Subatomic homogeneity without the excluded middle presupposition: An argument from conjunction[1]

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Abstract. While discussion of homogeneity effects usually focuses on examples involving pluralities, the effect is often taken to hold within atoms as well (e.g. Löbner 2000, Spector 2013, Križ 2015). This paper brings to the literature on homogeneity an independent difference between pluralities and atoms, namely their behaviour with conjoined predicates. I show that the theory of homogeneity based on an excluded-middle presupposition produces unwanted results for conjunctions predicated of atomic subjects. I suggest that subatomic homogeneity is in fact the result of covert exhaustivity, which strengthens predicates in positive sentences.

Keywords: homogeneity, colour terms, atomicity, plurality, conjunction, exhaustivity

1. Introduction

A lively area of research discusses homogeneity (all-or-nothing) effects (see e.g. Löbner 2000, Križ 2015, Bar-Lev 2021, Križ and Spector 2021, and citations therein). Usually, this research focuses on examples like (1), involving a predicate composing with a plurality. The observation about such sentences is that the predicate is implied to hold of all atomic parts of the plurality in the positive (1a), and to hold of none of them in the negative (1b).[2]

(1)   a.   Aisha saw the children.
                 ≈ she saw all of the children
                 ≉ she saw at least some of the children
         b.   Aisha didn't see the children.
                  ≉ she didn't see all of the children
                  ≈ she saw none of the children

While most often discussed for pluralities, the homogeneity paradigm is also found with atoms; the go-to example involves colour terms (e.g., Löbner 2000, Križ 2015).

(2)   a.   The flag is green.
                 ≈ all of the flag is green
                 ≉ at least some of the flag is green
         b.   The flag isn't green.
                  ≉ not all of the flag is green
                  ≈ none of the flag is green

I will refer to the effect in (1) and (2) as 'plural' and 'subatomic' homogeneity respectively.

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[2] Pragmatic factors can weaken the effect to allow exceptions. We will return to this in section 3.4.

A classic way to derive the homogeneity effect is to postulate an 'excluded-middle presupposition' (EMP), which ensures that predication only results in the assignment of a truth-value if the predicate holds of all or no parts of its argument (Löbner 2000; cf. Schwarzschild 1994, Gajewski 2005). In this paper, I show that the EMP runs into a problem when conjoined predicates take an atom as their argument, as in (3).

(3)   The flag is green and white.

What is special about atomic subjects is that they force predicate conjunctions to be intersective. As a result, I will argue that the lexical meaning of colour terms and like predicates must be existential; that is, the lexical meaning of *green* is 'partly green,' not 'entirely green' (Harnish, 1976; Levinson, 1983).[3] This will be shown to be incompatible with the EMP.

Positing existential meaning for colour terms obtains (2b) immediately: the lexically existential meaning of *green* is negated. To deal with the strong truth conditions of (2a) as well as the conjunction in (3), I posit covert exhaustification on colour terms, based on an Exh(aust) operator (Chierchia et al., 2012). For colour predication, Exh takes alternatives generated from the set of colour terms and excludes the non-asserted predicates.

This paper is organized as follows. I begin with background on the EMP and the special case of subatomic homogeneity in section 2. Then, in section 3, I turn to conjoined predicates, showing that the EMP makes wrong predictions for sentences with atomic subjects. Finally, section 4 posits an account of subatomic homogeneity based in exhaustivity, specifically the exclusion of non-asserted summative predicates. Section 5 concludes, and an appendix briefly discusses the state of the EMP with conjoined predicates that take a plural argument.

2. Background: the EMP and subatomic homogeneity

We begin with some background on the excluded-middle presupposition, as well as subatomic homogeneity effects and the predicates with which they are observable.

2.1. The excluded-middle presupposition

To deal with homogeneity effects, Löbner (2000) introduces a 'presupposition of indivisibility' (henceforth 'excluded middle presupposition'). According to this hypothesis, predication introduces the presupposition that the predicate holds of all or no parts of its argument. This is the case regardless of whether the parts are atomic parts of pluralities or subatomic parts of atoms. The EMP results in truth-value gaps for non-homogeneous individuals or pluralities; predicates are neither true nor false of such arguments.

An influential formalization of this idea comes from Gajewski (2005); his proposal is tailor-made for plural homogeneity, but can be modified to deal with subatomic homogeneity as well (as shown below). Gajewski's proposal is that the EMP is introduced by an obligatory distributivity operator. DIST is defined in (4); (5) provides a sample LF.

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[3]This existential meaning could arise compositionally from the degree semantics of partial predicates (see Yoon 1996 and Kennedy and McNally 2010).

(4) $[\![\text{DIST}]\!] = \lambda P.\ \lambda x : \forall y[y \sqsubseteq_{\text{AT}} x \rightarrow P(y)] \vee \forall y[y \sqsubseteq_{\text{AT}} x \rightarrow \neg P(y)].\ \forall y[y \sqsubseteq_{\text{AT}} x \rightarrow P(y)].$

(5)   [The children] [DIST [sang]].

In the positive case, DIST asserts that the predicate holds of all atoms in the plurality. This is consistent with the first presuppositional disjunct.[4] Given the assertion, the only noticeable effect of the presupposition is that, if only some of the children sang, the sentence would be undefined rather than false.

(6)   The children sang.
    a.   presupposition: either all of the children sang or none of the children sang
    b.   assertion: all the children sang
    $\rightarrow$ all of the children sang

In the negative case, even if the assertion is only that not all the children sang, the presupposition projects past negation and effectively strengthens this to mean that none of them sang. The assertion is incompatible with the first presuppositional disjunct, so the only remaining possibility is for the second disjunct to hold—that is, for none of the children to have sung.

(7)   The children didn't sing.
    a.   presupposition: either all of the children sang or none of the children sang
    b.   assertion: not all the children sang
    $\rightarrow$ none of the children sang

Given the all-or-nothing presupposition, it does not matter that the assertion of DIST is universal rather than existential. Having an existential assertion would yield identical definedness and truth conditions, because DIST is only defined for predicates that hold of all or none of their plural argument's atomic parts.

