

Restrictions on complement anaphora*

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Abstract This paper discusses the semantic status and the restrictions on complement anaphora, i. e. pronouns that are anaphorically related to quantifiers and seem to refer to the ‘complement set’ of the latter – the set of those individuals that are in the restrictor but *not* in the nuclear scope of the quantifier. Our main empirical point, motivated by data from German, is that contrary to the claims in the literature, true complement set reference is not exclusively determined by the logical properties of the quantifier but also by its syntactic context. Based on this observation, we argue that plural quantifiers provide anaphoric antecedents by a particular inference mechanism, which is sensitive to syntactic information: We submit that speakers employ verifying strategies for sentences with plural quantifiers where a ‘test’ discourse referent is inserted in the ‘syntactic slot’ the plural quantifier originally occurs in. If a discourse referent, when inserted in this slot, yields truth-conditions for the resulting sentence that are equivalent to those of the original sentence, it can be used as an antecedent for anaphora.

Keywords: quantifiers, anaphora, complement anaphora, monotonicity, negation

1 Introduction

In configurations where a plural pronoun is anaphorically related to a non-c-commanding quantifier, speakers have different options for anaphora resolution (cf. in particular Moxey & Sanford 1993; Sanford, Moxey & Patterson 1994). First of all, the pronoun can pick up the entire restrictor of the quantifier (the ‘maximal set’, henceforth ‘MaxSet’).¹ This is what we find in (1a), where (under its most prominent

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¹ Our formulation above is imprecise. The antecedent of the pronoun should be a plurality and we will have to specify how this is related to the sets described above. Furthermore, our wording falsely suggests that there is always exactly one RefSet or CompSet. We will return to both issues below.

construal) ‘they’ seems to refer to the set of all boys.² However, the pronoun can apparently also relate to different proper subsets of the restrictor set. In (1b), ‘they’ appears to refer to those boys that ate their cake, i. e. to the intersection of the restrictor set and the nuclear scope set (the ‘reference set’, for short ‘RefSet’). In (1c), on the other hand, the pronoun is attributed a property that is incompatible with the nuclear scope of the quantifier the pronoun relates to, yet the resulting discourse is non-contradictory. This phenomenon has been termed ‘complement anaphora’. One very salient description of the phenomenon suggests that the antecedent of the pronoun in these cases is the set of all those individuals that are in the restrictor, but not in the nuclear scope of the quantifier (the ‘complement set’ or ‘CompSet’), i. e. the set of those boys that did *not* eat their cake.

- (1) a. Less than three [_R boys] [_S ate their cake]. That’s really strange, because
they usually like cake! *they = the boys*
 b. Most [_R boys] [_S ate their cake]. In fact, **they** ate it very fast.
they = the boys who ate their cake
 c. Very few [_R boys] [_S ate their cake]. **They** threw it away.
they = the boys who didn’t eat their cake

We will see later that the suggestion that complement anaphora are generally disambiguated as referring to the CompSet is problematic, hence, while we will continue to use the general term ‘complement anaphora’ (‘CA’) from the literature to refer to the phenomenon under discussion, we wish to draw attention right from the start to a terminological distinction between CompSet reference and CA; the former is a theoretical suggestion that explicates the phenomenon we are interested in.

1.1 The question

As noted in Moxey & Sanford 1993; Sanford et al. 1994; Kibble 1997; Nouwen 2003 a. o., it is by no means random which choice speakers make in a particular context. CA in particular is clearly restricted: Whereas it is possible in (1c), it is blocked in (2), which has a strong contradictory flavor.

- (2) Most [_R boys] [_S ate their cake.] # **They** threw it away.

The first question that arises, therefore, is how to properly characterize the contexts which license CA. Or, to be more precise, in which contexts can a pronoun be attributed a property that is incompatible with the nuclear scope of the quantifier?

² In (1) and subsequent examples, ‘R’ and ‘S’ indicate the syntactic correlates of the quantifier’s restrictor and nuclear scope, respectively.

