Minimal sufficiency, plural predication, and scalarity

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Abstract. Minimal sufficiency readings of exclusive modifiers (*Just the thought of food makes me hungry*) have resisted a comprehensive semantic analysis that accurately predicts their distribution. In this paper we show that the distribution of minimal sufficiency readings is directly correlated with the interpretation of plural arguments and that the distributional facts reflect the connection between plural predication and scalarity: sufficiency readings are licensed precisely in contexts where ordering relations over alternatives are reversed. We develop a semantics for exclusives that is capable of generating either exclusive or sufficiency readings depending on the direction of scalarity.

Keywords: exclusives, alternatives, plurals, distributivity, cumulativity, presupposition.

1. Introduction

The empirical focus of this paper is the contrast in the interpretation of the exclusive modifier *just* in sentences like (1a) vs. (1b).

(1) a. **Just** five of these kids can play that piano.
b. **Just** five of these kids can lift that piano.

The *exclusive* reading of *just* is displayed in (1a). Established theories of exclusives (Horn, 1969; Rooth, 1992; Beaver and Clark, 2008; Coppock and Beaver, 2014) analyze (1a) in terms of two components: a "positive" presupposition that five of these kids can play that piano (the *prejacent*, paraphrasable as the corresponding sentence without the exclusive) and a "negative" assertion that more than five of these kids cannot play that piano. That is, (1a) entails that five is the *highest* number of kids who can play that piano.

The *minimal sufficiency* reading of *just* (Grosz, 2012; Coppock and Beaver, 2014; Coppock and Lindahl, 2014; Liu, 2017; Panizza and Sudo, 2020; Wimmer, 2022) is displayed in (1b). In contrast to (1a), in (1b) the prejacent is asserted rather than presupposed. There is also a presupposition that the prejacent is low on a contextually determined scale: in contrast to (1a), (1b) conveys that five is the *lowest* number of kids who can lift that piano.

In this paper, unlike existing work on sufficiency readings, we do not treat the exclusive reading as basic and derive the sufficiency reading via construction-specific compositional mechanisms. Instead, we argue that the availability of a given reading is predictable from the logical properties of the predicate. The paper is structured as follows. Section 2 reviews the characteristic inferences associated with exclusive and sufficiency readings and argues that a unified analysis is called for. Section 3 shows that the interpretation of *just* is systematically determined by the linguistic environment in which it appears, and is specifically sensitive to the interpretation of plural arguments. Section 4 identifies a unifying generalization based on the direction of scalarity allowed by different predicates, and we show how plural predication constrains scalarity. Section 5 proposes an analysis of *just* that is sensitive to scalarity and generates both readings in the appropriate environments.

2. Inferences

Support for treating the prejacent of (1a) as presupposed and the exclusive content as asserted comes from the inferences that are licensed when exclusive sentences are embedded under entailment-canceling operators (Horn, 1969). In (2), negation targets the exclusive content and ignores the prejacent: B's "No" response to A's question asserts that more than five kids can play, while still presupposing that five can play.

(2) A: Can **just** five of these kids play that piano?
B: No, {six/#four} can.
→ five kids can play the piano

The same test reveals the prejacent in minimal sufficiency sentences as at-issue: B's answer in (3) entails that five kids cannot lift the piano. However, the scalar presupposition projects out of A's question, which conveys that five is a low number. Despite these differences, one feature (2) and (3) share is that B's response must concern higher scalar values, not lower ones.

(3) A: Can just five of these kids lift the piano?
B: No, but {six/#four} can.
→ five kids can't lift the piano

A successful analysis of minimal sufficiency readings needs to relate their inferential profile to that of exclusive readings, explain which inferences are licensed when, and account for why the prejacent's at-issue status varies between readings.

Is the difference between exclusive *just* and sufficiency *just* a matter of lexical ambiguity, as suggested by Grosz (2012)? We think something more systematic is going on. Coppock and Beaver (2014) observe that sufficiency readings are productive across the class of exclusives. The naturally occurring examples in (4) (from the Corpus of Contemporary American English: `https://www.english-corpora.org/coca/`) show sufficiency readings with the English exclusives *only* and *merely*.

(4) a. These ingredients respect millions of years of evolution and leverage existing reactions in the body so **only a small amount** is needed to enhance biochemistry.
b. Researchers have found that **merely the status of being a mother** can lead to perceptions of lowered competence and commitment and lower salary offers.

Minimal sufficiency readings of exclusives are also attested in other languages. The naturally occurring examples in (5) (from the Paracrawl corpus: `https://paracrawl.eu/`) show that the Spanish exclusive *sólo* displays both exclusive (5a) and sufficiency (5b) readings. Liu (2017) makes analogous observations about *jiù* in Mandarin.

(5) a. **Sólo** hay un problema.
'There is just one problem.'
b. Con **sólo un poco más de esfuerzo**, hubiéramos triunfado.
'We would have succeeded with just a little more effort.'

The regularity of this phenomenon across languages and across lexical items in a single language suggests that there is a systematic connection between exclusive and sufficiency readings that should be accounted for. Although we focus on English *just* in this paper, our arguments apply to other exclusives as well to the extent that they pattern similarly. The main argument,

however, against an ambiguity account is that the interpretation of *just* is predictable from the linguistic context it appears in, as we show in the next section.

3. Distribution

To understand the relationship between exclusive and minimal sufficiency readings of *just*, we need to know which linguistic environments license each reading. In this section we survey a range of distributive, cumulative, and collective predicates (Champollion, 2020) and show that the interpretation of exclusive modification is tightly connected to the interpretation of plurality. Sufficiency readings are available with cumulative construals of "atom predicates" (Winter, 2002), but not collective "set predicates" or distributive construals of atom predicates.[1]

We assume a semantic ontology in which the domain of individuals includes sums, as in Link (1983) and much subsequent work. Additionally, we adopt Winter's (2001; 2002) typology of predicates, based on observations in Dowty (1987). This typology draws a sharp distinction between predicates whose denotations range over atomic individuals and predicates whose denotations range over sets of atoms.