2.2. Subatomic homogeneity

With atomic subjects, homogeneity effects are only observable with a subset of predicates, namely those that are true of an individual by virtue of being true of that individual's material parts. This is what Löbner (2000) calls 'summative' predicates (8a), as opposed to 'integrative' predicates (8b) which do not refer to their argument's material parts.

(8)   a. (i)   The cow is **black**.   ((i) examples from Löbner 2000)
        (ii)   The desk is **metal**.
    b. (i)   The cow is **mad**.
        (ii)   Aisha is a **professor**.

That is, a desk is metal by virtue of its material parts being metal, but Aisha is not a professor by virtue of her material parts being professors.

Summative predicates show a homogeneity effect because while they hold of all parts of their argument in the positive (8a), they hold of none of them in the negative:

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[4]I am using the term 'presupposition' to refer to the domain condition on the lambda-expression, and 'assertion' to refer to the output condition.

(9)   The cow is not black.
        ≈ the cow is not black at all

For Löbner (2000), subatomic homogeneity results from the same EMP as with pluralities. Rather than putting this presupposition in a DIST operator, I will for the time being simply put it in the lexical entries of summative predicates, as in (10).

(10) $[\![\text{green}]\!] = \lambda x : \forall y[y \sqsubseteq x \to \text{green}(y)] \vee \forall y[y \sqsubseteq x \to \neg\text{green}(y)]. \ \forall y[y \sqsubseteq x \to \text{green}(y)].$

Of course, another avenue would be to stipulate that such predicates come with an operator identical to DIST but making reference to subatomic parts rather than atomic parts; I will return to this possibility in section 4.1. The presence of the EMP in (10) in the lexical meaning is motivated by the fact that the presence of this presupposition is regulated lexically, in light of the summative–integrative distinction. Besides, the current assumption is no different from stipulating a subatomic DIST operator that necessarily takes scope immediately above the predicate; readers who would prefer a subatomic DIST operator can think of the proposal in (10) in those terms.

The lexical entry in (10) straightforwardly captures that *green* is universal in the positive:

(11)   The flag is green.
        ⤳ the flag is entirely green

In the negative (12), the assertion and presupposition combine to yield the strong meaning that the flag is not green at all:

(12)   The flag is not green.
        a.   presupposition: the flag is either all green or not green at all
        b.   assertion: the flag is not all green
        →   the flag is not green at all

Thus, as far as the basic paradigm is concerned, the EMP can in principle explain the homogeneity effect with both atoms and pluralities.

The EMP account of homogeneity has come under various types of criticism in the literature (Spector, 2013; Križ, 2015), both in terms of the core proposal that a presupposition is at work in creating the homogeneity paradigm, and in terms of Gajewski's linking of this presupposition to distributivity. On the latter point, Križ (2015) shows that homogeneity is also observable with non-distributive plural predication. For the sake of argument, I put these criticisms aside, and instead turn to a new kind of argument against the EMP, focusing specifically on subatomic homogeneity. I discuss plural homogeneity briefly in an appendix.

3. Conjoined predicates with an atomic argument: A problem for the EMP

In this section, I build a new argument against the EMP, based on the interpretation of conjoined predicates. Indeed, the EMP is incompatible with the meanings observed when conjoined predicates take an atomic subject. In particular, I show that conjoined predicates are always interpreted intersectively when their argument is atomic; the EMP would therefore incorrectly predict contradictions in many cases, due to being incompatible with the lexically

weak meanings that must be posited for summative predicates. Thus, regardless of the status of the EMP for plural homogeneity, the EMP is in fact untenable for subatomic homogeneity.

This section is organized as follows. I start by overviewing intersective and non-intersective meanings for conjunctions with plural subjects in section 3.1. Then, in section 3.2, I show that while predicate conjunctions may be interpreted non-intersectively with plural subjects, they can only be interpreted intersectively with atomic subjects. In section 3.3, I show that this leads to problems for the EMP, which would regularly create non-intuited contradictions with conjoined predicates. I therefore reject the existence of the EMP, at least for predication with atomic subjects. Finally, in section 3.4, I turn to the notion of non-maximality, asking whether it could rescue the EMP account by weakening the meaning of the conjoined predicates post-semantically; I show that this is not the case.

3.1. Intersective and non-intersective conjunction

To begin our discussion of conjunction, we first observe two different interpretations for conjoined predicates with a plural subject. We then turn to conjoined predicates with an *atomic* subject, to see why it may appear appealing to view these through the same lens as pluralities.

Descriptively, both intersective (13a) and non-intersective (13b) conjunctions of predicates are observed with plural subjects.

(13) a. The children are blonde and Swedish.   (intersective)
          ↝ they are all blonde and all Swedish
      b. The children are singing and talking.   (non-intersective)
          ↝ some are singing and others are talking

The predicates in these examples are chosen to bring out one or the other interpretation pragmatically, but of course, a non-intersective interpretation is available for (13a), and the intersective interpretation is only missing from (13b) due to our world knowledge that one cannot sing and talk at the same time.[5] For the purposes of this paper, it will suffice to stipulate that there are two meanings for *and* (when it conjoins predicates), one intersective and one not:

(14) a. $[\![\text{and}_1]\!] = \lambda P.\lambda Q.\lambda x. P(x) \wedge Q(x).$
      b. $[\![\text{and}_2]\!] = \lambda P.\lambda Q.\lambda x. \exists x',x''[x = x' \oplus x'' \wedge P(x') \wedge Q(x'')].$ (Krifka, 1990)

The distinction between intersective and non-intersective conjunction with plurals is often taken to hold with atoms as well. The possibility of an intersective interpretation is straightforward:

(15)   The tourist is drunk and tired.

As for non-intersective conjunction, Krifka (1990) assumes that conjunctions of summative predicates like (16) are necessarily non-intersective, because the conjoined predicates are *prima facie* contradictory (17).

