

A semantic underspecification-based analysis of scope ambiguities in gapping¹

Sang-Hee PARK — *University at Buffalo, SUNY*

Jean-Pierre KOENIG — *University at Buffalo, SUNY*

Rui P. CHAVES — *University at Buffalo, SUNY*

Abstract. Gapping is known to interact with scopal operators to create an ambiguity between so-called wide- and distributive-scope readings (Siegel, 1984). In this paper, we offer an analysis of these readings which combines an underspecified treatment of scope and a general theory of coordination. Utilizing the technique of semantic underspecification (Richter and Sailer, 2004), we develop a new coordination rule that captures an asymmetry in the semantic contributions between initial and non-initial conjuncts observed independently of Gapping. This semantic asymmetry in coordination as well as well-justified assumptions about tense and scopal operators (Condoravdi, 2002; Champollion, 2015) correctly predict the various readings of conjoined sentences with or without Gapping.

Keywords: Gapping, coordination, scope, semantic underspecification, Lexical Resource Semantics.

1. Introduction

Gapping is an ellipsis construction characterized by the obligatory absence of a finite verb, as shown in (1a), but other material may go missing, too, as shown in (1b).

- (1) a. Fred ordered coffee and Mary tea.
b. Kim wanted to try to write a novel and Tim a song.

One basic issue raised by Gapping is that the strings that are coordinated do not seem to have equal status; instead, we seem to be coordinating a full clause with a sequence of unconnected constituents. This presents a problem to one of the basic assumptions in syntax/semantics: coordination combines constituents of like category and semantic type.

A more difficult challenge is posed by scopal interactions between Gapping and operators such as negation and modals (Siegel, 1984, 1987). This is exemplified by (2), where a lexical verb as well as, potentially, a finite auxiliary are missing from the second conjunct. The challenge is to explain the availability of two different readings: (2) has a *distributive-scope reading* (henceforth, DSR) in which the negated modal contributed by the auxiliary is part of each conjunct's interpretation (see (2a)). But this sentence also has a *wide-scope reading* (henceforth WSR) in which the negated modal outscopes the conjunction (see (2b)).

- (2) John can't live in Barcelona and Mary in New York.
a. Distributive-scope reading: $\neg\Diamond[\text{live-in}(j,\text{brc})]\wedge\neg\Diamond[\text{live-in}(m,\text{ny})]$
(Paraphrase: It is impossible for John to live in Barcelona – e.g. because he can't stand traffic jams – and it is impossible for Mary to live in New York – e.g. because she hates cold winters.)

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- b. Wide-scope reading: $\neg\Diamond[\text{live-in}(j,\text{brc})\wedge\text{live-in}(m,\text{ny})]$
 (Paraphrase: What's impossible is for John to live in Barcelona and Mary to live in New York – e.g. because they can't be apart from each other.)

Assuming that the missing material in Gapping stands for a copy of its antecedent, the availability of (2a) is expected. The problem is (2b): since scopal operators contributed by auxiliaries do not usually take scope beyond their local clauses, the wide-scope of *can't* is unexpected. So, how does Gapping allow for readings (WSRs) that are otherwise unavailable?

In this paper, we propose an analysis which takes advantage of semantic underspecification techniques (Reyle, 1993; Egg et al., 2001; Richter and Sailer, 2004; Copestake et al., 2005) while using independently motivated type-theoretic semantics for tense and scopal operators (Condoravdi, 2002; Champollion, 2015). Our key analytic intuition is to consider the two readings of (2) as different denotations of a *single, underspecified* description, a view we share with previous semantic underspecification-based approaches to scope ambiguity. Since ellipsis is known to be a potential source of scope ambiguity (Shieber et al., 1996), a treatment in terms of semantic underspecification is attractive. We suggest that the scope ambiguity in (2) hinges on two processes: (i) (semantic) recovery of the gapped material and (ii) specification of the semantic type of conjunction. The two possible scopal relations in (2) follow from these processes. In a way this can be seen as equivalent to an analysis that appeals to a syntactic ambiguity between vP- and CP-domain coordination (Potter et al., 2017), but there is a critical conceptual difference. In our analysis there is *no* grammatical ambiguity in Gapping sentences: the various readings of a Gapping sentence are instead modeled with a single set of constraints which correspond to (i.e., formally denote) two distinct fully specified representations in the logical language.

The paper is structured as follows. In Section 2 we present data to support the empirical claim that WSR is not a general property of Gapping but rather limited to cases in which Gapping occurs in coordinate structures. Previous accounts are discussed in Section 3. Section 4 contains an informal sketch of our analysis of Gapping and the DSR/WSR ambiguity, as well as an independently motivated coordination rule that captures these readings. The analysis is recast in Lexical Resource Semantics in Section 5. Finally, Section 6 summarizes and concludes the paper.

