Multiple Coordination: Meaning Composition vs. the Syntax-Semantics Interface*

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Abstract

This paper argues that multiple coordinations like *tall, thin and happy* are interpreted in a "flat" iterative process, but using "nested" recursive application of binary coordination operators in the compositional meaning derivation. Ample motivation for flat interpretation is shown by contrasting such coordinations with nested, syntactically ambiguous, coordinate structures like *tall and thin and happy*. However, new evidence coming from type shifting and predicate distribution with verb phrases show motivation for an independent hierarchical ingredient in the compositional semantics of multiple coordination with no parallel hierarchy in the syntax. This establishes a contrast between operations at the syntax-semantics interface and compositional semantic mechanisms. At the same time, such evidence motivate the treatment of operations like type shifting and distributivity as purely semantic.

1 Introduction

In many languages, a common type of coordination involves constructions of the form X_1, X_2, ... *and/or* X_n, where a coordinator appears only with the last conjunct. The other conjuncts are often separated using a comma intonation, but not necessarily with an overt coordinator.[1] Although the syntax of multiple coordinations has occupied many works, their semantics has not been a central issue in the literature, and apparently for a good reason. Indeed, in many cases it seems easy to analyze multiple coordinations using a simple generalization of the operations that are used in the binary case. Thus, suppose that your syntactic theory assumes a trinary structure for coordinations like *walked, talked and looked at the scenery*. The semantics of *and* in such structures can be defined as a straightforward trinary version of the binary operator in coordinations like *walked and talked*. Your life as a semanticist is even easier if the syntax of multiple coordination is binary and adds for you the "missing" coordinator(s) in a logical form like *walked [and talked [and looked at the scenery]]*. When the interpreted syntactic structure only involves such binary constructions, multiple coordination does not exist as far as semantics is concerned.

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[1] See Haspelmath (2004:pp.4-5) for a typological overview across languages.

The appearance that the semantics of multiple coordination can be easily dismissed relies to a large extent on a lexical coincidence: the coordinators *and* and *or*, which are the primary examples in multiple coordinations, are treated as associative by most semantic theories. When this is the case, the order in which they apply when having more than two conjuncts may seem not to matter for the semantics. However, this appearance is false when covert semantic operators come into the picture, which is the case in virtually all semantic theories. Suppose that some covert operator O is allowed to apply to the conjuncts in a multiple coordination like X_1, X_2 coor X_3. The associativity of *and* and *or* as binary coordinators guarantees that for the sake of meaning derivation, it does not make a difference if the multiple coordination is treated as similar to the binary structure (X_1 coor X_2) coor X_3 or as similar to the binary structure X_1 coor (X_2 coor X_3). However, associativity of *and* and *or* does not guarantee preservation of the equivalence when O applies to one or more of the conjuncts in these structures. Thus, for instance, whether O(X_1 coor X_2) coor $O(X_3)$ is equivalent to $O(X_1)$ coor O(X_2 coor X_3) depends not only on the the coordinator, but also on the semantics of O. This is where the syntax and semantics of multiple coordinations have important implications for theories of type shifting and covert semantic operators in general.

In this paper, various potential sources of non-associativity in multiple coordinations will be used as the main propeller for studying its semantics. Two basic approaches will be taken as useful possible starting points. In a *flat interpretation* process, the coordinator combines with all conjuncts simultaneously at the same syntactic-semantic level. An alternative approach is *nested interpretation*: recursive application of coordination operator(s) in a hierarchical syntactic-semantic process. We will consider various cases of multiple coordination in different linguistic domains, which will show strong evidence for a uniform flat interpretation process. However, this conclusion will be challenged by evidence coming from the interplay of multiple coordinations with type shifting and distributivity operators. Especially, it will be argued that judgements about multiple VP coordinations that were assumed to involve such operations are inconsistent with a simple n-ary procedure for flat interpretation.

In order to address this challenge for flat interpretation, I will propose a new method of implementing it. Instead of the assumption that a coordinator denotes an n-ary operator that can apply to an arbitrary number of operands, I will propose that n-ary coordination is semantically binary. Semantic interpretation in multiple coordinate structures will be achieved by allowing the binary coordinator to apply as many times as necessary for interpreting the coordination. Thus, although the interpretation procedure will be assumed to be "flat" and all conjuncts are interpreted at the level of the multiple coordination, the binary semantics of coordination will be held responsible for "nesting" effects. This nesting will result in non-associativity effects when purely semantic operations like type shifting and distributivity intervene. Other semantic operations which also have a manifestation in the syntax or at the syntax-semantics interface, will shown to create no nesting effect.

The structure of this paper is as follows. Section 2 articulates the preliminary distinction between flat interpretation and nested interpretation. Section 3 shows evidence for flat interpretation. Section 4 shows problems for flat interpretation. Section 5 settles the apparent conflict by opting for a flat interpretation using a nested compositional process. Section 6 goes over previous accounts of the phenomena discussed in section 3, and shows that for most previous treatments of these phenomena, the advantages of flat interpretation are preserved by the present proposal. Section 7 makes some final remarks on the possible formal relations between multiple coordination, "wide scope" coordination, and the polymorphism of coordination operators.

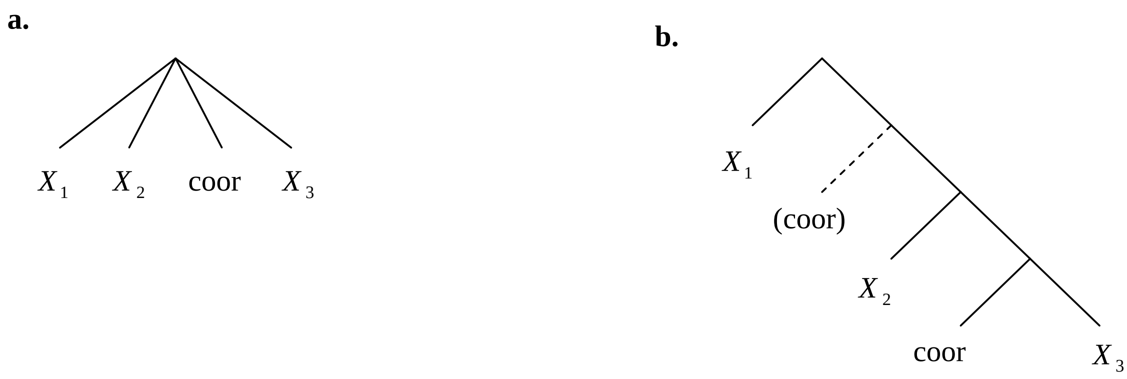

Figure 1: flat structures vs. nested structures for multiple coordination

2 Flat interpretation vs. nested interpretation

Consider the following coordinations.

(1) *found, bought and ate*
in the garden, on the roof or behind the garage
Mary, John and Sue
big, small or middle-sized

I henceforth refer to such coordinations, with more than two conjuncts but only one coordinator, as *multiple coordinations*.[2] In terms of constituency, two types of structures can be classified in the syntactic literature on such coordinations. One type of structures, which I will refer to as *flat*, involves a quadruple structure with the three conjuncts at the same level as in figure 1a. Another type of structures, which I will refer to as *nested*, involves binary structures only, with three layers for the three conjuncts as in figure 1b. In this paper I will not consider all the syntactic details that are necessary in order to flesh out flat structures and nested structures for multiple coordination. For our purposes here it is sufficient to consider these two different kinds of assumptions about constituency, and the interpretative processes that correspond to each of them.[3]

Moving on to the semantics, the well-known cross-categorial treatment of coordination in Partee and Rooth (1983) employs schemes of *generalized conjunction* and *generalized disjunction*, which recursively extend the two-place propositional connectives $\wedge$ and $\vee$ to all t-ending types in the functional type-theoretical hierarchy. I use the notation '$\sqcap^2$' and '$\sqcup^2$' for the binary versions of the generalized operators, as defined below.

[2]The typology that is proposed Haspelmath (2004) refers to coordinations with *multiple coordinands*. Haspelmath does not distinguish between coordinations as in (1) and coordinations of the form X_1 coor X_2 coor ... coor X_n, where the coordinator is repeated (cf. (8) below). For the purposes of this paper, however, it is imperative to distinguish between the two types of coordination, and I henceforth reserve the term *multiple coordination* only for coordinate structures of the type that is illustrated in (1).

[3]For proposals that advocates flat structures for multiple coordinations see Jackendoff (1977:pp.50-51) and Sag et al. (1985), among others. For theories that favor nested structures see Munn (1993) and Johannessen (1998:p.143), among others. See de Vries (2005) for a recent overview and a proposal within the minimalist program.

(2) $$\sqcap^2_{\tau(\tau\tau)} = \begin{cases} \wedge_{t(tt)} & \tau = t \\ \lambda X_\tau.\lambda Y_\tau.\lambda Z_{\sigma_1}.(\sqcap_{\sigma_2(\sigma_2\sigma_2)}(X(Z)))(Y(Z)) & \tau = \sigma_1\sigma_2 \end{cases}$$

(3) $$\sqcup^2_{\tau(\tau\tau)} = \begin{cases} \vee_{t(tt)} & \tau = t \\ \lambda X_\tau.\lambda Y_\tau.\lambda Z_{\sigma_1}.(\sqcup_{\sigma_2(\sigma_2\sigma_2)}(X(Z)))(Y(Z)) & \tau = \sigma_1\sigma_2 \end{cases}$$

The schemes in (2) and (3) embody the most popular conception of the cross-categorial behavior of the coordinators *and* and *or*, and I will not elaborate too much on their advantages or technical details. For argumentation, bibliographical notes and technical discussion see Winter (2001) and the references therein. For readability, I will henceforth suppress the superscript '2' on all binary operators whenever this does not lead to unclarity. For convenience I also use here a two place function notation like $\sqcap(X, Y)$ instead of the properly unary ("Curried") notation $(\sqcap(X))(Y)$. A similar convention is adopted for the general n-ary operators defined below.

If the structure of n-ary coordinations is flat as in figure 1a, the most straightforward way to interpret it is by assuming that the coordinator denotes an n-ary operator. The recursive definitions of generalized conjunction and disjunction are easily extended to the n-ary case using the definitions of the binary operators. This is done in the following definitions, for $n \geq 3$ and any t-ending type τ:

(4) $$\sqcap^n_{\tau^1(\tau^2...(\tau^n\tau))} = \lambda X^1_\tau....\lambda X^n_\tau.\ \sqcap^2 (X^1, \sqcap^{n-1}(X^2, ..., X^n))$$

(5) $$\sqcup^n_{\tau^1(\tau^2...(\tau^n\tau))} = \lambda X^1_\tau....\lambda X^n_\tau.\ \sqcup^2 (X^1, \sqcup^{n-1}(X^2, ..., X^n))$$

Since the binary operators of generalized conjunction and disjunction are both associative, the arbitrary right-association in these definitions of the n-ary operators is of course innocuous.

After this short summary of structures and meanings that play a role in analyses of multiple coordination, let us move on to the interface between the two. I would like to distinguish between two strategies for interpreting multiple coordination. In a *flat interpretation* procedure, all conjuncts compositionally combine with the coordinator at the same syntactic-semantic level of the multiple coordination. In a *nested interpretation* procedure, syntactic sub-constituents of the coordination are semantically interpreted as part of the recursive interpretation process. Although there is a natural parallelism between the hierarchical structure and its interpretation procedure, this parallelism is not necessarily complete. Therefore, throughout this paper I will bother to distinguish between the possible presence of hierarchy in the structure and its possible presence in the interpretation procedure.[4]

Arguably, the simplest way to implement flat interpretation is using the semantic definitions of the n-ary coordination operators. For example, assuming a flat structure as in (6a) below, a trinary analysis of the disjunction operator leads to the meaning in (6b).

(6) a. [big, small or middle-sized]

b. $\sqcup^3(\mathbf{big}, \mathbf{small}, \mathbf{middle\text{-}sized})$

By contrast, assuming a nested structure and a nested interpretation procedure, the binary structure in (7a) below is analyzed using binary operations as in (7b).

(7) a. [big (or) [small [or middle-sized]]]

[4] While a nested interpretation procedure presupposes a nested structure, flat interpretation can also be implemented within a nested structure. This requires to defer interpretation to the hierarchical level of the multiple coordination and may thus lead to some complications. But it is an analytical possibility that I do not need to rule out for the purposes of this paper.

b. $\sqcup^2(\mathbf{big}, \sqcup^2(\mathbf{small}, \mathbf{middle\text{-}sized}))$

Note that in the analysis in (7), I deliberately do not make a commitment to the syntactic presence of a phonologically silent *or*. What is crucial for our purposes here is that under the assumption of nested interpretation, each element in the hierarchical syntactic structure gets a semantic interpretation.[5]

Flat n-ary interpretation of a flat structure as in (6), and nested binary interpretation of a nested structure as in (7) are probably the most straightforward options for analyzing the syntax and semantics of multiple coordination. The ultimate conclusion of this paper will be that neither of these options adequately describes multiple coordination. It will be argued that we need a more sophisticated version of flat interpretation, which encodes nesting of binary coordination in the compositional mechanism. For the purpose of presentation, however, the two simple options that are illustrated in (6) and (7) are a good starting point for the discussion of the data.

3 Evidence for flat interpretation: multiple coordination vs. RC-coordination

As discussed in the previous section, syntactic and semantic theories may employ "flat" procedures or "nested" procedures for the interpretation of multiple coordinations of the form X_1, X_2 coor X_3. By contrast, virtually all theories have to assume nested interpretation for coordinations of the form X_1 coor X_2 coor X_3, at least as an option. The trivial reason is that in such coordinations the subexpression X_1 coor X_2 (and symmetrically X_2 coor X_3) can be analyzed as an interpretable constituent that is coordinated with X_3 (X_1, respectively).

Consider for instance the following coordinations, as opposed to the coordinations in (1).

(8) *found and bought and ate*
in the garden or on the roof or behind the garage
Mary and John and Sue
big or small or middle-sized

I will henceforth refer to such coordinations as containing a *repeated coordinator*, or in short *RC-coordinations*. In the coordination *big or small or middle-sized*, for instance, the two nested interpretations in (9b) and (10b) are available, as semantic reflexes of the nested structures in (9a) and (10a).