(16) a. The flag is green and white.   (Krifka, 1990)
      b. This is beer and lemonade.

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[5]See Poortman (2017) for discussion of how the choice of predicates in a conjunction affects the likelihood of speakers preferring to interpret a conjunction intersectively.

(17)   a.   #The flag is green and the flag is white.
        b.   #This is beer and this is lemonade.

By 'contradictory,' I mean that summative predicates apply to all the material parts of their argument in positive sentences, so two cannot be true of the same individual at the same time. Krifka's (1990) view is that in light of this, it must be that *and*, by quantifying existentially over parts of the subject (14b), 'breaks up' the subject into proper parts in (16).

In the rest of this section, I show two things. First, the conjunctions in (16) are actually intersective, in spite of initial appearances. In fact, conjunction with atomic subjects is never non-intersective. Then, I show that the lack of non-intersective interpretation of such conjunctions makes the EMP account of subatomic homogeneity untenable. In examples like (16), the EMP and a non-intersective conjunction would create the contradictory 'all green and all white' meaning that Krifka suggests avoiding through a non-intersective interpretation of *and*.

3.2. Conjunction with atoms is always intersective

To see that conjunction with an atomic subject is always intersective, we begin by looking at the colour-term conjunctions in more depth, making two observations. First, there are expressions which can be used to exclude non-intersective interpretations (specifically *both* and *as well as*), but these can be used with colour conjunctions without creating a contradiction. Thus, an intersective interpretation must at least be available for (16). Then, we see that the intersective interpretation must in fact be the only available interpretation, in light of the way colour conjuncts behave with modifiers that make them explicitly universal (e.g., *entirely*). Krifka's account overgenerates in predicting this to be consistent. Finally, we turn to predicates other than colour terms and observe once again that Krifka's proposal overgenerates. Indeed, outside the domain of colour terms and some other summative predicates, apparently non-intersective interpretations of conjunctions with atomic subjects like in (16) are straightforwardly unavailable as a matter of course.

We begin with colour conjunctions, to see that Krifka's account undergenerates in one way and overgenerates in another. The first observation is that an intersective interpretation of colour conjunctions must at least be available. This is due to colour conjunctions' behaviour with *both . . . and* and *as well as*. Indeed, at least when it composes with conjoined predicates, *both* forces an intersective interpretation of a conjunction (Schwarzschild, 1994; Paillé, 2021), and this is more generally the case with *as well as*. (18) shows that these 'marked' conjunctions are acceptable with an intersective interpretation, while (19) shows that they do not allow for a non-intersective interpretation.

(18)   a.   All the children are both blonde and Swedish.
        b.   All the children are blonde as well as Swedish.

(19)   a.   (i)   All the children are (#both) singing and talking (at the same time).
             (ii)   John and Mary are (#both) 28 and 31 years old. (adapted from Krifka 1990)
        b.   (i)   #All the children are singing as well as talking (at the same time).
             (ii)   #John and Mary are 28 as well as 31 years old.

As such, we have at our disposal a set of lexical resources that exclude the non-intersective interpretation of *and*. If colour conjunctions were necessarily non-intersective, *both* and *as well as* should be incompatible with them. However, this is not the case:

(20)   a.   The flag is both green and white.
       b.   The flag is green as well as white.

(20) suggests that the intuited meaning of (16) is actually compatible with an intersective interpretation of *and*; this is an undergeneration problem for Krifka.

In fact, colour conjunctions with atomic subjects do not only allow an intersective *and*; they reject non-intersective interpretations entirely. To see this, let us contrast pluralities with atoms again. With pluralities, the availability of a non-intersective conjunction means that each conjunct can be made explicitly universal with modifiers like *entirely*:

(21)   The flags are entirely green and entirely white.
       ⤳ some of the flags are entirely green, the others are entirely white

If a non-intersective conjunction was available with atomic subjects, we should be able to create a sentence like (21) but with an atomic subject (Paillé, 2021). It would mean that the flag has an entirely green subatomic part and an entirely white subatomic part. This prediction is not borne out:

(22)   #The flag is entirely green and entirely white.

Here, Krifka's account overgenerates. Thus, not only is an intersective interpretation available with colour conjunctions, it is in fact the only possibility.

A similar overgeneration problem holds for Krifka's account outside the domain of colour terms. Indeed, the lack of non-intersective conjunction with atomic subjects is not a special fact of colour adjectives. Consider examples like (23) (cf. Winter 2001: 69ff). These are all contradictory, but this is unexpected if atomic subjects could compose with a non-intersective conjunction. With a non-intersective conjunction, the examples in (23) would have meanings paraphrasable as 'the forest has a sparse part and a dense part,' 'the table has a wet part and a dry part,' and so on.

(23)   a.   #The forest is sparse and dense.
       b.   #The table is wet and dry.
       c.   #The land is flat and hilly.
       d.   #The room is hot and cold.

This is in contrast with the behaviour of these same conjunctions with pluralities:

(24)   The forests (in Canada) are sparse and dense.

As such, there is nothing special about colours: as a rule, conjoined predicates with an atomic subject are only compatible with an intersective interpretation.

3.3. Consequences for the EMP

We have just seen that colour conjunctions like (25) are consistent while necessarily being intersective.

(25)   The flag is green and white.

This leaves no choice but to claim that colours' lexical meaning is not universal but existential. If the lexical meaning of the colour terms was universal, it would be impossible to conjoin them intersectively: nothing is entirely green and entirely white. On the other hand, if *green* means 'partially green' and *white* means 'partially white' (Harnish, 1976; Levinson, 1983), these predicates can be conjoined intersectively. Thus, we need lexical entries like (26).

(26) $[\![\text{green}]\!] = \lambda x.\ \exists y[y \sqsubseteq x \wedge \text{green}(y)]$.