All existing analyses (cf. Moxey & Sanford 1993; Sanford et al. 1994; Corblin 1996; Kibble 1997; Nouwen 2003; Kotek 2008), irrespective of their individual differences, answer this question by appealing to the logical properties of the quantifier. Broadly speaking, what sets (1c) and (2) apart according to this view is that while ‘very few’ in (1c) is right-downward-monotone (i. e. licenses superset-to-subset inferences in its nuclear scope), ‘most’ in (2) isn’t.

The second question is closely related to the first one: When is reference to CompSet licensed? This latter question is usually not distinguished from the former, as all existing analyses either assume that all instances of CA involve reference to CompSet (cf. Kibble 1997; Nouwen 2003) or none of them do (but instead involve reference to some other set, cf. Corblin 1996, Kotek 2008). Accordingly, all existing analyses will either answer this question by A or by B:

- A CompSet reference is tied to the logical properties of the quantifier
(underlying assumption: all instances of CA involve reference to CompSet)
- B Never, there is no CompSet reference
(underlying assumption: no instance of CA involves reference to CompSet)

1.2 Contribution of this paper

Given this background, our paper will suggest that both answers put forward in the literature should be rejected and will propose a novel analysis for complement anaphora alongside with the corresponding alternative empirical generalizations.

The first point of our paper is that B is empirically false. In particular, we will show based on a series of German data³ that some instances of CA involve true CompSet reference. Our second point is that A is empirically invalid, too. Again based on data from German, we will show that CompSet reference is not exclusively tied to semantic properties of the quantifier, as quantifiers with the same logical properties differ in their ability to license CompSet antecedents. Instead, we will suggest another empirical generalization, namely that the syntactic context of the quantifier also plays a significant role. In particular, the presence of negation c-commanding the quantifier proves to be a necessary condition on CompSet reference.

Based on these findings, we propose that plural quantifiers may provide anaphoric antecedents by a particular inference mechanism that is sensitive to the syntactic context the quantifier occurs in. More precisely, we submit that speakers employ verifying strategies for sentences with plural quantifiers where a ‘test’ discourse referent is inserted in the ‘syntactic slot’ the plural quantifier originally occurs in.

³ We stick to German data, for which had access to several informants as well as our own native speaker intuitions, but we assume that to a large extent our generalizations carry over to English as well.

Any discourse referent which, when inserted in this slot, yields truth-conditions for the resulting form that are equivalent to those of the original sentence can be used as an antecedent for anaphora.

1.3 Structure of the paper

The paper is structured as follows: Section 2 introduces the observations and claims made in the existing literature, focussing in particular on the explication of hypotheses A and B above. In Section 3 we discuss German data that contradict both of these hypotheses and raise the question of what exactly determines the availability of CompSet reference. Section 4 introduces the proposal we make for accounting for the observations made in Section 3 and applies it to a number of examples. Section 5 concludes the paper and lists a number of questions raised by our analysis.

2 The distribution of CA: Determined by logical properties of the quantifier?

All existing accounts of CA unanimously assume that certain logical properties of the quantifier represent a necessary condition on the occurrence of CA. We address this condition and its motivation in Section 2.1. In Section 2.2 we look at the relation between CA and CompSet reference based on the discussion in the literature concerning the nature of the actual referent of the pronoun in CA-contexts. All of this will provide the background for our discussion of the German data in Section 3.

2.1 Tying CA to the logical properties of the quantifier

Experiments by Moxey & Sanford (1993) show that CA in English is not available with just any quantifier. While ‘they’ in (3a) and (3b) can pick out those MPs that did *not* attend the meeting, ‘they’ in (3c) and (3d) cannot do so.

- (3) a. Not all MPs came to the meeting. They were at the pub (instead).
b. Few MPs came to the meeting. They were at the pub (instead).
(Kibble 1997: 262 (12))
c. Most MPs came to the meeting. # They were at the pub (instead)
d. Less than 30 MPs came to the meeting. # They were at the pub (instead).

