

Proceedings of the
Sixteenth Amsterdam Colloquium
December 17 — 19, 2007

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Preface

The 2007 edition of the Amsterdam Colloquium is the Sixteenth in a series which started in 1976. Originally, the Amsterdam Colloquium was an initiative of the Department of Philosophy of the University of Amsterdam. Since 1984 the Colloquium is organized by the Institute for Logic, Language and Computation (ILLC) of the University of Amsterdam.

These proceedings contain the abstracts of most of the papers presented at the colloquium. In the first section one can find abstracts of talks given by the invited speakers. The second section contains contributions to the workshop on uninterpretability, co-organized by Hedde Zeijlstra. The third section consists of the contributions to the general program. In all cases the copyright resides with the individual authors.

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- » (the invited speakers) David Beaver, Patrick Blackburn, Pauline Jacobson, Angelika Kratzer, Louise McNally, James Pustejovsky, and Anna Szabolcsi
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The Editors
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Invited Speakers

ON THE LOGIC OF VERBAL MODIFICATION

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Abstract: We describe Linking Semantics, providing a uniform compositional analysis of argument-dropping inferences, quantifier scope, and temporal modification.

1. Introduction and principal definitions

A Montagovian verb chops through a set menu of arguments in a set order. Neo-Davidsonian verbs eat *à la carte*, selecting variable numbers of arguments and adjuncts in varying orders. But existing neo-Montagovian and neo-Davidsonian approaches do not exhaust the space of possible analyses of modification, and we present an alternative.¹

We define the meaning of a verb in terms of the roles specified by expressions the verb combines with. We use partial assignment functions, which act like Davidsonian events: they link the verb to its arguments and modifiers. A verb meaning is a *linking structure*, a function from assignments to truth values. In fact all verbal projections, including sentences, denote *linking structures*, while arguments and modifiers are uniformly functions from linking structures to linking structures.

Let L range over linking structures, f, g over role assignments, and x over individuals, which include times and worlds. We use the following notation for talking about assignments: (i) $g =_R f$ means that g differs from f at most with respect to the value it gives to role R , (ii) $f + [R, x]$ is defined when f does not have role R in its domain, and in this case denotes the assignment like f except additionally mapping R to x , and (iii) $f[R, x]$ is defined when f does have role R in its domain, and denotes the assignment like f except mapping R to x .

We use roles like “ARG1” and “ARG2”: these are to be understood in terms of surface syntax, so ARG1 (typically called a subject) is the argument that is canonically

¹As regards Montague Grammar, see, of course, Montague (1973). Relevant developments are in Dowty (1979a; 1979b), and developments specific to §4 are in Pratt and Francez (2001) and von Stechow (2002). For Davidsonian Event Semantics, the original proposals of Davidson (1980) and Castañeda (1967) have been developed in many directions, e.g. Kratzer (2003), Krifka (1992; 1989), Parsons (1990), Pietroski (2006), Schein (1993), and the Rothstein (1998) collection. Our event-free variant of Davidsonian Event Semantics is foreshadowed by proposals of McConnell-Ginet (1982) and Landman (2000:§3.4.3).

realized to the left of a verb in English, and ARG2 is the argument that is typically called a direct object. For any verb V , a set of canonical arguments is given by $C(V)$, thus $\{T(IME), W(ORLD), ARG1\}$ for an intransitive verb, $\{T, W, ARG1, ARG2\}$ for a transitive verb, and e.g. $\{T, W, ARG1, ARG2, ILOC\}$ for *put* (where ILOC means *internal location*). Nominal predicates have the standard $\langle e, t \rangle$ type, and determiners also have their standard $\langle \langle e, t \rangle, \langle \langle e, t \rangle, t \rangle \rangle$ meanings. We assume that syntactic role labels act on DP meanings to produce verbal modifier meanings.

We allow role labels to act on DPs in two ways depending on whether the role is taken to saturate an argument position (1), or not (2). A saturating role, such as ARG1, forms a modifier which maps a set of assignment functions to a new set that is no longer defined on that role: this prevents a verb from combining with two subjects. Non-saturating modification is discussed in §4.

- (1) $[[DP:SROLE]]_M = \lambda L \lambda f [[DP]_M^{f(W), f(T)} (\lambda x L (f + [SROLE, x]))]$
- (2) $[[DP:NROLE]]_M = \lambda L \lambda f [[DP]_M^{f(W), f(T)} (\lambda x L (f [NROLE, x]))]$

Here, we take prepositions to contribute nothing more than the identity of the role, and for purposes of this paper we will simply assume that $[[P DP]]_M = [[DP:P]]_M$.

We now define truth with respect to a model (taking $[w, w; T, t]$ to be an assignment mapping role w to w and T to t), and entailment:

- (3) $M, w \models S$ iff $\exists t [[S]]_M ([w, w; T, t])$
- (4) $\phi \models \psi$ iff $\forall M, w \ M, w \models \phi \rightarrow M, w \models \psi$

Linking Semantics depends on two further axioms. The argument reduction axiom (5) has the effect that missing optional arguments act as if existentially closed. The temporal closure axiom (6) implies that something which happens during an interval can also be said to have happened within all larger intervals.

- (5) **Argument reduction axiom** For any verb V and Model M , if $f \in [[V]]_M$, $C(V) \subseteq \text{dom}(g)$, and $g \subset f$, then $g \in [[V]]_M$.
- (6) **Temporal closure axiom** For any verb V and Model M , if $f \in [[V]]_M$, $f =_T g$ and $f(T) \sqsubset g(T)$, then $g \in [[V]]_M$.

2. Basic derivations and inferences

Linking Semantics derivations have the following basic format:

- (7) $[[Mary]]_M^{w, t} = \lambda P [P(m)]$
 $[[Mary:ARG1]]_M = \lambda L \lambda f [\lambda P [P(m)] (\lambda x L (f + [ARG1, x]))]$
 $= \lambda L \lambda f [L (f + [ARG1, m])]$
 $[[past]]_M = \lambda L \lambda f [L (f) \wedge f(T) < \text{NOW}]$
 $[[laughed]]_M = \lambda g [\text{laugh}'(g) \wedge g(T) < \text{NOW}]$
 $[[Mary laughed]]_M = [[Mary:ARG1]]_M ([[laughed]]_M)$
 $= \lambda f [\text{laugh}'(f + [ARG1, m]) \wedge f(T) < \text{NOW}]$
 $M, w \models \text{Mary laughed}$ iff $\exists t \text{laugh}'([w, w; T, t; ARG1, m]) \wedge t < \text{NOW}$

Let us define an *existential DP* to be one such that “DP VP” entails “something VP”, and thence an *existential modifier* to be either an existential DP or a PP consisting of a preposition and an existential DP. Then the following argument reduction lemma holds: if (i) all DPs and modifiers in a sentence S are existential, (ii) S includes at least the canonical arguments of its main verb, and (iii) S' is a sentence consisting of S plus any number of additional existential modifiers, then $S' \models S$ in Linking Semantics. Here is a simple example:

- (8) $M, w \models$ Brutus stabbed Caesar with a knife in the forum *iff*
 $\exists t \text{ some}(\text{knife}'_{w,t})(\lambda x$
 $[\text{stab}'([\text{W}, w; \text{T}, t; \text{ARG1}, b; \text{ARG2}, c; \text{WITH-INST}, x; \text{EXT-LOC}, \text{the_forum}'])$
 $\wedge t < \text{NOW}])$

It follows from the above argument reduction lemma that *Brutus stabbed Caesar with a knife in the forum* \models *Brutus stabbed Caesar with a knife*, and *Brutus stabbed Caesar with a knife* \models *Brutus stabbed Caesar*.

However, downward monotone DPs reverse this effect. Claim: if (i) all DPs and modifiers in a sentence S except one are existential, (ii) that one modifier is downward monotone, (iii) S includes at least the canonical arguments of its main verb, and (iv) S' is a sentence consisting of S plus any number of additional existential modifiers, then $S \models S'$ in Linking Semantics. So, for example, *Nobody stabbed Caesar* \models *Nobody stabbed Caesar with a sword*.

3. Quantification and Scope

We now consider a more complex derivation, for a sentence involving two quantified arguments:

- (9) $\llbracket \text{every country} \rrbracket_M^{w,t} = \lambda P \text{ every}(\text{country}'_{w,t})(P)$
 $\llbracket \text{every country:ARG2} \rrbracket_M = \lambda L \lambda f [\text{every}(\text{country}'_{f(\text{W}),f(\text{T})})(\lambda y L(f + [\text{ARG2}, y]))]$
 $\llbracket \text{a diplomat} \rrbracket_M^{w,t} = \lambda P \text{ some}(\text{diplomat}'_{w,t})(P)$
 $\llbracket \text{a diplomat:ARG1} \rrbracket_M = \lambda L \lambda f [\text{some}(\text{diplomat}'_{f(\text{W}),f(\text{T})})(\lambda x L(f + [\text{ARG1}, x]))]$
 $\llbracket [\text{a diplomat:ARG1}] \text{ visited } [\text{every country:ARG2}] \rrbracket_M =$
 $\lambda f [\text{some}(\text{diplomat}'_{f(\text{W}),f(\text{T})})$
 $(\lambda x [\text{every}(\text{country}'_{f(\text{W}),f(\text{T})})$
 $(\lambda y [\text{visit}'(f + [\text{ARG1}, x; \text{ARG2}, y]) \wedge t < \text{NOW}])])]$
 $M, w \models [\text{a diplomat:ARG1}] \text{ visited } [\text{every country:ARG2}]$ *iff*
 $\exists t \text{ some}(\text{diplomat}'_{w,t})(\lambda x [\text{every}(\text{country}'_{w,t})$
 $(\lambda y [\text{visit}'([\text{W}, w; \text{T}, t; \text{ARG1}, x; \text{ARG2}, y]) \wedge$
 $t < \text{NOW}])])$

Note that the temporal closure axiom plays an essential role in the above interpretation. The meaning of “A diplomat visited every country” comes out as meaning that there is a single interval in the past which contains all the visits, but this does not imply that the visits were simultaneous. For example, suppose the diplomat visited Uganda on Tuesday, and Kenya on Wednesday. Temporal closure guarantees that for any interval containing Tuesday the diplomat visited Uganda in that interval, and

for any interval containing Wednesday the diplomat visited Kenya in that interval. Thus the diplomat visited both countries in any interval containing both Tuesday and Wednesday.

We can get the reverse scoping just by raising the object DP:

- (10) $M, w \models [\text{every country:ARG2}][[\text{a diplomat:ARG1}] \text{ visited}]$ iff
 $\exists t \text{ every}(\text{country}'_{w,t})(\lambda y[\text{some}(\text{diplomat}'_{w,t})$
 $(\lambda x[\text{visit}'([\text{W}, w; \text{T}, t; \text{ARG1}, x; \text{ARG2}, y]) \wedge$
 $t < \text{NOW}])])$

Here we see that in Linking Semantics movement does not need to leave a trace behind. Also note that there is nothing inherent to the framework that requires movement: we could equally well have defined the semantics directly on surface structures in such a way that the set of all meanings of a sentence was given by applying their meanings in every possible order to the meaning of the main verb.

4. Temporal Modification

Up to now we have only considered modifiers which saturate an argument position. A saturating modifier operates on some role in a linking structure so that the resultant linking structure contains only assignments which do not have that role in their domain. For example, an ARG2 modifier outputs a linking structure consisting of assignments which are not defined for ARG2. This is what prevents a verb from combining with two direct objects.

We will now consider temporal modifiers. We take the fact that multiple temporal modifiers can appear simultaneously in a sentential clause, either separately or ‘stacked’, to indicate that temporal modifiers are non-saturating. In terms of Linking Semantics this means that although a temporal modifier operates on the T role in the linking structure to which it applies, the resultant structure contains assignments which still have T in their domain. Thus this structure can be the object of further temporal modification.

Temporal modification presents special challenges, as Pratt and Francez 2001 make especially clear. First, one temporal modifier can affect the interpretation of another. Thus “July” refers to a different period in (11) than in (12).

- (11) Last year, it rained in July.
 (12) Two years ago, it rained in July.

When temporal modifiers are quantificational, one modifier may determine the domain for another, as in (13).

- (13) Last year, it rained every day.

Furthermore, a quantificational temporal modifier may bind another modifier, so that e.g. “the afternoon” is bound by “most days” in (14).

- (14) On most days, it rained in the afternoon.

Finally, order of application matters. We explain the fact that (15) and (16) are in-

felicitous in terms of two claims: first, clause internal modifiers are interpreted with narrower scope than fronted modifiers, and, second, wider scope temporal modifiers provide a temporal interval within which narrower scope modifiers must be interpreted. Thus, rather obviously, (15) and (16) are bad because “last year” is bigger than “July”, and bigger than any day.

(15) ? In July, it rained last year.

(16) ? Every day, it rained last year.

We will now outline how these observations regarding temporal modification can be accounted for using the earlier definitions for Linking Semantics. We assume that both “in July” and “last year” operate on the same role, τ , and further assume that times are highly structured entities. In particular, a time may be the sum of several intervals, so that, for example, the constant *july* picks out the sum of all intervals which correspond to the entire month of July in some year. We write $x \in y$ to mean that x is an atomic part of y . Note that the subinterval relation \sqsubseteq is also defined over times. If $x \in y$, then $x \sqsubseteq y$, but the reverse need not hold. For example, December 2007 is a subinterval of 2007, but is not, in this sense, a part of 2007, since 2007 corresponds to a single (atomic) interval.

We also define $x = \iota y \phi$ to mean that x is the unique entity y such that the condition ϕ holds, and will assume that undefinedness results when this condition fails. However, in this short paper we will not define the formal mechanisms needed to control the propagation of undefinedness. We can now use the iota operator to define *july'*, a function from times to intervals, as follows: $july'(t) = \iota x[x \in july \wedge x \sqsubseteq t]$. So $july'(t)$ is defined when there is a unique part of *july* (the parts being intervals corresponding to particular instances of July) which falls within t . Then $[[\text{July}]_M]^{w,t} = \lambda PP(july'(t))$. We deal with “last year” similarly, using a constant *last-year* which has one atomic part, the subinterval corresponding to the year prior to the year utterance.

$$\begin{aligned}
 (17) \quad & [[\text{in July}]_M] &= & [[\text{July}:\tau]_M] \\
 & &= & \lambda L \lambda f [[[\text{July}]_M]^{f(\mathbb{W}),f(\mathbb{T})} (\lambda x[L(f[\tau, x])])] \\
 & &= & \lambda L \lambda f [L(f[\tau, july'(f(\tau))])] \\
 & [[\text{last year}:\tau]_M] &= & \lambda L \lambda f [L(f[\tau, \text{last-year}'(f(\tau))])] \\
 & [[\text{it rained}]_M] &= & \lambda f [\text{rain}'(f) \wedge f(\tau) < \text{NOW}] \\
 & [[\text{it rained in July}]_M] &= & \lambda f [\text{rain}'(f[\tau, july'(f(\tau))])] \\
 & & & \wedge july'(f(\tau)) < \text{NOW}] \\
 & [[\text{Last year, it rained in July}]_M] &= & \lambda f [\text{rain}'(f[\tau, july'(\text{last-year}'(f(\tau))])] \\
 & & & \wedge july'(\text{last-year}'(f(\tau))) < \text{NOW}] \\
 & M, w \models \text{Last year, it rained in July iff} & & \\
 & & & \exists t \text{rain}'([\mathbb{W}, w; \tau, july'(\text{last-year}'(t))]
 \end{aligned}$$

So “Last year, it rained in July” is true just in case it rained in the interval given by the unique July last year, which, by temporal closure, will be the case if it rained at least once in July last year. It should now be clear why (15) is infelicitous: combining

“July” and “last year” in the opposite order creates undefinedness, since there is no t such that $last-year'(july'(t))$ is defined.² Note that the condition introduced by the past tense is redundant, since last year only contains past times. This is why the tense requirement does not appear in the final statement of the truth conditions.

We now turn to a quantificational case. We interpret temporal quantificational and definite DPs compositionally in the obvious way: $[[\det N]]_M^{w,t} = [[\det]]_M([[N]]_M^{w,t})$. We then interpret an interval denoting noun relative to the temporal index. So given an $\langle e, t \rangle$ type constant day , we use a function from times to (temporal) entities $day'(t) = \lambda x[day(x) \wedge x \sqsubseteq t]$, and this will be the value of $[[day]]_M^{w,t}$. We skip the details of the derivation, but the compositional machinery of Linking Semantics works in just the same way for the following example as in those above:

- (18) $M, w \models$ Last year, on most days it rained in the afternoon *iff*
 $\exists t most(day'(last-year'(t)))(\lambda t' rain'([w, w; T, afternoon'(t')]))$

Here the restrictor of *most* is $day'(last-year'(t))$, which picks out the (characteristic fn. of the) set of intervals corresponding to days last year (provided t contains last year). The scope of *most* is $\lambda t' rain'([w, w; T, afternoon'(t')])$, which picks out the set of intervals containing a unique afternoon such that it rained during that afternoon. So, “Last year, on most days it rained in the afternoon” is defined on intervals containing last year, and says that in most intervals which are days contained in last year, raining took place sometime during the afternoon subinterval of those intervals.

The same type of analysis of quantificational temporal modifiers explains why (16) is infelicitous: its interpretation requires that each daylong interval contains the interval corresponding to last year. Further, the machinery allows arbitrarily many quantificational and non-quantificational temporal modifiers in a sentence, provided only that each modifier is interpreted relative to an interval in which it is defined. Thus, e.g. “In few years is it the case that in most months it rains for over three hours on exactly seven days” should present no problem for our more enthusiastic readers.

5. Conclusion

Linking Semantics is rather more like Davidsonian event semantics than it is like Montague Grammar, but has inherent advantages over both. In Davidsonian Event Semantics the analysis of quantification is problematic: either quantifiers are treated externally to the event system and quantified in (cf. Landman 2000), or else the definitions of the quantifiers must be greatly (and non-uniformly) complicated (cf. Krifka 1989). In general, and though we have not argued for this here, Davidsonian Event Semantics places inappropriate demands on the ontology of events: Linking Semantics makes no commitments at all as regards the nature of events, but denies that events play a special part in the syntax-semantics interface. The advantages of

²We note a (fixable) problem with the analysis: “It didn’t rain tomorrow” comes out true rather than infelicitous. To solve this we would need to give the past tense morpheme an additional definedness condition saying that the contextually given time interval contains at least some part which is in the past.

Linking Semantics over Montague Grammar for a free word-order language with morphological case marking should be obvious. But even for English the advantages are substantial: (i) verbal alternations (like the dative alternation) as well as valency changes can be analysed without postulating an underlying verbal ambiguity, (ii) quantifiers can be analyzed *in situ* without boosting verb types unnaturally, and (iii) the analysis of sentences with multiple temporal modifiers is much simpler than in neo-Montagovian treatments (Pratt and Francez 2001; von Stechow 2002).

Bibliography

- Castañeda, H.-N.: 1967, Comments, in N. Rescher (ed.), *The Logic of Decision and Action*, University of Pittsburgh Press, Pittsburgh
- Davidson, D.: 1980, The logical form of action sentences (originally 1967), in *Essays on Actions and Events*, pp 105–122, Clarendon Press, Oxford
- Dowty, D.: 1979a, Dative ‘movement’ and Thomason’s extensions of Montague Grammar, in S. Davis and M. Mithun (eds.), *Linguistics, philosophy, and Montague grammar*, pp 153–222, University of Texas Press, Austin
- Dowty, D.: 1979b, *Word Meaning and Montague Grammar*, Reidel, Dordrecht
- Kratzer, A.: 2003, *The Event Argument and the Semantics of Verbs*
- Krifka, M.: 1989, Nominal reference, temporal constitution and quantification in event semantics, in J. v. B. Renate Bartsch and P. van Emde Boas (eds.), *Semantics and Contextual Expression*, pp 75–115, Foris, Dordrecht
- Krifka, M.: 1992, Thematic relations as links between nominal reference and temporal constitution, in I. Sag and A. Szabolcsi (eds.), *Lexical Matters*, pp 29–53, CSLI Publications
- Landman, F.: 2000, *Events and Plurality: The Jerusalem Lectures*, Kluwer Academic Publishers
- McConnell-Ginet, S.: 1982, Adverbs and Logical Form, *Language* 58(1), 144–184
- Montague, R.: 1973, The proper treatment of quantification in ordinary English, in J. Hintikka, J. Moravcsik, and P. Suppes (eds.), *Approaches to natural language*, pp 221–242, Reidel
- Parsons, T.: 1990, *Events in the semantics of English: a study in subatomic semantics*, MIT Press
- Pietroski, P.: 2006, *Events and Semantic Architecture*, Oxford University Press, USA
- Pratt, I. and Francez, N.: 2001, Temporal prepositions and temporal generalized quantifiers, *Linguistics and Philosophy* 24(2), 187–255
- Rothstein, S.: 1998, *Events and Grammar*, Kluwer Academic Publishers
- Schein, B.: 1993, *Plurals and Events*, Mit Press
- von Stechow, A.: 2002, Temporal prepositional phrases with quantifiers: Some additions to Pratt and Francez (2001), *Linguistics and Philosophy* 25, 755–800

DO NEGATIVE POLARITY ITEMS FACILITATE THE PROCESSING OF DECREASING INFERENCEs?

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Negative polarity items occur within the immediate scope of operators that support decreasing inferences. It is natural to expect the presence of a licensed NPI to facilitate the processing of decreasing inferences based on the licenser. In joint work with L. Bott and B. McElree I conducted a series of experiments to test this. We found no facilitation in terms of either verification accuracy or processing speed; instead, the presence of an NPI slowed down the processing of valid inferences. The talk will report on the experiments and consider various theories of licensing as potential explanations.

1. Introduction

An operator is monotone decreasing iff it licenses inferences from sets to subsets. Negative polarity items are generally confined to the immediate scope of monotone decreasing operators. The correlation between the inferential property and NPI-acceptability is the cornerstone of the widely accepted scalar accounts of NPI-licensing (e.g. Kadmon & Landman 1993, Krifka 1995, Lahiri 1998, and Chierchia 2006). Glossing over their differences, the intuition is as follows. The NPI widens the domain of quantification and carries the requirement that the truth of the sentence as evaluated against the widened domain should entail its truth as evaluated against the normal domain that a plain indefinite would invoke. This requirement can only be satisfied in a decreasing context. Furthermore, Geurts & van der Slik 2005 showed that inference processing is sensitive to the monotonicity profiles of quantifiers, quite independently of matters of NPI-licensing. Therefore the following is a natural prediction of the scalar accounts:

The presence of a licensed NPI highlights the monotone decreasing character of the licenser, and facilitates, in one way or another, the processing of decreasing inferences supported by the licenser.

In joint work with Lewis Bott and Brian McElree I conducted three experiments to test

this prediction. As regards the facilitation of processing, our hypothesis was that the presence of the NPI may make the verification of decreasing inferences more accurate or faster. Using the NPIs *ever* and *any* we conducted a direct inference verification experiment and two self-paced reading time experiments.

2. Experiments

In the first experiment participants read vignettes and responded to a yes/no question. In the stimuli, S2 contained a decreasing or a non-decreasing quantifier with or without an NPI (all combinations). We used disjunction to ensure that encyclopedic knowledge and focus did not play a role in the inference. For example:

S1. Our camp is on Staten Island.

S2. Almost no/every camper has ever/∅ caught a cold or suffered bruises.

S3. Would it be reasonable to say that almost no/every camper has suffered bruises?

We found that participants discriminated between valid and invalid inferences: they accepted valid inferences much more often than invalid ones. On the other hand, and contrary to the prediction above, we found no facilitation whatsoever. The presence of an NPI in S2 did not induce participants to accept more valid inferences or to reject more invalid ones.

In the second and third experiments S3 was not a question but a declarative introduced by a *since*-clause. We presented the inference in a *since*-clause in an attempt to replicate the use of pronominal anaphora in eliciting naturalistic quantifier scope interpretations (Tunstall 1999, Szabolcsi 2007). Participants read the vignettes region by region, at their own pace, and reading times were measured. The reincarnation of the above stimuli would now be as follows. #'s indicate the division into regions:

S1. Our camp is on Staten Island. #

S2. Almost no/every camper # has ever/∅ # caught a cold # or suffered bruises. #

S3. Since # almost no/every camper # has ever/∅ # suffered bruises, # the parents are (un)happy, # and ... # ...

Again, we found that participants were sensitive both to the licensing of the NPI in S2 and to the validity of the inference in S3. When S2 contained an NPI, they read the NPI-region and/or the immediately following region significantly slower if the NPI was not licensed. When neither S2 nor S3 contained an NPI and thus only validity was at

stake, they read the inference region of S3 (*suffered bruises*) and/or the immediately following region significantly slower if the inference was invalid. However, the presence of a licensed NPI in S2 did not have a facilitation effect on the speed of the reading of S3. In fact, we observed the opposite effect. When reading valid inferences, participants significantly slowed down on the inference region if the previous sentence contained a licensed NPI, as compared to the case where S2 did not contain an NPI. This effect obtained irrespective of whether the NPI was repeated in S3.

In sum, the experiments were sensitive enough to detect facilitation if there had been one. But we did not find facilitation, in terms of either accuracy or speed.

3. Possible explanations for the lack of facilitation

The simplest explanation for the lack of facilitation is that the human processor does not recognize the connection between the abilities of certain operators to support decreasing inferences and to license NPIs, and therefore the presence of a licensed NPI does not specifically highlight the decreasing character of its licenser. This might be for two rather different reasons.

One possibility is that the scalar account of NPI-licensing is correct in the abstract, but in fact licensing is syntacticized. Suppose that NPIs carry a syntactic feature [-de] and the sentence is unacceptable unless [-de] is deleted in construction with an operator that carries a [+de] feature. Operators with [+de] may be coextensive with the monotone decreasing ones, but this is an extra-grammatical fact. If inferences are, in contrast, computed purely model theoretically, the processor has no reason to associate decreasingness and NPIs.

Another possibility is that decreasingness is not the key property in NPI-licensing, even if it is factually correct that most NPI-licensors are decreasing. Giannakidou 1998 proposes such an account. According to this, non-veridicality and anti-veridicality are the key properties. Some version of this account might be correct for *ever* and *any*. Alternatively, there is a family of theories that identify interpreted or uninterpreted negatives as the key players. Ladusaw 1992 assimilates Romance negative concord to NPI-licensing, arguing that n-words as well as verbal negation in Romance languages are NPIs, and their licenser is an overt or silent anti-additive item. De Swart and Sag 2002 recast this analysis, with n-words interpreted as anti-additive quantifiers that are absorbed into a single polyadic quantifier. Postal 2005 and Szabolcsi 2004 propose the flip-side account and assimilate NPI-licensing to negative concord. More precisely, according to Postal NPIs are not lexical items in need of licensing. Instead, surface forms like *no one* and *anyone* are alternative morphologies

that spell out the combination of an underlying indefinite and one or more negations. The choice between them depends on whether the negations are left alone or cancelled by other negations in the sentence. (One of Postal's strong descriptive arguments for the claim that *any*-forms contain a lexical negation comes from the phenomenon known as "secondary triggering".) Szabolcsi recasts Postal's proposal along the lines of de Swart and Sag: both the NPI and the licenser have a negation component in their lexical semantics; these negations are factored out to form a polyadic negative quantifier. Given that all decreasing operators are either negations or can be decomposed into a negation plus an increasing operator, this analysis is fully compatible with the correlation between NPI-licensing and decreasingness. But the processor will have no particular reason to recognize that correlation.

4. Possible explanations for (the lack of facilitation and) the slowdown

Recall that the experiments did not simply fail to detect a facilitatory effect; they detected a slowdown on the inference region when the preceding sentence contained a licensed NPI. What explains the combined findings? The semantics or pragmatics of the NPI may incur a significant processing cost, which has not yet been taken into account. It may play a role in predicting the observed effects in two different ways.

No facilitation plus somewhat costly NPI processing: NPI presence does not improve either the accuracy or the speed of inference processing. On the other hand it incurs some cost that is manifested in longer reading times.

Some facilitation plus very costly NPI processing: NPI presence does facilitate inference processing in some way and to some extent, but it also incurs a cost that is large enough both to wipe out all facilitatory effects and to additionally lengthen reading times.

How would the extra cost arise? On the Ladusaw-de Swart & Sag-Postal-Szabolcsi account the factoring out of the negative component of the NPI's lexical representation and the formation of a polyadic quantifier with the negation component of the licenser may well be costly. On the Kadmon & Ladman-Krifka-Lahiri-Chierchia account, the NPI itself carries scalar implicatures. Chierchia (2006: 554-560) follows Krifka and Lahiri in attributing an *even*-like flavor to the base meaning of the NPI *any*. This activates a set of domain-alternatives and carries the implicature that even the broadest choice of the domain of quantification will make the sentence with *any* true. Departing

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from Grice, implicatures are added and strengthened meanings are calculated recursively, at every step of the sentences's composition. Domain widening and implicature calculation are plausibly costly.

The upshot is that both kinds of theoretical account might be able to explain the findings (no observable facilitation of accuracy, some slowdown in reading times). What our findings clearly rule out is an account that predicts that NPIs should have a squarely facilitatory effect. Further work is needed to assess the magnitude of the effects and determine whether one of the models is favored by the processing data.

As one issue of interest, notice that while stressed NPIs undeniably have an *even*-flavored meaning, not all NPIs do. Some examples of NPIs without domain widening are n-words interpreted as NPIs (Chierchia 2006), occurrences of unstressed *any* applied to unambiguously defined domains (*The empty set does not have any proper subsets* – does not mean ‘even a marginal proper subset’, Krifka 1995), and items like the adverb *anymore* (*He doesn't live here anymore* ‘He lived here and that has changed’), the auxiliary *need* (*He need not come early*), and others (van der Wal, 1999). The existence of such NPIs is one reason why some accounts maintain that the phenomenon of NPI-licensing *per se* is not a scalar matter. On the other hand, the non-scalar accounts may freely acknowledge that some NPIs do have an *even*-flavor that has to be taken into account in the full description of their distribution and meaning (Szabolcsi 2004, and especially Giannakidou 2007). If so, they predict that the processing of an NPI is more costly when the NPI carries tangible scalar implicatures.

Chierchia's account accommodates the existence of NPIs without tangible domain widening in the following way. In contrast to items like *some* and *many*, whose scalar alternatives can be deactivated and thus their implicatures (‘but not all’) suspended in appropriate contexts, he assumes that *any* is grammaticized to always activate a set of domain-alternatives. But Chierchia requires the proposition with the widest possible domain of quantification only to entail its counterparts with particular domains; that is, it has to be either stronger than or equivalent to them. “Domain widening, as implemented here, is a *potential* for domain widening” (2006:559, emphasis in the original). In this way his account does not distort interpretations. However, the combined effect of the grammaticized activation of domain-alternatives and the recursive computation of scalar implicatures is that NPIs will incur the same processing cost regardless whether they actually involve domain widening (*The campers have not suffered ANY bruises*) or not (*The empty set does not have any proper subsets*). This prediction contrasts with that of the non-scalar accounts, see above.

Further work should be able to determine which prediction is borne out by processing. Bott & Noveck 2004 showed that interpreting *Some of the children are in the classroom* with an implicature to mean ‘Some [but not all] of the children are in the

classroom' is more costly than the same sentence interpreted without the implicature, as in 'Some [and possibly all] of the children are in the classroom'.

Bibliography

- Bott, L. and Noveck, I.: 2004, Some utterances are underinformative: The onset and time course of scalar inference. *Journal of Memory and Language*, 51, 437-457.
- Chierchia, G.: 2006, Broaden your views: Implicatures of domain widening and the "logicality" of language. *Linguistic Inquiry* 37/4, 535-591.
- Geurts, B. and van der Slik, F.: 2005, Monotonicity and processing load. *Journal of Semantics*, 22, 97-117.
- Giannakidou, A.: 1998, *Polarity Sensitivity As (Non)Veridical Dependency*. *Linguistik Aktuell/Linguistics Today* 23. John Benjamins.
- Giannakidou, A.: 2007, The landscape of EVEN. *Natural Language and Linguistic Theory* 25, 39-81.
- Kadmon, N. and Landman, F.: 1993, Any. *Linguistics and Philosophy* 16, 353-422.
- Krifka, M.: 1995, The semantics and pragmatics of polarity items. *Linguistic Analysis* 25, 209-257.
- Ladusaw, W.: 1980, *Polarity Sensitivity as Inherent Scope Relations*. Garland.
- Ladusaw, W.: 1992, Expressing negation. *Semantics and Linguistic Theory* II, Columbus, OH.
- Lahiri, U.: 1997, Focus and negative polarity in Hindi. *Natural Language Semantics* 6, 57-123.
- Postal, Paul M.: 2005, Suppose (if only for an hour) that NPIs are negation-containing phrases. <http://www.nyu.edu/gsas/dept/lingu/events/polarity/papers/postal-paper.pdf>
- de Swart, H. and Sag, I. A.: 2002, Negation and negative concord in Romance. *Linguistics and Philosophy* 25/4, 373-417.
- Szabolcsi, A.: 2004, Positive polarity – negative polarity. *Natural Language and Linguistic Theory* 22/2, 409-452.
- Szabolcsi, A.: 2007, Scope and binding. Submitted to Maienborn, von Stechow and Portner (eds.), *Semantics: An International Handbook of Natural Language Meaning*. <http://semanticsarchive.net/Archive/TlmYzE3M/>
- Szabolcsi, A., Bott, L. and McElree, B.: 2007, The effect of negative polarity items on inference verification. Submitted.
- Tunstall, S.: 1998, *The Interpretation of Quantifiers: Semantics and Processing*. PhD, UMass.
- van der Wal, S.: 1999, *Negative Polarity Items and Licensing*. PhD, U. of Groningen.

Uninterpretability

UNINTERPRETABLE NEGATIVE FEATURES ON NEGATIVE INDEFINITES

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It was proposed by Ladusaw 1992 and Zeijlstra 2004 that negative indefinites in negative concord languages are semantically non-negative indefinites carrying an uninterpretable negative feature that has to be checked against a semantic negation. This analysis is extended to languages that do not exhibit negative concord. Crucial evidence comes from the fact that negative indefinites give rise to split readings, in which another (modal etc.) operator takes scope in between the negative and the indefinite meaning component. Split readings also provide an argument against implementing the licensing conditions for negative indefinites in certain ways proposed in the literature, in particular against the NEG-criterion of Haegeman and Zanuttini 1991, but also against the analyses of Ladusaw 1992 and Kratzer 2005.

1. Introduction

Negative indefinites in negative concord languages have puzzled linguists for a long time. If they are semantically analyzed as negative quantifiers, as is the standard assumption about the corresponding elements in e.g. English, then why do they not always contribute negative force? For instance, why does the interpretation of the following sentence from Italian only involve one negation, while there are two negative indefinites, *nessuno* and *niente*?

- (1) **Nessuno** ha visto **niente**. (Italian)
n-person has seen n-thing
'Nobody has seen anything.'
*'Nobody has seen nothing.' (= 'Everybody has seen something.')

2. A cross-linguistically unified analysis of negative indefinites

Recently, the insight emerged that negative indefinites in negative concord languages are best analyzed as semantically non-negative indefinites that have to be licensed by negation (see Ladusaw 1992; Zeijlstra 2004). Under this view, negative concord is a form of syntactic agreement: negative indefinites carry an uninterpretable negative feature that has to be checked against an interpretable negative feature on a semantically negative element. In the case of (1), this is assumed to be an abstract negative

operator that simultaneously licenses both negative indefinites under Multiple Agree, as shown in (2) (see Zeijlstra 2004 for details of the analysis).

- (2) $\text{Op}_{\neg[\text{iNEG}]}$ nessuno_[uNEG] ha visto niente_[uNEG]
-

I argue that this analysis of negative indefinites is not only adequate for negative concord languages, but also for languages not exhibiting negative concord, such as English, German and Dutch (see Penka 2007). In these languages, negative indefinites *prima facie* appear to have negative force on their own and thus it seems that they can and should be analyzed as negative quantifiers. However, evidence against this view comes from the fact that negative indefinites in these languages give rise to split readings, where another operator takes scope in between the negative and the indefinite meaning component, as illustrated in (3) (see o.a. Bech 1955/57; Jacobs 1980).

- (3) Du brauchst keine Jacke anziehen. (German)
 you need n-DET jacket wear
 ‘You don’t need to wear a jacket.’

Although in (3), the negation takes scope above the modal verb *brauchen* (‘need’) (in fact, *brauchen* is an NPI), the salient reading is the one where the indefinite is interpreted in the scope of the modal (*de dicto* reading).

The existence of split readings follows immediately if it is assumed that in non-negative concord languages, too, negative indefinites carry an uninterpretable negative feature. As the real carrier of semantic negation is assumed to be a covert negation operator, negation can take scope above the modal while the indefinite is interpreted below. The structure assumed to underlie (3) is given in (4).¹

- (4) du $\text{Op}_{\neg[\text{iNEG}]}$ [[keine_[uNEG] Jacke anziehen] brauchst]

What distinguishes negative concord languages from non-negative concord languages then is not the fact that in the former negative indefinites are semantically non-negative, while in the latter they are inherently negative, but rather the precise licensing conditions for uninterpretable negative features. In non-negative concord languages, Multiple Agree is not available for negative features. Moreover, the licensing negation can never be realized overtly in non-negative concord languages.² Thus, a cross-linguistically unified analysis of negative indefinites results, which reduces differences in the behavior of negative indefinites to parametric variation.

¹To abstract away from V2-movement, the word order for embedded clauses is given.

²There are in fact also negative concord languages in which negative indefinites can only be licensed by abstract negation, but not by an overt element interpreted as negation. An example is French, where negative indefinites co-occurring with the negative marker *pas* obligatorily yield a double negation reading (see Penka 2007).

3. The nature of the licensing relation

The existence of split readings is not only crucial for the analysis of negative indefinites in non-negative concord languages, but also argues against certain implementations of the way negative indefinites associate with the licensing negation in negative concord languages. In negative concord languages, split readings are expressed transparently, in the sense that negation is marked on the modal verb in addition to the negative indefinite, cf. (5).

- (5) **No** hace falta que te pongas **ninguna** chaqueta. (Spanish)
NEG makes need COMP you wear.SUBJ n-DET jacket
'You don't need to wear a jacket.'

The fact that other operators can take scope in between negation and the negative indefinite shows that checking of uninterpretable negative features does not involve movement of the negative indefinite to the licensing negation. This argues against accounts based on the NEG-criterion of Haegeman and Zanuttini 1991, which postulates that negative indefinites have to move to the specifier of NegP in order to check their negative features against the negative head.³

Data like (5) also pose a problem for accounts like Ladusaw 1992 and Kratzer 2005, which argue that negative indefinites are indefinites that have to stand in a certain semantic relation with negation in order to be licensed. Ladusaw 1992, employing a Heimian analysis of indefinites, proposed that negation is the operator that has to bind free variables introduced by negative indefinites. Kratzer 2005 took up Ladusaw's proposal, but replaced unselective binding by a Hamblin semantics, in which indefinites introduce alternatives. Under both approaches, negative indefinites are assumed to semantically associate with the negation operator, and it should thus not be possible that other semantic operators take scope in between negation and negative indefinites.

4. Conclusion

The assumption that negative indefinites carry uninterpretable negative features leads to a cross-linguistically unified analysis of negative indefinites, which explains phenomena like negative concord and split readings. Data involving split readings provide evidence that the licensing relation is purely syntactic in nature, and moreover, that checking of negative features does not involve movement.

³Whereas Haegeman and Zanuttini 1991 and Zanuttini 1991 assumed that the NEG-criterion holds in some languages at LF and in others at S-structure, Haegeman 1995 argued that the NEG-criterion universally has to be satisfied in the surface syntax. This leaves the possibility to undo movement of negative indefinites at LF in order to derive the correct interpretation. But then the original motivation for the NEG-criterion, namely to ensure a configuration in which 'absorption' of multiple negations can take place, becomes void.

Bibliography

- Bech, G.: 1955/57, *Studien über das deutsche Verbum infinitum*, Danske Videnskaberne Selskab: Historisk-filologiske meddelelser, Munksgaard, Kopenhagen
- Haegeman, L.: 1995, *The Syntax of Negation*, (Cambridge Studies in Linguistics 75), Cambridge University Press
- Haegeman, L. and Zanuttini, R.: 1991, Negative Heads and the NEG-Criterion, *The Linguistic Review* 8, 233–251
- Jacobs, J.: 1980, Lexical decomposition in Montague grammar, *Theoretical Linguistics* 7, 121–136
- Kratzer, A.: 2005, Indefinites and the operators they depend on: From Japanese to Salish, in G. N. Carlson and F. J. Pelletier (eds.), *The Partee Effect*, pp 113–141, CSLI Publications
- Ladusaw, W. A.: 1992, Expressing Negation, in C. Barker and D. Dowty (eds.), *Proceedings of SALT II*, Ohio State Working Papers in Linguistics 40, pp 237–259, Ohio State University
- Penka, D.: 2007, *Negative Indefinites*, Ph.D. thesis, Universität Tübingen
- Zanuttini, R.: 1991, *Syntactic Properties of Sentential Negation: A Comparative Study of Romance Languages*, Ph.D. thesis, University of Pennsylvania
- Zeijlstra, H.: 2004, *Sentential Negation and Negative Concord*, Ph.D. thesis, University of Amsterdam

MODAL VERBS IN COMPLEMENT CLAUSES – INTERPRETABLE OR NOT?

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This paper is concerned with modal markers in complement clauses under certain matrix predicates. It discusses two approaches, one by Fabricius-Hansen and Stechow 1982, the other by Geurts and Huitink 2006, and examines whether overt modal auxiliaries in complement clauses are interpreted or not. This depends on the the complement type: Finite complements are marked modally either overtly or covertly. Infinitival complements are inherently modal and do not allow overt deontic modals.

1. Introduction

Comparing (1) and (2), we find that both have the same meaning.

- (1) Er zwingt sie dazu, dass sie arbeitet.
He forces her PART that she works.
- (2) Er zwingt sie dazu, dass sie arbeiten muss.
He forces her PART that she work-INF must.

This means that the modal verb in (2) does not contribute any additional meaning to the clause. How are these modal verbs distributed and why do they occur?

The distribution of modals in complement clauses depends on the complement type. Finite complement clauses will be investigated first, and two approaches concerned with "superfluous" modal auxiliaries will be examined. Second, the approaches will be examined with regard to infinitival complements.

2. Finite complement clauses

In the preferred reading, both complement clauses in (1) and (2) are modally marked. The question is where the modality comes from and why absence and presence of the modal lead to the same meaning of the complement clause. Two answers have been given: Either we assume a (covert) presence of a modal in both cases or we assume the complement clause to be inherently modal and consider the overt modal in (2) as an agreement phenomenon. The first position is associated with an early paper by Fabricius-Hansen and Stechow 1982 in which the authors show that subject clauses

in certain contexts must be interpreted modally, no matter whether they contain an overt modal or not.

The second position could be argued for in the light of modal concord (Geurts and Huitink 2006). In their view, the modal verb is not interpreted because it merely doubles the modality of the embedded clause.

2.1. Transmitted modals

According to Fabricius-Hansen and Stechow 1982, the modal has to be inserted when not present in order to assure interpretability. They argue that (3) and (4) are semantic equivalents. As a consequence, the interpretation of (4) should be *It is possible that it is possible that Ede becomes a professor*, which is not the case. One of the modal markers must not be interpreted – but which of them is redundant?

- (3) Dass Ede Professor wird, ist eine Möglichkeit.
That Ede a professor becomes, is a possibility.
- (4) Dass Ede Professor werden könnte, ist eine Möglichkeit.
That Ede a professor become-INF can, is a possibility.

The minimal pair in (5) and (6) can clarify this.

- (5) Dass Ede Professor werden könnte, ist eine erfreuliche Möglichkeit.
That Ede a professor become-INF could, is a pleasing possibility.
- (6) Dass Ede Professor werden könnte, ist erfreulich.
That Ede a professor become-INF could, is pleasing.

Again, both clauses are semantically equivalent. As there is no modality marker in the matrix clause in (6), it must be the modality marker in the complement which is relevant. Fabricius-Hansen and Stechow 1982 conclude that the complement clause has to be interpreted modally in all similar cases. When there is no overt modal it has to be "transmitted" (p. 189) from the matrix clause into the complement for a correct interpretation.

2.2. Modal concord

Geurts and Huitink 2006 suggested that apart from negative concord we can assume modal concord as well. A good example is modal concord of adverbials and auxiliaries as in (7). A cumulative meaning as in (8) does not seem to be intended, so the doubling in (7) must be a concord effect.

- (7) You may possibly have read my little monograph upon the subject.
- (8) It is possible that it is possible that you have read my little monograph upon the subject.

Applying this idea to complement clauses this means that the complement clause itself is modally marked and that the modal merely indicates modal agreement. When interpreting the sentence, the modal has to be ignored because modality is present covertly and independently of the modal. Considering (9) and (10), it could be triggered by the matrix predicate with regard to modal type as well as quantificational force.

- (9) Er ermöglicht ihr, dass sie arbeiten kann.
He enables her that she work-INF can.
- (10) Er befiehlt ihr, dass sie arbeiten soll.
He orders her that she work-INF should.

Considering only finite complement clauses, both positions are equally well. The complement clause is to be interpreted modally and it does not matter in this case whether we transmit modality via a covert modal or assume inherent modality because of an agreeing element. A finite complement clause can be modalized covertly.

3. Infinitival complement clauses

Let us turn to infinitive complements. Both examples are semantically equivalent. Under the modal transition view, the modal in (12) has to be interpreted. Under the modal concord view, it must *not* be interpreted.

- (11) Er zwingt sie zu arbeiten.
He forces her to work.
- (12) Er zwingt sie, arbeiten zu müssen.
He forces her work-INF to must.

To decide which view is right, let us have a look at infinitival complement clauses embedded under a deontic predicate:

- (13) Er befiehlt ihr zu arbeiten.
He commands her to work.
- (14) *Er befiehlt ihr arbeiten zu sollen.
He commands her work-INF to should.

(14) shows that the modal *is* interpreted, leading to ungrammaticality. If considering modal auxiliaries as modal concord markers, (14) should be grammatical analogous to (12).¹ The ungrammaticality of (14) is a strong argument against the modal concord approach in this case.

Why is (14) not well-formed? Castañeda 1970 shows that iteration of modality is not allowed in the case of "sollen" while it is possible – even though redundant – for other modality types (cf. (15) and (16)).

¹Note that in the finite complement in (10) the deontic auxiliary is grammatical.

- (15) *Er soll arbeiten sollen.
He should work-INF should-INF.
- (16) Er muss arbeiten müssen.
He must work-INF must-INF.

Hence, the ungrammaticality of (14) is evidence of an underlying modality in the infinite complement clause. The modal transition approach is not satisfactory either because the modal is not allowed to mark the modality of the complement clause. Non-deontic modals can be added but they are redundant. This redundancy, though, must be of another type than the one of concord elements because it does not contribute semantic content although the modal is interpreted.

4. Conclusion

Concerning modal auxiliaries in complements of certain predicates, we have to distinguish between finite and infinite complement clauses. In finite clauses, modality can be covert or overt, so both approaches presented in the paper cope with the facts.

In infinitival complements, modality is present covertly. When we assume that deontic and non-deontic modality can be treated similarly², modal auxiliaries in infinitival complements cannot be modal concord elements. The modal transition approach does not provide better results because modal auxiliaries should be grammatical for all modality types which is not the case.

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Bibliography

- Castañeda, H.: 1970, On the semantics of the ought-to-do, *Synthese* 21, 449–469
- Fabricius-Hansen, C. and Stechow, A. v.: 1982, Explikative und implikative nominalerweiterungen im deutschen, *Zeitschrift für Sprachwissenschaft* 8(2), 173–205
- Geurts, B. and Huitink, K.: 2006, Modal concord, in P. Dekker and H. Zeijlstra (eds.), *Proceedings of the ESSLI Workshop Concord Phenomena at the Syntax-Semantics Interface*, pp 15–20, Málaga

² Another way out is to distinguish between deontic and other modality types. But Geurts and Huitink 2006 explicitly include deontic modality which is correct for concord between adverbials and deontic auxiliaries (see above).

ENGLISH PAST AND PERFECT AS SEMANTICALLY VACUOUS MOOD MARKERS

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This paper presents an explanation for the observation that in some contexts the English simple past appears not to be interpreted as semantic past tense. We will propose (i) that English sentences obligatorily carry mood, (ii) that the English simple past is lexically ambiguous between expressing tense or mood, and (iii) that the semantic function of mood is to facilitate modal subordination.

1. Introduction: The Puzzle

It is a well-known fact about English that in certain contexts – for instance, in subjunctive conditionals – past tense or perfect markers appear not to be interpreted as semantic past tense or perfect. For instance, in (1a) the finite verbs in antecedent and consequent are marked for the simple past. However, the conditional cannot receive an interpretation according to which the leaving of Peter took place in the past. Something similar can be observed for the perfect in (1b) as well.

- (1) a. If Peter left in time, he would be in Amsterdam this evening.
b. If Peter had left in time, he would have been in Amsterdam this evening.

There exists numerous proposals explaining this observation. They can be classified into two groups. According to a first group (cf. Ippolito 2003) the past (or perfect) in these sentences carries its standard meaning, but it contributes this meaning in an unexpected way to the meaning of the sentence. I have argued elsewhere (Schulz 2007) that these approaches have systematic difficulties in accounting for the truth conditions of subjunctive conditionals. Alternatively (cf. Iatridou 2000) it has often been proposed that the simple past (or the perfect) has a mood/modality meaning in subjunctive conditionals. The main problem of approaches along this line is that they miss formal precision. In this paper we will sketch a proposal along the second line of approach that is fully formalized.¹

2. The solution: the English mood system

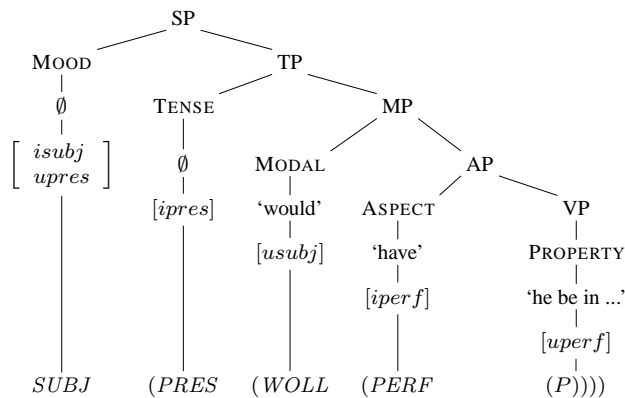
To account for the described observation we propose that English assertive sentences obligatorily carry mood. The simple past and the past perfect are ambiguous between

¹For more details see Schulz 2007.

a temporal/aspectual meaning and a mood meaning. In subjunctive sentences the simple past and the perfect are interpreted as mood markers, while in normal simple sentences they carry their standard temporal/aspectual meaning. This means that the proposal has to consist of a syntactic and a semantic part. On the side of syntax we have to describe the logical form sentences like (1a) and (1b) are associated with. On the side of semantics we have to provide a theory of interpretation for these logical forms.

2.1. The syntax

We propose that English sentences come with a mood projection that scopes over the tense projection. We distinguish three mood operators that can occur in the head of the mood projection: an indicative mood, a subjunctive mood, and a counterfactual mood. Following others we assume that the tense inflection on finite verbs is semantically vacuous. The function of the inflection is to signal that the verb carries an uninterpretable feature. This feature has to be checked against the interpretable feature of a covert temporal operator in the head of the tense projection. Verbs marked by the simple past are proposed to be lexically ambiguous. They can either carry an uninterpretable feature demanding a past tense operator or an uninterpretable feature demanding a subjunctive mood operator. Similarly the auxiliary *have* can either be interpreted as carrying an interpretable perfect feature or an uninterpretable feature that, together with a past tense inflection, demands the counterfactual mood. For illustration we give below one of the syntactic analyses we predict for *he would have been in Amsterdam*.



As result of the lexical ambiguities we assume, sentences involving the simple past or the perfect are assigned more than one logical form. For instance, a sentence like *Peter left in time* can either be interpreted as $IND(PAST(Peter.leave.in.time))$ or $SUBJ(PRES(Peter.leave.in.time))$.

2.2. The semantics

A central challenge of approaches that propose the simple past to be lexical ambiguous is to explain why in simple sentences the simple past is always interpreted as tense marker. We can explain this observation in terms of the semantics we assume for the mood operators. This semantics predicts that simple sentences giving information about the actual world that carry the subjunctive mood are semantically anomalous. Hence, the simple past has to be interpreted as semantic past tense.

To be more specific, we propose that the semantic function of the English mood is to facilitate modal subordination. Modal subordination refers to the ability of English sentences to introduce or refer to hypothetical contexts. Let us introduce some terminology. We call the context where information about the actual world is stored C . T is the context a sentence ψ is about (if the sentence is about a hypothetical context, then $C \neq T$). F is the context a sentence ψ gives information about (if ψ introduces a hypothetical context, then F may differ from T). Now we propose that the mood operator tests whether a certain relation holds between the contexts C and F after update with the sentence in scope of the mood operator. If the relation holds, then the update is accepted, otherwise it is rejected. For the counterfactual mood we propose that it tests whether F is inconsistent with the facts of C , the subjunctive mood tests whether F is inconsistent with the expectations of C , and the indicative mood tests whether F is consistent with the expectations of C . Expectations are locally defined on the level of possible worlds. The expectations of a world are how you expect the world to develop into the future in the normal course of events. This approach then predicts that simple sentence about the actual world cannot stand in the subjunctive mood, because for such sentence we have $C = F$. But then the subjunctive mood would demand that the expectations of C deviate from what you believe to be the case in C - which is impossible.

3. Adding a diachronic perspective

It is well-known that similar unexpected uses of past tense markers can also be observed in other languages. How to explain this cross-linguistic pattern? There appears to be not only a cross-linguistics synchronic pattern, but also a diachronic pattern: past tense markers systematically develop into markers of a subjunctive mood (Dahl 1997). Past tense markers start to imply counterfactuality in subjunctive conditionals. Later on the counterfactual inference becomes obligatory and the temporal meaning gets lost. The sentences can then also be used with reference to the present or the future. Next the meaning changes from inconsistency to unexpectedness and the marker appears also in other constructions besides subjunctive conditionals. Now, a new past tense marker can develop into a marker of counterfactuality. Such a diachronic circle can explain the cross-linguistic pattern, but also language specific differences. Different languages may be in different stages of the circle. Interaction with other processes in this language can influence the particular

pathway taken by a language.

The most critical point in proposing such a diachronic circle is to explain its beginning: why should a past subjunctive conditional start to imply counterfactuality? Using the local notion of expectations introduced in Schulz 2007, we can predict that the combination of past tense and subjunctive mood implies counterfactuality simply by its semantics. However, then we also predict that one cannot use past subjunctive conditionals in case one still thinks it possible that the antecedent is true. Such conditionals exist, even though rarely. Nevertheless, I doubt that we can explain these examples as language misuses. An alternative approach would be to use a global notion of expectations that compares the worlds in a context according to their normality (cf. Veltman 1996). This would allow for past subjunctive conditionals in case you still consider the antecedent possible. However, now we have to tell a different story about why past markers develop into mood markers. An idea followed by many authors is that counterfactuality starts out as conversational implicature of past subjunctive conditionals. A problem these approaches often have to face is that, as far as they are formally precise, they stop with the inference that the speaker does not know that the antecedent is possibly true. To improve on such approaches one can adopt a formalization of implicatures proposed in Schulz and van Rooij 2006 and propose that the counterfactual inference is an effect of competence maximization. Competence strengthens *the speaker does not know the antecedent to be possible to the speaker knows the antecedent not to be possible*.

Bibliography

- Dahl, Ö.: 1997, The relation between past time reference and counterfactuality: A new look, in A. Athanasiadou and R. Dirven (eds.), *On conditionals again*, pp 97–112, John Benjamins, Amsterdam/Philadelphia
- Iatridou, S.: 2000, The grammatical ingredients of counterfactuality, *Linguistic Inquiry* 31(2), 231–270
- Ippolito, M.: 2003, Presuppositions and implicatures in counterfactuals, *Natural Language Semantics* 11, 145–186
- Schulz, K.: 2007, *Minimal models in semantics and pragmatics: Free choice, exhaustivity, and conditionals*, Ph.D. thesis, University of Amsterdam, Amsterdam
- Schulz, K. and van Rooij, R.: 2006, Pragmatic meaning and non-monotonic reasoning: The case of exhaustive interpretation, *Linguistics and Philosophy* 29(2), 205–250, see also Schulz 2007
- Veltman, F.: 1996, Defaults in update semantics, *Journal of Philosophical Logic* 25(3), 221–261

Interpretable but not interpreted

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This paper takes the position that the interpretive procedure may selectively ignore pieces of an LF that on other occasions it associates with an interpretation. I cite arguments (from earlier work) that pronouns in particular can go uninterpreted.

1. Introduction

Is the procedure that interprets syntactic structures obliged to interpret everything it sees? No, I suggest in this note. Even items that are in principle associated with an interpretation may go uninterpreted.

In what follows I summarize recent work that points to this conclusion. This work argues that, if we start from a view of interpretation along the lines of Heim and Kratzer 1998, and we take the position that the interpretive procedure treats pronouns and traces as variables, then in certain cases it seems that these elements are just ignored. I will limit myself here to arguments that pronouns can go uninterpreted. My concern will be with pronoun-containing constituents that have the meaning we would obtain with a variable in the position of the pronoun and a binder at the top ((1b)). I will present reasons for thinking that the meaning comes from an LF where an item that contributes nothing on its own moves from the surface position of the pronoun, leaving (as movement does) a binder and a trace ((1c)). And I will present reasons for thinking that this item is in fact the pronoun itself ((1d)).

- (1) a. [... pronoun ...]
b. [**1** [... var₁ ...]]
c. [∅ [**1** [... t₁ ...]]]
d. [(pronoun_i) [**1** [... t₁ ...]]]

(Parentheses around the pronoun indicate that the pronoun goes uninterpreted.)

2. Uninterpreted pronouns in dream reports (P[ercus and]S[auerland 2003])

Dream reports like (2a) are ambiguous, though to see this one needs to consider complex scenarios -- scenarios where John dreams that he is someone else, and where, in his dream, he himself appears as another character. (2a) can report that the “dream ego” got hit by an avalanche or that that other character did. Let’s focus on the former reading. In PS we take the position that in this case the complement clause has the meaning that we would obtain with a variable in the position of the pronoun and a binder at the top ((2b)). The idea is that the complement of *dream* gives us the property that the subject attributes to the dream ego -- here, the property of being hit by an avalanche. How do we arrive at this meaning for the complement clause? Notice that a pronoun that “stands for the dream ego,” just like a pronoun that “stands for the dreamer,” takes the form that a variable bound by the subject would take. In essence, we argue that we arrive at this meaning for the complement clause when, at LF, a pronoun bound by the subject moves to the top of the embedded clause and goes uninterpreted ((2c)). Summarizing, we take “dream ego” pronouns to be pronouns whose positions are occupied at LF by variables bound at the top of the complement clause. And we argue that the way the binder gets there is by movement of a bound pronoun which then goes uninterpreted.

- (2) a. John dreamed [that an avalanche hit him]
- b. ... [**2** [that an avalanche hit var₂]]
- c. John [1 t₁ dreamed [(him₁) **2** [an avalanche hit t₂]]

The argument is that, if we assume this, an otherwise surprising constraint on the readings that dream reports exhibit gets explained naturally in terms of a familiar constraint on movement. We show that dream reports with more than one pronoun exclude readings on which a “dreamer” pronoun c-commands all the “dream ego” pronouns. John could not use (3a), for example, to describe a dream in which he revisited his own wedding from the perspective of his wife’s grandfather. Why should this be? Assuming that “dreamer” pronouns are just pronouns bound by the subject, to arrive at such a reading we would have to move one variable bound by the subject (the “dream ego” pronoun) over a c-commanding variable bound by the subject ((3b)). This is a classic superiority violation: one element is moving to the edge when there is a closer identical element around that could move instead. Note that for this explanation not only must movement occur from the surface position of “dream ego” pronouns, but also the *pronoun itself* must be moving: superiority concerns competition between two like items.

- (3) a. I dreamed that I was marrying my grand-daughter.
- b. *I [1 t₁ dreamed [(my₁) **2** I₁ was marrying t₂ grand-daughter]]

3. Uninterpreted variables in resumption (D[emirdache and]P[ercus], to appear)

Jordanian Arabic contains resumptive constructions like the relative clauses in (4a,5a), where we find a clitic pronoun and the epithet *ha-l-Hmar*, a complex term made up of a pronominal item *ha* and an expressive. These relative clauses admit meanings of the kind we would obtain from structures like (4b,5b). In DP we argue that these meanings arise via movement of a pronoun which then goes uninterpreted ((4c,5c)).

- (4) a. kull walad [illi fakartu _____ ?innu Layla bitHibb-uh] ...
 every boy that you.thought that Layla loves-him
 b. [**2** [you thought that Layla loves **var₂**]]
 c. [(uh₁) **2** [you thought that Layla loves **t₂**]]
- (5) a. kull walad [?umm-oh fakkart ha-l-Hmar _____ bi-l-bajat] ...
 every boy mother-his thought pro-the-donkey at-the-house
 b. [**2** [**var₂**'s mother thought that [**var₂** the donkey] is at home]]
 c. [(oh₁) **2** [**t₂**'s mother thought that [**ha₂** the donkey] is at home]]

One argument of ours (recapitulating Demirdache 1991) is, again, that an otherwise surprising constraint on readings gets reduced to a familiar constraint on movement. In certain environments, a clitic pronoun and an epithet can only “behave as cobound variables” when the clitic *precedes* the epithet -- the relative clause in (6a) does *not* describe individuals whose mother thinks they will end up in prison. Importantly, these environments (all quantificational) are environments where an epithet could not appear as the sole resumptive element. On our perspective, this means that something is preventing movement from the position of the epithet’s pronoun. And in that case, when the clitic follows the epithet as in (6a), the only remaining way of generating the “cobound” reading is to move from the clitic’s position, violating crossover constraints ((6b)):

- (6) a. kull walad [?um ha-l-Hmar fakkart ?innu rah yzittu-u bi-l-Habs]
 every boy mother pro-the-donkey thought that they.will put-him in-prison
 b. * [(u₁) **2** [[**ha₂** the donkey]’s mother thought that they will put **t₂** in prison]]

This argument is fundamentally an argument that resumptive constructions involve movement from the surface position of a pronoun, and not that what is moving is a variable that goes uninterpreted. But this further step looks plausible in light of the dream report evidence, and also in light of the fact that, hidden in the Jordanian data, there is an argument that *traces* can go uninterpreted. Space limitations force me to refer the reader to DP for this latter argument. I will just enigmatically note that, if what we say there is correct, then this has the attractive consequence that, despite initial appearances, the movement of resumptive pronouns respects conditions on long distance movement.

4. Other uninterpreted pronouns ?

If binders could be freely inserted, then we would expect another structure for our pronoun-containing constituents where the pronoun remains in situ and gets bound by a freely inserted binder at the top. So our discussion until now suggests that binders can only get into the syntax via movement. Once we take this position, we find candidates for moved uninterpreted pronouns in a variety of other variable binding constructions.

English-style “intrusive” resumptive constructions are a prime example, and here there is evidence. For instance, (7a) and (7b) are perceived as differing in status when we try to understand them as involving two cobound variables, and this is what we would expect: since (8) indicates that the pronoun in the initial position can’t move up, the difference in (7) comes out as the difference between weak and strong crossover.

(7) Who did {a. # his mother, b. ## he } wonder whether he had a rare disease?

(8) * Who did {a. his mother, b. he } wonder whether you had a rare disease?

Among other constructions, those with *have* (though notoriously tricky) deserve a look. One line takes sentences like *John has a daughter* to be paradigmatic: in *John has an X*, *X* is a relation. In (9a), then, *who he can rely on* should restrict the *daughter* relation, arguably by denoting a relation itself, and we now have a simple way to obtain this:

(9) a. John has a daughter who he can rely on.

b. daughter [(**he**₃) **1** [(who) **2** **t**₁ can rely on **t**₂]]

5. Conclusion

Anaphora aside, we don’t often imagine that an element’s interpretation can depend on the context in which it appears. Here I explored a version of this hypothesis, suggesting that sometimes elements are just ignored. I looked at pronouns, in cases where ignoring them is actually of use -- if binders only arise via movement, interpreting them would have led to a type mismatch somewhere. I have other elements in mind too, though.

Bibliography

- Demirdache, H.: 1991, *Resumptive Chains in Restrictive Relatives, Appositives and Dislocation Structures*, Ph.D. thesis, MIT, Cambridge Mass.
- Demirdache, H. and Percus, O.: to appear, When is a pronoun not a pronoun? The case of resumptives, in *Proceedings of NELS 38*, GLSA, UMass, Amherst
- Percus, O. and Sauerland, U.: 2003, Pronoun movement in dream reports, in M. Kadowaki, S. Kawahara (eds.), *Proceedings of NELS 33*, GLSA, UMass, Amherst

General Program

TEMPORAL AND CIRCUMSTANTIAL DEPENDENCE IN COUNTERFACTUAL MODALS

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This paper analyzes counterfactual readings of *might/could have* using circumstantial rather than metaphysical modal bases. This accounts for scenarios in which the assumptions of the metaphysical analysis are not met, for a phenomenon of truth value varying with contextual assumptions, and is consistent with deterministic models.

1. Branching time semantics for *might/could have*

Mondadori (1978) and Condoravdi (2002) advanced the hypothesis that uses of *might have* like in (1) have a semantics which exploits branching time models. In a model where the sentence is true relative to a world w_0 and time n , there is a time t which precedes n and a world w which is a metaphysical alternative to w_0 at t such that in w there is an event of John winning which is temporally included in the interval $[t, \infty)$. Metaphysical alternative means that w and w_0 are exactly the same up to t . Informally, w is a branch from w_0 at t where John later wins.

(1) At that time, John might have won the game, but he didn't. (Condoravdi 2002)

I assume along with Condoravdi that the time operator associated with *have* scopes over the modality (but see Stowell 2004), and that in examples where the main verb is eventive there is always a covert futurity inside the scope of the modal (see also Abusch 1998). (2) is Condoravdi's denotation for *might*, where $M(w, t)(w')$ is understood as " w' is a metaphysical alternative to w at t ".

(2) $[[\text{might}]] = \lambda p \lambda w \lambda t \exists w' [M(w, t)(w') \wedge AT([t, \infty), w', p)]$

I argue that there are examples which should fall under the same analysis as (1), but where the modality can not be metaphysical, because the requirement that the alternatives should be literally the same as the base world up to the reference time is not met. Consider this scenario: there were two huge old trees in my front yard, of similar

age and appearance. In a summer storm, one of them was blown down. Fortunately, it fell away from the house onto the driveway, rather than towards the house onto my husband's office. When we looked at the broken trunk, we saw that it was rotted inside, so this was a dangerous tree. My husband made the argument in (3). I made the argument (4) to an opposite conclusion.

- (3) HUSBAND: I might have been killed, because the tree could have fallen onto my office. Let's cut down the other tree. It might fall onto my office in another storm.
- (4) WIFE: We bought the house for the trees, and now you want to cut them down? Anyway the tree guy told us that because of the location of the rot in the trunk, the tree could only fall away from the house. So the tree could not have fallen onto your office.

The specific problem is that the rot in the trunk was in a specific location before the storm in the base world w_0 , and we can assume that this specific location makes it impossible for the tree to fall onto the house. In this case, the husband's statement is false on the branching-time analysis. How then can his argument have any validity? Also, intuitively, the husband's argument ignores the specific location of the rot, while the wife's argument pays attention to it. It is not clear how to fit these assumptions into the branching-time analysis.

Similar points can be made about sports-math modality, which is a modal idiom of sports writers and fans which has a very specific semantics. In assessing the truth of sentences (5) and (6) in a world w , one pays attention to the schedule of league play in w , the results in w of games up to week 11, the league regulations in w which concern participation in the post-season playoffs, and nothing else.

- (5) In week 11 of the football season, mathematically, Buffalo could still have reached the playoffs.
- (6) In week 11 there was still a mathematical possibility of Buffalo reaching the playoffs.

It seems that (5) and (6) can be true in models where the base world w_0 has no metaphysical alternatives at week 11 where Buffalo reaches the playoffs, as a result of *other* facts in the base world and (therefore) in its metaphysical alternatives, such as all the Buffalo players having broken legs.

2. Factual-circumstantial modality

Notice that all of the assumptions we are talking about are facts. In a possible worlds framework, we want to assess truth with respect to a possible world w , but factor in a

choice of facts about w which are considered relevant. This kind of modality is known as a factual or circumstantial modality. Kratzer (1991) proposed the following framework for circumstantial modality, as a special case of a general framework. A contextually given function, here notated as Pr , maps any possible world w to a set of facts about w . A fact about w is a proposition p such that p is true in w . Adding a time argument gives the type $[(I \rightarrow W \rightarrow [W \rightarrow 2] \rightarrow 2)]$, with the constraint that for any w, t and p such that $\text{Pr}(t)(w)(p) = 1$, $p(w) = 1$. $\text{Pr}(t)(w)$ is used as a set of relevant facts about $\langle w, t \rangle$ which enters as a modal base into the semantics of a modal which is evaluated at $\langle w, t \rangle$. Three kinds of information are relevant to the truth assessment of sports math modality: (i) propositions describing the league schedule in w at t ; (ii) propositions describing the result of play in w up to t ; and (iii) propositions describing league regulations in w at t . Only the propositions in (ii) are necessarily facts about $\langle w, t \rangle$. Regarding (i), it might be that the play which is planned in w is not carried out, because of a natural disaster. In this case, the propositions describing the planned play are not all facts about $\langle w, t \rangle$. Regarding (iii), it might be that the league regulations for picking the teams that participate in the playoffs are not followed in w , because of a computer error. So sports-math is a circumstantial-deontic modality, with a specific factual-circumstantial modal base function Pr_{sm} , and a specific deontic ordering function Or_{sm} . A speaker who uses a sports math sentences intends to fix parameters in the lexical entry of the modal as Pr_{sm} and Or_{sm} . (7) describes Pr_{sm} semi-formally using a lambda expression with a question as a body, assuming the Karttunen semantics for questions.

- (7) $\text{Pr}_{\text{sm}} = \lambda t \lambda w [\text{what NFL team plays what NFL team at what time preceding } t \text{ in regular-season play with what final score in } w]$

Let's use the logical form (8b) for (8a), where the modal has two hidden arguments filled by referential indices. The first hidden argument is used as the modal base, and the second hidden argument is used as the ordering source function. In a sports-math context, the contextual assignment function g satisfies $g(1) = \text{Pr}_{\text{sm}}$ and $g(2) = \text{Or}_{\text{sm}}$. Adding time sensitivity to the semantics for an existential modal found in Kratzer (1991) results in (9) as the lexical entry of the modal.