But positing existential meanings for colour terms is not compatible with the EMP. As mentioned in section 2, given that the EMP ensures that predication is undefined if the predicate only holds of some material parts, there is effectively no way to create an existential lexical entry. That is, tweaking the lexical entry in (27a), repeated from (10), to make the assertion existential (27b) changes nothing. (27a) and (27b) are equivalent, since both are only defined for arguments that are either entirely green or not green at all, and both are undefined for arguments that are only partly green.

(27) $[\![\text{green}]\!] =$
       a. $\lambda x : \forall y[y \sqsubseteq x \to \text{green}(y)] \vee \forall y[y \sqsubseteq x \to \neg\text{green}(y)].\ \forall y[y \sqsubseteq x \to \text{green}(y)]$.
       b. $\lambda x : \forall y[y \sqsubseteq x \to \text{green}(y)] \vee \forall y[y \sqsubseteq x \to \neg\text{green}(y)].\ \exists y[y \sqsubseteq x \wedge \text{green}(y)]$.

As such, the EMP is incompatible with the existential meaning that is necessary to make colour terms mutually compatible.

In addition to making conjunctions non-contradictory, the meaning for colour terms posited in (26), which is existential and without an EMP, immediately explains the meaning of negative sentences:

(28)   The flag is not green.
         ⤳ the flag is not green at all

As such, what remains is to find a way to strengthen the lexically existential meaning of colour terms (26) in positive sentences (without creating contradictions in conjunctions), so that 'partly green' comes to mean 'entirely green.' This effectively turns upside-down the puzzle raised by the homogeneity paradigm: rather than finding a way to strengthen negative sentences, we will need a way to strengthen positive ones. This will be the topic of section 4.

To conclude, the argumentation we have seen is as follows. First, predicate conjunctions are always intersective when their argument is atomic. If summative predicates like colour terms were lexically universal, sentences like (25) would therefore be contradictory. Since they are not contradictory, we need existential meaning for summative predicates, but this cannot be achieved with an EMP on summative predicates. By definition, the EMP ensures such predicates are undefined if they are only true of some parts of their argument. In section 4.1, we will see that even if we sever the EMP from lexical items in order to let it scope higher, the outlook for the EMP does not improve.

To convincingly claim that the EMP is incompatible with the existential meaning of colour terms that we can observe in their conjunctions, I may have been overly hasty in assuming that the observed existential force comes from lexical meaning. It is not impossible than colours are lexically universal but are *pragmatically weakened* in conjunctions, misleadingly giving them the appearance of being lexically existential. Indeed, a pragmatic weakening effect is independently observed in the literature on homogeneity, under the name of 'non-maximality.' As such, before moving on to my own analysis of subatomic homogeneity in section 4, I end this section by showing that the required existential meaning of colour terms in fact *cannot* be obtained through weakening; colour conjunctions are not non-contradictory due to a non-maximality effect. This underscores the need for existential lexical meaning (26).

3.4. Conjoined colours are not weakened through non-maximality

So far, I have overlooked one important component of homogeneity, which could in principle be used to explain intersective colour conjunctions' acceptability without getting rid of the EMP.[6] Indeed, homogeneity effects can allow some exceptions; this is known as 'non-maximality.' For instance, (29) can be judged as true if most but not all of the professors smiled (Križ, 2015).

(29)   The professors smiled.

Depending on pragmatic factors, non-maximality can go so far as to yield an existential meaning. (30) is from Malamud (2012: 4–5).

(30)   a.   SCENARIO: *Mary has a large house with over a dozen windows in different rooms. She locks up and leaves to go on a road trip with her friend Max, forgetting to close just a few of the many windows in various rooms. A few minutes into the ride, Max says, "There is a thunderstorm coming. Is the house going to be OK?" Mary replies:*
         b.   Oh my, we have to go back—the windows are open!

Given the scenario in (30a), any number of open windows warrants going back home, and (30b) can be interpreted existentially.

In light of this, defenders of the EMP could argue that colour conjunctions like (25) involve a non-maximality effect: the universal meaning of each colour term is pragmatically weakened, in the same way that we observe weak meanings with pluralities in (29) and (30). To evaluate this, I begin with a particular theory of non-maximality, and show that it cannot in fact take a semantically contradictory assertion and 'pragmatically' make it acceptable. Then I ask more generally what sort of prediction *any* theory would make if it tried to allow the pragmatic weakening of conjuncts in semantically contradictory conjunctions; I suggest that any such theory, even if it worked for colour terms, would overgenerate elsewhere in language.

Before we begin, let me address a possible objection to the non-maximality account of colour terms' existential meaning. The objection would be that, unlike the case of pluralities, there is no need for a special scenario for the existential meaning of colour terms to arise. However, this sort of objection does not stand up. Indeed, conjoined colour terms' existential meaning

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[6]I thank Nina Haslinger for raising this point.

could be claimed to arise automatically (without any special scenario) because the existential interpretation is the only non-contradictory option available. Faced with the choice between a 'maximal' contradictory interpretation of conjunctions, and a non-maximal non-contradictory interpretation, speakers would choose the non-contradictory, non-maximal parse without requiring a special scenario. This is in contrast with pluralities, where no contradiction is inherent to 'maximal' readings.

Nonetheless, as it turns out, the non-maximality account of colour terms' mutual compatibility does not work. I start by showing that a particular theory of non-maximality does not carry over to the colour conjunction data. Based on the intuition that non-maximal readings are possible when exceptions are pragmatically irrelevant to the issue at hand in a conversation, Malamud (2012) and Križ (2015), following van Rooij (2003), argue that in conversation, the set of possible worlds is partitioned, and the goal of a conversation is to determine which cell the real world is in. When an exception is irrelevant for current purposes, it is because it does not affect which cell of the partition the real world is in. On this approach, in (30), Mary's statement semantically means that all the windows are open. But the worlds in which all the windows are open are in the same cell as all the worlds where there is even as little as a single window open, because Mary and Max must go back home to close the window(s) either way. To represent this, if w_1 is a world in which all the windows are closed, w_2 is a world in which only some windows are open, and w_3 is a world in which all the windows are open, the pragmatic partitioning of worlds is as in (31).