On Winter's approach, predicates can be classified as either atom or set predicates depending on their behavior in sentences with singular and plural quantificational determiners (*every* vs. *all*; see also Moltmann, 1997; Hackl, 2002; Brisson, 2003; Champollion, 2015; Križ, 2016; Kuhn, 2020). If the choice of a singular vs. plural quantifier makes no difference in the acceptability or truth-conditions of a sentence with a predicate P, then P is classified as an atom predicate. Otherwise, P is classified as a set predicate. This test categorizes *smile* as an atom predicate because *All the students smiled* means the same thing as *Every student smiled*; *gather* by contrast is categorized as a set predicate because *All the students gathered* is acceptable and contingent whereas *#Every student gathered* is not (for a semantics of singular vs. plural determiners that grounds this distinction, see Winter, 2002).

As Champollion (2020) and others observe, it is still useful to distinguish between construals of atom predicates: (6a) can be construed distributively (6a) or cumulatively (6b).[2] The cumulative construal involves applying a property to a plural argument by "adding up" the properties of the plural argument's parts (Scha, 1981; Link, 1983; Krifka, 1999; Schmitt, 2019); for instance, (6b) can be true of two composers if one wrote the score and one wrote the lyrics.

(6) The composers wrote musicals.
   a. Each of the composers wrote musicals separately.
   b. The composers wrote musicals together.

Gillon (1987) observed that sentences like (6) also have "intermediate" readings that involve splitting a plurality into cumulative subsets: if the atomic individuals in the denotation of the plural subject *the composers* are Richard Rodgers, Oscar Hammerstein II, and Lorenz Hart then (6) must be interpreted as applying the predicate to the non-maximal sums

[1] Our empirical observations build on Liu (2017), who uses plural semantics to unify the analysis of the Mandarin exclusive *jiù*. He observes that its exclusive vs. sufficiency readings correlate with plural predication and explains this through variation in alternative sets based on sums vs. atoms. While his analysis focuses on deriving "weak" readings absent in English *just*, he does not address the link between plural predication, scalarity, and presupposition projection, which is our focus here.

[2] Similarly, Bar-Asher Siegal (2024) shows that both atom and set predicates can yield collective reciprocal readings.

Rodgers⊕Hammerstein and Rodgers⊕Hart for the sentence to be judged as true, since all three composers never wrote a musical together, and none of them wrote a musical individually.

We assume with Schwarzschild (1994; 1996) that plural noun phrases are interpreted relative to contextual COVERS. On this approach, a sentence NP_{pl} VP is true if every element in the intersection of NP_{pl}'s denotation with a contextually determined domain variable is included in the denotation of VP. Distributive construals arise when the cover is resolved to a set containing only the atomic individuals in the domain, whereas cumulative and intermediate construals arise when the cover is resolved to a set including sums of individuals. This approach treats the variable interpretation of plural arguments as an instance of quantificational domain selection (see also Gillon, 1987; van der Does and Verkuyl, 1996; Moltmann, 1997; Brisson, 2003; Malamud, 2006; Bar-Lev, 2024).

This quick sketch of plural semantics and predicate types glosses over many important details in a complex body of literature. See Champollion (2020) and references cited therein for review and discussion of the relevant issues, and comparison between approaches. Instead of using contextual covers it would be equally possible to use a generalized distributivity operator whose semantics is relative to covers (Link, 1987; Roberts, 1987; Lasersohn, 1998; Champollion, 2016) or adopt Schmitt's (2019) analysis of cumulativity in terms of plural projection. What matters for present purposes is that we recognize at least a three-way typology between set predicates and distributive and cumulative construals of atom predicates, since it is this distinction that matters for the interpretation of exclusive modification.

The interpretation of plural arguments constrains whether an exclusive (↓) or sufficiency (↑) reading of *just* is available. Representative examples of set predicates include *meet*, *gather*, *live together*, and *be similar* (Winter, 2002). Only exclusive readings of *just* are possible with these predicates. (7a) can only mean that groups other than the faculty did not meet; it cannot mean that the faculty is the smallest group to have had a meeting, and similar remarks apply to the other (7) examples.

(7) a. **Just the faculty** met. ↓
b. **Just the graduate students** gathered in my office. ↓
c. **Just three students** live together. ↓
d. **Just two paintings** were similar. ↓

Atom predicates vary in whether sufficiency readings of *just* are possible. When world knowledge forces a distributive construal, only exclusive readings are possible (8). (8a) can only mean that individuals other than my sister did not smile; it cannot mean that my sister is the smallest sufficient individual to count as having smiled (whatever that would mean), and similar remarks apply for *be vegetarian*, *be in the fridge*, and the object argument of *read*, all of which must be interpreted distributively due to selectional restrictions.

(8) a. **Just my sister** smiled. ↓
b. **Just the graduate students** are vegetarians. ↓
c. **Just five eggs** are in the fridge. ↓
d. I read **just three papers**. ↓

Atom predicates that can apply cumulatively to sums without applying to their parts include *lift*, *be numerous*, and *outnumber*. These predicates license sufficiency readings of *just*: for

instance, (9a) can mean that five is the smallest number of kids to have lifted the piano.