2. Data on the DSR/WSR ambiguity

We begin by establishing the basic descriptive generalizations regarding the DSR/WSR ambiguity. As Siegel (1984, 1987), Potter et al. (2017) and others have noted, the DSR/WSR ambiguity is not correlated with a particular modality and can occur with or without negation. The sentence in (3) exemplifies disjunctive Gapping with the deontic modal *must*, with its DSR and WSR provided in (3a) and (3b).

- (3) Leslie must eat the spinach or Robin the broccoli.
- a. $\text{DSR} = \Box[\text{eat}(l,s)]\vee\Box[\text{eat}(r,b)]$
 Leslie and Robin are under independent obligations, but we are not sure which one is the case: Leslie must eat the spinach or Robin must eat the broccoli.
- b. $\text{WSR} = \Box[\text{eat}(l,s)\vee\text{eat}(r,b)]$
 What must happen is: Leslie eat the spinach or Robin eat the broccoli.

Auxiliaries are not the only elements that participate in the DSR/WSR ambiguity. Adverbs induce the same kind of ambiguity:

- (4) Kim often reads newspapers and Sue magazines.
- a. $DSR = \textit{often}[\textit{read}(k,n)] \wedge \textit{often}[\textit{read}(s,m)]$
Kim often reads newspapers and Sue often reads magazines (but not necessarily at the same time).
 - b. $WSR = \textit{often}[\textit{read}(k,n) \wedge \textit{read}(s,m)]$
Often, Kim reads newspapers and Sue reads magazines.

Crucially, the WSRs of (2)-(4) are unavailable if Gapping does not occur. Compare for instance (3) and (4) with (5a) and (5b) below.

- (5) a. Leslie must eat the spinach or Robin must eat the broccoli.
b. Kim often reads newspapers and Sue (often) reads magazines.

However, although Gapping is a necessary condition for the DSR/WSR ambiguity, it does not seem to be a sufficient condition. Culicover and Jackendoff (2005) note that Gapping is not limited to coordinate structures; see (6), for example.

- (6) Robin speaks French, not to mention Leslie German.
(Culicover and Jackendoff, 2005: 278)

But, sentences such as (6) do not induce the same kind of scopal interactions observed in Gapping with Boolean connectives we illustrated above. Sentence (7) does not have an auxiliary wide-scope reading, i.e. 'It is not the case that [Robin speaks French, not to mention Leslie German]'.
(7) Robin doesn't speak French, not to mention Leslie German.

In the case of comparative structures, such as (8), an apparent wide-scope reading is available: (8) has a reading in which the auxiliary *can't* outscopes *better than*. But note that this reading is available without Gapping: cf. *Robin can't speak French better than Leslie speaks German*.

- (8) Robin can't speak French better than Leslie German.

This suggests that there are two independent mechanisms involved in the licensing of DSR vs. WSR readings: Gapping (which is responsible for the absence of a tensed element) and coordination (see Section 4).

3. Previous analyses: The DSR/WSR ambiguity as a syntactic ambiguity

In this section we briefly discuss previous proposals for the DSR/WSR ambiguity. We will consider syntactic transformational analyses (Section 3.1) and a Type-Logical Categorical Grammar analysis (Section 3.2).

3.1. Syntactic transformational analyses

There are three main analyses of Gapping within the tradition of transformational syntax. The first is the 'large coordination analysis' that posits that Gapping sentences derive from coordination of full clauses and elision of redundant material (Ross, 1970; Sag, 1976; Jayaseelan,

1990; Hartmann, 2000, a.o.). In this analysis, (2) would be assigned a structure roughly equivalent to that of its ungapped counterpart. This leads to an obvious problem, however: since each conjunct contains its own auxiliary in this analysis, it can only predict DSRs.

Alternatively, one can assume that Gapping sentences involve a hidden, subsentential coordination, roughly at the vP-level ('small coordination analysis') (Coppock, 2001; Lin, 2002; Johnson, 2009; Toosarvandani, 2013). In this analysis, (2) would have a structure such as (9) at some stage in the derivation.

(9) [T can't [vP [vP John live in Barcelona] and [vP Mary live in New York]]]

This structure involves a coordination below T, a position where the auxiliary is located. As one can expect, this analysis has the opposite problem: it only accounts for WSRs.

More recently, Potter (2014) and Potter et al. (2017) develop a hybrid analysis which combines the large and small coordination analyses ('two source analysis'). These authors characterize Gapping as a move-and-elide operation that applies precisely to two distinct syntactic structures: CP and vP coordination. Below, (10a) and (10b) show the two alternative parses for (2) in Potter et al.'s analysis (where strikethrough indicates nonpronunciation).

