

The Downward Persistence of Individual-Level Predicates

March 7, 1998

1 Introduction This paper aims to demonstrate that an assumption regarding the entailments of plural NPs that is central to many approaches to plural semantics cannot be maintained. The analyses of Lasnik 1995; Link 1983 and 1993; Schwarzschild 1991 and 1993, among others, are explicitly designed so as to block the entailment from a collective reading to a distributive one. We offer empirical evidence that the entailment is in fact valid for individual-level predicates and explain its apparent failures in terms of a pragmatic default principle of “exhaustiveness implicature.” An analysis is then sketched which seeks to retain the crucial insights of Lasnik’s 1995 and Schwarzschild’s 1996 approaches to plural semantics, but which predicts the correct entailments.

2 Assumptions For the purposes of this discussion, we will assume with *inter alia* Link 1983 and 1993; Landman 1989; Lasnik 1995; and Schwarzschild 1991 and 1996, and contra e.g. Schein 1993, that capturing the semantics of plural NPs requires enriching the domain of interpretation to include “plural objects” that can be built up from individuals by means of a mereological sum operator \oplus . For simplicity, we will follow Link 1983 in assuming that \oplus is a semi-lattice join operation¹ and use \sqsubseteq to represent the corresponding “part-whole” ordering.

3 Atomic and Joint Readings A crucial benchmark for any theory of plural semantics is its ability to capture the distinction between “distributive” and “collective” readings. We use here the special terminology “atomic” and “joint” reading to refer to the restriction of these concepts to individual-level predicates. By individual-level, we refer to predicates that can be meaningfully applied to a non-group, in contrast to group-level predicates like *gather* or *see each other*.

A common approach to the atomic/joint distinction has been to argue that certain individual-level predicates need not be downward-persistent along the part-whole ordering on objects (taken to include both individuals and “pluralities,” i.e. non-singleton groups thereof). For instance, “be asleep” is obligatorily downward-persistent and thus allows no joint reading. Thus, (1b) and (c) are equivalent. On the other hand, “lift the couch” does not require such persistence. Therefore, (2b) and (c) are independent. If the first but not the second holds, we have a pure joint reading. The other way around yields the pure atomic reading.

- (1) (a) John and Mary are asleep.
(b) $\text{John} \oplus \text{Mary} \in \llbracket \textit{asleep} \rrbracket$
(c) $\text{John} \in \llbracket \textit{asleep} \rrbracket$ and $\text{Mary} \in \llbracket \textit{asleep} \rrbracket$
- (2) (a) John and Mary lifted the couch.
(b) $\text{John} \oplus \text{Mary} \in \llbracket \textit{lifted the couch} \rrbracket$
(c) $\text{John} \in \llbracket \textit{lifted the couch} \rrbracket$ and $\text{Mary} \in \llbracket \textit{lifted the couch} \rrbracket$

We argue that the atomic/joint distinction cannot be captured in this way. First of all, our intuitive judgements regarding the logical relationship between the joint reading and the atomic reading are less than clear. Are the two in fact independent? It does not seem entirely infelicitous to claim that *John lifted the couch* in a situation where he and Mary have lifted it together, but he has never actually lifted it alone. As a more dramatic example, consider a collectively committed

¹I.e. it is commutative, idempotent, and associative. Landman and Schwarzschild actually work with a set inclusion ordering, but a few extra restrictions on \oplus make the two algebras isomorphic (see Landman 1989).

murder, none of whose perpetrators dealt the final mortal blow to the victim. We still feel justified in saying of each of them separately “he has killed a man,” even though the pure joint reading as described above ought not to allow it. It seems that to handle such cases, the conception sketched above would need to introduce a new special mechanism, e.g. a metonymy operator that could exceptionally allow atomic responsibility for joint action.

Harnish 1976 has explored the possibility that even under the pure joint reading, (2a) entails the sentences *John lifted the couch* and *Mary lifted the couch*. The fact that in isolation, either sentence is usually taken to convey that its subject lifted the couch *alone* is argued to actually be the result of a conversational implicature. In a nutshell: since in the description of an event, the identities of its participants are generally relevant, the Gricean maxims of Relation and Quantity (Grice 1989) conspire to oblige the speaker to mention them all. Thus, *John lifted the couch* will usually implicate that John was the sole lifter in the relevant event, which is inconsistent with the pure joint reading. We call this an “exhaustiveness implicature.”