(9) a. **Just five kids** lifted the piano.↑ / ↓
b. **Just the graduate students** are numerous.↑ / ↓
c. The soldiers were outnumbered by **just this one enemy squad**.↑ / ↓

A striking feature of the (9) examples is that the interpretation of *just* covaries with the construal of the prejacent (Liu, 2017). (9a) can be interpreted distributively or cumulatively: either five kids each lifted the piano, or five kids lifted the piano together. When the prejacent gets a distributive construal, only an exclusive reading of *just* is available: five kids each lifted the piano, and it's not the case that a sixth kid lifted the piano alone. When the prejacent gets a cumulative construal, *just* switches to the sufficiency reading: five kids were the smallest group to lift the piano together. Similarly, (9b) can either get a sufficiency reading presupposing that the graduate students are the smallest group to count as numerous (i.e., they are more numerous than expected), or an exclusive reading denying that other groups are numerous. (9c) makes a similar point even though *this one enemy squad* denotes an atomic individual, so the prejacent only has one reading. However, the interpretation of *just* correlates with what the alternatives to the prejacent are taken to be. The exclusive reading of (9c) excludes alternatives that involve a distributive construal: no other squad individually outnumbered the soldiers. When alternatives involve larger sums, (9c) gets a sufficiency reading: the smallest group to outnumber the soldiers is this one enemy squad.

Sufficiency readings of *just* are also available with causative predicates like *make* (10a), comparatives (10b), and gradable predicates in the positive form (10c), all of whose semantics involves crossing a threshold; *count* in (10d) also explicitly refers to a threshold (examples from COCA).[3] In addition to fairly marginal and implausible exclusive readings, the (10) examples all have more prominent sufficiency readings that identify the denotation of the phrase modified by *just* as the minimal element to cross the relevant threshold; when the focus associate is plural (10c), each part of the plurality is credited with making some smaller contribution toward crossing the threshold.

(10) a. **Just thinking about lice** is enough to make your skin crawl.↑ (/ ↓)
b. I have said over and over: **just being governor** was more of a privilege than I ever expected to receive, and probably more of a privilege than I ever felt I deserved.↑ (/ ↓)
c. **Just two minor repairs** have already made the extra money worth it.↑ (/ ↓)
d. For the intellectual in this way of thinking, **just being what we are** counts as a political act.↑ (/ ↓)

Sentences with cumulative readings of multiple numerically quantified noun phrases (Scha, 1981; Brasoveanu, 2013) can receive minimal sufficiency readings when *just* modifies one of the arguments (11). (11a) shows a modification of Scha's famous example; a naturally occurring example (from COCA) is shown in (11b). The (11) examples both have sufficiency

[3]Although we do not have space to review the semantics of these predicate classes, in the case of causal claims Baglini and Bar-Asher Siegal (2020; 2025) argue that a cause in a causal statement is a necessary condition within a sufficient set of conditions. In examples like (10a), *just* indicates that the cause denoted by the focus associate is the minimally sufficient condition for bringing about the result denoted by the predicate, and no other (expected) conditions are needed.

readings: (11a) can mean that 600 is the smallest number of Dutch firms who cumulatively use 5000 American computers, and (11b) means that 100 is the smallest number of companies responsible for 71 percent of the world's carbon emissions. Although (11a) also has an exclusive reading in which 600 Dutch firms each use 5000 American computers and no other firms do, world knowledge precludes an exclusive reading of (11b).

(11) a. **Just 600 Dutch firms** use 5000 American computers.↑ / ↓
b. **Just 100 fossil fuel companies** are responsible for 71 percent of the world's carbon emissions.↑

Perhaps most tellingly, sufficiency readings appear with "upward scalar" predicates (Beck and Rullmann, 1999; Buccola and Spector, 2016), which typically involve modal possibility. A predicate is upward scalar if sentences containing it license entailments to higher scalar values. For instance, given the assumption that if n kids can lift the piano together, so can $n+1$, the predicate *can lift that piano* is upward scalar because (12a) entails that more than five kids can lift the piano. Similarly in (12b), if five eggs are sufficient to bake a cake, so are six eggs (but not necessarily four eggs). Beck and Rullmann (1999) define upward scalarity as a property of degree predicates, but this notion can be generalized to predicates of individuals (Rullmann, 1995): a predicate P is upward scalar if $P(x)$ entails that P applies to all sums containing x; upward scalarity from this perspective is essentially the opposite of distributivity.

(12) a. **Just five of these kids** can lift that piano. ↑ / ↓
b. **Just five eggs** are sufficient to bake a cake. ↑

The (12) sentences are most naturally interpreted as having minimal sufficiency readings: (12a) means that five is the smallest number of kids who can lift the piano; (12b) means that five is the smallest number of eggs that are sufficient to bake a cake.

Although distributivity forces an exclusive reading of *just*, the reverse is not true: cumulative construals of plural arguments are still compatible with exclusive readings, depending on what the alternatives are. Suppose the alternatives to Rodgers and Hart are Mozart and Handel; in this context, (13) can receive an exclusive reading denying that Mozart or Handel wrote musicals, although this reading does not involve "atomic" distributivity because Rodgers and Hart only wrote musicals together. However, imagine a context in which it usually takes at least ten people to write a musical: then (13) can get a sufficiency reading emphasizing that a small number of people wrote a musical all by themselves.

(13) **Just Rodgers and Hart** wrote musicals.↑ / ↓

Prior literature on minimal sufficiency readings does not get the distributional generalizations right. Grosz (2012) claims that *just* is lexically ambiguous between a standard exclusive entry and a semantically bleached entry whose only contribution is the low scalar presupposition. The challenge for an ambiguity analysis is to explain why the availability of the different readings is sensitive to the linguistic environment: all else being equal, we should expect both entries to be uniformly available. Coppock and Beaver (2014) analyze minimal sufficiency readings using a series of type-shifting operations that confine the scope of *just* to the modified expression, while the exclusive content is obviated by a matrix existential quantifier; the truth-conditions that result are equivalent to the prejacent. Since Coppock and Beaver do not restrict the availability of the relevant type-shifts, their analysis does not account for the distributional restrictions

described above. A second problem for this sort of analysis is that restricting the scope of *just* to its nominal argument fails to capture the scalar presupposition at the sentential level. Coppock and Lindahl (2014) attempt to restrict sufficiency readings to causative constructions and propose a modal analysis in which *just* quantifies over premise sets. To the extent that their analysis is successful it undergenerates readings, as we have shown that sufficiency readings appear with predicates that do not refer to causation.