(31) $\{\{w_1\}, \{w_2, w_3\}\}$

Identifying the real world as being in the set $\{w_2, w_3\}$ is 'good enough' pragmatically, even if Mary's utterance is only semantically true in w_3, not w_2.

This account does not carry over to colour term conjunctions like (32), however. Recall that by the EMP and the intersective status of the conjunction, the semantic meaning of (32) is that the flag is both entirely green and entirely white.

(32)   The flag is green and white.

Yet, there are no worlds in which a surface can be entirely of two colours all over. That is, there are no worlds in which (32) is semantically true. The theory of non-maximality just sketched out relies on the idea that non-maximal readings involve there being a world in which the sentence is semantically true, with the real world being in the same cell as that world. If there is no world in which the sentence is semantically true, it is impossible for the real world to be in the same cell as that world. Thus, under this theory, there is generally no way for a semantically contradictory sentence to be made acceptable through non-maximality.

Perhaps this is just a problem with Malamud and Križ's theory. As such, putting aside any actually-existing theory of non-maximality, let's return instead to the intuitive appeal of understanding conjunctions like (32) as non-maximality. The idea is quite simply that (32) is semantically contradictory, but due to some pragmatic contradiction-avoidance principle, this is fixed pragmatically by weakening each conjunct to an existential. In fact, even this intuitive, non-formalized version of the non-maximality account immediately runs into a problem. In-

deed, giving this much power to the pragmatics overgenerates significantly. Consider any of the examples in (23), such as (33), repeated from (23b).[7]

(33)   #The table is wet and dry.

(33) is semantically contradictory: while *wet* is only existential, *dry* is universal, making the two predicates incompatible (Yoon, 1996). The pragmatic weakening account just sketched out informally for colour conjunctions (32) should kick in here as well, and weaken the offending predicate (here only *dry*) to an existential. (33) would mean that the table has a wet part and a dry part. Yet, this pragmatic weakening clearly does not occur, because the sentence is intuited as a contradiction. Therefore, even an informal appeal to non-maximality as a way of understanding colour conjunctions immediately makes incorrect predictions.

In sum, while there is an allure to viewing conjoined colour terms as an instance of non-maximality, where the intersective conjunction of lexically universal colour terms is intuited as non-contradictory due to a pragmatic weakening effect, this runs into significant problems. Under Malamud (2012) and Križ's (2015) account, the semantically contradictory nature of the conjunctions means that it is impossible for the actual world to be in the same cell as the set of worlds denoted by the sentence, because there are no such worlds. More generally, an important empirical problem surfaces in examples like (33), where we observe that, as a matter of fact, semantically contradictory conjunctions are *not* fixed through pragmatic weakening of the conjuncts. This makes it undesirable to make such a claim for colour terms.

4. Strengthening summative predicates

The conclusion reached so far is that, in light of the lack of non-intersective conjunction with an atomic subject, colour terms must be lexically existential (34). Going forward, I will abbreviate the assertion in (34) as $\text{green}_\exists(x)$.

(34) $[\![\text{green}]\!] = \lambda x.\ \exists y[y \sqsubseteq x \wedge \text{green}(y)]$.

As pointed out in section 3.3, this immediately obtains the meaning of negative sentences:

(35)   The flag is not green.
        ⤳ the flag is not green at all

But for positive sentences, something must occur to strengthen colour terms' lexical meaning. As such, the problem has been turned upside down. For Gajewski (2005), the homogeneity paradigm involves an unstrengthened assertion in the positive and strengthening in the negative. But what we need (at least for summative predicates) is in fact strengthening in the positive; the meaning of the negative comes out from summative predicates' lexical meaning.

In addition to capturing the positive side of the basic homogeneity paradigm (36a), the strengthening must also capture the intuited meaning of conjoined predicates (36b). In (36b), *green* and

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[7]An even closer correlate to (32) would be (i), where both predicates are universal given the modification of *wet* with *completely*:
(i)   #The table is dry and completely wet.
This mirrors formally the conjunction of two colour adjectives in (32), since these adjectives are also supposedly both lexically universal under the EMP–non-maximality account.

white are not strengthened so much as to be mutually incompatible, but they are strengthened enough for all pieces of the flag to have one colour or the other.

(36)　a.　The flag is green.
　　　　　↝ the flag is all green
　　　b.　The flag is green and white.
　　　　　↝ all parts of the flag are green or white (the flag is only green and white)

In the following two subsections, I attempt this strengthening twice. The first attempt is theoretically conservative in that it tries to maintain the claim that the EMP exists and is the cause of the all-or-nothing effect observed with colour terms. It attempts this by severing the EMP from the lexical meaning of colour terms. The intuition is that the EMP is introduced above the entire conjunction (*green and white*) rather than in each conjunct. While this successfully avoids the generation of a contradiction, I show that significant problems arise in other ways. Thus, in section 4.2, I depart entirely from the EMP account of subatomic homogeneity. The proposed account is that lexically existential summative predicates are exhaustified vis-à-vis one another in positive sentences (cf. Paillé 2020, 2021). Thus, a colour term like *green* (lexically 'partially green') comes to mean 'partially green, and not partially of any other colour.'[8]

4.1. Severing the EMP from summative predicates' lexical meaning

As proposed by Gajewski (2005), the purpose of the EMP is mainly to strengthen the meaning of negative sentences; for positive sentences, its only effect is to make non-homogeneous cases undefined rather than false. In this section, we consider using the EMP for the polar opposite of this: what if the EMP strengthened positive sentences, and had no effect on negative ones (other than making non-homogeneous cases undefined rather than false)?