(9) a. [big or [small or middle-sized]]
b. $\sqcup^2(\mathbf{big}, \sqcup^2(\mathbf{small}, \mathbf{middle\text{-}sized}))$ (=(7b))

(10) a. [[big or small] or middle-sized]
b. $\sqcup^2(\sqcup^2(\mathbf{big}, \mathbf{small}), \mathbf{middle\text{-}sized})$

On top of these obvious nested binary interpretations, we may like to assign flat analyses as in (6) also to the RC-coordinations in (8). In fact we will see some evidence for this effect in the next section. For the purposes of the present section, however, we can ignore this point.

[5] To give an example for interpretation without a silent *or*, an alternative analysis of the structure in (7a) could exploit the "Currying" trick, and use a trinary semantics for the coordinator. The meanings $(\sqcup^3(\mathbf{middle\text{-}sized}))$ and $((\sqcup^3(\mathbf{middle\text{-}sized}))(\mathbf{small}))$ would then be assigned to the constituents *[or middle-sized]* and *[small [or middle-sized]]*, respectively, and the resulting analysis would be as in (6b).

The obvious availability of nested analyses for RC-coordinations opens a unique window into the interpretation of *multiple* coordinations. Semantic contrasts between multiple coordinations and RC-coordinations are *prima facie* evidence for the flat interpretation of the former, and vice versa. For instance, if we find out that the multiple coordination *big, small or middle-sized* lacks one of the interpretations of the structure in (9a), this may be taken as evidence for the flat interpretation in (6) and against the nested interpretation in (7). The present section will review such systematic empirical differences between multiple coordination and RC-coordination. Some of these data have occasionally been discussed in the literature, mostly in relation to specific theories of the phenomena involved: distributivity, the scope of coordination, temporal alternation, DP-internal conjunction, and "left-subordinating" *and*. The focus of our discussion in this section, however, is not on the detailed analysis of these phenomena. Rather, the data will only be used for establishing primary evidence about the prosodic-syntactic-semantic differences between multiple and RC coordination. The implications of these contrasts for different semantic theories of the relevant phenomena will be discussed in section 6.

3.1 Collective DP conjunctions

Consider the following pair of sentences.

(11) a. Dylan and Simon and Garfunkel wrote many hits in the 60s. (due to Hoeksema (1988:26))

b. Dylan, Simon and Garfunkel wrote many hits in the 60s.

As pointed out in Winter (2001:pp.62-66) and Winter (2000a), sentences like (11a) can easily get a "mixed" distributive-collective interpretation.[6] Everybody who is familiar with the popular song writers in the 60s can understand (11a) as making two separate claims: one on Dylan's output of hits, and another on the output of the duo Simon and Garfunkel. This reading can be emphasized by putting a short pause after *Dylan* in (11a). By contrast, such a reading is impossible in (11b): the sentence can only be interpreted as a claim about the overall hit output that the three artists wrote in the 60s, or as a claim on the individual output of each of the three artists.[7] The following pairs of sentences show similar contrasts.

(12) a. John and Mary and Sue made a lot of money.

b. John, Mary and Sue made a lot of money.

(13) a. Mary and Sue and this man had a baby.

b. #Mary, Sue and this man had a baby.

The contrast in (12) is of the same sort as in (11). Sentence (13a) can, with the right intonation, be felicitously read as making a claim about two different babies: Mary's baby (whose father is unknown, perhaps) and Sue and the man's baby. By contrast, sentence (13b) can only have an infelicitous interpretation, claiming that the three people had the same baby, or, alternatively, claiming that each of the three people, including the man, had a baby.

A somehow different contrast than the ones above, but closely related to them, is exemplified by the following pair of sentences.

[6] See also de Vries (2005), who observes similar facts and attributes them, like Winter (2001) (see below), to a syntactic distinction between multiple coordination and RC-coordination.

[7] The latter claim is factually questionable: as far as I know, Art Garfunkel did not write many hits on his own in the 60s.

(14) a. Blücher and Wellington and Napoleon fought against each other near Waterloo. (due to Hoeksema (1983:p.75))

b. Blücher, Wellington and Napoleon fought against each other near Waterloo.

Sentence (14a) can be used to report on the historical alignment of forces (B&W vs. N), whereas (14b) cannot. Further details about similar examples to (14a) and the ensuing debates about reciprocals and the structure of "groups" can be found in Lasersohn (1995:ch.9) and Winter (2001:pp.38-42), and the references therein.

3.2 Wide scope conjunction

Consider the following sentence.

(15) Here you're not allowed to dance and (to) stamp your feet.

This sentence can be interpreted in two different ways. Under one interpretation, (15) means that what you are not allowed to do is dancing while stamping your feet. Under this interpretation, dancing on its own, as well as feet stamping without dancing, are not necessarily prohibited. We say that this reading shows a *narrow scope* (NS) of the conjunction below the negated modal *not allowed*. Another way to read the sentence is as claiming that there are two things you are not allowed to do: one is to dance and another is to stamp your feet. We then say that the sentence is interpreted with *wide scope* (WS) for the conjunction over the negated modal.[8]

When we consider RC-conjunctions and multiple conjunctions, such "scope" ambiguities can also be observed in cases like the following.

(16) a. Here you're not allowed to sing aloud and dance and stamp your feet.

b. Here you're not allowed to sing aloud, dance and stamp your feet.

Sentence (16a), especially with a short pause before the first *and*, can be interpreted as entailing that you are not allowed to do two things: sing aloud, and dance while stamping your feet. This interpretation can be highlighted by adding *but you are allowed to dance quietly*. Under this reading, the sentence involves WS over the negated modal for the first *and*, but NS for the second *and*. By contrast, in sentence (16b) the negated modal has to have the same scope relative to the three conjuncts of the multiple conjunction: either you are not allowed to do the three activities together, or you are not allowed to do each of them independently of the others. There is no interpretation under any intonation contour which allows a "two prohibitions" reading of (16b) parallel to the reading we observe in (16a).

Similar contrasts between RC-conjunctions and multiple conjunctions are given in the following examples.

(17) a. Here you can't mess up the bathroom and use the kitchen and leave the dishes unwashed (but you're allowed to use the kitchen if you wash the dishes)

[8]As far as I know, this type of examples was first discussed by Oehrle (1987), who concentrated on more complicated cases that involve gapping constructions, as in *Mrs. J. cannot live in Boston and Mr. J. in LA.* See also Szabolcsi and Haddican (2004), which deals with related phenomena on the interaction between coordination and negation. Similar examples involving modals and *dis*junction show the well-known *free choice* puzzles of disjunction (Zimmermann (2000)). Recent work (see Alonso-Ovalle (2006), Fox (2006)) analyzes such cases of disjunction using (non-scopal) mechanisms of implicatures. Note that such pragmatic strengthening accounts are not likely to be the source of the WS reading of (15), which is weaker than its NS reading.

b. Here you can't mess up the bathroom, use the kitchen and leave the dishes unwashed (?but you're allowed to use the kitchen if you wash the dishes)

(18) a. In this room we prohibit drinking and smoking and leaving your ashtray full (but we allow smoking if you take care to empty the ashtray).

b. In this room we prohibit drinking, smoking and leaving your ashtray full (?but we allow smoking if you take care to empty the ashtray).

3.3 Wide scope disjunction

A similar effect to the "scope" ambiguity of conjunction in sentences (15)-(18) has been observed by Rooth and Partee (1982) with respect to disjunction in sentences like the following.

(19) John is looking for a maid or a cook.

Consider the situation where John does not have a particular maid or cook in mind – the *de dicto* interpretation of sentence (19). One possible way to make (19) true under this interpretation is in a situation where John will be satisfied if he finds a maid, and he will also be satisfied if he finds a cook. The kind of interpretation that makes (19) true in such situations is often referred to as *narrow scope* (NS) disjunction with respect to the intensional verb *look for*. However, Rooth and Partee point out another kind of situations that make (19) true: situations where John has only one kind of profession in mind, either a maid or a cook, but not both. This interpretation of sentence (19) can be stressed by adding a phrase like *but I don't know which* to the sentence, and it is paraphrased by the sentence *John is looking for a maid or looking for a cook*. Accordingly, this is referred to as the *wide scope* interpretation of the disjunction over the intensional verb.

Now RC-disjunctions and multiple disjunctions can be shown to contrast in terms of their possible scopes, similar to the contrasts we observed in (16)-(18) with respect to conjunction. Consider for instance the following two sentences.

(20) a. John is looking for a partner or a maid or a cook (but I don't know which).

b. John is looking for a partner, a maid or a cook (but I don't know which).

Sentence (20a), especially with a pause before the first *or*, can be read as stating uncertainty between two possibilities. One possibility is that John is looking for a partner; another possibility is that he is looking for a maid or a cook, with the NS interpretation of this disjunction. Thus, similarly to what we saw for the RC-conjunctions in (16a)-(18a), the two coordinators in the RC-disjunction (20a) may have different scopes with respect to the verb. However, in the multiple disjunction (20b), there is no reading that allows such a situation: unambiguously, the uncertainty expressed by the *but* phrase is with respect to the three possibilities – partner, maid and cook. Thus, in multiple disjunctions like (20b), the intensional verb *look for* has to have the same relative scope with respect to the three disjuncts. This is similar to what we have seen in the multiple conjunctions in (16b)-(18b).

3.4 Adverbs of alternation and VP conjunction

Let us move on to another type of sentences that show a semantic distinction between RC-coordination and multiple coordination. Consider the following two sentences.

(21) a. Mary alternately looks relaxed and tired and exhausted.

b. (?)Mary alternately looks relaxed, tired and exhausted.

Sentence (21a), with a slight pause before the first *and*, can easily mean that Mary's appearance alternates between two states: a relaxed appearance, and an appearance of tiredness and exhaustion. By contrast, sentence (21b) can only mean that Mary's appearance alternates between three states. Furthermore, some speakers I consulted even consider (21b) to be infelicitous, as they only accept usages of *alternately* with two-state alternation. Similar contrasts appear between the following pairs of sentences.

(22) a. John's swagger alternately bemused and irritated and infuriated his soldiers.
b. (?)John's swagger alternately bemused, irritated and infuriated his soldiers.

(23) a. John alternately feels guilt and anger and hate for his family.
b. (?)John alternately feels guilt, anger and hate for his family.

In the *a* sentences above, again with a short pause before the first *and*, alternation can be between two states: bemusing vs. irritation+infuriation in (22a), guilt vs. anger+hate in (23a). In sentences (22b) and (23b) only alternation between three states is possible, if possible at all.

A similar effect can be illustrated with other adverbials of alternation, as in the following sentences.

(24) a. Our visitor read and ate and drank on (two) different occasions/ at different times.
b. Our visitor read, ate and drank on (#two) different occasions/ at different times.

(25) a. John slept and worked and smoked on (two) different occasions.
b. John slept, worked and smoked on (#two) different occasions.

(26) a. Sue read poetry and sang and played the guitar on (two) different occasions.
b. Sue read poetry, sang and played the guitar on (#two) different occasions.

3.5 DP-internal conjunction

Dowty (1988) drew attention to English DPs like the following.

(27) that/the/a man and woman

(28) every man and woman

What is common to these examples is that the DP-internal conjunction can lead to a plural interpretation, involving pairs of men and women. Following Heycock and Zamparelli (2005), I will refer to such interpretations as *split* interpretations. For more on split readings of DP-internal conjunctions across different languages, see also King and Dalrymple (2004). In addition to the split interpretations, examples as in (29) and (30) below can also be used to refer to a single who is both a friend and a colleague (or an officer and a gentleman, respectively).

(29) that/the/a friend and colleague/officer and gentleman

(30) every friend and colleague/officer and gentleman

Heycock and Zamparelli refer to such interpretations as the *joint* interpretation of the conjunction.

Consider now the trinary conjunctions in the following sentences.

(31) a. I met yesterday that biographer and friend and colleague of Richard.

b. I met yesterday that biographer, friend and colleague of Richard.

Sentence, again with a slight pause before the first *and*, (31a) can be read as reporting on meeting two people: one of them is Richard's biographer and the other is Richard's friend and colleague. By contrast, sentence (31b) can only be understood as talking either about one person or about three people. Thus, while the two conjunctions in (31a) can be split and joint respectively, the trinary conjunction in (31b) must be read as uniformly joint or uniformly split.

Similar judgements hold with respect to the following contrastive pairs.

(32) a. This amount of $100,000 will go to a poet and novelist and playwright.

b. This amount of $100,000 will go to a poet, novelist and playwright.

(33) a. We will talk to every soldier and officer and gentleman in the ship.

b. We will talk to every soldier, officer and gentleman in the ship.

(34) a. This Batman film featured every foe and friend and colleague he ever faced.

b. This Batman film featured every foe, friend and colleague he ever faced.

Sentence (32a), but not sentence (32b), can report on a prize that will go to two people: one of them a poet and the other a novelist and playwright. Sentence (33a) may mean that we will talk to soldiers as well as to officers who are also gentlemen, whereas sentence (33b) does not have this interpretation. Similarly, Batman's friends in (34a) can also be his colleagues, whereas for this to be possible in (34b), they also have to be his foes, contradicting normal understandings of these nouns.

3.6 "Left-subordinating" *and*

Culicover and Jackendoff (2005:ch.13) discuss a use of conjunction that they call *left-subordinating* (LS) *and*. Consider their following examples.

(35) a. You drink another can of beer and I'm leaving.

b. Big Louis sees you with the loot and he puts out a contact on you.

In such examples, the conjunction can roughly be interpreted as a conditional. For instance, (35a) has roughly the meaning "if you drink another can of beer, I'm leaving". Culicover and Jackendoff point out that such uses of *and* are impossible in multiple coordinations like the following.

(36) a. ?You drink another can of beer, Bill eats more pretzels, and I'm leaving.

b. ?Big Louis sees you with the loot, you look guilty, and he puts out a contact on you.

In such examples the conjunction cannot get the LS-*and* meaning. For instance, (36a) cannot be interpreted as meaning "if you drink another can of beer (and if) Bill eats more pretzels, then I'm leaving". However, consider the examples in (37) below, with a comma intonation before the second *and*.

(37) a. You drink another can of beer and Bill eats more pretzels, and I'm leaving.

b. Big Louis sees you with the loot and you look guilty, and he puts out a contact on you.