Panizza and Sudo (2020) recognize that minimal sufficiency readings are unavailable with distributive construals of plural arguments and propose an analysis in which their availability is closely tied to the compositional mechanics that underlie plural predication. Like Coppock and Beaver (2014), they analyze *just* as taking local scope over the modified expression and obviate the exclusive content using a matrix existential quantifier. However, for Panizza and Sudo the existential type-shifting operation is Winter's (1996; 2001) *C*, whose application is triggered when a generalized quantifier-denoting argument composes with a set predicate, leading to type mismatch as both are type $\langle et \rangle t$. *C* raises the type of the quantifier by mapping it to a third-order property of individuals, which can subsequently take a set predicate as its argument; the resulting truth-conditions are again equivalent to the prejacent. Although this proposal successfully rules out sufficiency readings in the presence of distributivity, it predicts that they should only appear with set predicates—exactly the wrong class of non-distributive predicates, as we have seen from the examples in (7).

In the remainder of this paper we pursue a unified analysis of *just* that delivers either an exclusive or a sufficiency reading depending on the nature of the predicate, the argument, and the entailments of the prejacent.[4]

4. Scalarity

The empirical facts reviewed above show that the interpretation of exclusive modification is closely tied to the interpretation of plurality. Only exclusive readings of *just* are possible with set predicates and distributive construals of atom predicates. Both exclusive and sufficiency readings are possible with cumulative construals. In upward scalar environments, especially in the presence of possibility modals, only sufficiency readings are possible. Why are exclusives sensitive to plural predication in this way?

We think an explanatory analysis should consider how exclusive meaning interacts with informative strength. Exclusive readings of *just* convey that the focus associate is the maximal argument that satisfies the predicate. Sufficiency readings of *just* convey that the focus associate is the minimal argument that satisfies the predicate. This parallel suggests that both readings should be derived from a common core meaning. We suggest that the uniform contribution of exclusives across both readings is to contribute two inferences: an inference to the truth of the prejacent, and an inference that the prejacent is the strongest true focus alternative. Whether this latter contribution is interpreted as enforcing maximality or minimality depends on the

[4]Readers familiar with Buccola and Spector (2016) may recognize a familiar pattern. Buccola and Spector discuss the range of interpretations available to sentences containing downward entailing and non-monotonic modified numerals like *less than five* and *between three and seven*: in the presence of distributivity, these expressions generate upper-bounded scalar entailments that disappear when distributivity is not present. Although we are inspired by their analysis, there are several differences between exclusives and degree modifiers that need to be accounted for: exclusives are cross-categorial, focus-sensitive, and presuppositional.

properties of the predicate and the pragmatic strength ordering over focus alternatives (Beaver and Clark, 2008; Coppock and Beaver, 2014).

The observation that both exclusive and sufficiency readings maximize informativity enables a straightforward account of why sufficiency readings are not licensed in the presence of distributivity. As we have seen, examples like (14) can only have exclusive readings. This follows from the nature of distributivity: on the assumption that if five kids can play the piano, then each kid can play the piano, there is no way for five kids to be the smallest argument of the predicate *can play that piano*. Sufficiency readings are ruled out because they are in conflict with distributive entailments. When a predicate is interpreted distributively, larger plural arguments necessarily lead to stronger statements: the informative strength of a proposition denoted by a sentence containing a distributive predicate is positively correlated with the nominal argument's mereological size. *Just* for this reason marks the focus associate as the maximal argument of the predicate, leading to an exclusive reading.

(14) **Just five of these kids** can play that piano.

An analogous argument can be made for set predicates like *gather* (15). Set predicates typically have a relational meaning: a set predicate is true of a set-denoting argument if the relation denoted by the predicate holds between every member of the set. Set predicates therefore give rise to a limited sort of "weak distributivity" (Dobrovie-Sorin, 2014; Champollion, 2015; Buccola and Spector, 2016; Kuhn, 2020). If a set of ten students gathered, then every plural subset of students also gathered, excluding the singletons. These "weak" distributive entailments rule out a sufficiency reading in (15) for the same reason as in (14): the informative strength of a proposition denoted by a sentence containing a set predicate is positively correlated with the size of the nominal argument.

(15) **Just ten students** gathered in my office.

Sometimes, however, the semantics of a particular predicate/argument combination does not uniquely determine informative strength. These are the contexts in which both readings can emerge. For instance, suppose (16) is uttered in a context in which the question under discussion concerns how many kids lifted the piano individually. This context favors a distributive construal and *just* is therefore understood exclusively. Similarly, if (16) is uttered in a context in which the question under discussion concerns which groups lifted the piano, then the informative strength of a proposition is likewise positively correlated with the size of the nominal argument and (16) is interpreted exclusively with a cumulative prejacent: five kids lifted the piano together, and no other groups lifted the piano.

(16) **Just five kids** lifted the piano.

However, (16) is also compatible with a context in which the pragmatic informativity relations between the prejacent and its alternatives are quite different. If the question under discussion involves an implicit modal component—in this case, how many kids were cumulatively sufficient to lift the piano—then it is no longer the case that informative strength is positively correlated with the mereological size of the nominal argument. That is because of the background fact that it is easier for larger groups of people to lift a piano. In this context, stronger alternatives involve smaller groups of piano lifters. In contrast to the previous examples, here pragmatic strength relations over alternatives are *inversely* correlated with the mereological size of the

nominal argument. For this reason, *just* marks the focus associate as the minimal argument of the predicate, leading to a sufficiency reading.