4 Evidence The following argument against downward persistence appears in some form or other in most of the sources cited. Imagine a situation in which (3a) is true on the pure joint reading, i.e. neither John nor Mary is serving as the sole physical cause for the couch’s upward movement. Assume furthermore that the couch weighs 100kg, and neither John nor Mary can lift over 60kg alone. It is claimed that (3b) must be false. In particular, assume that *X is V-ing* implies *X can V*. Then if (b) were true, (c) would have to be, which seems to contradict our assumption.

- (3) (a) John and Mary are lifting the couch.
 (b) John is lifting the couch.
 (c) John can lift the couch.

It is certainly the case that on the joint reading, (3a) cannot end up entailing that John be able to be the sole physical cause of the upward movement of a 100kg object. However, it is debatable whether (3c) actually means this. We claim that examples of the following type demonstrate a context in which downward entailment is not blocked:

- (4) (a) John can lift the couch, if Mary helps him.
 (b) I can lift the couch, if you grab the other end.
 (c) I lifted your couch as I promised, but I ended up needing Mary’s help.

Notice that (4a) does not claim that if certain prerequisites obtain (namely Mary’s help), then it is possible for John to be the sole physical cause of the couch’s upward movement. This shows quite clearly that *be lifting X* cannot be coextensive with *be the sole physical cause of X’s upward movement*. (4b) gives a more colloquial example of the same phenomenon, and (4c) demonstrates that the entailment is not tied to modality.

The data in (4) are not surprising if one assumes with Harnish that individual-level predicates always entail downward and ascribes the apparent falseness of (3c) to implicature. In particular, the examples in (4) all allow the entailment to go through, in that they cancel the exhaustiveness implicature by introducing the other participants into the discourse. In the next sections, we will explore what effect recognizing the facts of downward persistence must have on one’s theory of plural semantics.

Another suggestive piece of evidence comes from the adverb *mit* found in many varieties of colloquial German.² One of its main functions is to cancel an exhaustiveness implicature without necessitating mention of other participants. Thus, (5b) cannot be understood to mean that Hans was the sole lifter, unlike (5a).

- (5) (a) Hans hat das Sofa angehoben
 Hans has the sofa lifted
 ‘Hans lifted the sofa.’

²The separation of *mit* from the final verb in (5b) suggests that this word is indeed distinct from the homophonous verbal prefix. Judgements on these data are subject to a good deal of variation.

- (b) Hans hat mit das Sofa angehoben
 Hans has “MIT” the sofa lifted
 ‘Hans participated in the lifting of the sofa.’

If the predicate in (5a) did not entail downward, then (5a) could be false while (5b) were true. This would require giving *mit* a complex, non-intersective semantic analysis that would enable it to operate on predicates to change their denotation. However, we show in section 7 how a simple treatment of the semantic contribution of *mit* can be given if downward entailment is assumed.

5 Upward Closure So that the interpretation of the application of any predicate to a plural NP can be stated uniformly, Link 1983; Roberts 1987; and Lasersohn 1995 distinguish “basic” predicate denotations from their closures under the sum operation (here written $\oplus[P]$). It is still possible to continue to interpret the semantic contribution of singular arguments by reference to the former, but it is with respect to the latter that sentences with plural subjects must be evaluated. The intent is that John \oplus Mary may be in the denotation of *lift the couch* not only by virtue of joint action, but also possibly thanks to closure even on an atomic reading.