In section 2, I mentioned that the idea of putting the EMP in colour terms' lexical entries is not quite in line with Gajewski's (2005) proposal for pluralities, where the EMP actually comes from a DIST operator above the predicate that combines with a plural DP. Would severing the EMP from summative predicates' lexical entries solve the problem identified in section 3 for conjunctions? In particular, if the EMP comes from a subatomic $\text{DIST}_{\text{Subat}}$ operator (37), this operator could scope over both colour terms at once (38), from where it would not make them mutually incompatible.

(37)　$\llbracket \text{DIST}_{\text{Subat}} \rrbracket$
　　　$= \lambda P.\ \lambda x : \forall y[y \sqsubseteq_{\text{SUBAT}} x \rightarrow P(y)] \vee \forall y[y \sqsubseteq_{\text{SUBAT}} x \rightarrow \neg P(y)].\ \forall y[y \sqsubseteq_{\text{SUBAT}} x \rightarrow P(y)].$

(38)　The flag is $[\text{DIST}_{\text{Subat}} [\text{green and white}]]$.

Under this hypothesis, because colour terms' EMP comes from $\text{DIST}_{\text{Subat}}$ and not their lexical entry, colours are lexically non-presuppositional and existential as in (34).

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[8]See Harnish (1976) and Levinson (1983) for a similar account of colours' apparently universal meaning, and Magri (2014) and Bar-Lev (2021) for accounts of plural homogeneity that also make use of exhaustivity. I do not presently compare my account with Magri's or Bar-Lev's, which are tailor-made for pluralities and which differ significantly in the kinds of alternatives that yield the homogeneity effect once exhaustified.

Moving the EMP from colour terms' lexical meaning to an operator creates a near-identical result for non-conjoined predications. With non-conjoined colour terms, $\text{DIST}_{\text{Subat}}$ simply gives our non-presuppositional colour terms the presupposition given to them lexically in (10).[9]

(39) a. The flag is $[\text{DIST}_{\text{Subat}} \text{ green}]$.
      b. $[\![\text{DIST}_{\text{Subat}} \text{ green}]\!]$
          $= \lambda x : \forall y[y \sqsubseteq x \to \text{green}_\exists(y)] \lor \forall y[y \sqsubseteq x \to \neg\text{green}_\exists(y)]. \text{ green}_\exists(x).$

The same goes for negative sentences. Regardless of the relative scope of $\text{DIST}_{\text{Subat}}$ and *not* (40)–(41), colour terms with $\text{DIST}_{\text{Subat}}$ in negative sentences are only defined if the flag is all green or not green at all, and the asserted meaning is that the flag does not have a green part. Hence, the sentence is only true if the flag is not green at all.

(40) $[_{vP} \text{ not } [_{vP} \text{ the flag is } [\text{DIST}_{\text{Subat}} \text{ green}]]]$.

(41) a. $[_{TP} [\text{the flag}]_1 [_{vP\text{-}2} \text{ DIST}_{\text{Subat}} [_{vP\text{-}1} \lambda_1 [_{vP} \text{ not } [_{vP} t_1 \text{ is green}]]]]]$.
      b. (i) $[\![vP\text{-}1]\!] = \lambda x. \neg\text{green}_\exists(x).$
          (ii) $[\![vP\text{-}2]\!] = \lambda x : \forall y[y \sqsubseteq_{\text{SUBAT}} x \to \neg\text{green}_\exists(y)] \lor \forall y[y \sqsubseteq_{\text{SUBAT}} x \to \text{green}_\exists(y)].$
               $\forall y[y \sqsubseteq_{\text{SUBAT}} x \to \neg\text{green}_\exists(y)].$

On the other hand, severing the EMP from colour terms' lexical meaning makes a significant difference for conjunctions (38). Before the functional application of $\text{DIST}_{\text{Subat}}$, the meaning of the conjunction is as in (42) (the subject in (38) is atomic and, therefore, only an intersective conjunction is possible).

(42) $[\![\text{green and white}]\!] = \lambda x. \text{green}_\exists(x) \land \text{white}_\exists(x).$

$\text{DIST}_{\text{Subat}}$ then composes with the conjunction, producing (43).

(43) $[\![\text{DIST}_{\text{Subat}} [\text{green and white}]]\!]$
      $= \lambda x : \forall y[y \sqsubseteq x \to [\text{green}_\exists(y) \land \text{white}_\exists(y)]] \lor \forall y[y \sqsubseteq x \to \neg[\text{green}_\exists(y) \land \text{white}_\exists(y)]].$
      $\text{green}_\exists(x) \land \text{white}_\exists(x).$

There is no contradiction in (43) of the kind seen in section 3, when the EMP was contributed by colour terms' lexical meaning. Yet, (43) is still not a welcome result. It will be useful here to distinguish between 'parts' and 'pieces' (see Wągiel (2021) and references therein), where a 'part' refers to a pragmatically salient part of an object, and a 'piece' refers to any part of an object. In a flag, the parts are in fact the colours themselves: the flag of France, for example, has three parts, namely the red, white, and blue strips. But (physical instantiations of) flags can have any number of pieces, which need not correspond to the parts. Pre-theoretically, it's not clear whether the relation $\sqsubseteq$ in (43) refers to parts or pieces, so I consider both possibilities.

Let's walk through the disjuncts in the presupposition one by one. The first disjunct requires all parts/pieces of the flag to themselves have both a green and a white part. If this is to be

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[9]In fact, the presupposition is not quite the same. In the presupposition in (10), the positive disjunct ($\forall y[y \sqsubseteq x \to \text{green}(y)]$) meant 'all parts are all green.' But in (39b), we have something weaker: 'all parts are at least partly green.' If 'part' is understood as any mereological piece, this comes out to the same (if there was a non-green piece, this non-green piece would lack a green piece; thus, there cannot be any non-green piece). If 'part' is understood as meaning 'pragmatically salient part,' then (39b) does not require the flag to be entirely green, contrary to what is intended. If so, the hypothesis under consideration in this subsection immediately runs into an important problem.

understood as meaning that all *parts* (as opposed to *pieces*) must have both colours, this is absurd: as noted above, parts of flags are pragmatically salient parts by virtue of only having one colour. But nothing improves if this is to be understood as meaning that all *pieces* of the flag must have two colours. In that case, however small a piece you choose, it would have to be made up of a white piece and a green piece. And those pieces themselves would also need to be made up of a white piece and a green piece, and so on. Flags certainly don't work this way, nor indeed does any (mental representation of any) object. As such, regardless of whether one understands 'part' as referring to parts or pieces, we would have needed this disjunct of the presupposition to contain a disjunction ('all parts are green *or* white') rather than a conjunction.