- (8) a. In week 11, mathematically Buffalo could have reached the playoffs .
b. $[[\text{in week 11}][\text{have} [\text{might}(1)(2) [\text{Buffalo reach the playoffs}]]]]$

- (9) $[[\text{might}]]$ is the function f such that $f(\text{Pr})(\text{Or})(P)(t)(w) = 1$ iff

$$(\exists u \in \cap \text{Pr}(t)(w)) (\forall v \in \cap \text{Pr}(t)(w)) [v \leq_{\text{Or}(t)(w)} u \rightarrow (\exists z \in \cap \text{Pr}(t)(w)) [z \leq_{\text{Or}(t)(w)} v \wedge P(t)(z)]]$$

$$\text{where } v \leq_x u \text{ iff } \{p \mid p \in X \wedge p(u)\} \subseteq \{p \mid p \in X \wedge p(v)\}$$

When Pr_{sm} is the first argument of *might*, the domain of quantification for any quantifier in the formula in (9) is the set of worlds which have the same history of play as the base world up to week 11. In any model of reasonable complexity, this is a much more inclusive set than the set of metaphysical alternatives to the base world at week 11. Furthermore, the ideal worlds according to Or_{sm} are ones where the schedule and the regulations for determining participation in the playoffs are followed. This makes it relatively easy to find witnesses for the existential quantifiers. Indeed one can use as a witness for both $\exists u$ and $\exists z$ any old world w_2 which has the same results as the base world up to week 11, which follows the regulations and schedule, and has a particular pattern of results for the whole season which allows Buffalo to qualify. It does not matter if in the base world at week 11, the Buffalo players are in such bad shape that Buffalo does not win any more games in the base world or its metaphysical alternatives, because the domain of quantification is not limited to metaphysical alternatives, just to worlds which have the same results as the base world up to w_0 . Or suppose we are talking about computer football matches, where the systems play according to certain deterministic algorithms. Then we can get the kind of shift illustrated in (10).

- (10) In week 11, Buffalo could still technically have reached the playoffs. But that would require Buffalo defeating Chicago in week 12. And that is impossible because of the algorithms implemented in those systems.

An additional point is that the circumstantial analysis is consistent with deterministic models, while the metaphysical analysis is not. In a deterministic model (take one where all worlds have a deterministic classical physics), metaphysical alternative sets are trivial, consisting of singleton sets, so metaphysical modals are vacuous. But there can still be non-trivial circumstantial alternative sets. If we think natural language semantics should be consistent with a range of model types including deterministic ones, this is a good consequence.

In the tree example, the husband's and wife's facts both include facts about the storm, the size and configuration of the tree, the fact that there was such-and-such degree of rot in the trunk, and (perhaps in the ordering source) a scientific or rule-of-thumb theory of tree motions under the influence of wind. The wife's facts include in addition the specific location of the rot on the driveway side of the tree. This removes the apparent contradiction between (3) and (4), and formalizes intuitions about the arguments. To this one has to add an account of the validity of the husband's argument about the other tree. I suggest the facts are centered, with a parameter for the tree.

3. Temporal dependence

An important consequence of the metaphysical analysis is the account it gives of time-sensitivity. The branching-time story about (11) is that at w_0 at 12:00, there is a branch (a metaphysical alternative) which leads to a win of John. In w_0 at 12:30, some branches have been passed, and there are no branches which lead to a win of John.

(11) At noon, John still might have won the race. But at 12:30, he could not have won the race.

Does the new analysis have the same kind of time dependency? Formally, this is simple. As formulated above, the premise function has world and time arguments. In a compositional semantics that manipulates properties of time, we can set up the rules and denotations such that in the denotation of *could win the race*, the temporal argument of the property is identified with the temporal argument of the premise function. In fact this is already achieved in (9). The move is technically possible because the description of the function $[[\text{might}]]$ can refer to the temporal argument of the premise function and the temporal argument of the property denoted by the phrase headed by *might*.

As long as the premise function is time dependent – as long as for a given world, it can have different values at different times – the denotation of the phrase headed by the modal can be time dependent too. Pr_{sm} is time dependent, because $\text{Pr}_{\text{sm}}(w, t)$ has information about a monotonically increasing set of game results as t increases. In fact, if $t < t'$ then $\text{Pr}_{\text{sm}}(t)(w) \subseteq \text{Pr}_{\text{sm}}(t')(w)$, and therefore $\cap \text{Pr}_{\text{sm}}(t')(w)$ is a subset of $\cap \text{Pr}_{\text{sm}}(t)(w)$. So as time passes, the domain of quantification shrinks. This is similar to what happens in the branching-time analysis, where as time passes the set of metaphysical alternatives $\lambda v[M(t, w)(v)]$ used as a domain of quantification shrinks monotonically. In fact, the new analysis is a generalization of the old one. (12) defines a premise function in terms of the metaphysical-alternative relation M . Using it in combination with a trivial ordering source reconstructs the branching time analysis within the circumstantial analysis.

(12) $\text{Pr}_m = \lambda t \lambda w \lambda p [p = \lambda v [M(t, w)(v)]]$

4. Epistemic readings

What I have analyzed as circumstantial readings can also have an epistemic flavor. In example (13) about oil prospecting, we can say either that salient facts about the base world were consistent with there being oil reserves under the ranch, or that this was

consistent with the beliefs of the speaker at that time or with information available to the speaker and others. Similar examples are discussed in von Stechow and Gillies (2007).

- (13) We bought a ranch which might have contained a significant oil reserve. But there is nothing under this ranch but salt water. Let's sell it and move on.

But consider this variant of the tree example. The two trees are in a part of our forest reserve which we never visited before. The tree fell away from a plantation of endangered orchids. We find it several months after it fell. The facts about the rot are as before. Here is the sentence:

- (14) The tree could have fallen on the orchids. Let's cut down the other tree. It might fall on the orchids in another storm.

In this case, there was nobody around before the time of the storm who believed the propositions in the modal base or took them to be common ground. So the modal base or ordering source could not be epistemic. On the other hand, there is no problem with saying that the modality refers to relevant information about the tree at the time of the storm, as represented in the modal base, combined with an ordering source capturing our rule-of-thumb theory of tree motions.

Because the framework is one which is also applied to counterfactuals with *if*, we can account for certain relations to sentences like (15).

- (15) If the rot had been on the opposite side, the tree might/would have fallen on the office.

Bibliography

- Abusch, Dorit (1998) "Generalizing Tense Semantics for Future Contexts". In Susan Rothstein, ed., *Events and Grammar*, 13-33.
- Condoravdi, Cleo (2002) "Temporal Interpretation of Modals: Modals for the Present and for the Past". In *The Construction of Meaning*, edited by D. Beaver, et. al.
- von Stechow, Kai and Anthony S. Gillies (2007). "'Might' Made Right". *Semantics Archive*.
- Kratzer, Angelika (1991) "Modality". In *Semantics: An international handbook of Contemporary Research*, edited by Arnim von Stechow and Dieter Wunderlich, pp. 639-650.
- Mondadori, Fabrizio (1978) "Remarks on Tense and Mood: The Perfect Future". In Franz Guenther and Christian Rohrer, eds., *Studies in Formal Semantics*.
- Stowell, Tim (2004) "Tense and Modals" In *The Syntax of Time*, edited by Jacqueline Gueron and Jacqueline Lecarme, MIT Press.

DISCOURSE COHERENCE AND VP ELLIPSIS WITH SPLIT ANTECEDENTS

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Prüst et al. 1994 propose a model of discourse coherence that resolves VP ellipsis reference as a side effect of coherence establishment. This paper extends that framework using the Cause-Effect model from Kehler 2002. The extended framework allows a straightforward account of split antecedent cases of VP ellipsis from Webber 1978.

1. Introduction

Cases of VP ellipsis with antecedents in multiple clauses (“split antecedents”) such as (1a), whose interpretation is shown in (1b), interest researchers studying the syntax, semantics, and pragmatics because they pose a challenge for syntactic theories of VP ellipsis and their interpretations are strongly connected to pragmatic factors.

- (1) a. Wendy is eager to sail around the world and Bruce is eager to climb Kilimanjaro, and **they will** if they have enough money. (Hardt 1999, adapted from Webber 1978)
- b. Wendy will sail around the world and Bruce will climb Kilimanjaro.

I will show that this interpretation falls out of a general account of discourse coherence if we assume that VP ellipsis reference is resolved as a side effect of discourse coherence establishment.

1.1. Previous Approaches

This paper aims to re-examine the hypothesis advanced by Prüst et al. 1994 that verb phrase ellipsis reference is resolved as a side effect of discourse coherence establishment. Incorporating the Cause-Effect coherence model of Kehler 2002 will allow an analysis split antecedent VP ellipsis.

Two recent accounts of split antecedents have recognized the importance of discourse factors but failed to provide a specific theory of how discourse factors interact with ellipsis to produce the observed meanings. Hardt 1999 uses dynamic semantics

to model split antecedents. He claims that a salient mapping of subjects to predicates gives the reading of (1). Elbourne 2008 treats elided VPs as definite descriptions in a situation semantics. Contextual domain restrictions match each elided VP to its subject in (1). Both acknowledge discourse factors at work, but are vague about how they work.

One thing Hardt and Elbourne have in common is that they conclude VP ellipsis and pronouns are similar. This similarity is represented in the present account by modeling both as unification variables.

2. A Discourse Grammar

Kehler 2002 identifies three broad families of discourse coherence, with many specific coherence relations within each family. I will show that the Parallel and Result relations predict the reading of (1).

2.1. The Parallel Relation

The Parallel relation is illustrated in (2).

- (2) a. Mary likes John.
- b. Susan does too.

To account for this sort of example, Prüst et al. define a unification algebra over the well formed formulas of a familiar typed logic. Their logic adds sorts and variables over sorts, a preorder relation on logical formulas, and two operators, the Most General Unification and the Most Specific Common Denominator¹.

Sorts are written in small caps and a **variable** over a sort is underlined. For example, GIRL ranges over the girls in the model. Variables with the same subscript must covary; variables without a subscript vary independently.

Formulas in the logic are (pre)ordered by specificity. $\phi \sqsubseteq \psi$ is read ϕ is at least as specific as ψ . For example, $\text{mary} \sqsubseteq \text{GIRL} \sqsubseteq \text{HUMAN} \sqsubseteq \text{ENTITY}$.

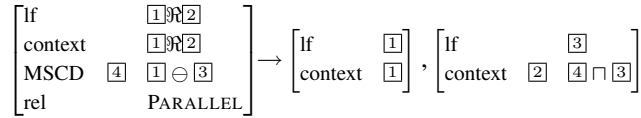
The **MGU** of ϕ and ψ , written $\phi \sqcap \psi$, is the most general object χ such that $\chi \sqsubseteq \psi$ and $\chi \sqsubseteq \phi$. If such an object exists, we say ϕ and ψ unify.

The **MSCD** of ϕ with respect to ψ of the same type, written $\phi \ominus \psi$, is the most specific object χ such that $\phi \sqsubseteq \chi$ and χ and ψ unify.

The discourse grammar is a set of rules that say how the attributes of a complex discourse are derived from the attributes of its parts. The Parallel rule tracks four attributes. The logical form, or **lf**, is the context-invariant meaning of the discourse. The **context** is the contextually determined meaning of the discourse. The **rel** attribute is the discourse coherence relation that holds between the constituents of a complex discourse unit. The **MSCD** attribute is the MSCD of the discourse. The Parallel rule restates Prüst et al.'s List rule as (3).

¹For a more detailed specification of the syntax and semantics of the logic and the unification algebra defined over it, see Prüst et al. 1994

(3) PARALLEL:



Constraints:

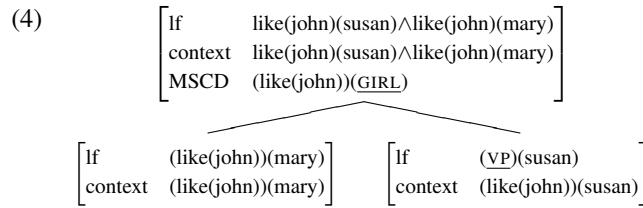
$\boxed{1}$ has no variables.

$\boxed{4}$ has no variables over a trivial sort.

\mathfrak{R} is the propositional relation expressed by a clausal connective. The default relation is propositional conjunction when no other relation is expressed.

The Parallel rule calculates the MSCD of it's daughters, and fills in the context value of its second daughter by unifying the MSCD with that daughter's If, which resolves variable references.

The Parallel rule parses the discourse in (2) and resolves the VP ellipsis reference as shown in (4). In the If of *Susan does too*, VP is a variable that ranges over VP meanings (type $\langle e, t \rangle$). It represents the missing complement to the auxiliary *does*.



2.2. Cause-Effect Relations

Kehler 2002, Chapter 6 provides an account of pronouns where pronouns are represented as variables and their reference is resolved by coherence unification. He illustrates this with the example (5). The discourse presupposes the world knowledge encoded by formula (6). The \mapsto arrow states that the truth of the proposition on the left of the arrow leads one to expect the proposition on the right to hold.

(5) City council denied the protesters a permit because...

- a. ...they feared violence.
- b. ...they advocated violence.

(6) $[\text{fear}(\text{RESULT}_1)(\text{GROUP}_3) \wedge \text{advocate}(\text{RESULT}_1)(\text{GROUP}_2) \wedge \text{allow-to-cause}(\text{RESULT}_1)(\text{GROUP}_2)(\text{ENTITY}_4)]$
 $\mapsto \text{deny}(\text{ENTITY}_4)(\text{GROUP}_2)(\text{GROUP}_3)$

The discourses (5a) and (5b) are coherent by Kehler's Explanation relation. Explanation coherence is established by unifying the If of the first clause with consequent of the presupposed \mapsto implication. The If of the second clause is unified with

a term in the antecedent of (6). It's this unification of the second clause that causes *they* to be interpreted as 'city council' in (5a) and 'the protesters' in (5b).

The **presup** attribute is used by Cause-Effect relations to store coherence-generated presuppositions. The unification process that establishes Explanation described above is captured by the Explanation rule shown in (7).

(7) EXPLANATION:

$$\left[\begin{array}{l} \text{If} \quad \boxed{1} \mathfrak{R} \boxed{2} \\ \text{context} \quad \boxed{1} \mathfrak{R} \boxed{2} \\ \text{presup} \quad ((\phi \wedge \psi) \mapsto \chi) \sqcap ((\boxed{3} \wedge \psi) \mapsto \boxed{4}) \\ \text{rel} \quad \text{EXPLANATION} \end{array} \right] \rightarrow \left[\begin{array}{l} \text{If} \quad \boxed{4} \\ \text{context} \quad \boxed{1} \quad \chi \sqcap \boxed{4} \end{array} \right], \left[\begin{array}{l} \text{If} \quad \boxed{3} \\ \text{context} \quad \boxed{2} \quad \phi \sqcap \boxed{3} \end{array} \right]$$

$(\phi \wedge \psi) \mapsto \chi$ and $(\boxed{3} \wedge \psi) \mapsto \boxed{4}$ unify.
 $\phi \wedge \psi \mapsto \chi$ is salient world knowledge or can be accommodated by the participants in the conversation.
 \mathfrak{R} is the propositional relation expressed by a clausal connective. The default relation is propositional conjunction when no other relation is expressed.

3. Split Antecedents

Returning now to (1), which I've simplified in (8), we can clearly see that the first two clauses are Parallel, and each Parallel clause stands in the Cause-Effect relation Result with the ellipsis containing clause. Each Parallel clause is connected to the ellipsis clause by the discourse presupposition (9).

(8) Wendy is eager to sail around the world and Bruce is eager to climb Kilimanjaro, and **they will**.

(9) [want-to'(VP_j)(HUMAN_i)] \mapsto will'(VP_j)(HUMAN_i)]

The reading we get for the VP ellipsis clause is the result of unifying each of the Parallel clauses with the antecedent of its own instance of (9), unifying an instance of the second clause with the consequence of each instance of the presupposition, and combining the two specifications of the second clause using the same operation connecting the Parallel clauses. This process is captured by the Result² rule (10)².

(10) RESULT²:

$$\left[\begin{array}{l} \text{If} \quad \boxed{1} \mathfrak{R}_1 \boxed{2} \\ \text{context} \quad \boxed{1} \mathfrak{R}_1 \boxed{2} \\ \text{presup} \quad \left\{ \begin{array}{l} \phi, \\ (\psi \mapsto \chi) \sqcap (\boxed{3} \mapsto \boxed{5}), \\ (\xi \mapsto \eta) \sqcap (\boxed{4} \mapsto \boxed{5}) \end{array} \right\} \\ \text{rel} \quad \text{RESULT} \end{array} \right] \rightarrow \left[\begin{array}{l} \text{If} \quad \boxed{3} \mathfrak{R}_2 \boxed{4} \\ \text{context} \quad \boxed{1} \quad (\boxed{3} \sqcap \psi) \mathfrak{R}_2 (\boxed{4} \sqcap \xi) \\ \text{rel} \quad \text{PARALLEL} \end{array} \right], \left[\begin{array}{l} \text{If} \quad \boxed{5} \\ \text{context} \quad \boxed{2} \quad (\boxed{5} \sqcap \chi) \mathfrak{R}_2 (\boxed{5} \sqcap \eta) \end{array} \right]$$

Constraints:

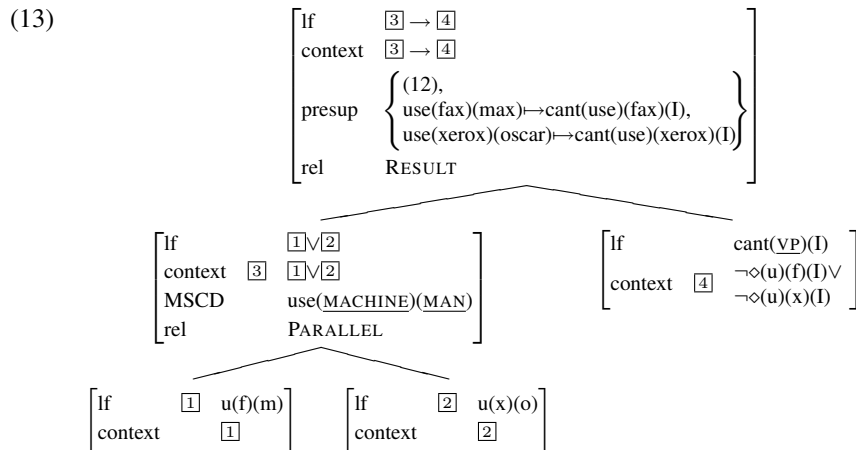
²Both Result and Result² can be generalized to a Resultⁿ rule schema. See Baker prep for this generalized rule.

$\psi \mapsto \chi$ and $(\boxed{3} \mapsto \boxed{5})$ unify, and $\xi \mapsto \eta$ and $(\boxed{4} \mapsto \boxed{5})$ unify.
 ϕ is salient world knowledge or can be accommodated by the participants in the conversation.
 $\psi \mapsto \chi$ and $\xi \mapsto \eta$ instantiate ϕ

Result² is illustrated in more detail with (11). The presupposition (12) accounts for (11), resulting in the discourse parse shown in (13).

(11) Whenever Max uses the fax or Oscar uses the Xerox, I can't. (Fiengo and May 1994)

(12) $\text{use}'(\underline{\text{MACHINE}}_j)(\underline{\text{HUMAN}}_i) \mapsto \neg(\text{can}'(\text{use}'))(\underline{\text{MACHINE}}_j)(\underline{\text{HUMAN}}_k)$



Interestingly, the If of the discourse is strictly more general than the intuitive reading for this discourse. But the presuppositions must also be satisfied for the discourse to be felicitous, correctly predicting that (11) is only felicitous when I can't use whichever of the fax or the Xerox is being used at the time.

Prüst et al. offer (14) as an example of a discourse that does not have a split antecedent reading for the elided VP.

(14) Maaik dances. Brigitte sings. Saskia does too.

The discourse grammar I propose predicts no split antecedent reading here as well³. There is no salient presupposition that would allow Cause-Effect coherence to felicitously apply in this context and supply the split antecedent reading.

Elbourne 2008 uses (15) to show that changing the discourse environment of (14) can provide a split antecedent reading.

³In fact, the Parallel relation must be modified slightly to allow a single clause to be Parallel to both subparts of a complex clause to get any reading here at all.

- (15) Saskia, being a competitive type, has managed to acquire all the skills Maaike and Brigitte possess. Maaike dances. Brigitte sings. Saskia does too.

But this new discourse environment makes an Cause-Effect presupposition salient, allowing Cause-Effect coherence to hold between the two Parallel antecedent clauses and the ellipsis clause. The present account predicts this split antecedent reading the same way it predicts the reading of (8).

4. Conclusion

There is a large debate in the literature over whether or not there is syntax in the ellipsis site, with Merchant 2001; Fiengo and May 1994 arguing that there is syntax in the ellipsis site and Hardt 1999 arguing that there is not. Though the present account would seem to be a semantic theory of ellipsis, with no syntax in the ellipsis site, it is also compatible with a syntactic theory of ellipsis. If unification variables range over syntactic objects and world knowledge is represented syntactically, then the coherence analysis is compatible with the arguments from Merchant 2001; Merchant prep and Frazier and Clifton 2006 that the ellipsis site contains syntactic structures.

Unlike Elbourne's 2008 model, this model makes very few assumptions about the syntax of the ellipsis site. It shows that a better understanding of general cognitive abilities like inferences to the most coherent understanding of a situation we can simplify our accounts of complex natural language phenomena.

Bibliography

- Baker, A. C.: In prep., *Verb Phrase Ellipsis Resolution as a Side Effect of Discourse Coherence*, In prep
- Elbourne, P.: 2008, *Ellipsis Sites as Definite Descriptions*, to appear in *Linguistic Inquiry*
- Fiengo, R. and May, R.: 1994, *Indices and Identity*, MIT Press
- Frazier, L. and Clifton, C.: 2006, Ellipsis and discourse coherence, *Linguistics and Philosophy* 29(3), 315–346
- Hardt, D.: 1999, Dynamic interpretation of verb phrase ellipsis, *Linguistics and Philosophy* 22(2), 187 – 221
- Kehler, A.: 2002, *Coherence, Reference, and the Theory of Grammar*, Stanford: CSLI Publications
- Merchant, J.: 2001, *The syntax of silence: Sluicing, islands, and the theory of ellipsis*, Oxford Press
- Merchant, J.: in prep, *Voice and Ellipsis*, Unpublished draft
- Prüst, H., Scha, R., and van den Berg, M.: 1994, Discourse grammar and verb phrase anaphora, *Linguistics and Philosophy* 17, 261–327
- Webber, B. L.: 1978, *A Formal Approach to Discourse Anaphora*, Ph.D. thesis, Harvard University

ASPECT AND COERCION IN ANCIENT GREEK

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The interpretations of aoristic and imperfective aspect in Ancient Greek cannot be attributed to unambiguous aspectual operators but suggest an analysis in terms of coercion in the spirit of de Swart (1998). But since such an analysis cannot explain the Ancient Greek data, we combine Klein's (1994) theory of tense and aspect with Egg's (2005) aspectual coercion approach. According to this theory, (grammatical) aspect relates the runtime of an eventuality and the current time of reference (topic time), whereas tense relates the moment of utterance and the topic time.

These relations can trigger aspectual selection restrictions (and subsequent aspectual coercions) just like e.g. aspectually relevant temporal adverbials, and are furthermore susceptible to the Duration Principle of Egg (2005): properties of eventualities must be compatible with respect to the duration they specify for an eventuality, otherwise coercion is called for. The Duration Principle guides the selection between different feasible coercion operators in cases of aspectual coercion but can also trigger coercions of its own. We analyse the interpretations of aorist and imperfective as cases of coercion that avoid impending violations of aspectual selection restrictions or the Duration Principle, which covers cases that are problematic for de Swart's (1998) analysis.

1. Introduction

This paper discusses the semantics of aoristic and imperfective aspect in Ancient Greek. The aorist indicates that an eventuality is completed, e.g., receiving the reign in (1). But for unbounded predicates (which introduce no inherent boundaries for eventualities) it has an ingressive interpretation, e.g., the begin of joy and courage in (2), or a 'complexive' interpretation (with begin and end), e.g., serving a term as senator in (3):

- (1) *teleutē-sa-ntos* *Aluatteō* *ex-e-dexa-to*
die-AOR-PTCP.GEN.SG Alyattes.GEN.SG from-PAST-take.AOR-3SG
tē-n *basilēiē-n* *Kroiso-s*
the-ACC.SG reign-ACC.SG Kroisos-NOM.SG
"After Alyattes died, Kroisos received (AOR) the reign." Hdt.1.26.1

- (2) *Apothenēisk-ei d' oun Mario-s (...) kai mega*
 die.IMP.PR-3SG and then Marius.NOM.SG and great.NOM.SG
e-sch-e parautika tē-n Rōmē-n charma kai
 PAST-have.AOR-3SG immediately the-ACC.SG Rome-ACC.SG joy.NOM and
tharso-s
 courage-NOM.SG
 “Then Marius dies ... and immediately, great joy and courage took possession (AOR) of Rome.” Plu. *Mar.* 46.5
- (3) *allē-n men archē-n oudemia-n pōpote ērxa*
 other-ACC.SG though office-ACC.SG no-ACC ever PAST.rule.AOR.1SG
en tēi polei, e-bouleu-sa de
 in the.DAT.SG state.DAT.SG PAST-be.a.senator-AOR.1SG but
 “I never held any other office in the state but I served a term as senator (AOR).” Pl. *Ap.* 32a9

Imperfective aspect in Ancient Greek by default is interpreted progressively, as in (4); but habitual interpretations also exist (5).

- (4) *Kuro-s eti pros-ēlaun-e*
 Kyros-NOM.SG still to-PAST.march.IMP-3SG
 “Kyros was still marching on (IMP).” X. *An.* 1.5.12
- (5) *en dexia-i de kai en aristera-i autou te kai tōn*
 in right-DAT.SG PRT and in left-DAT.SG him.GEN PRT and the.GEN.PL
hippe-ōn peltasta-is chōra ēn
 cavalry-GEN.PL targeteer-DAT.PL place.NOM.SG PAST.be.IMP.3SG
 “To the right and left from him and the cavalry was (IMP) the usual place for the targeteers.” X. *Cyr.* 8.5.10

The interpretations of (1)-(5) cannot be explained in terms of unambiguous aspectual operators. E.g., for the aorist, one would have to assume an ambiguity between a change-of-state operator like Dowty’s (1979) BECOME and Krifka’s (1989) AOR operator that maps predicates *P* onto (locally) maximal phases of *P*.

Instead, the interpretations resemble the result of aspectual coercion, as in the analogous English examples (6)-(9) (Moens and Steedman 1988):

- (6) When Mary arrived, Max ran (he started running, ingressive, cp. (2))
- (7) Max ran in ten minutes today (he started running, ran, and then stopped running, complexive, cp. (3))
- (8) Max played the Moonlight Sonata for two minutes (he played a part of it, progressive, cp. (4))
- (9) Max played the Moonlight Sonata for two decades (he played it over and over

again, habitual, cp. (5))

This seems to suggest applying de Swart's (1998) account of the different forms of the French past tense to the Ancient Greek data, which would put down the interpretations (1)-(5) to coercion triggered by aspectual restrictions of independent temporal operators. But this would not work for Ancient Greek, where tense can be distinguished morphologically from aspect and the aoristic/imperfective distinction is not restricted to tensed forms. Such a coercion analysis for Ancient Greek would furthermore entail that aoristic and imperfective morphology are semantically vacuous, because the semantic effect of choosing either one would be attributed entirely to aspectual restrictions from other sources.

What is more, the default status of the progressive interpretation of the imperfective would remain unexplained, and habitual interpretations of stative predicates like in (5) cannot be based on aspectual coercion anyway (these interpretations are stative, too).

The last problem also holds for French: De Swart's analysis cannot explain the habitual interpretation of the stative main clause in (10) in terms of a selection restriction of the French imparfait for unbounded predicates:

- (10) Quand j'étais petit, je ne dormais pas bien
'When I was young, I usually didn't sleep well.'

2. The semantics of aorist en imperfective

To describe aorist and imperfective, we distinguish *aspectual class* (or 'aktionsart') from *grammatical aspect*. Aspectual class is introduced by the semantics of an uninflected verb and its complements and adjuncts and describes the temporal progression of the eventuality denoted by the verb; grammatical aspect is introduced by aspectual inflection and locates the eventuality temporally with respect to the reference or topic time (TT), about which a claim is made (Klein 1994). Tense relates TT to the moment of utterance, see (11b).

Aorist and imperfective are both grammatical aspects. The aorist states that the runtime of a specific eventuality (Klein's TSit) is located within TT; the imperfective, that TT is located in TSit (following Gerö and v. Stechow 2003). For the aorist, this means that its argument (a property of eventualities) must be bounded, i.e., the property must not hold for a proper part of an eventuality for which it holds. Otherwise, some constellations of TT and TSit describable by the imperfective of an unbounded *P* could be expressed using an aorist of *P* as well: In these constellations, the eventuality *e* whose runtime is TSit has at least one part *e'* that is (due to the divisivity of *P*) also in the extension of *P*, and this second eventuality *e'* is so small that its runtime TSit' is located in the topic time. Fig. 1 illustrates this constellation; in this figure, the topic time is indicated by the brackets, and the runtime of the eventualities (TSit and TSit', respectively), by the beams.

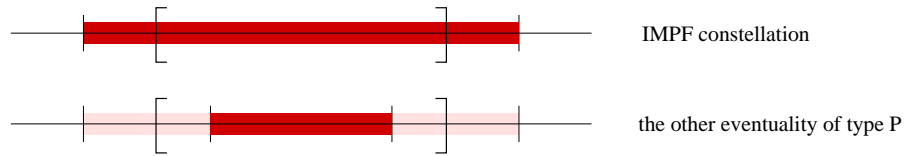


Figure 1: The imperfective of unbounded predicates

We rule out this unwanted potential overlap between imperfective and aorist in terms of an aspectual class restriction of the aorist. Eventually, this restriction is due to a case of ‘pragmatic strengthening’, which removes semantic overlap between competing instantiations of the same grammatical feature (here, aspect). In contrast, the imperfective does not restrict the aspectual class of its argument.

This analysis directly assigns the main clause of (1) a complete interpretation (the subordinate clause determines the topic time as the time after Alyattes’ death). The aorist semantics (11a) maps properties of eventualities P onto the set of times that include the runtime of an eventuality of type P . Then the semantics of tenses maps a property P' of the topic time (which itself is rendered as anaphor t_{TT}) onto a proposition. (11b) shows this mapping for the past tense, here P' is mapped onto a conjunction of $P'(t_{TT})$ with the proposition that t_{TT} precedes the utterance moment t_0 . (11c) states that the entire transfer of the reign to Kroisos took place within the topic time, which lies before t_0 :

- (11) a. $\lambda P \lambda t \exists e. P(e) \wedge \tau(e) \subseteq t$
 b. $\lambda P. P(t_{TT}) \wedge t_{TT} < t_0$
 c. $\exists e. \text{receive-reign}'(\text{kroisos}')(e) \wedge \tau(e) \subseteq t_{TT} \wedge t_{TT} < t_0$

For (4), we get a progressive interpretation. The semantics of the imperfective (12a) maps properties of eventualities P onto the property of being a proper part of the runtime of an eventuality of type P , which together with the interpretation of the past tense in (11b) yields (12b) as the semantics of (4): The runtime $\tau(e)$ of an eventuality e of Kyros marching on includes the topic time t_{TT} , which precedes t_0 . In the larger context, the topic time is determined as the time of Klearchos riding through Menon’s army. At the end of TT, the eventuality e is still continuing, which yields the progressive effect:

- (12) a. $\lambda P \lambda t \exists e. P(e) \wedge t \subset \tau(e)$
 b. $\exists e. \text{march-on}'(\text{kyros}')(e) \wedge t_{TT} \subset \tau(e) \wedge t_{TT} < t_0$

In this analysis, we ignore the *imperfective paradox* (there need not be a full eventuality of type P for the imperfective to be true). The resolution of this problem goes far beyond the scope of this paper and is in principle independent of our account. See e.g. Dowty (1979) and Landman (1992) for in-depth discussions of the problem.

3. Aspectual coercion and the Duration Principle

The interpretations of (2) and (3) emerge as an attempt to avoid an impending mismatch between the selection restriction of aorist and the aspectual class of its argument in terms of intervening coercion operators like INGR or MAX that map unbounded onto bounded predicates:

$$(13) \quad \text{INGR}(P)(e) \text{ iff } e \text{ is the smallest eventuality such that } \neg \exists e'. e' \supset \prec e \wedge P(e') \\ \text{and } \exists e''. e \supset \prec e'' \wedge P(e'')$$

$$(14) \quad \text{MAX}(P)(e) \text{ iff } P(e) \wedge \forall e'. e \sqsubset e' \rightarrow \neg P(e')$$

INGR resembles Dowty's BECOME. $\text{INGR}(P)$ holds for smallest eventualities e that do not abut on a preceding eventuality (relation ' $\supset \prec$ ') of type P but abut on a following eventuality in the extension of P . MAX is similar in spirit to Krifka's AOR. It maps a predicate P on the set of locally maximal eventualities in the extension of P (we assume that eventualities are convex, i.e., without interruptions). E.g., the second clause of (3) gets the interpretation in (15). In spite of this coercion analysis, we are not forced to assume that the aorist morphology is semantically empty.

$$(15) \quad \exists e. \text{MAX}(\text{be-senator}'(\text{speaker}'))(e) \wedge \tau(e) \subseteq t_{TT} \wedge t_{TT} < t_0$$

The habitual interpretation of imperfective aspect and the choice of aspectual coercion for the aorist are put down to the *Duration Principle* (DP) of Egg (2005): properties of eventualities must be compatible with respect to the duration they attribute to an eventuality. This information may be exact (as in *for five minutes*) or take the form of a 'typical duration' (e.g., we know that the duration of playing a sonata usually is measured in minutes, but not seconds or days). The DP guides aspectual coercion and can trigger coercion of its own.

The DP plays a role in coercion, which is due to the fact that coercion operators may influence duration. In particular, an ingressive operator shortens, and a habitual operator lengthens, the typical duration introduced by its argument. The role of the DP is visible in cases where there are several potential coercion operators that are equally useful to avoid a specific aspectual mismatch: The need to ensure compatibility with respect to the duration attributed to an eventuality may guide the choice among these operators. This determines which operators to use for the aspectual class coercion of unbounded predicates in the aorist.

If the topic time is very short then an ingressive coercion is chosen like in (2): Here *parautika* 'immediately' fixes the topic time as a time point, and coercion in terms of an ingressive operator returns an eventuality (the beginning of joy and courage) of very short duration that may be situated within TT. Complexive coercion would not be possible because the runtime of a maximal eventuality of being glad and courageous, including its beginning and ending, would not fit within a time point. But if the topic time is longer, a complexive coercion is possible like in (3),

where TT is the whole life of the speaker, which can comprise the runtime of serving a term as senator from begin to end.

For the imperfective, the DP explains the default status of the progressive interpretation. Here, the topic time is part of the runtime of the eventuality. As long as the typical duration involved in the predicate *P* that introduces the eventuality is not smaller than TT, a literal, ‘progressive’ interpretation is available, e.g., in (4), where TT is (in the larger context) specified as the time that Klearchos is riding through Menon’s army.

Only if the topic time is longer than the typical duration of the eventuality must one resort to coercion, e.g., in (5), where the topic time (the time during which Kyros waged wars, i.e., years) is longer than the typical duration of targeteers being in a specific strategic position. With a habitual operator the impending DP mismatch can then be avoided, because it considerably lengthens the typical duration (habits may well last for years). For (5), this leaves the aspectual class of the predicate untouched, which proves that no aspectual class coercion has taken place.

The same explanation is available for the French (10): the typical duration of sleeping uneasily is shorter than the duration of adolescence, but the typical duration of the habit of sleeping uneasily is not.

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Bibliography

- Dowty, D.: 1979, *Word meaning and Montague grammar*, Reidel, Dordrecht
- Egg, M.: 2005, *Flexible semantics for reinterpretation phenomena*, CSLI Publications, Stanford
- Gerö, E.-C. and v. Stechow, A.: 2003, Tense in time: the Greek perfect, in R. Eckardt, K. v. Heusinger, and C. Schwarze (eds.), *Words in time: diachronic semantics from different points of view*, pp 251–294, de Gruyter, Berlin
- Klein, W.: 1994, *Time in language*, Routledge, London and New York
- Krifka, M.: 1989, *Nominalreferenz und Zeitkonstitution*, Fink, München
- Landman, F.: 1992, The progressive, *Natural Language Semantics* 1, 1–32
- Moens, M. and Steedman, M.: 1988, Temporal ontology and temporal reference, *Computational Linguistics* 14, 15–28
- de Swart, H.: 1998, Aspect shift and coercion, *Natural Language and Linguistic Theory* 16, 347–385

RESULTATIVES AND DYNAMIC SEMANTICS

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This paper intends to make three related points concerning resultative constructions. 1. On the basis of Hungarian data it is argued that out of three possible strategies, the method proposed in Kratzer 2004 is preferable. The case endings that mark Hungarian resultatives can be taken as the overt counterparts of the covert morphemes proposed in Kratzer 2004. These morphemes are taken to introduce causal information and to hold the resultative construction together. 2. On the basis of data from Russian and Hungarian it is argued that prefixes and particles are to be analysed with the same tools as nominal result predicates, adjectives, nouns or *PPs*. 3. It is argued that the best method of semantic composition for resultatives involves dynamic semantics with asymmetric merge (Muskens 1996).

1. Introduction

This contribution offers a semantic analysis of resultative constructions involving a verb and a ‘nominal’ secondary predicate (an adjective, a nominal or a *PP*), and a verb and an aspectual prefix or particle. More general considerations about the linguistic expression of causation, or parallels with the syntax and morphology of causatives (*Aunt Polly had/made Tom whitewash the fence*) will be set aside.

The paper is structured as follows. The present section introduces the core set of data, together with arguments for including certain particle verbs. Section 2. discusses problems for semantic composition presented by such constructions. Section 3. provides a simple dynamic sketch and discusses some worked-out cases. Conclusions, open questions are discussed in Section 4.

The Data

The focus of this paper is the semantics of resultative constructions involving a verb and an adjective (*hammer the metal flat*), a verb and a *PP* containing a result nominal (*cradle the child to sleep*) and a verb and certain aspectual prefixes or particles such as German *er-schreiben*, ‘to acquire by writing’. In these constructions the event described by the verb is commonly taken to cause the eventuality contributed by the

secondary predicate. The data set also includes cases that are not always considered genuine resultatives, in that the secondary predicate or result *PP* describes the end point of a spatial trajectory. A case in point is *whistle off the stage*. It will be seen however that examples like these lend themselves to the same kind of analysis as genuine resultatives; the specific difference is exactly the introduction of a spatial trajectory.

One of the arguments for taking prefixes into consideration comes from Russian. This language lacks adjectival resultatives, as seen in (1a–b), but it can express resultative meanings by means of prefixation, as shown in (1c). (The data are taken from Spencer and Zaretskaya 1996.)

- (1) a. Ona pokrasila dver' *zeljonoj/zeljonuju/zeljonaja
She painted door green-INSTR/-ACC/-NOM
b. *Reka zamjorzla v blok l'da
River froze into block of-ice
c. Ona vy-terla stol
She VY-wiped(Perf) table 'She wiped the table clean'

In Hungarian the same meaning can be expressed with an adjectival resultative or with a prefixed verb, as seen from (2).

- (2) A folyó jég-gé fagyott/be-fagyott
The river ice-Transl froze/into-froze
'The river froze solid/froze up'

There are restrictions on adjectival resultatives in Hungarian, in that they cannot introduce new arguments. Intended meanings (conveyed with adjectives in Germanic languages) are regularly expressed with prefixed verbs, cf. the pair in (3).

- (3) A kutya fel-ugatta/*éber-re ugatta a szomszédokat
The dog up-barked/*awake-onto barked the neighbours-Acc
'The dog barked the neighbours awake'

From the Russian and Hungarian data I conclude that certain prefix–verb combinations express resultative meanings. These are to be analysed with the same methods as resultative constructions where the secondary predicate is an adjective or some other constituent containing a nominal. The prefix is assumed to be a lexicalised label, whose contribution is known to speakers of the language.

An additional argument comes from the variety of combinations involving prefixes like Hungarian *ki-* 'out(wards)'. (4a) is a clear resultative case; (4b) describes a giving event with an additional spatial trajectory; (4c) is a complex event where an event of sound emission causes the Theme to be 'off', relative to its original location. The contribution of the prefix is the same in all three cases; what varies is (i) its interaction with the host verb and (ii) the concept associated with the complex verb at the level of Lexical Conceptual Structure (LCS).

- (4) a. ki-sír *x*-et *y*-ból whine *x* out of *y*
 b. ki-ad *x*-et *y*-on (keresztül) hand *x* out of/through *y*
 c. ki-fütyül whistle off/out of somewhere

A Note on Hungarian Case Markers in Complex Predicates

In resultative and depictive constructions Hungarian adjectives receive case endings. The depictive ending is *-n* ‘on’. Result adjectives are marked with *-ra*, *-re* ‘onto’ (cf. (3)). Nouns expressing results are also marked, and their ending depends on the transition described by the verb. ‘Permanent’, qualitative change is marked with Translative case, *-vá*, *-vé* (*-v* is assimilated to the final consonant of the noun stem); an example was shown in (2). Nominals describing some resulting shape are marked with *-ba*, *-be* ‘into’ (e.g. *kariká-ba* ‘into a hoop’).

2. Problems for Semantic Composition

Resultative constructions pose several challenges for compositional semantic analysis. The fundamental problem, presented by complex predicates in general, is how to combine two predicative expressions into one complex. That these predicates may be of variable arity is merely an added difficulty. Resultative constructions, in Germanic languages at least, are not explicitly marked: they are ‘concealed’ causatives (Bittner 1999). The next problem is therefore how the causal relation is introduced.

Resultatives (like causatives in general) can present an argument structure different from that of the host verb (for detailed discussion and analysis cf. Wunderlich 1997). They can have Themes not subcategorised for by the host verb (*bark awake*). The original Theme or Patient of the verb may be demoted (G. *er-schreiben*, ‘acquire by writing’), or suppressed altogether (*drink dry*).

Arguments in resultative constructions have additional properties, which may be of interest to semanticists: (i) The Theme may not be left implicit, not even with host verbs that in isolation admit implicit arguments. (Consider *John drank* vs **John drank dry*). (ii) Particles or prefixes may contribute distinguished arguments that are quasi-indexical in the sense of Mitchell 1986, in that their preferred construal is indexical or anaphoric, but they can just as well be bound by quantifiers. (Cf. *After every party Dick is carted off to an undisclosed location.*) (iii) Opacity or definiteness restrictions on certain classes of host verbs disappear. *Mary baked every loaf* is strange as an out-of-the-blue sentence, whereas *Mary baked every loaf crisp* is perfect.

In addition resultatives can present sentence-internal dynamic effects, either on their own or when interacting with sentence material. For instance Hungarian *el-szeret* ‘love away’, ‘woo away’ presupposes a pre-existing relationship for the Theme, which is broken up by the Agent’s activities. That is, resultatives can often be presupposition triggers themselves. They also interact with presupposed material: The sentence *Sie erschrieb sich ihr Geld mit Krimis* ‘She made her money writing detec-

tive stories' (Wunderlich 1997) presupposes that the Agent has money; the assertion part of the sentence elaborates on the way she has made that money. The problem is that the same information is encoded twice over, once in the presupposition of the possessive *ihr Geld* 'her money', and once in the subevent structure of *er-schreiben*. A proper analysis needs to rely on sentence-internal dynamic composition (which will need to be omitted here, for lack of space).

3. Sketch of an Analysis

In the literature there have been three main strategies to analyse resultative constructions. The first is at the construction or composition level: a syntactic or a translation rule combines the two predicates and introduces the causal relation (Dowty 1991, von Stechow 1996, Bittner 1999, von Stechow 2007). Alternatively, one of the participating predicates may be type-lifted into a function that expects the other predicate as argument. Either the entry of the verb may undergo resultative extension (Wunderlich 1997) or the result predicate can be augmented (Kratzer 2004).

Given the overt morphological marking of Hungarian result predicates, this paper relies on a version of Kratzer's strategy: The morpheme on result adjectives yields a state description that needs to be completed with the description of the causing event. The analysis proposed here departs from Kratzer in that neither predicate will be a function expecting the other as argument. Instead they correspond to open propositions conjoined with asymmetric merge. This eliminates the need for complex and ad hoc type changing operations. It also allows, at least in principle, room for the analysis of dynamic effects in sentence internal composition.

- (5) a. *piros-ra* $\mathcal{E}s; red(s)(\alpha); Res(e) = s$
 b. *red-∅* $\mathcal{E}s; red(s)(\alpha); CAUSE(s)(e)$

(5) shows Hungarian and English result adjectives. State discourse referents are introduced with random assignment \mathcal{E} (Berg 1996, among many others). Subformulae are conjoined with asymmetric merge ; (Muskens 1996, van Eijck and Kamp 1997). Both translations contain a free event variable e that needs to be bound to the discourse referent supplied by the verb. In the Hungarian case the adjective describes **the** consequent state of the verb, hence the function *Res* (Kamp and Roßdeutscher 1994). The argument linking associated with *Res* ensures that the verb and the adjective share their Theme argument, i.e. the introduction of a new Theme argument by the adjective is precluded. There is no such restriction in the English case. Since English *paint* can be telic, its entry already contains a state discourse referent. In the English case the result adjective is therefore merged to the consequent state of *paint*, in what is seen as an instance of modification. Hungarian *fest* 'paint' on the other hand is atelic, so the adjective will *add* a consequent state to its entry.¹

¹A clarification: the function *Res* in (5a) encodes the end state conventionally associated with the event described by the complex verb.

Verbs of creation are puzzling for resultative constructions. An expression like *dem Mantel zu eng schneiden* ‘to tailor the coat tight, into a tight fit’ means that a new **and** tight coat has been created. In this case too the state descriptions contributed by the two predicates are merged. The consequent state of *schneiden* is, say, $\text{EXIST}(s)(x)$; merge with $\text{tight}(s')(y)$ yields $\text{EXIST}(s)(x); \text{tight}(s)(x)$.

A prefix like *ki-* ‘out(-wards)’ is analysed as involving two states and two ‘Gruberian’ discourse referents, a Source and a Goal, such that the Goal is ‘OUT’ relative to the Source. The Theme is AT the Source in the initial state and AT the Goal in the final state. The transition from one state to another is caused by the event described by the verb.

- (6) *ki* ‘out(-wards)’
 $\mathcal{E}(s, s', \sigma, \gamma); \text{AT}(s)(\sigma, \beta); \text{AT}(s')(\gamma, \beta); \text{OUT}(\sigma, \gamma); \text{CAUSE}(s')(e); s \prec s'$

In the case of *ki-fütyül* ‘whistle off’ *ki* attaches to an atelic verb of sound emission, adding two states and a new Theme to its event structure, together with the trajectory of the Theme from Source to Goal.

In the case of *ki-ad* ‘hand out’ (e.g. in a scenario of handing something through the window) several of the discourse referents in (6) are merged with those in the entry of the verb. The Theme β is merged with the Theme of the verb, and the two state discourse referents s, s' are also merged with the precondition state and consequent state of the verb. The result is an event description where change of possession is accompanied by spatial movement. It is inferred that the Agent (in state s) is at the Source location, and the Beneficiary is at the Goal (in state s').

4. Conclusion; Open Questions

This paper has provided a brief analysis of resultatives where the causal relation between the two main event descriptions is contributed by morphology (nominal resultatives) or by the secondary predicate itself (prefixes and particles). The analysis has relied on sentence-internal dynamic composition, notably, on random assignment (\mathcal{E}) and asymmetric merge. Thanks to this method neither predicate has had to be lifted to a higher order functional type expecting the other as argument. In addition, sentence internal merge is sufficiently flexible for handling variations in argument linking and in the aspectual type of the host verbs. A principled analysis of demoted or suppressed arguments is a task for the future. So is the analysis of interactions with presuppositions and other ‘dynamic’ sentence material.

Allowing the analysis to be driven by morphology is an attractive strategy, motivated by theoretical and empirical considerations. Nevertheless it needs to be supplemented by a more careful analysis of verb meanings. The problem is that the morphology-driven strategy would treat resultatives and depictives on a par. It is a well-known fact however that depictives are possible in several languages where nominal resultatives are not (in Russian and in Romance languages). The end note

therefore is that variation in the internal structure of verbs needs to be factored into a satisfactory analysis of nominal resultatives.

References

- Berg, M.: 1996, *The Internal Structure of Discourse*, Ph.D. thesis, University of Amsterdam, Amsterdam
- Bittner, M.: 1999, Concealed Causatives, *Natural Language Semantics* 7, 1–79
- Dowty, D.: 1979/1991, *Word Meaning in Montague Grammar*, Vol. 7 of *Studies in Linguistics and Philosophy*, Reidel/Kluwer, Dordrecht, 2nd edition
- Goldberg, A. E. and Jackendoff, R.: 2004, The English Resultative as a Family of Constructions, *Language* 80, 532–568
- Kamp, H. and Roßdeutscher, A.: 1994, Remarks on Lexical Structure and DRS-Construction, *Theoretical Linguistics* 20
- Kratzer, A.: 2004, Building Resultatives, in C. Maienborn and A. Wöllstein-Leisten (eds.), *Event Arguments in Syntax, Semantics, and Discourse*, Niemeyer, Tübingen
- Mitchell, J. E.: 1986, *The Formal Semantics of Point of View*, Ph.D. thesis, University of Massachusetts, Amherst, MA
- Muskens, R.: 1996, Combining Montague Semantics and Discourse Representation Theory, *Linguistics and Philosophy* 19(2), 143–186
- Rothstein, S.: 2001, *Predicates and Their Subjects*, Kluwer, Dordrecht
- Rothstein, S.: 2004, *Structuring Events*, No. 6 in *Explorations in Semantics*, Blackwell
- Spencer, A. and Zaretskaya, M.: 1996, Copredication in Russian—Lexical Resultatives, in *Essex Research Reports in Linguistics*, University of Essex, Colchester
- van Eijck, J. and Kamp, H.: 1997, Representing Discourse in Context, in J. van Benthem and A. ter Meulen (eds.), *Handbook of Logic and Language*, Elsevier
- von Stechow, A.: 1996, The Different Readings of *Wieder* ‘Again’: A Structural Account, *Journal of Semantics* 13, 87–138
- von Stechow, A.: 2007, *Syntactic and Lexical Causativization: Become and Cause Again*, Paper presented at CONSOLE XV Brussels
- Wunderlich, D.: 1997, Argument Extension by Lexical Adjunction, *Journal of Semantics* 14(2)

QUANTITY IMPLICATURES IN EXTENDED LOGIC PROGRAMMING

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This paper describes a formalization of quantity implicatures using extended logic programming. In this approach an implicature example is translated into a logic program and from the WFSX semantics of this program quantity implicatures are derived. This formalization provides the insight that scalar implicatures are computationally more complex than exhaustivity implicatures. Furthermore, the approach has a close connection to one using circumscription as in van Rooij and Schulz 2004.

1. Introduction

Traditionally the formal study of Gricean quantity implicatures such as:

- (1) Q: “Who is coming to the party?”
A: “John or Mary is coming.”
Imp: John or Mary aren’t coming both (a). No one (relevant) besides John or Mary is coming (b).

is done in a model-theoretic fashion. In van Lambalgen and Hamm 2004 the authors argue that such methods are inadequate if one wants to bestow any cognitive relevance to formal accounts. In cognitive science, humans are regarded as information processing, ie. computational, machines. Thus, in order for formal approaches to make cognitive sense, they must be computational in nature. In their study of tense and aspect of verbs Van Lambalgen and Hamm create such a computational approach by making use of the formalism of *Logic Programming*.

The above example shows two types of implicatures. The first one, from ‘or’ to ‘not and’, is one of the standard incarnations of a *scalar* implicature (Horn 1972). The second type does not have a standard label, we shall dub it an *exhaustivity* implicature, after the exhaustivity function in Groenendijk and Stokhof 1984.

In the following we will apply the formalism of extended logic programming to quantity implicatures and show a difference in computational complexity between scalar and exhaustivity implicatures. We will also see how it is related to a circumscription based approach. Section 2 begins with introducing extended logic programming, which is applied to implicatures in section 3. We will discuss the results of this approach in section 4 and end with a brief conclusion.

2. Extended Logic Programming

We will use a special form of logic programming called: *Extended Logic Programming*. An extended logic program Π is a finite set of *rules* that have the following form:

$$H \leftarrow B_1, \dots, B_n, \text{not } B_{n+1}, \dots, \text{not } B_m \quad (0 \leq n \leq m)$$

H, B_1, \dots, B_m are objective literals, meaning that they are either an atom A or its explicit negation $\neg A$ ¹. The set of all objective literals of a program Π is called its Herbrand base, denoted by $\mathcal{H}(\Pi)$. The symbol *not* stands for default negation, hence *not* L is called a default literal. An *interpretation* of a program Π is a set $T \cup \text{not } F$ ² such that T and F are disjoint subsets of $\mathcal{H}(\Pi)$.

Ordinarily, one works with logic programs using their top-down procedural semantics. However, we will only consider declarative bottom-up semantics. Such semantics define what the valid models of a program Π are. For this paper we use the *Well-Founded Semantics with eXplicit Negation* (WFSX) (Alferes and Pereira 1996). A WFSX model M of a logic program Π is an interpretation of Π that is a fixed-point of the Φ operator, which we will not define further. Such a model M is called a *Partial Stable Model* (PSM). These PSMs can be organized into a downward complete semi-lattice with a unique minimal element called the *Well-Founded Model* (WFM).

3. Application to Implicatures

Before giving the approach, let us get some preliminaries out of the way. First of all, this is a global approach to implicatures, we assume some form of semantical representation, ie. a formula, and start from there. Furthermore, though we look at scalar implicatures, there will be no use of Horn-scales as such. Finally, implicatures are always considered in the context of an (overt) question to avoid at least some contextual issues.

3.1. Translation to a Logic Program

In a typical implicature example there are three formal elements: a question predicate, an answer formula and a domain of individuals. Take the example from the introduction, there we have $come(x)$ as the question predicate, $come(j) \vee come(m)$ as the answer formula and we take $\{j, m, b\}$ as a domain of individuals (adding b as other “relevant” people). A full definition of the function to translate this into a logic program is given in de Vries 2007, we will skip that here.

Implicatures are non-monotonic inferences. A motivation to use logic programming is its ability to deal with non-monotonicity elegantly, via the default negation

¹The use of this explicit negation is why this version is called *extended* logic programming.

²*not* $\{L_1, \dots, L_n\}$ denotes the set $\{\text{not } L_1, \dots, \text{not } L_n\}$.

not. In this approach, we apply non-monotonic reasoning to the question predicate, which we do by introducing a *default rule* for every individual:

$$\begin{aligned} \neg \text{come}(j) &\leftarrow \text{not } \text{come}(j) \\ \neg \text{come}(m) &\leftarrow \text{not } \text{come}(m) \\ \neg \text{come}(b) &\leftarrow \text{not } \text{come}(b) \end{aligned}$$

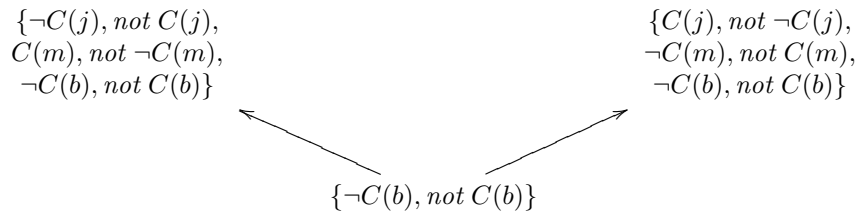
Intuitively these rules say that we can conclude the fact that a person will not come, if we cannot derive (default negation) the fact that that person will come. We assume to have all knowledge, ie. a closed world, about whether people are coming or not.

The general approach to translate the answer formula is to transform it into conjunctive normal form (CNF) and then generate rules from this form. For every disjunction in this CNF we do the following: for every literal in the disjunction we introduce a rule with that literal as its head and the rest of the literals negated in the body. In this example, $\text{come}(j) \vee \text{come}(m)$ is already in conjunctive normal form. Thus, we get the following rules, which we combine with the above rules to complete the program Π_1 :³

$$\begin{aligned} \text{come}(j) &\leftarrow \neg \text{come}(m) \\ \text{come}(m) &\leftarrow \neg \text{come}(j) \end{aligned}$$

3.2. Application of WFSX

To derive implicatures we look at the well-founded model (WFM) and the partial stable models (PSMs) of the above program Π_1 . Both are given in the following semi-lattice (C stands for *come*):



The bottom element is the WFM. The WFM is enough to derive the second implicature (1b): “No one besides John or Mary is coming.” After all, Bill is not coming and this would be the case for every other extra individual in the domain. For the first implicature (1a) we must look at the maximal elements in the semi-lattice, making it somewhat more complicated. In this case, these are the two PSMs at the top. In both models Mary and John don’t come both, thus we conclude this as an implicature.

3.3. Quantifiers

To show the generality of the method in the previous section we will work out a more complex example. Suppose the answer in example 1 was different:

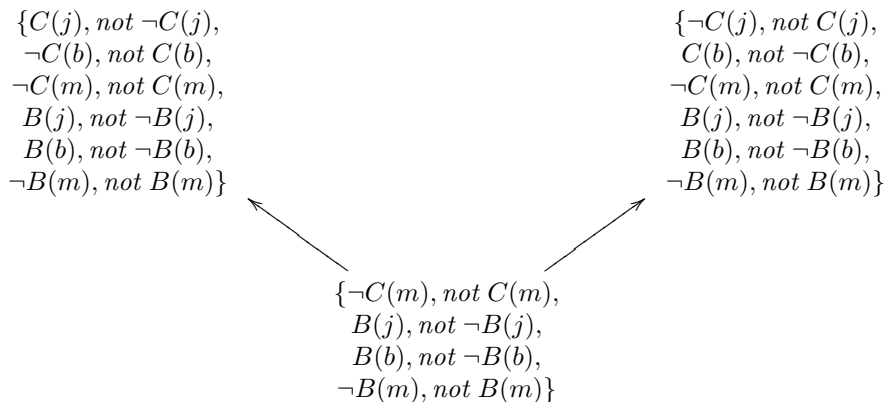
³Notice that a simple binary disjunction generates two rules, because the arrow in logic programming is not contrapositive.

- (2) A: “Some boys are coming to the party.”
 Imp: Not all boys (a) and no girls (b) are coming to the party.

The answer formula is: $\exists x(boy(x) \wedge come(x))^4$, which contains an existential quantifier. If we have a finite domain of individuals, as is often the case, then such a quantifier can be translated into a large disjunction (or conjunction in the case of the universal quantifier) in which every disjunct is an instance of the original formula with the quantifier variable replaced by an individual from the domain. For this example, using the domain $\{j, m, b\}$, we get: $(boy(j) \wedge come(j)) \vee (boy(m) \wedge come(m)) \vee (boy(b) \wedge come(b))$. The conjunctive normal form of this formula can be translated to a set of rules (omitted here due to spatial reasons). Let us call this set of rules Π_2 .

The use of quantifiers inevitably introduces the use of other predicates than the question. In this example we have the *boy*-predicate. This predicate does not require a non-monotonic interpretation (like the question predicate). It seems most intuitive to explicitly state the extension of *boy*, since the sex of an individual is usually something static. Thus, we add the background knowledge: $\{boy(j), \neg boy(m), boy(b)\}$ to Π_2 . See de Vries 2007 on how to deal with predicates that don't have a fixed extension. For the question we add the same default rules as in example 1 to Π_2 , since it has not changed.

The WFSX semantics of Π_2 is given by the following semi-lattice (C for *come* and B for *boy*):



Again, the exhaustivity implicature (2b): “No girls are coming to the party” is derivable from the WFM, since all the girls in our domain, ie. Mary, are not coming. For the scalar implicature (2b) we look at the maximal elements. In both, there is only one boy coming, which means that we can derive: “Not all boys are coming to the party”.

⁴Arguably, ‘some’ means ‘at least two’, which better captures the plurality of ‘boys’. However, since we derive the same implicatures, a translation with two existential quantifiers would only unnecessarily complicate matters.

4. Discussion

There are a number of interesting things to say about the approach above: its computational complexity, the connection with circumscription and the possibility to deal with epistemically weaker implicatures.

4.1. Computational Complexity

In both examples the exhaustivity implicature is derivable from the well-founded model (WFM) and the scalar implicature requires the maximal partial stable models (PSMs). This is interesting, because the WFM is efficiently computable in polynomial time. However, to get the maximal PSMs we need to compute all of the PSMs, which at the moment requires super-polynomial time, ie. we cannot do it efficiently.

Because of this difference in computational complexity we conclude that there is a complexity difference between exhaustivity implicatures and scalar implicatures, at least for these examples. In fact, the phenomenon generalizes very well over different types of examples (de Vries 2007). Thus, we have an interesting direction for further research, both in the formal domain as well as in psychology.

In psycholinguistics there is a debate whether scalar implicatures are computed by default (Levinson 2000) or are context dependent (Carston 1998). Defaultists argue that the cancellation of scalars requires extra computational effort, while context dependents argue the opposite: the computation of the implicature itself is costly. The approach in this paper favors the latter position, since we found that scalars are computationally complex and furthermore, to work with a logic program in a traditional, top-down sense one only needs the cheaper WFM.

4.2. Connection with Circumscription

The method of this paper has a close connection to circumscription. The translation from example to logic program is similar to the work of Wakaki and Satoh 1997. Furthermore, under some, not trivial, but, non-critical, assumptions it is proven in de Vries 2007 that there is a one-to-one correspondence between the maximal elements in the semi-lattice of PSMs⁵ of a program Π based on answer formula ϕ and question predicate Q and the models of the circumscription of ϕ with respect to Q . This is exactly the circumscription approach described in van Rooij and Schulz 2004. However, their final method is a two step approach which allows for weak and strong epistemic interpretations and differs from purely applying circumscription.

4.3. Epistemic Strength

One could say that the derivation of the scalar implicature, computing all the PSMs and then taking the maximal elements, looks somewhat contrived. Actually, however, this two step process is a good thing. For instance, when it comes to impli-

⁵Technically this is proven for answer-sets, however the answer-sets of a program correspond one-to-one to the maximal elements, see Alferes and Pereira 1996.

catures under negation, one often feels that an epistemically weaker implicature is required. Such an epistemically weaker interpretation can be: looking at all the PSMs, instead of considering just the maximal elements (which would be the strong interpretation). This idea is different from van Rooij and Schulz 2004, see de Vries 2007 for more.

5. Conclusion

The formalism of extended logic programming can deal nicely with quantity implicatures. The approach shows that there is a difference in computational complexity between exhaustivity and scalar implicatures, the latter being more complex.

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Bibliography

- Alferes, J. J. and Pereira, L. M.: 1996, *Reasoning with logic programming*, Vol. 1111, Springer-Verlag Inc., New York, NY, USA
- Carston, R.: 1998, Informativeness, relevance and scalar implicature, in R. Carston and S. Uchida (eds.), *Relevance Theory: Applications and Implications*, pp 179–236, John Benjamins, Amsterdam
- de Vries, G.: 2007, Formalizing implicatures using extended logic programming, *Master's thesis*, University of Amsterdam
- Groenendijk, J. and Stokhof, M.: 1984, *Studies in the Semantics of Questions and the Pragmatics of Answers*, Ph.D. thesis, University of Amsterdam
- Horn, L.: 1972, *On the Semantic Properties of Logical Operators in English*, Ph.D. thesis, University of California
- Levinson, S.: 2000, *Presumptive Meanings*, MIT Press, Cambridge
- van Lambalgen, M. and Hamm, F.: 2004, *The Proper Treatment of Events*, Blackwell
- van Rooij, R. and Schulz, K.: 2004, Exhaustive interpretation of complex sentences, *Journal of Logic, Language and Information* 13(4), 491–519
- Wakaki, T. and Satoh, K.: 1997, Compiling prioritized circumscription into extended logic programs, in *IJCAI (1)*, pp 182–189

SEMANTICS OF WH-QUESTIONS WITH THE VERBAL *HOW* IN MANDARIN

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This paper studies wh-questions with the verbal “*zenme*”(“how”) in Mandarin, e.g. “*Yuehan zenme-le Mali?*”, a literal English translation of which is “*John how-ed Mary?*” First I give a semantic analysis of the denotation of such questions, arguing that the verbal “how” quantifies over properties of events. Second I give a compositional semantics of such wh-questions, based upon works by Berman (1994) and Lahiri (2002). Third, I discuss the meanings of the use of this “how” as zero-place, one-place, and two-place verbs, and argue that “how” is uniformly used as a two-place/transitive verb, and this explains some properties of such “how” questions.

1. Introduction

In addition to the usual distinction between argument and adjunct wh-questions, there is a special type of wh-questions in Mandarin with the verbal use of “how” as the head of a VP. Little attention has been paid to this type of questions. I will explore their special properties in this paper.

The wh-word *zenme* in Mandarin Chinese can be used in a manner wh-question, as shown in (1):

1. Yuehan zenme da-de Taijiquan?
John how hit-DE¹ Taichi
How did John practice Taichi?

The same word *zenme* can also be used as the head verb of a VP, as shown in (2)-(5). It can be used as a zero-place verb as in (2), an intransitive verb as in (3), or a transitive verb as in (4). But it cannot be used as a ditransitive verb, as in (5).

¹ DE is part of the cleft construction *shi...de*, which can be used to indicate past tense.

- | | |
|--|--|
| <p>2. Zenme-le?
How-ASP²
What happened?</p> <p>4. Yuehan zenme-le Mali?
John how-ASP Mary
What did John do to Mary?</p> | <p>3. Yuehan zenme-le?
John how-ASP
What happened to John?</p> <p>5. *Yuehan zenme-le Mali yi-ben-shu
John how-ASP Mary one-CL³-book
John what Mary a book?</p> |
|--|--|

The meaning of such questions is roughly the same as the corresponding *what* questions in other languages, which also exist in Mandarin, as shown in (6):

6. Yuehan dui Mali zuo-le shenme?
John to Mary what-ASP what
What did John do to Mary?

There are subtle differences between these two types of questions in Mandarin, but in this paper I will concentrate on the semantics of the verbal *how* questions.

2. Denotation of the verbal *how* questions

In terms of the Hamblin-style denotation of questions, the verbal *how* questions are the same as the usual argument *wh*-questions, like *what* and *who*, in that they denote a set of propositions as possible answers to the question. The issue here is the semantic representation. It is obvious that *wh*-pronouns like *what/who* range over individuals of type *e*. What does this verbal *how* denote? Since they are used as various verbs, there isn't a common type. The answer will be clear if we adopt the neo-Davidsonian event semantics (Parsons 1990), in which a verb denotes a type/property of events, e.g.:

7. a. John hit Mary.
b. $\exists e [\text{hitting}(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{Mary})]$

Thus the verbal *how* in Mandarin ranges over types/properties of events, and the semantic representation of the denotation of such questions, e.g. as in (4), should be:

8. $\{p \mid \exists P \in D_{\langle s, t \rangle}. [p = \wedge \exists e. [P(e) \wedge \text{Agent}(e, \text{John}) \wedge \text{Patient}(e, \text{Mary})]]\}$

3. Compositional semantics

² ASP: aspect marker. “-le” is the perfective aspect marker.

³ CL: classifier. “ben” is the classifier for books and similar objects.

My next goal is to give a compositional semantics of such questions. If we look at the representation in (8), there are two tasks to perform: (1) there should be a way of deriving the event semantics compositionally; (2) there should be a way of deriving the question denotation. In order to do the first, I'll use Kratzer's (1996) event identification rule, as shown in (9):

9. Event Identification (Kratzer 1996: 122)

$$\begin{array}{ccc} f & g & \rightarrow h \\ \langle e, \langle s, t \rangle \rangle & \langle s, t \rangle & \langle e, \langle s, t \rangle \rangle \\ & & \lambda x_e \lambda e_s [f(x)(e) \ \& \ g(e)] \end{array}$$

As for the compositional semantics of questions, there have been a few proposals, e.g. Berman (1994), Reinhart (1998), Lahiri (2002), and Shimoyama (2006). Berman (1994) gives the following rule for the Q morpheme (see also Baker 1970):

$$10. \llbracket Q\phi \rrbracket^{M,g} = \{p: \exists (x_1 \dots x_n) [p = \llbracket Q\phi \rrbracket^{M,g'}]\}, \text{ where } g' \approx_{\phi} g.$$

Reinhart (1998) introduces choice functions to abstract the domain restriction without moving a wh-phrase, and points out that choice functions do not work for higher-order entities, such as properties. Lahiri (2002) gives the following rule for the non-wh-in-situ type complementizer:

$$11. \lambda p \lambda q [q = p]$$

Shimoyama (2006) uses Rooth's (1985, 1996) pointwise functional application rule to derive the Hamblin set, with the semantic contribution of the Q marker being trivial.

Since Chinese is a wh-in-situ language, there are two possible ways of deriving a Hamblin set. If we assume LF movement, then Lahiri's rule (11) can be used directly in conjunction with Kratzer's rule (9). But current research in Chinese linguistics agrees that wh-arguments do not move, and wh-adjuncts undergo LF movement. Then what about the verbal "how"?

First, one of the ways of showing that wh-arguments do not move at LF is that they can escape syntactic islands, while wh-adjuncts cannot. For example:

- 12a. Yuehan xihuan shei xie de shu? b. *Yuehan xihuan ni zenme xie de shu
 John like who wrote DE book John likes you how wrote DE book
 [who_i [John likes the book who_i wrote]] *[how_i [John likes the book that you wrote how_i]]

In (12a), the direct question reading is available, while in (12b) it shows that the direct question reading is not available. If we assume that wh-adjuncts have to move at LF, (12b) is ruled out by any mechanism that accounts for islands. What about the verbal *how*

questions? They are good direct questions in these island constructions. For example:

13. Yuehan xihuan Mali zenme-le de ren?
 John like Mary how-ASP DE4 person.
 [how_i [John likes the person that Mary how_i-ed]]

Therefore it suggests that the verbal *how* in Mandarin patterns with wh-arguments. The following examples with the exhaustivity marker “dou” also show the same effect.

- 14 a. Yuehan dou xihuan shei?
 John all like who
 Who all does John like?
- b. Yuehan dou zenme-le Mali?
 John all how-ASP Mari.
 What all did John do to Mary?
- c. ?? Yuehan dou zenme da-de Taijiquan?
 John all how hit-DE Taichi
 Intended reading: What are all the ways that John practiced Taichi?

The exhaustivity marker “all” is not compatible with a manner question, as shown in (14c). But this exhaustivity marker is perfectly good with the argument question in (14a) and the verbal *how* question in (14b). This also suggests that the verbal *how* question patterns with the wh-argument question. If wh-arguments do not move at LF, it is a plausible assumption that the verbal *how* does not move either. Therefore the verbal *how* should be bound by the Q morpheme. Thus the LF representation of a verbal “how” question should be:

15. [Q [...how...]]