(10) a. Gapping in CP coordination (DSR):
 [CP John can't live in Barcelona] and [CP Mary_x [in New York]_y ~~t_x can't live t_y~~]]
 b. Gapping in vP coordination (WSR):
 John_j [T can't [vP [vP t_j live in Barcelona] and [vP Mary_x [in New York]_y ~~t_x live t_y~~]]]

Potter et al. assume that the availability of CP- and vP-domain Gapping follows from there being proper landing sites for the remnants (which are Topics or Foci) within these projections (Rizzi, 1997; Gengel, 2007): specifically, CP coordination Gapping involves topicalization to CP-Top while in vP coordination Gapping the remnants move to vP-Foc. This leads us to an interesting prediction: if Gapping applies to a structure where topicalization of the remnant is unavailable (i.e., if a CP coordination parse is unavailable), the DSR should be unavailable. Potter et al. (2017: 1142) observe that this prediction is borne out in (11). Note that in this example the left peripheral PP occupies CP-Top.

(11) [CP With only ten dollars between them, [TP James_x could [vP [vP t_x get a sandwich] and [vP Mary a bowl of soup]]]]]

One possible objection to this account (which requires much closer examination than we can provide here) is that there are cases where the prediction is not borne out. For instance, it is known that topicalization has the effect of preventing *wh*-extraction (Lasnik and Saito, 1992; Boeckx and Jeong, 2004; Haegeman, 2012); see (12).²

²The matter is of course complicated by the fact that *wh*-relatives seem to tolerate topic 'island' violations:

(i) A university is the kind of place in which, that kind of behavior, we cannot tolerate. (Haegeman, 2012)

Moreover, topicalization across a *wh*-phrase seems possible in cases such as (ii).

(ii) ?This book, to whom should we give? (Pesetsky, 1982: 13, attributed to A. Watanabe)

However, given that many speakers unanimously find the examples in (12) to be unacceptable, we believe the variability in (i)-(ii) does not affect our claim here that the supposed topicalization of remnants cannot adequately predict the availability or absence of DSRs.

- (12) a. *When did THIS BOOK everyone read?
 b. *Who did you say that TO MARY John introduced?

If true, a CP coordination parse is ruled out for (13) according to Potter et al.'s analysis: the only possibility is one where *Bill* and *to Sue* have moved to vP internal positions for Foci.

- (13) Who did you say that John introduced to Mary and Bill to Sue?

Potter et al. thus predict that, if a negation precedes the putative coordinated vP in (13), as in (14), the DSR should be unavailable. This prediction is not borne out: (14) readily admits a DSR, i.e. 'Who did you say that Bill wouldn't introduce to Sue and John wouldn't introduce to Mary?'

- (14) Who did you say that Bill wouldn't introduce to Sue and John to Mary?

Furthermore, there are problems with the argument that vP coordination can be involved in gapped clauses in the first place. In their critique of the small coordination analysis, Kubota and Levine (2016: 122-5) provide empirical evidence that gapped conjuncts pattern as an S, not as a vP. Since Potter et al.'s analysis preserves the basic ideas of the small coordination analysis, essentially the same critique applies to it. Here, we repeat one of Kubota and Levine's arguments that is based on the distribution of *merely*. Given that *merely* is a vP modifier, it should be able to precede gapped clauses, if a vP coordination parse is available. This prediction is not borne out, as (15) shows:

- (15) Robin didn't comment only that our margins were too small, and {Leslie merely/*merely Leslie} that our footnotes were too long.

(modified based on Kubota and Levine's (37))

Thus, recent transformational analyses (Potter, 2014; Potter et al., 2017), although capable of licensing both DSR and WSR readings, are based on problematic assumptions about the syntax of Gapping. Moreover, the connection purported to exist between the site of coordination and the availability of one reading or another does not seem to hold, which suggests that an account of DSR/WSR in terms of syntactic ambiguity is not on the right track.³

3.2. A Type-Logical Categorical Grammar analysis

Analyses of Gapping developed in Categorical Grammar provide treatments in terms of coordination of non-traditional constituents (Oehrle, 1987; Steedman, 2000; Kubota and Levine, 2012, 2016, a.o.). Here, we focus on the recent proposal in Kubota and Levine (2016).

Kubota and Levine offer an analysis in which the surface asymmetry in Gapping (i.e. coordination of a full clause with a string of remnants) and the DSR/WSR ambiguity result from two separate, simultaneous derivations at the semantic and prosodic levels. In this analysis, gapped clauses such as *John steak* are a sign of syntactic category $S|((S\backslash NP)/NP)$ (i.e. an S missing a transitive verb in the middle); the use of lambda binding at the prosodic level makes it possible to keep track of the position of the missing verb (see (16)).