Given that the first disjunct in the presupposition in (43) does not yield the observed strong (non-universal, but more than just existential) meaning for conjoined colour terms, could we rely on the second disjunct? Intriguingly, it is not incompatible with the assertion, even in the positive (recall that this is the disjunct intended to capture the meaning of *negative* sentences). It can quite nicely be understood as referring to parts and not pieces: for all parts of the flag, they are not both partially green and partially white.[10] However, the disjunct does not strengthen the colours' existential meaning. The assertion that the flag is partly green and partly white is not strengthened to mean that the entire flag is *only* green and white; this disjunct is compatible with the presence of other colours on the flag.[11]

Thus, (43) does not produce the strengthening effect we are trying to obtain. The analysis under consideration, where subatomic homogeneity effects arise due to positive sentences being strengthened by an EMP contributed by a $DIST_{Subat}$ operator, can deliver the right results for both negative and positive non-conjoined cases (but see footnote 9), but not for colour conjunctions.

4.2. An exhaustivity account of subatomic homogeneity

We have now seen that attempting to capture colour terms' meaning with an EMP creates problems whether the EMP is introduced locally by colour terms themselves (section 3) or by an operator that can scope over entire colour conjunctions (section 4.1). In this last section, I therefore step away from the EMP entirely and suggest an alternative route to strengthening colour terms (and other summative predicates). Recall that we are attempting to properly strengthen colour terms' existential meaning in a way that does not make colour terms mutually incompatible, while still deriving the observed meaning of colour conjunctions, where in the positive, the conjunction covers all subatomic parts of the subject.

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[10]This cannot refer to pieces; there is no reason why a piece of a flag could not have more than one colour. All flags except monochrome ones would lead to semantic undefinedness if this presuppositional disjunct referred to pieces.

[11]Another problem arises for the second disjunct in the presupposition of (43) when we turn to objects other than flags. The negative disjunct in (43), if understood as referring to parts rather than pieces, works for flags because of an idiosyncrasy about flags: the parts of flags are made up of the colours themselves, and therefore the parts of flags have only one colour each. This is not the case with other objects, where salient parts can have more than one colour. For example, imagine a fork whose handle has stripes of different colours. It seems that in such a case, the pragmatically salient parts of the fork (outside of special contexts) are still the handle as a whole and the prongs; thus, a particular part (the handle) can have more than one colour.

I suggest (cf. Paillé 2020, 2021) to strengthen colour terms' existential meaning through covert exhaustification (Chierchia et al., 2012), via an Exh operator defined in (44).

(44) $[\![\text{Exh}_{\text{ALT}}(\text{S})]\!]^{\text{w}} = 1$ iff $[\![\text{S}]\!]^{\text{w}} = 1$ and $\forall \phi \in \text{ALT} (\phi(w) = 1 \rightarrow [\![\text{S}]\!] \subseteq \phi)$

Take colour terms to act as alternatives to one another. This could be because they all serve as answers to questions under discussion of the type *What colour is this?* or because of a general phenomenon whereby predicates from the same conceptual domain act as alternatives to one another (Paillé, 2020). Thus, exhaustifying a sentence with a colour term will exclude all other colours.[12]

(45)   a. $[\![\text{Exh}_{\text{ALT}} [\text{the flag is green}]]\!]$
             $= 1$ iff the flag is green$_\exists$ & the flag is not white$_\exists$ & the flag is not blue$_\exists$ & ...
        b. $[\![\text{Exh}_{\text{ALT}} [\text{The flag is green and white}]]\!]$
             $= 1$ iff the flag is green$_\exists$ & the flag is white$_\exists$ & the flag is not blue$_\exists$ & ...

Under this account, the conjunction data (45b) is non-contradictory. Exh does not exclude any alternative entailed by its prejacent; if it scopes above both *green* and *white*, neither colour term is strengthened to exclude the other. What is more, (45b) also captures the intuition that the flag is *only* green and white. That is, the meaning is strengthened enough to exclude other colours, but not strengthened to the point of making the colour terms incompatible with one another.

There is one last ingredient to this account. As stated, the meaning derived is only of the form 'the flag has a part of such and such colour, and does not have a part of any other colour.' Yet, this does not make the existential meaning of the colour terms universal. While much current work uses exhaustivity to turn various types of existentials into universals (Bowler, 2014; Bar-Lev and Margulis, 2014; Oikonomou, 2016a, b; Bassi and Bar-Lev, 2018; Francis, 2019, 2020; Staniszewski, 2020), in (45), colour terms' lexical meaning remains existential, with non-asserted colours excluded. Thus, I rely on world knowledge kicking in to strengthen the meaning even more: we know that all areas of a surface have some colour, so that 'partially green, and no other colour' in (45a) is strengthened pragmatically to 'green all over.'