Natural language appears to lack lexical predicates that are "upward scalar" with respect to parthood (i.e., if P applies to x, then P applies to all sums containing x, but not necessarily any subparts of x). However, Beck and Rullmann (1999) show that it is possible to derive upward scalar predicates at the phrasal level using possibility modals (see also Nadathur and Bar-Asher Siegal, 2022 for a related analysis of progressive aspect in terms of modal culmination). The assumption that if n kids can lift the piano together, so can $n+1$ means that the prejacent of (17) entails that n kids can lift the piano together for all $n > 5$ (see Beck and Rullmann's paper for an explicit derivation of this result using focus semantics). The incompatibility of an exclusive reading with the cumulative construal of (17) follows from this fact: there is no way for five kids to be the maximal argument of the predicate *can lift that piano* because there is no maximal argument. Instead, informative strength is again inversely correlated with the mereological size of the nominal argument, and *just* for this reason marks the focus associate as minimal.

(17) **Just five of these kids** can lift the piano.

Although pragmatic strength orderings often reduce to entailment relations (as is plausibly the case in (14), (17)), sometimes they do not: the prejacent of (16) does not entail that six kids lifted the piano. Rather, this sentence is most naturally uttered in a context in which alternatives are ordered by the difficulty, likelihood, or impressiveness of the lifting event, which leads to the characteristic inverse correlation between the number of lifters and the informative strength of an alternative that underlies sufficiency readings, but entails nothing about whether other lifting events occurred. Similarly, sufficiency readings can arise in contexts where the ordering over local alternatives to the focus associate does not track mereological size: the relevant sense of minimality in (18) is not about parthood, but rather how unpleasant or disgusting some activity is. It is not necessary to assume that less surprising catalysts for making your skin crawl (having lice, say) include the denotation of *thinking about lice* as a mereological part in order to obtain the minimal sufficiency reading, which should instead be paraphrased as: thinking about lice is the least unpleasant (lice-related) activity that is enough to make your skin crawl.

(18) **Just thinking about lice** is enough to make your skin crawl.

This variation in the relations used to order alternatives in context is characteristic of exclusive modifiers. Exclusive readings of *just* are known to also display it (Krifka, 1993; Coppock and Beaver, 2014). For instance, the naturally occurring (19) (from COCA) does not ask whether people bearing their souls on television is anything else in addition to a scam, which is the expected reading if the exclusive content always involves logically stronger alternatives; rather the question is whether it is a scam or something more legitimate. In this context the alternatives appear to be ordered on a scale of legitimacy rather than strict logical entailment. This is still an exclusive reading because the contribution of *just* is to mark the prejacent as the maximal true alternative on this scale.

(19) Should people bear their souls on television, or is it all **just a scam**?

The conclusion to be drawn from this discussion is that the distribution of exclusive vs. sufficiency readings is sensitive to the pragmatic strength orderings that are possible in a particular context, and specifically whether maximizing informative strength involves picking out the

largest or smallest argument to satisfy a predicate. Exclusive readings are observed in the presence of distributivity because distributive entailments enforce a positive correlation between informative strength and mereological size. Sufficiency readings are observed with predicates like *enough* and *sufficient* as they are associated with upward scalar entailments, which enforce the reverse correlation. The sensitivity to plural interpretation we observed in section 3 was somewhat surprising: nothing about the semantics of exclusive modification refers to plurality or parthood. However, once we recognize that the key to this pattern involves the constraints placed by the entailments of the prejacent on available pragmatic orderings over alternatives, our observations fall into place.

More abstractly, what appears to matter is the direction of isomorphism between two context-sensitive ordering relations: a "global" strength ordering over propositional alternatives to the prejacent, and a "local" category-specific ordering over alternatives to the focus associate. We propose that exclusives refer explicitly to these two orderings and implement our proposal by enriching the semantics of *just* with two free variables over relations: $\geq_R$, a relation over objects in the focus associate's alternative semantic value (Rooth, 1992), and $\geq_S$, a relation over propositions in the prejacent's alternative semantic value.[5] When *just* modifies a nominal argument, mereological parthood is a natural choice for $\geq_R$, but we have seen (in, e.g., (18)) that other gradable properties can instantiate this variable as well; when *just* modifies a numeral expression, $\geq_R$ is plausibly identified with the natural ordering of numbers. Exclusive readings arise when $\geq_R$ and $\geq_S$ are positively correlated. Sufficiency readings arise when $\geq_R$ and $\geq_S$ are inversely correlated.

This notion of scalar isomorphism is present in Beck and Rullmann's (1999) analysis of degree properties: they treat "downward scalar" predicates as monotone increasing functions from degrees to propositions, and "upward scalar" predicates as monotone decreasing functions from degrees to propositions. We present generalized definitions of scalarity in (20) using our pragmatic ordering relations $\geq_R$ and $\geq_S$.

(20) a. A predicate P is **downward scalar** iff $\forall x, y : x \geq_R y \rightarrow P(x) \geq_S P(y)$.
b. A predicate P is **upward scalar** iff $\forall x, y : x \geq_R y \rightarrow P(y) \geq_S P(x)$.

As we have seen, exclusive readings of *just* are licensed with downward scalar predicates and sufficiency readings are licensed with upward scalar predicates.

5. Analysis

Coppock and Beaver (2014) propose an analysis of exclusives designed to capture their sensitivity to pragmatic ordering relations. According to Coppock and Beaver exclusive meaning is specified in terms of two operators, MIN and MAX. MIN contributes existential quantification over alternatives: some alternative at least as strong as the prejacent on a pragmatic strength ranking is true (21a). MAX contributes universal quantification: no alternative stronger than the prejacent is true (21b). Below, ALT is a variable over sets of propositional alternatives; on Beaver and Clark's (2008) theory of focus, which models questions under discussion as ordered sets, ALT can be viewed as anaphoric to the QUD, which additionally supplies the ordering relation $\geq_S$. The presupposed content of exclusive sentences is specified in terms of MIN and the at-issue content is specified in terms of MAX. A polymorphic entry for *just* instantiating this

[5] Our use of $\geq_S$ follows Beaver and Clark (2008), who use S to index the current context and $\geq_S$ to order the alternative answers to the current QUD. Our introduction of $\geq_R$ is novel.

schema is given in (21c), using Sæbø's (2009) notation with at-issue content in the numerator and presuppositions in the denominator. We call this entry $just_{ex}$ for "exclusive *just*".

