly (and under the assumption that all cover variables in (42) and (i) are assigned power covers), while the truth conditions of (42) and (i) aren't necessarily the same (depending on one's assumptions regarding lexical cumulativity, see Kratzer 2007), their falsity conditions are identical.

As for two-place S-predicates, one may consider predicates like *outnumber* and *outweigh* which are Standardly 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). This is expected assuming they associate with minimal covers: if *Cov* in (43) is assigned a minimal pair-cover of $\langle \bigsqcup D, \bigsqcup D \rangle$ which is a minimal-singleton pair-cover of $\langle [\![\text{the kids}]\!], [\![\text{the adults}]\!] \rangle$, we'll get truth if the plurality consisting of all kids outnumbers the plurality consisting of all adults and falsity otherwise.

(43) [the kids] [[$\star\star$ [*Cov* outnumber]] [the adults]]

4.2 Upward Homogeneity and a problem of scope

On top of the Surprisingly Homogeneous behavior of predicates like *lift the piano*, 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 plurality predicated over satisfies the predicate, but some of these pluralities are part of some plurality which does.[24] For instance, if the kids together with some or all of the adults lifted the piano, both *the kids lifted the piano* 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 kids lifted the piano* stronger, so that they require no kid to participate in any piano-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 is only a property of US-predicates, while S-predicates show no Upward Homogeneity: *the bottles don't cost 6 dollars* is true if overall they cost 3 dollars but you can buy them together with something else for 6 dollars.

Let me now suggest a way to modify our definition of $\star$ in order to capture Upward Homogeneity. The idea is to make the falsity conditions of $\star$ even stronger than in (38), 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.[25] We modify then the falsity conditions of $\star$ as in (44):

(44) $[\![\star]\!](P)(x) = 0$ *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*:

(45) a. LF: [DP [$\star$ [*Cov* VP]]]
b. $[\![(45a)]\!]^c = 0$ *iff* $\neg\exists P' \subseteq \{x' : [\![\text{VP}]\!](x') \neq 0 \wedge Cov^c(x') \neq 0\}[\bigsqcup P' \circ [\![\text{DP}]\!]]$

Now *the kids lifted the piano* will no longer be false if some of the kids lifted the piano

24 My use of 'Upward Homogeneity' slightly differs from Križ's and covers what he calls Sideways Homogeneity.
25 This move is greatly inspired by Križ's (2015) account of Upward Homogeneity.

together with some adults, since there is a piano-lifting plurality which overlaps the subject of predication ($[\![$the kids$]\!]$), and is crucially within the cover since it is a power cover of $\bigsqcup D$ (given that *lift the piano* is a US-predicate associating with power covers, see fn. 20). So both *the kids lifted the piano* 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 piano-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 with S-predicates which do not associate with power covers but rather with minimal ones. 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 §3.5 and fn. 20). 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 $\star$ in (46) for *DP VP*, which are the same as in (39).[26] In other words, with minimal covers it doesn't matter whether we assume the overlap-based falsity conditions in (44) or rely on the parthood-based falsity conditions of $\star$ in (38); so Upward Homogeneity doesn't arise when minimal covers are used (i.e., with S-predicates) in the same way that it didn't arise with our previous definition in (38).

(46) If Cov^c minimally covers $\bigsqcup D$, and covers both $[\![\text{DP}]\!]$ and $\overline{[\![\text{DP}]\!]}$, then:
$[\![(45a)]\!]^c = 0$ *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 kids didn't lift the piano*. The LF in (47) would be predicted to be derivable by our previous system in (38), but its meaning is extremely weak:[27] it will end up true as long as we can find pluralities that didn't lift the piano the sum of which is $[\![$the kids$]\!]$. Note that this is compatible with there being pluralities of kids that did lift the piano the sum of which is $[\![$the kids$]\!]$!

26 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.

27 Assuming *Cov* is assigned a power cover of $\bigsqcup D$. Note that the problem doesn't arise for S-predicates, i.e., assuming minimal covers. If both instances of *Cov* in (i) are assigned the same minimal cover, the LFs in (i) have equivalent meanings.