Note that this “how” cannot be interpreted via a choice function, and we can only use the rule given by Berman (1994) if we want to specify the semantic contribution of the Q morpheme, unlike in Shimoyama’s approach. Rule (10), however, does not abstract the domain restriction of the variables. Therefore I propose that the verbal “how” carries its own domain restriction e.g. x^D and the Q morpheme abstracts this domain restriction and returns a question denotation at the same time, as shown in (16).

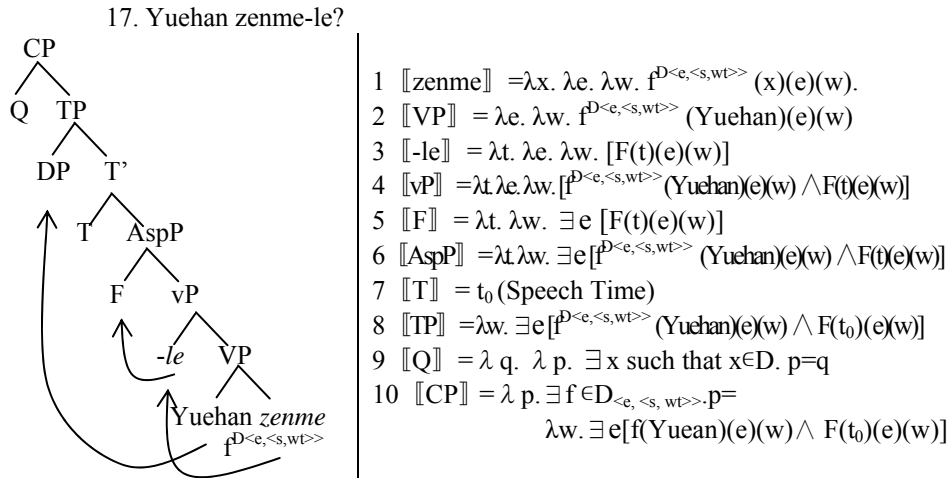
16. $[[Q]] = \lambda q. \lambda p. \exists x \in D. p=q$, where q contains a restricted variable x^D

For example, if “how” is a transitive verb, it would denote $f^{D\langle e, \langle s, wt \rangle \rangle}$, and such a question would have the LF “ [Q [...f^{D<e, <s, wt>>} ...]] ”. By applying rule (16), we get the correct interpretation $\lambda p. \exists f \in D_{\langle e, \langle s, wt \rangle \rangle}. p=[...]$. See (17) on the next page for a sample derivation.

⁴ DE is a structural morpheme in relative clause constructions in Mandarin Chinese.

4. *Zenme* (“how”) as a transitive verb

As shown in (2)-(5), the verbal “how” can be used as various verbs except as a ditransitive. If we assume that “zenme”(how) is uniformly used as a transitive verb, then all the facts are explained. First, in cases like (2), the meaning of such a question is not “what happened?”, but rather “what happened to a contextually salient individual?”. For example, if the question is asked about the addressee, then the question is understood as “what happened to you?”. Since Chinese is a free pro-drop language, this is not surprising at all. Second, in cases like (3), the subject DP is actually the patient of the verb. Then it originates in the object position and moves to the subject position. As for the ditransitive, its ungrammaticality is straightforward since the verbal “how” can be used only as a transitive verb. I give a sample derivation in (17) for (3). If the subject is dropped, as in the case of (2), the LF structure would be similar, with the DP replaced by a pro, thus deriving the correct interpretation.



The semantics of the aspect marker *-le* is taken from Lin (2004). The verbal complex in the small v moves to Asp at LF to check the aspectual feature F, which, in the case of the perfective aspect *-le*, means that the event time precedes t, which in turn is t_0 here.

5. Conclusion

A few issues remain to be addressed. The first one is the uncancellable Malefactivity

Presupposition, i.e. the patient of the event should be affected in a negative way. If the event is generally regarded as a benefactive one, e.g. *kissing*, the answer is then either humorous, or interpreted as malefactive, e.g. if the patient of the *kissing* event did not like to be kissed. In some cases, *zenme* does not even have to be a transitive verb, as long as the malefactivity presupposition is satisfied. For example, (18) can be a good answer to (3), where John is not the patient of the event.

18. Yuehan shuai-le yi-jiao.
John fall-ASP one-MEASURE
John stumbled.

What is the trigger of this presupposition, and how can we account for answers like (18)? I will explore ways of incorporating the presupposition as part of the semantics of *zenme* and also argue that answers like (18) do not contradict my proposal, since a typical answer to (3) should still be one in which John is the patient of some event, while answers like (18) are actually not direct answers.

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Bibliography

- Baker, C.L.: 1970. Notes on the description of English questions: the role of an abstract question morpheme, *Foundations of Language* 6: 197-219.
- Berman, S.: 1994. *On the Semantics of Wh-Clauses*. Garland, New York and London.
- Kratzer, A.: 1996. Severing the external argument from its verb, in J. Rooryck and L. Zaring (eds) *Phrase Structure and the Lexicon*. Kluwer.
- Lahiri, U.: 2002. *Questions and Answers in Embedded Contexts*, Oxford University Press.
- Lin, T.: 2004. Aspect, distributivity, and Wh/QP interaction in Chinese. *Language and Linguistics* 5.3:615-642, Taipei, Taiwan, China.
- Reinhart, T.: 1998. Wh-in-situ in the framework of the Minimalist Program. *Natural Language Semantics* 6: 29-56.
- Shimoyama, J.: 2006. Indeterminate phrase quantification in Japanese. *Natural Language Semantics*, 14:139-173.

MEANING AND USE OF RHETORICAL QUESTIONS

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This paper attributes the use of rhetorical questions as emphatic statements to their literal meaning as a question. The proposed account of rhetorical questions focusses on *negative polarity items* (NPIs), a characteristic of these questions.

The integration of an NPI into a question greatly affects the set of exhaustive answers to this question (i.e., the meaning of the question). For yes/no-questions this introduces the presupposition that the corresponding question without the NPI is already settled in the negative, which is seen as the main impact of the NPI and the reason for the rhetoricity of the question (Krifka 1995; van Rooy 2003).

It will first be shown that for *wh*-questions, however, the integration of an NPI does not settle the corresponding question without NPI in the same way. It is argued that rhetoricity already emerges from the general threshold-lowering effect of NPIs, which makes in particular *wh*-questions too general to be of interest to the speaker (in a literal interpretation).

Second, I will then explain why rhetorical questions do not violate felicity conditions even though they are not interpreted as ordinary information-seeking questions: They are used in indirect speech acts, which explains why they do not seek information, and in such speech acts, questions are evaluated against the common ground. Rhetorical questions thus emerge a means of presenting a statement not as the speaker's personal opinion, but as a consequence of the common ground, which explains their persuasive effect.

1. Introduction

In rhetorical questions, the speaker does not demand information, instead, these questions function as *emphatic statements*: For yes-no questions, as negated statement, for *wh*-questions, as the statement that none of the entities as specified in the *wh*-phrase would allow an affirmation of the question:

- (1) *Did you lift a finger to help Max?* 'You did not lift a finger to help Max'
- (2) *Who lifted a finger to help Max?* 'No one lifted a finger to help Max'

Rhetorical questions are relevant for the semantics-pragmatics interface since there is a seeming contradiction between their literal meaning (question) and their function in discourse (statement). I will show that even for rhetorical questions one can uphold the claim that the function of utterances in concrete utterance contexts is based on their context-independent ‘literal’ meanings. I will also explain why rhetorical questions do not violate the maxim of manner even though they express a statement in an indirect way, viz., through a question.

Rhetorical questions can host strong *negative polarity items* (NPIs) like *lift a finger*. My account of rhetorical questions focusses on NPIs, which are characteristic for these questions. In the following, I will often compare pairs of a rhetorical question incorporating a strong NPI and the corresponding question without the NPI, e.g., (1) and (3), or (2) and (4), and refer to them as ‘ Q_R ’ and ‘ Q ’, respectively:

(3) *Did you help Max?*

(4) *Who helped Max?*

Other linguistic characteristics of rhetorical questions are the modals *could* and *would*, the weak polarity item *ever*, and *wh*-phrases that are extended by *on earth*, e.g., *who on earth*. I will show that these expressions, too, can be explained in terms of my account of the impact of the integration of strong NPIs into questions.

2. Answer sets for rhetorical yes/no-questions

Following Groenendijk and Stokhof (1997), the meaning of a question is the set of exhaustive answers, formalised as a partition of the (contextually relevant) set of possible worlds. Then the interpretation of a rhetorical question in terms of a negative statement has a semantic basis, in that this statement is an element of the answer set of the rhetorical question (Han 2002).

I will first focus on the impact that the incorporation of a strong NPI into a question has onto these answer sets. By reconstructing this phenomenon, it is possible to explain the intuition that rhetorical questions are no ordinary *information-seeking* questions (Caponigro and Sprouse 2007).

For rhetorical yes/no-questions, this impact is analysed in Krifka (1995) and van Rooy (2003): Strong NPIs indicate the minimal endpoint of a scale, which is entailed by all other alternatives (e.g., all amounts of helping entail lifting at least a finger to help). Thus, asking (1) instead of (3) and thus debating whether the hearer offered at least a minimal amount of help entails that all stronger alternatives - including an affirmative answer to (3) - are false, since any of them would entail an affirmative answer to (1), which would settle (1) in advance. (1) thus leaves open only the alternative between the hearer’s helping minimally or doing nothing at all.

Integrating a strong NPI in a question has a threshold-lowering effect; it makes an affirmative answer more probable. This effect can also be observed for *ever* and the modals *could/would*: *Ever* introduces an existential quantification over times,

could/would, an existential quantification over possible worlds. Thus, asking either of (5) or (6) presupposes that (3) has a negative answer:

(5) *Did you ever help Max?*

(6) *Would you help Max?*

The positive answer to (3) is the proposition that the hearer helped Max at $\langle w, t \rangle$, where w is the actual world and t , the reference time in the past anaphorically referred to in the proposition (following Partee 1973). This proposition would immediately settle (5) in the affirmative, since (5) can be paraphrased as the question of whether there is some t' in the past such that the hearer helped Max at $\langle w, t' \rangle$. (The reasoning for (6) is analogous.)

We can now reformulate the insights of this account in terms of answer sets: Both Q_R 's and Q 's answer set have two partitions (for the affirmative and the negative answer). Q_R 's answer set is derived from the one of Q by moving all worlds where the hearer offered at least a little amount of help from the partition for the negative answer to the partition for the affirmative answer.

For Q 's answer set, this boils down to *eliminating* its affirmative element (for (1), that the hearer helped in a substantial way): This answer would settle Q_R immediately (by entailing its affirmative answer), which would be incompatible with uttering Q_R felicitously.

This account explains why Q_R rules out an affirmative answer to Q , but leaves open the question of why Q_R is understood in a stronger version, i.e., as implying that Q_R , too, cannot be answered in the affirmative. In other words, Q_R is not understood as a question (however weak) at all.

3. Answer sets for rhetorical *wh*-questions

For rhetorical *wh*-questions Q_R , the integration of strong NPIs brings about rhetoricity in a different way. Its main impact does not lie in a restriction of the corresponding Q 's answer set but in the fact that it turns Q into an extremely general question Q_R , which holds good for much more entities than the original Q .

Asking Q_R does not restrict the corresponding Q 's answer set in a relevant way by presupposing that Q must have been settled in a specific way. The only element of the answer set of Q that is ruled out by asking Q_R is ' Q holds good for all entities E as specified in the *wh*-phrase', which would settle Q_R by entailing that Q_R holds for all $e \in E$. For instance, if all E helped, they all at least lifted a finger to help.

Since no other element of Q 's answer set could settle Q_R by entailing one of Q_R 's answers, asking Q_R does not rule out any of these elements. In particular, for any $E' \subset E$, the answer that Q holds good for only $e \in E'$ does not entail that Q_R holds good for only the elements of E' . E.g., 'only A and B helped Max' does not entail 'only A and B lifted a finger to help Max', since there might be a C who did not really help Max but who provided at least a minimal amount of help.

Instead, the impact of strong NPIs in rhetorical *wh*-questions lies in the fact that they redraw the boundaries in the partition of possible worlds (the formalisation of the answer set) by lowering the threshold for the question to hold for elements of the set E : A world in the partition element of Q representing the answer that Q holds only for elements of an E' may end up in a partition element of Q_R for the answer that Q_R holds only for $e \in E''$, where $E' \subset E''$, since the answer to Q_R attributes a weaker property to elements of E'' than the answer to Q to elements of E' . Thus, worlds are shifting in the direction of partitions where a weaker answer is true for larger groups of entities, while the partition element where the question is true for no entity gets rather depleted in the move from Q to Q_R .

E.g., for (4), a world in the partition of 'only A helped' may turn up in the partition of 'only A and B lifted a finger to help', but not vice versa. And, the answer to (4) that no one helped is much more probable (or, its partition element has much more worlds) than the answer to (2) that no one lifted a finger to help.

This shift of worlds towards partitions where a weaker, less informative answer is true for larger groups of entities is due to the move from Q to Q_R . Thus, uttering Q_R instead of Q amounts to choosing a question that holds good for much more entities than Q , but has an answer that attributes a much weaker property to them. But this makes the answer to a *wh*-rhetorical question uninteresting.

Weak NPIs such as *ever* and modals like *would/could* add to this effect by making the question even weaker. Adding *on earth* does too, because it explicitly removes (implicit) contextual restrictions on the set of entities as specified in the *wh*-phrase: E.g., the set of persons relevant for a question with *who on earth* (and hence its answer set) is much larger than the one for the corresponding question with *who*.

E.g., in (7) the answer would (without any contextual restrictions) list all persons for whom there is some time t in some world w such that they help Max at $\langle w, t \rangle$ at least in a minimal way:

(7) *Who on earth would ever lift a finger to help Max?*

In sum, the integration of a strong NPI into a question does not change its status as a question but severely influences its answer set. This affects yes-no and *wh*-questions in different ways, but indicates for either that the speaker is not interested in an answer.

4. Rhetorical questions as indirect speech acts

At a first glance, rhetorical questions as questions whose speaker is not interested in an answer seem to violate felicity conditions for questions (Searle 1969), e.g., the sincerity condition (speakers want to have a specific piece of information) or the essential condition (they try to get this piece of information from the hearer by means of the question).

But speakers are cooperative and do not violate felicity conditions without a motivation, hence, hearers try to reconstruct this motivation of the speaker. When they do so, they will notice that rhetorical questions are often used in *indirect speech acts*, where a 'direct' speech act refers to a felicity condition of the intended speech act (Gordon and Lakoff 1975). E.g., in *Could you pass the salt?*, the intended speech act is a request.

The intended speech act for (7) is *statement*: A preparatory condition of a statement is that it is not obvious for the speaker that the hearer already knows what is being stated, and the speaker can refer to this condition with a rhetorical question. (Further possible speech acts for which rhetorical questions can be used include advice, refusal, warning, etc.)

Rhetorical questions indeed show a typical effect for indirect speech acts, viz., that the hearer can react to *both* the direct and the indirect speech act (Bach and Harnish 1979; Asher and Lascarides 2001). E.g., confronted with (7), the hearer can indicate affirmation (e.g., by nodding; reaction to indirect speech act) and answer 'nobody' (reaction to direct speech act.)

But this interpretation as indirect speech act now is the decisive clue to the interpretation of rhetorical questions: In indirect speech acts, questions are not interpreted w.r.t. the hearer's background because they do not request information; instead, they are evaluated against the *common ground*. (The hearer's own background is irrelevant here, it might even differ from the common ground.)

During this evaluation, the hearer recognises that only the negative element of the set of possible answers is compatible with the common ground, therefore these rhetorical questions are interpreted as *negative statements*. For rhetorical *wh*-questions, the statement negates the existence of a suitable entity for which the question holds, e.g., for (7): no one would even offer a minimal amount of help to Max in any world at any time, a rather strong statement.

On the basis of this analysis, one can now explain the motivation for rhetorical questions. They are a means of presenting a statement not as the personal opinion of the speaker, but as a consequence of the common ground, which justifies the additional complexity of the utterance and thus complies with the maxim of manner. This yields the typical *persuasive* effect of rhetorical questions.

However, this mechanism can be abused: Speakers can present their own opinions in the form of rhetorical questions, while the intended statement is not part of the common ground. They intend hearers to recognise the rhetorical question by its form (e.g., the fact that it comprises NPIs) and its special interpretation (answer set), and to accommodate the statement into the common ground.

5. Conclusion and outlook

The proposed analysis of rhetorical questions tries to bridge the gap between their literal meaning (a question) and their function (a statement) in terms of their role as

indirect speech acts.

This analysis directly carries over to the related phenomenon of *non-negative* rhetorical questions like (8):

(8) *Well, who is responsible for this mess?* (intended meaning: 'You are.')

Here felicity conditions for questions seem to be violated, too, since no information is required. The only difference to the cases discussed so far is that the only element of the answer set that is compatible with the common ground happens to be not negated. In contrast to the proposed analysis, theories of rhetorical questions that force a negative interpretation in any case would yield the wrong predictions here (e.g., the one of Han 2002).

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Bibliography

- Asher, N. and Lascarides, A.: 2001, Indirect speech acts, *Synthese* 128, 183–228
- Bach, K. and Harnish, R.: 1979, *Linguistic communication and speech acts*, MIT Press, Cambridge
- Caponigro, I. and Sprouse, J.: 2007, Rhetorical questions as questions, in *Proceedings of Sinn und Bedeutung 11*, Barcelona
- Gordon, D. and Lakoff, G.: 1975, Conversational postulates, in P. Cole and J. Morgan (eds.), *Syntax and Semantics 3: Speech Acts*, pp 83–106, Academic Press, New York
- Groenendijk, J. and Stokhof, M.: 1997, Questions, in J. van Benthem and A. ter Meulen (eds.), *Handbook of logic and language*, pp 1055–1124, Elsevier, Amsterdam
- Han, C.-H.: 2002, Interpreting interrogatives as rhetorical questions, *Lingua* 112, 201–229
- Krifka, M.: 1995, The semantics and pragmatics of polarity items, *Linguistic Analysis* 25, 209–258
- Partee, B.: 1973, Some structural analogies between tenses and pronouns in English, *The Journal of Philosophy* 70, 601–609
- van Rooy, R.: 2003, Negative polarity items in questions: strength as relevance, *Journal of Semantics* 20, 239–273
- Searle, J.: 1969, *Speech acts. An essay in the philosophy of language*, Cambridge University Press, Cambridge

Inclusive and exclusive plurals reconciled

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1. Introduction

In this paper we work out a novel approach to the semantics/pragmatics of nominal number in languages such as English, which distinguish morphologically plural forms from singular ones. In Section 2 we discuss two fundamental challenges any account must meet, after which we turn, in Section 3, to proposing a solution that resolves both. In Section 4 we discuss some consequences and comparisons with previous approaches.

2. Two challenges

2.1. The parallelism between formal and semantic markedness of number

Typically, in languages that have a singular/plural contrast in nominals, the plural is morphologically marked, i.e., it is encoded in a special morpheme, while the singular is not, i.e., there is no special morpheme signalling singular number (Greenberg 1966, Corbett 2000). Semantically, however, the plural seems to be the *less* marked member of the pair. Thus, assuming the terminology in Link (1983), we see in (1)-(3) that a singular form is interpreted as having atomic reference only, but the plural has two interpretations: (i) an *exclusive* interpretation, referring to sums only (and excluding atoms) and (ii) an *inclusive* interpretation, referring to both atoms and sums:

- | | |
|--|--------------------------------|
| (1) Mary saw <i>a horse</i> . | (atom) |
| (2) Mary saw <i>horses</i> . | (sum; exclusive plural) |
| (3) Do you have <i>children</i> ? Yes, I have one/two/... | (atom + sum; inclusive plural) |
| (4) If you have <i>children</i> , you may come to our party. | (atom + sum; inclusive plural) |
| (5) Mary didn't solve <i>problems from this list</i> . | (atom + sum; inclusive plural) |

A fundamental question is then how to reconcile the morphology and the semantics of

number given the tendency of language to pair up morphologically unmarked forms with unmarked meanings (*Horn's division of pragmatic labor*, Horn 2001: 155).

• *The Horn pattern for number*: the singular form is semantically and morphologically unmarked; the marked plural form is semantically marked.

Farkas and de Swart (2003) and Farkas (2006) propose an analysis that respects the Horn pattern based on the assumption that atomic reference is assigned by default. Unfortunately, this account does not extend to languages like Chinese, which lack number morphology, and where unmarked NPs are number neutral rather than atomic in reference. The proposal developed here conforms to the Horn pattern while at the same time capturing Chinese.

2.2. When is the inclusive interpretation of the plural available?

The inclusive interpretation is available in questions, conditionals and negation (3-5) but unavailable in upward entailing, episodic contexts (2). Even in questions and conditionals, the naturalness of the plural form varies (Farkas 2006, Spector 2005):

- (6) Do you have *an MA degree/MA degrees*?
- (7) Does Sam have *#Roman noses/a Roman nose*?
- (8) Does a worm have *#an eye/eyes*?

The plural in (6) is less neutral than in (3); the contrast is exacerbated in (7), and in (8) we prefer a singular over a plural form. Obviously, the generalization that noses come in singleton sets and eyes in pairs has something to do with the matter. We seek an analysis that not only predicts when inclusive interpretations are possible, but also sheds light on the principles that guide the choice of nominal form.

3. The semantics of singular and plural morphology

3.1. The plural is semantically marked

The morpho-syntax of number, we assume, involves the existence of a single privative feature [pl] realized in an inflectional projection we call NumP. Singular nominals involve neither a singular feature nor a NumP projection. The feature [pl] is assigned the family of interpretations in (9):

- (9) a. $[[pl]] = \lambda x. x \in \text{Sum}$ (exclusive interpretation of plural)
b. $[[pl]] = \lambda x. x \in \text{Sum} \cup \text{Atom}$ (inclusive interpretation of plural)

Sums are always within the denotation space of the relevant variable; the difference concerns the question of whether atoms are excluded or not. The two meanings are ordered by (truth-conditional) strength: (9a) asymmetrically entails (9b). This relationship is crucial in determining the choice between interpretations in context.

3.2. Constraints on the use of number morphology

We rely on O(ptimality) T(heory) to account for the presence or absence of nominal number morphology (NNM) in a language. Following Hendriks et al. (2007, Ch. 7), we take NNM in a language to hinge on the interaction between the constraints in (10):

- (10) a. *FunctN: Avoid functional structure in the nominal domain.
b. FPI: reference to sums is parsed by an expression in NumP.

The first constraint is a member of the *Struc family, penalizing use of structure. The second is a faithfulness constraint requiring reference to sums to be morphologically marked. A nominal associated with a variable x is taken to involve ‘reference to sums’ iff sums are among the intended values of x , i.e., if relative to some verifying situation s in the model, the set of values that x is assigned in s includes sums. Chinese ranks *FunctN over FP, which blocks overt NNM. In the absence of a morphological contrast between marked and unmarked nominals, unmarked forms are interpreted as number neutral. A language like English, which has a plural marker, has the ranking FPI >> *FunctN, and therefore in English reference to sums is overtly marked by the presence of [pl]. The fact that it is sums reference rather than atom reference that requires marking is, we hypothesize, connected to the cognitive primacy of atomic reference. Atomic reference is thus considered the unmarked interpretation.

3.3. Choice of interpretation

The polysemous semantics proposed in (9) permits both inclusive and exclusive readings of the plural. We use the independently motivated S(trong) M(eaning) H(ypothesis) to account for how the choice of interpretation is done in particular contexts (Dalrymple et al. 1998, Winter 2001, Zwarts 2003). Our hypothesis is formulated as SMH_PL:

- SMH_PL: *the Strongest Meaning Hypothesis for plurals*: prefer the stronger interpretation of [pl] over the weaker one, unless the former conflicts with the context.

In neutral cases, such as the upward entailing environments exemplified in (2), the SMH_PL favors the exclusive interpretation over the inclusive one, because the exclusive interpretation is stronger in these contexts. In downward entailing contexts and questions, the SMH_PL leads to the inclusive interpretation, because of scale reversal under monotonicity reversal (Fauconnier 1976, Sauerland 2003). The weaker, inclusive reading of the plural in such contexts leads to a stronger claim for the sentence as a whole. We predict that, other things being equal, a plural is interpreted inclusively in downward entailing contexts and exclusively in upward entailing ones.

The SMH_PL is a pragmatic principle, which can be overridden by contextual information. The fact that eyes always come in pairs is sufficient to weaken the interpretation of (8) to an exclusive plural interpretation. However, there are limits to the influence of context. We cannot normally weaken (2) to an inclusive interpretation. These restrictions arise from the competition between singular and plural.

3.4. Competition between singular and plural forms

In languages with morphological number, speakers have a choice between the use of a singular or a plural form. As we see in (5)-(7), this choice is not always free. In order to account for the distribution of forms and meanings, we need to set up a bidirectional OT analysis. We use here the format of the bias constraints proposed by Mattausch (2006). Bias constraints block particular combinations of unmarked (u) and marked forms (m) with common, unmarked meanings (α) and infrequent, marked meanings (β). With the bidirectional learning algorithm, the ranking $\{ *u, \beta; *m, \alpha \} \gg *Struct \gg \{ *m, \beta; *u, \alpha \}$ emerges as an evolutionary stable pattern. This models the emergence of Horn's division of pragmatic labor as the optimal communication strategy that arises under evolutionary pressure. If we exploit FPI and the semantics of [pl] in (9) to instantiate the bias constraints for NNM, we obtain the bidirectional tableau 1, where forms are paired with their domain of interpretation in the lattice. Under this constraint ranking, intended sum reference calls for the use of a plural form, and plural forms have exclusive or inclusive sum reference. The tableau also shows that we assign the (unmarked) singular form the (unmarked) meaning of atomic reference under strong bidirectional optimization.

	*sg,sum/ at ∪ sum	*pl,at	*FunctN	*pl, sum/ at ∪ sum	*sg, at
<sg, atom> \uparrow					*
<sg, at ∪ sum>	*				
<sg, sum>	*				
<pl, atom>		*	*		
<pl, at ∪ sum> \uparrow			*	*	
<pl, sum> \uparrow			*	*	

Tableau 1: bidirectional optimization over singular/plural forms and meanings

We make two further predictions. Under the assumption that the speaker knows what Mary saw (namely one horse, or more than one horse), we can explain why (2) cannot be weakened to an inclusive interpretation: intended atomic reference calls for a singular form. Intended atomic reference is also at stake in (7). The problem for a unidirectional account is that the inclusive semantics in (9b) is not falsified by a situation in which the only contextually relevant alternatives involve atoms (as with Roman noses). Under the bidirectional analysis, we see that in this case not only the pair <pl, atom ∪ sum> is relevant, but also the pair <pl, atom>. But <pl, atom> is a suboptimal pair, because of the high ranked constraint *pl,atom. The use of the plural in sentences like (7) is thus blocked by the preference for a singular form in a context in which sum values are pragmatically excluded. We also predict the contrast between (3) and (6): the use of the plural in (6) signals that sum values are relevant, a situation that is culturally more striking in the case of MA degrees than in the case of children.

4. Results and comparisons

The analysis presented meets the challenges raised in Section 2, without special stipulations for languages with or without NNM (English vs. Chinese). Its advantage over Sauerland et al. (2005) is that it conforms to Horn’s division of pragmatic labor. Unlike Spector (2005), we do not rely on a special higher order implicature mechanism, and we predict the possibility of inclusive plurals with indefinites as well as definites:

(11) If *the children in a divorced family* stay with the mother they are well fed.

We differ from Zweig (2006) in that we provide an explicit account of the interpretation of singulars and we explain why in (2) sum interpretation is not cancelable.

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Bibliography

- Corbett, G.: 2000, *Number*, Cambridge University Press, Cambridge.
- Dalrymple, M., Kanazawa, M., Kim, Y., Mchombo, S. and Peters, S.: 1998, Reciprocal expressions and the concept of reciprocity, *Ling. and Philosophy* 21, 159-210.
- Farkas, D.F. and Swart, H.E. de: 2003, *The semantics of incorporation: from argument structure to discourse transparency*, CSLI Publications, Stanford: CA.
- Farkas, D.F.: 2006, The unmarked determiner, in: S. Voegeleer and L. Tasmowski-de Rijk (eds.), *Non-definiteness and plurality*, John Benjamins, Amsterdam.
- Fauconnier, G.: 1979, Implication reversal in natural language, in: F. Guenther and S.J. Schmidt (eds.), *Formal semantics and pragmatics for natural languages*, Reidel.
- Greenberg, J.: 1966, *Language Universals*, Mouton, the Hague.
- Hendriks, P., de Hoop, H., Swart, H. de, and Zwarts, J.: 2007, *Conflicts in Interpretation*, ms. Groningen/Nijmegen/Utrecht.
- Horn, L.R.: 2001, *A natural history of negation*, CSLI Publications, Stanford CA.
- Link, G.: 1983, The logical analysis of plural and mass nouns: a lattice-theoretic approach, in: R. Bäuerle et al. (eds.), *Meaning, use and interpretation of language*, de Gruyter, Berlin, 302-323.
- Mattausch, J.: 2007, Optimality, bidirectionality & the evolution of binding phenomena, *Research on Language & Computation* 5, 103-131.
- Sauerland, U.: 2003, A new semantics for number, in: *SALT* 13, 258-275.
- Sauerland, U., Anderssen, J. and Yatsushiro, J.: 2005, The plural is semantically unmarked, in: S. Kepser and M. Reis (eds.), *Linguistic Evidence*, de Gruyter.
- Spector, B.: 2005, Aspects of the pragmatics of plural morphology: on higher-order implicatures, in: U. Sauerland and P. Stateva (eds.), *Presuppositions and implicatures in compositional semantics*, Palgrave-Macmillan (to appear).
- Winter, Y.: 2001, Plural predication and the strongest meaning hypothesis, *Journal of Semantics* 18, 333-365.
- Zwarts, J.: 2004, Competition between word meanings: the polysemy of *around*, in: *Proc. of Sinn & Bedeutung*, Konstanz, 349-360.
- Zweig, E., 2006, The implications of dependent plural readings, in: *NELS* 36, 735-746.

QUANTIFICATION IN THE CODA OF EXISTENTIALS

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Existential sentences with PP codas containing quantifiers (e.g. *There's ominous music in most nightmares*) are analyzed. It is argued that they require abandoning the common view that codas denote properties of individuals. An alternative analysis is presented in which codas are not predicates but rather contextual modifiers. The parallels between codas and temporal modifiers are discussed, as is a previously unnoticed contrast between codas and post-copular predicates in the licensing of free choice *any*.

1. Introduction

This paper proposes a semantics for existentials in which a PP coda contains a quantified expression, as in (1). (In an existential of the form *there be NP XP*, I refer to the NP as the *pivot* and the XP as the *coda*.)

- (1) There's [a drummer]_{pivot} [in most punk bands]_{coda}.

Such examples have not been explicitly analyzed in the literature, and I argue that existing approaches to existentials must be amended in order to accommodate them. I suggest an analysis that assimilates codas to contextual PP modifiers, treating both as generalized quantifiers over contextual variables or context sets, and demonstrate some of the empirical advantages of this assimilation.

Most analyses of existentials model codas as denoting properties of individuals of type (e, t) . For example, McNally 1992 models them as secondary predicates, on a par with depictive modifiers (e.g. *alive* in *The whale swallowed Jonah alive*). Barwise and Cooper 1981 model pivots as denoting generalized quantifiers (GQs) and codas as post-nominal modifiers combining intersectively with the common noun in the pivot. On their analysis codas thus contribute a restriction for the pivot GQ. The same effect is achieved in a different way in Zucchi 1995, where codas operate on the context change potential of existentials, restricting the domain relative to which the common noun in the pivot is interpreted to a set denoted by the coda. Keenan 1987 analyzes codas as predicates that take pivots as subjects, and thus provide the scope set for the pivot GQ rather than its restriction. In all four analyses, codas are type (e, t) and contribute a property (or set) of individuals.

2. Quantified codas

PP codas with quantifiers as in (1) above cannot be modeled simply as contributing a property or set. If this were the case, the coda in (1) would have to contribute the property of being in most punk bands (or the set of individuals who are in most punk band). But there is clearly no reading of (1) involving this property. Rather, the sentence means that most punk bands *have* a drummer.

Furthermore, if codas contribute sets, whether to the restriction or to the scope of the pivot, then multiple codas should be interpreted as multiple conjuncts, giving rise to familiar kinds of conjunct-elimination entailments. However, multiple quantified codas do not give rise to such entailments: (2a) entails neither (2b) nor (2c).

- (2) a. There are two phones in every home in most countries. \nrightarrow
- b. There are two phones in most countries.
- c. There are two phones in every home.

The logical form of (2a) is represented informally in (3), where the second coda binds a context variable in the restriction of the quantification in the first.

- (3) For most countries c , for every home h in c , there are two phones in h

The behavior of quantified codas thus requires some mechanism for handling their scopal behavior, both in relation to the pivot and in relation to each other.

3. Contextual modifiers

Given these properties of codas, it is natural to model them on a par with temporal PP modifiers such as those in (4).

- (4) a. Mary wept [during my funeral].
- b. Mary wept [during every funeral].

Contextual modifiers with quantifiers (4b) are analyzed in Pratt and Francez 2001 and von Stechow 2002. They raise a parallel problem to the one raised by quantificational codas in that they generally scope over the existential quantification over events in the sentence they modify. They can therefore not be analyzed as intersective predicates of events in a Davidsonian event-semantics. Thus, while (4a) can be analyzed along the lines of (5), (4b) cannot be assigned a similar intersective meaning, since it does not describe a weeping event occurring throughout every funeral.

- (5) $\exists e[\text{weep}(m, e) \ \& \ \text{during}(e, \text{my funeral})]$

Like multiple codas, multiple temporal PP modifiers are not interpreted intersectively but rather form what PF call *cascades*⁸⁶. This is exemplified in (6a), the meaning of which can be represented informally as in (6b).

- (6) a. Madonna said a prayer before each meal during most holidays.
 b. For most holidays H , for each meal m during H , there is an event of Madonna saying a prayer before (the onset of) m .

Here, as in (2a), each modifier binds a restriction within the previous one(s).

The parallelism between temporal modifiers and codas can be made transparent by viewing sentence meanings as GQs over intervals. For example, the meaning of *Mary wept* can be written as (7), where i is the type for intervals.

$$(7) \quad [[\text{Mary left}]] = \lambda P_{(i,t)} \mathbf{a}(\lambda i[\text{weep}(m)(i)], P)$$

Modifiers can then also be modeled as GQs over intervals that take sentence meanings as their arguments. For example, the derivation of the meaning of *during every funeral* is as in (8).

$$(8) \quad \begin{aligned} [[\text{during}]] &= \lambda P_{((i,t),t)} \lambda Q_{((i,t),t)} [\mathcal{P}(\lambda i[\mathcal{Q}(\lambda j[i \subseteq j])])] \\ [[\text{every funeral}]] &= \lambda P_{(i,t)} [\text{every}(\lambda i[\text{funeral}(i)], P)] \\ [[\text{during every funeral}]] &= \lambda Q_{((i,t),t)} [\text{every}(\lambda i[\text{funeral}(i)], \\ &\quad \lambda i'[\mathcal{Q}(\lambda j[j \subseteq i'])])] \end{aligned}$$

(7a) says that the set of intervals in which Mary weeps has a non-empty intersection with the set of subintervals of the funeral interval.¹ When no modifiers are present, sentence meanings are applied to the set of subintervals of the contextually salient reference interval \mathcal{R} . I suggest an analogous analysis of existentials and codas.

4. Semantics for existentials

I take *bare existentials* (BEs) (existentials with no overt coda) to denote the GQ denoted by their pivot. However, I assume that GQs can range over sets of entities of any (simple) type (individuals, events, times, etc.). The meaning of a BE is given in (9), where τ is any simple type, \mathcal{Q} is a relation between sets determined by the determiner of the pivot, and N is a set determined by the common noun in the pivot.

$$(9) \quad [[\text{there be NP}]] = [[\text{NP}]] = \lambda P_{(\tau,t)} [\mathcal{Q}_{((\tau,t),((\tau,t),t))}(N_{(\tau,t)}, P)].$$

For example, consider the derivation of the existential in (1) above. The meaning of *There is a drummer* is in (10).

$$(10) \quad [[\text{there is a drummer}]] = [[\text{a drummer}]] = \lambda P_{(e,t)} [\mathbf{a}(\lambda x[\text{drummer}(x)], P)].$$

In the absence of modification, the meaning in (10) is applied to a contextually relevant domain of entities, possibly the universe of discourse. I model codas as generalized quantifiers over such contextual sets. Thus, the meaning of *in most punk bands* is derived as in (11). (For legibility I write @ for “applied to”).²

¹I abstract away from issues of tense and aspect here.

²Alternatively, codas and temporal modifiers could be analyzed as involving quantifying-into the NP position, e.g. by a rule of quantifier raising (see von Stechow 2002). I see no stakes in the choice of analysis for my core semantic arguments.

$$\begin{aligned}
 (11) \quad & [[\text{most punk bands}]] = \lambda P_{(e,t)} [\mathbf{most}(\lambda x [\mathbf{PB}(x)], P)] \\
 & [[\text{in most punk bands}]] = [[\text{in}]] ([[\text{most punk bands}]]) = \\
 & \lambda \mathcal{P}_{((e,t),t)} \lambda \mathcal{Q}_{((e,t),t)} [\mathcal{P}(\lambda y [\mathcal{Q}(\lambda x [\text{in}(x, y)])])] @ \\
 & (\lambda P_{(e,t)} [\mathbf{most}(\lambda x [\mathbf{PB}(x)], P)]) = \\
 & \boxed{\lambda \mathcal{Q}_{((e,t),t)} [\mathbf{most}(\lambda x [\mathbf{PB}(x)], \lambda y [\mathcal{Q}(\lambda x [\text{in}(x, y)])])]}
 \end{aligned}$$

This meaning combines by function application with the meaning of the BE in (10) to derive the meaning of (1) as in (12).

$$\begin{aligned}
 (12) \quad & [[\text{There is a drummer in most punk bands}]] = \\
 & [[\text{in most punk bands}]][[\text{there is a drummer}]]) = \\
 & \lambda \mathcal{Q}_{((e,t),t)} [\mathbf{most}(\lambda x [\mathbf{PB}(x)], \lambda y [\mathcal{Q}(\lambda u [\text{in}(u, y)])])] @ \\
 & (\lambda P_{(e,t)} [\mathbf{a}(\lambda z [\text{drummer}(z), P)])] = \\
 & \boxed{\mathbf{most}(\lambda x [\mathbf{PB}(x)], \lambda y [\mathbf{a}(\lambda z [\text{drummer}(z), \lambda u [\text{in}(u, y)])])]}
 \end{aligned}$$

4.1. Stacking

As noted above, the effect of coda stacking is to restrict the quantification over context sets in the first coda. However, the meaning in (12) cannot compose with further coda modifiers. Semantically, multiple codas quantify over context sets restricting the quantification introduced by the first coda, which in turn quantifies over the context sets that form the scope sets for pivot GQs. There are various ways of introducing context sets into the restriction of a quantificational structure³. However, there are not many explicit analyses of how modifiers binding such sets are to be interpreted compositionally. Here I assume that any quantificational structure can be made open to further contextual restriction by abstraction over an (otherwise possibly implicit) context set in the restriction. I call this process *contextualization*.

$$(13) \quad \text{contextualization:} \\
 Q(\alpha_{(\tau,t)}, \beta_{(\tau,t)}) \Rightarrow \lambda C_{(\tau,t)} [Q(\alpha_{(\tau,t)} \& C, \beta_{(\tau,t)})]$$

Contextualization derives (14) from the meaning in (12). (12) can combine straightforwardly with a further modifier, yielding an output that can itself be contextualized.

$$(14) \quad \lambda C [\mathbf{most}(\lambda x [\mathbf{PB}(x) \& C(x)], \lambda y [\mathbf{a}(\lambda z [\text{drummer}(z), \lambda u [\text{in}(u, y)])])])$$

As an example, the derivation of *There is a drummer in most punk bands in every festival* is given in (15). I write $[[\phi]]_{cont}$ for the result of contextualizing a quantificational formula ϕ .

³For example, by making the meaning of nouns regional (Pratt and Francez 2001, Stanley and Gendler Szabó 2000), or by building an implicit domain restriction into the meaning of quantifiers (Westerstahl 1984).

$$\begin{aligned}
 (15) \quad & [[\text{there is a drummer in most punk bands in every festival}]] = \\
 & [[\text{in every festival}]] ([[\text{there is a drummer in most punk bands}]]_{cont}) = \\
 & \lambda \mathcal{Q}_{((e,t),t)} [\mathbf{every} (\lambda x_1 [\text{festival}(x_1)], \lambda y_1 [\mathcal{Q} (\lambda z_1 [\text{in}(z_1, y_1)])])]] \\
 & @ (\lambda C [\mathbf{most} (\lambda x [\text{PB}(x) \ \& \ C(x)], \lambda y [\mathbf{a} (\lambda z [\text{drummer}(z), \lambda u [\text{in}(u, y)])])])]]) = \\
 & \boxed{ \begin{aligned} & \mathbf{every} (\lambda x_1 [\text{festival}(x_1)], \\ & \quad \lambda y_1 [\mathbf{most} (\lambda x [\text{PB}(x) \ \& \ \text{in}(x, y_1)], \\ & \quad \quad \lambda y [\mathbf{a} (\lambda z [\text{drummer}(z), \lambda u [\text{in}(u, y)])])])]]) \end{aligned} }
 \end{aligned}$$

5. Codas, predicates and free choice *any*

The assumption that pivots and codas stand in a subject-predicate relation (e.g. in a “small clause”) is common in syntactic literature and underlies the widespread typological view that existentials and copular constructions derive from a common source (e.g. Freeze 1992). However, codas exhibit several semantic properties that predicates do not (see Francez 2007). Here I discuss one such property: the licensing of free choice *any*.

Codas, but not post-copular predicates, license free choice *any*, as the contrast between (16a,b) shows. (16c) shows that codas in this respect pattern with contextual modifiers, as expected on the current analysis.

- (16) a. There’s a drummer in any punk band.
 b. ??A drummer is in any punk band.
 c. The drummer smokes in any punk band.

I suggest that the key to understanding this contrast is the availability of a generic reading for *any* (Dayal 1998, Horn 2000). In both (16a) and (16b), *any* is interpreted as involving a quasi-universal force similar to the force associated with generics. In fact, both (16a) and (16c) are paraphrasable with a generically interpreted indefinite replacing *any*, as in (17a,b) respectively, both of which can have a generic reading.

- (17) a. There’s a drummer in a punk band.
 b. The drummer smokes in a punk band.

Thus, a coda with free choice *any* is a sub-type of quantificational coda, where the quantification is generic. Generic NPs are generally infelicitous in post-copular predicates, as shown in (18). Presumably, the reason is that predicates denote properties of individuals, and generics conceptually cannot form such properties. A guard cannot have the property of being in the generic jail.

- (18) ??A corrupt guard is in a jail. (strange on generic reading of *a jail*)

Codas in contrast do not, on the current ⁸⁹ proposal, denote properties of individuals, but quantify over context sets, generic quantification being one possibility.

6. Conclusion

In conclusion I point out two general consequences of assimilating codas to contextual modifiers. First, modification is a method for determining values for context sets, possibly by binding to explicit quantifiers. Second, an interval, such as the standard “reference interval”, also constitutes a context set, namely the set of its subintervals.

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Bibliography

- Barwise, J. and Cooper, R.: 1981, Generalized quantifiers and natural language, *Linguistics and Philosophy* 4, 159–219
- Dayal, V.: 1998, ANY as inherently modal, *Linguistics and Philosophy* 21(5), 433–476
- Francez, I.: 2007, *Existential propositions*, Ph.D. thesis, Stanford University
- Freeze, R.: 1992, Existentials and other locatives, *Language* 68(3), 553–95
- Horn, L.: 2000, Any and (-)ever: Free choice and free relatives, in A. Z. Weyner (ed.), *Proceedings of IATL 15*, pp 71–111
- Keenan, E.: 1987, A semantic definition of indefinite NP, in E. Reuland and A. ter Meulen (eds.), *The representation of (in)definiteness*, pp 286–317, MIT Press, Cambridge, MA
- McNally, L.: 1992, *An interpretation for the English existential construction.*, Garland, New York
- Pratt, I. and Francez, N.: 2001, Temporal prepositions and temporal generalized quantifiers, *Linguistics and Philosophy* 24(2), 187–222
- Stanley, J. and Gendler Szabó, Z.: 2000, On quantifier domain restriction, *Mind and Language* 15(2&3), 219–261
- von Stechow, A.: 2002, Temporal Prepositional Phrases with Quantifiers: Some Additions to Pratt and Francez (2001), *Linguistics and Philosophy* 25(5), 755–800
- Westerståhl, D.: 1984, Determiners and context sets, in J. van Benthem and A. ter Meulen (eds.), *Generalized quantifiers in natural language*, pp 45–71, Floris, Dordrecht
- Zucchi, A.: 1995, The ingredients of definiteness and the definiteness effect, *Natural Language Semantics* 3(1), 33–78

THE PRAGMATICS OF BISCUIT CONDITIONALS

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During one of his recorded shows the American comedian Demetri Martin told the following joke, much to the amusement of his audience:

She was amazing. I never met a woman like this before. She showed me to the dressing room. She said: "If you need anything, I'm Jill." I was like: "Oh, my God! I never met a woman before with a *conditional identity*." [Laughter] "What if I don't need anything? Who are you?" — "If you don't need anything, I'm Eugene." [More laughter]
(Demetri Martin, *These are jokes*)

Martin's joke is possible because of a peculiarity of certain conditional sentences. Some conditional sentences relate propositions that have no conditional relationship. This is by no means contradictory or paradoxical. The sentence

- (1) If you need anything, I'm Jill.

links the clauses "you need anything" and "I'm Jill" in a conditional construction, but semantically we may naturally perceive the propositions expressed by these clauses as conditionally unrelated; the name of the woman does not depend on whether the addressee needs anything or not. To humorously misapprehend such conditional sentences, as Martin does, is to pretend to see a conditional relationship where none exists.

Examples that would lend themselves to similar joking have been discussed as a special case of conditionals from a variety of angles under a variety of names. I will speak of *Biscuit Conditionals* (BCs), a term which is derived from Austin's famous example (2) (Austin 1956).

- (2) There are biscuits on the sideboard if you want them.

It is widely assumed that BCs differ from standard conditionals (SCs) like (3) in that "the *if*-clauses in [BCs] specify the circumstances in which the consequent is relevant (in a vague sense, also subsuming circumstances of social appropriateness), not the circumstances in which it is true" (Iatridou 1991, p.51).

- (3) a. If it does not rain, we will eat outside.
b. If the butler has not killed the baroness, the gardener has.

In order to explain these intuitive differences, many theorists have proposed a difference in kind between SCs and BCs (e.g., recently, Siegel 2006). I argue that this is not necessary: a purely pragmatic explanation is possible based on a simple, uniform and entirely standard semantics. What needs explanation then are the following two issues:

- (i) **Non-Conditional Readings of BCs:** How is it possible that the conditional surface structure in BCs does not give rise to standard conditional readings? In particular, why do BCs convey the (unconditional) truth of their consequents?
- (ii) **Discourse Function of BCs:** What, then, is the reason for using a conditional construction, if it is not to restrict the truth of the consequent? In other words, what is the discourse function of BCs and, most importantly, how does it come about?

1. Non-Conditional Readings: Epistemic Independence

The idea how to explain the non-conditional readings of BCs pragmatically is very simple: since normally we would not expect the truth or falsity of propositions

you want some (P) & there are biscuits on the sideboard (Q)

to depend on one another, a speaker who asserts the conditional sentence in (2) felicitously must believe in the unconditional truth of the consequent Q . To spell out this idea we have to make precise what it means for two propositions to be independent in some appropriate sense.

I suggest that the right kind of independence of propositions is epistemic. Although in the actual world the truth values of P and Q are fixed, what matters for our concern is whether these propositions are believed to depend on one another. From this point of view we can say that P and Q are *epistemically independent* for an agent (in a given epistemic state) if learning one proposition to be true or false (where this was not decided before) is not enough evidence to decide whether the other proposition is true or false (where this was not decided before).

Here is a more formal take on the same idea. Take a set W of possible worlds, propositions $P, Q \subseteq W$ and an agent's epistemic state $\sigma \subseteq W$ of worlds held possible. We write \bar{P} for $W \setminus P$, the negation of proposition P . We say that the agent holds P possible and write $\diamond_{\sigma} P$ or, dropping the obvious index, $\diamond P$ iff $\sigma \cap P \neq \emptyset$. We say that P and Q are EPISTEMICALLY INDEPENDENT (on σ) iff for all $X \in \{P, \bar{P}\}$ and all $Y \in \{Q, \bar{Q}\}$ it holds that $(\diamond X \wedge \diamond Y) \rightarrow \diamond(X \cap Y)$.

We can now make our initial idea more precise. Let's assume a very simple-minded material or strict implication analysis of conditionals for both SCs and BCs, evaluated on the epistemic state σ of the speaker. So, if the speaker says 'If P , Q ', we may infer that, if he spoke truthfully, his epistemic state is such that $\sigma \cap P \subseteq Q$. But if we have reason to assume that at the same time the same speaker does not

believe in a conditional relationship between P and Q , we may infer even more, namely that the speaker either believes in the falsity of P or the truth of Q . This is so, because if $\diamond P$ and $\diamond \bar{Q}$, then by epistemic independence we have $\diamond(P \cap \bar{Q})$ which contradicts $\sigma \cap P \subseteq Q$. Consequently, if we furthermore have reason to assume that the speaker considers it at least possible that the antecedent proposition is true, which seems uncontroversial for (indicative) BCs, we may conclude that the speaker actually believes Q .¹ Whence, I propose, the feeling of entailment: a speaker who (i) speaks truthfully in asserting ‘If P , Q ’, (ii) considers P and Q epistemically independent and (iii) considers P at least possible *must* believe in Q .

Where does the notion of epistemic independence come from? Why is it justified to use it in the way we do? First of all, it is easy to verify that epistemic independence is the purely qualitative counterpart to standard *probabilistic independence*² and equivalent to Lewis 1988’s notion of orthogonality of questions (see van Rooij 2007). Moreover, epistemic independence is strictly weaker than the more standard notion of *logical independence* (relativized to an epistemic state).³ For our purposes, however, logical independence is too strong, because (belief in) logical independence of P and Q excludes that either P or Q is believed true or false. In other words, logical independence does not have a flawless ‘positive fit’: there are instances of intuitively independent propositions which are not logically independent on some epistemic states. Epistemic independence is weak enough to circumvent this problem.

Still, it might be objected that epistemic independence is actually too weak to capture our intuitions about independence properly, for it shares with probabilistic independence the counterintuitive trait that if a proposition P is believed true, then any proposition Q is independent of P , even P itself. In other words, epistemic independence does not have a flawless ‘negative fit’: there are intuitively dependent propositions which are epistemically independent on some states. This problem

¹The same argument more concisely: (i) the speaker utters “if P , Q ”, so we assume $\sigma \cap P \subseteq Q$; (ii) we assume that P and Q are epistemically independent, so that in particular $\diamond P$ and $\diamond \bar{Q}$ entails $\diamond(P \cap \bar{Q})$; (iii) we assume $\diamond P$ as a presupposition of indicative conditionals; (iv) if $\diamond \bar{Q}$ were true, we would have a contradiction between (i), (ii) and (iii); (v) we conclude that $\sigma \subseteq Q$.

²Propositions P and Q are **PROBABILISTICALLY INDEPENDENT** given a probability distribution $\Pr(\cdot)$ iff $\Pr(P \cap Q) = \Pr(P) \times \Pr(Q)$. If we equate the epistemic state σ of the agent with the support of the probability distribution $\Pr(\cdot)$ as usual and get $\sigma = \{w \in W \mid \Pr(w) \neq 0\}$, we can show that probabilistic independence entails epistemic independence. First, we establish that if $\Pr(P \cap Q) = \Pr(P) \times \Pr(Q)$, then for arbitrary $X \in \{P, \bar{P}\}$ and $Y \in \{Q, \bar{Q}\}$ it holds that $\Pr(X \cap Y) = \Pr(X) \times \Pr(Y)$. From the three arguments needed, it suffices to give just one, as the others are similar. So assume that $\Pr(P \cap Q) = \Pr(P) \times \Pr(Q)$ and derive that $\Pr(P \cap \bar{Q}) = \Pr(P) \times \Pr(\bar{Q})$: $\Pr(P \cap \bar{Q}) = \Pr(P) - \Pr(P \cap Q) = \Pr(P) - (\Pr(P) \times \Pr(Q)) = \Pr(P) \times (1 - \Pr(Q)) = \Pr(P) \times \Pr(\bar{Q})$. Next, assume that $\Pr(X \cap Y) = \Pr(X) \times \Pr(Y)$ and that $\diamond X$ and $\diamond Y$. That means that $\Pr(X), \Pr(Y) > 0$. Hence, $\Pr(X \cap Y) > 0$, which is just to say that $\diamond(X \cap Y)$.

The converse, however, is not the case. Epistemic independence does not entail probabilistic independence. It may be the case that proposition P is not enough (evidence, support, information) to decide whether Q is true or false, but still learning that P is true, for instance, makes Q more or less likely.

³ P and Q are **LOGICALLY INDEPENDENT** (on σ) iff for all $X \in \{P, \bar{P}\}, Y \in \{Q, \bar{Q}\}$: $\diamond(X \cap Y)$.

could be fixed with a suitable intermediate notion.⁴ But the fix is not necessary for our present purpose. For the above argument perfect ‘positive fix’ is all that is required: we only have to make sure that intuitively independent propositions are treated appropriately.

2. Discourse Function: Context Shifts for Optimality

What is left to be explained is why BCs are used in the first place, if their discourse effect, as far as information is concerned, is that of a simple assertion of the consequent. The received view on the matter—which is explicit in the above quote from Iatridou 1991 and implicitly endorsed also by Siegel 2006—is that a BC is used in order not to make an ill-formed utterance in case the (assertion of the) consequent alone is possibly irrelevant, infelicitous or in some other sense inappropriate *unless the antecedent is true*. However, there are good reasons for discharging the received view as flawed.

Here is why. According to the received view, whenever a BC “if P , Q ” is used in a context where its antecedent P is true, (the assertion of) its consequent should be felicitous too. Yet this is not so, as the following example shows. Imagine that we want to go swimming and you are waiting for me while I am packing my bag. If I say to you—out of the blue—that there are biscuits on the sideboard (Q) it is conceivable, if not likely that you may not know what exactly I meant to tell you. (May you eat the biscuits? Do I want you to stay away from them? Must you hand them to me? Throw them into my bag?) And this may be so, even though you are in fact hungry and lust for sweets and I know it. The critical point is that it may not be intelligible *in which way* the utterance “ Q ” has to be understood, maybe because it is not *common ground* that you would like to eat biscuits, although this is true and known by both speaker and hearer. In contrast, the BC in (2) makes entirely clear for what reason the information Q is given.

This example suggest that rather than to speak of ‘relevance conditionals’ we should think of at least some BCs as ‘*intelligibility conditionals*’: the antecedent somehow (see below) assures that the consequent is understood appropriately. This is certainly what is going on in (4a) and (4b) and plausibly also in (4c).⁵

- (4) a. He’s a buhubahuba, if you know what I mean.
b. If we now turn to the last point of order, fund cuts have been tremendous.

⁴A suitable intermediate notion will have to be counterfactual: we could say that P and Q are COUNTERFACTUALLY INDEPENDENT on σ iff P and Q are logically independent on σ^* , where σ^* is the agent’s epistemic state obtained by minimally revising σ to incorporate P , \bar{P} , Q and \bar{Q} as alive possibilities. What is undesirable about this intermediate option is that, normally, we would rather like to use the notion of (in-)dependence of propositions to account for belief revision, not the other way around.

⁵In example, (4c) the speaker might either worry about not being understood, about saying something ungrammatical (while still being understood), or both.

- c. He trapped two mongeese, if that's how you make the plural of "mongoose". (Noh 1998)

Furthermore, it is quite clear that different antecedents may change the interpretation of the consequent dramatically. Just imagine, in relation to the first example of this paper, how amazing Jill would have been to Demetri with the conditional identity in (5): whereas with (1) Demetri might feel encouraged to ask for help, with (5) he might feel encouraged to ask for Jill's phone number (or worse).

- (5) If you want to go out tonight, I'm Jill.

Taken together, at least sometimes, BCs are used in discourse to coordinate a proper reception of the consequent between conversationalists.

Are all BCs intelligibility conditionals in this discourse coordinating sense? The answer clearly should be negative. There are also BCs like (6) which relate in some fashion to communicative rules or the actual linguistic conduct of the speaker.

- (6) If I may say so, you are not looking good.

All sorts of politeness hedging would file here. Witness, for instance, phrases like "if I may say so", "if you ask me" or "if I may interrupt".

So, what other discourse functions of BCs are there and how are they related? Also, can we derive the discourse functions of BCs, whatever they may be, from a reasonable standard semantics? I believe that we can and that this will also give away the relation between various conceivable discourse functions.

I believe that, in general and in the case at hand, we can gain substantial insight from explanations of language use which are based on the assumption that language use is in some sense optimized, be that by explicit reasoning within the limits of the humanly possible, or over time in the course of language change. In order to be optimal in a given context an utterance needs to fulfill a number of requirements. An exhaustive list of conditions necessary for optimality is not needed here. It is enough to note, on a fairly intuitive basis, that in certain contexts an utterance requires certain features for its optimality, amongst which intelligibility, social and circumstantial appropriateness and, perhaps, linguistic well-formedness.

A fairly standard dynamic semantics of conditional sentences squares well with this view on language use in explaining the discourse functions of BCs. The standard analysis in dynamic semantics of conditionals is to say that if c is a simple context set, i.e. a set of possible worlds, update with "if P , Q " is given as:

$$c + \text{"if } P, Q\text{"} = (c \cap P \cap Q) \cup (c \cap \bar{P}).$$

A slightly different way of looking at the standard analysis reveals a three-step procedure (cf. Swanson 2003, Isaacs and Rawlins 2007 for highlighting this view in the context of non-standard conditionals): firstly, the original context c is updated with the antecedent P to yield a provisional, hypothetical context $c + P$; secondly, the

consequent Q is evaluated in this hypothetical context $c + P$; and lastly, the effects of the second step are merged back into the original context.

Implicit in this view of conditional sentences and crucial for the present purpose is the idea that the antecedent of a conditional changes a context into a hypothetical context in which the consequent is evaluated. That means that a conditional “if P , Q ” is optimal in a context c only if (i) “ Q ” is optimal in $c + P$ (because that is where the consequent is interpreted) and (ii) “ Q ” is not optimal in c (if we assume that the conditional “if P , Q ” is more costly than the use of mere “ Q ”). Since, as we noted above, there are plenty of ways in which an utterance “ Q ” can fail to be optimal in a context c , yet succeed to be optimal in context $c + P$, there are plenty of reasons to use a conditional sentence in various different contexts.⁶ The view that results from these considerations is that BCs, along with SCs, are used as context-shifters to secure optimality of utterances. To contrast the present suggestion directly with the received view stated at the beginning of this section, we could say that BCs are used in cases where the consequent alone is possibly irrelevant, infelicitous or in some other sense non-optimal *unless processed in the context of the antecedent*.

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Bibliography

- Austin, J. L.: 1956, Ifs and cans, *Proceedings of the British Academy* 42, 109–132
Iatridou, S.: 1991, *Topics in Conditionals*, Ph.D. thesis, MIT
Isaacs, J. and Rawlins, K.: too appear, 2007, Conditional questions, *Journal of Semantics*
Lewis, D.: 1988, Relevant implication, *Theoria* 54, 162–174
Noh, E.-J.: 1998, A relevance-theoretic account of metarepresentative uses in conditionals, in V. Rouchota and A. H. Jucker (eds.), *Current Issues in Relevance Theory*, pp 271–304, John Benjamins
van Rooij, R.: 2007, Strengthening conditional presuppositions, *Journal of Semantics* 24(3), 289–304
Siegel, M. E. A.: 2006, Biscuit conditionals: Quantification over potential literal acts, *Linguistics and Philosophy* 29, 167–203
Swanson, E.: 2003, Biscuit conditionals and the common ground, in J. Hale (ed.), *Proceedings of the Student Session of NASSLLI*, pp 26–34

⁶Indeed, truthfulness could just as well be included here.

THE RELEVANCE OF AWARENESS

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Relevance is a crucial concept in linguistics, but also a notoriously vague notion. Recently, some formal decision-theoretic notions of relevance have been applied successfully to linguistics (van Rooij 2003; van Rooij 2004), but none of these captures the impact of modalized sentences, in particular possibility statements. We treat decision problems of possibly *unaware* agents (cf. Fagin and Halpern 1988; Modica and Rustichini 1994) and give an update procedure that captures *becoming aware* of further contingencies. We define the relevance of such updates, and hint at the pragmatic reasoning surrounding possibility statements in dialog.

1. Decisions, relevance and awareness

It's Alice's birthday. Bob, our Bayesian baker, is uncertain whether Alice likes cake and thus faces a DECISION PROBLEM, i.e. a structure $D = \langle S, P, A, U \rangle$, where

S is a set of relevantly distinct STATES OF THE WORLD,
 P is a PROBABILITY DISTRIBUTION on S ,
 A is a set of ACTIONS, and
 U is a UTILITY FUNCTION, $U: S \times A \rightarrow \mathbb{R}$.

Bob's decision problem (shown in Figure 1(a)) contains states s_1 and s_2 for Alice's preferences, probabilities for these possibilities (e.g. $P(s_2) < P(s_1)$, not shown), actions a_c ('bake a cake') and a_\emptyset ('do nothing'), and utilities for all possible combinations of states and actions ($U(s_1, a_c) = 0.5$: even if Alice doesn't like cake, Bob still does). Bob quickly checks the EXPECTED UTILITY of his actions

$$EU_D(a) \stackrel{\text{def}}{=} \sum_{s \in S} P(s) \times U(s, a)$$

and concludes that a cake it will be, since baking the cake is an action which maximizes expected utility (in this case it is the only one). If he learns that the actual state is in $T \subseteq S$, he will update his beliefs and recalculate his actions' EXPECTED UTILITY AFTER LEARNING that $T \subseteq S$:

$$EU_D(a, T) \stackrel{\text{def}}{=} \sum_{s \in S} P(s|T) \times U(s, a).$$

A reasonable measure for the relevance of such information is the following variant

	a_c	a_\emptyset		a_c	a_\emptyset		a_c	a_s	a_\emptyset
$s_1 : c$	1	0	$s_1 : c, \neg e$	1	0	$s_1 : c, \neg e$	1	0.4	0
$s_2 : \neg c$	0.5	0	$s_2 : \neg c, \neg e$	0.5	0	$s_2 : \neg c, \neg e$	0.5	0.4	0
			$s_3 : c, e$	-5	0	$s_2 : c, e$	-5	0.4	0
			$s_4 : \neg c, e$	-5	0	$s_4 : \neg c, e$	-5	0.4	0
(a) Care for cake?			(b) Bad eggs			(c) Shortbread			
	a_c	a_s	a_\emptyset						
$s_1 : c, \neg e$	1	0.4	0	a_c Bake chocolate cake					
$s_2 : \neg c, \neg e$	0.5	0.4	0	a_s Bake shortbread					
$s_3 : c, e$	-5	0.4	0	a_\emptyset Do nothing					
$s_4 : \neg c, e$	-5	0.4	0	c Alice likes chocolate cake					
$s_5 : c, \neg e$	1	-10	0	e The eggs are off					
$s_6 : \neg c, \neg e$	0.5	-10	0	-5 Eating rotten eggs (nasty)					
$s_7 : c, e$	-5	-10	0	-10 Allergic reaction (dangerous)					
$s_8 : \neg c, e$	-5	-10	0						
(d) Allergies				(e) Key					

Figure 1: Decision problems resulting from various updates.

of the VALUE OF SAMPLE INFORMATION (cf. Raiffa and Schlaifer 1961):¹

$$\text{VSI}_D(T) \stackrel{\text{def}}{=} \max_{a \in A} \text{EU}_D(a, T) - \text{EU}_D(\text{BA}(D), T),$$

where $\text{BA}(D)$ is the set of actions with maximal expected utility in D .² But then, how to deal with a case where Alice brings up something genuinely new as in (1)?

(1) ALICE: Hmm, the eggs might be off, did you think of that?

Intuitively, Alice’s remark in (1) does not eliminate previously considered alternative states, but *brings new options into consideration*. The decision problem in Figure 1(a) represented Bob’s awareness of the situation, and his implicit assumption that the eggs are fresh. After Alice mentions the possibility that they might be off, $\diamond e$, Bob’s decision problem is updated to (something like) Figure 1(b). Another possibility is that Alice could suggest a new action ($\diamond a_s$) leading to Figure 1(c):

(2) ALICE: You could make shortbread instead.

Or she might give a possible consequence of a given action ($\diamond(a_s; r)$, where r stands for ‘have an allergic reaction’), bringing Bob to Figure 1(d):

(3) ALICE: But hold it! Will your allergies react to shortbread?

BOB: Glad you reminded me to check, but no: I’m only allergic to nuts.

All of these changes to Bob’s representation of the situation seem to be additive. The difficulty is simply stated: where do we find the elements being added? In particular, new states need probabilities and the results of new actions need utilities. The notion of awareness (cf. Fagin and Halpern 1988) suggests an answer: these elements were already present ‘in the background’, but not yet explicitly brought into consideration.

¹The idea is that information T is *irrelevant* iff all of your behavior lacking T is never a mistake in the light of T (i.e. you are not doing anything ‘wrong’ without the information T , so you don’t need it).

²The expected utility of a set of actions is the average of the expected utilities of its elements.

2. Formal system

The system we construct has two components: a BACKGROUND MODEL \mathfrak{M} and an AWARENESS STATE \mathfrak{A} which filters out certain possibilities that the agent is not explicitly considering: we write $\mathfrak{M}|\mathfrak{A}$ for such a FILTERED MODEL, where the function-restriction notation is not intended literally but rather to suggest this filtering process. From any model M (background or filtered) we can ‘read off’ a decision problem $\delta(M)$. While $\delta(\mathfrak{M})$ describes the *actual* decision problem faced by the agent, $\delta(\mathfrak{M}|\mathfrak{A})$ describes the decision problem the agent is *aware* of. Anticipating somewhat, the update with a possibility formula φ will be performed on the awareness state only: $\delta(\mathfrak{M}|\mathfrak{A})$ gives the decision problem before the update, $\mathfrak{A}[\varphi]$ is the awareness state updated with φ , so $\delta(\mathfrak{M}|\mathfrak{A}[\varphi])$ is the decision problem we get after filtering the background model through this updated awareness state.

We assume throughout finite sets Φ of primitive propositions and Γ of actions. A MODEL M is a structure $\langle \mathcal{P}, \mathcal{A}, \mathcal{W}, \mathcal{O}, P, \mathcal{U} \rangle$, where

- \mathcal{P} is a subset of Φ (primitive propositions);
- \mathcal{A} is a subset of Γ (actions);
- \mathcal{W} is a (finite) set of WORLDS;
- \mathcal{O} is a (finite) set of OUTCOMES (think: ‘future states of the world’);
- P is a PROBABILITY DISTRIBUTION on \mathcal{W} ;
- \mathcal{U} is a UTILITY FUNCTION for outcomes: $\mathcal{U}: \mathcal{O} \rightarrow \mathbb{R}$.

A world $w \in \mathcal{W}$ is a pair $\langle V_w, R_w \rangle$ where $V_w: \Phi \rightarrow \{0, 1\}$ is the VALUATION FUNCTION (the current state of the world) and $R_w: \Gamma \rightarrow \mathcal{O}$ is the RESULT FUNCTION telling the outcome of each action; an outcome $\omega \in \mathcal{O}$ is simply a valuation function $V_\omega: \Phi \rightarrow \{0, 1\}$. (The current state of the world does not necessarily define its future evolution: there might be multiple worlds with the same propositional valuation but where actions have different outcomes.) Probabilities are defined on *worlds* and thus embrace future contingencies, while utilities are given on *outcomes*. We also define $\mathcal{V}_{\mathcal{W}} \stackrel{\text{def}}{=} \{V_w ; w \in \mathcal{W}\}$ for convenience in referring only to the valuations in some set of worlds.

(C1) Representing awareness. Given a valuation V and a set $\mathcal{P} \subseteq \Phi$ of primitive propositions, we write $V^{\mathcal{P}}$ for the largest set of valuations that agree with V on all propositions in $\Phi \setminus \mathcal{P}$. If \mathcal{V} is a set of valuations and we can find some $\mathcal{P} \subseteq \Phi$ such that $\mathcal{V} = V^{\mathcal{P}}$ for some $V \in \mathcal{V}$, then we say that \mathcal{V} REPRESENTS AWARENESS of the primitive propositions \mathcal{P} and UNAWARENESS of (and implicit belief about) all others.³ A set \mathcal{W} of worlds represents awareness of \mathcal{P} iff $\mathcal{V}_{\mathcal{W}}$ does; any structure containing both worlds and propositions ‘satisfies constraint (C1)’ if the worlds represent awareness of the propositions.

³This conflation of awareness and implicit belief is not as restrictive as it might seem, since we can still represent beliefs probabilistically: an agent can ENTERTAIN a possible state of affairs (explicitly consider a world where that state obtains) while assigning it probability zero.

The background model. The background model \mathfrak{M} is a model as defined above, with $\mathcal{P}_{\mathfrak{M}} = \Phi$ and $\mathcal{A}_{\mathfrak{M}} = \Gamma$. It satisfies (C1) (i.e., $\mathcal{W}_{\mathfrak{M}}$ represents awareness of $\mathcal{P}_{\mathfrak{M}}$) and in addition we require that every possible result function occur with every possible valuation in some world. We associate with \mathfrak{M} a STEREOTYPICAL CAUSALITY FUNCTION $\mathcal{S}_{\mathfrak{M}}: \mathcal{V}_{\mathcal{W}_{\mathfrak{M}}} \rightarrow \wp(\mathcal{W}_{\mathfrak{M}})$, which gives for each valuation the worlds with that valuation whose outcomes are *subjectively stereotypical* according to the agent. These outcomes ‘spring to mind’ when the agent entertains a possibility (see the stereotypicality constraint (C2) below).⁴

The awareness state. An awareness state $\mathfrak{A} = \langle \mathcal{P}_{\mathfrak{A}}, \mathcal{A}_{\mathfrak{A}}, \mathcal{W}_{\mathfrak{A}} \rangle$ is defined with reference to a background model \mathfrak{M} :

- $\mathcal{P}_{\mathfrak{A}}$ is the set of primitive propositions being attended to, with $\mathcal{P}_{\mathfrak{A}} \subseteq \Phi$;
- $\mathcal{A}_{\mathfrak{A}}$ is the set of actions being explicitly considered, with $\mathcal{A}_{\mathfrak{A}} \subseteq \Gamma$
- $\mathcal{W}_{\mathfrak{A}}$ is the set of worlds being entertained, with $\mathcal{W}_{\mathfrak{A}} \subseteq \mathcal{W}_{\mathfrak{M}}$;

We require in addition two consistency constraints: the awareness state should satisfy (C1) (otherwise the model we read off from it will not do so), and also the following:

(C2) Stereotypicality constraint. For every world $w \in \mathcal{W}_{\mathfrak{A}}$, $\mathcal{S}_{\mathfrak{M}}(V_w) \subseteq \mathcal{W}_{\mathfrak{A}}$. That is, among the outcomes an agent entertains for any current state of affairs, she must always entertain at least the causally stereotypical ones.