(21) a. $\text{MIN}(p) = \lambda w.\exists q_{\in \text{ALT}} : q(w) \wedge q \geq_S p$
b. $\text{MAX}(p) = \lambda w.\forall q_{\in \text{ALT}} : q(w) \rightarrow p \geq_S q$
c. $[\![\text{just}_{ex}]\!] = \lambda P_{\tau\langle st\rangle} \lambda x_\tau \lambda w. \frac{\text{MAX}(P(x))(w)}{\text{MIN}(P(x))(w)}$

This analysis captures the truth-conditions of sentences with exclusive readings of *just* (and *only*, etc) as follows. In a context where $\geq_S$ is identified with logical entailment, a sentence like (22) is predicted to presuppose that I met the graduate students: since all stronger alternatives entail the prejacent on an entailment scale, the contribution of MIN (that the prejacent or some stronger alternative is true) entails the prejacent. The exclusive content is at-issue and says that stronger alternatives are false; e.g., it's not the case that I met the graduate students and the faculty. Since stronger alternatives involve applying the predicate to larger sums of individuals, pragmatic strength is positively correlated with parthood, which as we have seen is characteristic of exclusive readings.

(22) I **just** met **the graduate students**.

In a context where $\geq_S$ is identified with some other gradable property (academic rank, say), (22) is predicted to presuppose only that I met some people ranked at least as high as the grad students; the exclusive content denies that I met higher-ranked people. In both contexts, the prejacent is entailed by the combination of presupposition and assertion. In the latter context, pragmatic strength is not correlated with parthood but academic rank. However, since this correlation is positive, the so-called "rank-order" reading of (22) (Horn, 2000) still conforms to our downward scalarity generalization.

When exclusive sentences are embedded under entailment-canceling operators, the prejacent is only predicted to project when alternatives are ordered by entailment. In (23), the negation of the exclusive content entails that some higher-ranked alternative is true; when these alternatives entail the prejacent, it projects under negation, and when they do not entail the prejacent, it does not project. This prediction is correct: as Krifka (1993), Beaver and Clark (2008), and others have observed, (23) can be heard either as asserting that I met others besides the grad students (presupposing that I met the grad students) or as asserting that I met some people ranked higher than the grad students (regardless of whether I met the grad students).

(23) I didn't **just** meet **the graduate students**.

This analysis does not account for minimal sufficiency readings even once our upward scalarity generalization is recognized. Consider (24a), which can intuitively be paraphrased as saying that Kim and Lee are the smallest group of people to have lifted the piano. In an upward scalar context, we expect an inverse correlation between mereological size and pragmatic strength, so the stronger alternatives plausibly involve smaller sums of individuals: Kim lifted the piano on her own, and Lee lifted the piano on his own. If these are the alternatives, an analysis of (24a) as presupposing Coppock and Beaver's MIN applied to the prejacent and asserting MAX would predict (24a) to presuppose that Kim and Lee lifted the piano, and assert that neither lifted it on their own, which is not correct. Negation in (24b) applies to the prejacent, not the inference that the prejacent is minimal—which survives negation.

(24) a. **Just Kim and Lee** lifted the piano.
b. It's not true that **just Kim and Lee** lifted the piano.
→ Kim and Lee didn't lift the piano

The problem with applying a standard exclusive entry to account for minimal sufficiency is that the different semantic components that exclusives contribute vary in at-issue status between exclusive and sufficiency readings. We argued that both readings involve an inference to the prejacent and an inference that the prejacent is the strongest true alternative. Standard analyses of exclusive readings treat the prejacent as presupposed and the maximality of the prejacent as at-issue. With sufficiency readings we observe the reverse pattern: the prejacent is at-issue and the minimality of the prejacent is presupposed. In light of this contrast, we propose to model sufficiency readings as presupposing Coppock and Beaver's MAX applied to the prejacent and asserting MIN. An entry for *just* instantiating this schema is given in (25), which we call $just_{ms}$ for "minimal sufficiency *just*".[6]

(25) $[\![\text{just}_{ms}]\!] = \lambda P_{\tau\langle st\rangle}\lambda x_{\tau}\lambda w.\frac{\text{MIN}(P(x))(w)}{\text{MAX}(P(x))(w)}$

This analysis captures the truth-conditions of *just* sentences with sufficiency readings as follows. A sentence like (24a) is predicted to presuppose that stronger alternatives are false. Since in this context pragmatic strength is inversely correlated with parthood, the exclusive content says: Kim didn't lift the piano on her own, and Lee didn't lift the piano on his own. This prediction is correct: as we have seen, (24b) shows that this inference projects under negation. The at-issue content says that the prejacent or some stronger alternative is true; since it is already presupposed that stronger alternatives are false, the content of the assertion is equivalent to the prejacent. This prediction is also correct as (24b) shows that negation targets the prejacent.

What is the relation between $just_{ex}$ and $just_{ms}$? Why do we observe "projection reversal" in upward scalar contexts? Since the flavor of *just* is sensitive to context and the linguistic environment, this alternation is presumably not a matter of lexical ambiguity, or else we would predict both flavors to be uniformly available. Rather, downward scalar environments systematically select for $just_{ex}$ and upward scalar environments for $just_{ms}$. The entries in (21c) and (25) vary only in the at-issue status of each component. We suggest that the direction of scalar isomorphism is what determines the at-issue status of *just*'s semantic contributions: *just* sentences have to make an assertion about higher scalar values, and presuppose something about lower scalar values, and whether we get $just_{ex}$ or $just_{ms}$ in a given context depends on which configuration would satisfy this constraint.

