Subatomic and plural homogeneity as exhaustification effects of different kinds*

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Abstract

Homogeneity (all-or-nothing) effects are observed in both atoms and pluralities. In this paper, I compare two theories of homogeneity. The first is made for plural homogeneity and the second for subatomic homogeneity, but both capture the effect through existential lexical meaning paired with local exhaustification in positive sentences. I show that neither approach can be extended to the side of the paradigm it was not intended for. But relying on exhaustification for at least subatomic homogeneity is well motivated: all predicates belonging to taxonomies (rather than scales), whether displaying homogeneity effects or not, are interpreted as weak/strong in the same environments, and it is not clear what mechanism other than exhaustification could account for these facts in a united way. Hence, I maintain that homogeneity is an exhaustification effect, and suggest that plural and subatomic homogeneity are simply due to different kinds of local exhaustification.

1 Introduction

Discussion of homogeneity effects usually focuses on pluralities (1), but the effect holds within atoms as well (2) (e.g., Löbner 2000, Spector 2013, Križ 2015, 2019) with so-called 'summative' predicates—predicates that are true of an individual by virtue of being true of its parts.

(1) a. Adam saw the children.
≈ he saw **all** of the children
b. Adam didn't see the children.
≈ he saw **none** of the children

(2) a. The flag is green.
≈ **all** of the flag is green
b. The flag isn't green.
≈ **none** of the flag is green

In this paper, I compare two similar accounts of homogeneity, both of which posit existential lexical meaning that is strengthened in positive sentences but not negative ones. Bar-Lev (2021) proposes a theory of plural homogeneity (1) that obtains strengthening through the Inclusion of alternatives; Harnish (1976), Levinson (1983), and Paillé (2021) have a theory of summative predicates (2) that obtains strengthening through the Exclusion of alternatives. I take these theories in turn (sections 2–3) to show that neither cannot be extended to the side of the homogeneity paradigm it does not set out to explain. Then, in section 4, I defend that (2a) should be viewed as a strengthening effect: in particular, this makes it possible to collapse identical data around summative (3a) and non-summative (3b) predicates.

(3) a. The white flag is #(also) red.
b. This comedy is #(also) a tragedy.

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I therefore suggest that the Inclusion and Exclusion theories are both correct for a different part of the homogeneity paradigm (plural vs. subatomic homogeneity). What unites (1) and (2) is that both are exhaustification effects (and necessarily locally computed, as we will see), but the Exh(aust) operator (Chierchia et al. 2012) operates over different kinds of alternatives and, as a result, differs in whether it Includes or Excludes them.

2 An *Inclusion* account of *plural* homogeneity

Bar-Lev (2021) develops a theory of plural homogeneity based in the inclusion of parts; in plural predication, a predicate in a positive sentence is assigned the value 'true' for each part of a plurality, through a strengthening operation (Inclusion) carried out by Exh.

On this view, the meaning of plurals is existential: the plain meaning of *the children laughed* is that at least one laughed (assume there are two children, a and b).

(4) $[\![\text{The kids laughed}]\!] = 1$ iff $\mathsf{laughed}(a) \vee \mathsf{laughed}(b)$.

This existential meaning is due to an existential plural operator, ∃-PL:

(5) a. $[\![\exists\text{-PL}]\!] = \lambda D_{\langle et\rangle}.\lambda P_{\langle e,\,st\rangle}.\lambda x_e.\exists y \in D \cap Part_{\text{AT}}(x)[P(y) = 1]$. (Bar-Lev 2021:1062)
b. $Part_{\text{AT}}(x) = \{y : y \sqsubseteq_{\text{AT}} x\}$

The kids laughed has the LF in (6a), where the domain D is presented as a subscript on ∃-PL; (6a) obtains the meaning in (6b), which (given that $[\![\text{the kids}]\!] = a \oplus b$) is equivalent to (4).

(6) a. [The kids] [∃-PL$_D$ laughed]. (Bar-Lev 2021:1062)
b. $[\![\text{(6a)}]\!] = 1$ iff $\exists y \in D \cap Part_{\text{AT}}([\![\text{the kids}]\!])[\mathsf{laughed}(y) = 1]$.

When (6a) is negated, this proposal immediately obtains the right truth conditions. For positive sentences, (6b) must be strengthened. Bar-Lev posits subdomain alternatives:

(7) ALT = {a laughed ∨ b laughed, a laughed, b laughed}

The sentence is exhaustified, but because the alternatives are not closed under conjunction and the alternatives 'a laughed' and 'b laughed' are not Innocently Excludable (Fox 2007), Exh excludes nothing. Instead, Bar-Lev uses the notion of Innocent Inclusion, according to which Exh asserts that non-excluded alternatives are *true*, insofar as this can be done consistently:

(8) **Innocent Inclusion procedure**: (Bar-Lev 2021:1067)
a. Take all maximal sets of alternatives that can be assigned true consistently with the prejacent and the falsity of all [innocently excluded] alternatives.
b. Only include (i.e., assign true to) those alternatives that are members in all such sets—the **Innocently Includable** alternatives.