Notice however that once our conclusion is accepted, this “summation” becomes irrelevant for the semantics individual-level predicates at any rate, since persistence will ensure the presence of all atomic subparts even in the basic predicate denotation. Intuitively, the truth conditions for such a sentence can be reformulated thus:

- (6) $\llbracket \text{Subject Predicate} \rrbracket = 1$ iff for all $x \sqsubseteq \llbracket \text{Subject} \rrbracket$, $x \in \llbracket \text{Predicate} \rrbracket$

6 The Informational Impoverishment of Predicate Extensions It should be observed that the predicate closure operation complicates the expression of the atomic/joint distinction, since nothing about a group itself can be used to tell whether it was in the basic denotation or was derived by closure. Nonetheless, without downward persistence, we could at least partially distinguish the extensions of predicates on the pure atomic vs. pure joint readings. To see if $x \in \oplus[P]$ solely by virtue of joint action, all we needed to do was find out for each $y \sqsubseteq x$ whether y was in the basic denotation of P . On the other hand, since we are now forced to accept downward persistence, the predicate can have all the same members on either reading. Thus there is nothing at all left in predicate extensions which can be referenced by adverbs and determiners which interact with the atomic/joint dichotomy, such as *together*, *alone*, *each*, and *separately*.

We agree with Lasersohn 1990 that the level of granularity at which the atomic/joint distinction can be expressed is that of events. Because of their characteristic of closing both downward and upward, predicate denotations will simply not carry enough information to encode the difference. There still must be some kind of “basic denotation” at which the semantics of plurals bottom out. Our intent is to interpret events in just this way. Rather than denoting sets of individuals, each predicate will now be associated with a particular event-type and an inventory of thematic roles. The lifter-role of a predicate associated with a lifting event-type will relate each lifting event to the unique object that was the sole lifter in that event. To achieve this goal, we enrich our model to include:

- a set E of events,
- a total function EVENT-TYPE from E onto $\wp(E)$,
- the interpretation function \mathcal{T} , a total function from predicates of the language into EVENT-TYPE(E) (we write $P_{\mathcal{T}}$ for $\mathcal{T}(P)$), and
- for each $K \in \text{EVENT-TYPE}(E)$, a set ROLES(K) of total functions from K into the domain D of objects (individual and plural).

Intuitively, EVENT-TYPE divides the events up into (possibly overlapping) types, \mathcal{T} correlates each predicate with the appropriate event-type, and ROLES assigns each event-type an inventory of appropriate thematic roles. Each such role in turn associates each event in a given event-type with the individual or group of individuals who play that role in that event. We do not go any further here into how grammatical positions or functions become associated with roles— for discussion, see Bayer 1996.

7 Towards an Analysis One of the main insights of Schwarzschild 1991 and 1996 is that the application of a predicate to an argument takes into account not only the extensions of each, but also how the extension of the argument can be divided up. Specifically, unlike Link, he does not actually close the denotation of the predicate; rather, he evaluates the truth of the predication by determining for some specific cover of the denotation of the subject³ whether each of its cells is an element of the predicate denotation. He furthermore argues that the choice of cover is pragmatically determined. We will incorporate this insight into the account we sketch below. The most important difference between the approaches is that for us, interpretation proceeds by pragmatic association of subparts of the argument denotation with *events*.

To determine the value of $\llbracket \text{Subject Predicate} \rrbracket$, it is necessary to establish a pragmatic association Δ between the atoms of $\llbracket \text{Subject} \rrbracket$ and the events of the type appropriate to $\llbracket \text{Predicate} \rrbracket$. We write $\text{Atoms}(x)$ for $\{y \mid y \sqsubseteq x \text{ and for all } z \in D, z = y \text{ if } z \sqsubseteq y\}$. (7a) is the minimal requirement that any appropriate Δ must fulfill. The basic sentence interpretation rule given in (7b).

- (7) (a) Δ is a total function from $\text{Atoms}(\llbracket \text{Subject} \rrbracket)$ into $\text{Predicate}_{\mathcal{T}}$
 (b) $\llbracket \text{Subject Predicate} \rrbracket^{\Delta} = 1$ iff
 for all x in the domain of Δ , $x \sqsubseteq \theta_{\text{Subj}}(\Delta(x))$
 (where θ_{Subj} is the role in $\text{ROLES}(\text{Predicate}_{\mathcal{T}})$ associated with *Subject*)

These principles give a very weak semantics for sentences with plural subjects. Without further restrictions, their effect will be equivalent to (6) above. The idea is that contextual factors, or other elements like adverbs, can introduce pragmatic restrictions that further constrain Δ . First of all, the context serves in most cases to introduce the “exhaustiveness implicature” discussed above. This can be formalized as the default requirement (8), which holds whenever the common ground of discourse does not contain any other participants in the event. Although we state this as a Δ -restriction, we believe it is derivable from Gricean maxims.