This result can be captured using a single lexical entry. Existing scalar analyses of exclusives use a free variable representing an underspecified ordering over propositional alternatives, $\geq_S$, to unify entailment vs. rank-order readings. We argued that the isomorphism between $\geq_S$ and an ordering over alternatives to the focus associate, $\geq_R$, is what predicts the availabil-

[6]Our analysis bears some similarity to a number of proposals in the literature on clefts. In particular, Velleman et al. (2012) analyze English *it*-clefts using the exact schema we have proposed in (25) as making an at-issue contribution consisting of Coppock and Beaver's MIN operator applied to the underlying prejacent and presupposing MAX (see also Büring and Križ, 2013). Since these proposals were developed primarily on the basis of data involving cleft constructions in downward scalar contexts, we do not predict synonymy between clefts and sufficiency readings of exclusives. The obvious next step in investigating the parallel between clefts and exclusives would be to investigate clefts in upward scalar contexts; for reasons of space, we do not pursue this line here.

ity of exclusive vs. sufficiency readings. The phenomenon of projection reversal in upward scalar contexts suggests that suggests that the at-issue content of *just* sentences is restricted to quantifying over alternatives derived from higher scalar values, and the presupposed content is restricted to quantifying over alternatives derived from lower scalar values. Our entry uses $\geq_R$ and $\geq_S$ to partition the prejacent's alternative semantic value into two subsets of alternatives that are delivered to the asserted and presupposed level respectively. The quantification at each level will ensure that the output of *just* is always equivalent to either an exclusive or a sufficiency reading depending on the direction of scalarity.

We define the FIELD of a relation in (26), from which the set itself can be reconstructed (it is the set of things that are ordered; see Krifka, 1999: pg. 11, Coppock and Beaver, 2014: pg. 393), and does not have to be redundantly represented.

(26) $\text{FIELD}(\geq) := \{x | \exists y[x \geq y \vee y \geq x]\}$

We define the auxiliary operators `above` and `below` in (27), which partition an ordered set around a fixed point. Their arguments are type-flexible: P and x represent *just*'s two semantic arguments, $\geq_R$ is a relation over objects that match P in type, and $\geq_S$ is a relation over propositions.

(27) a. $\texttt{above}(P,x) = \{q_{\in \text{FIELD}(S)} | \exists Q_{\in \text{FIELD}(R)}[Q \geq_R P \wedge Q(x) = q]\}$
b. $\texttt{below}(P,x) = \{q_{\in \text{FIELD}(S)} | \exists Q_{\in \text{FIELD}(R)}[P \geq_R Q \wedge Q(x) = q]\}$

The `above` operator can be thought of as delivering the subset of the prejacent's alternative semantic value that consists only of propositions derived by substituting higher scalar values for the P argument. For instance, suppose *just* composes with a plural argument, as in (28), in a context in which $\geq_R$ has been resolved to the natural ordering of numbers. Assuming for simplicity that *five kids* denotes a generalized quantifier over individuals, the `above` operator will create a set of propositions derived by applying quantifiers over sums with higher cardinality to the scope property, i.e., propositions in which higher numbers of kids played the piano (28a).

(28) Just five kids played the piano.
a. $\texttt{above}(\lambda P.\exists x[P(x) \wedge \textbf{kids}(x) \wedge \#(x) = 5], \lambda x.x$ played the piano$) = \{[\![5$ kids played the piano$]\!], [\![6$ kids played the piano$]\!], [\![7$ kids played the piano$]\!]...\}$
b. $\texttt{below}(\lambda P.\exists x[P(x) \wedge \textbf{kids}(x) \wedge \#(x) = 5], \lambda x.x$ played the piano$) = \{[\![5$ kids played the piano$]\!], [\![4$ kids played the piano$]\!], [\![3$ kids played the piano$]\!]...\}$

Similarly, the `below` operator can be thought of as delivering the subset of the prejacent's alternative semantic value that consists only of propositions derived by substituting lower scalar values for the P argument. In (28b), `below` creates a set of propositions derived by applying quantifiers over smaller sums to the scope property, i.e., propositions in which smaller numbers of kids played the piano. We assume that $\geq_R$ is always reflexive and that the `above` and `below` sets therefore both include the prejacent. We also assume that $\geq_R$ and $\geq_S$ are totally ordered sets with the same cardinality, which guarantees that the union of the `above` and `below` sets is equal to the prejacent's alternative semantic value.

Although the `above` and `below` sets are drawn from the prejacent's alternative semantic value (the field of $\geq_S$), the direction of $\geq_S$ plays no role in their calculation. In an upward scalar context (29), `above` still delivers a set of propositions derived from substituting higher scalar

values for the P argument, and likewise for `below` and lower values. The difference between the downward scalar (28) and the upward scalar (29) is that in (28) the `above` alternatives are stronger than the prejacent on the $\geq_S$ scale and the `below` alternatives are weaker, whereas in (29) the opposite is true.

(29) Just five kids lifted the piano.

a. $\texttt{above}(\lambda P.\exists x[P(x) \wedge \textbf{kids}(x) \wedge \#(x) = 5], \lambda x.x$ lifted the piano) = $\{[\![5$ kids lifted the piano$]\!], [\![6$ kids lifted the piano$]\!], [\![7$ kids lifted the piano$]\!]...\}$

b. $\texttt{below}(\lambda P.\exists x[P(x) \wedge \textbf{kids}(x) \wedge \#(x) = 5], \lambda x.x$ lifted the piano) $= \{[\![5$ kids lifted the piano$]\!], [\![4$ kids lifted the piano$]\!], [\![3$ kids lifted the piano$]\!]...\}$

An entry for *just* equivalent to $just_{ex}$ in downward scalar environments and $just_{ms}$ in upward scalar environments is given in (30), again using Sæbø's (2009) "fraction" notation for presuppositions. To simplify the notation we write `above`/`below` for $\texttt{above}(P,x)$/$\texttt{below}(P,x)$.