Thus, when Exh takes (6a) as its prejacent, it asserts the alternatives 'a laughed' and 'b laughed'; this creates the meaning that all the children laughed.

At first glance, this account could be extended to subatomic homogeneity; there would be a non-plural operator akin to (5) referring to the subatomic parts of atoms. I assume that subatomic homogeneity is defined in terms of the arbitrary pieces (rather than the salient parts) of objects. For presentation, I will discuss a flag made up of two pieces, a and b, but this is an abstraction, as objects are made up of an infinity of (possibly overlapping) arbitrary pieces. On this view, the weak truth conditions in (9) would hold prior to exhaustification.

(9) $[\![\text{The flag is red}]\!] = 1$ iff $\mathsf{red}(a) \vee \mathsf{red}(b)$.

Including the subdomain alternatives 'a is red' and 'b is red' results in the meaning that the flag is all red; after all, a and b are standing in for an infinity of pieces covering the entire flag.

Despite these first appearances, trying to extend this Inclusion account to subatomic homogeneity leads to problems with data from conjoined colour predicates like (10).

(10) a. The flag is red **and** white.
b. The red flag is **also** white.

Positing the Inclusion of pieces to explain the quantificational strength of colour terms does not create the intuited meanings for (10). To see this, we must first appreciate that both sentences in (10) involve Boolean (intersective) conjunctive material managing to co-predicate two colour terms consistently (Paillé 2021).

(10b) is straightforwardly Boolean; additive particles have never been claimed not to be Boolean. But (10a) is less obvious. In fact, Krifka (1990) takes such examples to involve a non-Boolean conjunction; he assumes that colour terms are lexically universal, so the only way that (10a) might be consistent is if *and* predicates each adjective of a different part of the subject. A non-Boolean *and* makes it possible to predicate each conjunct of a different part of the subject (11a), resulting in consistent truth conditions (11c) even with lexically universal colour terms (11b).

(11) a. $[\![\text{and}]\!] = \lambda P.\lambda Q.\lambda x.\exists x', x''[x = x' \oplus x'' \wedge P(x') \wedge Q(x'')]$.
b. $[\![\text{red}]\!] = \lambda x.\forall y[y \sqsubseteq x \rightarrow \mathsf{red}(y)]$.
c. $[\![\text{(10a)}]\!] = 1$ iff $\exists x, x'[\text{the.flag} = x \oplus x' \wedge \mathsf{red}_\forall(x) \wedge \mathsf{white}_\forall(x')]$.

There is nothing wrong with the truth conditions in (11c); the question is whether they arise due to quantification by a non-Boolean *and*. Descriptively, with plural subjects, the availability of non-Boolean *and* means that the conjuncts can be made explicitly incompatible via *completely*:

(12) The flags are completely red and completely white.
≈ some of the flags are completely red, and the rest are completely white

If the truth conditions in (11c) arise due to quantification by *and*, it should also be possible to make the colour terms in (10a) explicitly incompatible—like (12), but with an atomic subject:

(13) #The flag is completely red and completely white.

This is inconsistent; Krifka's prediction did not hold up. Thus, it cannot be the case that there is a non-Boolean *and* (11a) available when the subject is atomic, as in (10a) and (13).

In sum, given the consistency of both examples in (10), a desideratum for theories of subatomic homogeneity is to capture that colour predicates are consistent (non-universal) when conjoined intersectively. Can the Inclusion theory of subatomic homogeneity meet this challenge? For this theory to stand a chance, let's start by assuming that colour terms are lexically existential (14), so that they can be consistently conjoined through a Boolean *and* or *also*.

(14) $[\![\text{red}]\!] = \lambda x.\exists y[y \sqsubseteq x \wedge \mathsf{red}(y)]$.

Prior to exhaustification, on the Inclusion theory, (10a) has the truth conditions in (15a) and the alternatives in (15b).