- (16) $\lambda\varphi.\text{john} \circ \varphi \circ \text{steak}; \lambda P.P(s)(j); S|((S\backslash NP)/NP)$

³Potter et al. do not discuss cases such as (6)-(7), but it would be possible in principle to give such examples a treatment in terms of adjunction at the CP-level, which would explain the unavailability of WSRs.

Kubota and Levine assume the following Gapping-specific entry to coordinate signs such as (16) (ε stands for an empty string).

$$(17) \quad \lambda \sigma_2 \lambda \sigma_1 \lambda \varphi. [\sigma_1(\varphi) \circ \text{and} \circ \sigma_2(\varepsilon)]; \lambda W \lambda V. V \sqcap W; (S|X)|(S|X)|(S|X)$$

The derivation for the WSR of (e.g.) *John can't eat steak and Mary pizza* proceeds as follows. First, we conjoin *John steak* and *Mary pizza* via the entry in (17). Next, we create a TV constituent consisting of the lexical verb *eat* and a variable representing the auxiliary gap, using hypothetical reasoning (i.e. implication introduction). We then combine the resulting signs to obtain (18). Note that (17) ensures that the verb is pronounced only in the first conjunct.

$$(18) \quad \lambda \varphi_0. \text{john} \circ \varphi_0 \circ \text{eat} \circ \text{steak} \circ \text{and} \circ \text{mary} \circ \varepsilon \circ \text{pizza}; \lambda f. [f(\text{eat}(s))(j) \wedge f(\text{eat}(p))(m)]; \\ S|(VP/VP)$$

Kubota and Levine postulate a special semantics for auxiliaries (i.e. they are propositional operators that take a proposition missing a predicate modifier as argument; see (19)). Thus, when the auxiliary *can't* composes with the sign in (18), the WSR is obtained.

$$(19) \quad \frac{\lambda \sigma_0. \sigma_0(\text{can't}); \quad \lambda \varphi_0. \text{john} \circ \varphi_0 \circ \text{eat} \circ \text{steak} \circ \text{and} \circ \text{mary} \circ \varepsilon \circ \text{pizza}; \\ \lambda \mathcal{F}. \neg \diamond \mathcal{F}(\text{id}_{et}); S|(S|(VP/VP)) \quad \lambda f. [f(\text{eat}(s))(j) \wedge f(\text{eat}(p))(m)]; S|(VP/VP)}{\text{john} \circ \text{can't} \circ \text{eat} \circ \text{steak} \circ \text{and} \circ \text{mary} \circ \varepsilon \circ \text{pizza}; \neg \diamond [\text{eat}(s)(j) \wedge \text{eat}(p)(m)]; S} |E$$

The derivation for the DSR involves an additional step: deriving a VP/VP entry from the higher-order entry in (19), which is then given as argument to coordinated clauses that contain gaps (for details, see Kubota and Levine (2016: 149-50)).

Despite its elegance, it is not clear how this analysis can differentiate in a principled manner between cases of Gapping that involve Boolean connectives and cases such as (6). In Kubota and Levine's analysis, the DSR/WSR ambiguity follows from (i) the ambiguity of modals and (ii) the mechanism that composes clauses that contain gaps (i.e., (17)). This seems to predict that WSRs should in principle be available whenever there is an auxiliary gap. But as we saw above, the WSR is not available in (7). Kubota and Levine's analysis does not seem to provide a motivated account as to why this is the case.

4. Our semantic account

4.1. The plot

We suggest that the DSR/WSR ambiguity of Gapping sentences corresponds to a conjoining of eventuality descriptions vs. tensed propositions as in Potter et al.'s analysis, but without positing a syntactic ambiguity. Conceptualizing the DSR/WSR ambiguity this way requires a flexible syntax-semantics interface that techniques of semantic underspecification afford us (Reyle, 1993; Egg et al., 2001; Richter and Sailer, 2004; Copestake et al., 2005). Instead of assuming that the two readings of (2) correspond to distinct syntactic parses, we propose that these readings are different *resolved* meanings of a *single, underspecified* meaning. Since this underspecified meaning can be linked to a uniform syntactic structure, the various readings of Gapping sentences can be accounted for without the need to posit syntactic ambiguity. This is one major advantage over previous syntactic analyses in which each different scopal reading requires a corresponding unique syntactic parse or derivation.

As our earlier discussion showed (see Section 3.2), strings consisting of gapping remnants (such

as *Mary in New York*) behave as constituents of category S, rather than vP. We therefore assume that Gapping sentences involve clausal (S) coordination. The novelty of our proposal lies in our treatment of coordination. We assume that the semantics of coordination is underspecified: what is being conjoined can be a subterm of the semantics of the first conjunct, provided that the conjoined terms match in their semantic type. The DSR and WSR possibilities arise as the result of different ways of specifying these underspecified meanings: (i) the gapped clause denotes a tensed proposition (DSR), or (ii) it denotes an eventuality description (WSR). We lay out details of the proposal in the remainder of this paper.