- (8) For all x in the domain of Δ , $x = \theta_{\text{Subj}}(\Delta(x))$

As a further example, the adverb *together* seems to function to force a joint reading. This follows if we assume that *together* introduces the constraint that Δ is a constant function.

The last such Δ -restrictor we want to address is associated with the German adverb *mit* discussed in section 4 above. This can be given a simple analysis by assuming that it places a restriction on Δ that has the effect of canceling the exhaustiveness implicature:

- (9) For all x in the domain of Δ , $x \neq \theta_{\text{Subj}}(\Delta(x))$

An important characteristic of all these Δ -restrictions is that they can also be taken over to give the right readings for group-level predicates, as long as (7a) is correctly revised (exactly what Δ 's domain should be in these cases is a complex issue that we suppress here for reasons of space). For instance, if we are told that the girl scouts met, we invoke the same exhaustiveness implicature to conclude that they were the only meeters in the relevant situation. Adding *mit* to the German translation cancels this implicature in exactly the same way.

8 Conclusion We have sought to demonstrate that despite appearances to the contrary, individual-level predicates are downward persistent along the part-whole ordering. The analysis we sketched left some fundamental issues unresolved, such as how the compositional semantics of sentences with multiple plural NPs should be approached. Furthermore, we have not presented any general theory of what kind of constraints may serve as Δ -restrictions; it is clear that we have yet to delimit the natural class that human languages can make use of. Nonetheless, we believe that our proposal spells out the general shape that any account of plurals will have to take in order to cope with the complications that downward entailments introduce.

³Translating Schwarzschild's terminology into our semi-lattice structure, we can say a set $S \subseteq D$ is a cover of an object $x \in D$ iff for every $y \sqsubseteq x$ there is some $z \in S$ such that $y \sqsubseteq z$.

References

- Bach, E. (1986). The algebra of events. *Linguistics and Philosophy* 9.1, 5–16.
- Bayer, S. L. (1996). *Confessions of a Lapsed Neo-Davidsonian: events and arguments in compositional semantics*. New York: Garland.
- Grice, H. P. (1989). *Studies in the Way of Words*. Cambridge: Harvard University Press.
- Harnish, R. (1976). Logical form and implicature. In T. Bever, J. Katz, and T. Langendoen (Eds.), *An Integrated Theory of Linguistic Ability*. New York: Thomas Cromwell.
- Landman, F. (1989). Groups, I. *Linguistics and Philosophy* 12.5, 559–605.
- Lasnik, P. (1990). Group action and spatio-temporal proximity. *Linguistics and Philosophy* 13.2, 179–206.
- Lasnik, P. (1995). *Plurality, Conjunction, and Events*. Dordrecht: Kluwer.
- Link, G. (1983). The logical analysis of plurals and mass terms: a lattice-theoretical approach. In R. Bäuerle et al. (Eds.), *Meaning, Use, and Interpretation of Language*. New York: de Gruyter.
- Link, G. (1993). Plural. In D. Wunderlich and A. von Stechow (Eds.), *Handbook of Semantics*. Berlin: Mouton de Gruyter.
- Roberts, C. (1987). *Modal Subordination, Anaphora and Distributivity*. Ph. D. thesis, University of Massachusetts, Amherst, MA.
- Schein, B. (1993). *Plurals and Events*. Cambridge: MIT Press.
- Schwarzschild, R. (1991). *On the meaning of definite plural noun phrases*. Ph. D. thesis, University of Massachusetts, Amherst, MA.
- Schwarzschild, R. (1992). Types of plural individuals. *Linguistics and Philosophy* 15.6, 641–675.
- Schwarzschild, R. (1996). *Pluralities*. Dordrecht: Kluwer.