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

(47) [The kids] $\star$ [*Cov* $\lambda 1$ [NEG t_1 lifted the piano]]

One could try to solve the problem by requiring $\star$ to apply also to *lifted the piano* as in (48): since the variable t_1 ranges over pluralities, it would make sense to pluralize its sister.[28]

(48) [The kids] $\star$ [*Cov* $\lambda 1$ [NEG t_1 $\star$ [*Cov* [lifted the piano]]]]

This alone will however not be enough: given our semantics for $\star$ in (38), (48) will end up true as long as no individual kid lifted the piano, even if other pluralities of kids did.[29] But given our modification in (44), the truth conditions of (48) turn out to be stronger: *NEG* t_1 $\star$*[Cov lifted the piano]* will yield truth only if the value assigned to t_1 overlaps with no plurality that lifted the piano. 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 piano. This can only be true if no plurality of kids participated in any piano-lifting. Moving *the kids* then turns out to have no effect on the interpretation.

5 Summary and outlook

I argued following Schwarzschild (1994); Heim (1994) that both specified and underspecified meanings should be derivable. I presented a novel categorization of predicates according to their specification properties, and a way to describe it within the SH system by associating predicates with cover-types. I further argued that the Specification properties of predicates correlate with their Homogeneity properties and put this correlation forward as a desideratum for theories of Homogeneity. I proposed a modification of the standard view according to which Homogeneity is the result of a trivalent semantics of pluralization, and claimed that together with the association between predicates and cover-types it predicts the correlation between Specification and Homogeneity. In the next sections I discuss some remaining issues, and in appendix A I provide a comparison with some previous accounts.

5.1 What governs the choice of covers?

In §3 I stipulated the association between cover-types and meaning-types in (30). I would like to briefly discuss now the question mentioned there about the possible reasons behind it. There are two options which come to mind. First, the lexical semantics of predicates can constrain the possible assignments of the cover variable which modifies them. This option raises two immediate problems: (i) The same predicate can be used to construct both US- and S- predicates: *lifted the piano* is a US-predicate, but *lifted 250 lbs* is an S-predicate; (ii) it does not seem trivial to explain how kids might learn such a meaning component.[30]

28 I assume here that both cover variables are assigned a power cover of $\bigsqcup D$.

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

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

A second option which does not face such problems is to assume, as in Schwarzschild (1994, 1996), that the context in which different predicates are uttered is the sole reason for the choice of cover.[31] A possible distinction we could rely on is the following: it is easy to conceive of an underspecified meaning of *the kids lifted the piano* as informative (e.g., as an answer to the question *who participated in lifting the piano?*), while an underspecified meaning would be in most contexts uninformative for *the bottles cost 6 dollars* (i.e., we normally do not consider questions like *what things are part of something that costs 6 dollars?*). We can then entertain the idea that by default a cover variable is assigned a power cover, and it is only in contexts where this results in an uninformative meaning that we instead use a minimal one.[32] If this is on the right track, we'd predict that contextual manipulations will affect the choice of cover-types. Let me now provide preliminary evidence that this is not an outlandish prediction.

Consider a piano-lifting competition where a contestant only gets a prize if they lift the piano alone (and otherwise they get nothing). It seems possible to report the results of the contest with *the contestants didn't lift the piano so no one got a prize* even if they managed to lift it together, as long as none of them lifted it individually (cf. the discussion of (12)). Similarly, S-predicates may also have weaker readings than usual given specific contexts. 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 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.[33] 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.

5.2 Connection to previous typologies of predicates

As a first approximation, our typology of predicates in (4) 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.[34] If the distinction made here indeed correlates with these distinctions,[35] one might hope to shed new light on the behavior of *all* 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

31 For a recent discussion of whether distributivity and collectivity are determined by contextual factors or by lexical semantics see Glass (2018).

32 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. 12).

33 As Benjamin Spector has pointed out to me, this could however be analyzed as my friend being ignorant about the identity of the (minimal) cover rather than using a power cover.

34 Putting aside distributive predicates, which weren't discussed in this paper, the two distinctions are identical.

35 Preliminary reason to suspect it doesn't comes from predicates like *be consistent* and *be compatible* which are are S-predicates but have been argued to be *gather*-type by Kuhn (2017). The same can be said of *agree*.

predicates is compatible with both distributive and collective situations, *all* with *numerous*-type predicates is only compatible with distributive situations.

(49) a. All the kids lifted the piano ✓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 Dowty's (1987). Developing a theory along these lines is left for future work.

A Appendix: Comparison with previous approaches

A main goal of this paper has been to argue for the Homogeneity-Specification correlation and put it forward as a desideratum for any theory of Homogeneity. As mentioned at the very beginning, no existing theory capture it. In this section I provide a discussion of several approaches to Homogeneity, focusing mainly on why they fail to account for the Homogeneity-Specification correlation. I will also briefly remark on a way to amend an account due to Krifka (1996) (and more recently Križ & Spector 2017) in order to capture the Homogeneity-Specification correlation.