The filtered model, $\mathfrak{M} \upharpoonright \mathfrak{A}$, carries over the propositions, actions and worlds from \mathfrak{A} and is defined as follows: $\mathfrak{M} \upharpoonright \mathfrak{A} \stackrel{\text{def}}{=} \langle \mathcal{P}_{\mathfrak{A}}, \mathcal{A}_{\mathfrak{A}}, \mathcal{W}_{\mathfrak{A}}, \mathcal{O}', P', U' \rangle$, where⁵

$$\begin{aligned} \mathcal{O}' &\stackrel{\text{def}}{=} \bigcup \{R_w[\mathcal{A}_{\mathfrak{A}}] ; w \in \mathcal{W}_{\mathfrak{A}}\}, \\ P'(w) &\stackrel{\text{def}}{=} P_{\mathfrak{M}}(w | \mathcal{W}_{\mathfrak{A}}), \\ U' &\stackrel{\text{def}}{=} \mathcal{U}_{\mathfrak{M}} \upharpoonright \mathcal{O}_{\mathfrak{A}}. \end{aligned}$$

Reading off a decision problem. When reading off $\delta(M)$ from a model M , we cannot always take worlds in \mathcal{W}_M as states. Worlds that only differ in their outcomes for actions that are *not being considered* (if the model is filtered) should be combined into the same state. We do this via a partition on \mathcal{W}_M , and the complete decision problem $\delta(M) = \langle S, P, A, U \rangle$ is given by:

$$\begin{aligned} S &\stackrel{\text{def}}{=} \{ \{w' \in \mathcal{W}_M ; V_w = V_{w'} \text{ and } R_w \upharpoonright \mathcal{A}_M = R_{w'} \upharpoonright \mathcal{A}_M\} ; w \in \mathcal{W}_M \}; \\ P(s) &\stackrel{\text{def}}{=} P_M(s) = \sum_{w \in s} P_M(w); \\ A &\stackrel{\text{def}}{=} \mathcal{A}_M; \\ U([w]_{\equiv_M}, a) &\stackrel{\text{def}}{=} \mathcal{U}_M(R_w(a)). \end{aligned}$$

⁴Inasmuch as the stereotypical causality function represents the agent’s expectations, we expect it to be closely related to her probability distribution. The details of the relation are somewhat unclear, and seem not to be important for our purposes.

⁵Here $R_w[\mathcal{A}_{\mathfrak{A}}]$ and $\mathcal{U}_{\mathfrak{M}} \upharpoonright \mathcal{O}_{\mathfrak{A}}$ refer to ordinary function image and restriction, not update and filtering.

Now that we can read off a decision problem from a filtered model, all that remains is to define the three kinds of awareness updates exemplified by (1)–(3).⁶

Updating with $\diamond p$. In becoming aware of p , the agent realizes “ p might be differently valued to what I have been assuming”. So she adds worlds with valuations the same as those she already entertains, except for the value of p . This leaves unspecified the outcomes: $\mathcal{S}_{\mathfrak{M}}$ picks out only the *stereotypical* worlds.⁷ (See Figure 1(b).)

$$\langle \mathcal{P}, \mathcal{A}, \mathcal{W} \rangle [\diamond p] = \langle \mathcal{P} \cup \{p\}, \mathcal{A}, \mathcal{W} \cup \mathcal{W}' \rangle$$

where $\mathcal{W}' = \bigcup \{ \mathcal{S}_{\mathfrak{M}}[V_w^{\{p\}}] ; w \in \mathcal{W} \}$.

This update preserves (C1), and the new awareness state will satisfy (C2). Moreover, updating more than once with $\diamond p$ will have no additional effect.

Updating with $\diamond a$. $\langle \mathcal{P}, \mathcal{A}, \mathcal{W} \rangle [\diamond a] = \langle \mathcal{P}, \mathcal{A} \cup \{a\}, \mathcal{W} \rangle$. The worlds already come equipped with their (stereotypical) a -outcomes (see Figure 1(c)), so (C1) and (C2) are trivially preserved, and applying the update repeatedly has no additional effect.

Updating with $\diamond(a; p)$. The possibility that a might lead to p introduces *non-stereotypical* worlds: it might be that a leads to p for very strange reasons. The update is explicitly concerned with the possibility that p should be *brought about by* a , not simply hold in the current state of the world.

$$\langle \mathcal{P}, \mathcal{A}, \mathcal{W} \rangle [\diamond(a; p)] = \langle \mathcal{P}, \mathcal{A}, \mathcal{W} \cup \mathcal{W}' \rangle$$

where $\mathcal{W}' = \{ \langle V_w, R_w^{(a;p)} \rangle ; w \in \mathcal{W} \}$

and $R_w^{(a;p)}$ is the same outcome function as R_w except that at the outcome of a the valuation of p is inverted. This update again preserves (C1) and (C2), and will not change the awareness state the second time if performed twice in succession.⁸

3. Relevance, awareness and pragmatic inference

Given these awareness updates, we can take over the notion of relevance that we introduced in Section 1 without substantial amendment. We only have to define the expected utility after becoming aware of contingency x : $\text{EU}_{\delta(\mathfrak{M} \uparrow \mathfrak{A})}(a, \diamond x) =$

⁶We define awareness updates only for primitive propositions and actions. That is, we do not identify any natural-language modality with our \diamond operator — after all, simply mentioning a proposition should also induce awareness of it. Some modals, however, may be used specifically to induce awareness updates.

⁷It may help to gloss this in procedural terms. First we add p to the propositions the agent is aware of. Next, for each world w in \mathcal{W} , take the valuations that agree with V_w except for possibly at p (that is, trivially V itself and one other), collect their stereotypical worlds (according to $\mathcal{S}_{\mathfrak{M}}$) and add them all.

⁸The non-stereotypicality of these worlds means that the same update *may* be performed informatively more than once, if new worlds are added in the meantime.

$EU_{\delta(\mathfrak{B} \uparrow \mathfrak{A}[\diamond x])}(a)$. This measure of RELEVANCE OF AWARENESS may take a pivotal role in the pragmatic reasoning triggered when agents are purposefully *made aware* of contingencies in dialog.⁹

For instance, Bob in example (1) may reason as follows: Alice is trying only to make me aware of a possibility; the awareness update had better be relevant; this is so only if it changes my course of action, so it should convince me not to bake a cake.¹⁰ Such reasoning has no place yet in our model, since we deal only with the single-agent perspective. An obvious extension is to include explicit uncertainty about (higher-order beliefs about) the background model. That is, from assuming that Alice believes her information is relevant, Bob can conclude that she also believes sufficiently strongly that the eggs are off. If Bob considers Alice expert (well-informed; competent) then his conclusions about what she believes influence his own beliefs. Similar pragmatic reasoning lets Bob conclude in (2) that baking shortbread does not require eggs: the uncertainty and expertise relates only to the outcomes of actions rather than to the probabilities of worlds.

Example (3) involves a different kind of uncertainty, and here separating Alice's belief that her move is relevant from her expertise in the matter is crucial. The awareness update is in fact irrelevant, since Bob's allergies (as he knows) will not be triggered by anything he bakes.¹¹ Alice is nonetheless motivated by relevance: it is her uncertainty about Bob's awareness that leads her to mention the possibility.

Reasoning about beliefs about awareness requires fully-fledged awareness models in the style of Fagin and Halpern 1988. Our system focusses on dynamic awareness updates; explicit modeling of the entire relevance-based pragmatic reasoning process in a single framework seems a most promising direction for further research.

Bibliography

- Fagin, R. and Halpern, J. Y.: 1988, Belief, awareness and limited reasoning, *Artificial Intelligence* 34, 39–76
- Modica, S. and Rustichini, A.: 1994, Awareness and partitioned information structures, *Theory and Decision* 37, 107–124
- Ozbay, E. Y.: 2007, Unawareness and strategic announcements in games with uncertainty, in D. Samet (ed.), *Proceedings of TARK XI*, pp 231–238
- Raiffa, H. and Schlaifer, R.: 1961, *Applied Statistical Decision Theory*, MIT Press
- van Rooij, R.: 2003, Questioning to resolve decision problems, *Linguistics and Philosophy* 29, 727–763
- van Rooij, R.: 2004, Utility, informativity and protocols, *Journal of Philosophical Logic* 33(4), 389–419

⁹Just as with an eliminative update, awareness updates are relevant iff some action which maximized expected utility before the update no longer does so after. In particular, since updating with $\diamond a$ doesn't change existing probabilities or utilities, $\diamond a$ is relevant iff a becomes the unique best action after update.

¹⁰The "reasoning refinement" of Ozbay 2007 can be recast in similar terms as a relevance-based inference.

¹¹That is, the update merely transforms his implicit belief into *the same* explicit belief.

LOW RISK QUANTIFIERS: A GAME-THEORETICAL APPROXIMATION TO THE DP-RESTRICTION ON IV2-PRESENTATIONALS

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Low risk quantifiers (LRQs) are quantifiers for which an opponent has no superior falsification strategy in a GTS-style verification game. LRQs are shown to closely approximate the class of DP-quantifiers allowed in a presentational construction of German involving prosodically and information-structurally integrated V2 clauses. The notion of "risk" will be linked to a speaker strategy in competitive argumentation.

1. The DP-Restriction on IV2-Presentationals

German IV2-Presentationals (IV2Ps) have been discussed by Gärtner (2001; 2002), and Endriss & Gärtner (2005). The hallmark of IV2Ps, illustrated in (1a), is a Verb Second (V2) clause that is prosodically and information-structurally integrated into the preceding (matrix) clause and contains a fronted weak demonstrative. These characteristics make IV2Ps a hybrid of syntactically integrated relative clauses, (1b), which are verb final in German, and sequences of non-integrated main clauses, (1c).

- (1) a. *Henk kennt viele Linguisten, (/) die arbeiten an Spieltheorie*
"Henk knows many linguists who work on game theory"
b. *Henk kennt viele Linguisten, (/) die an Spieltheorie arbeiten*
c. *Henk kennt viele Linguisten. (\) Die arbeiten an Spieltheorie*

IV2Ps, (1a), and restrictive relatives, (1b), differ from main clause sequences, (1c), in that the former two restrict the range of *viele* ("many") to counting linguists working on game theory, while (1c) expresses the claim that Henk is acquainted with many linguists, all of whom work on game theory.

Importantly, the class of DPs that can be "IV2P antecedents," i.e. occur in the first clause as antecedent of the demonstrative or as modifyee of an IV2P, is restricted. Thus, note the impossibility of negative and universal quantifiers in (2a), which IV2Ps share with main clause sequences, (2c), but not with restrictive relatives, (2b).

- (2) a. * *Henk kennt keinen/jeden Linguisten, (/) der arbeitet an Spieltheorie*
 "Henk knows no/every linguist who works on game theory"
 b. *Henk kennt keinen/jeden Linguisten, (/) der an Spieltheorie arbeitet*
 c. *Henk kennt keinen/jeden Linguisten. (\) * Der arbeitet an Spieltheorie*
- (3) provides the core list of determiners heading IV2P antecedents, (3a), and determiners incompatible with IV2P, (3b).
- (3) a. *ein* ("a"/"one"), *zwei/drei/.../n* ("two"/"three"/.../n), *einige* ("some"),
mehrere ("several"), *viele* ("many"), *mindestens n* ("at least n"),
genau n ("exactly n")
 b. *der* ("the"), *jeder* ("every"), *alle* ("all"), *die meisten* ("most"), *kein* ("no"),
wenige ("few"), *höchstens n* ("at most n")

2. Low Risk Quantifiers

The main point of this paper is the claim that game-theoretical semantics (GTS) can be adapted in such a way that a very close approximation to the quantifier classification in (3) results. For this purpose, let us look at utterances u of minimal sentences $[\alpha \beta]$ where α is a DP-quantifier and β an operator-free one-place predicate. For any such utterance u take the speaker, S, to be the "proponent" (or "verifier") and the hearer, H, to be the "opponent" (or "falsifier") in the verification game for u . Then,

- (4) A DP-quantifier α is a *low risk quantifier* if there is no superior falsification strategy for H in the verification game for u containing α

If a DP-quantifier is not a low risk quantifier (LRQ), it is a *high risk quantifier* (HRQ). Superiority of strategies will be discussed in section 3. (5) and (6) provide strategies for the most straightforward HRQs and LRQs, respectively.

- (5) High risk quantifiers (– IV2P antecedents)
- | | |
|-------------------------------|---|
| a. <i>kein</i> (P)(Q): | H presents $a \in P \cap Q$ |
| b. <i>jeder</i> (P)(Q): | H presents $a \in P - Q$ |
| c. <i>der</i> (P)(Q): | H presents $a \in P$ for $a \neq b$
after S has presented $b \in P \cap Q$ |
| d. <i>höchstens_n</i> (P)(Q): | H presents $R' \subseteq P \cap Q$
for $R' \cap R = \emptyset$ and $ R' + R > n$
after S has presented $R \subseteq P \cap Q$ for $ R \leq n$ |

- (6) Low risk quantifiers (+ IV2P antecedents)
- a. *ein*(P)(Q): S presents $a \in P \cap Q$
 - b. *einige*(P)(Q): S presents $R \subseteq P \cap Q$ for $|R| \geq 2$
 - c. *n*(P)(Q): S presents $R \subseteq P \cap Q$ for $|R| = n$
 - d. *mindestens_n*(P)(Q): S presents $R \subseteq P \cap Q$ for $|R| \geq n$

This already covers the majority of non IV2P antecedents, (3b), and IV2P antecedents, (3a), respectively.¹ The rules just given are closely related to Hintikka's original game rules for GTS (cf. Saarinen 1979) and their extensions to generalized quantifiers (Clark 2007; Pietarinen 2007).

The treatment of *die meisten* ("most") in (7) follows the automata-theoretic characterization of *most* by van Benthem (1987) in providing a falsification strategy for H. This makes *die meisten* an HRQ in accordance with its status as non IV2P antecedent.

- (7) *die_meisten*(P)(Q): For each (new) $a \in P \cap Q$ presented by S,
H presents a (new) $b \in P - Q$

For the treatment of *viele* ("many") as an LRQ, I suggest strategy (8).

- (8) *viele*(P)(Q): S presents $R \subseteq P \cap Q$ for $|R| > \mu$

μ is a placeholder for the various thresholds involved in the various construals of *many*. The important point is that once S makes a choice of a set of individuals, it is quite unclear how H could falsify S's claim by counterexamples, given the general vagueness and context dependence of *many*. In order to capture the fact that *wenige* ("few") is not an IV2P antecedent, I suggest that its high risk nature lies in the possibility for H to apply the strategy open to S in the case of *many*.²

- (9) *wenige*(P)(Q): H presents $R \subseteq P \cap Q$ for $|R| > \mu$

3. Previous Accounts

We have seen that – with the exception of *genau n* ("exactly n ")³ – the distinction

¹ Strategies for *alle* and *mehrere* match the ones for *jeder* and *einige*, and are thus omitted.

² Alternatively one could assume that "H presents $R' \subseteq P \cap Q$ after S has presented $R \subseteq P \cap Q$ for $|R| \leq \varphi$, such that $R' \cap R = \emptyset$, and $|R| + |R'| > \varphi$ " (φ = the threshold placeholder for *few*).

³ The rule "H presents $a \in P \cap Q$ for $a \notin R$ after S has presented $R \subseteq P \cap Q$ for $|R| = n$ " makes it an HRQ.

between LRQs and HRQs adequately captures the classes of $+/-$ IV2P antecedents. Apart from being an intrinsically interesting exercise in quantifier classification,⁴ the LRQ-approach constitutes an advance over previous accounts of the DP-restriction on IV2Ps. Its first merit is uniformity. Each previous account had to rely on (at least) two distinct principles to achieve a satisfactory classification. Gärtner (2001) requires the weak demonstratives in IV2Ps to pick up an accessible discourse referent in the sense of Kamp & Reyle (1993). In order to rule out definite antecedents, an incompatibility of V2-clauses with the definite's presupposition had to be added. Endriss & Gärtner (2005) require the DP antecedents (i) to be "topical" in the sense of Endriss (2006), based on the notion of minimal witness-set (cf. Szabolcsi 1997)⁵, and (ii) to allow for information-structural assignment of quantificational restrictor and nucleus in the sense of Herburger (2000). (i) filters out weak determiners like *kein* ("no"), *höchstens n* ("at most n"), and *wenige* ("few") while (ii) rules out universal *jeder* ("every"), definite *der* ("the") and *die meisten* ("most"). The second merit is empirical coverage. While the approach by Gärtner (2001) is not worked out enough to allow broader comparison⁶, the more explicit theory of Endriss & Gärtner (2005) misclassifies both *mindestens n* ("at least n") and *genau n* ("exactly n") [!] as non IV2P antecedents.⁷

If we extend empirical coverage further, the LRQ-approach yields a mixed picture. First, to the extent that rules (8)/(9) can be upheld for *many/few*, a variant of them can be used to characterize *fast alle* ("almost all") and *fast keine* ("almost no") as HRQs. H would have to present $R \subseteq P-Q$ and $R \subseteq P \cap Q$ for $|R| > \mu$, respectively. And in fact, neither *fast alle* nor *fast keine* is an IV2P antecedent.

On the other hand, a treatment of *nicht alle/nicht jeder* ("not all"/"not every") as HRQ demands the additional assumption that for a quantifier α to count as LRQ, S must not be

⁴ In terms of Barwise & Cooper (1981:219) we are dealing with [+weak]/[$\neg\downarrow$] or [+weak]/[\neg -antipersistent].

⁵ The "topic condition" itself contains two clauses, requiring that a generalized quantifier be replaceable (modulo some type-shift) by a minimal witness set (i) *salva veritate* and (ii) without loss of anaphoric possibilities (Endriss 2006:253).

⁶ In this system, set referents introduced by abstraction and summation and picked up by plural anaphors (Kamp and Reyle 1993: chapter 4) have to be ruled out as accessible in IV2Ps in order to prevent serious overgeneration. Also, an account for modal subordination failure is required (Gärtner 2002). The integrated nature of IV2Ps seems to require anaphora resolution to precede operations like abstraction and accommodation (cf. Kamp and Reyle 1993: section 4.4.4).

⁷ Endriss (2006) hints at the possibility of accounting for the behavior of *mindestens n* by assuming that *mindestens* is not part of the quantifier here but functions as a focus operator. However, it is unclear why the same reanalysis couldn't apply to *höchstens n* too, which would thereby be ruled in incorrectly.

forced to assume the role of falsifier during the verification game for u of a minimal sentence $[\alpha \beta]$ (as characterized above). Recall that the GTS game rule for *not* reverses the roles of verifier and falsifier for the ensuing subgames (Pietarinen 2007:184).

4. GTS and Risk

The LRQ-approach differs from standard GTS in the following respects. First, the GTS-rule for *most* – adapted in (10) – would incorrectly make *die_meisten* an LRQ.

$$(10) \quad \text{most}(P)(Q): \quad \text{S presents } R \subseteq P \cap Q \text{ for } |R| > P/2$$

However, the existence of (10) does not invalidate the classification of *most* as an HRQ, given that (10) co-exists with (7). This is where the notion of superiority in the definition of LRQ comes in. Verification strategy (10) is inferior to falsification strategy (7). This subtle point can be brought out by (11) as another viable alternative to (7).

$$(11) \quad \text{most}(P)(Q): \quad \text{H presents } R \subseteq P - Q \text{ for } |R| \geq P/2$$

With reference to van Benthem (1986:208) one can define superiority in terms of ease of "refutation" vs. ease of "confirmation" wrt. numbers of individuals to be checked.⁸

As a second point of divergence, note the appeal to a "falsification strategy" in (4), as opposed to the standard "winning strategy" concept of GTS. The LRQ-approach aims at defining a particular class of quantifiers. This is independent of the standard GTS objective of giving truth conditions for languages with quantifiers, for which winning strategies (and reference to models) are crucial.

Finally, use of the notion "risk" is a deliberate attempt at bridging the gap between GTS and other branches of game theory influential in pragmatics (cf. Clark 2007; Jäger 2007). I speculate that risk is a factor in competitive argumentation games too. The intuition to be worked out is that the proponent of an IV2-Presentational is trying to secure the second move – use of the integrated V2 clause. An LRQ is the right choice then, because it will go unchallenged. Use of an HRQ, on the other hand, obliges the opponent to challenge S, who therefore risks not to be able to make the second move.

4. Conclusion

It has been shown that low risk quantifiers (LRQs), i.e. quantifiers for which an

⁸ Apart from issues concerning infinite domains, this intuition also motivates GTS-rules like (5b) for *every* instead of something like "S presents $R \subseteq P \cap Q$ for $|R| = |P|$ ".

opponent has no superior falsification strategy in a GTS-style verification game, closely approximate the class of DP-quantifiers allowed in German IV2-Presentationals. The notion of risk has been linked to a speaker strategy in competitive argumentation.

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Bibliography

- Barwise, J., and Cooper, R.: 1981, Generalized Quantifiers and Natural Language, *Linguistics and Philosophy* 4, pp. 159-219
- Clark, R.: 2007, Games, Quantifiers, and Pronouns, in A.-V. Pietarinen (ed.), pp. 207-227
- Endriss, C.: 2006. *Quantificational Topics*, Ph.D. thesis, University of Potsdam
- Endriss, C., and Gärtner, H.-M.: 2005, Relativische Verbzweitsätze und Definitheit, in F.-J. d'Avis (ed.), *Deutsche Syntax: Empirie und Theorie*, pp. 195-220, Acta Universitatis Gothoburgensis, Göteborg
- Gärtner, H.-M.: 2001, Are There V2 Relative Clauses in German?, *Journal of Comparative Germanic Linguistics* 3, pp. 97-141
- .: 2002, On the Force of V2-Declaratives, *Theoretical Linguistics* 28, pp. 33-42
- Herburger, E.: 2000, *What Counts*. MIT Press, Cambridge MA
- Jäger, G.: 2007, Game Dynamics Connects Semantics and Pragmatics, in A.-V. Pietarinen (ed.), pp. 103-117
- Kamp, H., and Reyle, U.: 1993, *From Discourse to Logic*. Kluwer, Dordrecht
- Pietarinen, A.-V.: 2007, Semantic Games and Generalized Quantifiers, in A.-V. Pietarinen (ed.), pp. 175-198
- (ed.): 2007, *Game Theory and Linguistic Meaning*, Elsevier, Amsterdam
- Saarinen, E. (ed.): 1979, *Game-Theoretical Semantics*. Reidel, Dordrecht
- Szabolcsi, A.: 1997, Strategies for Scope Taking, in A. Szabolcsi (ed.), *Ways of Scope Taking*, pp. 109-154, Kluwer, Dordrecht
- van Benthem, J.: 1986, The Logic of Semantics, in *Essays in Logical Semantics*, pp. 198-214, Reidel, Dordrecht
- .: 1987.: Towards a Computational Semantics, in P. Gärdenfors (ed.), *Generalized Quantifiers*, pp. 31-71, Reidel, Dordrecht

SPECIFICITY AND IMPLICATURES¹

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In this paper we argue for a unified treatment of the effects of specificity in the Russian pronominal system and in the case of differential object marking in Romanian. Based on a model of semantic underspecification and pragmatic reasoning, we claim that different readings of indefinites can be traced back to the different binding properties of an implicit argument (the referential anchor) which we postulate for specificity markers, and additional pragmatic restrictions on binding arising from conventional implicatures.

1. Introduction

It is well known in the literature that indefinites tend to be ambiguous between so-called specific and non-specific readings. Under the label of “specificity” a whole number of different contrasts have been discussed, including epistemic, scopal and relative specificity (cf. Farkas 1995, von Heusinger 2007). While in many languages there seem to be unmarked indefinites which tend to reflect the whole amount of specificity-related ambiguities, languages may also overtly mark different types of specificity by different means such as indefinite pronouns (German, Russian, etc.) or differential object marking (Turkish, Romanian, etc.). In this paper, we claim that much of the difficulty in giving precise semantic values for markers of particular types of specificity can be traced back to semantic underspecification relating to pragmatic enrichment and inference. In particular we will present a semantic model for indefinites based on the notion of referential anchoring and show how pragmatic interactions account for scope and epistemic effects in the Russian pronominal system and in the development of differential object marking and clitic doubling in Romanian.

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2. Effects of Specificity in Russian and Romanian

In the following, we will present the key data of our inquiry. In the first step, we show one example for the phenomenon investigated; and in the second step, we give an overview of the readings arising in the interaction with intensional and extensional operators, on the one hand, and the epistemic status of the indefinite with regard to the identifiability of its referent by the speaker, on the other hand.

2.1. Russian Data

Indefinite noun phrases in Russian can be accompanied by indefinite pronouns such as *kakoj-to/koe-kakoj/nibud'*, as shown in (1), cf. Dahl (1970).

- (1) *Igor' hochet zhenit'sja na kakoj-to/koe-kakoj/kto-nibud' studentke.*
 Igor wants marry wh-to/ koe-wh/wh-nibud' student
 'Igor wants to marry some student.'

These pronouns serve as indefinite determiners and disambiguate different readings with respect to the features summarized in Table 1:

Table 1: Available readings for indefinites marked with indef. pronouns in Russian

Interaction with...	<i>koe-wh</i>	<i>wh-to</i>	<i>wh-nibud'</i>
extensional quantifiers	wide scope	wide scope preferred	narrow scope
intensional operators	wide scope	wide scope	narrow scope
Identifiability of the referent by the speaker	yes	no	no

While *koe* and *to* induce wide scope readings in most contexts, wide scope readings are excluded for indefinites with *nibud'*. Narrow scope readings in which the referent of the indefinite strictly depends on some referents in the sentence as in (2) are not available for *nibud'* but are acceptable for *to* under narrow scope.

- (2) *Kazhdyj muzh zabyl kakuju*-nibud'/-to datu, a imenno den' rozhdenija svoej zheny*
 Each man forgot wh-nibud'/to date namely birthday of his wife
 'Each husband has forgotten a certain date – his wife's birthday.'

2.2. Romanian Data

Romanian exhibits differential object marking with the case marker *pe*, depending on referentiality and animacy, such that some animate indefinite direct objects may be marked by *pe*. If a direct object is *pe*-marked, usually clitic doubling also occurs. It is, however, possible for *pe*-marked indefinite direct objects to occur without clitic

doubling as well. We distinguish the following structures:

- (3) *Ion a văzut -o pe o secretară.* **+CL +PE**
 John has seen CL PE a secretary
 ‚John saw a specific secretary’
- (4) *Ion a văzut pe o secretară.* **-CL +PE**
 John has seen PE a secretary
 ‚John saw a specific secretary’
- (5) *Ion a văzut o secretară.* **-CL -PE**
 John has seen a secretary
 ‚John saw a secretary’

While in present-day Romanian a semantic contrast between the type +CL +PE and type -CL +PE is not very clear any more, in the first half of the 20th century, such a contrast is observable in the statistic distribution of these types in contexts involving different kinds of specificity, cf. von Heusinger & Onea (to appear). The semantic effects observed are listed in Table 2:

Table 2: Readings for indefinite direct objects in Romanian (first half 20th century)

Interaction with	+CL +PE	-CL +PE	-CL -PE
extensional quantifier	wide scope	wide scope	preferred narrow scope
intensional operators	wide scope	wide scope	wide or narrow scope
Identifiability of the referent by the speaker	yes	not preferred	no

3. Semantic Analysis

In order to account for the data we will present a model of semantic underspecification for indefinite NPs. Hereby we will use the notion of referential anchoring (von Heusinger 2007) which we will model as parameterized choice functions (Kratzer 1998) involving an implicit *e*-type argument.

3.1. Referential Anchoring

In the discussion about indefinites, examples in which narrow scope indefinites strictly co-vary with the quantifier phrase, as shown in the English translation of (2) where the dates are strictly dependent on the individual husbands, have been widely discussed. Based on Kratzer (1998), we assume that this dependency can best be accounted for as shown in (6):

(6) $\forall x(\text{husband}(x) \rightarrow \text{had forgotten}(x, f_x(\text{date})))$

In the formalism, f is a free function variable, representing a contextually salient partial function from individuals into choice functions. The subscripted x is an implicit argument of the indefinite and is of type e . f_x is a partial choice function that takes some set as an argument and returns an individual member of this set. In our example, the implicit argument is bound by the universal quantifier and therefore f_x maps the set of dates to particular dates depending on each husband. In other words, the dates are referentially anchored to each husband. Note that if the implicit argument was not anchored to husbands but, say, to the speaker, a wide scope reading would also be possible.

We assume that argumental indefinites can generally be modelled as parameterized choice functions in this way; indefinites always introduce discourse referents referentially anchored to some (possibly non-established) individual. The major advantage of this view is that the referential anchor, modelled as an implicit argument, allows for interaction both with quantifier expressions and discourse participants.

3.2. Binding Constraints on the Implicit Argument

The basic idea of this section is that indefinites are underspecified with regard to effects of specificity, but lexical or functional markers may fix different specific readings by imposing constraints on the binding of the implicit argument. Accordingly, the contrasts from table 1 and 2 can be captured by constraints on the implicit argument. For the sake of simplicity we assume that in Russian *koe/to/nibud'* take $\langle e, t \rangle$ type arguments and ignore the meaning of the *wh*-pronoun. For Romanian we assume that *pe* is an overt case marker licensed by specific readings of indefinites. Hence, for *pe* only licensing conditions apply instead of lexical entries:

Table 3: *Lexical entries / licensing conditions for specificity markers*

	<i>koe-</i>	<i>-to</i>	<i>-nibud'</i>	<i>pe</i>	CL
lexical entry	$\lambda P f_x(P)$ $x=\text{speaker}$	$\lambda P f_x(P)$	$\lambda P \exists x f_x(P)$	licensed if the referential anchor of the indefinite is bound as a pronoun	marks familiarity to the speaker
scope	wide	–	narrow	wide	–

As shown in Table 3, the only difference between the lexical entries of specificity markers concerns the binding properties of the implicit argument. While for Russian *to*, no constraints are postulated, and hence any scope properties are allowed, we assume that the implicit argument of *koe-* must be bound by the speaker yielding necessary wide scope and identifiability by the speaker. The implicit argument of the non-specificity marker *nibud'* is existentially closed at the lexical level yielding narrow

scope. The Romanian differential object marker *pe* can only mark indefinites which have referential anchors bound outside their clause like pronouns bound according to Principle B of Binding-Theory (Chomsky 1981) giving rise to wide scope (cf. Table 2).

4. Pragmatic Enrichment

As one can observe, not all aspects of Table 1 and 2 have been accounted for in the semantic analysis. Indefinites with *to* exhibit a strong preference for wide scope over extensional quantifiers and always take wide scope over intensional operators, but according to Table 3 their scope properties are lexically underspecified. We will account for these aspects pragmatically by means of conventionalised implicatures.

As shown in von Heusinger & Onea (to appear), in Romanian, clitic doubling and differential object marking interact giving birth to pragmatic effects. The key argument is as follows: It is hypothesised that clitic pronouns signal discourse familiarity of their referents. Since indefinites are discourse new, they cannot be discourse familiar. Therefore the semantic import of clitic doubling gets re-interpreted as signalling familiarity to the speaker. *Pe*, on the other hand, marks indefinite direct objects only if their implicit argument gets bound outside the clause. If a clitic doubling co-occurs with *pe*-marking, clitic doubling marks familiarity to the speaker and hence turns the speaker into a very salient binder for the implicit argument of the *pe*-marked indefinite. Thus, the speaker becomes the referential anchor of the indefinite. If, however, *pe*-marking is used without clitic doubling, pragmatic reasoning yields that the indefinite is not referentially anchored to the speaker, since otherwise clitic doubling could have been used. Some preference of unmarked indefinite direct objects (-CL -PE) for narrow scope under extensional operators can be derived.

The same pattern can be applied to the case of *to* in Russian. For *to* two pragmatic contrasts apply. On the one hand, *to* contrasts with *koe*. Both can occur in any logical environment and since *koe* lexically signals that the speaker is the referential anchor, we consider *koe* to be more informative. Therefore, if *to* is used, the hearer can infer that the conditions for *koe*, namely speaker anchoring, are not met. From here we derive the rather strange reading of *to* as marking non-identifiability of the referent by the speaker. This conventional implicature can be cancelled or reinforced as in (7).

- (7) *Igor videl kakuju-to zhenshchinu* ^{ok} *Ja dejstvitel'no ne znaju kto eto byl.*
 Igor saw wh-to woman I really don't know who it was.
 'Igor saw some woman. I really don't know who it was.'

On the other hand, *to* contrasts with *nibud'*. Again, *nibud'* has restrictions on the implicit argument, existentially binding it at the lexical level, which makes it more infor-

mative. *To* has no such restrictions. Pragmatic reasoning now applies in different ways for intensional and extensional contexts: in intensional contexts, only wide and narrow scope come into consideration. *Nibud'* signals narrow scope and therefore the implicature arises that *to* signals wide scope. In extensional contexts, on the other hand, an additional reading in which the referent of the indefinite co-varies with some other referent as shown in (2) must be considered. Since in this case wide scope is not the only alternative to the semantics of *nibud'*, the implicature arises that the implicit argument of *to* is not narrow scoped, i.e. it is either bound by the extensional quantifier or out-scopes it. The latter is of course a more typical possibility.

5. Conclusion

In this paper, we have argued for an underspecified uniform semantics for indefinites involving an implicit argument and choice functions. The implicit argument interacts with quantifiers and the discourse context fixing an appropriate referential anchor for the indefinite. We further argued that lexical and functional markers of different specificity types impose restrictions on the binding of the implicit argument. Using these assumptions we have accounted for a range of scope and epistemic properties of indefinites in Russian and Romanian. The remaining properties of specificity markers in Romanian and Russian have been derived by pragmatic reasoning arising from contrasts to other available markers.

Bibliography

- Chomsky, N.: 1981, *Lectures on Government and Binding*. Dordrecht: Foris Publications.
- Dahl, Ö.: 1970, Some Notes on Indefinites, in: *Language*, 46, 33-41.
- Farkas, D.: 1995, Specificity and Scope, in: L. Nash & G. Tsoulas (eds.), *Actes du Premier Colloque Langues & Grammaire*, pp. 119–137, Paris.
- Kratzer, A.: 1998, Scope or Pseudoscope? Are there Wide-Scope Indefinites, in S. Rothstein (ed.), *Events and Grammar*, pp. 163-196 Kluwer, Dordrecht.
- von Heusinger, K. : 2007, Referentially anchored indefinite NPs, in: I. Comorovski & K. von Heusinger (eds.), *Existence: Syntax and Semantics*, pp. 273-292, Dordrecht, Springer.
- von Heusinger, K. & Onea, E.: to appear, Triggering and blocking effects in the diachronic development of DOM in Romanian. To appear in *Probus*.

HOW TO UNIFY RESTRICTIVE AND CONDITIONAL *IF*-CLAUSES

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This paper compares two unifying analyses of restrictive and conditional *if*-clauses. The first, going back to Lewis and Kratzer, denies that *if* has any meaning, and attributes seemingly conditional uses to covert operators. The second analysis is due to Belnap and assigns a partial semantics to conditionals. On this account, the difference between restrictive and conditional *if*-clauses reduces to a mundane scope ambiguity. I will present three reasons to prefer Belnap's analysis.¹

1. Restrictive and conditional *if*-clauses

Pre-theoretically, there appear to be two kinds of *if*-clauses. The first kind of *if*-clause functions as a mere domain restrictor. Take (1) by von Fintel 1998:

- (1) Few people like New York if they didn't grow up there.
≈ Few people that didn't grow up in New York like it there.

It is natural to interpret the quantifier as ranging over individuals which satisfy the *if*-clause. Apart from this, the *if*-clause doesn't seem to make any contribution. Other conditionals, however, do seem to contribute a genuine conditional meaning. An example, taken from von Fintel and Iatridou 2002, is:²

- (2) Many of the students will succeed if they work hard.
≠ Many of the students who work hard succeed.

Sentence (2) isn't equivalent to its relative clause variant, i.e. quantification doesn't range over students who work hard. Rather, the sentence seems to ascribe many of the students a conditional property: $\lambda x.(x \text{ will succeed if } x \text{ works hard})$.

The present paper asks how these two kinds of *if*-clauses can best be unified. In the next section, we will look at the theory which is currently most popular.

¹A third Stalnakerian analysis proposed by von Fintel and Iatridou 2002, will, for reasons of space, be left out of the discussion. See Huitink 2007 for a critical discussion.

²The same holds for ordinary indicatives like 'If Oswald didn't shoot Kennedy, someone else did', but we focus on more difficult conditionals that, superficially, occur in the scope of determiner quantifiers.

2. The determiner-restrictor theory

Lewis 1975 observed that some *if*-clauses function as domain restriction devices. Since then, many linguists have come to believe that this is true of *if*-clauses *in general*, including conditional ones as in (2) that appear to stand on their own. For example, Kratzer 1991, 656 writes:

The history of the conditional is the story of a syntactic mistake. There is no two-place *if ... then* connective in the logical forms of natural languages. *If*-clauses are devices for restricting the domains of various operators. Whenever there is no explicit operator, we have to posit one.

That is, *if* has no meaning, but marks an additional restriction on the domain of some higher quantifier. Accordingly, (3) receives the following logical form, in which *if*'s complement is part of the restrictor, while the main clause forms the nuclear scope:

- (3) Few people like New York if they didn't grow up there.
 (few x : x is a human \wedge x didn't grow up in NY)(x likes it there)

This is true in a world w iff few values for x that satisfy the restrictive clause in w also satisfy the scope in w , i.e. iff few people that didn't grow up in New York like it there. Note that there is nothing in the representation that corresponds to *if*.

Given that *if* is semantically empty, how do we deal with sentences like (2) where the item seems to contribute a conditional meaning? As is clear from Kratzer's quote, whenever *if* appears to have meaning, this must be due to a covert operator, the domain of which is restricted by the *if*-clause. The covert operator is often an epistemic necessity modal. This leads to the following analysis:

- (4) Many students will succeed if they work hard.
 (many x : x is a student)((must: x works hard)(x succeeds))

This is true in a world w iff for many students x it holds that x succeeds in those accessible possible worlds in which x works hard, i.e. iff for many students the fact that he/she works hard licenses the conclusion that he/she will succeed.

3. Belnap's alternative

Many people seem to think that the only way to account for restrictive *if*-clauses is to allow that *if* is (at least in some cases) semantically empty.³ But there is another way. Belnap 1970 proposed that a conditional $\phi \rightarrow \psi$ has the same truth value as ψ if ϕ is true, and lacks truth value otherwise:

- (5) $[[\phi \rightarrow \psi]]^w = [[\psi]]^w$ if $[[\phi]]^w = 1$; otherwise $[[\phi \rightarrow \psi]]^w$ is undefined.

³A notable exception is Lewis himself, who was aware of Belnap's alternative, but dismissed it; see Lewis 1975, 11, fn 1. I aim to show that Lewis was too dismissive.

In a system like Belnap's, it seems natural to let quantifiers ignore individuals for which their scope is not defined. To see this, consider:

- (6) Most tickets were sold at checker 4. (adapted from Eckardt 1999)
 \approx Most tickets *that were sold* were sold at checker 4.

Being sold is a prerequisite of being sold at checker 4. When interpreting (6), we seem to take this into account, which suggests the following semantics for *most*:

- (7) $\llbracket (\text{most } x: \phi)(\psi) \rrbracket^g = 1$, iff $\llbracket \psi \rrbracket^{g[a/x]} = 1$ for most individuals a for which $\llbracket \phi \rrbracket^{g[a/x]} = 1$ and $\llbracket \psi \rrbracket^{g[a/x]} = 0/1$; 0 otherwise.

Notice that this definition is classical, i.e. not partial.⁴ Inserting Belnap's conditional in the scope of a quantifier now leads to domain restriction with the *if*-clause:

- (8) Most people don't like New York if they didn't grow up there.
 $(\text{most } x: x \text{ is human})(x \text{ didn't grow up in N.Y.} \rightarrow x \text{ doesn't like N.Y.})$

This is true iff most values of x that satisfy the restrictor *and meet the definedness conditions* of the scope, satisfy the scope, that is, iff most people that didn't grow up in New York, don't like it there. Conclusion: it is possible to maintain that *if* has conditional meaning and still account for restrictive *if*-clauses.

What about conditional *if*-clauses? One could follow Kratzer's lead and assume that there is a covert modal embedded under the quantifier which is restricted by the *if*-clause. Indeed, von Stechow 2007 speculates that Belnap's conditional may perhaps never stand on its own. But why should we resort to covert material? The determiner-restrictor theory is forced to do this because it denies that *if* has conditional meaning, but on Belnap's analysis *if* does have meaning of its own. Given this semantics, conditional *if*-clauses can alternatively be analyzed as wide scope takers. This leads to the next representation for (9):

- (9) Many of the students will succeed if they work hard.
 $(\exists Y: Y \text{ is a set of students} \wedge$
 $(Y \text{ works hard} \rightarrow (\text{many } x: x \in Y)(x \text{ will succeed}))$

I assume that *many of the students* presupposes a set of salient students, which is picked up by *they*. When defined, i.e. when the students referred to work hard, (9) is true iff many of them will succeed.

To sum up, there are two ways to unify restrictive and non-restrictive *if*-clauses. One is a classical approaches but comes at the cost of a rather baffling assumption: *if* is meaningless. It follows that seemingly conditional instances must be the work of covert operators. The other assigns a partial but not implausible semantics, and is able to attribute any observed conditional meaning to *if* itself. On this analysis, the difference between restrictive and conditional *if*-clauses reduces to an ordinary scope

⁴Nothing hinges on this; we could just as well say that (6) is undefined in case no tickets were sold.

ambiguity. One cannot help but feel that Belnap's account is far more elegant. For this reason alone, this semantics may be preferred. But there are further arguments.

4. Reasons to prefer Belnap's semantics

4.1. Conditionals in dialogue

The first argument comes from von Fintel 2007 who is concerned with conditionals in dialogue:

- (10) A: If he didn't tell Harry, he told Tom.
B: Probably so.

The propositional anaphor *that* seems to refer back to the conditional in A's utterance. But B's utterance isn't interpreted as expected under the determiner-restrictor theory. If this analysis were correct, B's utterance would incorporate a modalized sentence under *probably*, yet the sentence is interpreted as if *probably* embeds a conditional with a restrictive *if*-clause.

One cannot maintain that the anaphor simply stands for the consequent of the conditional in A's utterance, while a covert anaphor (a part of *probably*) refers back to the antecedent, parallel to the next dialogue:

- (11) A: Every student smokes.
B: Most (of them) do.

If implicit conditionalization were an option, the following utterance by B should be able to express that he told Tom in most worlds in which he didn't tell Harry, but this isn't borne out. It expresses that it is merely probable that he told Tom:

- (12) A: If he didn't tell Harry, he told Tom.
B: He probably told Tom.

Belnap's conditional fits the interpersonal traffic of conditionals like a charm:

- (13) A: If he didn't tell Harry, he told Tom.
he didn't tell Harry \rightarrow he told Tom
'if the conditional is defined, i.e if he didn't tell Harry, he told Tom'
B: Probably so.
(probably:)(he didn't tell Harry \rightarrow he told Tom)
'in most worlds where the embedded conditional is defined, i.e. where
he didn't tell Harry, he told Tom'

Von Fintel concludes that Belnap's conditional is a better implementation of Kratzer's idea that it is the "life-goal" of *if*-clauses to restrict the domain of some operator or

other. As argued above, however, this idea loses its motivation in Belnap's system, and we might explore his semantics as a genuine alternative.

4.2. Compositionality

My second argument is that Belnap's conditional allows for a more straightforward compositional semantics than the determiner-restrictor analysis does. The main problem for implementing the latter theory is that, at surface, *if*-clauses do not appear where they are interpreted. To solve this, von Stechow 2004 assumes that *if*-clauses are base generated as syntactic arguments of the operator whose domain they restrict. Overt word order is derived by movement. At LF, the *if*-clause reconstructs:

- (14) [s_[DP few people if they didn't grow up in New York] [v_p like it there]]

Compositional interpretation proceeds by constructing a complex restrictor out of the common noun and the *if*-clause, to which *few* is applied. The result is then applied to the rest of the sentence (due to lack of space, I must skip over the details). Another solution is proposed by von Fintel 1994, ch.3, who assumes that quantifiers take a free restrictor variable as their argument which may be bound by an *if*-clause:

- (15) [s_[DP few people i] [v_p [v_p like New York] [c_pif_i they didn't grow up there]]]

Through this co-indexation, the *if*-clause poses restrictions on the value the assignment function might give to *i*.

With Belnap's semantics, there is no longer any mismatch between syntax and semantics. LFs correspond to surface structure:

- (16) [s_[DP few people] [v_p [v_p like New York] [c_pif they didn't grow up there]]]

We need not assume that the *if*-clause is a syntactic argument of the quantifier, nor that it binds some domain restriction variable.

4.3. Iterated conditionals

My final argument comes from conditionals with conditional consequents:

- (17) If it rains or snows tomorrow, then if it doesn't rain tomorrow, it will snow.

This seems equivalent to 'if it rains or snows tomorrow *and* it doesn't rain, it will snow'. But on the determiner-restrictor analysis, (17) must be analyzed as a doubly modalized statement, which kills the equivalence:

- (18) (must: it rains or snows)((must: it doesn't rain)(it snows))

I can believe that it rains or snows, but at the same time believe that it is possible *relative to one of these live-possibilities* (where it rains or snows) that it neither rains nor

snows.⁵

Belnap's semantics straightforwardly predicts the desired equivalence:

(19) (it rains or snows) \rightarrow (it doesn't rain \rightarrow it snows)

If (19) has a truth value, i.e. if it rains or snows, then it snows if the embedded conditional has a truth value, i.e. if it doesn't rain. That is, it snows if it rains or snows but doesn't rain.

5. Conclusion

We should drop the determiner-restrictor theory and opt for Belnap's system instead.

Bibliography

- Belnap, N. D.: 1970, Conditional assertion and restricted quantification, *Noûs* 4(1), 1–12
- von Fintel, K.: 1994, *Restrictions on quantifier domains*, Ph.D. thesis, University of Massachusetts at Amherst
- von Fintel, K.: 1998, Quantifiers and 'if'-clauses, *The Philosophical Quarterly* 48(191), 209–214
- von Fintel, K.: 2007, *If: the biggest little word*, Slides. Available at <http://mit.edu/fintel/gurt-slides.pdf>
- von Fintel, K. and Iatridou, S.: 2002, *If and when if-clauses can restrict quantifiers*, Ms. MIT. Available at <http://web.mit.edu/fintel/www/lpw.mich.pdf>
- Geurts, B. and Huitink, J.: 2006, Modal concord, in P. Dekker and H. Zeijlstra (eds.), *Proceedings of the ESSLLI 2006 Workshop Concord Phenomena at the Syntax-Semantics Interface*, University of Málaga
- Huitink, J.: 2007, A unified account of restrictive and non-restrictive *if*-clauses, in M. Kluck and E. Smits (eds.), *Proceedings of the Fifth Semantics in the Netherlands Day*, pp 83–97, Groningen
- Kratzer, A.: 1991, Modality/Conditionals, in A. von Stechow and D. Wunderlich (eds.), *Semantik: ein internationales Handbuch der zeitgenössischen Forschung*, pp 639–656, De Gruyter, Berlin
- Lewis, D. K.: 1975, Adverbs of quantification, in E. Keenan (ed.), *Formal semantics of natural language*, Cambridge University Press
- von Stechow, A.: 2004, *Modale und Konditionale*, Handout. Available at <http://www2.sfs.uni-tuebingen.de/~arnim10/Handouts/Modalitaet.pdf>
- Zeijlstra, H.: 2007, *Modal concord is syntactic agreement*, Forthcoming in the Proceedings of SALT 17

⁵Proponents of the determiner-restrictor theory might be linking this to modal concord. Cf. 'Harry surely must stop talking soon': while containing two modal operators, this communicates just a single modality, see Geurts and Huitink 2006, Zeijlstra 2007. But it will be hard to make this compositional.

EVOLUTIONARY STABILITY OF GAMES WITH COSTLY SIGNALING

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The paper investigates evolutionary stability conditions of the class of signaling games with the following properties: (a) the interests of sender and receiver coincide, (b) different signals incur differential costs, and (c) different events (meanings/types) have different probabilities.

The main finding is that a profile belongs to some evolutionarily stable set if and only if a maximal number of events can be reliably communicated. Furthermore, it is shown that under the replicator dynamics, a positive measure of the state space is attracted to “sub-optimal” equilibria that do not belong to any asymptotically stable set.

1. Introduction

In his book *Convention*, David Lewis gave a game theoretic formalization of strategic communication (Lewis 1969). Lewis showed that a convention which guarantees successful communication can be self-reinforcing provided the interests of the communicators are sufficiently aligned. In game theoretic parlance, communication conventions are Nash equilibria. As the phenomenon of communication is of high relevance for many scientific disciplines, Lewis style *signaling games* and similar game theoretic models of communication received a great deal of attention since then (see for instance Spence 1973 and Crawford and Sobel 1982 in economics, Grafen 1990 and Hurd 1995 in biology, Skyrms 1996 in philosophy, Hurford 1989 and van Rooij 2004 in linguistics and much subsequent work in all mentioned disciplines). The common theme of all these models can be summarized as follows:

- There are two players, the sender and the receiver.
- The sender has private information about an event that is unknown to the receiver. The event is chosen by nature according to a certain fixed probability distribution.
- The sender emits a signal which is revealed to the receiver.

- The receiver performs an action, and the choice of action may depend on the observed signal.
- The utilities of sender and receiver may depend on the event, the signal and the receiver's action.

Depending on the precise parameters, signaling games may have a multitude of equilibria. Therefore the question arises how a stable communication convention can be established. A promising route is to assume that such equilibria are the result of biological or cultural evolution. Under this perspective, communication conventions should be evolutionarily stable in the sense of evolutionary game theory.

Trapa and Nowak 2000 consider the class of signaling games where signaling is *costless* (i.e. the utility of sender and receiver does not depend on the emitted signal) and the interests of sender and receiver completely coincide. Also, they assume that the actions of the receiver are isomorphic to the set of events. So the task of the receiver is essentially to guess the correct event. Furthermore, they assume a uniform probability distribution over events. Under these conditions it turns out that the evolutionarily stable states (in the sense of Maynard Smith 1982) are exactly those states where the sender strategy is a bijection from events to signals, and the receiver strategy is the inverse of the sender's strategy. This means that in an evolutionarily stable state, the receiver is always able to reliably infer the private information of the sender.¹

Pawlowitsch 2006 investigates the same class of games, with the additional restriction that the number of events and signals must be identical. She shows that each such game has an infinite number of neutrally stable strategies (again in the sense of Maynard Smith 1982) that are not evolutionarily stable. In these states, communication is not optimal because certain events cannot be reliably communicated. Perhaps surprisingly, these sub-optimal equilibria attract a positive measure of the state space under the replicator dynamics. Natural selection alone thus does not necessarily lead to perfect communication.

In many naturally occurring signaling scenarios emitting a signal may incur a cost to the sender. Games with *costly signaling* have been studied extensively by economists (like Spence 1973) and biologists (as Grafen 1990) because costs may help to establish credibility in situations where the interests of sender and receiver are not completely aligned (an effect that is related to Zahavi's 1975 famous *handicap principle*).

2. Matrix representation of games with costly signaling

A sender strategy is a function from the set \mathcal{E} of events into the set of signals \mathcal{F} , and vice versa for the receiver strategy. It is convenient to represent these functions as

¹Similar results have also been obtained by Wärneryd 1993. Since he only considers pure strategies though, his results are perhaps less general.

matrices containing exactly one 1 per row and only zeros otherwise. A symmetrized strategy is a pair of such matrices (S, R) . The probabilities of the events \mathcal{E} are represented as a vector \vec{e} of length $n = |\mathcal{E}|$. We can safely assume that $\forall i : e_i > 0$. The costs of the signals from \mathcal{F} are represented as a vector \vec{c} of length $m = |\mathcal{F}|$. Costs are negative utilities, so it is reasonable to assume $\forall i : c_i \leq 0$. If $c_i - c_j > 1$, the use of the j -th signal would die out under evolution. Therefore we can assume that $\forall i : c_i > -1$. Finally, I will only consider games that are *structurally stable*, i.e. there are no pairs of events that have identical probabilities, and no pairs of signals that incur identical costs. Almost all games of the class considered have this property, so this does not seriously restrict the generality of the setting.

We can construct matrices P and Q :

Definition 1

$$\begin{aligned} p_{ij}^S &\doteq s_{ij} \times e_i \\ q_{ij}^R &\doteq r_{ij} + c_i \end{aligned}$$

(S, R) and (P, Q) stand in a 1-1 correspondence. Therefore we can identify the strategies of sender and receiver with P and Q respectively.

3. Utilities

If the receiver correctly guesses the signal that the sender wants to communicate, both parties score a point. Additionally, the costs of the signal that the sender emits are added to the utility of both players. This (asymmetric) utility function can be expressed succinctly as

$$u(P, Q) = \text{tr}(PQ) \tag{1}$$

A mixed strategy x corresponds to a pair of stochastic matrices

$$(P^x, Q^x) = \left(\sum_{(P,Q)} x(P, Q) \times P, \sum_{(P,Q)} x(P, Q) \times Q \right).$$

The symmetrized expected utility function turns out to be

$$u(x, y) = \frac{1}{2} (\text{tr}(P^x Q^y) + \text{tr}(P^y Q^x)) \tag{2}$$

4. Strong evolutionary stability 123

The set of evolutionarily stable states (ESS) can be characterized as

Theorem 1 x is an ESS if and only if $m \leq n$, the first column of P^x has $n - m + 1$ positive entries, each other column of P^x has exactly one positive entry, and $q_{ji}^x = 1 + c_j$ iff $i = \min(\{i' : p_{i'j}^x > 0\})$, otherwise $q_{ji}^x = c_j$.²

In many cases there are also non-trivial evolutionarily stable sets (ESSet) in the sense of Thomas 1985, that can be characterized by the following theorem:

Theorem 2 A set of strategies A is an ESSet iff for each $x \in A$, x is an ESS or $m > n$, the restriction of P^x to the first n columns and the restriction of Q^x to the first n rows form an ESS, and for each y such that $P^x = P^y$, and Q^x and Q^y agree on the first n rows: $y \in A$.

5. Weak evolutionary stability

Next to the notion of (strong) evolutionary stability, there is also the concept of weak evolutionary stability (or neutral stability) that characterizes states where the incumbent strategy cannot be replaced by a mutant due to natural selection, but where it is not required that the incumbent is necessarily able to drive any mutant to extinction. The necessary and sufficient condition for neutral stability are

Theorem 3 x is a neutrally stable state (NSS) if and only if it is a Nash equilibrium and Q^x does not contain multiple column maxima.

In a NSS, non-determinism thus can only occur in the receiver strategy. It is quite restricted insofar as it can only occur as response to some zero column in P :

Observation 1 If x is a NSS and there are some i, i', j with $c_j < q_{ji}^x, q_{ji'}^x < 1 + c_j$, then $\forall i' : p_{i'j}^x = 0$.

This follows directly from the facts that non-determinism can only occur in response to multiple column maxima, which, due to structural stability, can only occur in a zero-column of P if P is pure.

Note that neutral stability without evolutionary stability is quite a pervasive phenomenon.

Observation 2 If $m, n \geq 2$, there is always at least one NSS that is not element of an ESSet.

For instance, putting all probability mass into the first column both on the sender side and the receiver side leads to an NSS that is obviously not contained in any ESSet.

²Proofs are omitted in this abstract for reasons of space. They can be found in the full paper, which is available online from <http://www.whomes.uni-bielefeld.de/gjaeger/publications/signalspiele.pdf>.

6. Dynamic stability and basins of attraction

The games considered in this paper are symmetrized asymmetric (or bimatrix) games. As developed in detail in Cressman 2003, there is a tight connection between static stability and dynamic stability under the replicator dynamics for this class of game. Most notably, a set of strategies is asymptotically stable under the replicator dynamics if and only if it is an ESSet. As a corollary, it follows that the asymptotically stable states are exactly the ESSs.

Let us have a look at the dynamic properties of the set of neutrally stable equilibria. It is rather obvious that all ESSs are isolated points in the sense that each ESS has an environment that does not contain any other Nash equilibria. This follows from the facts that (a) all Nash equilibria are fixed points under the replicator dynamics, and (b) each ESS is asymptotically stable under the replicator dynamics.

The set of NSSs that are not ESS has a richer topological structure.

Lemma 1 *Let x^* be a NSS that is not an ESS. There is some $\epsilon > 0$ such that for each Nash equilibrium y with $\|x - y\| < \epsilon$,*

1. *y is itself neutrally stable, and*
2. *for each $\alpha \in [0, 1]$, $\alpha x^* + (1 - \alpha)y$ is neutrally stable.*

We say that two NSSs x and y belong to the same continuum of NSSs if for each $\alpha \in [0, 1]$, $\alpha x^* + (1 - \alpha)y$ is neutrally stable.

Theorem 4 *Each NSS x has some non-null environment A such that each interior point in A converges to some neutrally stable equilibrium y under the replicator dynamics that belongs to the same continuum of NSSs as x .*

We get the immediate corollary:

Corollary 1 *Each NSS belongs to some continuum of NSSs that attracts a positive measure of the state space.*

It is obvious that each ESSet has a basin of attraction with a positive measure—this follows directly from the fact that each ESSet is asymptotically stable. The corollary shows though that the basins of attraction of the ESSets do not exhaust the state space. As pointed out in observation 2, In fact, there are NSSs that do not belong to any ESSet. As ESSets are asymptotically stable, each ESSet has an environment that does not contain any NSSs. Hence if an NSS x does not belong to any ESSet, the entire continuum of NSSs that x belongs to is disjoint from the ESSets. We thus get the additional corollary:

Corollary 2 *The set of Nash equilibria ¹²⁵that do not belong to any ESSet attracts a positive measure of the state space.*

These results are of immediate relevance for game theoretic pragmatics. For instance, van Rooij 2004 claims that “signaling games select Horn strategies”. This may be true for the stochastic dynamics used there, but under the deterministic replicator dynamics, even the much weaker claim that signaling games select evolutionarily stable sets turns out to be false.

Bibliography

- Crawford, V. P. and Sobel, J.: 1982, Strategic Information Transmission, *Econometrica* 50(6), 1431–1451
- Cressman, R.: 2003, *Evolutionary Dynamics and Extensive Form Games*, MIT Press, Cambridge (Mass.), London
- Grafen, A.: 1990, Biological signals as handicaps., *Journal of Theoretical Biology* 144(4), 517–46
- Hurd, P. L.: 1995, Communication in discrete action-response games, *Journal of Theoretical Biology* 174(2), 217–222
- Hurford, J. R.: 1989, Biological evolution of the Saussurean sign as a component of the language acquisition device, *Lingua* 77, 187–222
- Lewis, D.: 1969, *Convention*, Harvard University Press, Cambridge
- Maynard Smith, J.: 1982, *Evolution and the Theory of Games*, Cambridge University Press, Cambridge
- Pawlowitsch, C.: 2006, *Why evolution does not always lead to an optimal signaling system*, manuscript, University of Vienna, forthcoming in *Games and Economic Behavior*
- Skyrms, B.: 1996, *Evolution of the Social Contract*, Cambridge University Press, Cambridge, UK
- Spence, M.: 1973, Job Market Signaling, *The Quarterly Journal of Economics* 87(3), 355–374
- Thomas, B.: 1985, On evolutionarily stable sets, *Journal of Mathematical Biology* 22, 105–115
- Trapa, P. and Nowak, M.: 2000, Nash equilibria for an evolutionary language game, *Journal of Mathematical Biology* 41, 172–188
- van Rooij, R.: 2004, Signalling games select Horn strategies, *Linguistics and Philosophy* 27, 493–527
- Wärneryd, K.: 1993, Cheap talk, coordination and evolutionary stability, *Games and Economic Behavior* 5, 532–546
- Zahavi, A.: 1975, Mate selection — a selection for a handicap, *Journal of Theoretical Biology* 53, 205–213

SUBTRIGGERING AS ALTERNATIVES THROUGH REGULARITIES

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Abstract In this paper, we work out the connection between the well-known phenomenon of subtriggering for F(ree) C(hoice) I(tems) and the widespread intuition that these items exploit alternatives, by showing that the missing link is the notion of *regularity*.

1. Introduction: The subtriggering phenomenon

Legrand (1975:54-69) discusses cases in which *any* is triggered by a subordinate clause and accordingly call them *subtriggering* cases.¹ Dayal (1998, 2005) shows that subtriggering is not limited to relative clauses but extends to adjectives and postnominal modifiers.

- (1) a. *Mary bought anything from Carson's
- b. Mary bought anything she needed from Carson's
- c. Anyone who gives a damn about me will help me

Legrand's proposal is that sentences like (1b) have a conditional structure, which can be paraphrased by 'If anything was needed, she bought it from Carson's'. This allows one to account for the presence of *any* as well as of negative polarity expressions (1c), since both are licensed by conditional structures. This solution raises two problems.

First, the quantificational status of *any* remains unclear. On the one hand, since (1) is intuitively parallel to (2a), one is tempted to analyse *any* as a universal quantifier with wide scope. However, true universal quantifiers do not behave like *any*, as evidenced by (2b) and the contrast (2c-d).

- (2) a. She bought everything she needed from Carson's
- b. ??If everything was needed, she bought it from Carson's
- c. Pick every card
- d. Pick any card

On the other hand, if *any* is existential, the subtriggering effect is somewhat mysterious since it does not exist for standard indefinites (3).

- (3) She bought something she needed from Carson's

¹Examples (1a-c) are borrowed from Legrand.

Second, it has been noted by Dayal (2005) and Jayez and Tovena (2005a) that sub-triggering is *not* uniform. This is unexpected if subtriggering is just a covert conditional structure.²

- (4) a. *John read any good book [from Dayal]
[conditional paraphrase: if a/any book was good, John read it]
b. ??Tout étudiant qui était dans le couloir est rentré ‘Any student who was in the corridor came in’
[conditional paraphrase: if a/any student was in the corridor, (s)he came in]
c. Tout étudiant qui avait triché a été renvoyé ‘Any student who had cheated was excluded’
[conditional paraphrase: if a/any student had cheated, (s)he was excluded]

In the following, we address these two problems in turn.

2. \exists or \forall ?

Since certain FCIs like *tout* are universal quantifiers (Jayez and Tovena 2005a), it is not possible to claim that non-universal status is an intrinsic feature of FCIs. The opposite view (i.e. FCIs = \forall) is not tenable either since, for instance, imperative sentences draw a clear line between existential and universal determiners.

- (5) a. Pick any card
b. Prends n’importe quelle carte du paquet ‘Pick any card in the pack’
c. *Prends toute carte du paquet ‘Pick every-FCI card in the pack’

The notions of *widening* and of ‘enlarged’ set of alternatives (Kadmon and Landman (1993) and their followers) that point to the strong intuition that FCIs –whether universal or not– span the whole set of alternatives, are problematic (Jayez and Tovena 2005b). We will resort to the more neutral constraint of *Equity*. To provide a compact definition, we will use a hybrid logic mode of presentation (Arecas and ten Cate 2006). s, s' etc. are variable for information points (‘worlds’). \downarrow_s stores the current point in s . $\downarrow_s\phi$ means that ϕ is true at the current point, whose value is assigned to s . $@_s\phi$ means that ϕ is true at s . $\diamond/\square\phi$ have their usual meaning.

- (6) **Equity** In a tripartite LF [FCI] [R] [S], or O_M ([FCI] [R] [S]), where O_M is a modal operator, a FCI is anomalous under any interpretation that entails (a/a') or (b/b').

(a) $\downarrow_s\exists x(R(x) \ \& \ S(x))$ or (a') $\downarrow_s\diamond_M[\exists x(@_s\square_MR(x) \ \& \ S(x))]$

(b) $\downarrow_s\exists x(R(x) \ \& \ \neg S(x))$ or (b') $\downarrow_s\diamond_M[\exists x(@_s\square_MR(x) \ \& \ \neg S(x))]$

(6a', b') says that no individual in the restriction is positively (or negatively) discriminated, by satisfying (or not satisfying) the scope at every accessible point. This applies (i) to members of the current point (the value of s) if they still exist in all accessible points and (ii) to members of accessible points (hence the ‘ $\diamond_M[\exists x \dots]$ ’)

²One might object that the conditional paraphrases do not permit to derive the required universal reading, but, in any case, the subtriggered sentences should not be anomalous.

part), for instance events or objects that are ‘created’ within the accessible points. (6a,b) imposes equity at the current point. (6) simulates universal quantification on the restriction by putting all its members on a par. By themselves, ‘existential’ FCIs like *any* or the French *n’importe quel* do not determine an existential or a universal reading.³ *Pick any card* is preferably interpreted as ‘Pick a card’ and *Punish any misdemeanour* as ‘Punish every (possible) misdemeanour’.

Constraint (6) seems to predict that subtriggering is out in examples like (1b) or (4c), since some particular members of the restriction satisfy the scope, as for any episodic assertion. However, (6) characterises interpretations as anomalous, not sentences. Therefore, it is in principle possible that a sentence is anomalous under certain interpretations and felicitous under others.

3. Regularities

Crucially, subtriggering does not redeem a sentence whenever the relation between the property expressed by the head of the FCI phrase and the rest of the sentence is felt as purely accidental/circumstantial. For instance, in (4b), it is difficult to imagine a general reason why students in the corridor should come in. Put otherwise, there is no intuitive *law-like* regularity between being in a corridor and coming in, even if that sequence makes perfect sense in a given context. On the contrary, (1b) points to a connection between being needed and being bought and (4c) to a connection between being a cheater and being sanctioned. There is some leeway on what is perceived as law-like vs. circumstantial and even native speakers hesitate on certain examples. There is also cross-linguistic variation, that reflects different constraints on the global/local character of regularities. For instance, French *tout* prefers general laws whereas English *any* admits of particular individual dispositions. In (1b), one may imagine that Mary decided to buy everything she needed from Carson’s and that her actions of buying reflected this disposition. It is impossible to force the same reading in French with *tout*.⁴

- (7) ??Tout objet dont elle avait besoin a été acheté chez Carson
lit. Every-FCI object she needed was bought from Carson’s

Such complications may occasionally blur the picture, but an independent observation of Dayal provides additional support to the distinction. Dayal (1998) notes that *any* cannot refer to a contextually salient set. This limitation extends to subtriggering (8).

- (8) Every / ??Any student who had cheated was excluded, namely John, Gilbert and Stephen

If (8) simply were a universal judgement with a law-like flavour, the contrast would be unexpected. The fact that particular students cheated and were excluded does

³They should be called ‘non universal’. It is an open question whether there are strictly existential FCIs, which cannot get a universal reading at all.

⁴We use the passive in (7) because *tout* is not very felicitous as an object.

not preclude variation across alternatives, and there is no reason why *any* and *every* should be different. (8) suggests that subtriggered sentences refer exclusively to laws, rules or dispositions and do not express directly universal judgements of the form $\forall x\phi(x)$. A paraphrase of (4c) is ‘We applied a rule that says that every student who cheated was dismissed’. In general, assertions with maximality operators (in English and French, universal quantifiers and plural definites) have a descriptive reading and can refer, additionally, to laws, rules or disposition. E.g. *Every cheater was punished* refers to a fact (descriptive reading) and, presumably, to a rule. A sentence S refers to a regularity whenever it refers to a situation *s* by describing *s* as an application of the regularity. (9) spells out this intuition by coding the regularity as a conditional relation between properties, as opposed to simple material implication.

- (9) An assertive sentence S with a tripartite LF $[Q_{\forall}] [R] [S]$ refers to a regularity *r* whenever it is compatible with an interpretation $\downarrow_s [M_r ([Q_{\forall}] [R] [S])]$, where M_r is any suitable conditional modality (modal necessity, non monotonic entailment, etc.).⁵

It is sometimes possible to make the reference to regularities emerge through a suitable abstract anaphor.

- (10) a. Every/Any student who had cheated was excluded. This rule suffered no exception
 b. Mary bought everything/anything she needed from Carson’s. This decision (option, behaviour, tendency) fits her character
 c. Every student who was in the corridor came in. #This rule (tendency) suffered no exception

4. Alternatives and counterparts

A sentence with a universal interpretation can in principle be just descriptive or refer to a regularity. Since standard universal quantifiers are compatible with a descriptive LF, sentences with such quantifiers are always compatible with a descriptive interpretation, and can also refer to regularities. A descriptive interpretation cannot license a universal FCI since it violates (6a). E.g. the LF of (4c) is $[tout] [student-cheater] [excluded]$. The descriptive interpretation contains the presupposition that $\exists x student-cheater(x)$ and the main assertion that $\forall x(student-cheater(x) \Rightarrow excluded(x))$, which entails (11.1). Applying (9), the other possible interpretation for (4c) is provided in (11.2).

- (11) 1. $\downarrow_s \exists x(student-cheater(x) \& excluded(x))$
 2. $\downarrow_s [M_r ([tout] [student-cheater] [excluded])]$

Does (11.2) violate (6)? The answer is negative for two reasons. First (11.2) does not entail (6a). Admittedly, the conjunction of (11.2) with the presupposition that some students cheated does entail (6a)⁶, but the presupposition is not part of (11.2).

⁵We disregard tense for simplicity.

⁶Under the current assumption that regularities that hold at *s* are exemplified at *s*.