(15) a. $[\![\text{The flag is red and white}]\!]$
$= 1$ iff $(a \text{ is red}_\exists \wedge a \text{ is white}_\exists) \vee (b \text{ is red}_\exists \wedge b \text{ is white}_\exists)$

b. $$\text{ALT} = \left\{ \begin{array}{c} a \text{ is red}_\exists \text{ and white}_\exists \vee b \text{ is red}_\exists \text{ and white}_\exists, \\ a \text{ is red}_\exists \text{ and white}_\exists, \\ b \text{ is red}_\exists \text{ and white}_\exists \end{array} \right\}$$

When (15a) is exhaustified, none of the alternatives are excludable. But attempting to include the alternatives does not create the desired meaning. Recall that a and b stand in, for simplicity of presentation, for two arbitrary subatomic pieces of the flag; but in reality, there are an infinite amount of such pieces, which together cover the entire flag; and these can overlap. By including the alternatives in (15b), the meaning obtained is that for any arbitrary piece of the flag, that piece has both a partly red piece and a partly white piece. These pieces too must have a partly red piece and a partly white piece, and so on—all the way down. Every arbitrary piece would have to be divisible into differently-coloured pieces, which themselves are divisible in the same way. This is not the intuited meaning at all; in fact, such an object is impossible.

Perhaps this is such a problematic meaning that the alternatives in (15b) are simply not includable. If so, (15) is still problematic. The meaning of (10a) would simply be that there is a piece of the flag which has a red piece and also has a white piece. The colour terms remain existential. This is far from the intuition for (10a), which is that the flag is *only* red and white; the colour terms are stronger than merely existential.

For this reason, the Inclusion theory, while capable of dealing with plural homogeneity, should not be carried over to subatomic homogeneity.

3 An *Exclusion* account of *subatomic* homogeneity

A rather different account of homogeneity, also based in exhaustification, is proposed by Harnish (1976), Levinson (1983), and Paillé (2021) for subatomic homogeneity. Colour predicates are taken to be existential here as well (16a), obtaining the meaning of negative sentences immediately. Positive sentences are strengthened not through the Inclusion of all parts, but the Exclusion of other existential colour terms (16b).

(16) a. $[\![\text{red}]\!] = \lambda x.\exists y[y \sqsubseteq x \wedge \mathsf{red}(y)]$.

b. $[\![\text{Exh}_{\text{ALT}} \text{ [the flag is red]}]\!]$
$= 1$ iff the flag is $\text{red}_\exists \wedge$ the flag is not $\text{white}_\exists \wedge$ the flag is not $\text{green}_\exists \wedge \ldots$

(16b) does not make *red* semantically universal. Semantically, it only negates that the flag has other colours; but given our conceptualization of surfaces, this is pragmatically strengthened to mean that the flag is entirely red. Thus, *red* is 'semantically exclusive, pragmatically universal.'

This Exclusion account deals with conjunctions effortlessly. An Exh operator scoping above the entire conjunction will only exclude non-asserted colour terms; Exh does not exclude alternatives entailed by its prejacent (Chierchia et al. 2012).

(17) $[\![\text{Exh}_{\text{ALT}} \text{ [the flag is red and white]}]\!]$
$= 1$ iff the flag is $\text{red}_\exists \wedge$ the flag is $\text{white}_\exists \wedge$ the flag is not $\text{green}_\exists \wedge \ldots$

The account can also deal with the additive data (10b), since additives have independently been argued to weaken exhaustification (Bade 2016; see Paillé to appear on colour terms specifically).[1]

[1] The Exclusion account can also capture the truth-value gap intuited in non-homogeneous situations (see e.g. Löbner 2000 and Križ 2015) by adopting the trivalent Exh proposed by Bassi et al. (2021).

But the Exclusion theory cannot be extended to plural homogeneity. It crucially relies on world knowledge, so that 'partly red, and no other colour' is strengthened to meaning 'entirely red.' Nothing of the sort holds for pluralities; world knowledge does not dictate anything about the parts of pluralities. Translating the above Exclusion account to pluralities would involve claiming that plural predication is lexically existential, but is strengthened via the exclusion of conceptually related predicates:

(18) $$[\![\text{Exh}_{\text{ALT}} \text{ [the children are singing}_{\exists}]]\!] = 1 \text{ iff } \begin{cases} \text{there is a child who is singing} \wedge \\ \text{there is no child who is dancing} \wedge \\ \text{there is no child who is} \ldots \end{cases}$$

This both creates entailments that are straightforwardly not intuited (at least without contrastive focus on *singing*), and does not actually make the basic existential meaning 'pragmatically universal': it is possible for members of a plurality to be doing nothing. That is, the truth conditions in (18) are compatible with only one child singing, and the others doing nothing.

A reviewer for the Amsterdam Colloquium suggests that the Exclusion account could work by constraining the alternatives in (18) to mutually exclusive predicates; *sing* would not have *dance* as an alternative, but it would have *talk* and *keep quiet*, for example. If at least one child in the plurality is singing, none is talking, and none is keeping quiet, they must all be singing. However, on this proposal, we lose the ability to explain the *subatomic* homogeneity data, where alternatives are crucially *consistent* predicates (the colour terms are lexically existential). If only *inconsistent* predicates were alternatives, colour terms would not meet this requirement, and would therefore not be alternatives to one another.