(30) $[\![just]\!] = \lambda P_{\tau\langle st\rangle}\lambda x_\tau \lambda w : \frac{\forall q \in \texttt{above}[q(w) \rightarrow P(x) \geq_S q] \wedge \neg\exists q \in \texttt{above}[q >_S P(x)] \rightarrow \exists q[q(w) \wedge q \geq_S P(x)]}{\forall q \in \texttt{below}[q(w) \rightarrow P(x) \geq_S q] \wedge \neg\exists q \in \texttt{below}[q >_S P(x)] \rightarrow \exists q[q(w) \wedge q \geq_S P(x)]}$

By relativizing the at-issue content of *just* sentences to alternatives in the `above` set, and the presupposed content of *just* sentences to alternatives in the `below` set, we directly account for the observation that the asserted content of *just* sentences must address higher scalar values and the presupposed content must address lower scalar values.

To capture the phenomenon of projection reversal, the strategy our entry employs is one of "double specification". In exclusive readings, the MIN part projects and the MAX part is at issue, while in sufficiency readings, the MAX part projects and the MIN part is at issue. This suggests that all four conjuncts (positive assertion, positive presupposition, negative assertion, negative presupposition) are always there, but in some environments they are contingent and in some environments they are trivial. According to (30), the at-issue content of a *just* sentence is specified in terms of a positive and a negative statement about the alternatives in the `above` set. The presupposition is specified in terms of a positive and a negative statement about the alternatives in the `below` set. Aside from this difference in the alternatives *just* quantifies over at each level, the formulas are exactly the same.

The first conjunct at the at-issue level, which states that the prejacent is stronger than all true alternatives in the `above` set, is equivalent to Coppock and Beaver's MAX. Because MAX involves universal quantification its contribution to truth-conditions is only felt when the consequent is contingent. In a downward scalar context the `above` alternatives are stronger than the prejacent on the $\geq_S$ scale and are therefore excluded. In an upward scalar context this conjunct is true by definition and is trivial.

The first conjunct at the presupposed level states that the prejacent is stronger than all true alternatives in the `below` set. In a downward scalar context this conjunct is trivial. In an upward scalar context the `below` alternatives are stronger than the prejacent on the $\geq_S$ scale and are therefore excluded. We have derived projection reversal for MAX.

The second conjunct at the at-issue level delivers identical output to Coppock and Beaver's MIN, but because MIN involves existential quantification we have modified it to be conditional on the maximality of the prejacent relative to the existential quantifier's restriction. This conjunct says that if there is no alternative in the `above` set that outranks the prejacent on the $\geq_S$ scale, then

some alternative at least as strong as the prejacent is true. In a downward scalar context the `above` alternatives are stronger than the prejacent, so the antecedent is never satisfied and this conjunct is trivial. In an upward scalar context the antecedent is always satisfied and MIN is therefore entailed.

The second conjunct at the presupposed level says that if there is no alternative in the `below` set that outranks the prejacent on the $\geq_S$ scale, then some alternative at least as strong as the prejacent is true. In a downward scalar context this condition is always satisfied and MIN is entailed. In an upward scalar context all other `below` alternatives outrank the prejacent on the $\geq_S$ scale and this conjunct is trivial. We have derived projection reversal for MIN.

Putting all the pieces together, the output of *just* in a downward scalar context reduces to a MIN presupposition and a MAX assertion, equivalent to the familiar $just_{ex}$ entry. We visualize this situation in (31) by boxing contingent content and dimming trivial content.

$$(31) \qquad just_{ex} = \frac{\boxed{\forall q \in \texttt{above}[q(w) \rightarrow P(x) \geq_S q]} \wedge \neg\exists q \in \texttt{above}[q >_S P(x)] \rightarrow \exists q[q(w) \wedge q \geq_S P(x)]}{\forall q \in \texttt{below}[q(w) \rightarrow P(x) \geq_S q] \wedge \boxed{\neg\exists q \in \texttt{below}[q >_S P(x)] \rightarrow \exists q[q(w) \wedge q \geq_S P(x)]}}$$

In upward scalar context we find the opposite situation: *just* delivers a MAX presupposition and a MIN assertion, equivalent to $just_{ms}$, which we visualize in (32).

$$(32) \qquad just_{ms} = \frac{\forall q \in \texttt{above}[q(w) \rightarrow P(x) \geq_S q] \wedge \boxed{\neg\exists q \in \texttt{above}[q >_S P(x)] \rightarrow \exists q[q(w) \wedge q \geq_S P(x)]}}{\boxed{\forall q \in \texttt{below}[q(w) \rightarrow P(x) \geq_S q]} \wedge \neg\exists q \in \texttt{below}[q >_S P(x)] \rightarrow \exists q[q(w) \wedge q \geq_S P(x)]}$$

This entry for *just* therefore accounts for projection reversal while keeping the presupposed and at-issue content consistent. By modeling ordering relations over alternatives as free variables, our entry allows for significant context-sensitivity while still capturing the distribution of exclusive and sufficiency readings. It is impossible to get upward scalar resolutions of $\geq_R$ and $\geq_S$ with set predicates or distributive construals of atom predicates; given our entry, such choices of ordering relations would result in a global meaning that contradicts the distributive entailments of the prejacent. When the prejacent generates entailments to higher scalar values then downward scalar resolutions of $\geq_R$ and $\geq_S$ are likewise impossible.

6. Conclusion

Minimal sufficiency readings have posed a challenging problem for theories of exclusive semantics. This paper argued for a unified analysis of exclusive and sufficiency readings and showed that the interpretation of *just* depends on the logical properties of the linguistic environment. Sufficiency readings are ruled out with set predicates and distributive construals of atom predicates, while cumulative construals allow both readings depending on what the alternatives are taken to be. Sentences that generate entailments to higher scalar values require sufficiency readings. These distributional generalizations can be accounted for in terms of downward vs. upward scalarity: exclusives are sensitive to the direction of isomorphism between local and global ordering relations over focus alternatives, which determine the projection behavior of their semantic components. Future research should investigate why presupposition is linked to scalarity in the manner we observed.

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