This is as expected, since referring to a rule is conceptually distinct from referring to a concrete case where this rule applies. Second, (11.2) does not entail (6a') because regularities are in general represented as holding between properties, not specific individuals. When, in a given context, P depends on P' analytically (mathematical truths) or causally (physical and social laws), the individuals that satisfy P and P' can be replaced by any individuals that satisfy the same law-like structure. (4c) implies that, in the same context, any student who would have cheated would have been punished in the same way. This counterfactual interpretation is at the root of the treatment of causal/conditional and counterfactual sentences in most models (including for instance the analysis of counterfactuals by Lewis and that of 'common-sense entailment' by Asher and Morreau).⁷ The net result of such approaches is that $A \rightarrow B$ iff, for a certain suitable subset of accessible worlds, B is true whenever A is true. When A and B are first-order expressions, we have (12). Obviously, nothing requires that the set of individuals that satisfy P and P' be the same across all points r -accessible from s .

$$(12) \quad @_s M_r. ([Q_\forall][P(x)][P'(x)]) \text{ iff } @_s \Box_r. (\forall x (P(x) \Rightarrow P'(x)))$$

Two precisions are in order. First, we need not impose strong constraints on counterparts, for instance that they be distinct in different alternatives as in the ontology of Lewis (1968). Instead, we simply take counterparts to be individuals that satisfy the same properties across alternatives. So, a and b are counterparts w.r.t. P iff they satisfy P in different alternatives. Second, interpreting the FCI as existential in a subtriggering configuration is a bad move, since it makes it impossible to construct the regularity interpretation. However, this does not entail that non-universal FCIs with postnominal modifiers systematically get a universal reading. (13).

- (13) Pick any card that shows a blue square
[context: there are several cards with a blue square]

5. Comparison to other works

Dayal (1998, 2005) discusses contrasts like (1a-b) to support her claim that FC *any* has a strong modal force which must be disabled by some spatio-temporal restriction. So, (4a) is anomalous because it entails that John read every good book in every possible world, whereas (1b) limits Mary's purchases to what she needed. However, (14) is definitely out in English as well as in French, although there is clearly a spatio-temporal limitation.

- (14) a. *Because of the rain, any chair in the garden is wet
b. *À cause de la pluie, toute chaise du jardin est mouillée

Aloni's (2007) proposal does not make reference to modal force but to alternatives and a combination of exhaustiveness and mutual exclusion of possibilities, which is determined solely by the syntax-semantics interface. This raises two problems. First, no room is left for variation between different cases of subtriggering.

⁷See Kim and Kaufmann (2007) for the counterfactual implicature of Korean items.

Second, the proposal makes crucial use of a shift operator $\text{SHIFT}_{(s,t)}$ which partitions the set of possibilities. This is dubious in the case of FCIs. A sentence like *Pick any apple* does not explicitly entail that the addressee is forbidden to pick more than one apple (partition of the space of possible executions).

Menéndez-Benito (2005) notes that Spanish *cualquier* is less tolerant to subtriggering than *any*. She presents experimental results that suggest that subtriggered examples with *cualquier* improve when they express a rule or a ‘policy’. This result is consonant with certain observations on *tout*. She contemplates the possibility that a sort of generic interpretation emerges from the rule/policy sentences. We agree with the intuition behind her account. However, we tend to consider genericity, habituality and regularity as different options inside a broad family of modal patterns. For instance, it seems difficult to equate a fully generic sentence and a past tense subtriggered sentence. Obviously, more work is needed at this point to gain a better understanding of the cross-linguistic similarities and differences.

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Bibliography

- Aloni, M.: 2007, Free choice and exhaustification: an account of subtriggering effects, in Puig-Waldmüller, E. (ed.), *Proc. of Sinn und Bedeutung 11*, 16-30.
- Arecas, C. and ten Cate, B.: 2006, Hybrid logics, in Blackburn, P. et al. (eds), *Handbook of Modal Logics*, Elsevier, 821-868.
- Dayal, V.: 1998, ANY as inherently modal, *Linguistics and Philosophy* 21, 433–476.
- Dayal, V.: 2005, The universal force of free choice *any*, in Rooryck, J. and Van Craenenbroeck, J. (eds), *Linguistic Variation Yearbook 2004*, 5-40.
- Jayez, J. and Tovena, L.: 2005a, Free choiceness and Non-Individuation, *Linguistic and Philosophy* 28, 1–71.
- Jayez, J. and Tovena, L.: 2005b, When widening is too narrow, in Dekker, P. and Franke, M. (eds), *Proc. of the 15th Amsterdam Colloquium*, 131–136.
- Kadmon, N. and Landman, F.: 1993, *Any*, *Linguistics and Philosophy* 16, 353–422.
- Kim, M.-J. and Kaufmann, S.: 2007, Domain restriction in freedom of choice: A view from Korean *Indet-na* items, *Proc. of Sinn und Bedeutung 11*, 375-389.
- LeGrand, J. E.: 1975, *Or and Any: The Semantics and Syntax of Two Logical Operators*, Ph.D. thesis, University of Chicago.
- Lewis, D.: 1968, Counterpart theory and quantified modal logic, *The Journal of Philosophy* 65, 113-126.
- Menéndez-Benito, P.: 2005, *The Grammar of Choice*, Ph.D. thesis, University of Massachusetts at Amherst.

QUANTIFICATION IN *THAN*-CLAUSES

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This study proposes a solution to the problem of the non-homogeneous behaviour of quantifiers in comparative clauses. An interval-based approach is used for the implementation of the analysis. It is argued that the so called scope splitting modals, exemplified by *have to*, trigger the insertion of a covert exhaustivity operator of the kind proposed in Fox 2006 that is restricted by a set of alternatives ranked on a likelihood/effort scale. This explains the availability of more-than-min and more-than-max readings with *have to*. The present analysis also accounts for the fact that existential quantifiers, except for the polarity sensitive indefinites and possibility modals, are not interpreted under the comparative.

1. Introduction

Since Schwarzschild and Wilkinson 2002 sentences with quantifiers in comparative clauses have become the most serious test for any theory of comparison. Universal quantifiers contained within *than*-clauses usually appear to take scope over the comparative relation as demonstrated in (1). However, the ‘clause-boundness’ of QR along with other restrictions discussed in Schwarzschild and Wilkinson 2002 make an analysis that relies on scoping strategies virtually impossible.

- (1) a. John is taller than every girl.
 $\forall x: \text{girl}@x \rightarrow \text{Height}@j > \text{Height}@x$
= John is taller than the tallest girl.
b. John is taller than I predicted.
 $\forall w \in \text{Acc}@: \text{Height}@j > \text{Height}_w(j)$
= John is taller than my maximal prediction.

The facts turn out to be even more intricate. We find necessity modals that behave as if they didn’t outscope the comparative. In (2) *have to*, in contrast to *should*, triggers the so called more-than-min reading that corresponds to the narrow scope of the modal. Crucially, the availability of readings depends on the choice of the quantifier and does not seem to be due to scope ambiguity.

- (2) a. John is taller than he should be.
 $\forall w \in \text{Acc}_@: \text{Height}_@(j) > \text{Height}_w(j)$
 = John is taller than the maximally permitted height.
 b. John is taller than he has to be.
 $\text{Height}_@(j) > \max(\{d: \forall w \in \text{Acc}_@: \text{Height}_w(j) \geq d\})$
 = John is taller than the minimally required height.

The behaviour of existential quantifiers is no less puzzling. Possibility modals, like *be allowed* or *can*, result in the more-than-max interpretation, which can be represented by assigning narrow scope to the relevant modal with respect to the comparison, cf. (3). This option seems to be exploited by other existentials all of which appear in the form of polarity sensitive items, like *anyone*, cf. (4).

- (3) John is taller than allowed.
 $\text{Height}_@(j) > \max(\{d: \exists w \in \text{Acc}_@: \text{Height}_w(j) \geq d\})$
 = John is taller than the maximally permitted height.
 (4) John is taller than any girl is.
 $\text{Height}_@(j) > \max(\{d: \exists x: \text{girl}_@(x) \ \& \ \text{Height}_@(x) \geq d\})$
 = John is taller than the tallest girl.

We do not seem to be able to interpret indefinites, like *a girl* or *somebody*, under the comparative. They invariably get generic and wide-scope interpretations. Epistemic modals, like *might*, escape the scope of the comparative as well.

- (5) It is warmer today than it might be tomorrow.
 $= \exists w \in \text{Acc}_@: \text{Temp}_@(today) > \text{Temp}_w(\text{tomorrow})$
 = It is possible that it will be colder tomorrow than it is today.
 (6) a. Lucky is bigger than a cat. (generic)
 b. He did better than a student from his course. (wide scope)

Theories of the comparative should be able to account for the observed readings and explain why *than*-clauses license *any* and cannot host other existential quantifiers.

2. Interval based approach to the comparative and ‘selection strategy’

Our starting point is Beck 2007’s selection strategy, that relies on an interval-based interpretation of the comparative inspired by Schwarzschild and Wilkinson 2002 and Heim 2006. It amounts to the selection of the point of comparison from the interval denoted by the subordinate clause. So the comparison is ultimately between two points.

More specifically, Beck 2007's proposal is based on the adjectival meaning in (7a) due to Heim 2006 that enables us to treat *than*-clauses as generalised quantifiers over degrees, cf. (7b-d).

- (7) a. $\llbracket \text{tall} \rrbracket = \lambda w. \lambda D. \lambda x. \text{Height}_w(x) \in D$
 b. John is taller than he should be.
 c. $[\lambda D \text{ should } [\text{John } D \text{ tall}]]$
 d. $\lambda D. \forall w \in \text{Acc}_@: \text{Height}_w(\text{John}) \in D$
 = the set of intervals that include John's height in each accessible world

It is assumed that the set designated by the *than*-clause is passed to a *min* operator that returns the set of the smallest interval(s) contained in it. Then the selection step follows: the set obtained from the application of *min* is operated on by the specially defined *max* operator that gives the maximum of the interval from this set that either extends highest or lowest on the relevant scale. We demonstrate the derivation of the more-than-max reading of (8) in (9).

Among the advantages of the selection analysis is the fact that the observed readings are not obtained by assigning different scope to quantifiers and that the comparative is treated as a simple '>' relation between two degrees.

- (8) a. John is taller than I predicted.
 b. -----w3-----w2-----w1-----J----->
 J John's height in the actual world
 w1-w3 John's heights in prediction worlds

- (9) a. $\min(\lambda D. \forall w \in \text{Acc}_@: \text{Height}_w(\text{John}) \in D)$
 = $\{[\text{Height}_{w1}(\text{John}), \text{Height}_{w3}(\text{John})]\}$
 b. $\max(\{[\text{Height}_{w1}(\text{John}), \text{Height}_{w3}(\text{John})]\}) = \text{Height}_{w3}(\text{John})$
 c. $\llbracket \text{er} \rrbracket(\max(\min(\text{than-clause})))(\max(\min(\text{matrix-clause})))$
 = $\text{Height}_@(\text{John}) > \text{Height}_{w3}(\text{John})$

We build on Beck 2007's analysis and suggest that the 'selection of the point' step can be reduced to picking the maximum of the smallest *than*-clause interval. In effect, there is no selection going on: the item of comparison is always the maximal degree of the unique minimal interval. This is achieved by an exhaustification step in the derivations involving certain quantifiers, which affects the interval expressed by the *than*-clause. In the following sections we will sketch the analyses of the relevant *than*-clauses.

3. Universal quantifiers

This section aims to account for the contrast in (2). The availability of the more-than-min reading, cf. (2b), depends on the choice of modal. In general, universal modals seem to fall into two classes. *Should*-like modals always result in the more-than-max reading, whereas *have-to*-like modals, termed scope-splitters in Schwarzschild 2004, allow comparison with the minimum as well as with the maximum of the span corresponding to the accessible worlds¹. See Krasikova 2007 for discussion of the data.

Obviously, the proposal sketched at the end of the previous section can be immediately applied to the analysis of *should*-like modals. For the analysis of (2a) consider a situation in which John's goal is to become a pilot and pilots are required to be between 1.70m and 1.80m. Applied to this situation, the comparative clause of (2a), viz. (7d) would denote a set of intervals including [1.70; 1.80], provided that the accessible worlds are the ones in which John's goal is fulfilled. Picking the minimal interval from this set and passing it to the comparative operator defined in (10) gives us the desired comparison with the maximally permitted height, i.e. with 1.80m.

- (10) a. $\llbracket \text{er} \rrbracket = \lambda I. \lambda I'. \max(I') > \max(I)$
 b. $\llbracket \text{er} \rrbracket (\text{min}(\text{than-clause})) (\text{min}(\text{matrix-clause}))$
 c. $\llbracket \text{min} \rrbracket = \lambda D_{(dt)}. \iota D' \in D: [\forall D'' \in D: D' \subset D'']$

For (2b) we assume that we can insert a covert exhaustifier (*exh*), like *only*, freely at the LF, see (11). This insertion is motivated if it strengthens the ordinary meaning according to the pragmatic program defended in Fox 2006. Importantly, *exh* is restricted by the likelihood ordering that is associated with *have to*, see (12a-b). The likelihood scale only becomes prominent with *have-to*-like modals which explains the absence of the strengthening effect with the other class of modals. The meaning of (11) is given in (13).

- (11) $[\lambda D [\text{exh}_{C, >R} \text{have to}_{>R}] \sim C [\text{Peter } D_F \text{ tall}]]$

- (12) a. $\llbracket \text{exh}_{C, >R} \rrbracket = \lambda w. \lambda M. \lambda q. M(w)(q) \ \& \ \forall p \in C: p >_R q: \neg M(w)(p)$
 b. $\forall p, q: p >_R q$ iff p is less likely than q (or iff p is more difficult than q)
 c. $C = \{\lambda w. \text{Height}_w(\text{Peter}) \in D: D \in D_{dt}\}$

- (13) $\lambda D. \forall w \in \text{Acc}_@: \text{Height}_w(\text{Peter}) \in D \ \& \ \forall p \in C: p >_R [\lambda w. \text{Height}_w(\text{Peter}) \in D] \rightarrow \neg \forall w \in \text{Acc}_@: p(w)$
 = the set of intervals s.t. it is required that Peter's height falls into them and everything less likely / more difficult is not required.

¹ We may identify a scope splitter if embed it under *only* and get a sufficiency modal interpretation. See von Stechow and Iatridou 2005 for a descriptive overview of such modals and the semantics of the SMC.

Under the assumptions that $>_R$ is defined on propositions with non-overlapping intervals and that it corresponds to the ordering on the height scale, (13) amounts to the set of intervals that include the minimal compliance interval: in the pilot scenario these are the intervals that start with 1.70m. Combining this result with the matrix clause we get the extension for (2b) that corresponds to the more-than-min reading:

$$(14) \llbracket \text{er} \rrbracket([1.70; 1.70])(\min(\lambda D. \text{Height}_@(\text{Peter}) \in D)) = 1, \text{ iff } \text{Height}_@(\text{Peter}) > 1.70$$

The minimal compliance interval is determined by what is considered the most likely or the least difficult amount of the relevant property. Therefore the resulting reading depends on the direction of the likelihood scale and ultimately on the context of utterance, which is a welcome prediction.

4. Existential quantifiers

Applying *min* defined in (10c) to a *than*-clause containing an existential quantifier results in the undefinedness: the uniqueness condition is violated, i.e. the set in (15) may contain more than one minimal interval.

$$(15) \lambda D. \exists x: \text{Height}_@(x) \in D$$

We believe that this explains why existential quantifiers escape *than*-clauses in general. However, polarity sensitive items, like *any*, can occur there resulting in a universal interpretation. We argue that the free choice implicature associated with items like *any* can change the meaning of the subordinate clause so that the application of *min* becomes possible. In (17) the free choice effect of (16) is derived as a result of a parse with two covert *exh* operators defined in (18), following Fox 2006.

$$(16) \text{ a. Peter is taller than John or Bill.}$$

$$\begin{array}{ccccccc} | & \text{-----} & 1.70 & \text{-----} & 1.75 & \text{-----} & \text{P} & \text{-----} & > \\ & & \text{J} & & \text{B} & & & & \end{array}$$

- (17) a. $\lambda w. \lambda D. \text{exh}A'(\text{exh}A(\lambda w. \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in D))$
 b. $A = \{\lambda w. \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in D \mid D \in D_{\text{dt}}\}$
 c. $A' = \{\text{exh}(A)(p): p \in A\}$
 $= \{\lambda w. \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.70; 1.75];$
 $\lambda w. \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.70; 1.70] \ \&$
 $\neg \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.75; 1.75];$
 $\lambda w. \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.75; 1.75] \ \&$
 $\neg \exists x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in [1.70; 1.70] \ \dots\}$
 d. $\lambda w. \lambda D. \forall x \in \{\text{Bill, John}\}: \text{Height}_w(x) \in D$

$$(18) \llbracket \text{exh} \rrbracket^w(A_{(st)})(p_{st}) = \lambda w. p(w) \ \& \ \forall q \in I\text{-E}(p,A): \neg q(w), \text{ where } I\text{-E}(p,A) = \\ \cap \{A' \subseteq A \mid A' \text{ is a maximal set in } A, \text{ s.t., } \{\neg p: p \in A'\} \cup \{p\} \text{ is consistent}\}$$

The first layer of exhaustification is trivial. It retains the alternatives that contain either Bill's height or John's height or both. The second *exh* restricted by A' defined in (17c) excludes all alternatives except for the one with the biggest interval [1.70; 1.75]. This strengthens the original meaning to produce the universal interpretation in (17d) or the more-than-max reading. This procedure is parallel to Fox's derivation of the free choice effect in disjunctions under possibility modals.

We assume that a similar effect is responsible for the more-than-max interpretation of comparatives with *be allowed* and other non-epistemic possibility modals that cannot escape the comparative clause.

5. Conclusion

We presented an analysis for comparative sentences with quantifiers in *than*-clauses that solves a number of long standing problems in this area of semantics. It is based on the standardly assumed meanings of the comparative operator and the adjective. The analysis explains the diversity of readings available with universal modals without relying on a problematic scoping strategy, as well as the more-than-max reading of certain existential quantifiers that can be interpreted under the comparative.

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Bibliography

- Beck, S.: 2007, *Quantifiers in than-clauses*, Ms, Universität Tübingen
von Fintel, K. and Iatridou, S.: 2005, *Anatomy of a Modal*, MIT
Fox, D.: 2006, *Free choice and the theory of scalar implicatures*, Ms, MIT
Heim, I.: 2006, *Remarks on comparative clauses as generalized quantifiers*, Ms, MIT
Krasikova, S.: 2007, *Universal modals in comparative clauses*, Paper presented at SuB12, Oslo
Schwarzschild, R. and Wilkinson, K.: 2002, Quantifiers in Comparatives: A Semantics of Degree Based on Intervals, *Natural Language Semantics* 10:1-41
Schwarzschild, R.: 2004, *Scope splitting in the comparative*, Paper presented at the MIT Colloquium

CONTEXTUALITY AS SUPERVENIENCE

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Wilfrid Hodges proposes an explication of the context principle. I show that the explication is, in a certain respect, too weak and propose to replace it by the principle that meaning supervenes on contribution, which however, entails Hodges' principle.

1. Equivalent languages

If the interpretation of every *sentence* of a language is fixed, there might still be different options how to interpret *subsential* expressions. I call two languages *equivalent* iff they share the same set of expressions and the same grammar and also the same interpretation of sentences. (An interpretation is a function that assigns every expression in the language its meaning.) Equivalent languages differ at most wrt. to the interpretation of some non-sentences. The question is: are there different equivalent possible natural languages?

The answer is yes, if interpretations of natural languages are like interpretations in model-theoretic semantics.

1.1. Example 1: extensional interpretations

Let $M = (D, V)$ be a model of first-order logic and π a permutation of the domain D . $\pi M := (D, \pi V)$, where πV is defined in a way such that:

1. If a is a name, then $\pi V(a) = \pi(V(a))$;
2. if P is an n -place predicate,
then $(\pi a_1, \dots, \pi a_n) \in \pi V(P) \Leftrightarrow (a_1, \dots, a_n) \in V(P)$.

M and πM are *elementary equivalent*,¹ i.e. sentences have precisely the same interpretation (here, truth-value) in each model of a permutation-related pair, e.g. $\pi M \models Pa \Leftrightarrow \pi V(a) \in \pi V(P) \Leftrightarrow V(a) \in V(P) \Leftrightarrow M \models Pa$. Usually there

¹Permutations are not the only possible source of elementary equivalence, witness the Löwenheim-Skolem theorem that is used by Putnam in Putnam 1981 for his model-theoretic argument against metaphysical realism.

is more than one object in D , hence there are non-trivial permutations, and hence different equivalent languages of first-order logic.²

1.2. Example 2: intensional interpretations

If $M = (W, R, (Dw)_{w \in W}, V)$ is a model of first-order modal logic and π a permutation of $D := \bigcup (Dw)_{w \in W}$, then $\pi M := (W, R, (\pi Dw)_{w \in W}, \pi V)$, where for any $w \in W$, πDw is the image of Dw under π and πV is defined in a way such that

1. If a is a name, then $\pi V(a) = \pi(V(a))$;
2. if P is an n -place predicate, then for any $w \in W$,
 $(\pi a_1, \dots, \pi a_n) \in \pi V(P)(w) \Leftrightarrow (a_1, \dots, a_n) \in V(P)(w)$

Again, sentences receive precisely the same interpretations (here, propositions, understood as sets of possible worlds) in each model of a permutation-related pair. And again, since D need not be a singleton, there are non-trivial permutations, and hence different equivalent languages of first-order modal logic.

1.3. Putnam's scenario

Imagine that men and women talk two different languages that are syntactically identical varieties of English. The two languages interpret sentences in precisely the same way; yet there are still semantic differences. For instance the word "dog" means in the language of women what the word "cat" means in the language of men; the reason this difference has no implications at the level of sentence meanings is that compensatory reinterpretations are made in the rest of the language, with the effect that, e.g. "There is a cat on the mat", "Look, there is a cat", and even the one-word exclamative "Cat!" all mean the same in both languages, although the word "cat" means different things.

The scenario is a variant of one that is used by Hilary Putnam in Putnam 1981, pp 33–35, and Putnam 1983, pp IX–X. Putnam uses his scenario for another purpose, namely to illustrate under-determination of *reference* (on a certain conception, by the truthvalues of sentences), whereas I want to illustrate the under-determination of *meaning* (on a certain conception, by the meanings of sentences). But the model-theoretic facts that may be used to argue for under-determination are the same in both cases, e.g. the existence of certain permutations, see examples 1 and 2 above. Possibly you find the scenario, strange. The sentences of men and women mean precisely the same; *how could their words mean different things*, then?

²Cf. Quine 1968. Quine calls permutations of this kind *proxy-functions*.

2. The Context principle

2.1. Frege's Principle

To say the latter is to appeal to the context principle, the principle that “the meaning of an expression is the contribution that it makes to the meanings of sentences containing it.” Hodges 1998, p.20.

The context principle is usually traced to Frege, who wrote that “[o]ne must ask for the meaning of words in the context of a sentence, not in isolation”. (Frege 1968, p.X). But not all commentators agree that Frege held the above context principle even at the time when he wrote these words, see Pelletier 2001.

The principle might either be taken to express a *strict identity* of entities called meanings with entities called contributions, or that the meaning of an expression is *constituted* by its contribution,³ or that expressions have their meanings *in virtue* of their contributions, or at least that meanings are *determined* by their contributions.⁴

Cautiously, I will choose the last reading. Understood either way, the principle excludes the scenario. “cat” means different things in our two languages although the two terms contribute in precisely the same way to the same sentence meanings in their respective languages, hence, what “cat” means is not determined by the contribution of “cat” to the sentences it occurs in; but then, “cat” does not have its meaning in virtue of its contribution, neither could what “cat” means be constituted by nor be identical to the contribution of “cat” to those sentences.

Now let us try to make the principle precise in a way such that it *stays* inconsistent with the scenario.

In the following I will use some abbreviations. Variables e , e' , and L , L' range over arbitrary possible expressions, and languages, resp.

$eL \equiv e'L'$: expression e in L is *synonymous* to expression e' in L'

$eL \simeq e'L'$: the semantical *contribution* of e to L equals the semantical contribution of e' to L'

$L[e|e']$: e and e' are *intersubstitutable salva interpretatione*,
i.e. for any sentence s of L , exchanging e for e' or *vice versa* results in a sentence s' of L , such that s and s' are synonymous in L .

2.2. Hodges' Principle

Hodges proposes the following explication of the context principle.⁵

³ “[T]he sense of any expression less than a complete sentence must consist only in the contribution it makes to determining the content of a sentence in which it may occur” Dummett 1981, p.495

⁴ “[T]hat in the order of explanation the sense of a sentence is primary” Dummett 1981, p.4

⁵ To be precise, Hodges offers a more general explanans in order to make a more general explanandum (his principle “F”) precise, see Hodges 2001, p.16; but the context principle is an instance of F, and the principle below, together with the reverse conditional, is the corresponding instance of his explication of F. That explication is put in terms of meaning functions instead of in terms of synonymy, but these are two equivalent formulations. Cf also the principle of *full abstraction* on p.19f. of Hodges 1998.

Hodges' Principle if $L[e|e']$, then $eL \equiv e'L$.

(Assume this holds for all natural languages L and expressions e, e' of L .)

While Hodges' Principle is plausible in itself, it is unable in principle to rule out the above scenario. It deals solely with intra-linguistic synonymy and thus stays silent about the question whether there are different equivalent languages. We can only apply Hodges' Principle to compare meanings in equivalent languages if the languages are presumed to be identical. But that they are is something we want to establish, not something we should presuppose.

Therefore, we need to improve on Hodges' attempt. The outcome should at least rule out the above scenario; but it should possess a level of precision that allows to compare it with Hodges' Principle.

A complete analysis of the context principle should be able to answer the following questions. *What does it mean that contributions determine meanings? And what are contributions?* In the following I will answer the first question, and give a tentative answer to the second one.

3. What does it mean that contributions determine meanings?

First, there is a standard way to make determination precise, *viz.* in terms of supervenience. Applied to the case at hand, we get

Meaning Supervenes on Contribution If $eL \simeq e'L'$, then $eL \equiv e'L'$.

(Same contribution, same meaning).

This principle is a conditional, whereas Hodges principle was of biconditional form. So, one could also consider to add the other direction.

Contribution Supervenes on Meaning If $eL \equiv e'L'$, then $eL \simeq e'L'$.

(Same meaning, same contribution).⁶

Indeed, the pronouncement that meaning *is* contribution invites a biconditional form, simply because identity is symmetric. But, above we have seen that not all formulations of the principle are as strong as this. Indeed, Contribution Supervenes on Meaning may appear to be somewhat problematic. It is equivalent to saying that, if e in L and e' in L' *differ* in contribution, then they differ in meaning. This may be problematic. Depending on how you make "contribution" precise, the addition of new expressive capabilities to a language tends to change the contributions of the old terms, because they now also appear in new linguistic contexts. But does this automatically also change the *meanings* of the old terms?—It is for this reason that I do not adopt Contribution Supervenes on Meaning, here.

⁶In Hodges 1998, Hodges terms a similar principle restricted to *intra-linguistic* synonymy "strong compositionality"; in Szabo 2000, Szabó argues that principles about intra-linguistic synonymy are not enough: compositionality is a supervenience principle.

4. What are contributions?

When do e in L and e' in L' make the same contribution to the sentences they appear in? Surely, if both appear in precisely the same linguistic contexts and their appearance makes the resulting sentences mean the same. Our first definition simply declares this criterion to be sufficient *and* necessary.

Let $\mathcal{S}_{L,e}$ be the set of sentences of L which e appears. For any member $S(e) \in \mathcal{S}_{L,e}$, $S(x)$ is the result of replacing every occurrence of e with the variable x (that is neither in L nor in L'). The set of these, $\mathcal{S}(x)_{L,e}$, is the set of contexts in L in which e appears. Let μ be the function that assigns the meanings to the sentences of L and μ' be the function that assigns meanings to the sentences of L' .

1st try $eL \simeq e'L'$ iff $\mathcal{S}(x)_{L,e} = \mathcal{S}(x)_{L',e'}$ and
for every $S(x) \in \mathcal{S}(x)_{L,e}$, $\mu(S(e)) = \mu'(S(e'))$

1st try, together with Meaning Supervenes on Contribution implies Hodges' Principle. It also suffices to exclude equivalent languages, e.g. "cat" appears in the same contexts in the languages of men and women, and when it does so it makes the resulting sentences mean the same. Hence, **1st try** predicts that both versions of "cat" contribute in the same way to the sentences they appear in; it follows from Meaning Supervenes on Contribution that they mean the same.

On the other hand, according to our definition, e in L and e' in L' already differ in contribution when there is a single context in L that differs in some of its expressions from the corresponding context in L' . Imagine e.g. that L and L' only differ in that L' has "tac" where L has "cat", but that every sentence in which "tac" is used⁷ has the same meaning as the corresponding sentence of L ; and that the two languages are semantically indistinguishable for every other sentence. The example illustrates first, that our definition of contribution is not very natural. Wouldn't it be more appropriate to say that the semantic contribution of "dog" to L' equals the semantic contribution of "dog" in L ? It illustrates, second, that, as a result, so far Meaning Supervenes on Contribution is still a very weak principle: it fails to imply that "dog" in L' and "dog" in L mean the same.

Hence, a second try. The main idea is to individuate contexts more coarsely, namely along semantical lines rather than in terms of their expressions. In the remainder of the talk I will speculate how this could be done.

But if two expressions provide the same contribution according to our **1st try**, they would also do so according to such a 2nd try; therefore the latter, together with Meaning Supervenes on Contribution would still entail Hodges' principle and exclude different equivalent languages.

⁷To keep things simple, let's assume that words are only used and never mentioned in these languages.

5. Conclusion

Hodges' principle may be generalised in a way that it excludes the possibility of different equivalent languages.

If you are a contextualist, what should you do? First option: drop standard model-theoretic semantics. Second option: continue to do model-theoretic semantics but drop a realist interpretation of model-theoretic semantics. An instrumentalist might regard two permutation-related interpretations to represent the same meaning functions.⁸ Either way, for a contextualist, the interpretation of a language could not be something like an interpretation in a model.

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Bibliography

- Dummett, M.: 1981 *Frege: Philosophy of Language*, 2nd Ed. Harvard University Press, Cambridge
- Frege, G.: 1968, *Foundations of Arithmetic*, bilingual edition, J.L. Austin (ed. and trans.), Northwestern University Press, Evanston
- Hodges, W.: 1998, Compositionality is not the problem. *Logic and Logical Philosophy* 6, pp 7–33
- Hodges, W.: 2001, Formal Features of Compositionality, *Journal of Logic, Language and Information* 10, pp 7–28
- Pelletier, F. J.: 2001, Did Frege believe Frege's Principle?, *Journal of Logic, Language and Information* 10, pp 87–114.
- Putnam, H.: 1983, *Realism and Reason*. Philosophical Papers, Vol.3., Cambridge University Press, Cambridge
- Putnam, H.: 1981, *Reason, Truth, and History*. Cambridge University Press, Cambridge
- Quine, W.: 1968, Ontological Relativity. *The Journal of Philosophy* 65, pp 185–212
- Szabó, Z.: 2000, Compositionality as supervenience. *Linguistics and Philosophy* 23, pp 475–505

⁸Here I am indebted to Ede Zimmermann, *p.c.*

QUOTATION MARKS AS MONSTERS, OR THE OTHER WAY AROUND?

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Mixed quotation exhibits characteristics of both *mention* and *use*. Some even go so far as to claim it can be described wholly in terms of the pragmatics of language *use*. Thus, it may be argued that the observed shifting of indexicals under all quotation shows that a monstrous operator is involved. I will argue the opposite: a proper semantic account of quotation can be used to exorcize Schlenker's monsters from semantic theory.

Natural languages provide various, more or less opaque, ways to report another person's speech act. The extremes on the opacity-transparency scale are direct and indirect discourse. Direct discourse is most faithful to the original utterance, (1a), while an indirect discourse report preserves only the proposition originally expressed, typically adapting various words in the process, (1b):

- (1) a. Bush said: "The terrorists underestimated me"
- b. Bush said that the terrorists underestimated him

A third, and very common way to report something like this slip of the tongue is *mixed quotation*, i.e. an indirect report of which certain parts are quoted verbatim:

- (2) Bush said the terrorists "misunderestimated me"

In this paper I develop a semantics of (mixed) quotation and show how it can be used to analyze shifted indexicality.

1. Quotation and the use-mention distinction

Philosophers since the Middle Ages distinguish two fundamental language modalities: *use* and *mention*, exemplified by the subject terms of *I am a person* and *'T' is a letter*. Direct discourse is commonly treated as a kind of mention: the reporter uses the quotation marking to *mention*, i.e. refer to Bush's utterance rather than *use* the sentence to express a proposition herself. Indirect discourse on the other hand is usually analyzed wholly in terms of *use*. More specifically, it is analyzed on a par with

attitude reports, as an intensional semantic operator: $\text{SAY}_{x\varphi} \approx x$ uttered something that expressed proposition $\llbracket\varphi\rrbracket$ (Kaplan 1989):

- (3) $\llbracket\text{SAY}_{x\varphi}\rrbracket_w^c = 1$ iff there is a character $X \in (\{0,1\}^W)^C$ (of a sentence) uttered by x in context $c' = \langle w, x, t \rangle$ with $X(c') = \llbracket\varphi\rrbracket^c$

1.1. Quotation as mention

I argue against the above mentioned strict dichotomy (quotation = mention; indirect discourse = use), but first, let's consider some characteristics that do clearly separate quotation from indirect discourse: (i) quoted errors/ungrammaticalities do not affect the overall acceptability of the report; (ii) quoted indexicals retain their original form; and (iii) quotation blocks quantifying in and wh-extraction. These facts are easily explained on the classical Quine/Tarski/Geach/Kaplan analyses of quotation as mention, which state that the function of quotation marks is to form a name (or description) to refer to the enclosed expression.¹

A closer look at the data reveals that the distinction isn't as clear-cut. For instance, some features, such as the language, are easily adapted to the report situation, even in quotation, while indexicals sometimes retain their original form even in indirect discourse. This last is known as *shifted indexicality*, a phenomenon that has recently led to a substantial overhaul of the previously intensional semantics of indirect discourse (e.g. as given in (3)), arguing that monstrous operators (i.e. object language context quantifiers) are needed:

- (4) a. John_i said that I_i am a hero [lit. translation from Amharic, Schlenker 2003]
 b. $\text{SAY}_j^* \lambda c [\text{hero}(i(c), c)]$
 c. $\llbracket(4b)\rrbracket^{c_0} = 1$ iff for all contexts c compatible with John's original speech act in c_0 : the speaker of c is a hero in c

I argue below that this is not necessary:² shifted indexicality is really mixed quotation (but mixed quotation is not pure mention).

1.2. Quotation as use

That quotation in general cannot be described as mere mention, is further corroborated by the fact that (iv) anaphoric and elliptical dependencies occur between quoted

¹Cf. Oshima (2006) for an overview of mention-like characteristics of quotation, plus a more recent defense of the strict use-mention dichotomy in natural language reporting.

²Another way to avoid monsters *a priori* is to say that anything that can be bound is *ipso facto* not an indexical. Thus, English *I*, which remains unaffected by any embedding is indexical, but Amharic *I*, which differs from its English counterpart only with respect to embeddings in indirect speech reports, is not. However, Amharic *I* does not simply pick out any salient speaker, and it cannot be bound under extensional quantification. This remains unexplained on the 'a priori account', while both the monster account and the quotational account to be presented here offer a principled explanation of this special status of reportative embeddings.

and non-quoted phrases; and (v) from quotations we often infer the corresponding indirect version where the words are *used*, e.g. (2)⊨(1b). For mixed quotation Davidson gave a final argument: (vi) mentioning turns an expression of any type into a name (for that expression), but a name simply doesn't fit the grammatical position of the quotation in (2). Especially the last two arguments have led to the opposite idea of analyzing (mixed) quotation wholly in terms of the pragmatics of language use (e.g. Recanati 2001). Note that on a quotation-as-use view, the behavior of indexicals in mixed quotation (cf. (2)) shows that we're dealing with genuine monsters. What's more, as pointed out below, even on Potts' (2007) hybrid use-mention account, monsters seem unavoidable.

2. A hybrid use-mention analysis of quotation

As (i)-(iii) indicate mention, and (iv)-(vi) use, we need a truly hybrid account. My proposal is based on Potts (2007) and Geurts&Maier (2005). It extends DRT with Van der Sandt's (1992) theory of presupposition-as-anaphora (with which I assume minimal familiarity) and with a logic of mentioning. This last extension requires the addition of linguistic items to the domain of semantic interpretation. I introduce a new type u (in addition to the usual e and t) and corresponding domain D_u . Now, (Quinean) quotation marks turn a linguistic entity of any type into one of type u :

- (5) a. $D_u = \{\text{misunderestimated me, I, the terrorists underestimated me} \dots\}$
 b. If $\sigma \in D_u$ then $\ulcorner \sigma \urcorner$ is an expression of type u and $\llbracket \ulcorner \sigma \urcorner \rrbracket = \sigma$

This captures mentioning. Then we add a predicate for *using an expression to refer to something*:

- (6) $\llbracket \text{say}(x, \ulcorner \sigma \urcorner, P) \rrbracket = 1$ iff the syntactic category of σ matches the semantic type of P and x utters σ to express $\llbracket P \rrbracket$

In cases of normal language use $\llbracket \sigma \rrbracket = \llbracket P \rrbracket$ but we do not require that σ be grammatically well-formed or interpretable as such.³ Instead of computing *the* semantic value of the quoted expression, we now need to know what x means with her use of the expression. The idea is to leave the third component, P , open to presuppositional (i.e. contextually and pragmatically driven) resolution:

- (7) Bush said that the terrorists had ∂ [the property he pronounced as “misunderestimated me”] [∂ = presupposition marker]

$$\left[\begin{array}{c} \text{bush}(x) \\ x \text{ SAY}_x \left[\begin{array}{c} \text{terrorists}(y) P(y) \\ \partial [P \text{ say}(x, \ulcorner \text{misunderestimated me} \urcorner, P)] \end{array} \right] \end{array} \right]$$

³We do however require that σ has a syntactic category corresponding to a semantic type. Maier (2007) proposes an extension to the current account to deal with the apparent counterexamples to this constraint.

Assuming a minimal context, the presupposition P will be accommodated globally:

$$(8) \quad \left[x P \left[\text{bush}(x), \text{say}(x, \ulcorner \text{misunderestimated me} \urcorner, P) \right] \right. \\ \left. \text{SAY}_x \left[y \mid \text{terrorists}(y) P(y) \right] \right] \\ \approx \quad \text{Bush uttered “misunderestimated me” to express a property } P \text{ and said} \\ \text{that the terrorists have that property}$$

In a more realistic context we might be able to infer what property P Bush intended to express: misunderstanding him or underestimating him, or perhaps something still different.

The above derivation demonstrates how to handle (i) quoted errors, and (ii) indexicality. It’s worth noting that both (i) and (ii) are problematic for Potts’ (2007) closely related rival account of (mixed) quotation. Interestingly, as discussed in my (2007), (ii) may in fact be fixed in a Pottsonian framework by adding monstrous operators to the quotational machinery. The current proposal on the other hand achieves quotational shifting (and error neutralization) through pragmatics, without monsters. This is crucial, because the next section takes it one step further (or turns it around, as the title of the paper has it), analyzing Amharic shifting in terms of quotation.

The other use and mention characteristics, (iii)-(vi), are also taken care of. Of these, (iv) requires some additional assumptions that fall outside the scope of the current paper (but see again Maier 2007).

3. Shifted indexicals as mixed quotations

We’re interested here in the indexicals. On the current analysis, a mixed quoted first person, like the one in (2), comes out as referring to whatever the reportee intended to refer to when she originally used it. This means that a mixed quoted I will always refer to the reported speaker herself. But this is exactly what Schlenker’s Amharic I supposedly does, so I propose to analyze the Amharic I of (4) and its kin as mixed quoted, i.e. an accurate English gloss of the famous Amharic report would be (9):

$$(9) \quad \text{John said that “I” am a hero} \\ \left[x \left[\text{john}(x) \right. \right. \\ \left. \left. \text{SAY}_x \left[\left[y \mid \text{hero}(y) \right] \right] \right] \right] \rightsquigarrow \left[x y \left[\text{john}(x), \text{say}(x, \ulcorner I \urcorner, y) \right] \right. \\ \left. \text{SAY}_x \left[\left[\text{hero}(y) \right] \right] \right]$$

Now, it’s safe to assume that John used the word I to refer to himself, so $x = y$, which gets us the right truth conditions:

$$\rightsquigarrow \left[x \left[\text{john}(x), \text{say}(x, \ulcorner I \urcorner, x) \right] \right. \\ \left. \text{SAY}_x \left[\left[\text{hero}(x) \right] \right] \right]$$

Before addressing a number of prima facie objections, let’s take stock: instead of monsters (Schlenker 2003; Anand and Nevins 2004), complicated feature dele-

tion mechanisms (von Stechow 2002), or presupposed acquaintance relations plus introspection (Maier 2006), I now propose to analyze Amharic *I* in terms of an independently motivated, presuppositional, hybrid use-mention logic. The fact that only reportative contexts (not other intensional or extensional quantifiers, cf. fn. 2) can shift indexicals follows immediately from the inherently reportative nature of quotation.

I envisage three possible objections: (i) Amharic *I* cannot be quoted, since there are no quotation marks; (ii) a closer look at the morphology reveals that Amharic *I* is not even a word, it's a verb inflection, and surely we can't quote just an ending? (iii) the reference of a shifted indexical has become a purely pragmatic affair in the sense that extraordinary discourse contexts may make it refer to anything.

Ad (i), note that quotation marking does not coincide with quotation marks or fingerdance quotes. There are well-known constructions, even in English, that are completely unmarked, intonationally and orthographically, yet contain quotation marks semantically, e.g. *my name is Emar*. So, although in typical examples of mixed quotation (e.g. (2)) we mark the quoted words quite clearly, this may be just a means to draw attention to the peculiar or offensive choice of words in the original, and/or to emphasize the fact that these are not *your* words (i.e. your responsibility), but the other person's.

Objection (ii) can be brought out even clearer by the following example:

- (10) aləttazzəzəññ alə
 1.sg-will-not-obey-1.sg 3.sg.m-past-say
 'He_i said he_i would not obey me_j' [Amharic, Leslau 1995:779]

The complement in this Amharic speech report is a single word, literally meaning *I will not obey me*. Embedded in the report however, the first *I* (the subject) is interpreted as shifted, referring to the reported speaker, while the second rigidly refers to the reporter. The quotational account must therefore assume a logical form in which the morpheme corresponding to the subject is quoted while the other first person morpheme within the same word is not. Now, even if in written English quotation marks do not usually occur inside words, this is not really a problem, as we already noted that overtly written or spoken quotation marking need not coincide with semantic quotation. As remarked in section 2, in the hybrid account anything that corresponds to a semantic type, i.e. any morpheme, can in principle be quoted.⁴

Ad (iii), I concede that the current approach differs considerably from earlier accounts of shifted indexicality in this respect. On my account, a shifty Amharic *I*, i.e. a quoted *I*, refers to *the individual the reported speaker intended to refer to with her use of I*. Now, in most cases, people use first person pronouns correctly,

⁴In fact, as pointed out to me by Ede Zimmermann, the theory would even allow us to quote submorphemic constituents of words, as in *John said the ~~149~~ 'ag'mites' were falling down*. This should be fine because, as argued by Artstein (2002), although *mites* on its own is meaningless, it does contribute to the meaning of the whole word in a compositional fashion.

i.e. to refer to themselves, and our predictions coincide with e.g. Schlenker's. But one can imagine extraordinary speakers and contexts in which *I* is used to refer to something else, in the same way that Bush in (2) managed to use a non-word to mean *underestimate*. When one wants to report such a context in Amharic, the quotational account predicts that a shifted/quoted *I* would be able to pick up the reference originally intended (if those intentions are available in the common ground of the report situation), while Schlenker and the related semantic accounts would have it refer to the reported speaker regardless of her original intentions. Unfortunately, having no data on this matter, these diverging predictions currently serve merely to point out the difference between the pragmatic quotational account and the semantic monster accounts.

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Bibliography

- Anand, P. and Nevins, A.: 2004, Shifty operators in changing contexts, in R. Young (ed.), *Proceedings of SALT XIV*, CLC, Cornell, NY
- Artstein, R.: 2002, *Parts of Words: Compositional Semantics for Prosodic Constituents*, Ph.D. thesis, Rutgers
- Geurts, B. and Maier, E.: 2005, Quotation in context, *Belgian Journal of Linguistics* 17, 109–28
- Kaplan, D.: 1989, Demonstratives, in J. Almog, J. Perry, and H. Wettstein (eds.), *Themes from Kaplan*, pp 481–614, Oxford University Press, New York
- Leslau, W.: 1995, *Reference Grammar of Amharic*, Harrassowitz, Wiesbaden
- Maier, E.: 2006, *Belief in Context: Towards a unified semantics of de re and de se attitude reports*, Ph.D. thesis, Radboud University Nijmegen
- Maier, E.: 2007, Mixed quotation: between use and mention, in *Proceedings of LENLS 2007*, Miyazaki, Japan
- Oshima, D.: 2006, *Perspectives in Reported Discourse*, Ph.D. thesis, Stanford
- Potts, C.: 2007, The dimensions of quotation, in C. Barker and P. Jacobson (eds.), *Direct Compositionality*, pp 405–431, Oxford University Press
- Recanati, F.: 2001, Open quotation, *Mind* 110(439), 637–687
- van der Sandt, R.: 1992, Presupposition projection as anaphora resolution, *Journal of Semantics* 9, 333–77
- Schlenker, P.: 2003, A plea for monsters, *Linguistics and Philosophy* 26, 29–120
- von Stechow, A.: 2002, Binding by verbs: Tense, person and mood under attitudes, in M. Kadowaki and S. Kawahara (eds.), *Proceedings of NELS 33*, pp 379–403, GLSA, Amherst, MA

TENSE, ABILITIES AND ACTUALITY ENTAILMENT

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In French as in other languages differentiating the perfective and the imperfective morphologically, modal verbs sometimes behave like implicative verbs *in perfective sentences*. We present new data that previous accounts cannot explain. The offered analysis relies on a distinction between classical abilities and what we call action dependent abilities.

1. Introduction

As is well known, modal verbs differ from what Karttunen, 1971 calls implicative verbs in that they do not entail an event satisfying the property denoted by their infinitival complement (hence the possibility to deny the occurrence of an event of this type, cf. (1)) :

- (1) He could open the door [OK but he didn't do it]. (modal verb)
↯ He opened the door.
- (2) He managed to open the door [#but he didn't open it]. (implicative verb)
→ He opened the door.
- (3) He was managing to open the door [#but he wasn't opening it].
→ He partly opened the door.

However, in French as in several other languages differentiating the perfective and imperfective morphologically, modal verbs sometimes behave like implicative verbs *in perfective sentences* (Bhatt, 1999, Hacquard, 2006). This is at least the case on their so called circumstantial readings (among others the abilitative and the goal-oriented ones). On these readings, denying the truth of the infinitival complement results in a contradiction, cf. (4a) and (5a). Following Bhatt, 1999, we will say that in these cases, modal verbs trigger an "actuality entailment" (AE).

- (4) a. Marie a pu s'enfuir, #mais elle ne s'est pas enfuie. (abilitative reading)
Marie could.PERF. escape, # but she didn't do it.
- (5) a. La carte m'a permis d'entrer dans la bibliothèque, #mais je ne suis pas entrée. (goal-oriented reading)
The card permitted.PERF. me to enter the library, but I didn't do it.

The AE does not arise in perfective sentences (with the *passé composé*) on the deontic and epistemic readings, cf. (4b) and (5b), neither in imperfective sentences (with the

imparfait), on no matter which reading, cf. (4c) and (5c). Examples (4)-(5) are taken from Hacquard, 2006.

- (4) b. Marie a pu s'enfuir, comme elle a pu ne pas s'enfuir. (epistemic reading)
Marie could.PERF. have escaped, as she could have not escaped
c. Marie pouvait s'enfuir, OK mais elle ne s'enfuyait pas. (any reading)
Marie could.IMPERF. escape, OK but she didn't do it.
- (5) b. Le doyen m'a permis d'entrer dans la bib., OK mais je ne suis pas entrée.
(deontic reading)
The dean permitted.PERF. me to enter the library, OK but I didn't do it.
c. La carte/le doyen me permettait d'entrer dans la bibliothèque, mais je ne suis pas entrée. (any reading)
The card/the dean permitted.IMPERF. me to enter the library, OK but I didn't enter it.

2. Bhatt's and Hacquard's analyses

Bhatt multiplies lexical entries to explain these discrepancies in the semantic behavior of modal verbs. According to his analysis, modal verbs like *pouvoir* are in their circumstantial readings implicative verbs in disguise (or "fake" modal verbs). The AE of *pouvoir* under the relevant readings (4a) and (5a) comes then for free. He then explains why the AE vanishes in imperfective sentences by positing that imperfective morphology comes with an extra modal element, the generic operator GEN. As GEN does not require verifying instances (Krifka et al., 1995), no AE arises.

Hacquard sees two problems in Bhatt's analysis. Firstly, as pointed out by Bhatt himself, it predicts that indisputably implicative verbs like *réussir à* (*manage to*) lose their implicative behavior when combined with imperfective morphology, which is not the case (cf. (3)). Secondly, it leaves unexplained the robust cross-linguistic trend to use the same lexical item to express the whole set of readings illustrated in (4) and (5).

Hacquard keeps the Kratzerian view according to which modals share a core semantics in all their readings, and provide a structural account of the data, close in spirit to the one provided by Piñón, 2003.¹ Roughly, her threefold hypothesis is the following. 1° Despite aspectual/temporal morphology appearing on the modal itself, it is interpreted *below* the modal with deontic and epistemic readings, hypothesis supported by the English translation of (4b). On the contrary, it is interpreted *above* the modal with circumstantial readings. 2° The AE arises when aspect scopes above the modal only. 3° The AE does not arise in (4c) and (5c) because the imperfective morphology comes with an extra modal component (as in Bhatt's proposal).

¹Piñón, 2003 already provides a structural account in terms of scope. But contrary to Hacquard, he does not take address directly the aspectual difference between perfective and imperfective sentences (although nothing in his analysis prevents an extension of it to account for these facts).

3. Problems and new data

Hacquard's analysis is not completely satisfactory either for three reasons. Firstly, it does not solve the first problem of Bhatt (any verb, included implicative verbs, is predicted to lose its implicative behavior in imperfective sentences). Secondly, in order for the analysis sketched above to work into details, Hacquard adopts several non classical assumptions about Aspect.² Thirdly and more seriously, modals do not *always* trigger the AE in perfective sentences under their circumstantial readings, contrary to what Hacquard assumes. The AE can be cancelled in at least two cases. Firstly, the AE is not compulsory when the context provides elements (in italics in (6) and (7) below) helping to make clear that the circumstances (or the ability, the opportunity to reach the goal) are temporally bounded. For instance, the durative adverbial in (6) triggers the relevant (magical) context where the card enabled the agent to use the library only for a precise laps of time. In the case of (classical) abilities, weird contexts are often needed to conceive them as bounded (cf. (7)), but as soon as this special context is obtained, the AE disappears. Secondly, the AE is not automatically triggered either when the infinitival complement contains a stative predicate (cf. (8)). Note that if *avoir* is reinterpreted as a dynamic predicate (to mean *obtain*), the AE is again compulsory. It is thus the stativity which is responsible for the cancellation of the AE.

- (6) La carte a permis *pendant dix minutes seulement* d'entrer dans la bibliothèque. OK Mais stupidement je n'en ai pas profité.
The card permitted.PERF for ten minutes only to enter the library. But stupidly, I didn't enjoy the opportunity.
- (7) Notre nouveau robot a même pu repasser les chemises à *un stade bien précis de son développement*. OK Mais on a supprimé cette fonction (qui n'a jamais été testée) pour des raisons de rentabilité.
Our new robot could.PERF even iron shirts at a particular stage of its development. But we suppressed this function (which was never tested) for rentability reasons.
- (8) T'as pu avoir un repas gratuit, et tu ne t'es même pas levé !
You could.PERF have a meal for free, and you even didn't get up !

²1° Aspect is supposed to be base-generated as an argument of the verb, a position from which it needs to move out for type reasons (above or below the modal). 2° Aspect comes with its own world argument, which has to be bound locally. 3° This world argument must be bound by the modal if the modal is immediately above it (no AE arises), but cannot be bound by the modal if the modal is below it. In the latter case, the world argument of Aspect is bound by a matrix world binder (if the world argument of Aspect is the actual world, this yields the entailed event through a principle of event identification across worlds).

4. A semantic (non structural) account

The alternative analysis proposed here explain the (new) set of data presented above without assuming a structural (scopal) difference between the two sets of readings of modals. Like Hacquard, we keep Kratzer hypothesis that *pouvoir* is monosemous. However, contrary to the previous accounts, we do not assume that the imperfective morphologically systematically comes with a modal operator cancelling the AE triggered at the lexical level; the fact illustrated in (3) – implicative verbs keep their implicative behaviour in imperfective sentences – is not problematic anymore. We admit with Hacquard that the Perfect is interpreted below the modal in the epistemic reading (4a), since on this reading – and only this one –, the available paraphrase makes the alleged syntactical move transparent (on this reading, *a pu.PERF fuir* is perfectly paraphrasable by *peut avoir fui.PERF*).

There is an important property differentiating the *passé composé* and the *imparfait* which hardly plays a role in the previous accounts: sentences with the *passé composé* are *bounded* (they denote an event which has reached its final boundary)³, while sentences with the *imparfait* are *unbounded* (they denote an event which is by default supposed to continue afterwards). In a nutshell, our hypothesis is the following: *the AE is triggered when the eventuality described by the infinitive is the only one which can satisfy the "Boundedness Constraint" associated to the perfective* (HYP. 1). The proposed analysis rests on a distinction between two types of abilities, that we will introduce before showing how HYP. 1 can account for the data.

Generic abilities (GAs) correspond to the traditional conception (cf. eg Kenny, 1975): (i) GAs do not require verifying instances; (ii) GAs are ascribed to an agent *i* only if *i* could perform repeatedly the action if he wanted to; (iii) GAs are conceived by default as unbounded (if a GA is ascribed to *i* in *t*, it is typically assumed that *i* has the same GA in some $t' \supset t$).⁴ Now, let us suppose that this afternoon after lunch, Paul was able to hit three bull's eyes in a row. Besides, let us admit that this performance was not the result of a special training; therefore, Paul probably won't be able anymore to repeat its performance. On this use, *be able to* does not denote a GA, since (ii) is not fulfilled. What is proposed here is that on this use, the modal

³Note that this is true on the two readings of the *passé composé*. Used as a Perfect, it is a function which operates on an eventuality *v* and returns the result state *s'* of *v* (Kamp and Reyle, 1993). As de Swart, 2007 emphasises, on this use, it requires *v* to be bound, since it returns the resulting state of *v*. The *passé composé* also displays an aoristic reading (since the "pure" aoristic tense, the *passé simple*, is hardly used in spoken French). On this second use, the *passé composé* is a perfective past, and as the *passé simple*, denotes a bounded eventuality. Note that replacing the *passé composé* by the *passé simple* does not change anything to the contrasts above, which suggests that it is well and truly the *boundedness* (and not another feature of the Perfect) which plays a role here.

⁴Condoravdi already proposes to consider that *individual level predicates* (ILP) like *be intelligent* trigger an inference of this kind (and generic abilities are very similar to the dispositions denoted by ILP): "ILPs are associated with an inference of temporal persistence [...] [which] specifies the following: if an eventuality is going on at time *t* and you have no information that it is not going on at some later time *t'*, then infer it is going on at that later time *t'* as well. Note that this is a default inference, surfacing only if there is no information to the contrary."(Condoravdi, 1992, p.92)

verb denotes what we call an *action dependent ability* (ADA): (i') ADAs require an action to exist — actually, an ADA *ontologically depends* on the corresponding action;⁵ (ii') ADAs are weaker abilities than GAs because a unique and non repeatable performance suffices to imply the corresponding ADA⁶; (iii') ADAs have the same temporal boundaries than the action on which they depend and are thus bounded (Paul was able to hit three bull's eyes in a row exactly at the interval t he hit three bull's eyes in a row).

We can now see how HYP. 1 explains the relevant data. Let us first illustrate the idea with abilitative readings. Being imperfective, (4c) can easily describe an (unbounded) GA (cf. (iii) above), and thus does not force to assume a performance of this ability (cf. (i)). The AE is therefore not triggered. By contrast, being perfective, (4a) is by default understood as denoting an ADA, because ADAs are by definition bounded (cf. (iii') above). As an ADA taking place in t depends on a co-temporal action (cf. (i') and (iii')), (4a) entails an action in t .

The robot's example (7) contains a perfective sentence too. But it still manages to describe a GA, because the context helps to conceive the generic ability as bounded (the adverbial in italics cancels the inference triggered by default that the ability is temporally persistent). Thus, given (i) (GA does not require instances), the AE disappears. Finally, when the infinitival complement contains a stative predicate like in (8), it is even easier to avoid the interpretation where the modal verb denotes an ADA (and thus the AE), since there is no ADA without an action. However, if the stative predicate is coerced in an agentive one, then the modal verb has to be interpreted as denoting an ADA, and as a result, the AE is triggered.

Let us now turn to the non abilitative readings. The example (5b) does not yield an AE because the action a of the dean already provides the bounded v needed to satisfy the Boundedness Constraint associated to the perfective tense. By contrast, in (5a), the only candidate to fulfil this role is precisely an action a described by the infinitive (the only other possibility would be the state s of which the card is the Theme, but there is no reason to think that s is bounded). The AE is thus triggered. However, if the context indicates that the *situation* or the *opportunity* enabling the action a is itself already bounded, as in (6), then it is not necessary anymore to assume the occurrence of a to satisfy the Boundedness Constraint of the perfective tense.

⁵The dependence relation between an ADA and the action through which it occurs may be defined as a generation relation (Goldman, 1970), as a case of supervenience (Kim, 1974) or aggregation (Kratzer, 1989).

⁶Elgesem, 1997 already proposes that abilities do not always require repeatability.

In conclusion, it is possible to explain when and why implicative readings of modal verbs are compulsory without appealing to syntactical movements, on the basis of the classical semantic analysis of the perfective and imperfective tenses, and of a difference between two types of abilities.

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Bibliography

- Bhatt, R. (1999). *Covert Modality in Non-Finite Contexts*. PhD thesis, University of Pennsylvania.
- Condoravdi, C. (1992). Individual-level predicates in conditional clauses. Conference presented to the *LSA Meeting*, Philadelphia, PA.
- de Swart, H. (2007). A cross-linguistic analysis of the perfect. to appear in *Journal of Pragmatics*.
- Elgesem, D. (1997). The Modal Logic of Agency. *Nordic Journal of Philosophical Logic*, 2(2):1–46.
- Goldman, A. (1970). *A Theory of Human Action*. Prentice-Hall.
- Hacquard, V. (2006). *Aspects of Modality*. PhD thesis, Massachusetts Institute of Technology.
- Kamp, H. and Reyle, U. (1993). *From Discourse to Logic : Introduction to Model-theoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory*, volume 42 of *Studies in linguistics and philosophy*. Kluwer Academic, Dordrecht; Boston.
- Karttunen, L. (1971). Implicative verbs. *Language*, 47:340–358.
- Kenny, A. (1975). *Will, Freedom and Power*. Basic Blackwell, Oxford.
- Kim, J. (1974). Noncausal connections. *Noûs*, 8:41–52.
- Kratzer, A. (1989). An Investigation in the Lump of Thoughts. *Linguistics and Philosophy*, 12(5):607–653.
- Krifka, M., Pelletier, F. J., Carlson, G. N., ter Meulen, A., Chierchia, G., and Link, G. (1995). Genericity: An introduction. In Carlson, G. N. and Pelletier, F. J., editors, *The Generic Book*. University of Chicago Press, Chicago.
- Piñón, C. (2003). Being able to. In Garding, G. and Tsujimura, M., editors, *WCCFL Proceedings*, pages 384–397. Cascadilla Press, Somerville.

DYNAMICS OF REFLEXIVITY AND RECIPROCITY

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Plural reflexives and reciprocals are anaphoric not only to antecedent pluralities but also to relations between the members of those pluralities. In this paper, I utilize Dynamic Plural Logic (van den Berg 1996) to analyze reflexives and reciprocals as anaphors that elaborate on relations introduced by the verb, which can be collective, cumulative, or distributive. This analysis generalizes to languages like Cheyenne (Algonquian) where reflexivity and reciprocity are expressed by a single proform that I argue is underspecified, not ambiguous.

1. Introduction

While syntactic theories generally treat English reflexive and reciprocal anaphors as a natural class (Lees and Klima 1963; Pollard and Sag 1992, a.o.), their semantic connection has received little attention in formal semantics, with most studies focusing on reciprocals (Heim et al. 1991; Schwarzschild 1996; Dalrymple et al. 1998, a.o.). However, many languages express reflexivity and reciprocity with a single proform (Maslova *to appear*, a.o.). In this paper I propose an analysis in Dynamic Plural Logic (van den Berg 1996, henceforth DPIL) that makes the semantic parallel within and across languages explicit.

In the next section, I analyze transitive verbs in DPIL. Collective, cumulative, and distributive relations as well as the various scope options for the object are analyzed in terms of the DPIL distinction between the *global value* and the *dependent value* assigned to a variable by a *plural information state* (set of assignment functions).

In Section Three I analyze reflexives and reciprocals as anaphors that elaborate on the relations introduced by the verb. The same distinction between global and dependent values used to analyze transitive verbs also makes it possible to draw a semantic parallel between reflexives and reciprocals: they share a requirement on global values but have differing requirements on dependent values.

In Section Four, I extend this parallel to languages which express reflexivity and reciprocity with a single proform. Using data from Cheyenne, I show that treating such proforms as underspecified accounts for their reflexive, reciprocal, and mixed construals. This proposal also accounts for the possibility of *mixed elaboration* – a mixed construal made explicit by specification in subsequent discourse of different relations for different subgroups of the antecedent. Section Five is the conclusion.

2. Collectivity, Cumulativity, and Distributivity

According to Scha 1981, sentences with plural subjects and objects can be read collectively, cumulatively, or distributively. In addition, on a distributive reading the distributive operator can take either wide or narrow scope with respect to the object. Thus, (1) allows four readings, which can be disambiguated as in (2).

- (1) Sandy and Kathy lifted four boxes.
- (2) Sandy and Kathy . . .
- a. . . *together* lifted (a stack of) four boxes. (collective)
 - b. . . *between* them lifted (a total of) four boxes. (cumulative)
 - c. . . *each* lifted *the same* (stack of) four boxes. (narrow dist.)
 - d. . . *each* lifted a *possibly different* (stack of) four boxes. (wide dist.)

These four readings can be accounted for in DPIL if we assume that a transitive verb may optionally include an operator that distributes over the subject (δ_x) and that the scope of this operator may vary, as in (3).¹

- (3) Four translations of *lift*^{2,3}
- a. $lift_x^y \rightsquigarrow \epsilon_y \wedge Lxy$ (collective)
 - b. $lift_{\delta_x}^y \rightsquigarrow \delta_x(\epsilon_y) \wedge Lxy$ (cumulative)
 - c. $\delta_x(lift)^y \rightsquigarrow \epsilon_y \wedge \delta_x(Lxy)$ (narrow distributive)
 - d. $\delta_x(lift^y) \rightsquigarrow \delta_x(\epsilon_y \wedge Lxy)$ (wide distributive)

I assume the input to semantic composition to be an indexed string of morphemes interpreted left to right, where the translations are combined by dynamic conjunction (adapting Bittner 2007). In the indexed form, superscripts introduce new values for variables, subscripts indicate anaphora to the input values, and the indices x and y stand for the subject set and the object set, respectively.

In DPIL, *plural information states* (sets of assignment functions) encode the values for variables as well as the relations (*dependencies*) between these values. Thus, dependencies as well as values are transferred from state to state. The *global value* – i.e. the set of values assigned to a variable by a plural info state – is distinguished from a *dependent value* – i.e. a subset of the global value, restricted to a particular

¹For definitions, see van den Berg 1996, except for distributivity, where I assume the modified definition of Nouwen 2003.

²C.f. van den Berg 1996 (§5.4.2), who analyzes these using a ‘pseudo-distributivity’ operator which, for both the distributive and cumulative readings, scopes over both the variable introduction and the verb.

³The verb may also distribute over the object (δ_y). $\delta_y(lift_x)^y \rightsquigarrow \epsilon_y \wedge \delta_y(Lxy)$ yields a reading where Sandy and Kathy together lifted four boxes *one at a time*. (Including optional object-distributivity, there are eight translations for *lift*.)

value for another variable. This allows for a straightforward account of the four readings disambiguated in (2).

When the object variable is introduced (ϵ_y) in the scope of the distributive operator (as in (3b,d)), different y values can be introduced for each x value. Thus Sandy and Kathy can pick up different boxes on the cumulative and wide distributive readings (2b,d). If the object variable is introduced outside the scope of the distributive operator (as in (3a,c)), the y values must be the same for all x values. Thus, on the collective and narrow distributive readings (2a,c), both Sandy and Kathy pick up the same four boxes.

When the verbal relation is outside the scope of distributivity (as in (3a,b)), then the relation holds between the global value of x and the global value of y . Thus, on the collective and cumulative readings (2a,b), the plurality of Sandy and Kathy picks up the plurality of the boxes. When the verbal relation is in the scope of distributivity (as in (3c,d)), then for each x value the relation holds between that value and its dependent y values. Thus, on distributive readings (2c,d), Sandy picks up her four boxes and Kathy picks up hers.

The translations of these four readings are given in (4). The NP (4i) and the VP (4ii) are combined by dynamic conjunction (\wedge).

- (4) i. *Sandy and Kathy* . . . \rightsquigarrow
 $+ [v = s] \wedge \epsilon_x \wedge x = v \oplus w \wedge + [w = k]$
 ii. . . *lifted four boxes* \rightsquigarrow
 $\epsilon_y \wedge Lxy \wedge 4y \wedge \delta_y(By)$ (collective)
 $\delta_x(\epsilon_y) \wedge Lxy \wedge 4y \wedge \delta_y(By)$ (cumulative)
 $\epsilon_y \wedge \delta_x(Lxy) \wedge 4y \wedge \delta_y(By)$ (narrow distributive)
 $\delta_x(\epsilon_y \wedge Lxy \wedge 4y \wedge \delta_y(By))$ (wide distributive)

As noted by van den Berg 1996, plural anaphora respects the relations introduced in antecedent discourse. For example, in the context of the wide distributive reading of (1), the sentence *They brought them upstairs* is read analogously, i.e. *Sandy and Kathy each brought her stack of four boxes upstairs*.

3. Reflexive and Reciprocal Anaphors

In some languages, reflexivity and reciprocity are expressed by means of distinct proforms. For example, English *themselves* expresses reflexivity while *each other* expresses reciprocity. I analyze such anaphors as elaborating on the dependencies introduced by the verb. I propose that they share an identity requirement on global values (*global identity*) but differ in their requirements on dependent values (*distributive overlap* vs. *distributive non-overlap*). These requirements also determine which readings of the verb are compatible with which proform.

The proposed translations of the English plural reflexive and reciprocal are given in (5) and (6) respectively. The translation of the singular reflexive pronoun (e.g. *himself*) would differ from (5) only in number.

$$(5) \quad \textit{themselves}_{y,x} \rightsquigarrow +[PLy] \wedge +[y = x] \wedge +[\delta_y(y \circ x)]$$

$$(6) \quad \textit{each other}_{y,x} \rightsquigarrow +[y = x] \wedge +[\delta_y(y \oslash x)]$$

According to (5), the plural reflexive presupposes (+) plurality, like non-reflexive plural pronouns, as well as global identity and distributive overlap. The reciprocal (6) has two presuppositions: global identity, like reflexives, and distributive non-overlap (the plurality requirement follows). The shared presupposition of global identity requires that two arguments of the verb (here, the subject x and the object y) denote the same set.⁴ The distributive conditions impose further constraints on the dependencies between x and y that were introduced by the verb.⁵

The relations introduced by the verb may be elaborated on not only sentence-internally but also by subsequent discourse. For example, in discourse (7) the interpretation of sentences (7ii) and (7iii) depends on the relations introduced in (7i) by the verb and elaborated on by the reciprocal object. That is, each girl borrowed an outfit from the girl she dressed up as and returned that outfit to that girl.

- (7) i. Some girls dressed up like each other (for Halloween).
 ii. They borrowed outfits from each other.
 iii. (The next day,) they returned them.

Crucially, both the plurality of girls and the relations between them are passed on from (7i) to the subsequent discourse. If only the values were passed on, then the relations between the individual girls could be different in subsequent sentences.

These observations can be captured by the following analysis of discourse (7) (where $D = \textit{dress.up.like}$, $B = \textit{borrow.from}$, and $R = \textit{return}$):

- (8) i. $\epsilon_x \wedge \delta_x(Gx) \wedge PLx \wedge \delta_x(\epsilon_y \wedge Dxy) \wedge +[y = x] \wedge +[\delta_y(y \oslash x)]$
 ii. $+ [PLx] \wedge \delta_x(\epsilon_z \wedge Bxyz) \wedge \delta_z(Oz) \wedge PLz \wedge +[y = x] \wedge +[\delta_y(y \oslash x)]$
 iii. $+ [PLx] \wedge \delta_x(Rxzy) \wedge + [PLz]$

4. Reflexive/Reciprocal Underspecification

In contrast to English, many languages express reflexivity and reciprocity with a single proform. One such language is Cheyenne, which expresses both with the verbal affix *-ahte*. For example, Cheyenne (9) can be translated into English with a reflexive object, as in (10), or a reciprocal object, as in (11).

⁴Translations of the English reflexive and reciprocal without global identity, i.e. $\textit{themselves}_{y,x} \rightsquigarrow +[PLy] \wedge +[\delta_y(y \circ x)]$ and $\textit{each other}_{y,x} \rightsquigarrow +[\delta_y(y \oslash x)]$, would incorrectly allow for different members in the argument (x and y) sets.

⁵For the reflexive, a translation with distributive identity as opposed to distributive overlap, i.e. $\textit{themselves}_{y,x} \rightsquigarrow +[PLy] \wedge +[y = x] \wedge +[\delta_y(y = x)]$, would incorrectly preclude a collective interpretation of the verb (e.g., *the students praised themselves*). For the reciprocal, a translation with distributive non-identity as opposed to distributive non-overlap, i.e. $\textit{each other}_{y,x} \rightsquigarrow +[y = x] \wedge +[\delta_y(y \neq x)]$, would incorrectly allow a (subject-)collective interpretation of the verb.

(9) *ka'éskone-ho é-axeen-ah̄tse-o'o*
 child-PL.AN 3-scratch.AN-ah̄tse-3PL.AN

(10) The children scratched *themselves*

(11) The children scratched *each other*

In addition to allowing both a reflexive and a reciprocal construal, Cheyenne (9) allows a mixed construal, which is partially reflexive and partially reciprocal. On a mixed construal, (9) can refer to a group of children, some of whom scratched each other while others scratched themselves.

I propose that such proforms have only the global identity presupposition of the English anaphors. Thus, Cheyenne *-ah̄tse* has the following translation:

(12) *-ah̄tse* \rightsquigarrow $+[y = x]$

The translation (12) correctly allows the antecedent to be a singleton. For plural sets, the relations between the members are not specified, allowing for various construals. In particular, (13i) (= (9)) admits a mixed construal, compatible with (13ii).