4 An argument for homogeneity as exhaustification

An important benefit of the Exclusion account of subatomic homogeneity is that it can also capture the strength of non-summative predicates. Indeed, the Exclusion account of colour terms is part of a broader theory of predication (Paillé 2020); I claim it is a *general* property of predicates to exclude conceptually related predicates (that is: taxonomic sisters). This is motivated by data like (19). On the view that additive particles act to weaken or remove unwanted exhaustification (Krifka 1998; Sæbø 2004; Bade 2016), (19) shows that the meaning of many different predicates involves exhaustification. Unlike colour terms, the predicates in (19) are not summative; a fork is not a fork by virtue of its parts being forks, for example.

(19) a. A tragicomedy is a tragedy that is #(also) a comedy. (Paillé 2020)
b. A spork is a fork that is #(also) a spoon.
c. Some federal responsibilities are #(also) provincial.
d. Futons are couches that are #(also) beds.
e. Are any derivational morphemes #(also) inflectional?
f. Some left-wing ideas are #(also) right-wing.

Given (19), it must be that predicates are always exhaustified vis-à-vis their taxonomic sisters:

(20) $$[\![\text{This [Exh}_{\text{ALT}} \text{ tragedy] is a [Exh}_{\text{ALT}} \text{ comedy]}]\!]$$
$$= 1 \text{ iff this } \begin{pmatrix} \text{tragedy \&} \\ \text{not a comedy \&} \\ \text{not an epic} \end{pmatrix} \text{ is a } \begin{pmatrix} \text{comedy \&} \\ \text{not a tragedy \&} \\ \text{not an epic} \end{pmatrix} \Rightarrow \text{contradiction}$$

As such, the Exclusion account of subatomic homogeneity makes it possible to view this paradigm as part of a broader phenomenon of strengthening in predication; this is motivated empirically by the identical behaviour of colour terms with additive particles (cf. (10b)):

(21) a. The white flag is #(also) green.

b. $[\![$The [Exh$_{\text{ALT}}$ white] flag is [Exh$_{\text{ALT}}$ green]$]\!]$

$= 1$ iff the $\begin{pmatrix} \text{white}_\exists\ \& \\ \text{not green}_\exists\ \& \\ \text{not red}_\exists \end{pmatrix}$ is $\begin{pmatrix} \text{green}_\exists\ \& \\ \text{not white}_\exists\ \& \\ \text{not red}_\exists \end{pmatrix}$ $\Rightarrow$ contradiction

In sum, the Exclusion account of homogeneity can collapse data concerning the quantificational strength of summative predicates with the 'conceptual' strength of the predicates in (19). This advantage of the Exclusion theory makes it unappealing to throw it out—especially in favour of a theory of homogeneity that refers explicitly to part-structure, and is therefore impossible to carry over to the predicates in (19). Since we must keep the exhaustivity account of subatomic homogeneity as the only currently available option that can also explain (19), it seems best to claim that plural homogeneity is an exhaustification effect, too. On this view, plural and subatomic homogeneity at least have substantial common ground.

5 Conclusion: homogeneity as a local exhaustivity effect

We have considered two similar accounts of homogeneity that use Exh and weak lexical meaning to derive the paradigm: an Inclusion account made for pluralities and an Exclusion account made for atoms. Neither can be extended to the other half of the homogeneity paradigm. However, it remains that the two approaches share an important component: they involve weak lexical meaning together with covert exhaustification in positive sentences. This may be all that formally unites plural and subatomic homogeneity.

As exhaustification effects, plural and subatomic homogeneity must be claimed to only be computed locally. For colour terms, this claim is required for (21) as well as other data like (22a). Indeed, for (22a), a global Exh would not make *red* pragmatically universal; the truth conditions in (22b) are compatible with every flag being only partly red, as long as there is no other colour such that all flags are partly of that colour.

(22) a. Every flag is red.
≈ every flag is entirely red

b. $[\![$Exh$_{\text{ALT}}$ [every flag is red]$]\!] = 1$ iff $\begin{cases} \text{every flag is red}_\exists\ \wedge \\ \neg[\text{every flag is white}_\exists]\ \wedge \\ \neg[\text{every flag is green}_\exists] \end{cases}$

It must therefore be claimed for (22a) that a local Exh, below *every*, is the only parse available. A similar locality requirement must be posited for the Inclusion account of plural homogeneity: positive clauses are intuited as involving universal quantification even in downward-entailing environments (Križ 2015; Križ & Spector 2021) (23), so it must be claimed that Exh is necessarily located below the DE operator.

(23) If you solve the problems, you will pass the exam. (Križ 2015:27)
≈ 'If you solve **all** the problems, you will pass the exam.'

As such, subatomic and plural homogeneity are united specifically in being necessarily local exhaustification effects. How to derive such a locality constraint on Exh is left for other work.

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