Our analysis treats Gapping and coordination as independent phenomena which, when combined, create the ambiguity between DSRs and WSRs. By separating Gapping from coordination, our analysis can correctly predict the distribution of WSRs, while relegating the account for the unavailability of WSRs in cases such as (7) to construction-specific syntax/semantics principles.

For reasons of simplicity we assume that gapped clauses involve a WYSIWYG syntax (Sag et al., 1985; Culicover and Jackendoff, 2005; Abeillé et al., 2014) and that the missing content is recovered via the question under discussion (cf. Reich, 2007). Nothing crucial hinges on these choices, however. Our proposal could be recast in syntactic reductionist approaches to Gapping (e.g. the large coordination analysis) with elision of redundant material in tensed or untensed clauses, so long as the semantic treatment proposed here is preserved.

4.2. A type-driven account for DSR/WSR

We assume a type-logical distinction between eventuality descriptions and tensed propositions, implemented in a way similar to what Champollion (2015) suggests (see Comrie (1976), de Swart (1998) and Condoravdi (2002) for similar ideas). Readers interested in the details of Champollion's semantics are referred to his paper; here, we confine ourselves to aspects of his proposal that are relevant for our purposes.

Champollion's semantics is broadly Neo-Davidsonian with one major caveat: the event quantifier is introduced in the lexical entry of the verb rather than via existential closure. Accordingly, verbs and their projections up to the sentence level denote existential quantifiers over events, treated as predicates of sets of eventualities (of type $\langle vt, t \rangle$). As (20) illustrates, this means that a predicate such as *rain* is true of any set of events that contains a raining event (f ranges over event predicates).

$$(20) \quad \llbracket \textit{rain} \rrbracket = \lambda f \exists e [\textit{rain}(e) \wedge f(e)] \quad (\text{Champollion, 2015: 39})$$

Sentential operators such as negation and modals are treated as functions from eventuality descriptions to eventuality descriptions (of type $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$). Tense operates after all other operators have done their work: it maps the interpretation of the sentence to a truth value. Taken together, these assumptions mean that semantic scope in a simple sentence is as specified in (21): Tense has maximal scope, and the eventuality description has minimal scope. Scopal operators take scope between tense and the eventuality description.

$$(21) \quad [\text{Tense} [\{\text{modal, negation, adverbs of quantification, ...}\} [\text{eventuality description}]]]$$

Because clauses in general can only be of two types in this system, t or $\langle vt, t \rangle$, the ambiguity

of (2) is predicted: the DSR in (22a) results when the conjoined terms are of type t ; the WSR in (22b) results when the conjoined terms are of type $\langle vt, t \rangle$ (and the tense operator as well as the negated modal outscope the conjunction).

- (22) a. Semantic representation for (2) under the DSR:
 $\text{Tense}[\neg\Diamond(\text{live-in}(j, \text{brc}))] \wedge \text{Tense}[\neg\Diamond(\text{live-in}(m, \text{ny}))]$
 b. Semantic representation for (2) under the WSR:
 $\text{Tense}[\neg\Diamond(\text{live-in}(j, \text{brc}) \wedge \text{live-in}(m, \text{ny}))]$

The unavailability of the WSR in the ungapped counterpart of (2), i.e. *John can't live in Barcelona and Mary can't live in New York*, follows from the usual constraint that the semantic type of conjuncts must match (Partee and Rooth, 1983) and the fact that tensed propositions are of type t .

4.3. Coordination

In this subsection, we present empirical evidence that supports our treatment of coordination sketched in previous subsections, according to which: (i) each conjunct can be interpreted independently, and (ii) a scopal element within the initial conjunct can outscope the entire coordination. In particular, we show that (ii) is not restricted to Gapping, contrary to a widespread assumption.

Huddleston and Pullum (2002: 1332-3) already noted cases of coordination in which some feature of the initial conjunct affects the interpretation of the entire coordination. In (23) an interrogative clause is coordinated with a declarative clause, but the sentence as a whole expresses a single question.

- (23) Did you make your own contributions to a complying superannuation fund and your assessable income is less than \$31,000?
 (Huddleston and Pullum (2002: 1332); originally from a tax form)

Huddleston and Pullum also discuss cases where a modal auxiliary in the initial conjunct is interpreted to outscope both conjuncts (*ibid.*, p. 1333, fn. 53):

- (24) It might be up there and I can't see it.
 (Paraphrase: It might be that it is up there and I still can't see it.)