Unlike the multiple conjunctions in (36), these RC-conjunctions allow an LS interpretation of the second *and*.[9]

3.7 Summary – the case for flat interpretation

All the examples that have been presented above show contrasts between two types of coordination. One type of structures involves RC-coordinations of the form in (38a) below, with two occurrences of a coordinator coor. The other type of constructions is multiple trinary coordinations of the form in (38b).

(38) a. X_1 coor X_2 coor X_3

b. $X_1,\ X_2$ coor X_3

We have seen that RC-coordinations as in (38a), with two of the conjuncts "grouped together" by the prosody, allow an interpretation that parallels their phonological association. Under this interpretation, the two conjuncts that are phonologically associated also form a syntactic-semantic unit with respect to their semantic interpretation or scopal behavior. By contrast, multiple coordinations of the form (38b) do not allow such associations in the phonology-syntax-semantics interface. This is strong evidence for a *flat* interpretation of multiple coordination, at least in the broad sense suggested in section 2: the syntax-semantics interface should interpret multiple coordinations of the structure in (38b) without any proper sub-coordination of constituents that functions as a semantic unit. The simple version of flat interpretation that was tentatively suggested in section 2 achieves this semantic unity of multiple coordination by postulating that the arity of the coordination operator matches the number of the conjuncts. This matching between syntactic and semantic coordination can lead to a simple and attractive account of the data discussed so far. However, the following section reveals some challenges for this conception of flat interpretation.

4 Challenges for flat interpretation: type shifting and distributivity

In this section I first discuss some newly observed semantic phenomena about type shifting with multiple coordinations of intensional transitive verbs and extensional verbs. At first blush, these facts seem to imply that nested interpretation of multiple coordinations is preferable to flat interpretation, in contrast to what was observed in the previous section. However, this impression will be weakened once some parallel facts are also observed with predicate distributivity, which reveals further disadvantages to both simple strategies of interpreting multiple coordination that were described in section 2.

4.1 Type shifting and verb coordination – background

One of the main motivations for Partee and Rooth (henceforth P&R) to propose their type shifting strategy comes from binary coordinations of transitive verbs. P&R deal with coordinations

[9] Incidentally, Culicover and Jackendoff's informal proposal about the mismatch between certain syntactic coordinate structures and their "subordinate" interpretation is similar in its general thrust to the proposal in this paper. See also Yuasa and Sadock (2002) for more discrepancies between "coordination" and "subordination" in syntax and semantics.

that involve intensional transitive verbs (ITVs) and extensional transitive verbs (ETVs). ITVs are transitive verbs like *look for, seek, need* or *order*, which give rise to referentially "opaque" readings when their object is an existential DP. For instance, *Mary is looking for a French king* does not entail that a French king exists. By contrast, with an ETV like *kiss*, the sentence *Mary is kissing a French king* involves "transparent" predication that entails the existence of at least one French king.[10] Classically, sentences like *Mary is looking for a French king* are treated as ambiguous between two readings:

- A *de dicto* reading, where the ITV is referentially "opaque", and the sentence accordingly reports about Mary's intention to find some or other French king, without committing to the existence of such kings.
- A *de re* reading, where the ITV is referentially "transparent", and the sentence accordingly reports about Mary's intention to find a particular entity x, which the sentence claims to be a French king.

ETVs are assumed to be referentially transparent, and as a result simple sentences with ETVs are expected to show only the *de re* reading.

P&R, following Montague (1973), assume that ETVs and ITVs must have a common semantic type. This is needed in order to allow a compositional analysis of coordinations between ETVs and ITVs using P&R's cross-categorial treatment of coordination. Consider for instance the following examples.

(39) a. Mary sought and found a fish.

b. John needed and bought a new coat.

c. Sue ordered and got a new PC.

Unlike Montague, P&R assume that ETVs like *find*, *buy* and *get* are lexically assigned the standard type $e(et)$, a Curried version of the type for binary relations between extensional entities of type e. By contrast, following Montague, in order to derive opaque readings, P&R assume that ITVs need to have a lexical type where the argument is intensional. The exact type of this intensional argument need not concern us here.[11] What is important for our purposes is that in order to interpret coordinations as in (39) we need to allow the $e(et)$ type of the ETV to be shifted to the same type as that of the ITV. When we denote the required type shifting operator by 'AR' (for *argument raising*), P&R's analysis of the verb phrase in (39a) can be represented as follows.[12]

[10] For more tests that have been proposed for characterizing the differences between ETVs and ITVs, see Moltmann (1997) and the references therein.

[11] P&R, following Montague, assume that the type of the intensional argument of ITVs is the type of intensional quantifiers. Zimmermann (1993) proposes that ITVs take properties, rather than quantifiers, as their arguments. For further discussion and different proposals see Moltmann (1997) and Schwarz (2006). Another tradition in the literature (see e.g. Larson et al. (1997), Larson (2002)) is to decompose ITVs using predicates that take propositions as arguments. Famously, the verb *seek* is decomposed into *try to find* using the proposition-taking verb *try*. The decompositional literature does not elaborate on the semantics of ITV-ETV conjunctions like *sought and found a fish*, but it seems that the only way for treating such constructions using propositions would be to decompose the phonological form further using a rule of "conjunction reduction", which would derive a "logical form" like *tried to find a fish and found a fish*. Such a rule, in addition to its general unattractiveness (see Winter (2001:pp.8-10)), would face the same problems for interpreting ETV conjunctions that motivated P&R's "last resort" strategy, as discussed below.

[12] In P&R's treatment, the indefinite argument denotes an intensional quantifier of type $(s(et))(st)$. The ETV denotation can then be lifted using the argument raising $\mathrm{AR}^{P\&R}$ defined below, where w is the actual world.

(40) $(\sqcap(\mathbf{seek}, \mathrm{AR}(\mathbf{find})))([\![\text{a fish}]\!])$

The analysis in (40), where the type of the ETV is lifted by the AR operator, models the reading of (39a) that is equivalent to the following sentence.

(41) Mary sought a fish (*de dicto*) and found a fish.

In this analysis we say that the conjunction takes *wide scope* (WS) over the object. More sloppily we often say that the TV conjunction gets a "WS reading".

In contrast to ITV-ETV conjunctions as in (39), P&R point out that when a binary TV coordination contains two ETVs, the prominent reading of the sentence is the one where the conjunction takes *narrow scope* (NS) below the object. Consider for instance the following sentences.

(42) a. Mary found and ate a fish.
b. John bought and wore a new coat.
c. Sue got and used a new PC.

Sentence (42a), for instance, is readily interpreted as equivalent to the following statement, with an NS reading of the conjunction.

(43) There is a fish that Mary found and ate.

Similar observations hold for other ETV conjunctions as in (42), but see some reservations below.

An important part of P&R's proposal concerns this contrast in the scope of coordination between the behavior of ITV-ETV conjunctions and ETV-ETV conjunctions. In cases like (42), P&R exploit the identical type of the two ETVs, which makes it possible to analyze the coordination directly using generalized conjunction of functions of type $e(et)$. Consider for instance the binary analysis $\sqcap(\mathbf{find}, \mathbf{eat})$ of the ETV coordination in (42a). Argument raising may still be used in order to compose this denotation with the object, which leads to an NS interpretation of the conjunction. However – and most crucially – P&R claim that in such cases of ETV coordination, shifting the type of each of the two ETVs *before* they are coordinated would lead to an undesirable WS analysis of the conjunction. Thus, P&R allow the analysis in (44a), but rule out the analysis in (44b).

(44) a. $(\mathrm{AR}(\sqcap(\mathbf{find}, \mathbf{eat})))([\![\text{a fish}]\!])$ (P&R$^{\checkmark}$)
b. $(\sqcap(\mathrm{AR}(\mathbf{find}), \mathrm{AR}(\mathbf{eat})))([\![\text{a fish}]\!])$ (P&R$^{\times}$)

Independently of the precise intensional semantics of the AR operator and the indefinite object *a fish*, there is an important difference between (44a) and (44b). While the analysis in (44a) leads to the prominent NS paraphrase in (45a) below (=(43)), the analysis in (44b) leads to the logically weaker WS paraphrase in (45b).

$$\mathrm{AR}^{P\&R} = \lambda R_{e(et)} \lambda \mathcal{Q}_{(s(et))(st)} \lambda x_e.((\mathcal{Q}(w))(\lambda y_e.R(y)(x)))(w)$$

In Zimmermann's analysis, the indefinite denotes a property of type $s(et)$, which would lead to the operator AR^Z:

$$\mathrm{AR}^Z = \lambda R_{e(et)} \lambda \mathcal{P}_{s(et)} \lambda x_e.\exists y_e[R(y)(x) \wedge \mathcal{P}(w)(y)]$$

Ben-Avi (2006) and Ben-Avi and Winter (2006) study the systematic connection between intensionality and extensional systems involving quantifier composition and incorporation (e.g. van Geenhoven (1998)), which derive such intensional definitions of AR as a corollary of a general semantic setting.

(45) a. There is a fish that Mary found and ate. (NS conjunction)

b. There is a fish that Mary found and there is a fish that Mary ate. (WS conjunction)

Intuitively, since argument raising allows the binary relation denoted by the ETV to take an existential DP as a direct argument, applying raising to the conjoined relation $\sqcap(\mathbf{find}, \mathbf{eat})$ as in (44a) leads to the "one fish" analysis paraphrased in (45a). However, when AR applies separately to each conjunct as in (44b), the result is that each conjunct "consumes" the denotation of the object separately, which leads to the "possibly two fish" analysis paraphrased in (45b).

P&R claim that this latter, "two fish" analysis, is not a viable option for ETV coordinations. Thus, they propose that analyses as in (44b) are ruled out by a "last resort" principle for type shifting, according to which operators such as AR apply only at the point in the compositional analysis where they are needed for the interpretation. In the example above, P&R rule out the analysis (44b) because there is no type mismatch between the conjuncts, which can be coordinated as in (44a) without application of AR. Type shifting is necessary, however, for interpreting the conjunction in (40) and for composing the conjunction in (44a) with the indefinite object.

This application of type shifting only as a last resort operation was challenged in Groenendijk and Stokhof (1989) and Hendriks (1993). According to these works, type shifting operators should apply freely, and analyses like (44b) should not be ruled out. Against P&R's generalization, there are indeed some cases where two ETVs may appear in a conjunction while leading to a reading similar to the (45b). Some cases like that are reviewed in Winter (1995). For instance, the sentence *John sold and bought a car* contains two ETVs, but its prominent interpretation is that John sold one car and bought another one. Hence, although most ETV coordinations that come to mind support P&R's "last resort" strategy, there are also some evidence against it. For the empirical purposes of this paper I do not need to take a position with respect to the difficult choice between the "last resort" and the "liberal" approaches to type shifting. For sake of avoiding too much spurious ambiguity in the analysis of linguistic examples, I will henceforth consistently assume the "last resort" option in the analysis. However, this will not have much impact on the conclusions of this paper.

4.2 Type shifting and multiple coordination

Let us now get back to multiple coordination. Consider the following sentences with multiple TV conjunctions, each of them involving a combination of one ITV from (39) with two ETVs from (42).

(46) a. Mary sought, found and ate a fish.

b. John needed, bought and wore a new coat.

c. Sue ordered, got and used a new PC.

This type of examples, which as far as I know has not been discussed so far in the literature, reveals something about type shifting strategies and the interpretation of multiple coordination. Intuitively, the sentences in (46) most readily get a one-fish/one-coat/one-PC interpretation of the object with respect to the two ETVs, similar to the interpretation for which P&R argued in cases like (42). However, the multiple coordinations in (46) also contain an ITV, and the indefinite object can easily get a *de dicto* interpretation with respect to this verb. Thus, for instance, sentence (46a) can be true if Mary looked for any fish, not a particular fish. This does not affect our understanding that the fish that she eventually ate was the fish that she found, as it is the case for the ETV conjunction in (42a).

What this means is that P&R's view on TV coordination is incompatible with using a trinary conjunction operator for analyzing the multiple coordinations in (46). Let us see why. In the flat interpretation, a trinary conjunction should coordinate the three denotations of *sought*, *found* and *ate* in a structure like (47a) below. In order to resolve the type mismatch between the intensional transitive verb *sought* and the two ETVs, we have to apply argument raising before applying the trinary conjunction operator $\sqcap^3$. There is only one way to do that: to apply AR twice to each of the two ETVs in separation. This leads to the interpretation of the VP as given in (47b), and to an analysis of sentence (46a) as paraphrased in (47c).

(47) a. [[sought, found and ate] a fish]

b. $(\sqcap^3(\mathbf{seek}, \mathrm{AR}(\mathbf{find}), \mathrm{AR}(\mathbf{eat})))([\![\text{a fish}]\!])$

c. Mary sought a fish, found a fish and ate a fish.

This is the "possibly two fish" interpretation against which P&R argue in cases like (42). Under the trinary interpretation of the coordination in (47a) there is no way to apply a binary conjunction operator to the denotations of the two ETVs. Hence, the AR operator cannot apply to a binary conjunction of the two ETVs as it was possible to do in the analysis (44a) that was advocated by P&R for ETV coordinations. As a result, there is no way to get a "one-fish" interpretation of the trinary conjunction in (47a) together with a *de dicto* interpretation with respect to the intensional transitive verb *seek*.[13]

Under the nested binary interpretation of the conjunctions in (46) the situation is different. Using a binary syntax as in (48a) below, we get the type mismatch only when the binary coordination of the ETVs is conjoined with the ITV. This leads to the to the "one-fish" *de dicto* interpretation in (48b), which is paraphrased in (48c).

(48) a. [[sought, [found and ate]] a fish]

b. $(\sqcap^2(\mathbf{seek}, \mathrm{AR}(\sqcap^2(\mathbf{find}, \mathbf{eat}))))([\![\text{a fish}]\!])$

c. Mary sought a fish, and there was a fish that Mary found and ate.

What can we conclude from this difference between the flat interpretation and the nested interpretation? Under the simple alternatives described in section 2, I can only see two possible hypotheses about the examples in (46):

> *Simple nesting hypothesis*: The examples in (46) are straightforward evidence for a nested interpretation of multiple coordinations using a binary structure as in (48).
>
> *Simple flattening hypothesis*: The examples in (46) are not a knockdown argument against the flat trinary analysis in (47). Rather, we should start questioning the judgements on which P&R based their argument for the "last resort" analysis in (44a) as opposed to the analysis in (44b).