(13) i. *ka'éskone-ho é-axeen-ah̄tse-o'o* = (9)
 child-PL.AN 3-scratch.AN-ah̄tse-3PL.AN
 ii. *hetané-ka'éskone-ho é-axeen-ah̄tse-o'o naa*
 man-child-PL.AN 3-scratch.AN-ah̄tse-3PL.AN CNJ
hé'é-ka'èškóne-ho noná-mé'tó'e é-axeen-ah̄tse-o'o
 woman-child-PL.AN noná-NON.ID 3-scratch.AN-ah̄tse-3PL.AN

The conjunction (13ii) is a *mixed elaboration* of (13i), specifying a reflexive relation for the subgroup of the boy and a reciprocal relation for the subgroup of the girls. It is difficult to translate the Cheyenne discourse (13) into English. The least awkward translation is (14), where Cheyenne (13i) is rendered as (14i), without any object:

(14) i. The children *were scratching*.
 ii. The boy scratched *himself* and the girls scratched *each other*.

(15) i. The children scratched {*themselves, each other*}
 # ii. The boy scratched *himself* and the girls scratched *each other*.

If there is a reflexive or reciprocal object, as in (15i), then mixed elaboration is infelicitous (#).⁶ However, discourses parallel to Cheyenne (13) are acceptable in other languages which express reflexivity and reciprocity with a single proform. This holds regardless of the morphological category of the proform: it can be an affix, like Cheyenne *-ah̄tse*, a clitic, such as Polish *się* (Bittner, p.c.), Romanian *se* (Brasoveanu, p.c.), and French *se* (Déprez, p.c.), or an independent word, like German *sich* (Tonhauser, p.c.). The present proposal is a step toward understanding this cross-linguistic pattern.

⁶A discourse like (15) may be acceptable with 'themselves' on a collective interpretation. The proposed analysis of reflexives is compatible with collective translation of the verb: see Sections 2 and 3.

5. Conclusion

The DPIL distinction between global and dependent values allows a semantic parallel to be drawn between reflexive and reciprocal anaphors. Such anaphors are sentence-internal elaborations of the relations introduced by the transitive verb. These relations, which can be collective, cumulative, or distributive, can also be elaborated on in subsequent discourse. This analysis generalizes to languages that express reflexivity and reciprocity with a single proform. Such proforms are not ambiguous, but underspecified. They presuppose only global identity with the antecedent set, allowing singular antecedents as well as mixed construals.

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Bibliography

- van den Berg, M.: 1996, *Some Aspects of the Internal Structure of Discourse*, Ph.D. thesis, ILLC, University of Amsterdam, Amsterdam
- Bittner, M.: 2007, Online update: Temporal, modal and de se anaphora in polysynthetic discourse, in C. Barker and P. Jacobson (eds.), *Direct Compositionality*, Chapt. 11, pp 363 – 404, Oxford University Press, New York
- Dalrymple, M., Kanazawa, M., Kim, Y., Mchombo, S., and Peters, S.: 1998, Reciprocal expressions and the concept of reciprocity, *Linguistics and Philosophy* 21(2), 159–210
- Heim, I., Lasnik, H., and May, R.: 1991, Reciprocity and plurality, *Linguistic Inquiry* 22(1), 63–101
- Lees, R. B. and Klima, E. S.: 1963, Rules for English pronominalization, *Language* 39, 17–28
- Maslova, E.: *to appear*, Reflexive encoding of reciprocity, in E. König and V. Gast (eds.), *Reciprocals and Reflexives*, Mouton de Gruyter
- Nouwen, R.: 2003, *Plural Pronominal Anaphora in Context*, University of Utrecht, Graduate School of Linguistics Dissertations, LOT, Utrecht, The Netherlands
- Pollard, C. and Sag, I. A.: 1992, Anaphors in english and the scope of binding theory, *Linguistic Inquiry* 23, 261–303
- Scha, R.: 1981, Distributive, collective and cumulative quantification, in M. Stokhof and T. Janssen (eds.), *Formal Methods in the Study of Language*, pp 483–512, Mathematisch Centrum, Amsterdam 162
- Schwarzschild, R.: 1996, *Pluralities*, Kluwer Academic Publishers, Dordrecht

MASS NOUNS AND PLURAL LOGIC

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Abstract There are two main approaches to the semantics of mass nouns (cf. Bunt 1985, Pelletier & Schubert 1989). One uses sets as their semantic values, the other uses mereological sums. Both face difficult problems, notably with sentences like *The gold on the table weighs seven ounces* (Bunt 1985) and *The clay that made up those three bowls is identical with the clay that now makes up these two statues* (cf. Cartwright 1965). We propose a new theory able to solve these problems, in a framework different from predicate logic, called plural logic. Our semantics is faithful to the intuition that, if there are eight pieces of silverware on a table, the speaker refers to eight things at once when he says: *The silverware that is on the table comes from Italy*.

1. Introduction

Former approaches to the semantics of mass nouns either use sets or mereological sums as their semantic values. They face serious difficulties (cf. Bunt 1985, Pelletier & Schubert 1989). To address those, we propose a new theory, in a framework different from predicate logic, called plural logic.

2. Former approaches

2.1. The set approach to mass nouns

The set approach to mass nouns (e.g. Strawson 1959, Laycock 1972) treats them as predicates. (1) *This is wine* is true if and only if $I(\textit{this}) \in I(\textit{wine})$, where I is the interpretation function, $I(\textit{this})$ is what is demonstrated, and $I(\textit{wine})$ is the set of everything that can be said to be wine.

The question is then how to treat mass nouns in definite descriptions, as in (2) *The gold on the table weighs fifty grams* (Bunt 1985). If the description denotes the set having for element anything that is gold on the table, then how can we evaluate

the truth of the sentence? It would not do to give the sum of all weights. So we must impose restrictions on the elements of the set $I(\textit{the gold on the table})$.

Now comes a second difficulty concerning identity over time. Consider: (3) *The clay that made up those three bowls is identical with the clay that now makes up these two statues.* Which set could make $I(\textit{the clay that made up those three bowls}) = I(\textit{the clay that now makes up these two statues})$ true?

What about the set of all minimal parts of gold, i.e. the set of all the instances of gold that have no other instance of gold as part? However, with mass nouns like *garbage*, it is not clear what the minimal parts would be (cf. Pelletier & Schubert). Moreover, mass nouns like *time* and *space* do not seem to have minimal parts. So the semantics of mass nouns should not require them to have some.

2.2. The mereological approach to mass nouns

The mereological (or lattice-theoretic) approach to mass nouns (e.g. Link 1983, Gillon 1992) focuses first on mass nouns in definite descriptions. When M is a mass noun, it takes the definite noun phrase *the M that Qs* to refer to the mereological sum of everything that is some M that Qs. It is such a sum that is weighted in sentence (2), and whose identity over time is asserted in (3).

But (1) must still be dealt with. The proposal is this. (1) is true if and only if $I(\textit{this}) \leq I(\textit{wine})$, where \leq is the relation of parthood, $I(\textit{this})$ is what is demonstrated, and $I(\textit{wine})$ is the mereological sum of everything that is wine.

This yields a new problem with minimal parts. An atom of hydrogen is not water, though it is part of a molecule of H₂O. More strikingly, a leg of a chair is not furniture, though it is part of a chair, and a chair is some furniture (Bunt 1985).

Moreover, sentences containing mass nouns (just like sentences containing plurals) are liable to so-called collective, distributive, and intermediate construals (cf. Gillon). Thus, (4) *This silverware costs a hundred euros* may be true if the silverware costs, all together, a hundred euros (collective construal). It may be true if each piece of silverware costs a hundred euros (distributive construal). It may also be true if the silverware demonstrated consists in two sets of silverware, each set costing a hundred euros (intermediate construal). To capture these construals, a notion of covering akin to that proposed by Gillon is needed, and to express this notion, the apparatus of sets, or something as expressive, is required: mereological sums are not enough. Gillon's approach is thus mixed, being based on mereological sums, but using sets for coverings. (NB: Gillon uses the term *aggregation* instead of *covering*.)

The mereological approach (be it Link's or Gillon's) faces two additional, independent problems. Consider a sentence that could be taken from *Animal farm*,

George Orwell's novel: (5) *The livestock met on the hill*. The approach takes it to be true if and only if the mereological sum of the livestock met on the hill. But the right-hand side of this bi-conditional is in fact very odd: the English predicate *meet* does not seem to apply to mereological sums.

Finally, in a given circumstance, it may be that the mereological sum of the M is identical with the sum of the N (where *M* and *N* are two mass nouns), yet the sentences *The M Qs* and *The N Qs* have, intuitively, opposite truth-values. Thus, suppose that some wood of a given kind (e.g. some elm) is used to make furniture of different styles. Then intuitively, the sentence (6) *The furniture is heterogeneous* would be true, while (7) *The wood is heterogeneous* would be false. But furniture and wood have the same sum, so the theory predicts that (6) and (7) should have the same truth-value.

3. A new approach based on plural logic

We propose a new approach to solve these difficulties. Its starting point is the intuition that, if there are three solid bits of gold on the table, then the subject noun phrase of sentence (2) refers to three things at once. It is these three things that are jointly weighted. This makes mass nouns very similar to plurals, though not identical with them. (NB: Mass nouns are invariable in grammatical number. Therefore, it is coherent to suppose that number has no semantic value with these nouns.¹)

Now, Oliver & Smiley (2001) and Rayo (2002) have shown that, if we acknowledge that it is possible to quantify over absolutely everything there is, the semantics of plurals should not be characterized using predicate logic and sets. Indeed, some intelligible sentences containing plurals would be represented in a contradictory way. On the other hand, if one employed mereological sums and predicate logic, the semantics of plurals would turn out to be too weak. To avoid this, they propose to use plural logic. Plural logic contains plural terms (like 'as') that can refer to several things at once (to a "plurality of things"). A sentence where the predicate applies to a plural term is true when the objects that interpret the term satisfy together (collectively) the predicate. Plural logic also contains "superplural" terms (like 'css'), which can

¹ A difference between English and French confirms this. In English, mass nouns tolerate only determiners that can also be used with plurals: *some, all, any, the*. Not so in French, where the determiner must be singular: *de l'or / *des or* (some gold), *tout or / *tous or* (all / any gold), *l'or / *les or* (the gold). Moreover, mass expressions and plurals often seem to be co-referential: *The silverware is in the drawer / The pieces of silverware are in the drawer*. Strikingly, French possesses both a mass noun (*meuble*) and a count noun (*meuble*) that refer to pieces of furniture. Like their invariability with respect to number, all these data suggest that grammatical number has no semantic implications for mass nouns.

refer to “several pluralities” at once.²

We use plural logic to have a common framework for mass nouns and plurals, in which a mass expression may refer to several things at once. The denotation of a mass noun M is identified by a plural term, ‘ds’: some thing is M just in case it is one of the ds. Then sentence (1) is true just in case the things referred to by *this* are among the ds.

To deal with examples like (6) and (7), we first remark that if the furniture is cut into pieces, it is destroyed, but the wood remains. So a semantics of mass nouns should not identify furniture and wood. Typically, the parthood relation is taken to be extensional, which forces the identification of the two (Parsons 1970). To avoid this, we make the parthood relation a partial ordering, but require it to satisfy the axiom of strong complementation (cf. Simons 1987) only relative to any given mass noun M :

$$\forall u \forall v ((Mu \wedge Mv \wedge \neg (u \leq v)) \rightarrow \exists x (Mx \wedge x \leq u \wedge \neg \exists y (y \leq x \wedge y \leq v)))$$

In this way, our theory can coherently deny that the furniture is identical to the wood that makes it up.

The remaining problems concern definite descriptions. They are dealt with by requiring mass nouns to satisfy additional axioms (which are stated precisely in the *Appendix*). A definite mass noun phrase like *the gold on the table* refers to several things, the as. The axioms say that each of them is M (e.g., each is gold), self-connected (of a single piece, cf. Casati & Varzi 1999), and maximal for the relation of parthood. Each is, for instance, one of the solid bits of gold that are on the table.

The interpretation of (2) is then relative to the choice of a covering of the as. A covering of the as is given by a “plurality of pluralities”, the css. The sentence says, of each “plurality” of this covering, that the things that make up this “plurality” weigh seven ounces together. Among the various construals of the sentence, the collective one is of course the most salient (the other construals requiring much more context to become available). It is obtained when the covering contains only one “plurality”, the as themselves. The sentence says that the as (the solid bits of gold) weigh seven ounces together.

This applies straightforwardly to (4), which indeed motivated the need for coverings, and to (5). It also yields a satisfactory semantics for (3). The sentence is made true by a suitable choice of covering, the css, each of which is some clay that has retained its identity over time. (This does not require the existence of minimal parts.) At a previous time, the css together made up three bowls. They have been rearranged,

² This is only loosely speaking. In plural logic, no object is a “plurality” or a “plurality of pluralities”. But plural logic contains stronger forms of reference than singular reference: plural reference (to several things at once), and superplural reference (on the latter see Rayo 2006 and Linnebo & Nicolas 2008).

shuffled, so as to now make up two statues.

Moreover, the framework also applies to quantified statements, like (8) *All phosphorus is either red or black*. Roeper (1983) thought that this kind of example was problematic for set-theoretic approaches of mass nouns. In the present account, the sentence is made true by a covering that is a bi-partition of all the phosphorus, such that the bits of phosphorus in one “plurality” of this covering are red, while the other bits of phosphorus are black.

4. Conclusion

Set-theoretic and mereological approaches to the semantics of mass nouns face difficult problems, notably with sentences (1) to (8). Using plural logic, we have proposed an account able to solve these difficulties. The key was to define a notion of *covering* applicable to things that do not have a mereological sum. This allowed us to devise a semantics where mass nouns may refer to several things at once, while dealing satisfactorily with these difficulties. (For considerably more details from a partly different perspective, and for acknowledgements, see Nicolas, manuscript.) This semantics is faithful to the intuition that, if there are eight pieces of silverware on a table, the speaker refers to eight things at once when he says (9) *The silverware that is on the table comes from Italy*, and that in this particular case, he might as well have said (10) *The pieces of silverware that are on the table come from Italy*.

5. Appendix: main technical notions employed in our semantics for mass nouns

Maximal elements:

$$ys = \max[zs / Qzs] \equiv_{\text{def}} \forall zs \forall u ((Qzs \wedge u \angle zs) \rightarrow \exists v (v \angle ys \wedge u \leq v))$$

$$\wedge \forall v (v \angle ys \rightarrow \exists zs (v \angle zs \wedge Qzs)) \wedge \neg(\exists u \exists v (u \angle ys \wedge v \angle ys \wedge u \neq v \wedge O_{uv}))$$

Among the *zs* that *Q*, the *ys* are the maximal elements for the relation of parthood.

Axioms:

$$\forall zs (Mzs \rightarrow \forall x ((x \angle zs) \rightarrow Mx)) \quad \text{If some things are } M, \text{ each of them is } M.$$

$$\forall x (Mx \rightarrow \text{self-connected}(x)) \quad \text{If something is } M, \text{ it is self-connected.}$$

$$\exists zs (Mzs \wedge Qzs) \rightarrow \exists ys (ys = \max[zs / Mzs \wedge Qzs])$$

Guarantees that *the gold on the table* refers to the three solid bits of gold on the table.

Covering: the *css* are a covering of the *as* just in case:

$$\text{i) Any of the } \textit{css} \text{ is } M: \quad \forall x (x \angle^{\circ} \textit{css} \rightarrow Mx)$$

ii) For anything *x*, *x* overlaps one of the *css* iff *x* overlaps one of the *as*:

$$\forall x (\exists v (v \angle^{\circ} \textit{css} \wedge O_{xv}) \leftrightarrow \exists w (w \angle \textit{as} \wedge O_{xw}))$$

Truth-conditions of a sentence of the form ‘The M that Qs Ps’:

Let the *as* be the denotation of *the M that Qs*. They satisfy: $as = \max[zs / Mzs \wedge Qzs]$.
The interpretation of the sentence depends on the choice of a covering of the *as*.
Let the *css* be the chosen covering. The sentence is true if and only if the predicate *P*
applies to “each plurality” in the covering: $\forall ys (ys \angle' css \rightarrow Pys)$

Truth-conditions of ‘All M Ps’:

Let the *ds* be the denotation of the mass noun *M*. The interpretation of the sentence is
relative to the choice of a covering of the *ds* containing at least two “pluralities”.
Let the *css* be the chosen covering. The sentence is true if and only if the predicate *P*
applies to “each plurality” in the covering: $\forall ys (ys \angle' css \rightarrow Pys)$

Bibliography

- Bunt, H. C.: 1985, *Mass Terms and Model-Theoretic Semantics*, CUP
Casati, R. and Varzi, A.: 1999, *Parts and Places*, MIT Press
Gillon, B. S.: 1992, Towards a common semantics for English count and mass nouns,
Linguistics and Philosophy 15, 597-639
Laycock, H.: 1972, Some questions of ontology, *Philosophical Review* 81, 3-42
Link, G.: 1983, The logical analysis of plurals and mass terms: A lattice-theoretical
approach, in R. Bauerle, C. Schwartze and A. von Stechow (eds.), *Meaning, Use
and Interpretation of Language*, 302-323, de Gruyter
Linnebo, Ø. and Nicolas, D.: 2008, Superplurals in English, *Analysis* 68(3)
Nicolas, D.: Manuscript, Mass nouns and non-singular logic,
<http://d.a.nicolas.free.fr/research/papers.htm>
Oliver, A. and Smiley, T.: 2001, Strategies for a Logic of Plurals, *Philosophical
Quarterly* 51, 289-306
Parsons, T.: 1970, An analysis of mass and amount terms, *Foundations of Language* 6,
363-388
Pelletier, J. F. and Schubert, L. K.: (1989), Mass expressions, in D. Gabbay and
F. Guenther (eds.), *Handbook of Philosophical Logic*, 327-407, D. Reidel
Rayo, A.: 2002, Word and objects, *Noûs* 36, 436-464
Rayo, A.: 2006, Beyond plurals, in A. Rayo and G. Uzquiano (eds.), *Absolute
Generality*, OUP
Roeper, P.: 1983, Semantics for mass terms with quantifier, *Noûs* 17, 251-265
Simons, P.: 1987, *Parts: A study in ontology*, OUP
Strawson, P.: 1959, *Individuals*, Methuen

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There are two influential assumptions about Hungarian focus interpretation: i) in Hungarian two types of focus (information and identificational focus) are distinguished and ii) the pre-verbal focus in Hungarian has a strictly exhaustive reading encoded in a covert operator. In this paper I will sketch an alternative analysis of the Hungarian data showing that neither of the two assumptions needs to be maintained. I will argue that the particularities of “Hungarian focus” can be best accounted for by assuming presuppositional effects related to word order at the level of the verbal predicate.

1. Introduction

In Hungarian focussed expressions may occur in immediate pre-verbal position as shown in (1) or in a post-verbal position as shown in (2).

- (1) *Péter* [*Marit*]_F *csókolta* *meg*.
 Peter Mary.ACC kissed VM.
 ‘Peter kissed MARY.’
- (2) *Péter* *meg-* *csókolta* [*Marit*]_F.
 Peter VM kissed Mary.ACC
 ‘Peter kissed MARY.’

Syntactically the essential difference between pre- and post-verbal focus is that verbal prefixes acting as verbal modifiers (glossed: VM) must appear in post-verbal position if the focus is pre-verbal. Semantically the essential difference is that pre-verbal focus is assumed to be strictly exhaustive while post-verbal focus need not have an exhaustive interpretation. In view of examples like (3), it has been argued that the exhaustive interpretation of pre-verbal focus must be semantically encoded in form of a covert operator as shown in (4) which can interact with negation (cf. Szabolcsi 1981).

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- (3) *Nem [Péter]_F aludt a padlón, hanem [Péter és Pál]_F (aludt a padlón).*
 Not Peter slept the floor-on but Peter and Paul slept the floor-on
 ‘It isn’t Peter who slept on the floor; it’s Peter and Paul who slept on the floor.’
- (4) $\lambda P \lambda x (P(x) \wedge \forall y P(y) \rightarrow y = x)$

While Kenesei (1998), É.Kiss (1998, 2002) and others defend this solution (with minor modifications) and Wedgwood (2005) argues against it, Horvath (2005) claims that such an operator is needed independently of focus. In this paper I will argue that in order to account for the clearly distinct semantic and pragmatic effects related to the pre- or post-verbal focus in Hungarian neither the assumption that identificational focus (i.e. the pre-verbal focus) is associated with a covert operator nor the assumption that the Hungarian focus position bears an exhaustivity operator are necessary. My claim is that the particularity of Hungarian is that in case of a VM-V word order the event introduced by the verb must be asserted and cannot be interpreted anaphorically. Given this assumption, the specific focus effects discussed in the literature can be derived by standard Alternative Semantics and pragmatic reasoning.

2. Verbal modifiers, incorporation and event anaphora in Hungarian

VM are immediately pre-verbal in Hungarian, except in *wh*-questions, after negation or in the presence of pre-verbal focus. But there is reason to believe that if the event must be interpreted anaphorically VM-V word order is excluded as shown in the contrast between (5), in which the question must be interpreted as referring to the event introduced before, and (6) in which the question cannot refer to the same event:

- (5) *Péter meg- sebesült. A tegnap sebesült meg Péter?* $e_1 = e_2$
 Peter VM hurt the yesterday hurt VM Peter
 ‘Peter got hurt. Did Peter get hurt yesterday?’
- (6) *Péter meg- sebesült. A tegnap meg- sebesült Péter?* $e_1 \neq e_2$
 Peter VM hurt the yesterday VM hurt Peter
 ‘Peter got hurt. Did Peter get hurt yesterday (too)?’

Based on these observations I conclude that if the word order is V-VM the verb introduces its event referent as part of the presupposition and if the word order is VM-V the verb introduces an event that may not be part of the presupposition. This can be modelled by assuming that the verb moves to some PresP if its event is presupposed. But of course, if there is no VM in the sentence, there is no overt difference in the structure.

Note that the reason for verb-movement is the fact that it refers to a presupposed event and not the presence of focus. Crucially, however, if the focus marks an answer to a question, then the verb is interpreted anaphorically as referring to the event in question and in this case movement is necessary. This does not apply for other foci.

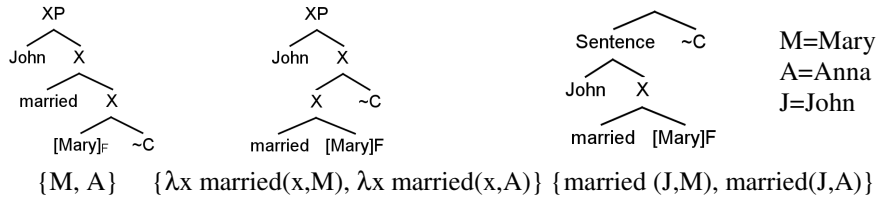
This analysis assumes verb movement and contrasts with the mainstream view that VM are generated post-verbally and prevented by focus to move to a pre-verbal position. The major advantage of this analysis has nothing to do with focus but with incorporation. Incorporated bare nouns syntactically behave like VM. Farkas & de Swart (2003) argue that incorporation of bare singulars in Hungarian happens in the pre-verbal position, since here a special compositional rule (unification) applies. If we assume VM-movement that would be blocked by pre-verbal focus, incorporation would be ruled out in the presence of pre-verbal focus. But incorporated bare singulars are possible in a post-verbal position even with pre-verbal focus. Under the V-movement analysis proposed here, however, bare nouns or VM stay at the same position regardless of focus and incorporation is hence predicted to be possible independently of focus.

3. Focus interpretation

I assume Alternative Semantics as the focus interpretation mechanism. As shown by Rooth (1992) focus generates a set of alternatives and introduces a presupposition on a set-variable $\sim C$ at the level at which focus gets interpreted. This presupposed variable must be satisfied by the context. One typical case is the question-answer paradigm:

- (7) Q: Who did John marry? = φ_1
 A: John married [Mary]_F. = φ_2
 $\|\varphi_1\|^0 = \{\text{John married Mary, John married Anne, John married Jeanette ...}\}$
 $\|\varphi_2\|^0 = \text{John married Mary}$
 $\|\varphi_2\|^A = \{\text{John married } x|x \in D_e\}$
 $\sim C: C \subseteq \|\varphi_2\|^A, \|\varphi_2\|^0 \in C, \exists p[p \neq \|\varphi_2\|^0 \wedge p \in C]$ - the presupposed variable.
 $\|\varphi_1\|^0$ satisfies the conditions on C, it is an available discourse antecedent.

The focus-presupposition may arise at different syntactic positions:



4. Pre-verbal and post-verbal focus in Hungarian

As often claimed in the literature, pre-verbal (identificational) focus is exhaustive while post-verbal (information) focus needn't be exhaustive in Hungarian. While I accept this descriptive observation I will argue that this does not justify the distinc-

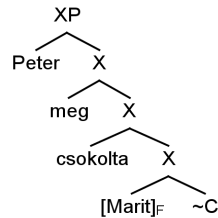
tion between two types of foci. My claim is that only the level at which focus is interpreted differs. The crucial observation is that post-verbal focus cannot be interpreted as an answer to a question but rather needs some lower level contrast:

- (8) [?]*Kit csókolt meg Péter? Péter meg- csókolta [Marit]_F.*
 Who kissed VM Peter Peter VM kissed Mary.ACC
 ‘Who did Peter kiss? Peter kissed MARRY.’

According to the assumed focus interpretation mechanism this means that post-verbal focus in Hungarian is interpreted at a lower level because if focus were interpreted at the sentence level it would presuppose a set of propositions, and thus would be a good answer to a question. On the one hand, this is not surprising, since the sentence contains an asserted verbal predicate and hence the event of the sentence must differ from the event under question. However this is not the proper explanation of the observation, since otherwise post-verbal focus should be possible with V-VM word order, which is not the case. Therefore I assume that in Hungarian focus-presupposition may not be projected over any verbal predicate. The observation that an asserted verbal predicate is incompatible with an answer to a *wh*-question, on the other hand, rules out pre-verbal focus with VM-V word order.

The clear difference between information (post-verbal) focus and identificational (pre-verbal) focus can be hence easily explained without assuming different kinds of mechanisms for focus interpretation. In (9) we present the case of post-verbal focus.

- (9) *Péter meg- csókolta [Marit]_F.*
 Peter VM kissed Mary.ACC
 ‘Peter kissed Mary’

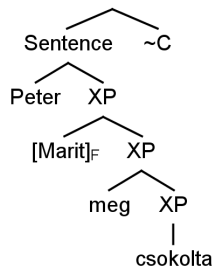


If the focus is post-verbal the verb is asserted. Because the presupposition cannot project over the asserted verb, focus generates a presupposition at the level of the DP and the alternatives are {Anna, Mary, Jane, Diana etc.} In this case, the presupposition cannot be satisfied by a question (or a VP operator) and hence a contrastive element must be introduced at the DP level as shown in (10), which is a very natural continuation of (9).

- (10) *Péter meg- csókolta [Marit]_F, és János meg- csókolta [Annát]_F.*
 Peter VM kissed Mary.ACC and John VM kissed Anna.ACC
 ‘Peter kissed MARY and John kissed ANNA.’

In the case of pre-verbal focus the situation is completely different as shown in (11):

- (11) *Péter [Marit]_F csókolta meg.*
 Peter Mary.ACC kissed VM
 ‘Peter kissed Mary’



Here the focus is interpreted at the sentence level and hence the alternatives are: {Peter kissed Mary, Peter kissed Jane, Peter kissed Anna etc.}. Such a presupposition can be satisfied by a *wh*-question. According to the focus interpretation rules presented above, the verb is not asserted, and hence the event of the verb is presupposed, and is naturally bound by the event under question. Whether this implies an existential presupposition on the participant under question needn't even be decided in order to derive exhaustivity:

The exhaustive reading arises because the pre-verbally focused expression gives an answer to a question and maximal level of informativity is pragmatically assumed. In line with Beaver & Clark (to appear) I assume that a question can be modeled as a set of possible answers, which may contain both partial answers and answers containing groups of individuals e.g.: {Peter kissed Mary, Peter kissed Joan, Peter kissed Mary and Joan, etc.}. Now, the only thing we need to assume is that the speaker wants to give a maximally informative answer and, since “Peter kissed Joan and Mary” is more informative than “Peter kissed Joan”, an exhaustivity implicature arises. Here, exhaustivity isn't a semantic issue since uniqueness is not presupposed. But if the exhaustivity is not based on an operator, we still need to explain the strange semantic phenomenon in (3).

5. The problematic example

First, the phenomenon presented in (3) is not general, as e.g. (12), is weird for most speakers, except for some reading in which Peter and Paul got a grade for a joint work:

- (12) ^{??}*Nem PÉTER kapott tízest, hanem Péter és PÁL (kapott tízest).*
 Not Peter got ten.ACC but Peter and Paul got ten.ACC
 ‘It isn't Peter who got a ten (grade), it's Peter and Paul who got a ten (grade)’

This shows that this kind of negation will only work in cases in which the conjunction delivered in the second clause can be conceived as referring to participants of the same event. Hence (3) can only have the reading according to which Peter and Paul slept both on the floor at the same time. But then the verb in (3) is anaphoric to a previously mentioned event. But if Peter and Paul are the participants of a particular event, the statement that Peter is the participant of the event is false. And indeed, we find this kind of examples in German too, as shown in (13), where a distributive reading is excluded:

- (13) *Nicht [Peter]F hat das Klavier hochgetragen sondern Peter, Paul und Jonas.*
 Not Peter has the piano up-carried but Peter Paul and Jonas
 ‘It isn't Peter who carried the piano up the stairs but Peter, Paul and Jonas.’

The main argument for a covert operator, thus, breaks apart. The operator prevents the proposition that Peter slept on the floor from being negated, but this is not desirable.

Conclusion

In this paper I have sketched an argument for a standard analysis of focus phenomena in Hungarian and I have shown that the distinction between information and identificational focus in Hungarian is not intrinsic to focus but to word-order effects on verbal presuppositions. In addition it has been shown that the assumption of an exhaustivity operator at some functional projection in Hungarian is not necessary. This approach includes a verb-movement syntactic analysis and thus opens the way to a unified treatment of the semantics of VM and incorporated bare nouns, which is subject to further research. However the theoretic expectation is that a detailed analysis of incorporation and verbal modification in Hungarian will come up with a clear explanation why exactly the event expressed in a VM-V word order is asserted and in a V-VM word order the event must be presupposed.

Bibliography

- Beaver, D. & Clark, B. to appear. *Sense and Sensitivity: How focus determines meaning*. To appear at Blackwell. Oxford.
- Farkas, D. & de Swart, H. 2003. *The semantics of incorporation: from argument structure to discourse transparency*. Stanford, CA: CSLI Publications.
- Horváth, J 2005. Is „focus movement” driven by stress? In: Christopher Piñón & Péter Siptár (eds.) *Approaches to Hungarian 9*. Budapest, Akadémiai Kiadó.
- Kenesei, I. 1998. Adjuncts and arguments in VP-focus in Hungarian," in *Acta Linguistica Hungarica* 45. 61-88.
- É. Kiss, K. 1998. Identificational focus versus information focus. *Language* 74.245-273.
- É. Kiss, K. 2002. *The Syntax of Hungarian*. Cambridge. Cambridge University Press.
- Rooth, M. 1992. A Theory of Focus Interpretation. in: *NLS* 1.75- 116.
- Szabolcsi, A. 1981. Compositionality in focus. *Folia Linguistica Societatis Linguisticae Europaeae* (15). 141–162.
- Wedgwood, D 2005. *Shifting the Focus. From static structures to the dynamics of interpretation*. Amsterdam, Elsevier.

ON THE LOGIC OF COMMUNICATIVE ACTS

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In this paper I answer the question how it could be that someone already communicates if his or her communicative intention is recognized by an addressee — without relying on the somewhat mysterious assumption that the *recognition* of a communicative intention implies somehow the *fulfillment* of this intention.

1. Communicative Intentions

Someone who utters a sentence usually communicates something (in particular, if he or she performs an illocutionary act like an assertion, a warning or a promise), but not every utterance act is communicative, and, of course, it is possible to communicate something without using language. Hence, the act type to-communicate-something-to-someone cannot be defined by reference to a particular type of *doing* like the utterance of a sentence. If one restricts oneself, as I will do, to intentional communicative acts, it is more promising to rely on the notion of a communicative intention. After all, it holds that S, by doing something, communicates intentionally to an addressee H that A only if S, by her doing, intends to bring it about that it is communicated to H that A

Given this connection between communicative acts and communicative intentions the former notion can be defined with reference to the notion of a communicative intention if one explicates the *goal* of this intention (i.e., the fact that S intends to bring about, namely that it is communicated to H that A) without reference to the notion of communication. If one, as I do, thinks that a communicative intention is an intention to bring it about that the addressee believes something, it holds:

(N) By doing α , S communicates (intentionally) to H that A only if S intends to bring it about that H believes that A

Now, a striking feature of communicative acts is that H's recognition of S's communicative intention implies that S communicated to H something, i.e., it holds:

(C) If H recognizes that S, by doing α , intends to bring it about that it is

communicated to H that A, then S, by doing α , communicates to H that A

Consider, for example, the following case: S, waiting at the airport in Lisbon for the departure of her flight to Paris, wants to inform her husband H about the time of her arrival. In order to do so, she sends him the following text message on his handy: *I will arrive at midnight*. Now, suppose that S's husband has been told that (due to bad weather) the airport in Paris will be closed soon. Hence, he does not acquire the belief that S will arrive at midnight. Nevertheless, it seems hard to deny that S communicated to H that she will arrive at midnight. It would be absurd to say something like 'S didn't communicate to H that she will arrive at midnight because he didn't believe her'. The opposite is correct: Although he didn't believe her, she has communicated to him the (alleged) time of her arrival.

Assumption (C) does not claim that the recognition of a communicative intention implies that S communicates *successfully*. However, many authors (Searle 1969, Bach and Harnish 1979, Sperber and Wilson 1986, Recanati 1987) endorse exactly this. According to these authors it holds:

(C*) If H recognizes that S, by doing α , intends to bring it about that it is communicated to H that A, then S, by doing α , communicates *successfully* to H that A

Assumption (C*) is puzzling. It seems natural to explain the distinction between successful and unsuccessful communicative acts by reference to the distinction between a fulfilled and an unfulfilled communicative intention. Roughly, S communicates *successfully* to H that A if and only if the following two conditions are fulfilled:

- (i) By doing α , S intends to bring it about that it is communicated to H that A
- (ii) S's doing α brings it about (in the manner expected by S) that it is communicated to H that A

Accordingly, S communicates *unsuccessfully* if and only if (i) is fulfilled, but (ii) is not.

Given this explication of the distinction between successful and unsuccessful communication, the assumption (C*) is tantamount to the assumption that the recognition of a communicative intention implies the *fulfillment* of this intention. But how should it be possible that a communicative intention is fulfilled if it is recognized by the addressee?

If (C*) is true, a communicative intention cannot be a perlocutionary one. In particular, if (C*) is true, (N) must be false because it is clearly possible both that H recognizes that S intends to make him believe that A and that H does not acquire the belief that A (because, for instance, H thinks that S is a liar). Hence, advocates of (C*)

usually claim that a communicative intention is an 'illocutionary intention' with an 'illocutionary goal' that is of such an extraordinary kind that (C*) comes out as true.¹

On my view it is unclear whether (C*) is really fulfilled within illocutionary frameworks that have been put forward so far. Moreover, since I think that (N) is more plausible than (C*) (after all, in the example given above something has gone wrong because H does not believe that she will arrive at midnight), hence, I think that (C*) is false. However, the weaker assumption (C) seems true. Let me therefore sketch an perlocutionary account of communicative acts that can explain why (C) is true.

2. Communicative Acts: Presence, Success, and Failure

Everybody agrees that S communicates successfully only if her communicative intention is fulfilled. However, usually it is also assumed that S does not communicate at all if her communication intention is not fulfilled. If this assumption is true, it is impossible to reconcile (N) with (C) since (C) is true even if the intention to bring it about that someone believes something is not fulfilled.

However, the assumption that the non-fulfillment of a communicative intention implies that S does not communicate by no means follows from the explication of the distinction between successful and unsuccessful communicative acts (obviously, this explication implies only that S does not communicate successfully if her communicative intention is not fulfilled). Moreover, I think this assumption is false. In the following I will argue, first, that the mere presence of a certain intention (or intentions) can be a conceptual sufficient condition for the presence of an act of a certain type, and, second, that this holds for the act type to communicate-something-to-someone.

The class of act types can be divided into, as I will say, result-defined act types and (pure) goal-defined act types.² Here are some examples:

RESULT-DEFINED ACT TYPES: S opened a window; S deceived H; S boiled water ;
S killed H; ...

GOAL-DEFINED ACT TYPES: S asked H whether A is the case; S lied to H,
S searched for her sunglasses; ...

A common feature of all mentioned act types is that someone performs such an act by

¹ For example, it has been claimed that (C*) is true for an intention to bring it about that H has a reason to believe that A (cf. Bach and Harnish 1979, Recanati 1987) .

² The following distinction was made (somewhat differently) also by Ryle 1949 and Kenny 1963.

doing something more basic: One kills someone by poisoning a Martini or by shooting a gun; and one asks someone something by uttering a sentence or making a gesture. Henceforth, I will express this as follows: By doing (something of type) α , S does something of type β . As before, I will assume both that S does α intentionally and that the fact that S has done α does not imply that S's doing α is also a doing of type β .

If β is a result-defined act type, it holds that S's doing α must bring about a certain effect (or effects) in order to perform an act of this type β at all. For example, if a poisoning of a Martini does not bring it about that someone dies, the poisoning of the Martini is not a killing. In contrast, if β is a goal-defined act type, the mere presence of a certain intention (or intentions) is conceptually sufficient for the performance of an act of this type β . For example, X's looking into a drawer is a search for her sunglasses even if she does not find them given that S intends to bring it about that S finds her sunglasses. The presence of this intention is sufficient for its being the case that S's looking into a drawer is a search.

In the light of the distinction between result-defined and goal-defined act types one may ask whether the act type to-communicate-to-someone-something is a result- or a goal-defined. Here are three arguments for the view that the mere presence of a communicative intention is (conceptual) sufficient for the presence of a communicative act.

First, if an act type β is a result-defined act type, there is no reasonable distinction between a successful and an unsuccessful *performance* of an act of this type. Consider, for instance, the following two sentences:

- (1) S killed H successfully by poisoning a Martini.
- (2) S killed H unsuccessfully by poisoning a Martini.

Obviously, both sentences are hard to understand due to the fact that the act type to-kill-someone is result-defined. In particular, the second sentence is extremely bizarre because the speaker presupposes (due to the use of 'killed') that a killing has occurred. But then it is unclear what could be meant by the qualification 'unsuccessfully'. Probably not 'unintentionally' — an utterance of 'S killed H unintentionally by poisoning a Martini' give no reason to cast doubt on the conceptual competence of the speaker. The interpretation that remains is that by using 'unsuccessfully' the speaker claims that the defining result of the killing has not been realized. But this contradicts the presupposition that a killing has occurred which explains the oddity of (2).

In contrast, no oddities arise, if an act type β is goal-defined:

- (3) S searched successfully for her sunglasses by looking into a drawer.
- (4) S searched unsuccessfully for her sunglasses by looking into a drawer.

Now, if communicative acts are result-defined, one should expect that (5) and (6) are odd:

- (5) S communicated successfully to H that it is raining by uttering 'It is raining'.
- (6) S communicated unsuccessfully to H that it is raining by uttering 'It is raining'.

But (5) and (6) are faultless. So we have a first reason to suppose that communicative acts are tokens of a corresponding goal-defined act type.

A *second* reason for this view relies on the fact that only verbs that characterize goal-defined act types can be used in a so-called explicit performative sentence. It is not possible (for obvious reasons) to use a verb that characterizes a result-defined act type in an explicit performative even if the act type under consideration can be performed by uttering a sentence. Consider the contrast between (7) and (8):

- (7) I hereby assert that it is raining.
- (8) I hereby convince you that it is raining.

Significantly, 'to communicate' is on par with 'to assert':

- (9) I hereby communicate to you that it is raining.

Third, and most importantly, the view favored here delivers a straightforward explanation for the above mentioned feature (C) of communicative behavior. Let me illustrate this by assuming that communicative acts are defined as follows:

- (D) By doing α , S communicates to H that A:=
By doing α , S intends to bring it about that H believes that A

According to (D), the mere presence of an intention to bring it about that someone believes that A is (conceptually) sufficient for the presence of a communicative act. Now, someone who recognizes that Q arguably also recognizes that P if the sentence that expresses Q entails analytically the sentence that expresses P. Given this principle, it follows from (D) that H recognizes that S communicates to him that A just if H recognizes that S intends to make him believes that A. Hence, the recognition of a communicative intention is tantamount to the recognition that S communicates something because *to recognize a communicative intention is just to recognize that someone already communicates* — as H recognizes that S searches for her sunglasses if H recognizes that S does what she does with the intention to find her sunglasses.

Obviously, according to (D) (or according to any other definition that characterizes communicative acts as goal-defined), it is false to say that S

communicated to H successfully that A if H has recognized merely her communicative intention because this intention is not fulfilled. However, according to (D) (or according to any other definition that characterizes communicative acts as goal-defined) its *also* false to say that S's doing α is merely an *attempt* to communicate if it holds both that S does α with a communicative intention and that this intention is not fulfilled — as it is false to say that S's looking into a drawer was merely an attempt to *search* for her sunglasses if she did not find them. From the perspective of (D) the opposite view rests either on a confusion between an attempt to perform an communicative act and an attempt to bring about the defining goal of a communicative act or on a confusion between an unsuccessful performance of a goal-defined act type and the non-performance of a result-defined act type. — I don't communicate because you don't believe me? No. You don't believe me although I communicate.

Bibliography

- Bach, K. & R. M. Harnish: 1979, *Linguistic Communication and Speech Acts*, MIT Press, Cambridge, Mass
- Grice, H. P.: 1957, Meaning , in: *The Philosophical Review* 66, 377-388.
- Kenny, A.: 1963, *Action, Emotion and Will*, Routledge, London
- Recanati, F.: 1987, *Meaning and Force. The Pragmatics of Performative Utterances*. Cambridge University Press, Cambridge.
- Ryle, G.: 1949, *The Concept of Mind*, University of Chicago Press, Chicago
- Searle, J. R.: 1969, *Speech Acts*, Cambridge University Press, Cambridge, Mass
- Sperber, D. and D. Wilson: 1986, *Relevance: communication and cognition*, Basil Blackwell, Oxford

INTERVENTION EFFECTS FOR INVERSE SCOPE READINGS: A DRT ACCOUNT

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Negated sentences with a universally quantified subject are usually interpreted with a wide scope of the negation. Consequently, sentences of the form *Every N not VP* and *Not every N VP* should behave very similarly. I discuss a contrast between the two types of sentences with respect to their NPI-licensing potential and their possible discourse continuations. I propose a DRT account of the discourse continuation facts that corroborates a representational theory of NPI licensing.

Which readings are available for sentences of the form *Every N not VP* is one of the big puzzles in natural language semantics (see for example Horn 1989). In this paper I do not attempt to solve it, but rather add to the puzzle. I discuss two sets of data with respect to which sentences of the form *Every N not VP* diverge from the allegedly synonymous sentences of the form *Not every N VP*.

1. Introduction

Sentence (1) has the two readings sketched in (2). In the so-called *inverse scope reading* (ISR) in (2-a) the universal quantifier is interpreted in the scope of the negation. It is widely assumed that this is the most natural reading for sentences of this type. The second reading, the so-called *surface scope reading* (SSR) in (2-b), respects the surface order of the quantifier and the negation.

- (1) *every-not*: Every student hasn't met a friend at the party.
(readings: (2-a), (2-b))
- (2) a. inverse scope reading: $\neg\forall x[\text{student}(x) \rightarrow \exists y[\text{friend}(y) \wedge \text{meet}(x, y)]]$
b. surface scope reading: $\forall x[\text{student}(x) \rightarrow \neg\exists y[\text{friend}(y) \wedge \text{meet}(x, y)]]$

I will not address the issue of why the ISR is the preferred reading for *every-not* sentences. Instead, I compare *every-not* sentences with sentences of the form *Not every N VP* as in (3). In *not-every* sentences the negation must take scope over the universal quantifier, i.e. they are paraphrases of an ISR of *every-not* sentences.

- (3) *not-every*: Not every student has met a friend at the party. (reading: (2-a))

I now turn to two phenomena that show a difference between *not-every* sentences and the ISR of *every-not* sentences: NPI licensing and reference to abstract objects.

2. NPI Licensing

Negative polarity items (NPIs) are expressions such as *ever*, *any* that are excluded from simple affirmative sentences. Instead they preferably occur in negated sentences, but can also be licensed in a number of contexts that are not negative in an obvious way, such as in the scope of *few*. A number of NPIs, such as *any* and *ever*, may occur in the scope of *not every*. This is shown in (4).

- (4) *not-every*: Not every student has met any friends at the party. (reading: (2-a))

Since *not-every* sentences can be used as paraphrases for the ISR of an *every-not* sentence, we would expect that NPIs are also licensed in this constellation. However, a *not-every* sentence with an NPI cannot have an ISR.

- (5) *every-not*: ?? Every student hasn't met any friend at the party.
reading: (2-b); (unavailable reading: # (2-a))

The unavailability of the ISR in (5) is parallel to the so-called *intervention effect*, in which a universal quantifier cannot take scope between a negation and an NPI. This is shown in (6), which lacks the otherwise prominent reading $\neg > \forall > \exists$.

- (6) ??Kim didn't give any apple to every teacher.
readings: $\forall > \neg > \exists$, $\neg > \forall > \exists$; unavailable readings¹: # $\neg > \forall > \exists$

The NPI is blocked if the universal takes scope between the negation and the NPI. This parallelism justifies speaking of an intervention effect in (5) as well.

2.1. Is There an Intervention Effect?

A reviewer suggested that the unavailability of the ISR with an NPI in (5) may be due to the fact that the ISR is an instance of metalinguistic negation. Luckily there is a way to test this. Horn 1989 showed that metalinguistic negation does not license NPIs. There are NPIs which are not sensitive to intervention effects — in particular verbal NPIs.² If there is a metalinguistic negation in the ISR of *every-not* sentences, these NPIs should be excluded as well. I switch to German examples to make this point because I could not collect enough native speaker judgments on the corresponding English data.

The German verb *scheren* (*care (for)*) is an NPI. It cannot occur in a simple affirmative sentence as in (7-a). In (7-b) the NPI is excluded with a clausemate positive

¹All readings in which the NPI is not in the scope of the negation are, of course, equally excluded.

²Klooster 1993 discusses this group of NPIs in some detail. I am grateful to Jack Hoeksema (p.c.) for emphasizing that not all NPIs are subject to intervention effects.

polarity item *ziemlich* (*quite*). Since PPIs are possible in sentences with a metalinguistic negation (Horn 1989, p.297), this shows that *scheren* is not licensed by a metalinguistic negation. (7-c) illustrates that *schert* is not sensitive to intervention effects since it is licensed even in the immediate scope of the universal quantifier.

- (7) a. Merkel schert sich *(nicht) um die Bierpreise.
 Merkel cares REFL not about the prices for beer
 b. Merkel schert sich nicht (*ziemlich) um die Bierpreise.
 Merkel cares REFL not quite about the prices for beer
 c. Kein Politiker schert sich um jede Gesellschaftsschicht.
 no politician cares REFL about every social class. ($\neg > \forall > \text{NPI}$)

Having established the non-sensitivity of *scheren* to intervention effects, we can turn to the original examples with the ISR. In German inverse scope readings are possible with a fronted universally quantified NP under a certain intonation. Assuming this intonation, we get the contrast in (8). The sentences in (8-a) and (8-b) show the same pattern as the English examples in (4) and (5) respectively, i.e. there is an intervention effect on the ISR of a *every-not* sentence. If we use the NPI *scheren* instead, the NPI is licensed even in an inverse scope reading.

- (8) a. Nicht alle Politiker machen sich jemals Gedanken um soziale
 not all politicians make REFL ever thoughts about social
 Gerechtigkeit. (reading: $\neg > \forall > \text{NPI}$)
 justice
 ‘Not all politicians have ever thought about social justice’
 b. *Alle Politiker machen sich nicht jemals Gedanken um soziale
 all politicians make themselves not ever thoughts about social
 Gerechtigkeit. (not available: $\# \neg > \forall > \text{NPI}$)
 justice
 c. Alle Politiker scheren sich nicht um soziale Gerechtigkeit.
 all politicians care themselves not about social justice
 (reading: $\neg > \forall > \text{NPI}$)

The data in (8) show that the ISR of *every-not* sentences is not an instance of metalinguistic negation. They also illustrate that a theory of NPI licensing needs to differentiate between NPIs that show intervention effects and those that don't.

2.2. Previous Approaches

The huge body of literature on NPIs notwithstanding, the licensing conditions for NPIs are still not fully understood. In particular, there are syntactic, semantic and pragmatic approaches. I will argue that the standard theories cannot distinguish between the *not-every* sentences and the ISR of *every-not* sentences.

Since the two sentences are synonymous, they should have the same semantic representation, which corresponds to (2-a). This means that the contrast between (4)

and (5) cannot be based on this representation. Both sentences also have the same entailment properties, i.e. the NPI is in a downward-entailing context, which is the basic licensing condition in the entailment-based approach of Ladusaw 1980.³

It is also hard to find a pragmatic difference between the two sentences. Both sentences share the implicature that some students met a friend and that some students did not. Consequently the mechanism of indirect licensing by a negative implicature assumed in Linebarger 1987 makes the same prediction for both examples.

It seems impossible to derive the intervention effect in (5) by looking at the relevant sentences as a whole. Taking the notion of “intervention” seriously, a reasonable analysis runs as follows: One has to assume that the NPI licensing is determined at the first relevant semantic operator. Then, *not every student* in (4) defines its scope as the domain for NPI licensing. Since it is downward-entailing (scale reversing, . . .), the NPI is licensed. Under an ISR for (5), however, the scope of *every student* is the domain for NPI checking. This domain is not downward-entailing, which accounts for the unavailability of the ISR.

While this is a viable approach, it is not clear whether the proponents of the respective theories would be willing to include the necessary structural notions. Furthermore whatever approach to intervention effects one adopts, the theory must be flexible enough to allow for NPIs that are not sensitive to those effects.

3. Discourse Continuations

In this section I discuss another type of data that shows a difference between *not-every* sentences and *every-not* sentences. The data stem from a different empirical domain: reference to abstract objects. Abstract entities (events, propositions, . . .) can be the antecedent for pronouns in discourse (Asher 1993). I show that there occurs an additional abstract discourse referent in the ISR of *every-not* sentences. This discourse referent is introduced between the negation and the universal quantifier. However, it is absent from *not-every* sentences.

Discourse referents introduced in the scope of negation are normally not accessible as antecedents for pronouns outside the scope of this negation (Kamp and Reyle 1993), see (9-a). Such a pronominal reference is possible if there is a continuation with a modal or hypothetical context, as in (9-b). This modal subordination allows us to “skip” the outermost negation and gives access to discourse referents in its scope.

- (9) a. Pedro doesn't own [a donkey]_i. He calls it_{*i} Emma.
b. Pedro doesn't own [a donkey]_i. He would call it_i Emma.

To apply this to the data with universally quantified subjects, I use appositive *which* relative clauses. There, the relative pronoun typically refers to abstract entities from the main clause. With a continuation in the indicative, (10), there is no

³This problem was noted in connection with intervention effects of the type in (6) in Jones 1996.

difference between the two antecedent clauses: *which* refers to the situation in which some visitors did not get presents.

- (10) Every visitor didn't get a present/ Not every visitor got a present,
 a. #which was very expensive. (*which* = every visitor got a present)
 b. which was a bit unfair. (*which* = some visitors didn't get a present)

An irrealis continuation allows for modal subordination as in (9-b). A continuation of the *every-not* sentence in (11) can refer to a situation in which every visitor received a present, i.e. (11-a). This continuation is unavailable in (12).

- (11) Every visitor didn't get a present, ...
 a. which would have been very expensive. (*which* = every v. got a p.)
 b. ??which would have been a bit unfair. (*which* = some v. didn't get a p.)
 (12) Not every visitor got a present, ...
 a. #which would have been very expensive. (*which* = every v. got a p.)
 b. ??which would have been a bit unfair. (*which* = some v. didn't get a p.)

This contrast can be accounted for by assuming an additional abstract discourse referent, written as p , which can serve as the antecedent in (11). This referent is not present in (12). This results in the DRSs in (13), using the linear notation for DRSs.

- (13) a. DRS for (11): $[\neg[p|p : [x|\text{visitor}(x)] \Rightarrow [y, e|\text{present}(y), \text{get}(e, x, y)]]]$
 b. DRS for (12): $[\neg[\emptyset|[x|\text{visitor}(x)] \Rightarrow [y, e|\text{present}(y), \text{get}(e, x, y)]]]$

Since modal subordination allows to skip the highest negation, the DRS in (13-a) provides an antecedent for *which*, but the DRS in (13-b) does not.⁴

4. A DRT-based Account of NPI Licensing

I propose a representational account of NPI licensing. K is an *NPI-licensing DRS* iff it occurs in a condition of the form $\neg K$ or $K \Rightarrow K'$.⁵ An NPI must occur in a DRS that is embedded in an NPI-licensing DRS. Different types of NPIs impose different conditions on the distance between the NPI and its NPI-licensing DRS: Verbal NPIs (*scheren* in (7)) must be licensed within the clause in which they are contained. For other NPIs we need a notion of distance defined by the number of DRSs that are accessible from the NPI but (i) still contained in the same NPI-licensing DRS and (ii) have a non-empty universe. Weak NPIs (*any, ever*) allow for at most one intervening DRS; strong NPIs (*lift a finger*) do not permit any intervening DRS at all.

(14) shows the DRSs for (4) and for the hypothetical ISR of (5). The NPI's semantics is underlined.

⁴I refrain from committing myself to the concrete nature of p . It would be a state in classical DRT, a proposition in SDRT, or a situation in other variants.

⁵Since $\neg K$ is equivalent to $K \Rightarrow \text{false}$, there is just one characterization of an NPI-licensing DRS.

- (14) a. DRS for (4): $[\neg[\emptyset][x|\text{student}(x)]\Rightarrow[y, e|\text{friend}(y), \text{meet}(e, x, y)]]$
b. DRS for (5): $[\neg[p]p : [x|\text{student}(x)]\Rightarrow[y, e|\text{friend}(y), \text{meet}(e, x, y)]]$

In both DRSs the restrictor of the universal quantifier ($[x|\text{student}(x)]$) is an intervener (which correctly excludes strong NPis). In (14-a) this is the only intervener, as the negation takes scope over a DRS with an empty universe. Consequently, the NPI is licensed in (4). In (14-b) the DRS following the negation contains the abstract discourse referent p in its universe. Therefore, this DRS is a second intervener. This violates the locality requirement of the NPI, and the intervention effect is derived.

5. Conclusion

I discussed two contrasts between *not-every* sentences and the inverse scope reading of *every-not* sentences: their NPI-licensing potential and their possible discourse continuations. Using DRT I derived both phenomena from the presence of an additional discourse referent in *every-not* sentences.

Intervention effects are a notorious problem for semantic and pragmatic accounts of NPis. The DRT account incorporates semantic insights but provides an appropriate notion of locality, which is necessary to account for intervention effects.

While I distinguish three types of NPis, I assume a single characterization of the licenser: the first box in an implication. This is a simplification, but it provides a uniform theory of NPI licensing for the core data. Differences among the types derive from restrictions on the NPI's depth of embeddedness in its licensing DRS.

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Bibliography

- Asher, N.: 1993, *Reference to Abstract Objects in Discourse*, Kluwer, Dordrecht
Horn, L. R.: 1989, *A Natural History of Negation*, University of Chicago Press
Jones, M. A.: 1996, *Foundations of French Syntax*, Cambridge University Press
Kamp, H. and Reyle, U.: 1993, *From Discourse to Logic*, Kluwer Academic Publishers, Dordrecht
Klooster, W.: 1993, Negatieve zinnen, *Gramma/TTT, Tijdschrift voor Taalwetenschap* 2(2), 119–143
Ladusaw, W.: 1980, *Polarity Sensitivity as Inherent Scope relations*, Garland Press, New York
Linebarger, M.: 1987, Negative polarity and grammatical representation, *Linguistics and Philosophy* 10, 325–387

DAVID LEWIS MEETS ARTHUR PRIOR AGAIN

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1. Introduction and Motivation

This paper proposes a hybridization of David Lewis’s counterfactual logic (Lewis 1973). As far as the author knows, in the literature of both hybrid and conditional logic (see, e.g., Areces and ten Cate 2007 and Nute and Cross 2001, respectively), such combination has never been studied. It, however, deserves to be studied since this hybridization enables us to formalize the following inference:

$$\frac{\begin{array}{l} \text{The pig is Mary.} \\ \text{Mary is pregnant.} \end{array}}{\text{Therefore: The pig is pregnant.}} \quad (1)$$

We can regard this inference as updating the local information, depending on the given situation (e.g., speaker), by using the global information, independent of the situation. To deal with the sentences containing ‘the’, we make use of David Lewis’s egocentric reading of counterfactual connectives. In order to deal with the second sentence, we need the modern hybrid formalism, whose roots trace back to Arthur Prior (see, e.g., Blackburn 2006). In addition, our hybridization has some technical merits: (1) Theorem 1: Completeness and decidability are preserved; (2) Theorem 2: We can characterize *the Limit Assumption* (saying that there are the closest worlds with respect to the possible antecedent of counterfactuals, and David Lewis rejected it metaphysically) by some *proof-rule*, used by hybrid logicians to obtain a general Kripke completeness result for pure formulas (see, e.g., Areces and ten Cate 2007, Theorem 5).

2. David Lewis’s Analysis of Contextually Definite Descriptions

It is well known that David Lewis proposed that the counterfactual conditional $\varphi \Box \rightarrow \psi$ (read ‘If it were the case that φ , then it would be the case that ψ ’) is true at a world w iff $(\varphi \wedge \psi)$ -worlds are closer to w than $(\varphi \wedge \neg\psi)$ -worlds (Lewis 1973). To define the ‘relative closeness’ of w rigorously, we need his ‘system of spheres’ representing a *comparative similarity* between worlds. A pair $\langle W, \$ \rangle$ is a *system of spheres* iff $W \neq \emptyset$ and $\$: W \rightarrow \mathcal{P}(\mathcal{P}(W))$ satisfies the following (we write ‘ $\$ _w$ ’ instead of ‘ $\$(w)$ ’): (S1) $\$ _w$ is nested: $S, T \in \$ _w \implies S \subset T$ or $T \subset S$; (S2) $\$ _w$ is closed under unions: $(S_\lambda)_{\lambda \in \Lambda} \subset \$ _w \implies \bigcup_{\lambda \in \Lambda} S_\lambda \in \$ _w$; (S3) $\$ _w$ is closed under (nonempty)

intersections: $(S_\lambda)_{\lambda \in \Lambda} \subset \$_w$ and $\Lambda \neq \emptyset \implies \bigcap_{\lambda \in \Lambda} S_\lambda \in \$_w$. Given a valuation $V : \text{Prop} \rightarrow \mathcal{P}(W)$ (where Prop is the set of all proposition letters), we can formulate the truth condition of the counterfactual conditional as follows:

$$w \in \llbracket \varphi \Box \rightarrow \psi \rrbracket_{\langle W, \$, V \rangle} \iff \begin{cases} \text{(A)} \cup \$_w \cap \llbracket \varphi \rrbracket_{\langle W, \$, V \rangle} = \emptyset \text{ or} \\ \text{(B)} (\exists S \in \$_w) [S \cap \llbracket \varphi \rrbracket_{\langle W, \$, V \rangle} \neq \emptyset \text{ and } S \cap \llbracket \varphi \rrbracket_{\langle W, \$, V \rangle} \subset \llbracket \psi \rrbracket_{\langle W, \$, V \rangle}], \end{cases}$$

where $\llbracket \varphi \rrbracket_{\langle W, \$, V \rangle}$ is the denotation of φ defined relatively to $\langle W, \$ \rangle$ and V . We usually drop the subscript from $\llbracket \varphi \rrbracket_{\langle W, \$, V \rangle}$ when it is clear from the context.

David Lewis (Lewis 1973, sec.5.3) considered Arthur Prior's egocentric reading of sentences and proposed that his counterfactual connective expresses *contextually definite descriptions* (e.g., 'The pig is pregnant'), whose logical form is '*The x such that φ is such that ψ* '. To be more accurate, he used the connective $\varphi \Box \rightarrow \psi$ defined as $\neg(\varphi \Box \rightarrow \neg\varphi) \wedge (\varphi \Box \rightarrow \psi)$, whose truth condition corresponds exactly to the case (B) above (' $\neg(\varphi \Box \rightarrow \neg\varphi)$ ' means that φ is possible). According to this egocentric reading, the truth of sentence is relativised to a thing or an individual, and so, the truth of sentence φ at x means that the individual x has the property φ . Then, a system of spheres around x represents its *comparative salience*, i.e., x 's degree of familiarity between things and individuals. Thus, 'The pig is grunting', formalized as ' $\text{Pig} \Box \Rightarrow \text{Grunting}$ ', is true at an individual x iff the grunting pig is more salient to x than the not-grunting pigs.

Furthermore, in Lewis's analysis, we can deal with a *sequence* of egocentric conditionals (Lewis 1973, p.114): Suppose that you are walking past a piggy.

The pig is grunting.
 ($\text{Pig} \Box \Rightarrow \text{Grunting}$)
 The pig with floppy ears is not grunting.
 ($(\text{Pig} \wedge \text{Floppy}) \Box \Rightarrow \text{Grunting}$)
 The spotted pig with floppy ears is grunting.
 ($(\text{Pig} \wedge \text{Floppy} \wedge \text{Spotted}) \Box \Rightarrow \text{Grunting}$)

According to the usual analysis of definite description as $\text{Grunting}(\iota x \text{Pig}(x))$, however, we cannot deal with such a sequence, since we never make both $\text{Grunting}(\iota x \text{Pig}(x))$ and $\neg \text{Grunting}(\iota x (\text{Pig}(x) \wedge \text{Floppy}(x)))$ true at the same time.

3. Hybrid Counterfactual Logic: David Lewis Meets Arthur Prior Again

David Lewis's counterfactual logic blends with modern hybrid logic in a surprisingly natural way. This explains the title of the present paper (see Blackburn 2006 for an in-depth explanation of connections between Prior's ideas, description and hybrid logics). Hybrid systems introduce nominals i (names for states) and satisfaction operators $@_i p$ (p is true at the state named by i) and formalize 'Mary is pregnant' as

@_{MARY}Pregnant. In reformulating Prior’s egocentric reading, Lewis also dealt with a similar kind of sentence (Lewis 1973, p.112): ‘*x* is such that (the Anighito meteorite is an *x* such that *x* is a rock)’. Familiarity with hybrid formalism would allow Lewis to write this sentence in most compact way possible: @_{ANIGHTO METEORITE}Rock. Here we can make David Lewis meet Arthur Prior again.

Thus, we can formalize our motivating inference (1) as follows:

$$[(\text{Pig} \BoxRightarrow \text{MARY}) \wedge @_{\text{MARY}}\text{Pregnant}] \rightarrow (\text{Pig} \BoxRightarrow \text{Pregnant}). \quad (2)$$

Figures 1 and 2 suggest that this formula is *valid*, i.e., true at any individual $w \in W$ and for any system of spheres $\langle W, \$ \rangle$. Note that the notion of *valuation* is same as before except that $V(i)$ is a singleton for any nominal i and that $w \in \llbracket @_i \varphi \rrbracket$ iff $v \in \llbracket \varphi \rrbracket$ where v is the denotation of i . In Figure 1, the dotted-lines express that the truth of ‘@_{MARY}Pregnant’ is independent of the given individual w .

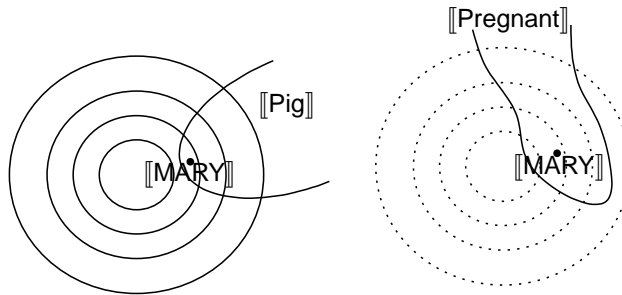


Figure 1 $w \in \llbracket \text{Pig} \BoxRightarrow \text{MARY} \rrbracket$ and $w \in \llbracket @_{\text{MARY}}\text{Pregnant} \rrbracket$

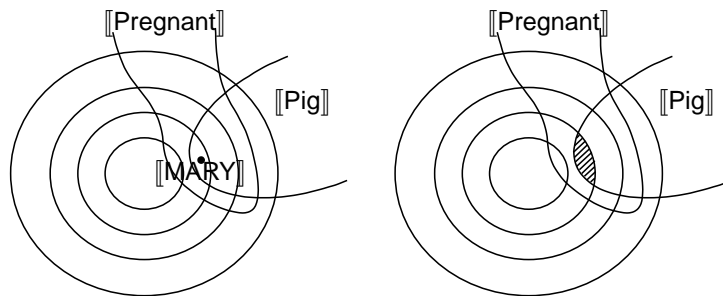


Figure 2 $w \in \llbracket \text{Pig} \BoxRightarrow \text{Pregnant} \rrbracket$

Next, we can give an axiomatization of hybrid counterfactual logic $\mathbf{V}_{\mathcal{H}(@)}$ (see the table below) that extends David Lewis’s \mathbf{V} (Lewis 1973, ch.6). Let us derive (2) as

Axioms and rules for $\mathbf{V}_{\mathcal{H}(\@)}$

CT	$\vdash \varphi$, for all classical tautologies φ
K@	$\vdash @_i(p \rightarrow q) \rightarrow (@_i p \rightarrow @_i q)$
Self-Dual	$\vdash \neg @_i p \leftrightarrow @_i \neg p$
Ref	$\vdash @_i i$
Intro	$\vdash @_i p \rightarrow (i \rightarrow p)$
Agree	$\vdash @_i @_j p \rightarrow @_j p$
Back	$\vdash @_i p \rightarrow (q \Box \rightarrow @_i p)$
ID	$\vdash p \Box \rightarrow p$
MOD	$\vdash (\neg p \Box \rightarrow p) \rightarrow (q \Box \rightarrow p)$
ARR	$\vdash \neg(p \Box \rightarrow \neg q) \rightarrow [((p \wedge q) \Box \rightarrow r) \leftrightarrow (p \Box \rightarrow (q \rightarrow r))]$
MP	If $\vdash \varphi \rightarrow \psi$ and $\vdash \varphi$, then $\vdash \psi$
DwC	If $\vdash (\theta_1 \wedge \dots \wedge \theta_n) \rightarrow \psi$, then $\vdash ((\varphi \Box \rightarrow \theta_1) \wedge \dots \wedge (\varphi \Box \rightarrow \theta_n)) \rightarrow (\varphi \Box \rightarrow \psi)$ ($n \geq 1$)
ILE	If $\vdash \varphi \leftrightarrow \psi$, then $\vdash (\varphi \Box \rightarrow \theta) \leftrightarrow (\psi \Box \rightarrow \theta)$.
Nec@	If $\vdash \varphi$, then $\vdash @_i \varphi$
Sub	If $\vdash \varphi$, then $\vdash \varphi\sigma$, where σ denotes a substitution that uniformly replaces proposition letters by formulas and nominals by nominals.

a theorem of $\mathbf{V}_{\mathcal{H}(\@)}$. By **Intro**, we have $@_{\text{MARY}} \text{Pregnant} \rightarrow (\text{MARY} \rightarrow \text{Pregnant})$. Then, we apply **DwC** to this and get:

$$(\text{Pig} \Box \rightarrow @_{\text{MARY}} \text{Pregnant}) \rightarrow [(\text{Pig} \Box \rightarrow \text{MARY}) \rightarrow (\text{Pig} \Box \rightarrow \text{Pregnant})].$$

But, from **Back**, we have:

$$@_{\text{MARY}} \text{Pregnant} \rightarrow (\text{Pig} \Box \rightarrow @_{\text{MARY}} \text{Pregnant}).$$

Thus, from two formulas above, we can derive:

$$@_{\text{MARY}} \text{Pregnant} \rightarrow [(\text{Pig} \Box \rightarrow \text{MARY}) \rightarrow (\text{Pig} \Box \rightarrow \text{Pregnant})].$$

By recalling the definition of $\varphi \Box \rightarrow \psi := \neg(\varphi \Box \rightarrow \neg\psi) \wedge (\varphi \Box \rightarrow \psi)$ and using some inference of propositional logic, we can derive (2).

4. Technical Merits

In the previous section, we have revealed that (2) is semantically valid and that (2) is a theorem of $\mathbf{V}_{\mathcal{H}(\@)}$. In this section, we will connect the notion of *validity* with the notion of *theorem*. That is, we will establish completeness (and decidability at the same time) of our logic. First of all, we can easily prove the soundness of our logic by induction on $\vdash \varphi$.

Proposition 1 (Soundness). $\mathbf{V}_{\mathcal{H}(\textcircled{a})}$ is sound with respect to the class of sphere models. That is, for any φ , $\vdash_{\mathbf{V}_{\mathcal{H}(\textcircled{a})}} \varphi \implies \llbracket \varphi \rrbracket = W$ for any sphere model $\langle W, \$, V \rangle$.

We can also prove the following completeness result:

Theorem 1 (Completeness and Decidability). $\mathbf{V}_{\mathcal{H}(\textcircled{a})}$ is complete with respect to the class of finite sphere models. That is, for any φ , $\llbracket \varphi \rrbracket = W$ for any finite sphere model $\langle W, \$, V \rangle \implies \vdash_{\mathbf{V}_{\mathcal{H}(\textcircled{a})}} \varphi$. Therefore, $\mathbf{V}_{\mathcal{H}(\textcircled{a})}$ is decidable.

Here ‘a finite sphere model’ means a sphere model whose domain is a finite set.