Note that these sentences have an asymmetric, consequential reading (similar to Kehler's (2002) Cause-Effect reading). If we assume that, in asymmetric coordination, the conjoined terms need not be alike in semantic type, the wide-scope of the question operator in (23) and the wide-scope modal in (24) follow from our treatment of coordination.⁴

Another piece of evidence supporting our analysis comes from the distribution of negative polarity items (NPIs). In (25a) the NPI *any* in the second conjunct is licensed by the negation *no* in the first conjunct. If we reverse the ordering of conjuncts, as in (25b), ungrammaticality

⁴An example case of asymmetric coordination involving type-mismatch is provided in (i), where an imperative is coordinated with a declarative:

- (i) Drink this and you will lose 8 pounds of belly fat.
 See Portner (2007) for arguments that imperatives and declaratives have distinct semantic types.

ensues, which suggests that the negation in the second conjunct is unable to outscope the entire coordination.⁵

- (25) a. There is no medicine or any treatment whatsoever.
b. *There is any treatment or no medicine whatsoever.

Again, this supports our empirical claim that scopal elements within initial conjuncts can outscope the entire coordination while those in non-initial conjuncts cannot, irrespective of Gapping.

5. An analysis in Lexical Resource Semantics

In this section we spell out our analysis within the framework of Lexical Resource Semantics (LRS, Richter and Sailer, 2004). In Section 5.1 we offer a brief introduction to LRS as well as an LRS account of coordination. We will then present an example analysis of conjunctive Gapping and show how its two readings are captured.

5.1. Lexical Resource Semantics

LRS is an approach to semantic underspecification that expands to semantics the Head-Driven Phrase Structure Grammar approach to grammars as *descriptions* of structures (Pollard and Sag, 1994; Ginzburg and Sag, 2000). In particular, a grammar with LRS semantics denotes sets of syntactic structures that have fully explicit meaning representations in a standard logical language (Ty2, Gallin, 1975), but it does so through underspecification. In other words, the grammar of a sentence of English only describes properties of the logical representations that any utterance of that sentence must have, and those properties may describe more than one well-formed logical representation. More specifically, lexical items in LRS contribute semantic resources to utterances. Every utterance must use up all and only the semantic resources provided by the lexical (possibly phrasal) items in all their legitimate combinations. What is legitimate is determined by semantic principles which restrict at each phrase how the semantic resources of its daughters may combine. What these restrictions do not rule out is allowed. Scope ambiguities between co-arguments of a verb or between predicates in the first conjunct and the conjunction can be seen as arising from a lack of restriction of their respective scopes.

The lexical resources contributed by lexical items are the value of the INCONT attribute (for internal content) and the value of the attribute PARTS gathers the meaning contributions of all words in a phrase. One may regard the INCONT value of a sign as that part of the logical representation of that sign that is outscoped by any other operators with which the sign combines within its syntactic projection. The value of the EXCONT (external content) attribute, on the other hand indicates the overall logical form of phrases. Semantic composition is ensured by some general principles, some of which have case-based definitions with each case corresponding to a particular syntactic combination. Two general principles (the INCONT and EXCONT principles) basically ensure that the meaning contributed by all lexical items is part of the meaning of phrases they belong to. Given these general constraints on use of semantic resources contributed by words and phrases, the semantics principle summarized in (26) (adapted from Richter and Sailer, 2004) governs how to project and compose the meaning of daughters in local trees.

⁵We thank F. Mouret for alerting us to this possibility.

- (26) SEMANTICS PRINCIPLE (SP): In each headed-phrase,
1. the EXCONT value of the head and the mother are identical,
 2. the INCONT value of the head and the mother are identical,
 3. the PARTS value contains all and only the elements of the PARTS values of the daughters,
 4. the following conditions hold:
 - (i) if the nonhead is a quantifier then its INCONT value is of the form $Qx[\rho \circ v]$, the INCONT value of the head is a component of ρ , and the INCONT value of the non-head daughter is identical with the EXCONT value of the head daughter,
 - (ii) if the nonhead is a quantified NP with an EXCONT value of the form $Qx[\rho \circ v]$, then the INCONT value of the head is a component of v
 - (iii) ...

Clause 4 of the SP is what is critical for us, as it includes a case-based definition of constraints imposed on semantic composition by particular (subcases of) syntactic constructions. Clause 4i covers the combination of a quantifier and a head noun whereas clause 4ii covers the combination of a quantified NP argument and a verb. We add two additional clauses, discussed below, for coordinate structures.⁶

Syntactically, we assume that coordinate constructions have a binary branching structure, licensed by two rules: (i) one that allows a coordinating marker (such as *and* and *or*) to attach to an unmarked constituent, and (ii) the other that composes a coordinator-marked constituent with an unmarked constituent (Beavers and Sag, 2004; Chaves, 2007). Each of these syntactic rules are paired with an LRS constraint, (27) and (28), respectively.