That the simple nesting hypothesis is problematic should be clear from section 3 and the theoretical discussion in section 6 below. In the remainder of this section I will aim to show that also the simple flattening hypothesis is untenable, despite possible reservations concerning P&R's view on TV coordination. An account of the data following these negative conclusions will be developed in section 5.

[13]Of course, it is possible to get a "one-fish" *de re* interpretation with respect to *seek* by giving the indefinite object wide scope over the whole conjunction. But this *de re* reading is different than the "one-fish" *de dicto* reading that we are after.

4.3 Is there reason to question Partee and Rooth's judgement?

As mentioned above, P&R's argument concerning ETV coordinations as in (42) was challenged by Hendriks (1993), who advocated a "liberal" type shifting that allows both analyses in (44). For Hendriks, the "possibly two fish" analysis with WS conjunction is acceptable, though perhaps pragmatically less prominent than the "one fish" reading with NS conjunction. Furthermore, if, contra P&R, sentences like *Mary found and ate a fish* (=(42a)) may in principle allow a "two-fish" interpretation, we may start wondering whether the "one-fish" reading is needed to begin with: the devil's advocate might claim that a "one-fish" reading as in (44a) (or perhaps only a "one-fish" *de dicto* reading as in (48b)) is missing altogether in cases like (42) and (46), and that it only seems to appear there by virtue of pragmatic strengthening of the "possibly-two-fish" analysis. This line of reasoning might save an n-ary flat analysis as in (47).

There are reasons to suspect such a pragmatic line already with respect to the sentences in (42) and (46), but I will not dwell on this point too much.[14] The reason that pragmatic strengthening may seem tenable in such cases to begin with is that the "possibly two-fish" analysis (44b) is entailed by the "one-fish" interpretation (44a). Thus, a pragmatic strengthening account of (42a) may try to avoid altogether the logically stronger proposition in (44a), where the AR operator applies to the whole ETV coordination, and to thereby save the flat analysis in (47b). However, can we do away with the application of AR to ETV coordinations in general? Let us analyze this question in more detail.

To be sure, we need to let the object have scope over the whole conjunction in many similar cases with a quantificational object. Consider the following sentences:

(49) a. Mary caught and ate less than half of the fish.

b. Mary bought and wore exactly one coat.

c. Mary got and used few of the PCs.

In sentence (49a), for instance, the analysis where the object takes scope over the conjunction, paraphrased in (50a), is not entailed by the analysis paraphrased in (50b), where the object takes scope below the conjunction.

(50) a. For less than half of the fish x: Mary caught and ate x.

b. Mary caught less than half of the fish and ate less than half of the fish.

Suppose that there are only five fish, and that Mary caught three of them and John caught the other two. Suppose further that Mary ate only one of the fish she found, as well as the other two that John caught. Sentence (49a) can intuitively be interpreted as true in such a situation, and similarly the analysis in (50a), with the quantifier taking scope over the conjunction. By contrast, the analysis in (50b) is false. This means that some scope mechanism should give the

[14] Suppose that the two existential quantifiers in the analysis (44b) would somehow be interpreted using one "discourse referent". Such a "strengthening" would have to be quite different from the behavior of conversational implicatures, which was recently drawn into attention by Chierchia (2004). For instance, unlike "exclusive *or*" implicatures, which are canceled in downward-entailing contexts (cf. (i) below), the "one fish" implication is not cancelled in such contexts (cf. (ii)).

(i) Every student who wrote a squib or made a classroom presentation got extra credit. #But those students who both wrote a squib and made a classroom presentation did not get extra credit. (after Chierchia (2004))

(ii) Every student who caught and ate a fish got sick. But those students who caught one fish, didn't eat it, and ate another fish at that good restaurant, did not get sick.

object DP in sentence (49a) wide scope over the ETV conjunction. One possibility to do that is by applying AR to the ETV conjunction as P&R do. But another possibility, which P&R also assume, is to give the object wide scope over the conjunction by using a scope shifting principle (Quantifying-in, Quantifier Raising etc.). To distinguish between these two possibilities, let us consider the following sentences, which add an ITV to the coordinations in (49).

(51) a. Mary sought, found and ate less than half of the fish.

b. Mary needed, bought and wore (exactly) one coat.

c. Mary ordered, got and used few of the PCs.

As in (49), these sentences as well ought to have an analysis where the object DP takes scope over the conjunction between the two ETVs. Importantly, under the simple flat interpretation this cannot happen without the object also taking scope over the ITV, leading to a *de re* interpretation. But isn't there also a *de dicto* interpretation of the object with respect to the ITV?

In the case of examples like (51), it is not easy to answer this question. However, when the context makes clear that the *de dicto* interpretation is preferred, my informants agree that such an interpretation is prominent in cases like the following.

(52) For the sake of her health, Mary looks for, finds and eats (exactly) five wild mushrooms every day.

Clearly, for this sentence to be true Mary doesn't need to look for specific mushrooms. Any five wild mushrooms will do. Thus, the prominent reading of (52) is with a *de dicto* interpretation of the object with respect to the intensional transitive verb *look for*.[15] Now, suppose that on a certain day Mary finds six mushrooms but eats only five of them. It's clear that sentence (52) can still be true in such a situation. This means that the object takes scope over the ETV conjunction as in the paraphrase (53a) below, and not as in (53b).

(53) a. Mary looks for (exactly) five wild mushrooms, and there are (exactly) five wild mushrooms that she finds and eats.
(object wide scope over the conjunction)

b. Mary looks for (exactly) five wild mushrooms, eats (exactly) five wild mushrooms and finds (exactly) five wild mushrooms.
(object narrow scope below the conjunction)

As far as I was able to check, speaker intuitions with respect to *de dicto* readings and conjunction scope are similar in the following example.

(54) In the course of his life, John has looked for, courted and married (exactly) five supermodels.

Here again, it seems possible for (54) to be true if John is a Don Juan who set his mind on looking for five supermodels, no matter which ones. Sentence (54) can be true if John courted many supermodels but ended up marrying (only) five of the supermodels he courted. This again shows the possibility of allowing the object to be interpreted *de dicto* with respect to the ITV, while having wide scope over the ETV conjunction within the multiple coordination.

[15]It should be remarked that whether ITVs can allow quantificational objects to have *de dicto* readings is a controversial issue. Zimmermann (1993) assumes that genuinely quantificational DPs cannot get *de dicto* readings with ITVs. Moltmann (1997) challenges this claim, and Schwarz (2006) shows some differences between ITVs in this respect. It is impossible to study this question without getting into the precise definition of "quantificational DPs" and the intricate semantics of ITVs. However, for the sake of the argument here, it is enough to accept that a sentence like *Mary looks for (exactly) five wild mushrooms* has a *de dicto* reading, which was agreed by any speaker I consulted.

4.4 Summary – Multiple coordination and Argument Raising

Let us summarize the conclusions from the examples discussed so far. One of Partee and Rooth's central motivations for proposing type shifting was the behavior of binary ETV coordinations, where the coordination was argued to take narrow scope below a conjunction of $e(et)$ binary predicates. We examined multiple conjunctions with an ITV conjunct, and saw that, assuming flat n-ary interpretation, the type shifting strategy derives a counterintuitive *wide* scope reading for the ETV conjunction over the object. In an attempt to save the n-ary interpretation hypothesis, we tried to challenge Partee and Rooth's assumption that their data should be accounted for by a purely semantic mechanism. We entertained the possibility that it is pragmatic strengthening that leads to the "conjunction narrow scope" impression in ETV coordinations. However, pragmatic strengthening alone does not seem to be helpful for the analysis of (52) and (54), where the object is not a simple upward monotone indefinite.

Admittedly, these last two examples are not the most natural sentences to rely on. Before concluding that the diseases of flat n-ary interpretation are incurable, it is better to look for more evidence about the interaction between quantifiers and multiple coordination. This is the subject of the remainder of this section.

4.5 Argument Raising and RC-coordinations

So far we have considered only multiple coordinations of ITVs and ETVs. Adding RC-coordinations to the picture also adds more evidence for P&R's "one-fish" readings. Consider the following pair of sentences.

(55) a. Mary sought, found and ate a fish. (=(46a))

b. Mary sought and found and ate a fish.

When uttering (55b) with a comma intonation after *sought*, this RC-coordination behaves similarly to the multiple coordination in (55a): both utterances strongly prefer the "one-fish" interpretation as in *Mary found and ate a fish* (=(42a)). By contrast, when uttering (55b) with a comma intonation after *found*, also a "two-fish" situation becomes possible.

This contrast between the two utterances of (55b) is unexpected if the "one fish" interpretation in (55a) is derived by pragmatic strengthening. To see that, consider the following meaning that is derived for (55b) using P&R's strategy, when the conjunction is read with association to the left (comma intonation after *found*).

(56) $\sqcap(\sqcap(\mathbf{seek}, \mathrm{AR}(\mathbf{find})), \mathrm{AR}(\mathbf{eat}))$

This analysis is equivalent to the "possibly two fish" analysis (47b) of (55a), obtained using a trinary coordinator. Thus, if a flat interpretation of (55a) along these lines was possible, we should have expected the (only) interpretation of this multiple coordination to be identical with the interpretation of the left-association utterance of (55b). The contrast between the two is further evidence for a "one fish" reading of (55a).

4.6 Distributivity and verb phrase coordination

The examples discussed by so far, following Partee and Rooth, involve conjunctions of ITVs and ETVs and their composition with an indefinite object. This type of examples has an empirical weakness: the most natural examples, of the *caught and ate a fish* variety, involve an existential quantifier and a conjunction. As we saw, it is a often hard to rely on such examples because of the logical entailment from the NS analysis to the WS analysis. A classically dual variation (see Winter (1995)) would be to use *universal* quantifiers with *dis*junction in the linguistic tests. Such test could be empirically stronger, but unfortunately, for the study of multiple coordinations with ITVs this option is not really helpful. The reason is that universal quantifiers do not easily get a *de dicto* reading when they appear as objects of ITVs.[16] However, there are other areas in the interpretation of VP coordination, where its interaction with universal quantification can be more easily studied. This brings us to distributivity operators.

Consider first the following example.

(57) The girls met in the bar and had a glass of beer.

This kind of examples was brought to the attention of theories of distributivity by Dowty (1986) and Roberts (1987).[17] Sentences of this type, involving predicate conjunction, show the need to let distributivity operators apply at the predicate level. The plural subject of this sentence gets a collective reading with respect to the predicate *meet* while still having a distributive interpretation with respect to the conjunct *had a glass of beer*. Thus, while the verb *meet* in (57) is predicated of the group of girls as a whole, the predicate *had a glass of beer* is predicated of individual girls, where the glass of beer varies from girl to girl. Dowty, Roberts and many others have concluded that the correct interpretation of sentences like (57) must therefore be along the lines of the formula in (58a), where the distributivity operator D is interpreted as in (58b), and G is the set of girls, which is presupposed to contain at least two members.[18] This leads to the analysis of (57) as in the formula (58c), paraphrased in (58d).

(58) a. $(\sqcap(\mathbf{meet}_{(et)t}, D(\mathbf{have\_beer}_{et})))(G_{et})$

b. $D_{(et)((et)t)} = \lambda A_{et}.\lambda B_{et}.\exists x[B(x)] \wedge \forall y[B(y) \rightarrow A(y)]$

c. $\mathbf{meet}(G) \wedge \forall y[G(y) \rightarrow \mathbf{have\_beer}(y)]$

d. The girls met in the bar and each girl had a glass of beer.

The treatment of distributivity using a universal operator on predicates as in (58b) was first proposed by Link (1983) within his lattice-theoretical approach to plurality. Further developments of distributivity operators have been proposed in the literature, but they are not crucial for the purposes of this paper and are henceforth ignored.[19]

Now consider the following examples.

(59) a. We are going to invite Mary and Sue to have a sandwich, drink a glass of milk or build a raft together.

b. Every Sunday at four O'clock, Mary and Sue have a sandwich, drink a glass of milk or build a raft together.

Consider for instance sentence (59a). Intuitively, for Mary and Sue to follow our invitation, it is enough that Mary has a sandwich and Sue drinks a glass of milk. Similarly, in (59b), for the sentence to be judged true, it should satisfy the requirement stated in (60) below.

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[16] On the empirical puzzle surrounding the definition of the class of DP objects allowing an opaque interpretation of ITVs, see Zimmermann (1993), Moltmann (1997) and Schwarz (2006).

[17] See Lasersohn (1995:ch.7,fn.8) for the complex chronology of the discussion of these examples.

[18] I am using here the Bennett (1974)/Scha (1981) assumption that plural individuals are simply et predicates. A more common practise is to assume a structured ontology of plural individuals in the e domain, but this practise is not needed for the purposes of this paper.

[19] See Schwarzschild (1996), as well as Winter (2000a) and Beck and Sauerland (2001), for an on-going debate about the precise formulation of distributivity operators.

(60) One of the following two conditions holds every Sunday afternoon:

(i) Mary has a sandwich or drinks a glass of milk, and Sue has a sandwich or drinks a glass of milk.

(ii) Mary and Sue build a raft together.

This behavior of the sentences in (59) has implications for the treatment of distributivity in multiple disjunctions, which are similar to what we saw above with Argument Raising in multiple conjunctions (cf. (47) and (48)). Suppose for instance that the disjunctions in (59) are flat as in (61a) below, and that the analysis of the coordination involves a trinary disjunction operator $\sqcup^3$. In order to allow distributivity for the first two disjuncts without forcing it on the third, collective, disjunct, we have to apply the distributivity operator to the first two disjuncts before applying the $\sqcup^3$ operator. There is only one way to do that: to apply D twice to each of the first two predicates in separation. This leads to the interpretation of the VP as given in (61b), and to an analysis of sentence (59b) as paraphrased in (61c).

(61) a. [[have a sandwich,] [drink a glass of milk] or [build a raft together]]

b. $(\sqcup^3(D(\mathbf{have\_sandwich}_{et}), D(\mathbf{drink\_milk}_{et}), \mathbf{build\_raft}_{(et)t}))(\{\mathbf{mary}, \mathbf{sue}\})$

c. Mary and Sue each have a sandwich, or Mary and Sue each drink a glass of milk, or Mary and Sue build a raft together.