Sketch of Proof. In sum, our completeness proof is a combination of Lewis’s completeness proof for counterfactual logic via the *selection functions* (Lewis 1973, pp.132-4) (roughly, multimodal Kripke frame having a binary relation R_φ for every formula φ) and ten Cate et al. 2005’s technique for completeness proof for hybrid logic. First, we prove that $\mathbf{V}_{\mathcal{H}(\textcircled{a})}$ is complete with respect to the class of models based on selection function by ten Cate et al. 2005’s technique. Counterfactual vocabulary fits this argument. Second, we construct a sphere model from a countermodel based on a selection function in a truth-preserving way (for this construction, see (Lewis 1973, sec.2.7)). Hybrid vocabulary does not affect this technique at all. Finally, we filter our sphere model down to a finite sphere model by filtration technique (Lewis 1973, sec.6.2). Hybrid vocabulary also fits this technique. \square

Another merit of our hybridization is related to *the Limit Assumption* saying that there are the closest worlds with respect to the possible antecedent of counterfactuals. To be more precise, a system of sphere $\langle W, \$ \rangle$ satisfies *the Limit Assumption* (LA) iff, for any $w \in W$ and any $X \subset W$,

$$\bigcup \$_w \cap X \neq \emptyset \implies \bigcap \{S \in \$_w \mid S \cap X \neq \emptyset\} \cap X \neq \emptyset.$$

David Lewis rejected it metaphysically (Lewis 1973, sec.1.4), but stated that there exists no *characteristic axiom* associated with it (Lewis 1973, sec.6.1, p.121). The same situation also occurs in our hybrid counterfactual logic. We say that formula φ corresponds to a property Q of systems of sphere if, for any $\langle W, \$ \rangle$, $\langle W, \$ \rangle$ satisfies $Q \iff \llbracket \varphi \rrbracket_{\langle W, \$, V \rangle} = W$ for any valuation V on $\langle W, \$ \rangle$. Note that any finite system of spheres trivially satisfies (LA) by (S1): $\$_w$ is nested. Then, we can prove that there exists *no* formula φ of hybrid counterfactual logic such that φ corresponds to (LA): Suppose for contradiction that there exists such a formula φ . Consider $\langle \mathbb{R}, \$ \rangle$ where $\$_r := \{(r - \varepsilon, r + \varepsilon), [r - \varepsilon, r + \varepsilon] \mid \varepsilon > 0\} \cup \{r\}, \emptyset, \mathbb{R}$. $\langle \mathbb{R}, \$ \rangle$ is a system of sphere but fails to satisfy (LA). By definition, for some valuation V on $\langle \mathbb{R}, \$ \rangle$, $\llbracket \varphi \rrbracket_{\langle \mathbb{R}, \$, V \rangle} \neq \mathbb{R}$. From Proposition 1, $\not\vdash_{\mathbf{V}_{\mathcal{H}(\textcircled{a})}} \varphi$. Then, by Theorem 1, $\llbracket \varphi \rrbracket_{\langle W', \$', V' \rangle} \neq W'$ for some finite sphere model $\langle W', \$', V' \rangle$. However, since $\langle W', \$', V' \rangle$ satisfies (LA) trivially, $\llbracket \varphi \rrbracket_{\langle W', \$', V' \rangle} = W'$. Contradiction.

We can, however, characterize (LA) by the following *proof-rule*:

CBG If $\vdash @_i \neg(\psi \Box \rightarrow \neg j) \rightarrow @_j \varphi$, then $\vdash @_i(\psi \Box \rightarrow \varphi)$,
where $i \neq j$ and j does not appear in φ and ψ .

We say that $\langle W, \$ \rangle$ admits **CBG** if every valuation falsifying the consequent $@_i(\psi \Box \rightarrow \varphi)$ can be extended to a valuation falsifying the antecedent $@_i \neg(\psi \Box \rightarrow \neg j) \rightarrow @_j \varphi$.

Theorem 2. $\langle W, \$ \rangle$ satisfies (LA) $\iff \langle W, \$ \rangle$ admits **CBG**.

This characterization is inspired by ten Cate and Litak 2007's characterization of the topological equivalent of the relational **S4**-frames (i.e., Alexandrov spaces) by the proof-rule called **BG**. We can prove this theorem as in (ten Cate and Litak 2007, Theorem 3.4). By this result, we claim that Lewis's rejection of (LA) would result in his non-acceptance of **CBG**.

5. Conclusion

We have argued that nominals fit naturally into Lewis formalism and their introduction is a desirable step. If our main thesis is true and we reject (LA) as Lewis, it means that work on topological and neighborhood semantics for hybrid logic opens new perspective for Lewis's counterfactual semantics.

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Bibliography

- Areces, C. and ten Cate, B.: 2007, Hybrid logics, in P. Blackburn, J. van Benthem, and F. Wolter (eds.), *Handbook of Modal Logic*, pp 821–868, Elsevier
- Blackburn, P.: 2006, Arthur Prior and hybrid logic, *Synthese* 150(3), 329–372
- Lewis, D.: 1973, *Counterfactuals*, Blackwell Publishing, 2 edition, 2nd edition was published in 1986.
- Nute, D. and Cross, C. B.: 2001, Conditional logic, in D. Gabbay and F. Guentner (eds.), *Handbook of Philosophical Logic*, Vol. 4, pp 1–98, Kluwer Academic Publishers, 2 edition
- ten Cate, B. and Litak, T.: 2007, Topological perspective on the hybrid proof rules, *Electronic Notes in Theoretical Computer Science* 174(6), 79–94, Proceeding of International workshop on hybrid logic 2006
- ten Cate, B., Marx, M., and Viana, P.: 2005, Hybrid logics with Sahlqvist axioms, *Logic Journal of the IGPL* 13(3), 293–300

COUNTERFACTUAL CONDITIONALS AND DYNAMIC LAWS

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In this paper we will argue that in order to account for the meaning of counterfactual conditionals we need to refer to and distinguish between static (f.i. analytical) laws and dynamic (f.i. causal) laws. We will propose an approach that combines premise semantics for counterfactuals in the style of Veltman 2005 with a representation of causal dependencies based on Pearl 2000.

1. Introduction

How to describe the truth conditions of counterfactual conditionals? Lets simplify matters and assume as logical form of such conditionals ‘ $A > C$ ’, where A is the antecedent, C the consequent and $>$ the conditional connector. An answer to the question that is on first view very attractive is the strict conditional approach. According to this approach $A > C$ is true with respect to model M and evaluation world w_0 , if the set of possible worlds in M where the antecedent is true (denoted by $\llbracket A \rrbracket^M$) is a subset of the set of possible worlds where the consequent holds ($\llbracket C \rrbracket^M$). It is well-known that this approach is too strong. We do not want to demand that the consequent is true on all antecedent-worlds. There are other facts true of the evaluation world that can be used in inferring the consequent. The central challenge of the semantics of counterfactuals is to characterize these facts and the way they play a role in the derivation. Authors agree that general laws have to be part of these facts, but that also some singular facts of the evaluation world can be used. Furthermore, we also know that the relevant facts depend not only on the evaluation world but also on the antecedent. A well-known and successful way to describe this dependence is *premise semantics* for counterfactuals (Veltman 1976, Kratzer 1979). This proposal distinguishes two sets of relevant facts, called *premises*: the set $P_1(w_0)$ of general laws taken to hold in the evaluation world w_0 , and a particular subset $P_2(w_0)$ of singular facts of w_0 . Let U be the set of possible worlds where all elements of $P_1(w_0)$ hold. The truth conditions of a counterfactual can then be formalized by (i) defining an order that compares worlds with respect to how many of the premises in $P_2(w_0)$ they make true, and (ii), demanding that the consequent of the counterfactual has to be true all worlds in $\llbracket A \rrbracket^M \cap U$ minimal with respect to the order.

Definition 1 (*Truth conditions according to premise semantics*)^{1,2}

$$w_1 \leq^{M, w_0} w_2 \text{ iff } \{\psi \in P_2(w_0) \mid M, w_1 \models \psi\} \subseteq \{\psi \in P_2(w_0) \mid M, w_2 \models \psi\},$$

$$M, w_0 \models A > C \text{ iff } \text{Min}(\leq^{M, w_0}, \llbracket A \rrbracket^m \cap U) \subseteq \llbracket C \rrbracket^M.$$

This approach leaves open how to define the functions P_1 and P_2 . A recent proposal made by Veltman 2005 is to take as P_2 the *basis* of the evaluation world, which is defined as a minimal set of facts of the evaluation world from which everything else true about this world can be derived (using the general laws in $P_1(w_0)$).³ This approach makes correct predictions for many traditionally hard examples for such conditionals. However, in some cases the predictions made are not in accordance with intuitions. In this paper we will concentrate on one particular type of such mispredictions.

2. A problem: causal counterfactuals

Suppose there is a circuit such that the light is on (L) exactly when both switches are in the same position (up or not up: $(S1 \wedge S2) \vee (\neg S1 \wedge \neg S2)$). At the moment switch one is down ($\neg S1$), switch two is up ($S2$) and the lamp is out ($\neg L$). Now consider the following counterfactual conditional:

- (1) If switch one had been up ($S1$), the lamp would have been on (L).

The approach of Veltman wrongly predicts that the conditional (1) is false in the given context. The relevant law of this example that defines the set U is $(S1 \leftrightarrow S2) \leftrightarrow L$. Because the state of the lamp can tell you something about the position of the switches (as much as the position of the switches gives you information about the state of the lamp), there are bases containing the fact $\neg L$. In consequence, among the worlds making the antecedent $S1$ true and maintaining a maximal subset of a basis of w_0 are also worlds that make $S1$, $\neg S2$, and $\neg L$ true. In other words, among the antecedent worlds on which the consequent has to be true there are worlds where the lamp is out and, thus, switch two down. Because of these worlds the conditionals (1) is evaluated to be false.

3. Solution: an ontic notion of basis

Notice that if bases that contain $\neg L$ were not considered, the approach would have made the correct predictions. Only one basis would have been left ($B(w_0) = \{\neg S1, S2\}$) and the minimal worlds according to the order would have been the worlds making $S1$, $S2$ and L true. Therefore, we propose that the origin of the mispredictions lays in the way Veltman defines a basis. The notion of basis Veltman

¹For sake of simplicity we assume here that minimal elements exist.

² $\text{Min}(\leq, S) = \{s \in S \mid \neg \exists s' \in S : s' \leq s \ \& \ s \not\leq s'\}$.

³A world can have more than one basis.

employs involves **epistemic** reasoning with laws. $\neg L$ is predicted to be part of a basis, because it gives you *information* about the position of the switches. However, the (dominant) reading of (1), according to which the sentence is true, is not epistemic, i.e. not about the conclusions you would derive given that you believed the antecedent to be true, but **ontic**, i.e. about how the world would have evolved if switch one had been up.⁴ We propose that the notion of basis has to take **causal dependencies** into account. To arrive at the right definition of a basis we need an ontic concept of what can be derived from laws. In order to formulate this concept we have to distinguish two types of laws. First, there are **static laws** like analytical laws and logical laws. With static laws ontic reasoning works in the standard deductive manner. But besides static laws there are also **dynamic laws**, like **causal laws**. Characteristic for these laws is that they come with a direction, like the direction from cause to effect. Ontic reasoning with these laws has to follow their direction. A basis of the evaluation world is then again defined as a minimal set of basic facts from which everything else about this world can be derived – but now the ontic notion of derivation is applied.

In order to formalize this idea one needs an appropriate notion of a model that keeps track of the relevant static and dynamic laws. While static laws can be encoded as restrictions on acceptable possible worlds, for dynamic laws we need a more complex representation that also holds information about the direction of the law. Here we use a representation building on the **causal models** of Pearl 2000. For a finite set of proposition letters \mathcal{P} we define a model M as a tuple $\langle C, U \rangle$, where C is a causal structure and U a set of possible worlds, the worlds where all laws hold. A causal structure is a tuple $\langle B, F \rangle$. B is a subset of the proposition letters called the *background variables*. F is a function mapping all elements of $\mathcal{P} - B$ to tuples $\langle Z_Y, f_Y \rangle$ where Z_Y is an n-tuple of elements of \mathcal{P} and f_Y an n-ary partial truth function. F provides for every non-background variable the propositional variables on which they directly causally depend (Z_Y) and the character of the dependency (f_Y). We demand additionally that the relation XRY that can be defined by the condition XRY iff $X \in Z_Y$ is acyclic and that all its minimal elements are members of B . This realizes the idea that causal dependencies are not cyclic and that the background variables have in the relevant context no causal history. One can think of them as chance events. The figure below sketches the model of example (1).

Based on this definition of a model we can now define our ontic notion of basis. We first introduce the *law closure* of a partial interpretation function i . This is the extension of i with the interpretation of proposition letters that can be derived by laws from i . Crucial here is that only derivations from causes to effects are allowed. The basis of a world w will be defined as the union of all smallest subsets of w (thus, partial interpretation functions) for which w is the law closure.⁵

⁴I argue elsewhere (Schulz 2007) that also an epistemic reading of conditional sentences has to be distinguished.

⁵For more details on the definitions see Schulz 2007.

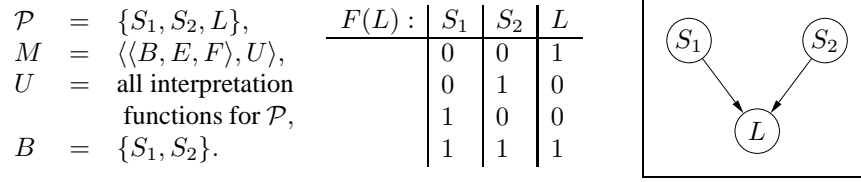


Figure 1: A model for example (1)

Definition 2 (Law closure)

Let i be a partial interpretation of \mathcal{P} . The law closure \bar{i} of i is the minimal i' with $i \subseteq i'$ fulfilling the following conditions.

- (i) $i' = \bigcap \{w \in U \mid i' \subseteq w\}$ (closure w.r.t. static laws),
- (ii) for all $P \in \mathcal{P} - B$ with $Z_P = \langle P_1, \dots, P_n \rangle$ such that $i(P)$ is undefined it holds that if for all $k \in \{1, \dots, n\}$: $i'(P_k)$ is defined and $f_P(i'(P_1), \dots, i'(P_n))$ is defined, then $i'(P)$ is defined and $f_P(i'(P_1), \dots, i'(P_n)) = i'(P)$ (closure w.r.t. dynamic laws).

Definition 3 (Basis)

The basis b_w of a possible world $w \in U$ is the union of all partial interpretation functions b that fulfill the following two conditions: (i) $b \subseteq w \subseteq \bar{b}$ and (ii) $\neg \exists b' : b' \subseteq w \subseteq \bar{b}' \ \& \ b' \subset b$.

4. Another problem: causal backtracking

If we use this notion of basis set as the premise function P_2 in premise semantics, we predict the counterfactual (1) to be true. However, there is a different but related problem of Veltman 2005 that we do not solve this way. This approach, as well as the one defined above, predicts causal backtracking to be valid. That means that in the described scenario the following counterfactual comes out as true.

- (2) If the lamp had been on, the switches would have been in the same position.

There is general agreement in the literature that while backtracking using static laws is fine, causal backtracking is highly marked if not even impossible (cf. Lewis 1979 and many others). We propose that according to the dominant ontic reading of counterfactuals that we aim to model here, causal backtracking is not possible, that means, counterfactual (2) should come out as false.⁶ We will go even a step further

⁶We do not want to claim this way that causal backtracking is in general not possible, but rather defend the position that it is excluded by the dominant ontic reading of counterfactuals. There is an marginal epistemic reading that does allow for backtracking, but this reading is not subject of the present paper (for more details on the epistemic reading see Schulz 2007).

and propose that we even want strong exclusion of backtracking, that means that we want be able to conclude that the causal history of the antecedent remains unchanged (cf. Lewis 1979, Pearl 2000 and others). In other words, the counterfactual (3) should come out as true.

- (3) If the lamp had been on, the switches would not have changed their position.

5. Solution: a new kind of minimization

Following an idea of Lewis 1979 we model strong exclusion of backtracking by allowing for violations of causal laws. We take U to be the set of worlds that follow the static laws, but not necessarily also the dynamic laws encoded in the causal structure. That means, for instance, that for example (1) among others also the world w_1 where both switches are up, but the lamp still is off is an element of U . However, if we use this new definition of U in premise semantics the counterfactual (1) no longer comes out as true. The problem is that we do not only allow for law violations that cut the antecedent from its causal history, but that all kinds of law violations are possible - for instance also law violations preventing the causal effects of the antecedent to hold (as in w_1).

I propose that to account for this problem we have to change the order with respect to which minimal worlds are selected. Instead of maximizing the overlap with the basis of the evaluation world, we have to minimize the law violations happening in a world. Because law violations result in extensions of the basis, this can be formalized by minimizing additional basis elements (clause (1) of def. 4). Using this order instead of the order of premise semantics already allows us to achieve weak exclusion of backtracking while at the same time predict examples like (1) to be true. To get additionally strong exclusion of backtracking I propose that also non-basis facts count for the truth conditions of counterfactuals, but to a lesser degree. We define a second order that maximizes the overlap with derivable facts of the evaluation world (clause (2) of def. 4). After minimizing with respect to the first order the worlds where the antecedent and the static laws hold, in a second step we minimize with respect to this second order (clause (3) of def. 4). These are the worlds on which we claim the consequent of the counterfactual to hold as well.

Definition 4 (The ontic reading of counterfactuals)

- (1) $w_1 \leq_B^{M, w_0} w_2$ iff $B(w_1) - B(w_0) \subseteq B(w_2) - B(w_0)$,
- (2) $w_1 \leq_D^{M, w_0} w_2$ iff $D(w_1) \cap D(w_0) \subseteq D(w_2) \cap D(w_0)$, where $D(w) = w - B(w)$,
- (3) $M, w_0 \models A > C$ iff $Min(\leq_D^{M, w_0}, Min(\leq_B^{M, w_0}, \llbracket A \rrbracket^M \cap U)) \subseteq \llbracket C \rrbracket^M$.

Based on this approach to the truth conditions of counterfactuals we predict the examples (1) and (3) to be true, while (2) is predicted to be false – as intended.

6. Conclusion

In this paper we have proposed an approach to the truth conditions of counterfactual conditionals that is based on premise semantics, but deviates from standard premise semantics (i) in assuming an ontic premise function, and (ii) in the way we propose that the premises influence the truth conditions. We propose that the consequent of a counterfactual has to be true on those antecedent worlds that (i) make all static laws true, (ii) add the least number of law violations, and (iii) with respect to facts derived from the basis are as similar as possible to w_0 . This approach improves on Veltman 2005 in being able to account for causal counterfactuals, without losing Veltman's appealing predictions. Furthermore, the approach predicts strong exclusion of causal backtracking. That means that it does not only prevent reasoning from effect to cause, but it supports the even stronger prediction that making the antecedent true leaves its causal history unchanged.

There are some issues left open for future research. First, similar to Veltman 2005 the present approach improves on standard premise semantics in providing a way to calculate the premises for concrete examples. However this calculation takes as input the set of general laws considered valid. As does Veltman 2005, we still need a theory for what should count as general laws. We do need even a bit more: we have to be able to make the distinction between static and dynamic laws. This is a problem that has to be investigated in future work. Second, here we studied the semantic meaning of counterfactuals on a very abstract level: on the level of propositional logic. We did not consider the linguistic fine structure of antecedent and consequent, as for instance the meaning of modals occurring there. This is a limitation that should be overcome in future work. In Schulz 2007 the present proposal has been extended with a more compositional approach to the meaning of conditionals is made. This work has to be continued in the future.

Bibliography

- Kratzer, A.: 1979, Conditional necessity and possibility, in R. Bäuerle, U. Egli, and A. von Stechow (eds.), *Semantics from different points of view*, pp 387–394, Springer, Berlin/Heidelberg/New York
- Lewis, D.: 1979, Counterfactual dependence and time's arrow, *NOÛS* 13, 455–476
- Pearl, J.: 2000, *Causality. Models, reasoning, and inference*, Cambridge University Press, Cambridge
- Schulz, K.: 2007, *Minimal models in semantics and pragmatics: Free choice, exhaustivity, and conditionals*, Ph.D. thesis, University of Amsterdam, Amsterdam
- Veltman, F.: 1976, Prejudices, presuppositions and the theory of counterfactuals, in J. Groenendijk et al. (eds.), *Amsterdam Papers in Formal Grammar*, Vol. 1, Centrale Interfaculteit, Universiteit van Amsterdam
- Veltman, F.: 2005, Making counterfactual assumption, *Journal of Semantics* 22, 159–180

CAUSAL REFERENCE AND INVERSE SCOPE AS MIXED QUOTATION

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Causal reference falls out from an account of mixed quotes that can be nested and applied to constructions: a speaker's use of a term is a mixed quote of the occasion on which the speaker acquired the term. Mixed quotes thus pervade shared language, despite the lack of quotation marks. This theory generates inverse scope under left-to-right evaluation, because an earlier quantifier can be quoted and outscoped. It also predicts the failure of polarity licensing in *'Alice introduced anybody to nobody'.

Mixed quotes are quotes that appear to mix mention and use, or direct and indirect quotation, such as (1).

- (1) Quine says that quotation 'has a certain anomalous feature.' (Davidson 1979)

I argue that mixed quotation is a general phenomenon that pervades language. In fact, most of our speech consists of mixed quotes of ourselves and each other. Of course, because the vast majority of utterances do not call for quotation marks in print, this point is only plausible if we broaden the notion of mixed quotation to include many of them. My first order of business is thus to explain a broader notion of mixed quotation. I then use this notion to analyze naming and quantification.

1. The essence of mixed quotation

Informally speaking, I take a mixed quote to mean what someone uses the quoted expression to mean (Geurts and Maier 2003). For example, (1) means that Quine says that quotation has the property that Quine uses 'has a certain anomalous feature' to mean. The quoted expression need not be grammatical, as (2) shows.

- (2) The president said he has an 'ecelectic' reading list. (Maier 2007)

1.1. Nested mixed quotes

Mixed quotation can be nested (iterated), just as pure quotation can be.

- (3) The politician said she is 'sorry to have used an 'epithet' '.

On one reading, (3) means that the politician said she has the property that she uses the phrase ‘sorry to have used an ‘epithet’ ’ to mean. Assuming that the politician is a normal English speaker, this property is to be sorry to have used an element of the set that someone unspecified uses the word ‘epithet’ to mean. The outer quotation level in (3) distinguishes the speaker’s sense of ‘sorry’ from the politician’s; the inner level distinguishes the politician’s sense of ‘epithet’ from others’.

1.2. Mixed quotes of constructions

A construction can be quoted, just as an ordinary expression can be.

- (4) The politician admitted she ‘lied [her] way into [her job]’.
- (5) It is a long story how I lied my way into this despicable position of deception.

Thanks to the square brackets in (4) or their spoken counterpart, the sentence is true if the politician said (5) as a normal English speaker. More precisely, the sentence is true just in case the politician admitted she the property gyz , where g is the ternary relation that she used the construction ‘lied ... way into ...’ to mean, y is her, and z is her job. Intuitively, what is quoted in (4) is not an expression but a construction that combines the subexpressions ‘my way’ and ‘this despicable position of deception’, along with their meanings, to form a verb phrase, along with its meaning.

An ordinary expression is a special case of a construction, namely a nullary one—a construction that takes no input. The binary construction quoted above is a canonical non-nullary construction, but less canonical ones can be mixed-quoted as well.

- (6) John doesn’t know much French, but he thinks he does and tries to show it off whenever possible. At dinner the other day, he ordered not ‘[some dessert] à la mode’ but ‘à la mode [some dessert]’.

On one reading, (6) is true if John ordered using the words ‘à la mode apple pie’ but not ‘apple pie à la mode’. That is, the second mixed quote in (6) is of a unary construction. The construction’s form maps expressions to expressions: it puts ‘à la mode’ before a dessert name. The construction’s meaning maps desserts to desserts.

1.3. Distinguishing syntactic and semantic interjection

Conventional punctuation using square brackets confuses two ways to interrupt a quote and interject words used from the quoter’s perspective. The first way, exemplified above, is for the meaning of the interjected words to combine *semantically* with the (rest of the) quote: in (4), the meaning of ‘her’ and ‘her job’, say the politician and her job, may serve as arguments to some functional meaning of the construction ‘lied ... way into ...’. The second way, exemplified below, is for the meaning of the interjected words to combine *syntactically* with the (rest of the) quote.

- (7) The secret guide suggested that interested eaters ‘kiss up to [name redacted], class of 2008, for a good meal’ at the Ivy.

The secret guide did not suggest that interested eaters kiss up to a redacted name.

To avoid this ambiguity of square brackets, we notate semantic interjection %*[like this]* and syntactic interjection ~*[like this]*. We further distinguish mixed quotes from pure and direct quotes by notating mixed quotes !*[like this]* and pure and direct quotes *[like this]*. For example, we notate (7) as follows.

- (8) The secret guide suggested that interested eaters !*[kiss up to ~[name redacted], class of 2008, for a good meal]* at the Ivy.

1.4. A sketch of a formalization

I analyze a mixed quote as a construction whose form is Qf and whose meaning is: *tg. x* uses the construction f to mean g . Here f and Qf are two functions on forms, related in some way Q yet to be specified. The meaning of the quote is anaphoric to some discourse referent x and presupposes that the speaker x uses f to mean a function g on meanings. These anaphoric and presuppositional dependencies are part of the quote's meaning and remain to be resolved, so the meaning of a mixed quote is *not* g , even provided that some speaker x uses a construction to mean g .

There are multiple Q 's, corresponding to different strategies of resolving these dependencies. To take a simple example from written English, suppose that f is a function that maps n strings to a string. Sticking to single quotation marks, we can then define another function Qf that maps n strings to a string, by

$$(9) \quad Qf x_1 \dots x_n = \overline{\overline{f(\overline{\overline{x_1}} \wedge \dots \wedge \overline{\overline{x_n}})}}}$$

where overlines cover literal strings and the operator \wedge denotes string concatenation. Given this Q , we can analyze the written form of (3) and (4) as follows.

$$(10) \quad (\lambda x. \overline{\overline{\text{The p. said she is } \wedge x}}) (Q((\lambda x. \overline{\overline{\text{sorry to have used an } \wedge x}})(Q \overline{\overline{\text{epithet}}}))$$

$$(11) \quad (\lambda x. \overline{\overline{\text{The p. admitted she } \wedge x}}) (Q(\lambda x_1 x_2. \overline{\overline{\text{lied } \wedge x_1 \wedge \overline{\overline{\text{way into } \wedge x_2}}}} \overline{\overline{\text{her her job}}})$$

The forms generated match (3) and (4) above, whereas the meanings generated match the paraphrases given under (3) and (4). These examples show how to analyze nested mixed quotes and mixed quotes of constructions.

I claim that the grammar of human language is largely generated by mixed quotes.

1.5. Mixed quotes of formal languages

For intuition, it may help to draw a parallel between this treatment of mixed quotation and the practice of code switching between natural and formal languages, such as embedding formulas in English sentences. Our analysis of mixed quotation amounts to paraphrasing the mixed quote in (12) in terms of the pure quote in (13).

- (12) Alice said $\Gamma(2)$ is negative.

- (13) Alice said what mathematicians use $\Gamma(2)$ to mean is negative.

Formulas can be quoted in a formal language as well as a natural language, for instance using *Gödel numbering*. Given a Gödel numbering, the truth and provability of a formula in a logic can then be defined as arithmetic predicates. These predicates are the formal analogues of our account of the meaning of mixed quotation.

2. The prevalence of mixed quotation

In a mixed quote as in a pure quote, the quoted speaker may be generic, hypothetical, or institutional, and the quoted use may be generic, hypothetical, or habitual (Geurts and Maier 2003). Mixed quotation is thus a versatile source of constructions: in principle, a mixed quote can draw its meaning from any construction use by any speaker, be it real or imagined, in the past, present, or future. Thus, mixed quotation can serve many purposes in the use and transmission of language.

2.1. Naming and other causes

A mild instance of prevalent mixed quotation is names according to a causal theory of reference (Kripke 1980). When Alice uses ‘Aristotle’ to mean Aristotle, unless she is baptizing Aristotle by coining the name, she relies on a previous use of the name to mean Aristotle. In other words, the nullary construction that pairs the name with the person is a mixed quote. This mixed quote is slightly unusual in two regards, but neither invalidates this analysis of names as mixed quotes.

First, the quoted form (say Q Aristotle) and unquoted form (say Aristotle) sound and look exactly the same, so one may be concerned as to how the hearer of Alice’s utterance can know to parse ‘Aristotle’ as a quote. But there are few ways for ‘Aristotle’ to appear in a sentence, among which this parse is likely the top candidate.

Second, Alice and her interlocutors may not recall a specific occasion on which a specific speaker used the name to mean Aristotle, so it may be indeterminate who the quoted speaker is. But like any other discourse referent, x can have its dependencies resolved as long as it is known that there exists a speaker (even an institutional one such as the English language) and a use (even a generic one such as usually). Such mixed quotes are common: the inner quote in (3) could be one, for example.

The use of ‘Aristotle’ that Alice mixed-quotes is either specifically the initial baptism of Aristotle or another mixed-quote of a use of ‘Aristotle’, and so on. The chain of naming occasions formed by mixed quotation $![[[\dots \text{Aristotle} \dots]]]$ is like a causal chain of naming, except the latter does not usually contain a generic event.

Why stop at names? This ‘copy-and-paste’ syntax and semantics works across the board, so the sentence ‘Aristotle saw his sister’ can be cobbled together solely by composing mixed quotes as in (14). Ordinary language, then, is full of mixed quotes.

(14) $![[[\text{Aristotle}]]]$ saw $![[[\text{him}]]]$ ’s sister

The analysis (14) assumes that the mixed-quoted expression ‘him’ is used to mean an anaphoric dependency. Similarly, in order for us to analyze Alice’s use of

‘I’ to mean herself as a mixed quote of Bob’s use of ‘I’ to mean himself, we must assume that the mixed-quoted use of ‘I’ means a context dependency on the first person, even though Bob also use the same form to mean himself.

2.2. Quantification and polarity

A quantifier can be thought of as a meta-construction: ‘everybody’ maps a unary construction to a nullary construction. In terms of form, it maps each string-to-string function f to the string f everybody. In terms of meaning, it maps each individual-to-proposition function g to the proposition $\forall y. gy$. This idea let us analyze ‘everybody saw Mary’ and ‘Mary saw everybody’, but does not alone generate ‘everybody saw everybody’ because this meta-construction only applies to unary constructions.

To resolve this issue, it may seem natural to allow ‘quantifying in’ any argument position of an n -ary construction, mapping it to an $(n - 1)$ -ary construction (Hendriks 1993). However, an analogy between surface scope in quantification and left-to-right evaluation in other linguistic side effects (Shan and Barker 2006) suggests only ‘quantifying in’ the last argument. We then generate only surface scope for (15).

(15) Somebody saw everybody.

Where does inverse scope come from, then? Mixed quotation offers one answer: we can generate inverse scope if we can quote the (wider) scope of the later quantifier as a construction, excluding that quantifier itself. For example, we can analyze (15) as (16) if we can mixed quote the unary construction ‘somebody saw –’, *hereby* used to mean the property of having been seen by somebody. The resulting interpretation can be glossed as (17) (which is coherent, unlike (18)—pace Quine (1960)).

(16) ![Somebody saw %[everybody]]

(17) For everybody y , the sentence [Somebody saw %[y]] is true.

(18) For everybody y , the sentence [Somebody saw %[y]] has eight letters.

Because the more-quoted quantifier takes narrower scope above, one might worry about a mixed-quoted quantifier taking inverse scope over an unquoted quantifier.

(19) The dean asked that a student ‘accompany every professor’. (Cumming 2003)

In fact, because written quotation marks may not indicate every level of actual quotation, we can treat such examples in terms of the syntactic interjection of §1.3.

(20) The dean asked that ![!~[![a student]]] accompany %[every professor]]

This account of inverse scope lets us explain why polarity licensing requires not just that the licensor take scope over the licensee, but also that the licensor precede the licensee if they are clausemates (Ladusaw 1979). For example, though ‘Alice introduced nobody to anybody’ has a surface-scope reading, *‘Alice introduced anybody to nobody’ does not have an inverse-scope reading.

Our explanation assumes that a clause like ‘Alice introduced anybody to Bob’ and a construction like ‘Alice introduced anybody to %[. . .]’ are not quotable, even though they can appear as part of a larger quotable item (for example when preceded by ‘nobody thinks’). Intuitively, they are not quotable because they are incomplete: they are unacceptable as utterances by themselves. This intuition can be enforced in one of two ways: either assign a different syntactic category or semantic type to a constituent that contains an unlicensed polarity item (Fry 1997), or always insert a licenser and a licensee in one fell meta-construction. If there is no construction ‘Alice introduced anybody to %[. . .]’ to quote, then the strategy for generating inverse scope in (16) fails. Hence the paraphrase (22) of (21), analogous to (17), is unacceptable.

(21) *![Alice introduced anybody to %[nobody]]

(22) *For nobody y , the sentence [Alice introduced anybody to %[y]] is true.

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Bibliography

- Cumming, S.: 2003, Two accounts of indexicals in mixed quotation, in P. de Brabanter (ed.), *Hybrid Quotations*, pp 77–88, *Belgian Journal of Linguistics* 17(1)
- Davidson, D.: 1979, Quotation, *Theory and Decision* 11(1), 27–40
- Fry, J.: 1997, Negative polarity licensing at the syntax-semantics interface, in P. R. Cohen and W. Wahlster (eds.), *Proceedings of the Annual Meeting of the Association for Computational Linguistics and 8th Conference of the European Chapter of the Association for Computational Linguistics*, pp 144–150
- Geurts, B. and Maier, E.: 2003, Quotation in context, in P. de Brabanter (ed.), *Hybrid Quotations*, pp 109–128, *Belgian Journal of Linguistics* 17(1)
- Hendriks, H.: 1993, *Studied Flexibility: Categories and Types in Syntax and Semantics*, Ph.D. thesis, Universiteit van Amsterdam
- Kripke, S. A.: 1980, *Naming and Necessity*, Harvard University Press, Cambridge
- Ladusaw, W. A.: 1979, *Polarity Sensitivity as Inherent Scope Relations*, Ph.D. thesis, University of Massachusetts, Reprinted by New York: Garland, 1980
- Maier, E.: 2007, Mixed quotation: Between use and mention, in K. Yoshimoto (ed.), *Proceedings of the 4th International Workshop on Logic and Engineering of Natural Language Semantics*, Japanese Society of Artificial Intelligence
- Quine, W. V. O.: 1960, *Word and Object*, MIT Press, Cambridge
- Shan, C.-c. and Barker, C.: 2006, Explaining crossover and superiority as left-to-right evaluation, *Linguistics and Philosophy* 29(1), 91–134

A METALINGUISTIC SEMANTICS FOR ECHO QUESTIONS

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This paper proposes a compositional semantics for echo questions in the structured meanings approach to questions, claiming that they are metalinguistic questions about expressions. It also points out inadequacies of the focus semantic approach of Artstein 2002 and the non-metalinguistic approach of Ginzburg and Sag 2001.

1. Introduction

This paper provides a compositional semantic analysis of echo questions adopting the structured meanings approach to questions (von Stechow 1982; von Stechow 1989). In particular, it analyzes echo questions as *metalinguistic* questions in the sense that they are questions about expressions (cf. Blakemore 1994; Iwata 2003; Janda 1985). To simplify the discussion, we will confine our attention to English.

Section 2 enumerates basic properties of echo questions, which suggest the metalinguistic nature of echo questions. Section 3 examines two previous attempts by Artstein 2002 and Ginzburg and Sag 2001 and point out their problems. Section 4 presents our analysis.

2. Metalinguistic Properties of Echo Questions

Echo questions come in two varieties, *yes/no-echo questions* and *wh-echo questions*. Yes/no-echo questions involve an echo-focused ordinary expression, whereas wh-echo questions involve an echo-focused wh-phrase. For example, (1B) is a yes/no-echo question and (1B') is a wh-echo question. The questioned phrases are capitalized throughout this paper.

- (1) A: I've bought you an aeroplane.
B: You've bought me an AEROPLANE?
B': You've bought me a WHAT? (adapted from Blakemore 1994, 197f)

Note that echo questions are basically 'echos' of the previous utterance, but are generally not completely verbatim. Most notably, indexicals are switched to retain the original references. We will come back to this point in section 4.

This section adduces five syntactic and semantic properties of echo questions that both yes/no- and wh-echo questions share. In particular, they suggest the metalinguistic nature of echo questions.

2.1. Lack of Inversion

As already evident in (1), echo questions do not show the subject-auxiliary inversion, unlike ordinary questions. Also, no wh-phrase in wh-echo questions undergoes wh-fronting, unlike in ordinary wh-questions.¹

Moreover, Artstein 2002 points out that echo questions are insensitive to the Coordinate Structure Constraint (CSC), suggesting that no movement is involved in echo questions.

- (2) A: John knows who ate beans and squid.
B: John knows who ate beans and SQUID?
B': John knows who ate beans and WHAT? (adapted from Artstein 2002, 102)

2.2. Insensitivity to syntactic constituency

Both yes/no- and wh-echo questions allow units smaller than a word, those larger than a word and even non-constituents to be questioned (cf. Artstein 2002).

- (3) A: Have you met the epidemiologist?
B: Have I met the epidemi-OLOGIST?
B': Have I met the epidemi-WHAT?
B'': Have I MET THE EPIDEMIOLOGIST?
B''': Have I WHAT? (adapted from Blakemore 1994, 203)
- (4) A: The dog wanted to eat the cat.
B: The dog WANTED TO EAT the cat?
B: The WHAT? (adapted from Bolinger 1987, 263)

2.3. Insensitivity to sentence types

Echo questions are insensitive to the sentential type of the echoed utterance. Thus, besides declaratives, they can ask about questions, imperatives, and exclamatives.

- (5) A: Who gave flowers to George?
B: Who gave FLOWERS to George?
B': Who gave WHAT to George? (adapted from Artstein 2002)
- (6) A: Talk to a fortune-teller.
B: Talk to a FORTUNE-TELLER?
B': TALK to WHAT/WHO? (Noh 1998, 604)

¹Artstein 2002, 88 observes that some languages allow and in fact prefer wh-fronting in wh-echo questions.

- (7) A: What a great pleasure this is!
B: What a great PLEASURE this is?
B': What a great WHAT this is? (Ibid.)

2.4. Non-licensing of NPIs

As Iwata 2003 observes, NPIs are not licensed in echo questions unlike in ordinary questions.

- (8) A: So you finally managed to solve some of the problems.
B: I finally MANAGED to solve {some/*any} of the problems?
B': I finally WHAT to solve {some/*any} of the problems? (adapted from Iwata 2003, 198)

2.5. Obligatory widest scope

Iwata 2003 also points out that wh-phrases in wh-echo questions always take the widest scope regardless of the syntactic environment, and they can never take the embedded scope.

- (9) A: Every student talked to the department chair.
B: Every student talked to WHO? (Iwata 2003, 218)
- (10) *Mary wonders John met WHO? (Ibid.)

2.6. Interim Summary

All of these points suggest the metalinguistic nature of echo questions. The first three properties indicate that echo questions do not interact with the syntax of the original utterance, and the latter two indicate that they do not interact with the semantics of the original utterance. Intuitively speaking, echo questions treat the echoed utterances as *linguistic expressions*. In the next section, two non-metalinguistic treatments of echo questions are examined, which do not capture this intuition.

3. Two Previous Attempts

3.1. Artstein 2002

Adopting the Roothian alternative semantics of focus, Artstein 2002 claims that echo questions are sentences that only have focus values. In particular, he takes the questioned part of an echo question to be just a focus. In the alternative semantics, each word or phrase has a focus value in addition to the ordinary semantic value, which is the set each of whose member is obtained by replacing the ordinary value of the focused material, if any, with something of the same semantic type. Also, Artstein assumes that wh-phrases in wh-echo questions have the set of alternatives matching in type (e.g. the set of individuals in the case of *WHAT*). For instance, (1B) and (1B')

would be assigned the following denotations, where $\llbracket x \rrbracket^f$ denotes focus value of the expression 'x'.

- (11) a. $\llbracket (1B) \rrbracket^f = \{A \text{ has bought } B \text{ a } x : x \in D_{\langle e, t \rangle}\}$
 b. $\llbracket (1B') \rrbracket^f = \{A \text{ has bought } B \text{ } x : x \in D_e\}$

Note that this account does not posit any movement in echo questions, and hence can explain the lack of inversion and the insensitivity to islands. Also, Artstein proposes an account of echo questions below the word level which takes the echo focused part of a word to be a function of type $\langle e, e \rangle$. Furthermore, he claims it is possible to account for echo questions of non-declarative utterances by assuming that echo questions have only focus values, while ordinary sentences only have ordinary values.

This theory is, however, empirically inadequate in that it cannot capture when echo questions interact with focus phenomena.

- (12) A: John only gave a [flower]_F to Mary.
 B: John only gave a FLOWER to Mary?

A's utterance here already contains a focus which is caught by the operator *only*. In order to echo this utterance, *only* in B's question must take the alternative induced by *FLOWER*. However, if that happens, the entire sentence would have a trivial focus value, and thus could not be an echo question.

Secondly, this theory does not give a straightforward account as to why echo questions do not license NPIs, since it claims that echo questions are questions on a par with ordinary questions.

3.2. Ginzburg and Sag 2001

Ginzburg and Sag 2001 claim that echo questions are disguised ordinary questions and paraphrasable by them.

- (13) a. You like WHO?
 b. Who did you say (just now) that you like? (Ginzburg and Sag 2001, 259)

However, not all echo questions can be paraphrased by an ordinary question (Iwata 2003). For example, (3B') and (4B) above would be analyzed as ungrammatical questions.

- (14) a. *What did you (just now) ask me if I have met the epidemi-?
 b. *What did you (just now) ask me the?

Moreover, it is not clear how the other properties mentioned in section 2 would be accounted for. In particular, the insensitivity to CSC, non-licensing of NPIs and the obligatory widest scope seem to pose a serious challenge.

4. A Metalinguistic Compositional Semantics

This section presents a new compositional semantics for echo questions couched in the structured meanings approach to questions. Crucially, it treats them as metalinguistic questions, following the intuition in section 2.

Firstly, a new semantic type u is introduced in addition to e and t (cf. Potts 2007).

- (15) $\text{Type} := e, t, u | (\text{TypeType}) | \langle \text{Type}, \text{Type} \rangle | \text{Type} \bullet \text{Type}$
- (16) a. D_u is the set of expressions
b. $D_{(\sigma\tau)} = D_\tau^{D_\sigma}$
c. $D_{\langle\sigma,\tau\rangle}$ is the set of structured meanings $\langle\alpha, \beta\rangle$ s.t. $\alpha \in D_\sigma$ and $\beta \in D_\tau$
d. $D_{\sigma\bullet\tau} = D_\sigma \times D_\tau$

In the structured meanings approach to questions, each question is assigned as its denotation a structured meaning, which is an ordered pair of a function (*background*) and a set (*restriction*) such that the former, when applied to any member of the latter, yields a truth-value. Note that the restriction is meant to be possible answers. Henceforth, I will not distinguish sets and their characteristic functions.

Below are the compositional rules having to do with structured meanings, the first three of which are used for ordinary questions (cf. Krifka 1991).

- (17) a. *Inheritance from Predicate*
If α has β and γ as its daughters and $\llbracket\beta\rrbracket^g = \langle\delta, \epsilon\rangle$ which is of type $\langle(\sigma(\tau\mu)), (\sigma t)\rangle$ and $\llbracket\gamma\rrbracket^g$ is of type τ , then $\llbracket\alpha\rrbracket^g = \langle\lambda x \in D_\sigma. \delta(x)(\llbracket\gamma\rrbracket^g), \epsilon\rangle$.
- b. *Inheritance from Argument*
If α has β and γ as its daughters and $\llbracket\beta\rrbracket^g$ is of type $(\sigma\tau)$ and $\llbracket\gamma\rrbracket^g = \langle\delta, \epsilon\rangle$ which is of type $\langle(\mu\sigma), (\mu t)\rangle$, then $\llbracket\alpha\rrbracket^g = \langle\lambda x \in D_\mu. \llbracket\beta\rrbracket^g(\delta(x)), \epsilon\rangle$.
- c. *Inheritance from Both*
If α has β and γ as its daughters and $\llbracket\beta\rrbracket^g = \langle\delta, \epsilon\rangle$ which is of type $\langle(\sigma(\tau\mu)), (\sigma t)\rangle$ and $\llbracket\gamma\rrbracket^g = \langle\zeta, \eta\rangle$ which is of type $\langle(\nu\tau), (\nu t)\rangle$, then $\llbracket\alpha\rrbracket^g = \langle\lambda x \bullet y \in D_{\sigma\bullet\nu}. [\delta(x)(\zeta(y))], \epsilon \times \eta\rangle$.
- d. *Metalinguistic Inheritance (single)*
If α has β and γ as its daughters and $\llbracket\beta\rrbracket^g = \langle\delta, \epsilon\rangle$ which is of type $\langle(uu), (ut)\rangle$ and $\llbracket\gamma\rrbracket^g$ is not of type $\langle(uu), (ut)\rangle$, then $\llbracket\alpha\rrbracket^g = \langle\lambda X \in D_u. \alpha[\delta(X)/\beta], \epsilon\rangle$, which is of type $\langle(uu), (ut)\rangle$.
- e. *Metalinguistic Inheritance (multiple)*
If α has β and γ as its daughters and $\llbracket\beta\rrbracket^g = \langle\delta, \epsilon\rangle$ which is of type $\langle(uu), (ut)\rangle$ and $\llbracket\gamma\rrbracket^g = \langle\zeta, \eta\rangle$ which is of type $\langle(u\bullet\dots\bullet uu), (u\bullet\dots\bullet ut)\rangle$, then $\llbracket\alpha\rrbracket^g = \langle\lambda X \bullet Y \bullet \dots \bullet Z \in D_{u\bullet u \bullet \dots \bullet u}. \alpha[\delta(X)/\beta, \zeta(Y \bullet \dots \bullet Z)/\gamma], \epsilon \times \eta\rangle$, which is of type $\langle(u \bullet u \bullet \dots \bullet uu), (u \bullet u \bullet \dots \bullet ut)\rangle$.

Here, here $u \bullet \dots \bullet u$ contains one or more u 's conjoined by \bullet , and " $\alpha[\delta(X)/\beta]$ " is that expression obtained from α by replacing every occurrence of β in α by $\delta(X)$.

Below are examples of stressed expressions in echo questions.

- (18) a. $\llbracket \text{AEROPLANE} \rrbracket^g = \langle \lambda X \in D_u.X, \{\ulcorner \text{aeroplane} \urcorner\} \rangle$
 b. $\llbracket \text{WHAT} \rrbracket^g = \langle \lambda X \in D_u.X, \{X : X \in D_u\} \rangle$
 c. $\llbracket \text{WHO} \rrbracket^g = \langle \lambda X \in D_u.X, \{X : X \in D_u \wedge \text{human}(\llbracket X \rrbracket^g) = 1\} \rangle$

The following are the complementizers used for yes/no- and wh-echo questions respectively, which relate the structured meaning of the body of an echo question to the previous utterance P , of which it is an echo.

- (19) a. $\llbracket C_{y/n-echo} \rrbracket^g = \lambda \langle \alpha, \beta \rangle \in D_{\langle (uu), (ut) \rangle}. \langle \lambda f.f(\forall X \in \beta : \llbracket \alpha(X) \rrbracket^g \Leftarrow \llbracket P \rrbracket^g \wedge \forall Y \in \text{Alt}(\beta) : \llbracket \alpha(Y) \rrbracket \Leftarrow \llbracket P \rrbracket^g \leftrightarrow [Y = X]), \{\lambda p.p, \lambda p.\neg p\} \rangle$
 b. $\llbracket C_{wh-echo} \rrbracket^g = \lambda \langle \alpha, \beta \rangle \in D_{\langle (u \bullet \dots \bullet uu), (u \bullet \dots \bullet ut) \rangle}. \langle \lambda X \bullet \dots \bullet Y \in D_{u \bullet \dots \bullet u}. \llbracket \alpha(X \bullet \dots \bullet Y) \rrbracket^g \Leftarrow \llbracket P \rrbracket^g, \beta \rangle$

Note that these do not require an echo question with a correct answer to be verbatim to the previous utterance, but just semantically entailed by it.

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Bibliography

- Artstein, R.: 2002, *Parts of Words*, Ph.D. thesis, Rutgers University
 Blakemore, D.: 1994, Echo questions: A pragmatic account, *Lingua* 94, 197–211
 Bolinger, D.: 1987, Echoes reechoed, *American Speech* 62, 262–279
 Ginzburg, J. and Sag, I.: 2001, *Interrogative investigations: the form, meaning, and use of English interrogatives*, CSLI, Stanford
 Iwata, S.: 2003, Echo questions are interrogatives? Another version of metarepresentational analysis, *Linguistics and Philosophy* 26, 185–254
 Janda, R. D.: 1985, Echo-questions are evidence for what?, in *Chicago Linguistic Society*, Vol. 21, pp 171–188
 Krifka, M.: 1991, A Compositional Semantics for Multiple Focus Constructions, in *SALT I*, pp 17–53
 Noh, E.-J.: 1998, Echo questions: Metarepresentation and pragmatic enrichment, *Linguistics and Philosophy* 21, 603–628
 Potts, C.: 2007, The dimensions of quotation, in C. Barker and P. Jacobson (eds.), *Direct Compositionality*, pp 405–431, Oxford University Press, Oxford
 von Stechow, A.: 1982, *Structured Propositions*, Technical Report 59, Sonderforschungsbereich 99, Universität Konstanz
 von Stechow, A.: 1989, Focusing and Backgrounding Operators, in W. Abraham (ed.), *Discourse Particles*, pp 37–84, John Benjamins

STRONG MEANING HYPOTHESIS FROM A COMPUTATIONAL PERSPECTIVE

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In this paper we study the computational complexity of reciprocal sentences with quantified antecedents. We observe a computational dichotomy between different interpretations of reciprocity and its connection with Strong Meaning Hypothesis.

1. Introduction

The English reciprocal expressions *each other* and *one another* are common elements of everyday English. In this paper we study the computational complexity of reciprocal sentences with quantified antecedents. We bring attention to possible cognitive consequences of complexity issues in semantics. Particularly, by observing a computational dichotomy between different interpretations of reciprocity we shed some light on the epistemological status of the so-called Strong Meaning Hypothesis (proposed in Dalrymple et al. 1998).

Our results also give an additional argument for the robustness of semantic distinction established by Dalrymple et al. 1998. Moreover, we present NP-complete natural language quantifiers which occur frequently in everyday English. As far as we are aware, all other known NP-complete semantic constructions are based on ambiguous and artificial branching operations.

1.1. Basic examples

We start by recalling examples of reciprocal sentences versions of which can be found in the corpus of English (see footnote 1 in Dalrymple et al. 1998). Let us consider the sentences (1)–(3).

- (1) An even number of parliament members refer to each other indirectly.
- (2) Most Boston pitchers sat alongside each other.
- (3) Some Pirates of the Caribbean were staring at each other in surprise.

The possible interpretations of reciprocity exhibit a wide range of variations. In this paper we will restrict ourselves to these three possibilities. Sentence (1) implies that there is a subset of parliament members of even cardinality such that each parliament member in that subset refers to some statement of each of the other parliament members in that subset. However, the reciprocals in the sentences (2) and (3) have different meanings. Sentence (2) entails that each of most of the pitchers is directly or indirectly in the relation of sitting alongside with each of the other pitchers from a set containing most pitchers. Sentence (3) says that there was a group of pirates such that every pirate belonging to the group stared at some other pirate from the group. Following Dalrymple et al. 1998 we will call the illustrated reciprocal meanings *strong*, *intermediate*, and *weak*, respectively.

2. Reciprocals as polyadic quantifiers

Monadic generalized quantifiers provide the most straightforward way to define the semantics of noun phrases in natural language. Sentences with reciprocal expressions transform such monadic quantifiers into polyadic ones. We will analyze reciprocal expressions in that spirit by defining appropriate lifts on monadic quantifiers. These lifts allow us to express the meanings of sentences with reciprocals in the compositional way with respect to monadic quantifiers occurring in sentences. For the sake of simplicity we will restrict ourselves to reciprocal sentences with monotone increasing quantifiers in the antecedent. However, our definitions can be extended to cover also sentences with decreasing and non-monotone quantifiers, for example following the strategy of bounded composition as explained by Dalrymple et al. 1998.

In order to define the meaning of the strong reciprocity we make use of well-know operation on quantifiers called *Ramseyfication*. Let Q be a monadic monotone increasing quantifier, we define:

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$$\text{Ram}_S(Q)AR \iff \exists X \subseteq A[Q(X) \wedge \forall x, y \in X(x \neq y \Rightarrow R(x, y))].$$

The result of such a lift is called *Ramsey quantifier*.

In an analogous way we define two other lifts to express intermediate and weak reciprocity. For intermediate reciprocity we have the following:

$$\begin{aligned} \text{Ram}_I(Q)AR \iff \exists X \subseteq A[Q(X) \wedge \forall x, y \in X \\ (x \neq y \Rightarrow \exists \text{ sequence } z_1, \dots, z_\ell \in X \text{ such that} \\ (z_1 = x \wedge R(z_1, z_2) \wedge \dots \wedge R(z_{\ell-1}, z_\ell) \wedge z_\ell = y))]. \end{aligned}$$

For weak reciprocity we take the following lift:

$$\text{Ram}_W(Q)AR \iff \exists X \subseteq A[Q(X) \wedge \forall x \in X \exists y \in X (x \neq y \wedge R(x, y))].$$

All these lifts produce polyadic quantifiers of type (1, 2). We will call the values of these lifts strong, intermediate and weak reciprocity, respectively. The linguistic application of them is straightforward. For example, formulae (4)–(6) give readings to the sentences (1)–(3).

- (4) $\text{Ram}_5(\text{EVEN})\text{MP Refer.}$
- (5) $\text{Ram}_I(\text{MOST})\text{Pitcher Sit.}$
- (6) $\text{Ram}_W(\text{SOME})\text{Pirate Staring.}$

3. Complexity of the reciprocal lifts

3.1. Strong reciprocity

We will restrict ourselves to finite models. We identify models of the form $M = (U, A^M, R^M)$, where $A^M \subseteq U$ and $R^M \subseteq U^2$, with undirected graphs. In graph theoretical terms we can say that $M \models \text{Ram}_5(Q)AR$ if and only if there is a complete subgraph in M of size bounded by the quantifier Q . For example, to decide whether some model M belongs to $\text{Ram}_5(\exists^{\geq k})$ we must solve the CLIQUE problem for M and k . A brute force algorithm to find a clique in a graph is to examine each subgraph with at least k vertices and check to see if it forms a clique. This means that for every fixed k the computational complexity of $\text{Ram}_5(\exists^{\geq k})$ is in PTIME. However, in general — for changing k — this is a well-known NP-complete problem.

Let us define a unary counting quantifier $\exists_y^{\geq k}$ — expressing the statement **At least k** for a natural number k — as follows:

$$M \models \exists_y^{\geq k} \varphi(y)[v] \iff \text{card}(\varphi^{(M,y,v)}) \geq v(k).$$

Then it is obvious that:

Proposition 1 *The Quantifier $\text{Ram}_S(\exists^{\geq k})$ is NP-complete.*

Therefore, strong reciprocal sentences with counting quantifiers in antecedents are NP-complete.

We can give one more general example of strong reciprocal sentences which are NP-complete. Let us consider the following sentences:

- (7) Most members of the parliament refer to each other indirectly.
- (8) At least one third of the members of the parliament refer to each other.
- (9) At least $q \times 100\%$ of the members of the parliament refer to each other.

We will call these sentences the *strong reciprocal sentences with proportional quantifiers*. Their general form is given by the sentence schema (9), where q can be interpreted as any rational number between 0 and 1. These sentences say that there is a clique A in M such that $\frac{\text{card}(A)}{\text{card}(U)} \geq q$.

For any rational number $q \in]0, 1[$ we say that a set $A \subseteq U$ is q -big if and only if $\frac{\text{card}(A)}{\text{card}(U)} \geq q$. In this sense q determines a proportional Ramsey quantifier R_q of type (2) such that $M \models R_q xy \varphi(x, y)$ iff there is a q -big $A \subseteq |M|$ such that for all $a, b \in A$, $M \models \varphi(a, b)$. Obviously such quantifiers might be used to express meanings of sentences like (7)–(9). It was observed by Mostowski and Szymanik 2007 that:

Proposition 2 *Let $q \in]0, 1[\cap \mathbb{Q}$, then the quantifier R_q is NP-complete.*

In fact one can show much more general results, but we leave this rather technical enterprise for the full paper.

4. The intermediate and weak lifts

Analogously to the case of strong reciprocity we can also express the meanings of intermediate and weak reciprocal lifts in graph-theoretical terms. We say that $M \models \text{Ram}_I(Q)AR$ if and only if there is a connected subgraph in M of size bounded by the quantifier Q . And $M \models \text{Ram}_W(Q)AR$ if and only if there is a subgraph in M of size bounded by the quantifier Q without isolated vertices.

We prove that the class of PTIME quantifiers is closed under intermediate lift and weak lift.

Proposition 3 *If Q is in PTIME, then $\text{Ram}_I(Q)$ is in PTIME.*

Proposition 4 *If Q is in PTIME, then $\text{Ram}_W(Q)$ is in PTIME.*

These results show that intermediate and weak reciprocal lifts do not increase the complexity of quantifier sentences in such drastic ways as in the case of strong reciprocal lifts. In other words, in many natural language situations intermediate and weak interpretations are relatively easy as opposed to the strong reciprocal reading.

5. The complexity perspective on SMH

Dalrymple et al. 1998 proposed a pragmatic principle, called Strong Meaning Hypothesis, to predict the proper reading of sentences containing reciprocal expressions. According to SMH the reciprocal expression is interpreted as having logically strongest truth conditions that are consistent with a given context. Therefore, if it is only consistent with specified facts, then the statement containing *each other* will be interpreted as strong reciprocal sentence. Otherwise, the interpretation will shift towards logically weaker readings, intermediate or weak, depending on the context.

SMH is a quite effective pragmatic principle. We will discuss shifts it predicts from a computational point of view using the results provided in the previous section.

Let us first think about the meaning of a sentence in the intensional way — identifying the meaning of an expression with an algorithm recognizing its denotation in a finite model. Such algorithms can be described by investigating how language users evaluate the truth-value of sentences in various situations. On the cognitive level it means that subjects have to be equipped with mental devices to deal with meanings

of expressions. Moreover, it is cognitively plausible to assume that we have one mental device to deal with most instances of the same logical notion. For example, we believe that there is one mental algorithm to deal with counting quantifiers in most of the possible contexts. In the case of logical expressions, as quantifiers, this analogy seems uncontroversial.

However, notice that some sentences are too hard for identifying their truth-value directly. Programming experience suggests that we can claim a sentence to be difficult when it can not be computed in polynomial time (see Mostowski and Szymanik 2005 for a more detailed discussion). Despite the fact that some sentences are too hard for direct comprehension we can identify their inferential relations with relatively easier sentences. For instance, knowing that φ implies ψ and that ψ is not true we can easily decide that φ is false, no matter how complex is φ .

According to SMH any reciprocal sentence, if it is only possible, should be interpreted as strong reciprocal sentence. We showed that strong interpretation is sometimes NP-complete. Therefore, it is reasonable to suspect that in some linguistic situations strong reciprocal interpretation is cognitively much more difficult than intermediate or weak interpretation. If it happens to be too hard, then the subject will try to establish the truth-value of a sentence indirectly, by shifting to the accessible inferential meanings. They are — depending on context — the intermediate or the weak interpretation. Summing up, our descriptive complexity perspective on reciprocity is consistent with SMH. Moreover, it gives a cognitively reasonable argument explaining some of SMH predictions.

Bibliography

- Dalrymple, M., Kanazawa, M., Kim, Y., Mchombo, S., and Peters, S.: 1998, Reciprocal expressions and the concept of reciprocity, *Linguistics and Philosophy* 21, 159–210
- Mostowski, M. and Szymanik, J.: 2005, Semantical bounds for everyday language, *Semiotica* to appear (see also ILLC Preprint Series, PP-2006-40)
- Mostowski, M. and Szymanik, J.: 2007, Computational complexity of some Ramsey quantifiers in finite models, *The Bulletin of Symbolic Logic* 13, 281–282

PLURACTIONALITY VS. DISCONTINUITY

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Verbal plurality that includes meanings such as iteration and frequency is commonly thought of as the pluralization of the event argument of a verb. This paper aims at identifying another source of iterativity whereby a sentence refers to a single but temporally discontinuous event. In Chuvash (Altaic, Turkic), this is what happens when the morpheme *-kala-* attaches to VP. I analyze this morpheme as a degree modifier on event predicates indicating that the degree to which a certain event type is realized with respect to a contextually determined gradable property falls below the standard of comparison. If continuity is fixed as a relevant property, the discontinuous interpretation results.

1. Introduction

Verbal plurality comprising iterative, frequentative, and other related meanings is commonly viewed as the pluralization of the time or event argument of a verbal predicate (Lasersohn 1995, Matthewson 2000, Yu 2003, van Geenhoven 2005, a.o.). (1) represents the classic definition in Lasersohn 1995:232:

- (1) $V\text{-PA}(X) \Leftrightarrow \forall e, e' \in X [V(e) \wedge \neg f(e) \otimes f(e')] \wedge \text{card}(X) \geq n$,
where f is a temporal or spatial trace function or a thematic role assigned by V.

This paper aims at showing how the meaning apparently involving multiple times/events can be derived without pluralization. Specifically, I propose that what looks like a plurality of events can in fact be a single, but *discontinuous* event. I will argue that this is exactly what happens in Chuvash (Altaic, Turkic) and provide arguments supporting this claim. Secondly, I will suggest that the discontinuative interpretation can obtain through *degree modification*. In Chuvash, the degree modifier indicates that the degree to which events in the denotation of VP possess a gradable property of continuity falls below the standard of comparison. I will develop a semantic analysis that captures this characteristic as well as a few additional readings induced by the degree modifier.

2. Repeatedness without distributivity and iteration

To begin with, compare (2a-b) from Chuvash (Altaic, Turkic). (2a) contains a non-derived predicate ‘plow a field’, while (2b) demonstrates its “iterative” counterpart derived by the *-kala-* morpheme:

- (2) a. vaš'a uj-a suxala-r-ě.
V. field-DA plow-PFV-3:SG
‘Vasja plowed a field.’
- b. vaš'a uj-a suxala-kala-r-ě.
V. field-DA plow-KALA-PFV-3:SG
‘Vasja plowed a field repeatedly.’

Apparently, (2b) is a genuine instance of pluractionality whereby the verbal predicate in (2b) is derived from that in (2a) by pluralization of its event argument. Nevertheless, pluractional analysis of *-kala-* faces a few complications.

First, *-kala-* does not produce the whole range of expected interpretations mentioned in the literature (e.g., Cusic 1981, Lasersohn 1995, Ojeda 1998, Yu 2003, Collins 2005). As Lasersohn (1995:253) notes, pluractionals tend to exhibit distributive readings whereby participants are distributed over events (this reading obtains if *f* in (1) is a theta role assigned by the verb). However, (2b) is incompatible with the distributive scenario ‘Vasja plowed one field after another’.

Secondly, assume that *f* in (1) is a temporal trace function mapping events onto their running times. Then if *-kala-* in (2b) renders the pluractional operator, the truth conditions of (2b) can be stated as follows:

- (3) $\|uj- suxala-kala-\|$ is true of the set of events X iff for every $e, e' \in X$
 $\|uj- suxala-\|$ holds of e and e' , and $\tau(e)$ does not overlap with $\tau(e')$.

But the predicate $\|uj- suxala-\|$ is quantized and telic (if e is an event in which the field has been plowed, then no proper part of e is an event in which the field has been plowed) and only contains atomic events in its extension (cf. Rothstein’s (2004) definition of telicity in terms of atomicity). Constructing a set out of these events will result in the interpretation involving repetitions of Vasja’s plowing of the whole field. But the scenario involving repetitions of the whole event with same participant (‘Vasja plowed the whole field repeatedly’) is inappropriate for (2b) either. The only possible scenario involves plowing the same field one part after another, making pauses in between, and this fact receives no explanation on the pluractional analysis.

Thirdly, *-kala-* exhibits a number of additional interpretations which true pluractional markers are not expected to possess. Different possibilities are illustrated in (4a-c):

- (4) a. *vil jurla-kala-r-ě.*
 he sing-KALA-PFV-3:SG
 ‘He sang for a while.’
- b. *maša koftă-na š'ix-kele-r-ě.*
 M. jacket-DA knit-KALA-PFV-3:SG
 ‘Masha knitted a jacket slowly.’
- c. *jīvaš'í šan-kala-r-ě.*
 tree whither-KALA-PFV-3:SG
 ‘The tree has partly withered.’

Evidently, none of (4a-c) involves pluractionality at all. There is no obvious way of deriving these interpretations under the pluractional analysis, and some other account for the distribution of *-kala-* is called for.

3. Degree modification and discontinuity

Intuitively, what all the readings in (3)-(4) have in common is the fact that the event referred to deviates from the standard for this event type. In other words, *-kala-* indicates that the degree to which an event possesses a certain *gradable property* (e.g. DURATION in (4a), VELOCITY in (4b), etc.) falls below the standard of comparison. (2b), I suggest, refers to a single, but *discontinuous* event, i.e., to an event with the degree of CONTINUITY below the standard for plowing events.

Formally, I propose that *-kala-* can be uniformly analyzed in terms of *degree restriction*:

$$(5) \ ||-kala-|| = \lambda P \lambda e \exists d [F_c(P)(e) = d \wedge d < \text{STANDARD}(F_c)(C)]$$

$\||-kala-||$, a function of the adverbial type $\langle\langle s, t \rangle, \langle s, t \rangle\rangle$, where s is the type of events, introduces a free variable F_c over degree functions (of type $\langle\langle s, t \rangle, \langle s, d \rangle\rangle$, where d is the type of degrees). F_c specifies the degree d to which an event e of the type P possesses a relevant gradable property (cf. Piñon's (2005) analysis of adverbs of completion). The value of F_c is fixed contextually. Also, $\||-kala-||$ ensures that d is less than the standard of comparison determined by the STANDARD relation for a given degree function with respect to the comparison class. In (3), C is a free variable over comparison classes whose value is fixed contextually as well.

If $\||-kala=||$ is analyzed as a VP modifier, the following derivation obtains (for simplicity, I represent the internal argument as an individual constant):

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- (6) a. $\| [\text{v plow}] \| = \lambda y \lambda e [\text{plow}'(e) \wedge \text{Theme}(y)(e)]$
 b. $\| [\text{VP plow the field}] \| = \lambda e [\text{plow}'(e) \wedge \text{Theme}(\text{the.field}')](e)$
 c. $\| \text{-kala-} [\text{VP plow the field}] \| = \lambda e \exists d [F_c(\lambda e' [\text{plow}'(e) \wedge \text{Theme}(\text{the.field}')](e'))(e) = d \wedge d < \text{STANDARD}(F_c)(C)]$

The event predicate in (6c) denotes a set of plowing events in which the field is the Theme; events of plowing the field possess a contextually fixed gradable property F_c to the degree d , and d falls below the standard of comparison. The event predicate in (6c), then, combines with the Agent relation via the Event Identification (Kratzer 1996).

I suggest that in the appropriate context, the free variable F_c can be assigned $F_{\text{CONTINUITY}}$ function as a value. $F_{\text{CONTINUITY}}$ takes an event of a specific event type and returns a degree on the $S_{\text{CONTINUITY}}$ scale associated with that function. (Other possible values of F_c responsible for the readings in (4) are functions that measure the duration of an event, its «speed», the degree of affectedness of the participant, etc.)

Since $S_{\text{CONTINUITY}}$ is an upper closed scale (that is, it consists of a set of degrees isomorphic to the interval $]0,1]$, see Kennedy and McNally (2005)), the standard of comparison is its maximal degree (Kennedy 2007):

$$(7) \text{STANDARD}(F_{\text{CONTINUITY}})(C) = \max(S_{\text{CONTINUITY}})$$

The *kala*-predicate in (2b) can now be represented as in (6) (leaving out the external argument). It holds of a plowing event as long as it has less than maximal degree of continuity.

$$(8) \lambda e \exists d [F_{\text{CONTINUITY}}(\lambda e' [\text{plow}'(e) \wedge \text{Theme}(\text{the.field}')](e'))(e) = d \wedge d < \max(S_{\text{CONTINUITY}})]$$

Given (8), we have to provide a definition of maximally continuous events. Let $\tau^C(e)$ be a *covering time* for e , that is, the total minimal interval which includes the initial and final moments of e . The event e , then, is maximally continuous iff for any subinterval of $\tau^C(e)$ there is some part of e that occurs at this subinterval (= there are no temporal gaps in $\tau^C(e)$, i.e., times, at which no part of e occurs):

$$(9) F_{\text{CONTINUITY}}(P)(e) = 1 = \max(S_{\text{CONTINUITY}}) \text{ iff } \forall e [P(e) \rightarrow \forall t [t < \tau^C(e) \rightarrow \exists e' [e' < e \wedge t = \tau(e')]]],$$

where $\tau(e)$ is a running time, as before, and $\tau^C(e)$ is a covering time

By (9), if the degree of continuity of an event is less than maximal, there is at least one temporal gap, a time within its covering time at which no subevent occurs:

$$(10) F_{\text{CONTINUITY}}(\text{P})(e) < 1 \rightarrow \forall e [\text{P}(e) \rightarrow \exists t [t < \tau^C(e) \wedge \neg \exists e' [e' < e \wedge t = \tau(e')]]]^1$$

Discontinuous interpretation of (2b) is therefore explained. Crucially, unlike pluractional markers, *-kala-* does not create pluralities of events and/or times out of the extension of a predicate it applies to. Since the denotation of the VP || plow the field || only contains events in which ||the field||, a particular individual, has been plowed, so does the *-kala-*-predicate || *-kala-* [plow the field] ||. Not taking into account (dis)continuity, the predicate denoted by VP || plow the field ||, (2a), and that the derived *kala-*-predicate || *-kala-* [plow the field] ||, (2b), have the same events in their denotation. That is the reason why (2b) does not allow interpretations ‘Vasja plowed one field after another’ and ‘Vasja plowed the whole field repeatedly’ — simply because these interpretations do not show up with (2a). Therefore, difficulties for the pluractional analysis mentioned in Section 2 do not emerge under the degree modifier analysis.

The ‘part-by-part’ interpretation of (2b) is accounted for as well. Since verbs like ‘plow’ take the Incremental Theme argument (Krifka 1992, 1998), the relation between individuals and events in their denotation satisfies Mapping to subobjects (MSO) property:

$$(11) \text{MSO}(\text{R}) \leftrightarrow \forall x, e, e' [\text{R}(x)(e) \wedge e' < e \rightarrow \exists x' [x' < x \wedge \text{R}(x')(e')]].$$

According to (11), every subevent of an event in which the field has been plowed is mapped onto some part of the field. Moreover, MSO as it stands in (11) holds regardless of whether an event has temporal gaps. As a result, Due to MSO, if we take any temporally continuous subevent of the overall discontinuous plowing event, there will be some part of the field that has been plowed in that subevent. What we finally get is exactly the interpretation in (2b): Vasja plowed one part of the field after another taking pauses in the course of the event.

4. Conclusion

Data from Chuvash provide evidence that what is commonly subsumed under the notion of ‘event plurality’ may originate from different sources. The most widely recognized option is pluractionality, attested in a variety of genetically unrelated

¹ I am grateful to the anonymous AC2007 reviewer who encouraged me to re-think an earlier version of the definition. One more way to deal with continuity would be by comparing the *length* of the covering time $\tau^C(e)$ and running time $\tau(e)$. If the two are identical, e is maximally continuous, otherwise it is not.

languages. Another option, discussed in this paper, is the degree restriction yielding the discontinuative interpretation if an event is measured against the continuity scale. Discontinuity is fundamentally different from the pluractionality in that it does not pluralize events, only creating temporal gaps in them.