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:

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

An application of $\star$ is obligatory by assumption, and it is defined as follows:

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

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

(52) 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 $x \in [\![P]\!]_+$, and false of it if $x \in [\![P]\!]_-$. By assumption, if both $x \in [\![P]\!]_+$ and $x \in [\![P]\!]_-$ 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 $\star$*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 piano but neither John nor Mary lifted it alone, we have the following situation:

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

When we apply $\star$, we get:

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

Since John $\sqcup$ Mary ends up in both the positive and the negative extensions of $\star$*lifted the piano*, we get a presupposition failure when we apply $\star$*lifted the piano* to John $\sqcup$ Mary. This is undesired of course, given that *John and Mary lifted the piano* is intuitively true.[36]

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

(55) 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.

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

When we apply $\star$ we get:

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

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

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

in a situation where the corresponding sentence (*John and Mary danced with Bill and Sue*) is intuitively true.[37] 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 Homogeneity-Specification correlation.

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:

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

Križ's (2015) objection to this view is that Homogeneity with non-distributive predication of the sort we see with *lift the piano* 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.[38]

A.3 Križ (2015)

Based on the Homogeneity pattern found with *lift the piano*, 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:

(59) **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.

37 One might wonder whether we can get rid of the assumptions that *lift the piano* 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.

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

While this simple constraint goes a long way in explaining Homogeneity with US-predicates like *lift the piano*, 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* a non-lexical predicate, in contrast with *gather*?), treating these predicates as non-lexical offers no perspective on the Homogeneity-Specification correlation. Furthermore, his use of a distributivity operator leads to the prediction that a sentence like *the kids didn't lift the piano* would have a reading on which it is undefined rather than false in a collective situation.

Finally, he also faces a problem with co-distributive predication which is in a sense similar to the problem discussed in §A.1 for Schwarzschild (I will present a simplified version of the problem and the solution; see Križ 2015: §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 $\langle \text{John} \sqcup \text{Mary}, \text{Bill} \sqcup \text{Sue} \rangle$ and false of $\langle \text{John}, \text{Sue} \rangle$ (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 $\langle \text{John}, \text{Bill} \rangle$ and $\langle \text{Mary}, \text{Sue} \rangle$ and false of any other pair of individuals. Then we close it under sum, resulting in a predicate which is true of $\langle \text{John} \sqcup \text{Mary}, \text{Bill} \sqcup \text{Sue} \rangle$, 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 us that contextual restriction (for which we utilized a cover) 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 ours.

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

Križ & 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 detail of their proposal), as follows:

(60) Candidate readings for *DP VP*:

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

The sentence *DP VP* is judged (super-)true if all of its candidate meanings are true (i.e., if (60a) is true), and (super-)false if all of them are false (i.e., if (60b) 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 Homogeneity with respect to every proper part. But what we have seen in fact is that a collective meaning leads to no Homogeneity at all, and that Homogeneity with respect to every proper part goes hand in hand with underspecification. So the Homogeneity-Specification correlation isn't accounted for.

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

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

We can compute the candidate readings for *DP* ^{D} *VP* based on (60):

(62) 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 kids didn't lift the piano* will have a distributive reading on which it's true in a collective situation if no kid lifted the piano alone, contrary to fact.

Unlike Križ, however, the general architecture of Krifka (1996); Križ & Spector (2017) can be reconciled with our view. Let me sketch a simplistic way to do it.[39] Suppose we have two pluralization operators: $\star^s$ (for strong star) which has the standard semantics in (63a), and another pluralization operator $\star^w$ (for weak star) which has the semantics in (63b) (compare to the truth and falsity conditions of $\star$ in (38)).

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

39 The details of the formal implementation in Križ & 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 $Cand^c_x$ 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) $Cand^c_x = \{\bigvee S : S \in \{S' : S' \text{ is a maximal subset of } Cov^c \cap \{y : y \sqsubseteq x\} \text{ s.t. } \forall y, z \in S'[y \circ z]\}\}^{\vee\wedge}$

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 ⋆ operators is obligatory, and that a cover variable heads its sister. We get two readings for *DP VP*:

(64) 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 (64a) is true), and (super-)false if both are false (i.e., if (64b) is false). This provides a different way to capture (28) and (34).

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