However, this "wide scope" of the disjunction over the two distributivity operators is not what we need if we want to allow Mary and Sue to do two different things. The paraphrase in (61c), unlike the sentences in (59), requires both girls to do the same thing: have a sandwich, drink milk or build a raft (together). Similarly to what we saw in the trinary analysis (47) of ITV-ETV conjunctions, the trinary analysis of sentences (59a-b) leaves no room for applying a binary disjunction operator to the denotations of the two distributive predicates. As a result, there is no way to get "distribution" over the first two disjuncts in (61a) together with a collective interpretation of the third disjunct. Note however, that unlike what we saw in simple ITV-ETV conjunctions, with collective-distributive disjunctions pragmatic strengthening could not save the n-ary analysis: the interpretation we are here after is logically weaker than what distribution would give us using the trinary disjunction.

The nested binary interpretation of the disjunctions in (59) may allow us treat them correctly. By contrast to the sentences in (48) above, where the ITV is the leftmost conjunct, in (59) the collective predicate is the rightmost disjunct. Thus, we should here assume association to the left as in (62a) below in order to get the interpretation we are looking for, which is formalized in (62b) and paraphrased in (62c).

(62) a. [[[have a sandwich,] [drink a glass of milk]] or [build a raft together]]

b. $(\sqcup^2(D(\sqcup^2(\mathbf{have\_sandwich}_{et}), D(\mathbf{drink\_milk}_{et})), \mathbf{build\_raft}_{(et)t}))(\{\mathbf{mary}, \mathbf{sue}\})$

c. Mary and Sue each [have a sandwich or drink a glass of milk] or Mary and Sue build a raft together.

Even though the constituency in (62a) may seem strange, some syntactic theories of coordination (e.g. Johannessen (1998:p.145)) allow them as a marked option. As with respect to ETV-ITV coordination, and whatever its other problems may be, nested interpretation seems to do a good job here.

But even nested interpretation is not likely to do the whole job. Plausibly for pragmatic reasons, collective predicates and distributive predicates can be ordered more freely than ITVs and ETVs when they appear in coordinations. Hence, consider the following variation of (59b).

(63) Every Sunday at four O'clock, Mary and Sue have a sandwich, build a raft together or drink a glass of milk.

In (63) the collective predicate appears in between the two distributive predicates. Also in this case we can get the sentence as true when Mary has a sandwich and Sue drinks a glass of milk. Thus, sentence (63) has the same reading of (59) paraphrased in (60). In this case a nested analysis of coordination cannot lead to the intended interpretation: there is no continuous constituent in (63) consisting only of the predicates *have a sandwich* and *drink a glass of milk*. As a result, the distributivity operator cannot apply in (63) to the two distributive disjuncts without thereby applying (counter-intuitively) to the collective disjunct as well.

Furthermore, similar judgements hold for the following RC-variant of (63), with an *or* added to the multiple disjunction.

(64) Every Sunday at four O'clock, Mary and Sue have a sandwich or build a raft together or drink a glass of milk.

This variant as well can be interpreted as equivalent to (60). To obtain this interpretation, there is no binary disjunction constituent in (64) to which the distributivity operator can apply and derive the intended meaning. Thus, although *a priori* it may seem reasonable to analyze RC-coordinations as in (64) only using binary operations, also such cases may require a more intricate strategy of interpretation, parallel to that of multiple coordination.

5 Flat interpretation using nested composition

Let us take stock of what we have seen in the last two sections. In section 3 we considered evidence for flat interpretation of multiple coordinations coming from the distinction between multiple coordination and RC-coordination. However, in section 4 we saw that flat interpretation as described in section 2 is too restricted: both Argument Raising and Predicate Distribution need to apply to semantic units that are proper sub-units of the multiple coordinate structure. Furthermore, these semantic sub-units may correspond to discontinuous phonological material in the coordination (cf. (63) and (64)).

I would like to propose that these challenges for flat interpretation result from our assumption about the n-ary semantics of multiple coordination. In order to analyze the problem, let us distinguish two different sub-processes in the compositional mapping from a syntactic unit C to a meaning M:

- Semantic *interpretation*: using the syntactic structure to extract the meanings $M_1, M_2, ..., M_n$ denoted by the sub-parts $C_1, C_2, ..., C_n$ of C.

- Semantic *composition*: the actual computation of the meaning M from the meanings $M_1, M_2, ..., M_n$.

Throughout the discussion in section 2, it was implicitly assumed that flat interpretation of an n-ary multiple coordination requires the coordinator to denote an n-ary operator. Thus, it was assumed that in an n-ary multiple coordination, semantic composition works "in one fell swoop": the n-ary operator applies to the meanings of the n conjuncts, which immediately derives the meaning of the whole coordination. Thus, the flat interpretation of the coordination in (65) below (=(6a)) was analyzed using the trinary operator in (65a) and without any nesting as in (65b).

(65) [big, small or middle-sized]

a. $\sqcup^3(\mathbf{big}, \mathbf{small}, \mathbf{middle\text{-}sized})$

b. $\sqcup^2(\mathbf{big}, \sqcup^2(\mathbf{small}, \mathbf{middle\text{-}sized}))$

However, when we assume flat interpretation it is not necessary to assume that meaning composition also works in this "flat" manner. An alternative way, which is the one I propose here, is to use only binary operators in the interpretation process. Thus, we will assume that the coordinator in such multiple coordinations is uniformly binary, and the compositional mechanism makes sure that this binary operator applies as many times as necessary to get the coordinate structure interpreted. The nested meaning in (65b) above will therefore be derived compositionally from a flat structure as in (65), or more generally, from any other structure of multiple coordination that undergoes flat interpretation. Furthermore, as we shall see below, the non-directionality of semantic composition will allow us to derive meanings using all the permutations of the conjuncts, independently of their linear order.

This leaves us with two questions to answer:

1. How precisely does the compositional mechanism interpret n-ary coordinations using binary operators, and how can this account for the effects that were discussed in section 4?

2. What does this treatment imply for the semantic differences between multiple coordinations and RC-coordinations that were reviewed in section 3?

The first question will be addressed in the remainder of this section. The answer to the second question will be based on distinguishing between purely semantic operators like type shifting and predicate distribution, and operators that belong in syntax-semantics interface. I will suggest that operators of the former kind can apply at any point in the composition process, hence to any semantic sub-unit of a multiple coordination. By contrast, operators at the syntax-semantics interface are syntactically triggered, and therefore cannot apply to semantic sub-units that have no syntactic correlates. This distinction will be used in section 6 when analyzing the data of section 3.

Let us first elaborate on the way in which semantic composition is assumed to apply in multiple coordination. We assume the following rule of semantic composition.

(66) **Multiple Composition** (MC): Let op be a binary operator, and let $x_1, x_2, ..., x_n$ be a sequence of denotations, where $n \geq 3$. Assume that the composition of op with $x_2, ..., x_n$ is recursively well-defined and derives the denotation Y. Then the composition of op with $x_1, x_2, ..., x_n$ is defined as the composition of op with x_1 and Y.

The MC rule allows us to recursively apply binary operators to any number of operands. In section 7 it will be shown that this rule is derived from the rule of *pointwise application* with tuples of product types, as proposed in Winter (1995). Pointwise application was proposed independently of multiple coordinations, for treating the semantics of "wide scope" conjunction and disjunction (see sections 3 and 6). Thus, as will be suggested in section 7, the MC rule may be understood within a wider context of product types in categorial semantics.

Let us see how the MC rule works in a simple multiple coordination like (65) above. Assuming flat interpretation and binary semantic operators, the syntax sends the following denotations for semantic composition.

(67) $\mathbf{big}$, $\mathbf{small}$, $\sqcup^2$, $\mathbf{middle\text{-}sized}$

Assuming that meaning composition is non-directional, any ordering of these denotations should be examined in the composition process. Especially, the $\sqcup^2$ operator can compose with the denotations $\mathbf{small}$ and $\mathbf{middle\text{-}sized}$, which leads to the meaning $Y = \sqcup^2(\mathbf{small}, \mathbf{middle\text{-}sized})$. By definition of the MC rule, this allows the derivation of the following meaning using the $\sqcup^2$ operator:

(68) $\sqcup^2(\mathbf{big}, Y) \ = \ \sqcup^2(\mathbf{big}, \sqcup^2(\mathbf{small}, \mathbf{middle\text{-}sized}))$ = (65b) above

Other orders for composing the denotations are possible as well, but in this associative case they lead to equivalent meanings.

As we saw in section 4, this associativity may disappear when dealing with Argument Raising and Predicate Distribution in multiple coordinations. Consider sentence (46a), restated below.

(69) Mary sought, found and ate a fish.

Using the MC rule, we can now allow flat interpretation of such multiple coordinations. This means that the following sequence of denotations are simultaneously sent for composition when interpreting the coordination in (69).

(70) $\mathbf{seek},\ \mathbf{find},\ \sqcap^2,\ \mathbf{eat}$

Similarly to the derivation above, this allows the binary $\sqcap^2$ operator to compose with the denotations $\mathbf{find}$ and $\mathbf{eat}$, which leads to the meaning $Y = \sqcap^2(\mathbf{find}, \mathbf{eat})$. But now, Y is of type $e(et)$, which cannot combine with the type of the intensional verb *seek* using the conjunction operator. According to Partee and Rooth's conception of type shifting, this situation of "type mismatch" allows the application of the Argument Raising operator to the denotation Y. What we get is the following meaning, which is the desired one.

(71) $\sqcap^2(\mathbf{seek}, \mathrm{AR}(Y)) \ = \ \sqcap^2(\mathbf{seek}, \mathrm{AR}(\sqcap^2(\mathbf{find}, \mathbf{eat})))$ as in (48b) above.

Note that in this derivation using the MC rule, the two pairs of denotations to which the two occurrences of the $\sqcap^2$ operator apply are of different types. This may seem strange, since these two occurrences of the conjunction operator result from the same *and*.[20] However, this is not expected to be a problem in a system where conjunction and disjunction are truly polymorphic operators (e.g. Emms (1991)) or untyped abstract Boolean operations (e.g. Keenan and Faltz (1985)). See more on this point in section 7.

Assuming that the compositional mechanism is non-directional, we also have other readings of the multiple coordination in (69) using the MC rule. The two associations of the conjunction for each of the six permutations of the conjuncts lead to the following readings, where all the conjunction operators are binary.

(72) a. $\sqcap(\mathbf{seek}, \mathrm{AR}(\sqcap(\mathbf{find}, \mathbf{eat}))) = \sqcap(\mathbf{seek}, \mathrm{AR}(\sqcap(\mathbf{eat}, \mathbf{find}))) =$
$\sqcap(\mathrm{AR}(\sqcap(\mathbf{find}, \mathbf{eat})), \mathbf{seek}) = \sqcap(\mathrm{AR}(\sqcap(\mathbf{eat}, \mathbf{find})), \mathbf{seek})$
= (71), the "one fish" analysis

[20]This is not quite the situation in Winter's (1995) conception, where *and* in meaningless and logical conjunction is a syncategorematic process. However, the general point about polymorphic operators equally hold for disjunction.

b. $\sqcap(\sqcap(\mathbf{seek}, \mathrm{AR}(\mathbf{find})), \mathrm{AR}(\mathbf{eat})) = \sqcap(\sqcap(\mathrm{AR}(\mathbf{find}), \mathbf{seek}), \mathrm{AR}(\mathbf{eat})) =$
$\sqcap(\mathrm{AR}(\mathbf{eat}), \sqcap(\mathbf{seek}, \mathrm{AR}(\mathbf{find}))) = \sqcap(\mathrm{AR}(\mathbf{eat}), \sqcap(\mathrm{AR}(\mathbf{find}), \mathbf{seek})) =$
$\sqcap(\sqcap(\mathbf{seek}, \mathrm{AR}(\mathbf{eat})), \mathrm{AR}(\mathbf{find})) = \sqcap(\sqcap(\mathrm{AR}(\mathbf{eat}), \mathbf{seek}), \mathrm{AR}(\mathbf{find})) =$
$\sqcap(\mathrm{AR}(\mathbf{find}), \sqcap(\mathbf{seek}, \mathrm{AR}(\mathbf{eat}))) = \sqcap(\mathrm{AR}(\mathbf{find}), \sqcap(\mathrm{AR}(\mathbf{eat}), \mathbf{seek}))$
= the "possibly two fish" analysis

One possible objection to this multitude of equivalent analyses may concern the spurious ambiguity it involves. I do not think this is a real problem. There is no *a priori* reason to think that spurious ambiguity with multiple coordination should be less severe than what is derived by ordinary scope mechanisms for simple sentences like *John gave a book to Mary* (six or more equivalent readings).

A potentially more serious objection to the analysis in (72) may concern the questionable status of the "possibly two fish" analysis in (72b) as a reading for (69). However, I do not think that such a criticism of the present proposal would be too strong either. The reason is that, before declaring that all the analyses in (72) are equally acceptable interpretations of sentence (69), we should consider at least two factors. First, as is well-known, the linear order of the conjuncts in a conjunction has strong implications for the temporal order of actions they report. In sentence (69), the search of a fish is strongly understood as preceding the finding, and finding is understood as preceding the eating. Taking temporal order into account leaves us with only two preferred analyses of (69):

(73) a. Right-association: Mary sought a fish, and then, she found and then ate a fish.

b. Left-association: Mary sought and then found a fish, and then, she ate a fish.

These two analyses directly correspond to the two agreed-upon readings of the RC-coordination in (55b) (=*Mary sought and found and ate a fish*). But note that while RC-coordinations as in (55b) allow prosody to help in disambiguation, there is no parallel way to phonologically disambiguate multiple coordinations as in (69). Conversely, when (55b) is not phonologically disambiguated, there is little contrast between (55b) and (69): both sentences strongly prefer "one fish" situations. Thus, while P&R's argument in favor of "one fish" readings was supported in section 4 above, I do not think that P&R's argument against the "possibly two fish" reading is a very strong one. Pragmatic factors may conspire to favor the "one fish" *interpretation* when readings of both kinds are available.[21] According to the present proposal, contrasts as in (55) between multiple coordinations and RC-coordinations are due to the fact that in RC-coordinations (55b) there is a prosodic way to disambiguate the sentence and lead to the "possibly two fish" reading, which is the only reading of the left-association intonation. By contrast, due to the lack of structural ambiguity in multiple coordinations, prosodical means can hardly contribute to their semantic disambiguation. In such contexts, as Hendriks (1993) suggests, pragmatic factors may lead us to prefer the "one fish" reading.