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Bibliography

- Collins, C.: 2001, Aspects of plurality in Hoan, *Language* 77, pp 456-76
- Cusic, D.: 1981, *Verbal Plurality and Aspect*. Ph.D.dissertation, Stanford University.
- van Geenhoven, V.: 2005, Aspect, pluractionality, and adverbial quantification, in A. van Hout, H. de Swart, and H. Verkuyl (eds.), *Perspectives on Aspect*, Springer, Dordrecht
- Kennedy, C.: 2007, Vagueness and grammar: the semantics of relative and absolute gradable adjectives, *Linguistics and Philosophy* 30, pp. 1-45
- Kennedy, C. and McNally L.: 2005, Scale structure, degree modification and the semantics of gradable predicates, *Language* 81, pp. 345-381
- Krifka, M.: 1998, The origins of telicity, in S. Rothstein (ed.), *Events and Grammar*, pp. 197-235, Kluwer, Dordrecht
- Laserson, P.: 1995, *Plurality, Conjunction, and Events*, Kluwer, Dordrecht
- Matthewson, L.: 2000, On distributivity and pluractionality, in B. Jackson and T. Matthews (eds.), *Proceedings of SALT X*, pp. 98-114, CLC Publications, Ithaca, New York
- Ojeda, A. E.: 1998, The semantics of collectives and distributives in Papago. *Natural Language Semantics* 6, pp. 245-270
- Piñon, C.: 2005, Adverbs of completion in an event semantics, in A. van Hout, H. de Swart, and H. Verkuyl (eds.), *Perspectives on Aspect*, Springer, Dordrecht
- Rothstein, S: 2004, *Structuring Events*, Blackwell, Oxford
- Yu, A.C.L.: 2003, Pluractionality in Chechen, *Natural Language Semantics* 11, pp. 289–321.

GRAMMATICAL INFERENCE BY SPECIALIZATION AS A STATE SPLITTING STRATEGY

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We exhibit connexions between two already known learning algorithms developed in different backgrounds. This allows to show that learning classical (or AB) categorial grammars by specialization can be identified with a “state splitting” strategy, in a search space made of extended automata. It also leads to a new interpretation of why it is possible to learn categorial grammars from semantically typed (in Montague’s sense) examples.

In recent papers (Tellier 2005; Tellier 2006), it was shown that classical (or AB) categorial grammars (CGs in the following) could easily be represented by extended automata called recursive automata (RA). This translation allowed to exhibit connexions between two previously distinct approaches of grammar learning from positive examples: the one used in the “BP algorithm” to learn subclasses of CGs (Buszkowski and Penn 1990; Kanazawa 1996; Kanazawa 1998) and the one used to learn regular grammars represented by finite state automata (Angluin 1982; Dupont et al. 1994). In particular, the “state merging” operator used in automata learning was shown to be nothing but a special case of the “unification of variables” operator used in the BP algorithm.

The previous learning algorithms all belong to the family of *generalization strategies*. A generalization strategy applies as follows: the initial hypothesis is a “least general grammar” representing the available examples. Then, an operator is used to generalize this hypothesis until it belongs to the target class. But in symbolic machine learning in general, and in grammatical inference in particular, there also exists a lesser known family of *specialization strategies*. In such strategies, the initial hypothesis is the whole target class of grammars. Each example is considered as a *constraint* which restricts this space, until the space is reduced to a single grammar.

1. Introduction

The aim of this paper is to show that the translation of CGs into RA, which has helped to better understand the family of generalization strategies, can also help to better understand the family of specialization strategies. As a matter of fact, as it was

the case for generalization strategies, specialization approaches have been proposed independantly in two distinct backgrounds: to learn CGs in the one hand, and to learn regular grammars represented by finite state automata in the other hand.

To reach this aim, we first need to briefly recall in section 2. how to transform a CG into a recursive automaton. For sake of simplicity, we restrict ourselves in most of this article to unidirectional CGs, but the definitions can be extended to plain CGs. In section 3., we first present the specialization strategy described in (Moreau 2004), allowing to learn rigid CGs from positive examples. We then explain how it relates to another specialization strategy, which targets regular languages represented by finite state automata (Fredouille and Miclet 2000). As expected, we show that Moreau’s algorithm can be interpreted as a “state splitting” strategy applying on RA. Finally, the whole picture is completed in section 4. by a new interpretation of yet another already known algorithm allowing to learn CGs from semantically typed (in Montague’s sense) examples (Dudau-Sofronie et al. 2001). It appears to be an efficiently controled specialization approach.

2. From categorial grammars to recursive automata

2.1. Basic definitions of categorial grammars

Definition 1 (unidirectional classical categorial grammars) *Let \mathcal{B} be an enumerable set of **basic categories** containing the **axiom** $S \in \mathcal{B}$. $Cat(\mathcal{B})$ is the smallest set such that $\mathcal{B} \subseteq Cat(\mathcal{B})$ and for any $A, B \in Cat(\mathcal{B})$, $A/B \in Cat(\mathcal{B})$ (for bidirectional CGs, we also have $B \setminus A \in Cat(\mathcal{B})$). For every finite **vocabulary** Σ , a **unidirectional categorial grammar** G is a finite relation over $\Sigma \times Cat(\mathcal{B})$. We note $\langle w, C \rangle \in G$ the assignment of the category $C \in Cat(\mathcal{B})$ to the word $w \in \Sigma$. In classical (or AB) unidirectional categorial grammars (UCGs in the following) the only syntactic rule, called Forward Application and noted FA is: $\forall A, B \in Cat(\mathcal{B})$, $A/B \ B \rightarrow A$. The language of G is: $L(G) = \{w = v_1 \dots v_n \in \Sigma^+ \mid \forall i \in \{1, \dots, n\}, \exists A_i \in Cat(\mathcal{B}) \text{ such that } \langle v_i, A_i \rangle \in G \text{ and } A_1 \dots A_n \rightarrow^* S\}$, where \rightarrow^* is the reflexive and transitive closure of the relation \rightarrow .*

Let for example, $\mathcal{B} = \{S, CN, IV\}$ (where *CN* stands for “common noun” and *IV* for “intransitive verbs”), $\Sigma = \{John, runs, a, man\}$ and $G = \{\langle John, S/IV \rangle, \langle runs, IV \rangle, \langle a, (S/IV)/CN \rangle, \langle man, CN \rangle\}$. This over-simple UCG only recognizes the sentences “John runs” and “a man runs”.

2.2. Recursive automata and their language

Definition 2 (recursive automaton) *A **recursive automaton** R is a 5-tuple $R = \langle Q, \Sigma, \gamma, q_0, F \rangle$ such that Q is the finite set of **states** of R , Σ is its finite **vocabulary**, $q_0 \in Q$ its (unique) **initial state** and $F \subseteq Q$ its (unique) **final state**. γ is the **transition function** of R , defined from $Q \times (\Sigma \cup Q)$ to 2^Q .*

We restrict ourselves to recursive automata (RA in the following) with unique initial and final states, but it is not a crucial choice. The only important difference between this definition and the classical definition of finite state automata is that in a RA, it is possible to label a transition either by an element of Σ or by an element of Q . To use a transition labeled by a state $q \in Q$, you need to generate a string belonging to the language $L_R(q)$ of this state q , i.e. a string corresponding to a path starting at the state q and reaching the final state F . The general definition of the set $\{L_R(q) | q \in Q\}$ is thus recursive: when it exists, it is a smallest fix-point. In fact, RA are a special case of Recursive Transition Networks (Woods 1970).

Definition 3 (language of a RA) We define the set of languages $L_R(q)$, for every $q \in Q$ as the smallest set satisfying: (i) $L_R(F) = \epsilon$; (ii) if there exists a transition labeled by $a \in \Sigma$ between q and q' , i.e. $q' \in \gamma(q, a)$ then: $a.L_R(q') \subseteq L_R(q)$; (iii) if there exists a transition labeled by $r \in Q$ between q and q' , i.e. $q' \in \gamma(q, r)$ then: $L_R(r).L_R(q') \subseteq L_R(q)$. Finally, the language of R is: $L(R) = L_R(q_0)$.

2.3. From unidirectional CGs to RA

Every UCG can be transformed into a strongly equivalent RA, i.e. a RA generating the same structural descriptions (Tellier 2006). Let G be a UCG over $\Sigma \times \text{Cat}(\mathcal{B})$. Build $R = \langle Q, \Sigma, \gamma, q_0, F \rangle$ as follows:

- let N be the set of every subcategory of a category assigned to an element of Σ in G (a category is a subcategory of itself). Then $Q = N \cup \{F\}$ with $F \notin N$. The initial state $q_0 = S$, the final one is F .
- For every $q \in Q$, define a transition labeled by q between the state q and F (that is, $F \in \gamma(q, q)$). For every $A/B \in N$, define a transition labelled by A/B between the states A and B ($B \in \gamma(A, A/B)$). For every $\langle w, C \rangle \in G$, add a transition labelled by w between the states C and F ($F \in \gamma(C, w)$).

The example UCG of subsection 2.1. can be transformed into the RA of Figure 1. (after an easy simplification process has been applied for readability):

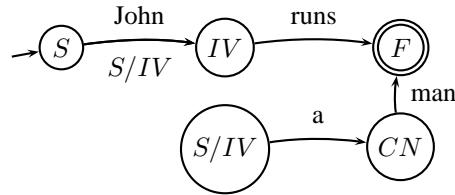


Figure 1: RA equivalent with a UCG

3. Learning by specialization

3.1. Learning rigid UCG from positive examples

A rigid CG G is a CG in which every word $w \in \Sigma$ is assigned at most one category C . Kanazawa has proved (Kanazawa 1998) that the set of every (bidirectional) CG is learnable “in the limit” (i.e. in the sense of Gold 1967) from positive examples, i.e. from sentences. Two distinct learning algorithms are now available for this purpose: Kanazawa’s, derived from “BP” (Buszkowski and Penn 1990), is a *generalization strategy*; the one proposed in (Moreau 2004) is a *specialization strategy*. It is the latter, in its unidirectional version, that we will briefly recall here.

At its start, each member of the vocabulary used at least once in the available example sentences is assigned a distinct variable. For example, for the sentences {“John runs”, “a man runs”}, the initial assignment is $\mathcal{A} = \{\langle John, x_1 \rangle, \langle runs, x_2 \rangle, \langle a, x_3 \rangle, \langle man, x_4 \rangle\}$. \mathcal{A} specifies a set of grammars: the set of CGs G such that there exists an substitution h satisfying $h(\mathcal{A}) = \{\langle w, h(C) \rangle \mid \langle w, C \rangle \in \mathcal{A}\} \subseteq G$. It is obvious that the initial set \mathcal{A} always specifies the whole set of rigid CGs built on Σ .

Then, each sentence is parsed with the assignments in \mathcal{A} . The only possible way to parse “John runs” with only FA is to substitute S/x_2 to x_1 . This substitution is a *constraint* that the variable x_1 must satisfy: x_1 is thus replaced by S/x_2 in \mathcal{A} . To parse “a man runs”, two solutions are possible: either $x_3 = (S/x_2)/x_4$, either $x_3 = S/x_5$ and $x_4 = x_5/x_2$ (with x_5 a new variable). \mathcal{A} then becomes a disjunction of distinct possible sets of assignments. A combinatorial explosion can occur.

3.2. State merges and state splits

The previous algorithm can now be interpreted in terms of operations applying on RA. As we have seen, \mathcal{A} is a disjunction of sets of assignments. Each of these sets can be transformed into a RA, as described in section 2.3.. What is the effect of a constraint on a RA ?

For UCG, the constraints always take the form: $x_k = x_l$, with x_k and x_l already introduced variables, or $x_k = X_m/X_n$, with X_m and X_n any *category built on the set of every variables union S* . The effect of a constraint of the form $x_k = x_l$ on a RA is a *state merge*. The effect of a constraint of the form $x_k = X_m/X_n$ can be decomposed in three steps: (i) X_m/X_n replaces x_k everywhere in the RA, (ii) every subcategory of X_m and X_n (including themselves) becomes a new state, linked to the state F by a transition labeled by its name, and every $/$ inside X_m/X_n becomes a transition, labeled by the fraction of the names of the linked states (at least, X_m and X_n are linked by X_m/X_n), (iii) the states of the same name are merged.

This operation can be compared to the “state splitting strategy” proposed in (Freddouille and Miclet 2000) to learn finite state automata by specialization. For example, the constraint $x_1 = S/x_2$ has the effect of splitting the state x_1 into two new states: S and x_2 (then, as a state named x_2 already exists, the new one is merged with the previous one). But our specialization operation is more general, because of

the recursive nature of the automata on which it applies. It is also better founded, because it is the formal counterpart of well-defined substitutions.

4. Learning from typed examples

The idea of learning CGs from typed (in Montague’s sense) examples was introduced in (Dudau-Sofronie et al. 2001). Montague’s types are derived from categories by a morphism, and associated with the vocabulary in the sentences. They can be interpreted as semantic information available in the environment or previously learned. We illustrate the learning strategy and its effects on RA on a simple example. Let:

$$\begin{array}{ccc} \text{a} & \text{man} & \text{runs} \\ \langle\langle e, t \rangle, \langle\langle e, t \rangle, t \rangle\rangle & \langle e, t \rangle & \langle e, t \rangle \\ (tx_1(tx_2e))x_3(tx_4e) & tx_5e & tx_6e \end{array}$$

In this typed sentence, t and e are the usual montagovian basic types. The last line is the result of a simple pre-treatment to reorder the types in a UCG fashion and to introduce distinct variables at every place where an operator / could occur. When we transform this initial assignment into a RA, we obtain three states (plus “F”), each linked to the unique final state F, with their own name and “a”, “man” and “runs” as respective labels. The learning algorithm applies as in section 3.1.: it consists in trying to parse the sentence, by defining constraints on the variables.

In a first step, the only way to apply *FA* between two consecutive types of the example is to define: $x_3 = /$. This, as already seen, provokes a state split. But the *FA* rule relying on the introduced operator can apply only if $tx_4e = tx_5e$, that is if $x_4 = x_5$, which specifies a state merge. Not every couple of states can be merged at this step: states are also semantically typed in the sense of (Coste et al. 2004). The result of this step is the set: $\{\langle a, (tx_1(tx_2e))/ (tx_4e) \rangle, \langle man, tx_4e \rangle, \langle runs, tx_6e \rangle\}$, corresponding with the first (simplified) RA of Figure 2.

In a second step, similar to the first one, we have: $x_1 = /$ and $x_2 = x_6$. The type t , corresponding with the category S , is now a subcategory of an assigned category, and a new state t playing the role of *initial state* is thus introduced. The RA obtained, on the right in Figure 2., is isomorph to the one of Figure 1., and recognizes the initial sentence. The types helped to converge to the correct solution quicker.

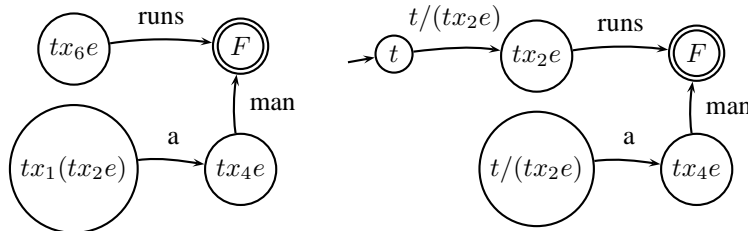


Figure 2: RA obtained when learning from typed examples

5. Conclusion

In this paper, we propose a new perspective on already known techniques. First, we see that RA are able to represent the *search space* of a specialization learning algorithm. In fact, as \mathcal{A} is a disjunction of sets, the search space of Moreau's algorithm can be represented by a *disjunction of RA*. Second, we show that the algorithm to learn CGs from typed examples proposed in (Dudau-Sofronie et al. 2001) is a specialization strategy with typed constraints. The initial semantic types associated with the elements of the vocabulary specify some kind of maximal bound on the possible splits to be performed, allowing to limit the combinatorial explosion of solutions.

Bibliography

- Angluin, D.: 1982, Inference of reversible languages, *J. ACM* 29(3), 741–765
- Buszkowski, W. and Penn, G.: 1990, Categorical grammars determined from linguistic data by unification, *Studia Logica* 49, 431–454
- Coste, F., Fredouille, D., Kermovant, C., and de la Higuera, C.: 2004, Introducing domain and typing bias in automata inference, in *proceedings of the 7th ICGI*, Vol. 3264 of *LNAI*, pp 115–126, Springer Verlag
- Dudau-Sofronie, D., Tellier, I., and Tommasi, M.: 2001, Learning categorical grammars from semantic types, in *proceedings of the 13th Amsterdam Colloquium*, pp 79–84
- Dupont, P., Miclet, L., and Vidal, E.: 1994, What is the search space of the regular inference, in *ICGI'94*, Vol. 862 - Grammatical Inference and Applications of *LNAI*, pp 25–37, Springer Verlag
- Fredouille, D. and Miclet, L.: 2000, Experiences sur l'inference de langage par specialisation, in *proceedings of CAP'2000*, pp 117–130
- Gold, E.: 1967, Language identification in the limit, *Inform. Control* 10, 447–474
- Kanazawa, M.: 1996, Identification in the limit of categorical grammars, *Journal of Logic, Language and Information* 5(2), 115–155
- Kanazawa, M.: 1998, *Learnable Classes of Categorical Grammars*, The European Association for Logic, Language and Information, CLSI Publications
- Moreau, E.: 2004, Apprentissage partiel de grammaires lexicalises, *TAL* 45(3), 71–102
- Tellier, I.: 2005, When categorical grammars meet regular grammatical inference, in *proceedings of the 5th LACL*, Vol. 4492 of *LNAI*, pp p.317–332, Springer Verlag
- Tellier, I.: 2006, Learning recursive automata from positive examples, *Revue d'Intelligence Artificielle New Methods in Machine Learning*(20/2006), 775–804
- Woods, W. A.: 1970, Transition network grammars of natural language analysis, *Communications of the ACM* (13), 591–606

ON THE OPTIMAL USE OF *ALMOST* AND *BARELY* IN ARGUMENTATION

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1. Introduction

Consider the following sentence:

- (1) Richard almost passed his UG exam, so he will probably get his bachelor's degree by the end of the year.

In sentence (1) the subject technically did not pass his exam. The word *almost* implies that he came close, but failed. Despite this negative result, a positive prediction for the rest of his studies is a logical follow-up to this statement (cf. Verhagen 2005). This observation forms the basis for this paper. We are especially interested in the reasons why people formulate sentences with the quantifier *almost*. In the example sentence it seems as if the first part is a statement that is used as an indirect argument for the second part, which in turn can be seen as the conclusion. So the fact that Richard almost passed his exam supports the conclusion that he will receive his bachelor's degree by the end of the year. In normal everyday language use, however, the argumentation does not necessarily have to be as clear and complete as in this example. The following sentence was taken randomly from the internet:

- (2) Ronaldo *almost* scored a goal in the remaining ten minutes for AC Milan [...] Ronaldo clearly got talent, and if he gets himself shaped-up, he is going to be an important player in AC Milan... [italics added]

In (2) it is stated that Ronaldo has got talent. The fact that he *almost* scored a goal seems to support this statement.

In this paper we will start out with a brief sketch of the semantics of *almost*. We will discuss the meaning of *almost*, as given by Penka (2006) and Nouwen (2006). After the semantics has been discussed, the focus of this paper will shift towards Argumentation Theory (van Eemeren *et al.* 1996). We will discuss the role that *almost* can play in argumentation and we will explain how this actually works from the perspective of a speaker with the help of Optimality Theory (Prince and Smolensky 2004). As far as we know, this is the first time that Optimality Theory is applied to Argumentation Theory.

2. The semantics of *almost*

In this section we will try to determine the exact meaning of *almost*, following Penka (2006) and Nouwen (2006). We will conclude the section with a discussion of how this can help us in determining why a language user would want to use *almost*. To begin, take a look at the following sentence pairs:

- | | |
|-----------------------------------|---|
| (3) a. It is six o'clock. | b. It is <i>almost</i> six o'clock. |
| (4) a. The victim was dead. | b. The victim was <i>almost</i> dead. |
| (5) a. John scored a goal. | b. John <i>almost</i> scored a goal. |
| (6) a. Hugh never drives his car. | b. Hugh <i>almost</i> never drives his car. |

The a-sentences all contain simple statements in which something happens or occurs. If we now turn to the b-sentences, one might say that by inserting *almost* the statements of the a-sentences have been negated on a logical level in the b-sentences. In (3), 'almost six o'clock' means that it is *not* six o'clock (yet); in (4) 'almost dead' means that the victim was *not* dead (yet); in (5) 'almost scored a goal' in effect comes down to the fact that John did not score a goal and in (6) 'almost never' means that Hugh does drive his car occasionally. Everything that comes to pass in the a-sentences technically does not come to pass in the b-sentences. However, *almost* does entail that the event which it seems to negate is never far away from occurring. In formal semantics it is said that the b-sentences constitute worlds that are minimally different from the worlds of the a-sentences.

Penka (2006) argues that the semantics for *almost* is similar to that of other operators like *only*, *at least*, *at most* and *more than*. That is, *almost* operates on a certain scale:

A sentence in which *almost* modifies an expression P entails the truth of a corresponding sentence without *almost* in which P is replaced by a value close by, but lower on the scale associated with P. (Penka 2006: 278)

Penka composes the following formula for the semantics of *almost* (Penka 2006: 279):

- (7) $[[\text{almost}_x]] = \lambda w. \lambda p_{\langle s, t \rangle}. \neg p(w) \ \& \ \exists q [q \approx p \ \& \ q(w)]$
 (The symbol \approx is used to signify the 'close-by' relation.)

The formula in (8) ensures that the proposition *almost p* is true if and only if *p* itself is false in the actual world, but there is an alternative proposition that is close by to *p* and that is true. Nouwen (2006) proposes an intensional approach to the meaning of *almost*, which is defined as follows:

Almost p is true if and only if there is a world which is not very different from the actual world in which *p* is true (Nouwen 2006: 165)

To illustrate this meaning, consider for example the next sentence, taken from random Google-searches on instances of *almost*:

(8) This blog has become *almost* a diary [italics added]

In the intensional approach we can analyze (8) in terms of a world that has a diary and the actual world which has a blog that has a lot of the characteristics that we would normally ascribe to diaries, yet not all of them. Thus, sentence (8) is true if there is a world in which the blog has one more diary-property than it has in the actual world, and therefore in this alternative world the blog *is* in fact a diary. Clearly then, the use of *almost p* draws the attention to this minimally different world which is not the actual world, but in which *p* holds.

Now that we have determined the formal meaning of *almost*, we gain some insight in the reasons why people would want to use it. If a speaker wishes to evoke a world in which *p* holds (for example because *p* would lead to the conclusion *q*, and the speaker would like the hearer to conclude *q*), then using *almost p* would be a good strategy, even though literally *almost p* entails *not p* and not *p*. The reason is that *almost p* involves the existence of a minimally different world in which *p* does hold, and this world gets ‘activated’ in the mental state of the hearer when the speaker uses *almost p*. The next section will focus on this use of *almost* in argumentation.

3. The use of *almost* in Argumentation Theory

The basic idea of Argumentation Theory is that the speaker or writer makes a certain statement which the hearer or reader will not automatically believe. An argumentation in its most basic form consists of two parts: a statement (also known as claim or conclusion) and an argument that supports the statement. The purpose of the speaker is to convince the hearer of the truth of the statement (conclusion). One condition is that the argumentation should be valid, meaning that the conclusion has to follow from the arguments (van Eemeren 1996). An example of a valid argumentation is of course *modus ponens*. The validity of an argumentation does not guarantee that the argumentation is convincing or that the conclusion is true, however. This also depends on other factors, such as the truth or plausibility of the premises.

Let us now return to the use of *almost* in argumentation and the reasons for people to use *almost*. It can sometimes be better for a speaker to say *almost p*, or to say *almost p, therefore q* than just plainly state *q* even when *q* is what the speaker actually would like to tell the hearer. To illustrate this point, take a look at the

following example, which is a pretty transparent yet popular advertising strategy (the example is taken from the internet):

- (9) Premise 1: (If you can drive a new car for free, then you should buy it.)
Premise 2: Drive a (Nearly) New Car for (Almost) Free!
Conclusion: (You should buy this car.)

If an advertiser uses only premise 2 (and leaves the first premise and the conclusion implicit) as a slogan, a hearer will be easily led to draw her own conclusions. She is provided with a tempting argument for buying the car. Note that p (i.e., the antecedent of the first, implicit premise) is not completely true in the actual world, because of the adverbs *nearly* and *almost* between parentheses. However, as we argued above, the actual world is only minimally different from the ideal world (in which the car *is* new and for free) and this is sufficient to lead the hearer to draw the implicit conclusion (at least, that is the speaker's intention). In fact, leaving the conclusion implicit can be an effective tool in argumentation: when a hearer draws the intended conclusion by herself, this is often more convincing than when the speaker explicitly states the conclusion.

4. An Optimality Theoretic analysis

In an Optimality Theoretic account of argumentation, the input is made up of the intention of the speaker to convince the hearer of a certain conclusion, given a certain situation in the real world. For instance, if a speaker wants to convince a hearer of the fact that John is a good striker, then the fact that John scored a goal would be a good argument in favour of this conclusion. However, if John did not score a goal in the actual world, then the speaker must come up with another argument in favour of the claim that John is a good striker. The candidates in an Optimality Theoretic account of argumentation are made up of possible arguments that should lead the hearer to come to the speaker's intended conclusion. The options for the speaker are the possible output candidates, which are evaluated against the following set of constraints:

- (10) *LIE: Speak the truth.
(11) GIVE-ARG: Provide an argument for the conclusion.
(12) EFCY: Be as efficient as possible in your argumentation; do not use more argumentative elements (premises or conclusion) than needed.
(13) EXPL: Be explicit in your argumentation; do not beat around the bush.

Tableau 1

Input: Convince hearer that John is a good striker; given that John did not score a goal, but he almost did (he just had bad luck), and given that if a striker does score a goal, he is a good striker.	*LIE	GIVE-ARG	EFFCY	EXPL
John scored a goal	*!			*
John did not score a goal		*!		*
☞ John almost scored a goal				*
John is a good striker		*!		*
☞ John almost scored a goal, so he is a good striker			*	

Under this ranking of the constraints and given the input, stating “John almost scored a goal” is more efficient but less explicit than “John almost scored a goal, so he is a good striker”. Because the constraints EFCY and EXPL are not ranked with respect to each other, both candidates can be the winners of the competition, which means that the conclusion (that the speaker wants to convey to the hearer) sometimes remains implicit, but is made explicit at other times. Just uttering “John scored a goal”, which would lead to the right conclusion, is rejected, because this violates the highest ranked constraint *LIE. Saying “John did not score a goal” and stating “John is a good striker” are both rejected, because they do not provide the hearer with a proper argument in favour of the conclusion that John is a good striker, and hence they both violate GIVE-ARG. The two outputs using *almost*, come forward as the best options: these utterances are not only true, but they also evoke a world which is so close to a world in which John did score a goal, that this is sufficient support for his being a good striker in the actual world.

5. Extension to *barely*

Our analysis can be extended to the use of *barely* in argumentation. Although the semantics of *barely* has been studied less than *almost*, it has a similar argumentative effect as *almost*. Suppose that a speaker wishes to convince the hearer of the fact that John is a bad striker. However, John did score a goal. The problem that the speaker is confronted with is similar to the problem with *almost*. For example, if the speaker would state that John did not score a goal, she would be lying. Were she to state that John did score a goal, the hearer will not conclude that John is a bad striker, so the best solution to the speaker’s problem is to state that John *barely* scored a goal. The speaker does tell the truth, yet because the actual world is only

minimally different from a world in which John did not score a goal, the hearer can still conclude that John is a bad striker in the actual world.

So, like *almost*, *barely* helps in directing the hearer towards a certain conclusion that is not completely supported by reality, but only indirectly by the existence of a minimally different world. Two ‘real’ illustrations of this type of argumentation are the following, taken from the internet:

- (14) The US have never won in Mexico, and *barely* scored a goal for the first time on Mexican soil in many years. You're seriously underrating Mexico [italics added]
- (15) Terrible game! You *barely* scored a goal! [italics added]

In (14) the speaker wishes to convince the hearer that she is seriously underestimating Mexico and one of the arguments provided to support this statement is that the US barely scored a goal (the other argument is that the US never won in Mexico). In (15) the statement (conclusion) is that it was a terrible game, and the argument in favor of that conclusion is that “you *barely* scored a goal”. Both argumentations are in accordance with our analysis.

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References

- Eemeren, Frans H. van, Rob Grootendorst & Francisca Snoeck Henkemans (1996) *Fundamentals of Argumentation Theory: a Handbook of Historical Backgrounds and Contemporary Developments*. Mahwah, NJ: Lawrence Erlbaum.
- Nouwen, Rick (2006) “Remarks on the Polar Orientation of *Almost*”. *Linguistics in the Netherlands 2006*, ed. by Jeroen van de Weijer and Bettelou Los, 162-173. Amsterdam/Philadelphia: John Benjamins.
- Penka, Doris (2006) “Almost there: The meaning of *almost*”. *Proceedings of Sinn und Bedeutung 10*, ed. by Christain Ebert and Cornelia Endriss, 275-286. Berlin: ZAS.
- Prince, Alan & Paul Smolensky (2004) *Optimality Theory: Constraint Interaction in Generative Grammar*. Oxford: Blackwell.
- Verhagen, A. (2005) *Constructions of Intersubjectivity*. Oxford: Oxford University Press.

THE EPISTEMICS OF PRESUPPOSITION PROJECTION

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We carry out (formalize) the Karttunen-Stalnaker pragmatic account of presupposition projection within a state-of-the art version of dynamic epistemic logic. This sheds light on a recent controversy on the appropriateness of dynamic semantics as a tool for analysing presupposition.

1. Introduction

Pragmatic accounts of presupposition projection go back to work of Karttunen and Stalnaker, who proposed that presuppositions are requirements on the common ground and that their projection behaviour should follow from the way this common ground is updated in a discourse. This idea has been worked out by various authors who made the idea of shifting context precise, most notably Heim 1983, and presupposition projection has been a major topic in dynamic semantics of natural language ever since, although there have been dissenting voices, see e.g. Schlenker 2007.

Recent advances in the logic of announcements and knowledge — the logic of public announcements of Plaza 1989, the action style dynamics of Baltag et al. 1999, and the axiomatisation of a very general logic of communication and change in van Benthem et al. 2006 — make it possible to have another go at formalizing the intuitions of Karttunen and Stalnaker. This task is taken up in this paper. Context is represented (not as a set of propositions but) as a multimodal Kripke model, utterances are (public) announcements, sequencing is uttering one announcement after another, context shift is epistemic updating, common ground is common knowledge between discourse participants (or, more subtly, knowledge that the speaker believes to have in common with the audience), and basic presuppositions are checks on common knowledge. We will show that the core of presupposition projection facts then follows from the way in which announcements are composed in dynamic epistemic logic.

2. The State of Knowledge of an Audience

The state of knowledge of an audience (or: set of agents I) is given by a multimodal Kripke model $\mathbf{M} = (W, V, R)$ where W is a non-empty set of possible worlds, $V: P \rightarrow \mathcal{P}(W)$ is a valuation that assigns to every basic proposition from a set P the subset of all worlds where that proposition is true, and R is a function that assigns

to every agent $i \in I$ an epistemic indistinguishability relation \sim_i , where $w \sim_i w'$ indicates that agent i cannot see the difference between worlds w and w' .

Our language will have basic propositions from P , and boolean combinations plus epistemic operations on these. We know from Baltag et al. 1999 that an axiomatisation of public announcement logic in terms of reduction axioms is impossible in the presence of common knowledge; the reason is that $[\!|\phi|]C\psi$ (after public announcement of ϕ it holds that ψ is common knowledge) cannot be expressed in terms of common knowledge alone. In van Benthem et al. 2006 a reduction axiom for restricted common knowledge is given, and it is also shown how public announcements are reduced in the presence of composite epistemic operators, where the composition uses the regular operations. The appropriate logic for this is epistemic PDL, which is what we will use in what follows. If p ranges over P and i over I , the language of epistemic PDL with public announcements is given by:

$$\begin{aligned}\phi & ::= \top \mid p \mid \neg\phi \mid \phi \wedge \phi' \mid [\pi]\phi \mid [\!|\phi|]\phi' \\ \pi & ::= i \mid ?\phi \mid \pi; \pi' \mid \pi \cup \pi' \mid \pi^*\end{aligned}$$

The interpretation of boolean formulas is as usual, that of $[\pi]\phi$ is given by:

$$\mathbf{M}, w \models [\pi]\phi \text{ iff for all } v \text{ with } (w, v) \in \llbracket \pi \rrbracket^{\mathbf{M}} : \mathbf{M}, v \models \phi,$$

where $\llbracket \pi \rrbracket^{\mathbf{M}}$ is the interpretation of the epistemic construct π . This is defined as in PDL, with $\llbracket i \rrbracket^{\mathbf{M}} = \sim_i$, $\llbracket ?\phi \rrbracket^{\mathbf{M}} = \{(v, v) \mid v \in W \text{ and } \mathbf{M}, v \models \phi\}$, $\llbracket \pi; \pi' \rrbracket^{\mathbf{M}} = \llbracket \pi \rrbracket^{\mathbf{M}} \circ \llbracket \pi' \rrbracket^{\mathbf{M}}$ (where \circ is relational composition), $\llbracket \pi \cup \pi' \rrbracket^{\mathbf{M}} = \llbracket \pi \rrbracket^{\mathbf{M}} \cup \llbracket \pi' \rrbracket^{\mathbf{M}}$, and $\llbracket \pi^* \rrbracket^{\mathbf{M}} = (\llbracket \pi \rrbracket^{\mathbf{M}})^*$ (where $*$ is reflexive transitive closure).

What this says is that the basic epistemic operations i are interpreted by means of \sim_i , and the composed ones by means of the regular operations on relations. Common knowledge is given by the reflexive transitive closure of the set of all individual accessibilities lumped together: $[(i \cup j \cup \dots)^*]\phi$ expresses that ϕ is common knowledge, and $(i \cup j \cup \dots)^*$ is interpreted as the relation $(\bigcup_{i \in I} \sim_i)^*$.

The communicative effect of a public announcement of ϕ is given by a restriction operation on epistemic models. If $\mathbf{M} = (W, V, R)$ is an epistemic model, then $\mathbf{M} \mid \phi$, the restriction of \mathbf{M} with ϕ , is the epistemic model $\mathbf{M}' = (W', V', R')$ where $W' = \{v \in W \mid \mathbf{M}, v \models \phi\}$, V' is V restricted to W' (for each $p \in P$, $V'(p) = V(p) \cap W'$), and R' is the result of restricting each \sim_i to $W' \times W'$. Note that the restriction operation is a partial function: if $\{v \in W \mid \mathbf{M}, v \models \phi\} = \emptyset$, then $\mathbf{M} \mid \phi$ is undefined. The interpretation of $[\!|\phi|]\psi$ is given by:

$$\mathbf{M}, w \models [\!|\phi|]\psi \text{ iff } \mathbf{M}, w \models \phi \text{ implies } \mathbf{M} \mid \phi, w \models \psi.$$

This logic has a sound and complete axiomatisation which consists of the axioms for PDL (see Segerberg 1982), the axioms for individual S5 knowledge, and the rules Modus Ponens, Necessitation for epistemic constructs π , and Necessitation for public announcements, plus a set of reduction axioms of the general form $[\!|\phi|][\pi]\phi' \leftrightarrow$

$[\pi']![\phi]\phi'$, where π' is the result of transforming π with $!\phi$. E.g., if π is the epistemic construct $(i \cup j)^*$ that expresses common knowledge between i and j , then the reduction axiom for π takes the following shape: $[\phi][!(i \cup j)^*]\psi \leftrightarrow [(?\phi; i \cup j)^*][!\phi]\psi$. The transformed epistemic construct $(?\phi; i \cup j)^*$ expresses so-called relativized common knowledge. See van Benthem et al. 2006 for further details.

3. Making Announcements to an Audience

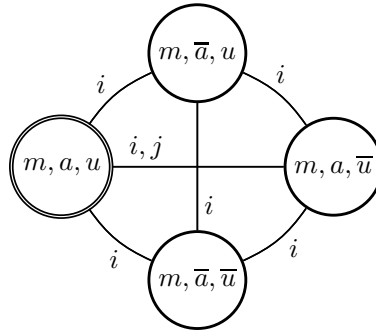
When a couple announces the birth of their child in the evening paper, this is an assertion with the epistemic effect of creating common knowledge. The readers now know about the birth and, moreover, also know that other readers know as well.

Our basic communicative actions are public announcements to a given audience. Let's investigate the special case of announcements of the form $C\phi$, where C is an abbreviation for the common knowledge operator. First of all, notice that it does not matter if we restrict attention to point-generated epistemic models, i.e., to models $\mathbf{M} = (W, V, R)$ with a distinguished world $w \in W$ (the actual world), and with the property that every $v \in W$ is reachable from w by a sequence of accessibility steps. For pointed models (\mathbf{M}, w) , we say that an update with $!\phi$ aborts if $\mathbf{M}, w \not\models \phi$. We get the following:

Proposition 1 *If \mathbf{M} is generated from w , then for all announcements of the form $C\phi$, either $\mathbf{M} \upharpoonright C\phi = \mathbf{M}$ or the update operation with $C\phi$ aborts in w .*

Proof: Assume $\mathbf{M}, w \models C\phi$. Then ϕ is the case at every world that can be reached through a sequence of accessibility steps. But then ϕ is the case everywhere in the model, since \mathbf{M} is generated from w . Hence $C\phi$ is also true everywhere, and the restriction operation does not remove any worlds. If, on the other hand, $\mathbf{M}, w \not\models C\phi$, the update operation aborts. \square

To give an example of this, assume three atomic propositions m, a, u (m for 'male', a for 'adult' and u for 'unmarried'), and consider the following Kripke model.

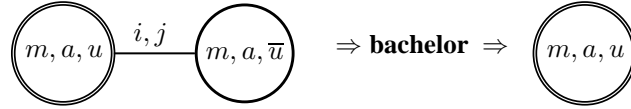


The double circle indicates the actual world. Reflexive arrows are not drawn; a connection between two worlds with label i means that i confuses these worlds. What the model says is that m, a, u all hold in the actual world, but j does not know about u , and i does not know about a and u . It is not difficult to see that in the actual world (and in fact in all worlds) Cm holds, whereas Ca and Cu do not hold. Here C is shorthand for $[(i \cup j)^*]$, the common knowledge operator for i and j . Updating with $!Cm$ (the announcement that m is common knowledge) does not change the model. The updates with $!Ca$ or $!Cu$, however, are undefined.

To handle lexical presuppositions in terms of public announcements, add the following shorthand to the logical language:

$$!(\phi, \phi') \text{ abbreviates } !(C\phi \wedge \phi').$$

Take the case of stating that someone is a bachelor, slightly simplified to fit our propositional framework. This statement presupposes that $m \wedge a$ is common knowledge, and asserts that u . The corresponding update **bachelor** equals $!(m \wedge a, u)$, or written out in full: $!(C(m \wedge a) \wedge u)$. Updating the previous example model with **bachelor** results in undefinedness, because, as we have seen, $C(m \wedge a)$ does not hold in the model. In the following example, where $C(m \wedge a)$ holds in the initial model, the update succeeds:



The basic presupposition projection facts now fall out of our set-up, because the logic provides a natural interpretation for ‘being presuppositional update’, namely being a public announcement of the form $!C\phi$, and for ‘saying things in order’, namely making one public announcement after another.

Immediate from proposition 1 we get an illuminating fact about updates with common knowledge:

Proposition 2 $\mathbf{M}, w \models [!C\phi]\psi$ iff $\mathbf{M}, w \models C\phi \rightarrow \psi$.

Another thing we get from proposition 1 is that putting a presupposition before an assertion has the same update effect as lumping them together:

Proposition 3 $\mathbf{M}, w \models [!(C\phi \wedge \phi')]\psi$ iff $\mathbf{M}, w \models [!C\phi][!\phi']\psi$.

Proof: $\mathbf{M}, w \models [!(C\phi \wedge \phi')]\psi$ iff (proposition 1) $\mathbf{M}, w \models C\phi$ and $(\mathbf{M}, w \models \phi'$ implies $\mathbf{M} \mid \phi', w \models \psi)$ iff $\mathbf{M}, w \models C\phi$ and $\mathbf{M}, w \models [!\phi']\psi$ iff (proposition 1) $\mathbf{M}, w \models [!C\phi][!\phi']\psi$. \square

For the analysis of presupposition projection we need a slight generalization of proposition 1:

Proposition 4 *If \mathbf{M} is generated from w , then for all announcements of the form $[\!|\phi|]C\psi$, either $\mathbf{M} \mid [\!|\phi|]C\psi = \mathbf{M}$ or the update operation with $[\!|\phi|]C\psi$ aborts in w .*

Proof: Assume $\mathbf{M}, w \models [\!|\phi|]C\psi$. Then $\mathbf{M}, w \models \phi$ implies $\mathbf{M} \mid \phi, w \models C\psi$. Therefore, it holds for every v with $\mathbf{M}, v \models \phi$ that $\mathbf{M} \mid \phi, v \models \psi$. It follows that for all v with $\mathbf{M}, v \models \phi$ we have $\mathbf{M} \mid \phi, v \models C\psi$. Therefore $\mathbf{M}, v \models [\!|\phi|]C\psi$ for all v in the domain of \mathbf{M} , and the restriction operation does not remove any worlds. Alternatively, if $\mathbf{M}, w \not\models [\!|\phi|]C\psi$, the update operation aborts. \square

The logic tells us that a formula of the form $[\!|\phi|]C\psi$ reduces to a relativized common knowledge statement. We will abbreviate this as $C(\phi, \psi)$. Proposition 4 tells us that updates with relativized common knowledge formulas express presuppositions.

Next, the logic gives a precise meaning to updating with (ϕ, ϕ') followed by updating with (ψ, ψ') , namely $[\!|(\phi, \phi')][\!|(\psi, \psi')]\chi$. The latter is an abbreviation for $[\!(C\phi \wedge \phi')][\!(C\psi \wedge \psi')]\chi$, or equivalently $[\!(C\phi \wedge \phi' \wedge [\!(C\phi \wedge \phi')](C\psi \wedge \psi'))]\chi$, which is in turn equivalent to:

$$[\!(C\phi \wedge \phi' \wedge [\!(C\phi \wedge \phi')C\psi \wedge (C\phi \rightarrow [\phi']\psi'))]\chi.$$

The projected presupposition is $C\phi \wedge [\!(C\phi \wedge \phi')C\psi$ and the projected assertion is $\phi' \wedge (C\phi \rightarrow [\phi']\psi')$.

Take for example the statement without presupposition $!m$ (the statement **male**) followed by the statement **bachelor**:

$$\begin{aligned} [\!|m][\!(C(m \wedge a) \wedge u)]\chi &\leftrightarrow [\!(m \wedge [\!|m](C(m \wedge a) \wedge u))] \\ &\leftrightarrow [\!(m \wedge [\!|m]Cm \wedge [\!|m]Ca \wedge [\!|m]u)]\chi \\ &\leftrightarrow [\!(m \wedge [\!|m]Ca \wedge [\!|m]u)]\chi \\ &\leftrightarrow [\!(m \wedge C(m, a) \wedge m \rightarrow u)]\chi \\ &\leftrightarrow [\!(C(m, a) \wedge m \wedge u)]\chi \end{aligned}$$

So the presuppositional part of the combined statement is $C(m, a)$ (common knowledge of a relativized to m) and the assertional part is $m \wedge u$.

Negating a basic statement should produce an update that tests for the same presupposition but that negates the assertion, in other words, the negation of (ϕ, ϕ') is $(\phi, \neg\phi')$. This generalizes to complex statements by means of the above separation of the presuppositional and assertional parts. For instance, implication between statements A and B where A is of the form $[\!(C\phi \wedge \phi')$ and B of the form $[\!(C\psi \wedge \psi')$ reduces to negating the sequence $[\!(C\phi \wedge \phi'); [\!(C\psi \wedge \neg\psi')$, which we know already how to do. This analysis allows us to compute the projection facts for such cases.

4. Presuppositions and Informativeness

Suppose we are in a context where the presupposition p is common knowledge. Then updating with statement $[\!(Cp \wedge q)$ has the same effect as updating with $!q$. If on the

other hand, p is true in the actual world but not yet common knowledge, then updating with $!(Cp \wedge q)$ will lead to an inconsistent state, but updating with $!p$ followed by an update with $!(Cp \wedge q)$ will not. In other words, the logic allows the use of $!p$ followed by $!(Cp \wedge q)$ in cases where p is compatible with the context model but not yet common knowledge, but in such cases the use of just $!(Cp \wedge q)$ is ruled out. Accommodation of the presupposition would consist of replacement of $!(Cp \wedge q)$ by $[!p]!(Cp \wedge q)$; as a matter of fact the update sequence $[!p]!(Cp \wedge q)$ and the single update $!(p \wedge q)$ are equivalent. The logic allows the use of $!(Cp \wedge q)$ and of $!p$ followed by $!(Cp \wedge q)$ in contexts where p is common knowledge, but by invoking the Gricean maxim ‘be informative’ one can explain why $!p$ followed by $!(Cp \wedge q)$ is *not* appropriate in such contexts.

5. Conclusion and Further Work

We hope we have convinced the reader that the program of giving a formal pragmatic account of presuppositions can be carried out in the framework of multimodal epistemic logic with relativized common knowledge and public announcement updates. Some further work is still needed, though, to forge from this a tool for the working linguist (e.g. inclusion of quantifiers, and a dynamic treatment of anaphoric linking).

Bibliography

- Baltag, A., Moss, L., and Solecki, S.: 1999, *The logic of public announcements, common knowledge, and private suspicions*, Technical Report SEN-R9922, CWI, Amsterdam
- Heim, I.: 1983, On the projection problem for presuppositions, *Proceedings of the West Coast Conference on Formal Linguistics 2*, 114–126
- Karttunen, L.: 1974, Presupposition and linguistic context, *Theoretical Linguistics* pp 181–194
- Plaza, J. A.: 1989, Logics of public communications, in M. L. Emrich, M. S. Pfeifer, M. Hadzikadic, and Z. W. Ras (eds.), *Proceedings of the 4th International Symposium on Methodologies for Intelligent Systems*, pp 201–216
- Schlenker, P.: 2007, Anti-dynamics: Presupposition projection without dynamic semantics, *Journal of Logic, Language and Information* 16(3), 325–356
- Segerberg, K.: 1982, A completeness theorem in the modal logic of programs, in T. Traczyk (ed.), *Universal Algebra and Applications*, pp 36–46, Polish Science Publications
- Stalnaker, R.: 1974, Pragmatic presuppositions, in M. Munitz and P. Unger (eds.), *Semantics and Philosophy*, pp 197–213, New York University Press
- van Benthem, J., van Eijck, J., and Kooi, B.: 2006, Logics of communication and change, *Information and Computation* 204(11), 1620–1662

ON THE SEMANTICS OF MODAL PARTICLE *DE* IN MANDARIN CHINESE

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I argue that the Mandarin modal particle *de* has a temporal presupposition in its ability and epistemic semantics. Hence the two uses are incompatible with past-denoting time adverbials. Elements like the contrastive focus marker *hai* ‘still’ have a temporal shifting property and can license past-denoting adverbials in modal *de*-sentences.

1. Introduction

1.1 Modal particle *de*

In Mandarin Chinese the particle *de* can be interpreted as a modal when it appears between a verb and a result or phase complement (e.g. *wan* ‘finished’, *hao* ‘well’). Independent empirical evidence suggests that this modal use is not a by-product of the resultative or depictive uses (see Wu 2004). When used as a modal, it allows three readings: ability (1-i), epistemic (1-ii) and circumstantial (2).

- (1) zhangsan mingtian zuo de wan naxie zuoye.
John tomorrow do DE finish those homework
i. ‘John is able to finish those homework assignments tomorrow.’ (ability)
ii. ‘Based on my (the speaker’s) knowledge, John will finish those homework assignments tomorrow.’ (epistemic)
- (2) zhe zhong shu zhiyou zai zher cai zhang de jianzhuang.
this type tree only at here then grow DE sturdy
‘This type of tree can grow sturdy only in this place.’ (circumstantial)

The modal use of *de* raises two interesting questions. One has to do with the fact that, in its ability and epistemic uses, it does not allow past-denoting time adverbials (3), whereas the circumstantial use is at least marginally compatible with such adverbials

((4), native judgment shows variation with this example.)

(3) zhangsan (*zuotian) zuo de wan naxie zuoye. (zuotian: yesterday)

(4) (?)dangshi de tianqi, naxie chaihwo dian de zhao.

then MOD weather, those wood burn DE on fire

‘The weather being what is was then, that wood could (have) burn(ed).’

The other interesting aspect lies in the fact the grammaticality of (3) improves, for example, with the introduction of the contrastive focus marker *hai* ‘still’ (5):

(5) zhangsan zuotian hai zuo de wan zuoye, (how come he cannot finish today?)

Mandarin Chinese has another modal particle *neng*, which shares the ability, epistemic and circumstantial uses with *de*¹. However, it is compatible with past-denoting adverbials in all three modal uses, with no need for an external salvage like *hai* ‘still’.

1.2 Actuality implication

The ability and epistemic uses of both *de* and *neng* involve the potentiality of accomplishing the result associated with the phase or result complement (Wu 2004, cf. Li & Thompson 1981 for a different suggestion). However, there is a strong actuality implication that the action denoted by the main verb (future) will be or (past) was initiated and the result will or has already come out. For instance, the readings of (1) imply that John will have finished the assignments by tomorrow (if he is trying to do them.²). In (6), the claim that our little hero Duoduo just acquired the ability to sit alone for 30 seconds strongly implies that she did perform such a feat the day before.

(6) duoduo zuotian neng du zuo sanshi miao le.

Duoduo yesterday NENG alone sit thirty second INCEPTIVE

‘D. was able to sit alone for 30 seconds yesterday, (and it was her first time).’

2. Background

In this paper I adopt Kratzer (1981, 1991)’s treatment of modality. Within her approach,

¹ In addition, *neng* can be used as a deontic modal expressing permission, which does not concern us here.

² For some native speakers of Mandarin Chinese, (1) implies (though does not presuppose or entail) that John indeed will work on the assignments.

modality introduces quantification over possible worlds (existential vs. universal), and is doubly relative to a set of accessible worlds (modal base) as well as to an ordering source. The modal base is a function that assigns to an evaluation world a set of propositions describing, e.g., the relevant circumstances, like the evidence available to the speaker (e.g. in the epistemic case ‘John must be the murderer’), and what the law provides (e.g. in the deontic case ‘John must go to jail’). The ordering source orders the set of worlds in the modal base according to an ideal. It is a function that assigns to an evaluation world a set of propositions whose truth is required by the circumstances, demanded by the law, etc.

3. Analysis

3.1 Quantification force

Both the ability and epistemic uses of *de* have universal, rather than existential, quantification force. Focusing on the ability use, there are a few pieces of evidence supporting this claim. The proposition denoted by a modal *de* sentence cannot be denied by its negative counterpart (7), in contrast to typical existential propositions (8).

(7) *zhangsan jinwan xie de wan lunwen, ye keneng xie bu wan.

John tonight write DE finish paper, also possible write not finish

Intended: *John is able to finish the paper tonight; also he might not be able to.

(8) John might go to Italy this December, or he might not.

Second, if the sentence in (1) is followed by ‘if he worked on the assignments tomorrow’, (9) falls out naturally, which has universal quantification. If the ability modal was existential quantification, we would not expect such a conclusion to follow.

(9) He would finish them. (*He (still) might not finish them.)

Third, modifiers like *yiding* ‘certainly’, which goes with universals rather than with existentials, can modify an ability proposition (10).

(10) zhangsan mingtian yiding zuo de wan naxie zuoye.

By contrast, the circumstantial use of *de* has existential quantificational force:

(11) ?zhe zhong shu zai zher zhang de gao, ye keneng zhang bu gao.

this type tree at here grow DE tall, also possible grow NEG tall

‘??This type of tree can grow tall here; it is also possible that it cannot.’

3.2 Semantics of *de*

For its semantic interpretation, the ability use of *de* is first restricted by a modal base $f(w)$, which yields a set of worlds w' such that the relevant ability proposition that holds in w also holds in w' . For instance, one such world could contain a set of propositions including ‘John can drive three days without rest’; ‘John is strong enough to kill a lion’; ‘John is able to finish his assignments tomorrow’, etc. This set of worlds are then ordered by the ordering source $g(w)$, which is a set of propositions that describe a body of circumstances (e.g. John is (not) sick or dying, there is (no) high-decibel noise around, the weather is (not) good, etc). The relevant *de*-proposition must hold in all possible worlds that satisfy the two conversational backgrounds. (12) gives the semantics of the ability use of *de*. The function $max_{g(w)}$ (adopted from Hacquard 2006) selects the set of ‘best worlds’ ranked in accordance with the ordering source.

(12) for world w , conversational backgrounds f, g , proposition p , time t

$$[[de]]_{\text{ability}}(w)(f)(g)(p)(t) = 1 \text{ iff } \forall w' \in \max_{g(w)} (\cap f(w)): p(w', t) = 1, \text{ where } t \subseteq t_{\text{top}}, t_{\text{top}} \geq t_0.$$

Here, the reference time t_0 is defined as the earliest possible time at which a proposition can hold; the topic time t_{top} is the time about which a proposition is made. If there is no overt topic time in a sentence, t_0 is the speech time and t_{top} is the speech time plus all the time following it. In the ability reading of (1), t_0 is the speaker’s present time, and t_{top} is the speaker’s tomorrow. The sentence says that, in all the best worlds determined by the conversational backgrounds, there exists a time (interval) in the speaker’s tomorrow in which John is able to finish his homework assignments.

Crucially, here the temporal presupposition $t_{\text{top}} \geq t_0$ explains the ungrammaticality of sentences like (3). The topic time t_{top} *zuotian* ‘yesterday’ precedes the reference time, that is, the speaker’s present time; hence it violates the constraint $t_{\text{top}} \geq t_0$.

The epistemic use of *de* has similar semantics, except for that the conversational backgrounds are different. The same temporal presupposition as in (12) exists in its epistemic semantics. The semantics of ability and epistemic *neng*, however, does not have such a temporal presupposition. Therefore it allows for past-denoting adverbials to co-occur with it. At this stage I have no idea as to why there is such a distinction.

The circumstantial uses of both *neng* and *de* are temporality-independent and their semantics can be defined as in (13). It is therefore no surprise that they are compatible with past-denoting adverbials (e.g. (4)). If my analysis is on the right track, it provides evidence that ability modality is not a special case of circumstantial modality or vice

versa. I do not have theoretical justification for why the circumstantial use of *de* does not have the same temporal presupposition that the ability and epistemic uses have.

$$(13) [[de]]_{\text{circumstantial}}(w)(f)(g)(p) = 1 \text{ iff } \exists w' \in \max_{g(w)} (\cap f(w)): q(w') = 1.$$

3.3 Modal bases

The ability and epistemic uses of *de* (and *neng*) are different only in terms of conversational backgrounds. Hacquard (2006) gave modal bases for epistemics and circumstantials along the lines of (14a-b), where, for our purpose, the variable *s* is the potential state or event associated with the *de*-proposition. According to Hacquard, the modal base for epistemic (14a) refers to a mental state which has *CONTENT* – a set of beliefs, hopes, desires, etc. The application of the function CIRC to *s* in (14b) yields all the possible worlds compatible with the relevant circumstances, for instance, the circumstances in which the tree can grow tall in the base world *w*: suitable soil, tropical climate, enough rainfall, etc. For the modal base with the ability use of *de*, I propose an ABILITY-LIST function, which, when applied to *s*, yields a set of propositions that depict all the abilities that an agent has and that are accessible from *w* where the ability in question holds of the agent. Interpreting (1a) with the notion of ABILITY-LIST, it says that John can finish the relevant homework assignments in the speaker’s tomorrow in every world that is accessible from *w* where John has the ability to finish the assignments and that is closest to the ideal determined by the relevant conversational background.

$$(14)a. f_{\text{EPISTEMIC}}(s) = \lambda s. \lambda w. w \text{ is compatible with CON}(s)$$

$$b.. f_{\text{CIRC}}(s) = \lambda s. \lambda w. w \text{ is compatible with CIRC}(s)$$

$$b.. f_{\text{ABILITY}}(s) = \lambda s. \lambda w. w \text{ is compatible with ABILITY-LIST}(s).$$

4. Temporal Shifting

Elements like the contrastive focus marker *hai* ‘still’ can salvage an otherwise ungrammatical *de*-sentence that is modified by a past-denoting adverbial (compare (3) with (5)). This is attributable to the fact that *hai* has the property of being able to shift (or re-value) the reference time (t_0) as defined above towards the past so that the temporality presupposition ($t_{\text{top}} \geq t_0$) of the ability and epistemic uses of *de* still holds. I assume the temporal shifting *hai* takes both the *de*-proposition and the overt temporal expression (like *zuotian* ‘yesterday’ in (5)) as arguments. Its semantics can be spelled out roughly as (15).

$$(15)[[hai]](p)(t)(w) = 1 \text{ iff } t \prec t_{\text{now}} \wedge t_0 = \text{START-POINT}(t_{\text{top}}) \wedge p(w, t)^3$$

Here I propose a function START-POINT which takes a time (interval) as its argument and returns the start point of that time. In the semantics of *hai* ‘still’, the time interval to which the function applies is the topic time, which is generally overt in *de* sentences in which *hai* is present. The reference time t_0 is (re-)valued to the start point of t_{top} . We can look at the future only before the future really starts to come into reality. The t_{now} in the semantics (15) is the speaker’s present time. The $t_0 = \text{START-POINT}(t_{\text{top}})$ component in (15) guarantees the $t_{\text{top}} \geq t_0$ presupposition in the semantics of the ability and epistemic uses of *de* to hold. This explains why the contrastive focus marker *hai* ‘still’ salvages otherwise ungrammatical *de*-sentences that contain past-denoting time adverbials.

Although the semantics of ability and epistemic *neng* does not have the same temporal presupposition as their *de* counterpart, it has nothing conflicting with the semantics of *hai* as laid out in (15). Therefore, it allows the co-occurrence of *hai*:

(16) duoduo zuotian hai neng du zuo sanshi miao.

‘Duoduo still (contrastive) was able to sit alone for 30 seconds yesterday.’

Past-denoting phrases like *benlai* ‘originally’ can license *de* as well. Presumably they can be analyzed along the same lines as *hai*. I stop here with this tentative speculation.

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Bibliography

- Hacquard, V.: 2006, *Aspects of Modality*, Ph.D. thesis, MIT, Cambridge, MA.
Kratzer, A.: 1991, Modality, in A. von Stechow and D. Wunderlich (eds.), *Semantics: An International Handbook of Contemporary Research*, pp 639-650, de Gruyter, Berlin.
Wu, C.H.: 2004, On *De/bu* and the Syntactic Nature of Resultative Verbal Compounding, *Language and Linguistics* 5, pp271-329.

³ In addition, *hai* can co-occur with future-denoting adverbials like *tomorrow*. In this case it is not used contrastively and should have a different semantic interpretation.

PARTITION SEMANTICS OF *AT LEAST* & *AT MOST*

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1. Introduction

Geurts & Nouwen (2007) convincingly demonstrated that there is a fundamental difference between *at least* and *at most* (“superlative modifiers”) and *more than* and *less/fewer than* (“comparative modifiers”) and that the differences have to do with modality. Then, they proposed for superlative modifiers, meanings that explicitly involved modal operators. However, as will be seen, their analysis does have some obvious, substantial problems. In the current work, we will argue that the modal properties characteristic of the superlative modifiers are due to their interactions with modal operators around, explicit or implicit, not due to their internal meanings, and propose alternative meanings for them, which are partitions of sets of possible worlds. The current analysis will be demonstrated to be empirically more adequate than Geurts & Nouwen’s in accounting for the modality-related properties of superlative modifiers and more. In the following, because of space limitations, we will mostly discuss on *at least*, being followed by a short discussion on *at most*.

2. Geurts & Nouwen (2007)

Interpreted out of context, the equivalence between (1a) and (1b) seems to be unquestionable, from which one would be tempted to conclude that *at least n* and *more than n-1* are synonymous.

- (1) a. John has at least [three]_F cars.
- b. John has more than two cars.

However, as Geurts & Nouwen (2007) pointed out, embedded in context, superlative and comparative modifiers suddenly behave differently in inference (pattern) as illustrated in (2):

- (2) Mary believes John has exactly four cars.
- a. \Rightarrow Mary believes John has more than two cars.
- b. \nRightarrow Mary believes John has at least [three]_F cars.

What is going on here, in intuitive terms, that an *at least*-sentence is felicitous only in a context where all the “cases” or “sub-propositions” compatible with the sentence are deemed possible; in the case of (2), in Mary’s belief, it is NOT possible that John has exactly three cars, it is NOT possible that John has exactly five cars although it is possible or must be the case that John has exactly four cars. This kind of observation involving modality prompted Geurts & Nouwen to suggest that superlative modifiers are modal expressions and propose a modal meaning for *at least*, as in (3).

- (3) If α is of type $\langle a, t \rangle$, then $\llbracket \text{at least } \alpha \rrbracket = \lambda X[\Box\alpha(X) \wedge \exists\beta[\beta \triangleright \alpha \wedge \Diamond\beta(X)]]$, where a is any type and ‘ \triangleright ’ symbolizes the “higher than in a scale” relation.

With the analysis there are problems, among which the most serious and obvious one, as they themselves admitted, is that their analysis predicts that an *at least*-sentence would always have a modal reading irrespective of its environment. For example, (4) will be wrongly predicted to have the reading it does not have, ‘If it must be the case that Betty had three martinis and it may be that she had more than three, then she must have been drunk’.

- (4) If Betty had at least three martinis, she must have been drunk.

2. Alternative Approach: Partition-Based Analysis

Alternatively, we will propose for *at least*, a meaning free of modal operators. Before that, a word is in order about the assumed framework and some notations to be adopted. Given that *at least* is a focus-sensitive expression (Krifka, 1999), we propose that *at least* is an operator taking a structured proposition as its argument along the lines of the structured-meaning approach to focus; a structured meaning of a sentence, or a structured proposition is an ordered pair of the background meaning and the focus meaning denoted $\langle B, F \rangle$, where the focus meaning, F is the ordinary meaning of the focused constituent and the background meaning, B is the result of λ -abstracting the focus meaning from the ordinary meaning of the sentence; for example, the logical form of (1a) will be something as in (5).

- (5) $\text{at-least}'(\langle \lambda x[\text{have}'(j, x) \wedge \text{car}'(x)], \lambda P.|P| \geq 3 \rangle)$.

And, a partial order \leq_B and an equivalence relation \sim_B , over possible worlds with respect to the extension of a background meaning are defined as follows:

(6) (Definitions of \leq_B and \sim_B)

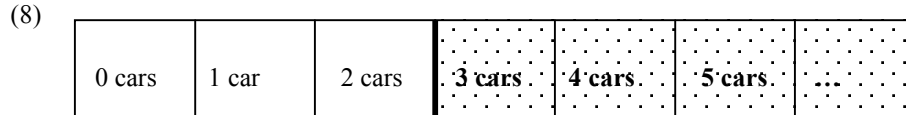
Let w and w' be possible worlds and $\langle B, F \rangle$ be a background-focus meaning.

- $w \leq_B w'$ iff w is exactly like w' except that $[B]^M(w) \subseteq [B]^M(w')$.¹
- $w \sim_B w'$ iff $|[B]^M(w)| = |[B]^M(w')|$.

Here is our analysis of the meaning of *at least*; an *at least*-sentence denotes a partition of the set of possible worlds whose cells correspond to the “sub-propositions” collectively constituting the propositional meaning of the sentence.

$$(7) \quad \llbracket \text{at-least}'(\langle B, F \rangle) \rrbracket^M = \{w \in W : \exists v \in W_M [F(v)(B(v)) = 1 \ \& \ \neg \exists u \in W_M [F(u)(B(u)) = 1 \ \& \ u <_B v] \ \& \ v \leq_B w]\} / \sim_B.$$

In words, first, there is formed a set of possible worlds such that $F(B)$ is true in it and its extension of B is minimal or more, and the set of possible worlds is partitioned into cells with respect to the cardinality of the extension of B . Then, the partition is the meaning of ‘at-least’($\langle B, F \rangle$). The meaning of (1a) by way of logical form (5) is now the set of sub-propositions: “John has (exactly) three cars”, “John has (exactly) four cars”, “John has (exactly) five cars”, ..., which is represented as the dotted area in the following diagram:



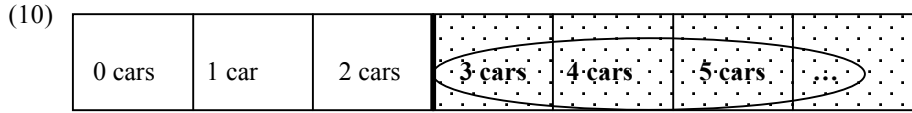
Now, the question is how the current analysis can account for differences between superlative and comparative modifiers in e.g. inference patterns as witnessed in (2). We contend that the differences can be explained by the way how an *at least*-sentence is to be interpreted in the environment of a modal operator, \square or \diamond ; we take epistemic and

¹ As far as the author knows, this relation between possible worlds with respect to the extension of a predicate was first introduced by Yabushita (1993) for an analysis of the exhaustive readings of (multiple-sentence) answers to wh-questions, and much more recently by Schulz & van Rooij (2006) and van Rooij & Schulz (2007).

doxastic operators are necessity operators. We will propose a semantic rule for an *at least*-sentence within the scope of a modal operator, necessity or possibility such that the truth conditions contain, on top of the standard Kripke-semantics truth conditions, (9i), the condition that for every sub-proposition there is some accessible possible world compatible with it, (9ii). The semantic rule in the case of a necessity operator is formally rendered as follows:

- (9) $\llbracket \Box[\text{at least}(\langle B, F \rangle)] \rrbracket^{M, w} = 1$ iff
- (i) $\forall w' [wRw' \rightarrow \exists c [c \in \llbracket \text{at-least}'(\langle B, F \rangle) \rrbracket^M \wedge w' \in c]$ and
 - (ii) $\forall c [c \in \llbracket \text{at-least}'(\langle B, F \rangle) \rrbracket^M \rightarrow \exists w' [wRw' \wedge w' \in c]]$,
- where R is the accessibility relation.

Given the above semantic analysis and the standard modal-logic semantics of belief, the inference patterns of *at-least* sentences as attested in (2) can be accounted for. In (2), Mary’s belief state is such that in every doxastically accessible possible world, John has exactly four cars, which does not satisfy condition (9ii), i.e. every sub-proposition is true at some doxastically accessible possible world. This accounts for the invalidity of the inference in (2b). The truth conditions of (2b) can be represented as in the following diagram, where the oval area denotes the set of Mary’s doxastically accessible possible worlds:



When an *at least*-sentence is not in the scope of a modal operator as in (4), the denotation of the sentence is stipulated to be the union of the cells of the original, partitioned meaning, i.e. $\cup \llbracket \text{at-least}'(\langle B, F \rangle) \rrbracket^M$; the antecedent in (4) will be synonymous with “Betty had more than two martinis”. This exempts the current analysis from the problem for Geurts & Nouwen’s.

One of the nice consequences of the current analysis is that it can provide a formal account for the long-standing observation about an *at least*-sentence, i.e., it resists exhaustification as an answer to a wh-question. Simply, the exhaustification mechanism, which is considered to uniquely identify one sub-proposition to be the case in the speaker’s knowledge as implemented in e.g. (Schulz & van Rooij, 2006), is

incompatible with condition (9ii), which requires that all the sub-propositions should be kept as possibilities.

3. The Turn of *At Most*

From the above discussions on the case of *at least*, it should be pretty straightforward what the current analysis of *at most* will be like. The semantic rule for *at most* is defined as follows:

$$(11) \quad \llbracket \text{at-most}(\langle B, F \rangle) \rrbracket^M = \\ \{w \in W: \exists v \in W_M[F(v)(B(v)) = 1 \ \& \ \neg \exists u \in W_M[F(u)(B(u)) = 1 \ \& \ u <_B v] \ \& \\ w \leq_B u\} / \sim_B.$$

Besides the problem associated with examples like (4), Geurts & Nouwen's analysis has an apparent problem, again as was admitted by themselves. That is, it cannot account for the equivalence between sentences like (12a) and (12b).

- (12) a. Betty didn't have at least three martinis.
b. Betty had at most two martinis.

In the current analysis, on the other hand, the equivalence in question will fall out from the proposed meanings of *at least* and *at most* necessarily.

4. Conclusion

We have reviewed some of the properties of *at least* which prompted Geurts & Nouwen (2007) to claim that it was a modal expression and to propose for it a meaning that involved modal operators explicitly. However, although the proposed meaning solves the problems it was designed to, it creates new problems, the most serious one of which is the presence of a modal interpretation for an *at least*-sentence irrespective of the context, as they themselves admitted. Alternatively, we have proposed a modality-free meaning for *at least* such that the meaning of an *at least*-sentence is a partition of a set of possible worlds and the modal properties of *at least* are to be derived from the interaction with a modal operator if there is one around. Besides being free from the problem in question, the current analysis has been demonstrated to account for facts like the incompatibility of an *at least*-sentence with an exhaustive reading, and the interpretation of a negative *at least*-sentence. In our current analysis, however, we have crucially assumed the "chameleon" meaning for an *at least*-sentence, i.e. a partition of a proposition in the environment of a modal operation and the proposition itself otherwise. As an anonymous reviewer pointed out, this might be considered to be an ad hoc

measure. It is left for future research to investigate if this quirk can be rectified or justified.

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Bibliography

- Geurts, B. & Nouwen, R.: 2007, *At Least* et al.: The Semantics of Scalar Modifiers, *Language* 83, vol. 3: 533-559.
- Krifka, M.: 1999, At Least Some Determiners Aren't Determiners, In K. Turner (ed.) *The Semantics/Pragmatics Interface From Different Points of View*, Elsevier: Oxford, 257-291.
- Schulz, K. & van Rooij, R.: 2006, Pragmatic Meaning and Non-monotonic Reasoning: The Case of Exhaustive Interpretation, *Linguistics and Philosophy* 29: 205-250.
- van Rooij, R. & Schulz, K.: 2007, *Only*: Meaning and implicatures, In Paul Dekker et al. (eds.) *Questions and Answers*, 199-224.
- Yabushita, K.: 1993, Exhaustiveness as an Operation on Information States, Talk given at *Conference on Logic and Linguistics*, Ohio State University, July 31, 1993.