- (27) if the daughter is a coordinating marker then
- a. the EXCONT value of the coordinating marker and the mother are of the form $\alpha \circ \beta$ (where \circ represents Boolean conjunction and disjunction), and
 - b. the EXCONT value of the argument of the coordinating marker is a component of β .
- (28) if one daughter is a coordinator-marked X (with an EXCONT value of the form $\alpha \circ \beta$), then the INCONT value of the other daughter is a component of α .

(27) imposes constraints on the combination of a coordinating marker and its argument (such as [*and*] [*Leslie speaks German*]). This constraint ensures that the conjunction contributed by the coordinating marker has wide scope over any (sub)expression contributed by its argument. (28), on the other hand, constrains the combination of two conjuncts, one of which marked by a coordinator (such as [*Bill speaks French*] [*and Leslie speaks German*]). This constraint ensures that the INCONT value of the first conjunct is a component of the conjoined meaning, but it imposes no constraint on the mother's EXCONT value. The DSR and WSR possibilities result precisely from this underspecification of the mother's EXCONT value, as is illustrated below in 5.2.

In this paper we use a notation for LRS which is based on the one in Penn and Richter (2004).

⁶Current versions of LRS mostly focus on headed phrases; it remains to be seen what general and case-based constraints are needed for nonheaded phrases. We leave discussion of this issue for future work.

The notation $\hat{\alpha}$ is used to express that the logical form α is the EXCONT value of the sign, whereas curly braces, as in $\{\beta\}$, indicate the sign's INCONT value. Square brackets with : indicate a *subterm* constraint: $\alpha : [\beta_1, \dots, \beta_n]$ means that β_1, \dots, β_n are subterms of α . In addition, lower case Greek letters will be used as meta-variables to indicate parts of logical forms which are not specified in the sign description.

5.2. Analysis

For purposes of exposition, we adopt a Davidsonian semantics as logical object language (Davidson, 1967). Representations in LRS are (partial) descriptions of terms in the object language. For illustration, in (29) we provide the denotation of the verb *live* (consistent with Champollion, 2015) and the corresponding description in LRS.

- (29) a. Denotation of *live*:

$$\llbracket \textit{live} \rrbracket = \lambda f \exists e [\textit{live}(e, x, y) \wedge f(e)]$$
 b. LRS description:

$$\textit{live}: \exists e (\{\textit{live}(e, x, y)\} \wedge \phi : [e])$$

The description in (29b) preserves all the information in (29a) except the INCONT specification added to it. The meta-variable ϕ represents some unknown formula which contains an event variable e . When the verb *live* composes with a tense-bearing auxiliary, ϕ will be identified with part of the tense meaning contributed by that auxiliary (more precisely, the relation between the time of eventuality and the speech time), although there are several other possible ways to specify ϕ .

We assume that modal auxiliaries in English contribute a modal as well as a tense meaning. This is illustrated by the denotation of *can't* and its LRS description in (30) (where V is eventive).⁷

- (30) a. $\llbracket \textit{can't} \rrbracket = \lambda V [t \circ s^* \wedge \neg \diamond V(\lambda e [\tau(e) \subseteq_T t])]$
 b. $\textit{can't}: t \circ s^* \wedge \neg \diamond \psi : [e, \tau(e) \subseteq_T t]$

The description in (30b) contains a present tense meaning ($t \circ s^* \wedge \dots, \tau(e) \subseteq_T t$) and a negated possibility modal ($\neg \diamond \dots$); s^* denotes the contextually given time of speech and $\tau(e)$ denotes the time of the eventuality e (Krifka, 1998). The meta-variable ψ is where the eventuality description containing the event variable e as well as the subformula $\tau(e) \subseteq_T t$ is introduced. This ensures that the eventuality description has narrow scope over the modal operator and does not outscope the tense meaning.

Since nothing depends on the precise syntactic analysis we adopt, we assume that the lexical descriptions in (29b)-(30b) and the constants j (for *John*) and \textit{brc} (for *in Barcelona*) combine in the usual way to produce the description in (31).

- (31) *John can't live in Barcelona*: $t \circ s^* \wedge \neg \diamond \exists e (\textit{live}(e, j, \textit{brc}) \wedge \tau(e) \subseteq_T t)$

⁷As it is, this analysis of auxiliaries undergenerates. To account for the fact that modals can scopally interact with quantifiers (as in *Someone can't be here*), we need to introduce a new meta-variable, γ (Richter and Sailer, 2004):

(i) $\textit{can't}: \hat{\gamma} t \circ s^* \wedge \gamma : [\neg \diamond \psi : [e, \tau(e) \subseteq_T t]]$

This description permits both the (i) Q (quantifier) $> \neg \diamond$ and (ii) $\neg \diamond > Q$ readings: (i) results when Q is identified with γ , and (ii) results when it is identified with ψ . Since the present paper is not concerned with quantifiers, we assume the simplified description in (30b) for ease of exposition.