Let us now return to VP disjunctions with distributivity as in (59a), restated below.

(74) We are going to invite Mary and Sue to have a sandwich, drink a glass of milk or build a raft together.

Distribution over the first two disjuncts in (74) is treated similarly to Argument Raising over the last two conjuncts in (69) (cf. (70) and (71) above). When interpreting the multiple disjunction in (74), the input to the compositional mechanism is the following sequence of denotations.

[21] Like Hendriks (1993), I believe that this point may have important implications that would go against P&R's "last resort" strategy of type shifting. But as said above, I leave the investigation of this question for further research.

(75) $\mathbf{have\_sandwich}_{et},\ \mathbf{drink\_milk}_{et},\ \sqcup^2,\ \mathbf{build\_raft}_{(et)t}$

We are interested in the analysis where the binary disjunction operator $\sqcup^2$ first composes with the denotations $\mathbf{have\_sandwich}$ and $\mathbf{drink\_milk}$. This leads to the following meaning:

$$Y = \sqcup^2(\mathbf{have\_sandwich}, \mathbf{drink\_milk}).$$

When combining the denotation Y with the denotation of the collective predicate *build a raft together*, the Predicate Distribution operator D can apply to Y. We get the following reading of the multiple disjunction in (74).

(76) $\sqcup^2(\mathbf{build\_raft}, D(\sqcup^2(\mathbf{have\_sandwich}, \mathbf{drink\_milk})))$ as in (62b) above.

As another example for the MC treatment of coordination, reconsider examples (63) and (64), reproduced below.

(77) Every Sunday at four O'clock, Mary and Sue have a sandwich, build a raft together or drink a glass of milk.

(78) Every Sunday at four O'clock, Mary and Sue have a sandwich or build a raft together or drink a glass of milk.

In sentence (77) we see evidence for the operation of MC within a non-directional compositional mechanism: in order to let Predicate Distribution take scope over the distributive disjuncts but not over the collective disjunct, as in (76) above, the meaning of the disjuncts in (77) have to be permuted so that the meaning of *have a sandwich* is interpreted adjacent to the meaning of *drink a glass of beer*. Similarly, sentence (78) is evidence that the flat interpretation strategy may even be needed for RC-coordinations: in order to compositionally allow permutation in (78) and derive a reading parallel to (76), there has to be a reading of (78) where the three disjuncts are interpreted at the same level. Thus, I assume that RC-coordinations like (78) can also undergo flat interpretation, in addition to the nested binary interpretation that has to be assumed by virtually any syntactic and semantic theory of coordination.

6 Accounts of multiple coordination vs. RC-coordination

The compositional mechanism that was described in the previous section employs flat interpretation of multiple coordinations using the proposed rule of Multiple Composition. Let us call this proposal the *MC strategy*. This strategy derives a superset of the analyzes that are derived by simpler procedures. As we have seen, in this way we can derive readings of multiple coordinations that are not derived by the flat n-ary interpretation of section 2. However, we should now be careful to make sure that the MC strategy does not overgenerate, and that while getting closer to nested interpretation it still respects the distinctions of section 3 between multiple coordinations and RC-coordinations. To do that, we should consider different semantic theories of the relevant phenomena and check their analysis of multiple coordinations and RC-coordinations using the MC strategy. Because of the variety of the phenomena discussed in section 3, there are quite a few theories that need to be considered. Some of these theories do not capture the contrasts between multiple coordination and RC-coordination using any of the interpretation procedures discussed in this paper. But this section will show that most of those semantic theories that do capture these contrasts are not affected by the proposed MC strategy.

6.1 Collective DP conjunctions

Reconsider the contrasts in (11) and (12), and the similar contrast in (13) that is restated below.

(79) a. Mary and Sue and this man had a baby.

b. #Mary, Sue and this man had a baby.

We address five treatments of such examples: cover/partition mechanisms, ambiguous boolean/non-boolean conjunction, unambiguous (boolean) conjunction, and two usages of group formation operators.

Covers or partitions Many recent theories of plurals (e.g. Schwarzschild (1996)) take distributivity to be governed by pragmatically-induced operators based on *covers*, *partitioning* or *cumulation*. Independently of their exact formulation, such theories normally use a simple i-sum formation operator (Link (1983)) as the meaning of *and* in (79). The associativity and commutativity of this operator entail that independently of their interpretation procedure, the subjects of (79a) and (79b) are coreferential. In both (79a) and (79b), the context may allow a "cover" or a "partition" of the subject where Mary is in one cell and Sue and the man are in another cell. Even a cover like $\{$Mary,Sue$\}$ and $\{$this man$\}$, with no parallel in surface constituents, is allowed for both sentences in (79). Thus, theories that are based on covers, partitions or cumulation cannot account for contrasts as in (79) using semantic principles alone.[22] These proposals may take contrasts as in (79) to be pragmatic only, independently of whether we use flat interpretation or nested interpretation of multiple coordination. Other theories, to which we now turn, can more easily account for such contrasts using flat interpretation of multiple conjunctions.

Ambiguous *and* A systematic proposal for the ambiguity of *and* in DP conjunctions was developed by Hoeksema (1983,1988), and adopted by many others. It is often assumed that *and* can either be interpreted as a boolean intersection of quantifiers or as an i-sum formation operator.[23] Both these binary operators can be extended to multiple conjunction using the MC rule. Let us denote the binary i-sum formation operator between e-type entities by '$\oplus$', and let $L = \lambda x_e.\lambda P_{et}.P(x)$ denote the type lifting operator from entities to generalized quantifiers. Because of the associativity and commutativity of both meanings of *and* under this account, there are two meanings for the subject of (79b) that are derived using the MC strategy.

(80) a. $\sqcap(L(\mathbf{mary}), \sqcap(L(\mathbf{sue}), L(\mathbf{this\_man})))$

b. $\oplus(\mathbf{mary}, \oplus(\mathbf{sue}, \mathbf{this\_man}))$

In the lack of any cover-based distributivity mechanism, these analyses lead to the totally distributive and totally collective interpretations of (79b), respectively. Both interpretations are infelicitous. By contrast, in (79a) the prominent reading can be analyzed using two different *and*'s. The structure *Mary and [Sue and this man]* can get the following interpretation, where *Sue and this man* is interpreted collectively using the i-sum operator, but the main conjunction is interpreted "distributively", using the intersective operator and type lifting.

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[22] Beck and Sauerland (2001) make some claims against Winter's (2000a) rebuff of covers as a polyadic distributivity mechanism. However, Beck and Sauerland do not address contrasts as in (11)-(13), which uses to argue against "non-atomic" distribution using covers or similar mechanisms. For other claims against covers see Lasersohn (1995:p.165), who uses examples with multiple conjunctions as in the following sentence: *John, Mary and Bill were paid exactly $14,000 last year.*

[23] The proposal that *and* is interpreted using a group/set formation operator is discussed below.

(81) $\sqcap(L(\mathbf{mary}), L(\oplus(\mathbf{sue}, \mathbf{this\_man})))$

This captures the intuitive contrast between (79a) and (79b).[24]

Uniformly boolean *and* The uniform theory of boolean *and* proposed in Winter (2001) uses the flat interpretation of multiple coordination for contrasts as in (79). The relevant meaning of (79a) is derived by applying a collectivity operator C to the two main conjuncts, which denote generalized quantifiers.[25]

(82) $\sqcap(C(L(\mathbf{mary})), C(\sqcap(L(\mathbf{sue}), L(\mathbf{this\_man}))))$

Winter (2001:ch.4) argues that the application of the C operator is triggered by the syntax of the DP – by an empty syntactic element or some other triggering mechanism that combines with a syntactic constituent of category D' within the DP. This D' constituent has to be semantically interpreted itself, which means that under the MC strategy and a flat structure as in figure 1a, the C operator can either apply to the whole conjunction (if the position of C is above the conjunction) or to each conjunct separately (if C appears within each conjunct), but not to a sub-conjunction as in (82).[26]

Nested ontologies – group formation operator Hoeksema (1983) and Link (1984), and more extensively Landman (1989) and Lasersohn (1995), assume a nested ontology for plural individuals, in which conjunctions like *Mary and [Sue and this man]*, under the given structure, can get a "nested" denotation that parallels their structure. Landman achieves such complex denotations by applying a *group formation operator* to the i-sum denotation of simple plurals like *Sue and this man*. Denoting this operator by '$\uparrow$', we get the following analysis of the subject in (79a).

(83) $\oplus(\mathbf{mary}, \uparrow(\oplus(\mathbf{sue}, \mathbf{this\_man}))) = \oplus(\mathbf{mary}, \{\mathbf{sue}, \mathbf{this\_man}\})$

Applying Landman's distributivity operator to this i-sum of Mary and the group for Sue and the man, we get the felicitous reading of (79a). Whether or not we also get a similar reading in (79b) depends on our assumptions about the group formation operator. If it is assumed to be a purely semantic operator, like Argument Raising and Predicate Distributivity in section 5, then the MC strategy would counterintuitively expect similar analyses to (83) also for (79b). However, if group formation is assumed to be reflected in the syntax by some means, then the MC strategy rules out such analyses for (79b) under the flat structure assumption: in a flat analysis of the multiple coordination there is no constituent corresponding to Sue and the man, to which the group formation operator could apply.[27]

[24] It is possible that with two *and*'s we can also account for this contrast using nested interpretation of multiple coordinations. However, such an account would depend on how precisely the meaning of the "missing" coordinator in conjunctions like *Mary, Sue and John* is reproduced from the overt coordinator.

[25] The C operator in Winter (2001) is proposed as a composition of two independently motivated operations: a *minimum* operator and a mechanism of *choice functions*.

[26] Depending on some fine details of this theory, which I will not discuss here, capturing the distinction between multiple coordination and RC-coordination may or may not rely on a syntactic distinction between the two constructions along the lines of figure 1.

[27] Winter (2001:ch.5) uses a version of a group formation operator only for *predicates* over pluralities. Hence, application of this group formation operator in the MC strategy, although not syntactically manifiested, has to rely on having predicative conjuncts in multiple coordinations. This does not allow to derive any felicitous reading parallel to (83).

Nested ontologies – group analysis of *and* Like Landman, also Hoeksema (1983) and Lasersohn (1995) employ a nested ontology of plurals. Unlike Landman, these two works treat the coordinator *and* itself as the group formation operator. Under this treatment, the MC strategy fails to predict the desired difference between (79a) and (79b). If we denote the binary group formation reading of *and* by $\oplus_{\mathcal{G}}$, both (79a) and (79b) get the following analysis using the MC strategy.

(84) $\oplus_{\mathcal{G}}(\mathbf{mary}, \oplus_{\mathcal{G}}(\mathbf{sue}, \mathbf{this\_man})) = \{\mathbf{mary}, \{\mathbf{sue}, \mathbf{this\_man}\}\}$

In (79a) this felicitous analysis is derived directly from the syntactic structure. However, the application of the MC rule infelicitously derives this analysis also for (79b). Distribution over groups as in Lasersohn (1995) would allow (79b) to get the same felicitous interpretation as (79a). Importantly, no similar problem would arise if (79b) were not analyzed using the MC strategy but rather by the n-ary flat interpretation of section 2. This is because a trinary group formation operator in (79b) would only derive the group $\{\mathbf{mary}, \mathbf{sue}, \mathbf{this\_man}\}$ with no division to subgroups. See also the discussion in subsection 6.4 below of Lasersohn's group-based semantics of alternation.

6.2 Wide scope conjunction

Reconsider the contrast in (16), restated below, and the similar contrasts in (17) and (18).

(85) a. You're not allowed to sing aloud and dance and stamp your feet.

b. You're not allowed to sing aloud, dance and stamp your feet.

As we have seen, (85a) has a reading where two things are disallowed: singing aloud and dancing while stamping your feet. No parallel reading appears in (85b). Three possible accounts of this phenomenon are discussed below: the scope of negation account of Oehrle (1987), the tuple-based account of Winter (1995), and a "deletion" approach.

Scope of negation Oehrle's paper mainly deals with gapping constructions like *Mrs. J. cannot live in Boston and Mr. J. in LA*. His account of the ambiguity in such cases can be applied to binary conjunctions as in (86) below. Adopting the proposal in Oehrle (1987:pp.227-8), we can assume that ambiguity in such cases results from two possible scopes for the negation: over the modal alone, or over the modal plus the infinite verb phrase. This is illustrated in (86a) and (86b).

(86) You're not allowed to dance and stamp your feet.

a. $(\mathbf{not}(\mathbf{allowed}))(\sqcap(\mathbf{dance}, \mathbf{stamp\_feet}))$

b. $\mathbf{not}(\mathbf{allowed}(\sqcap(\mathbf{dance}, \mathbf{stamp\_feet})))$

According to Oehrle's definition of negation, (86a) prohibits a simultaneous truth of both conjuncts *dance* and *stamp your feet*, whereas (86b) prohibits each of the two actions independently. However, this account alone cannot capture the contrast between (85a) and (85b), at least as long as the two conjunctions in these two sentences are assumed to be synonymous. Oehrle's account locates the ambiguity outside the conjunction, and therefore, without further assumptions each of the two sentences in (85) would only get interpretations equivalent to the following two meanings, independently of how the multiple coordination in (85b) is interpreted.

(87) a. $(\mathbf{not}(\mathbf{allowed}))(\sqcap(\mathbf{sing}, \sqcap(\mathbf{dance}, \mathbf{stamp\_feet})))$

b. $\mathbf{not}(\mathbf{allowed}(\sqcap(\mathbf{sing}, \sqcap(\mathbf{dance}, \mathbf{stamp\_feet}))))$

Tuple-based account Winter (1995) treats cases of "wide scope" conjunction by analyzing conjunctions as ordered pairs, and allowing functions to apply to each part of the pair separately. More details on this account are reviewed in section 7 below. When considering examples like (86) above, there are intuitively two options: to apply binary conjunction to the ordered pair directly, or to apply binary conjunction to the result of applying the modal verb pointwise, to each member of the pair. These two options lead to the narrow scope and wide scope readings of the conjunction, respectively, as in the two analyses below.