Beyond colour terms, something similar must go for other summative predicates, which show the same alternation between strong and weak meanings:

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[12]But see Paillé 2020, 2021 for comments on the syntax of Exh in (45). Indeed, there is evidence that, contrary to the way it is shown in (45), Exh is actually constrained to taking scope immediately above the colour(s): the LFs are actually [the flag is [Exh$_{\text{ALT}}$ green]] and [the flag is [Exh$_{\text{ALT}}$[green and white]]]. Among other things, this is necessary to explain one of the datapoints mentioned in the present paper, viz. (i), repeated from (17a).
(i)   #The flag is green and the flag is white.
If Exh was syntactically free, it could scope above the entire sentential conjunction (cf. Bade 2016), therefore excluding all colours other than green or white, but not generating a contradiction as needed for (i). Indeed, *green* would not be strengthened to meaning 'not white,' and *white* would not come to mean 'not green.' This can be understood in terms of a syntactic constraint on Exh, which has the effect that only the contradictory parse in (ii) is possible for (i) (assume for simplicity that the only colours are white, green, and red):
(ii) $[\![\text{The flag is [Exh}_{\text{ALT}} \text{ green] and the flag is [Exh}_{\text{ALT}} \text{ white]}]\!]$
        $= 1$ iff the flag is green$_\exists$ & not white$_\exists$ & not red$_\exists$ and the flag is white$_\exists$ & not green$_\exists$ & not red$_\exists$.
        $\Rightarrow$ contradiction
See the above citations for more discussion.

(46)   a.   The desk is metal.
              ⤳ the desk is all metal
        b.   The desk is wood and metal.
              ⤳ the desk is partly wood and partly metal, and nothing else
        c.   The desk is not metal.
              ⤳ the desk is not metal at all

These other summative predicates must also lexically quantify existentially over the parts of their argument, with covert exhaustification in the positive.

As a final note, it is not clear how the proposed account could carry over to plural homogeneity. However, some accounts of plural homogeneity (in particular Magri 2014 and Bar-Lev 2021) are quite similar, in positing that the homogeneity paradigm is the result of existential basic meaning (obtaining the meaning of negative sentences immediately) with covert exhaustification in the positive. If the present proposal is accepted, it is not unimaginable that plural and subatomic homogeneity are theoretically united in involving weak lexical meaning and exhaustification in the positive, while having an underlying difference in the nature of the alternatives provided as Exh's domain. For now, I leave a more thorough comparison of my proposal with other exhaustification-based accounts of homogeneity (and more generally other non-EMP accounts of homogeneity) for future work.

5. Conclusion

The literature on homogeneity is mostly concerned with the paradigm observed with pluralities. However, I suggest that the effect within atoms is not to be overlooked: atoms are less permissive than pluralities in their composition with conjoined predicates, setting a new target for theories of homogeneity. Focusing on one particular theory, viz. the presuppositional account of homogeneity, I showed that it yields undesirable meanings for colour conjunctions with atomic subjects. I therefore proposed an alternative account, in which summative predicates from a given domain (colour terms, material terms, etc.) act as alternatives to one another. If Exh scopes above their conjunctions, it does not strengthen them to be incompatible with one another, so that no problem arises from the intersective nature of the conjunction. Crucially, it does so while still excluding other alternative predicates.

A. Conjunction and the EMP with pluralities

While the main text of this paper focuses on problems for the EMP when predicates are conjoined and given an atomic argument, the outlook for the EMP is not clearly better when the argument of conjoined predicates is a plurality. Consider the examples in (47), which can be intuited either as intersective or non-intersective.

(47)   a.   The children are singing and dancing.
        b.   The children are not singing and dancing.

The empirical picture is not straightforward. As noted by Szabolcsi and Haddican (2004) (who write on conjunctions of individuals rather than predicates), sentences like (47b) are not clearly

acceptable in English. We are considering (47b) in its 'plain' form without stress on *and*; while (48) is clearly good (and intuited as meaning that all the children are singing or all the children dancing, but the children are not doing both), sentences like (47b) are not accepted by all speakers out of the blue.

(48)   The children are not singing AND dancing.

To the extent that (47b) is acceptable, however, it means that the children are neither singing nor dancing. Szabolcsi and Haddican (2004) note that context and choice of predicate can affect how easily unstressed *and* is acceptable under negation in English. Cases like (49) (my examples) are more clearly acceptable and highlight the judgment that conjoined predicates under negation, with unstressed *and*, have a 'neither-nor' meaning.

(49)   a.   The children are not brushing their teeth and doing their homework.
         b.   The Republicans did not successfully stage a coup and overthrow democracy.

With the empirical picture cleared up, we have a somewhat particular homogeneity effect to capture in (47). Either all the children danced and all the children sang (the intersective reading of (47a)), or all the children either danced, sang, or both (the non-intersective reading of (47a)), or none of the children danced and none of the children sang (47b). Taking inspiration from Krifka (1990), the presupposition we would actually need is in (50).

(50) $\lambda x : \exists x', x''[x = x' \oplus x'' \wedge \forall y[y \sqsubseteq_{AT} x' \to \text{sing}(y)] \wedge \forall y[y \sqsubseteq_{AT} x'' \to \text{dance}(y)]] \vee$
         $\forall y[y \sqsubseteq_{AT} x \to [\neg\text{sing}(y) \wedge \neg\text{dance}(y)]]$. (output condition).

In prose: either all the children danced, sang, or did both, or none of the children did either. This presupposition obtains the homogeneity effect because it rules out cases where some but not all children did neither. As the reader can see in (50), the meaning from Krifka's *and*— repeated in (51) from (14b)—must effectively be repeated in the presupposition, but *only for the first disjunct*.

(51) $[\![\text{and}]\!] = \lambda P.\lambda Q.\lambda x. \exists x', x''[x = x' \oplus x'' \wedge P(x') \wedge Q(x'')]$.

The fact that quantificational material from the meaning of *and* projects may be acceptable with the right theory of presupposition projection (see e.g. Chemla 2009 on quantification in presuppositions). But the asymmetry in projection is likely unprincipled: why would the first disjunct in the presupposition inherit quantificational material from *and*, but not the second?

In sum, capturing homogeneity effects with conjoined predicates with a plural subject is not without its own set of challenges for the EMP. This difficulty for the EMP parallels an issue discussed by Križ (2015) and Bar-Lev (2021), namely that the EMP is designed for homogeneity with distributive predicates, but is not straightforwardly reconcilable with the existence of the homogeneity paradigm with non-distributive predicates.

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