Finally, for the gapped clause *Mary in New York* we assume the description in (32).

$$(32) \quad \textit{Mary in New York}: \hat{\delta} : [m, ny, \omega]$$

This description says that *Mary in New York* has an unknown EXCONT value δ and that δ includes subterms *m* and *ny* (for *Mary* and *New York*) as well as some formula ω that represents the logical representation that corresponds to the gap.

With everything in place we now present our LRS analysis of (2). Figure 1 shows the syntactic structure of (2) along with the LRS descriptions and constraints added by (27) and (28) above (Boxed integers are tags).

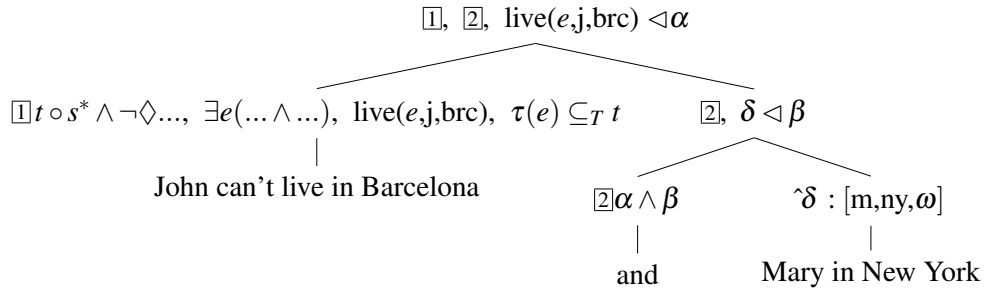


Figure 1: The LRS syntax-semantics interface for (2)

Recall that the constraints in (27) and (28) impose different requirements on the first vs. second conjuncts: all semantic resources contributed by the second conjunct must be a component of the conjoined meaning ($\delta \triangleleft \beta$), but for the first conjunct we only require that its INCONT value be a component of the conjoined meaning ($live(e,j,brc) \triangleleft \alpha$). Given this, two possibilities are predicted for the overall logical form of (2): the conjunction takes wide-scope ($[2] > [1]$) or the tense and modal meanings take wide-scope ($[1] > [2]$). In (33) and (34) we indicate the meta-variable assignments which satisfy all relevant requirements. (To make the descriptions more readable the logical forms that correspond to *can't* and *and* are highlighted in boldface.)

(33) LRS constraints for the DSR of (2)

- a. $\alpha = t \circ s^* \wedge \neg \diamond \exists e(live(e,j,brc) \wedge \tau(e) \subseteq_T t)$
 $\beta = \delta = t' \circ s^* \wedge \neg \diamond \exists e'(live(e',m,ny) \wedge \tau(e') \subseteq_T t')$
 $\omega = t' \circ s^* \wedge \neg \diamond \exists e'(live(e',x,y) \wedge \tau(e') \subseteq_T t')$
- b. Semantic representation resulting from the meta-variable assignment in (33a):
 $[t \circ s^* \wedge \neg \diamond \exists e(live(e,j,brc) \wedge \tau(e) \subseteq_T t)] \wedge [t' \circ s^* \wedge \neg \diamond \exists e'(live(e',m,ny) \wedge \tau(e') \subseteq_T t')]$

(34) LRS constraints for the WSR of (2)

- a. $\alpha = \exists e(live(e,j,brc) \wedge \tau(e) \subseteq_T t)$
 $\beta = \delta = \exists e'(live(e',m,ny) \wedge \tau(e') \subseteq_T t')$
 $\omega = \exists e'(live(e',x,y) \wedge \tau(e') \subseteq_T t')$
- b. Semantic representation resulting from the variable assignment in (34a):
 $t \circ s^* \wedge \neg \diamond [\exists e(live(e,j,brc) \wedge \tau(e) \subseteq_T t) \wedge \exists e'(live(e',m,ny) \wedge \tau(e') \subseteq_T t')]$

In the DSR of (2), depicted in (33b), each conjunct denotes a tensed proposition. In this reading the subformula that corresponds to the semantics at the gap (i.e. ω) comprises the tense

and modal meanings as well as the semantic resource contributed by the predicate *live*. In the description of the WSR of (2), depicted in (34b), each conjunct denotes an eventuality description, and there is a single instance of tense and modal taking wide-scope over the conjoined eventuality description.

6. Conclusion

We have shown in this paper that the DSR/WSR ambiguity in Gapping receives a simple solution within a semantic underspecification approach to the syntax/semantics interface such as LRS. This ambiguity follows directly from the way LRS works together with independently motivated constraints on coordination and semantic scope in simple sentences. If this analysis is correct, there is no need to stipulate a grammatical ambiguity or any Gapping-specific assumptions. Instead, the various readings of Gapping sentences follow from an independently motivated underspecification of what is being conjoined and a general theory of ellipsis.

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