(88)

a.

$$\frac{\mathbf{not}(\mathbf{allowed}) \quad \dfrac{\sqcap \quad \dfrac{\mathbf{dance},\mathbf{stamp\_feet}}{\langle \mathbf{dance},\mathbf{stamp\_feet}\rangle}}{\sqcap(\mathbf{dance},\mathbf{stamp\_feet})}}{(\mathbf{not}(\mathbf{allowed}))(\sqcap(\mathbf{dance},\mathbf{stamp\_feet}))}$$

b.

$$\frac{\sqcap \quad \dfrac{\mathbf{not}(\mathbf{allowed}) \quad \dfrac{\mathbf{dance},\mathbf{stamp\_feet}}{\langle\mathbf{dance},\mathbf{stamp\_feet}\rangle}}{\langle(\mathbf{not}(\mathbf{allowed}))(\mathbf{dance}),(\mathbf{not}(\mathbf{allowed}))(\mathbf{stamp\_feet})\rangle}}{\sqcap((\mathbf{not}(\mathbf{allowed}))(\mathbf{dance}),(\mathbf{not}(\mathbf{allowed}))(\mathbf{stamp\_feet}))}$$

Getting back to the contrast in (85), the RC-coordination in (85a) can be analyzed as follows, by applying boolean conjunction to the last two conjuncts, but combining the result with the first conjunct using tuple formation.

(89) $\langle \mathbf{sing}, \sqcap(\mathbf{dance},\mathbf{stamp\_feet})\rangle$

Applying *not allowed* to both parts of this pair (and boolean conjunction of the results), leads to the reading of (85a) that disallows singing, as well as dancing while stamping your feet. By contrast, in (85b), the MC strategy leaves us with only two options. One option is to apply *not allowed* to a triplet,[28] which leads to the reading where you are not allowed to do the three things independently of each other. Another option is to let the conjunction operator apply to the triplet, but then the MC rule (66) entails that we only get interpretations of (85b) that are equivalent to the meaning in (87a) above. This means that the contrast in (85) is respected.

A similar point holds with respect to any theory that would assume that cases like (86) can be interpreted using "deletion" of *not allowed* in the second conjunct. In (85b), the parallelism of deletion operators (see e.g. Merchant (2001)) may be used to make syntactic instances of *not allowed* in (85b) appear either in all three conjuncts or in no one of them. This again would capture the contrast in (85), at least using flat structures as in figure 1a.[29]

6.3 Wide scope disjunction

Reconsider the contrast in (20), restated below.

(90) a. John is looking for a partner or a maid or a cook (but I don't know which).

b. John is looking for a partner, a maid or a cook (but I don't know which).

Larson (1985) proposes a mechanism that syntactically regulates the scope of *or*. Using this treatment of (90a), one of the options is to give the second *or* wide scope over the intensional predicate. This leads to a logical form along the lines of the following representation.

(91) John is *or*$_i$ [looking for [[a partner] e_i [a maid or a cook]]]

[28] Formally, as in section 7 below, this does not have to be a triplet, but also a Curried pair $\langle A, \langle B, C\rangle\rangle$.

[29] Whether or not the contrast would be captured also using nested structures as in figure 1b would depend on specific syntactic assumptions on parallelism in such structures.

According to the semantic proposal in Winter (2000b), such structures are interpreted using tuples, similarly to the examples of wide scope conjunction discussed above, which leads to the desired analysis. By contrast, a flat structure of the disjunction in (90b) only leads to two representations, or their semantic equivalents:

(92) a. John is looking for [*or*$_i$ [[a partner] [a maid] e_i [a cook]]]

b. John is *or*$_i$ [looking for [[a partner] [a maid] e_i [a cook]]]

The structures in (92a-b) lead to the narrow/wide scope reading, respectively, of the disjunction with respect to the verb *look for*. The account here is based on the flat structure assumed for the disjunction, and it is not affected by the MC strategy.[30] Hence, the contrast between (90a) and (90b) is accounted for.

As with respect to WS conjunction, deletion accounts of WS disjunction can also account for contrasts as in (90) using flat structure for the disjunction and the parallelism assumption on deletion. See Schwarz (1999) for a deletion analysis of *either...or* that challenges Larson's proposal.

6.4 Adverbs of alternation and VP conjunction

Reconsider the contrast in (21), restated below, and the similar contrasts in (22)-(26).

(93) a. Mary alternately looks relaxed and tired and exhausted.

b. (?)Mary alternately looks relaxed, tired and exhausted.

I'll consider two treatments of such cases: the group analysis of *and* in Lasersohn (1995) and the tuple-based account of Winter (1995).

Group-of-events analysis of *and* Consider the following simple example.

(94) Mary was alternately tired and exhausted.

Lasersohn assumes that adjectives like *tired* and *exhausted* denote relations between individuals and events.[31] Further, he assumes that the conjunction *tired and exhausted* denotes a relation between the individuals x and the groups of events $e = \{e_1, e_2\}$ such that x stands in the *tired* relation to e_1 and in the *exhausted* relation to e_2. Formally:

(95) $[\![\text{tired and exhausted}]\!] = \lambda e.\lambda x.\exists e_1, e_2[e = \{e_1, e_2\} \wedge \mathbf{tired}(e_1)(x) \wedge \mathbf{exhausted}(e_2)(x)]$

Using this denotation for the conjunction in (94), Lasersohn is able to derive an intuitively correct semantics for the temporal alternation in the sentence.

When we apply Lasersohn's treatment to (93a) we get the following analysis for the conjunction.

(96) $\lambda e.\lambda x.\exists e', e''[e = \{e', e''\} \wedge \mathbf{relaxed}(e')(x) \wedge [\![\text{tired and exhausted}]\!](e'')(x)$

[30] How nested structures for multiple coordinations would be treated under Larson's account would depend on syntactic assumptions about whether and how the "missing" coordinator in (85b) is represented.

[31] More accurately, Lasersohn uses a neo-Davidsonian analysis of events, where a Θ-role operator mediates between the event and the individual. Here I ignore this aspect of his analysis.

Applying Lasersohn's definition of temporal alternation to this denotation entails alternation between e' and e''. Hence, no alternation is required in this analysis between *tired* and *exhausted*, a result which is intuitively welcome for (93a). However, using the MC strategy we can apply Larsersohn's group formation treatment of *and* in a way that derives the analysis (96) also for (93b). This is intuitively problematic. As with the group-based approaches discussed in subsection 6.1, the problem would not reappear for Lasersohn's approach if in (93b) we used a trinary interpretation of *and* instead of the MC strategy.

Tuple-based account Winter's (1995) account of cases like (94) is based on forming an ordered pair of the two conjuncts and applying *alternately*, with the proper semantics, to that pair. For this semantics to be well-defined, both members of the pair should be temporal denotations of adjectives: functions from temporal entities to sets of individuals. For instance, the denotation of *tired* in (94) should be a function from temporal entities t to the set of individuals who are tired at t. Thus, denoting the type of temporal entities by T, the type of the conjunction *tired and exhausted* in (94) is the product type $(T(et)) \bullet (T(et))$. Only this type allows interpretation of *alternately* in the sentence.

Moving on to (93), Winter's system can analyze (93a) by applying binary boolean conjunction to the sub-constituent *tired and exhausted*. Formally, this is illustrated below.

(97) $[\![\text{tired and exhausted}]\!]$

$= \sqcap(\mathbf{tired}_{T(et)}, \mathbf{exhausted}_{T(et)})$

$= \lambda t.\lambda x.\mathbf{tired}(t)(x) \wedge \mathbf{exhausted}(t)(x)$

This allows the derivation of the pair $\langle \mathbf{relaxed}, [\![\text{tired and exhausted}]\!]\rangle$, of type $(T(et))\bullet(T(et))$, to the tripartite conjunction in (93a), which is the type required for the argument of *alternately*. The resulting alternation is, as required, between two states: relaxation on the one hand and (simultaneous) tiredness and exhaustion, on the other hand.

Moving on to (93b), the MC strategy allows to interpret the multiple conjunction using the binary operator $\sqcap$, but it has no way of deriving a pair of $T(et)$ denotations from the triplet denoted by *relaxed, tired and exhausted*. Thus, using Winter's optional introduction of $\sqcap$ there are only two options: (i) simultaneous relaxation, tiredness and exhaustion – when $\sqcap$ is introduced; or (ii) three-way alternation (for speakers who accept it) – when the triplet is given as an argument to *alternately*. This is the intuitively required distinction between (93a) and (93b).

6.5 DP-internal conjunction

Reconsider the contrast in (31), restated below, and the similar contrasts in (32)-(34) above.

(98) a. I met yesterday that biographer and friend and colleague of Richard.

b. I met yesterday that biographer, friend and colleague of Richard.

As we saw, sentence (98a) allows a reading with two-people: one person a biographer, the other a friend and colleague of Richard. Sentence (98b) only admits a one-person reading and a three-people reading. I will address two approaches to the interpretation of sentences as in (98). Ambiguity of *and* as proposed in King and Dalrymple (2004), and the "set-product" account of Heycock and Zamparelli (2005).[32]

[32] I here ignore the proposal in Winter (1995), where cases like *every man and woman* are treated as cases of wide scope conjunction. Heycock and Zamparelli (2005) correctly argue that this proposal cannot extend to cases

Unambiguous *and* – set product Heycock and Zamparelli propose a definition of the semantics of *and* in constructions like *the man and woman*, which they call *set product*. Their definition is along the lines of the following definition.[33]

(99) $SP(A, B) = \{a \oplus b : a \in A \wedge b \in B\}$

In a DP like *the man and woman*, the *SP* operator leads to a reading that can roughly be paraphrased by: "the unique i-sum that contains a man and a woman". Because of the associativity of the *SP* operator, it generates only one reading for both sentences in (98). As a result, the contrast between them is not semantically accounted for. This is similar to the situation with cover-based theories of plurals discussed in subsection 6.1, so far as they rely exclusively on the associative i-sum operator.

Ambiguous *and* King and Dalrymple (2004:pp.75-76) propose that "split"/"joint" contrasts in DP-internal conjunction are due to a lexical ambiguity of *and*. For the "split" reading, King and Dalrymple assume a "group forming" interpretation of *and* in nominal conjunctions like *this boy and girl*. King and Dalrymple do not specify the details of this proposed analysis. One easy way to get such a reading of *and* is to replace the i-sum operator $\oplus$ in the definition of *SP* ((99) above) by the group formation operator $\oplus_{\mathcal{G}}$. I expect that this would lead to similar problems for the MC strategy that were discussed in subsection 6.1 in relation to Lasersohn's group-formation account of *and*, but I will not develop this point in detail here. On the other hand, along the lines of other ambiguity theories of *and*, King and Dalrymple's ambiguity assumption could be changed so that *and* is ambiguous between the boolean reading and Heycock and Zamparelli's associative *SP* operator (based on the i-sum operator). Under this ambiguity assumption, the MC strategy would derive the following readings for (98a) and (98b), respectively.

(100) a. $\sqcap(B, \sqcap(F, C))$, $SP(B, \sqcap(F, C))$, $\sqcap(B, SP(F, C))$, $SP(B, SP(F, C))$
b. $\sqcap(B, \sqcap(F, C))$, $SP(B, SP(F, C))$

The reading $SP(B, \sqcap(F, C))$ of (98a) allows situations with two people: one a biographer, the other both a friend and a colleague. This situation is only marginally allowed by the reading $SP(B, SP(F, C))$ that (98a) shares with (98b).[34] As a result, ambiguous *and* may be used for describing the contrast in (98) using the MC strategy, similarly to the boolean/i-sum ambiguity account of *and* discussed in subsection 6.1.

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like *that man and woman*, which I did not treat in Winter (1995) because of its different cross-linguistic status as compared to cases like *every man and woman*. This cross-linguistic difference is the point of departure for King and Dalrymple (2004) and Heycock and Zamparelli (2005). A discussion of the challenges that DP-internal conjunction poses for Winter's (2001) unified boolean assumption on *and* is left for another occasion.

[33] Simplifying, I here use the i-sum operator instead of H&Z's set union operator, and I do away with H&Z's generalization to the n-ary case, which is unnecessary in the MC strategy. Similar definitions to H&Z's were proposed in Link (1983) and Krifka (1990).

[34] "Marginally allowed" has to do with a general weakness of H&Z's proposal. Their definition of the *SP* operator leads to unwelcome uniqueness restrictions in definite DPs with DP-internal conjunctions. For instance, supposing that Richard has a unique biographer but two friends (or more), uniqueness is not satisfied for the doubleton $SP(B, F) = \{\oplus(b, f_1), \oplus(b, f_2)\}$. As a result, conjunctions like *the (only) biographer and friend of Richard* are expected to be inappropriate in such situations, contrary to judgements of my English informants. Thus, according to H&Z's proposal, the reading $SP(B, SP(F, C))$ for a definite like *the biographer, friend and colleague of Richard* can allow a two-people situation if (and only if!) Richard has exactly one biographer, exactly one friend and exactly one colleague, where exactly two of them are the same person.

6.6 "Left-subordinating" *and*

Consider the following contrast, restated from (36) and (37).

(101) a. You drink another can of beer and Bill eats more pretzels, and I'm leaving.

b. ?You drink another can of beer, Bill eats more pretzels, and I'm leaving.

Culicover and Jackendoff's (2005:ch.13) discussion tentatively assumes ambiguity of *and* between the common "coordination" meaning, and a "left-subordination" meaning similar to the meaning of conditionals. As in most other ambiguity treatments of *and* that were discussed in this section, Culicover and Jackendoff's assumption can be used to account for contrasts as in (101) using the MC strategy.

6.7 Summary: associativity and the MC strategy

The contrasts between multiple coordination and RC-coordination, and the ways in which the MC strategy allows (or disallows) different theories to deal with them, are summarized in table 1. This table strengthens the claim of section 3, that flat interpretation is advantageous to nested interpretation in being able to derive the semantic differences between multiple coordination and RC-coordination.

Phenomenon:Theory	**Interpretation**	
	flat	nested
Collective DP conjunctions:		
covers	$\times$	$\times$
ambiguous *and* (boolean/i-sum formation)	$\surd$	$\surd^1$
unambiguous *and* (boolean)	$\surd$	$\times$
group formation operator	$\surd^2$	$\times$
group analysis of *and*	$\times$(!)	$\times$
Wide scope conjunction:		
scope of negation	$\times$	$\times$
tuple-based account	$\surd$	$\times$
deletion	$\surd$	?
Wide scope disjunction:		
scope of coordinator	$\surd^3$	?
deletion	$\surd$	?
Adverbs of alternation and VP conjunction:		
group-of-events analysis of *and*	$\times$(!)	$\times$
tuple-based account	$\surd$	$\times$
DP-internal conjunction:		
set product	$\times$	$\times$
ambiguous *and* (boolean/i-sum set product)	$\surd$	$\surd^1$
"Left-subordinating" *and*:		
ambiguous *and* (boolean/LS)	$\surd$	$\surd^1$

$\surd/\times$ semantic contrast/no semantic contrast between multiple coordination and RC-coordination

$\surd^1$ depending on the strategy for resolving the ambiguity

$\surd^2$ relying on a flat structure and on a syntactic triggering of the group formation operator

$\surd^3$ relying on a flat structure for the multiple disjunction

(!) the MC strategy fails but n-ary flat interpretation does not

Table 1: **the MC strategy in contrasts between multiple and RC coordination**

Furthermore, from this table and the discussion above we can draw some conclusions about the common aspects to those cases where the MC strategy makes the necessary distinction between multiple coordination and RC-coordination. These are the cases where non-associativity effects with RC-coordination are assumed to be triggered its nested syntax. On the other hand, we have seen three cases where the semantics alone was assumed to be responsible for non-associativity effects with RC-coordination: group formation, type shifting, and distributivity operations. In such cases the results of the MC strategy for multiple coordinations lead to different results than their n-ary flat interpretation. When the non-associative operators are purely semantic, the MC strategy expects non-associative effects with multiple coordinations that are similar to non-associativity with RC-coordinations. As argued in section 4, this is desired in cases that involve semantic operations of type shifting and distributivity. In this section, however, similar non-associative effects were shown to be undesired in cases where purely-semantic group formation operators are assumed without syntactic triggering. If group formation operators are to be used, their syntactic triggering is required by the MC strategy. This dissociation between pure semantic operations and semantic operations at the syntax-semantics interface, and the subtle differences that it makes for the outcomes of the MC strategy, are at the heart of the proposal in this paper.

7 Multiple coordination as a "wide scope" phenomenon, and the polymorphism assumption

At an intuitive level, there is a relation between multiple coordination and wide scope coordination, which can be illustrated by the following two "equations".

(102)	*look for* [a maid or a cook]	$\cong$	[*look for* a maid] or [*look for* a cook]	(WS *or* reading)
(103)	Mary, John *or* Sue	$\cong$	[(*or*) Mary] [*or* John] [*or* Sue]	

In both examples, the italicized material in the expression on the left is duplicated for each of the disjuncts in the rightward paraphrase.[35] In this section I will briefly show some formal correspondences between the rule of *Pointwise Application* that was used in Winter (1995,1998) for treating wide scope coordination, and the Multiple Composition (MC) rule of section 5. I believe that this formal relation may point to a potentially important theoretical relation between the two phenomena.

In its most specific (Curried) form, the rule of Multiple Composition (MC) in (66) can be seen as the following type theoretical axiom, with the corresponding semantics.

(MC) $\alpha(\alpha\alpha), \alpha^{(1)}, \alpha^{(2)}, ..., \alpha^{(n)} \vdash \alpha,$ where $n \geq 2$

$$\mathsf{op}, x_1, x_2, ..., x_n \Rightarrow (\mathsf{op}(x_1))((\mathsf{op}(x_2))((\mathsf{op}(\ldots))(\mathsf{op}(x_{n-1}, x_n))\ldots))$$

In words: any binary operator of the (Curried) type $\alpha(\alpha\alpha)$ can combine with any number $n \geq 2$ of operands of type α using right association. If the compositional mechanism is non-directional, as we assume, then right-association does not lead to any loss in generality.

Without getting deeply into the possible categorial systems within which the MC rule can be derived, I would like to point out its relations with the "resource duplicating" rule that I

[35] Note that in English, an initial coordinator like the '(*or*)' in (103) is ungrammatical. But this is typically the standard case in many languages (cf. Haspelmath (2004)). Possible (cross-linguistic) semantic distinctions between the 'bisyndetic', 'monosyndetic' and 'asyndetic' paradigms of coordination (using Haspelmath's terminology) is a potentially fascinating subject for further research.

used in Winter (1995,1998) for treating coordinations. This rule, called *Pointwise Application* (PA), is used for allowing a tuple of the product type $\alpha \bullet \alpha$ to combine with a function of type $\alpha\beta$, by duplicating the function so to derive a tuple of the product type $\beta \bullet \beta$. Formally, and slightly generalizing, this rule, with the corresponding semantics, is defined in sequent format as follows.

$$\text{(PA)} \quad \frac{\Gamma_1 \vdash \gamma \quad \Gamma_2 \vdash \alpha \bullet \alpha \quad \gamma, \alpha \vdash \beta}{\Gamma_1, \Gamma_2 \vdash \beta \bullet \beta} \qquad \frac{X_1 \Rightarrow z \quad X_2 \Rightarrow \langle x_1, x_2 \rangle \quad z, x_1 \Rightarrow y_1 \quad z, x_2 \Rightarrow y_2}{X_1, X_2 \Rightarrow \langle y_1, y_2 \rangle}$$

Here and below: Γ_1 and Γ_2 are type-sequences and X_1 and X_2 are sequences of denotations. The PA rule says that an operator z that can combine with x_1 to derive y_1 and with x_2 to derive y_2, can also combine with the pair $\langle x_1, x_2 \rangle$ to derive the pair $\langle y_1, y_2 \rangle$.

The PA rule is used in for deriving "wide scope" effects of conjunction and disjunction (cf. subsections 6.2 and 6.3). As an example, consider the wide scope disjunction in *look for a maid or a cook*. After a separate rule determines the scope of the disjunctive coordinator over *look for*, the rest of the derivation is as follows, in natural deduction format.

$$\dfrac{\sqcup^2 \quad \dfrac{\mathbf{look\_for} \quad \dfrac{\mathbf{maid}, \mathbf{cook}}{\langle \mathbf{maid}, \mathbf{cook} \rangle}\,TF}{\langle \mathbf{look\_for}(\mathbf{maid}),\ \mathbf{look\_for}(\mathbf{cook}) \rangle}\,PA}{\sqcup^2(\mathbf{look\_for}(\mathbf{maid}),\ \mathbf{look\_for}(\mathbf{cook}))}\,unCurry + App$$

We assume the following standard rules for dealing with product types, in addition to function application (App). These rules allow *tuple formation* (TF) from type sequences, as well as Currying and unCurrying of function types. The (standard) semantics of these rules is omitted here.

$$\text{(TF)} \quad \frac{\Gamma_1 \vdash \alpha \quad \Gamma_2 \vdash \beta}{\Gamma_1, \Gamma_2 \vdash \alpha \bullet \beta} \qquad \text{(Curry)} \quad (\alpha \bullet \beta)\gamma \vdash \alpha(\beta(\gamma)) \qquad \text{(unCurry)} \quad \alpha(\beta(\gamma)) \vdash (\alpha \bullet \beta)\gamma$$

Now let us generalize the PA rule above as follows.

$$\text{(GPA)} \quad \frac{\Gamma_1 \vdash \gamma \quad \Gamma_2 \vdash \alpha_1 \bullet \alpha_2 \quad \gamma, \alpha_1 \vdash \beta_1 \quad \gamma, \alpha_2 \vdash \beta_2 \quad \beta_1, \beta_2 \vdash \beta}{\Gamma_1, \Gamma_2 \vdash \beta}$$

$$\frac{X_1 \Rightarrow z \quad X_2 \Rightarrow \langle x_1, x_2 \rangle \quad z, x_1 \Rightarrow y_1 \quad z, x_2 \Rightarrow y_2 \quad y_1, y_2 \Rightarrow y}{X_1, X_2 \Rightarrow y}$$

In words: an operator z that can combine with x_1 to derive y_1 and with x_2 to derive y_2, can also combine with the pair $\langle x_1, x_2 \rangle$ to derive whatever result y that y_1 and y_2 can derive. Especially, when assuming tuple formation (TF), the pair $\langle y_1, y_2 \rangle$ is derived from y_1 and y_2, and GPA accordingly generalizes PA. Furthermore, the following application of GPA derives MC by simple induction, and by using unCurrying in the base of the induction:

$$\frac{\alpha(\alpha\alpha) \vdash \alpha(\alpha\alpha) \quad \alpha^{(1)}, \alpha^{(2)}, ..., \alpha^{(n)} \vdash^{\mathbf{a}} \alpha^{(1)} \bullet \overbrace{(\alpha^{(2)} \bullet (... \bullet (\alpha^{(n-1)} \bullet \alpha^{(n)})...))}^{\sigma} \quad \alpha(\alpha\alpha), \alpha \vdash \alpha \quad \alpha(\alpha\alpha), \sigma \vdash^{\mathbf{b}} \alpha \quad \alpha\alpha, \alpha \vdash \alpha}{\alpha(\alpha\alpha), \alpha^{(1)}, \alpha^{(2)}, ..., \alpha^{(n)} \vdash \alpha}$$

The proof of the sequent marked by '$\vdash^{\mathbf{a}}$' is by simple iteration of tuple formation. The proof of the sequent marked by '$\vdash^{\mathbf{b}}$' is by simple induction on the length of the product type $\sigma = \alpha^{(2)} \bullet (... \bullet (\alpha^{(n-1)} \bullet \alpha^{(n)})...)$, with the base of the induction ($n = 3$) derived by unCurrying the type $\alpha(\alpha\alpha)$.

This fact on its own is mathematically uninteresting, but it establishes a relation between the apparently unrelated phenomena of multiple coordination and "wide scope" interpretations of coordination. Furthermore, the (MC) axiom as stated above implicitly assumes a monomorphic type system, since α should be interpreted as a monomorphic type variable. This is inappropriate for the treatment of coordination phenomena (cf. Emms (1991)). Especially, the proposed MC rule in (66) can only be profitably used within a polymorphic system. The GPA rule above allows us to use coordinators with a polymorphic type. Let me support these last two claims using the following application of (GPA) for deriving the prominent, "one-fish" *de dicto*, interpretation of the coordination in sentence (69) above (=*Mary sought, found and ate a fish*).

$$\frac{\begin{array}{ll} \sqcap \Rightarrow \sqcap & \\ \mathbf{seek}, \mathbf{find}, \mathbf{eat} \Rightarrow \langle \mathbf{seek}, \langle \mathbf{find}, \mathbf{eat} \rangle \rangle & (\mathit{TF}) \\ \sqcap, \mathbf{seek} \Rightarrow (\sqcap(\mathbf{seek}))_{\tau\tau} & \\ \sqcap, \langle \mathbf{find}, \mathbf{eat} \rangle \Rightarrow (\sqcap(\mathbf{find}, \mathbf{eat}))_{\sigma} & (\mathit{unCurry} + \mathit{App}) \\ (\sqcap(\mathbf{seek}))_{\tau\tau}, (\sqcap(\mathbf{find}, \mathbf{eat}))_{\sigma} \Rightarrow \sqcap(\mathbf{seek}, \mathrm{AR}_{\sigma\tau}(\sqcap(\mathbf{find}, \mathbf{eat}))) & (\mathit{type\ shifting} + \mathit{App}) \end{array}}{\sqcap, \mathbf{seek}, \mathbf{find}, \mathbf{eat} \Rightarrow \sqcap(\mathbf{seek}, \mathrm{AR}(\sqcap(\mathbf{find}, \mathbf{eat})))} \; GPA$$

In this derivation, τ is the type of ITVs and σ is the type of ETVs. The argument raising operator AR maps the latter to the former. Importantly, in the conclusion we get the following derivation:

$$\sqcap, \mathbf{seek}, \mathbf{find}, \mathbf{eat} \Rightarrow \sqcap(\mathbf{seek}, \mathrm{AR}(\sqcap(\mathbf{find}, \mathbf{eat})))$$

This derivation "consumes" twice the binary conjunction operator, each time for coordinating pairs of a different type: once for the conjunction of the two ETVs, and once for the conjunction of the argument-raised result with the ITV. This can only be done if the type variable γ in the formulation of the (GPA) rule above stands for a polymorphic type. Using the (MC) axiom as formulated above it is impossible to achieve such a polymorphic derivation, which was to begin with one of the main motivations of the proposed MC rule in section 5. This shows another reason to unify the MC rule for multiple coordination with the PA rule for wide scope coordination.

8 Conclusion

This paper started by considering two simple strategies for interpreting multiple coordination. In flat interpretation using n-ary operators, the coordination is interpreted in one fell swoop, without recursive application of coordination rules. In nested interpretation, recursive application of syntactic rules is responsible for a syntactic-semantic process that is similar to the binary process with RC-coordination. We saw many examples that distinguish between multiple coordination and RC-coordination, which motivated flat interpretation of multiple coordinations over their nested interpretation. Then, however, we saw that interactions between multiple coordination and semantic operations of type shifting and distributivity challenge the simple n-ary implementation of flat interpretation. In these cases nesting effects appear where sub-parts of the coordination, possibly even without linear adjacency, are interpreted as independent semantic units. This led us to introduce the MC rule for multiple coordination, which mimics nesting of binary operators within a non-directional compositional mechanism. Getting back to the differences between multiple coordination and RC-coordination, we saw that most existing theories of coordination and the related phenomena allow the MC strategy to preserve the observed differences between the two constructions. It was observed that the key factor for preserving those differences in any given account is the derivation of nesting effects in RC-coordinations using syntactic triggers, and not purely in the semantic composition process. Thus, an account along the lines of the MC rule allows us to achieve a clearer dissociation between the two compositional processes in the semantics of coordination.

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