Glossing over the differences in their actual proposals, Kibble (1997) and Nouwen (2003) (based on previous discussion in Moxey & Sanford 1993; Sanford et al. 1994) come up with the descriptive generalization in (4) – with the relevant notions of downward-monotonicity and proportionality given in (5a) and (5b) respectively. (For the sake of simplicity, a quantifier (an object in $D_{\langle\langle at \rangle t \rangle}$), is called ‘proportional’ if it is the result of applying a proportional function to an element from $D_{\langle at \rangle \cdot}$)

- (4) **Licensing condition of CA** (first version):
CA is only licensed by by proportional, downward-monotone quantifiers.
- (5) a. **downward monotonicity**
A function $f \in D_{\langle\langle a,t \rangle, t \rangle}$ is downward monotone iff for all $A, B \in D_{\langle a,t \rangle}$, $B \subseteq A$, if $f(A) = 1$, then $f(B) = 1$.
- b. **proportionality**
A function $f \in D_{\langle\langle at \rangle, \langle\langle at \rangle t \rangle \rangle}$ is proportional iff $f(A)(B)$ depends on the proportion of A s that are B s.

Crucially, this descriptive generalization is shared by all existing proposals (Corblin 1996, Kibble 1997, Nouwen 2003, Kotek 2008), irrespective of other differences between them. It correctly captures the pattern observed in (3): The functions denoted by ‘not all MPs’ in (3a) and ‘few MPs’ in (3b) are proportional and downward-monotone (but cf. Solt 2009 for more discussion on ‘few’ and Section 3.2 below for ‘not all’), whereas that denoted by ‘most MPs’ in (3c) is not downward monotone and that denoted by ‘less than 30’ in (3d) is not proportional.

The generalization in (4), however, leaves open which linguistic object is in fact meant by ‘quantifier’. Nouwen (2003) notes that it cannot refer exclusively to properties of the actual quantificational elements, i. e. the (modified) determiners, but must make reference to the entire DP.⁴ In particular, he points out that while CA in (3d) above is not licensed, it is possible in (6a), albeit the modified quantificational determiner is identical – and non-proportional – in both cases. The difference between (3d) and (6a) is that (6a) includes a partitive structure, so that the DP, as whole, is proportional. Moreover – and this point hasn’t been addressed explicitly in the literature – sentences like (6b) suggest that we cannot simply replace ‘quantifier’ by ‘quantificational DP’. The reason is that the quantificational DP ‘all of the MPs’, would fail to exhibit the right logical properties on its own; it is only the negation – located in the clausal spine and not within the DP – that makes CA available.

- (6) a. Less than 30 of the 50 MPs came to the meeting. They were at the pub (instead).
- b. I didn’t see all of the MPs at the meeting. They were at the pub (instead).

Since this seems to have an effect on the availability of CA, the term ‘quantifier’ in (4) above must be replaced by some notion of quantificational structure which is intended to capture the properties of the quantifier within its syntactic context.

⁴ If (4) were to be formulated in terms of the quantificational determiner, it would require this determiner to be right-downward-monotone and proportional. A function $g \in D_{\langle\langle at \rangle, \langle\langle at \rangle t \rangle \rangle}$ is right-downward-monotone iff for all $A, B, C \in D_{\langle at \rangle}$, $C \subseteq B$, if $g(A)(B) = 1$ then $g(A)(C) = 1$.

Hence, for (6b), we would evaluate monotonicity within the scope of negation, e.g. by observing that the superset-to-subset inference goes through in (7). From this, we end up with the generalization in (8):

- (7) I didn't see all the of the MPs at the meeting.
└ I didn't see and greet all the of the MPs at the meeting.
- (8) **Licensing condition of CA** (second version):
CA is only licensed by quantificational structures allowing superset-to-subset inferences with proportional quantificational DPs.

Note that while (8) makes predictions concerning the contexts where CA won't occur, it doesn't make any predictions w. r. t. when it will. Consider for instance (9). Even though the quantificational structure meets the criteria specified in 8, 'they' doesn't have to refer to the MPs that did *not* attend the meeting – rather (and most prominently) it seems to refer to the MPs that attended the meeting.

- (9) Few MPs came to the meeting. They each gave a short speech.

Nouwen (2003) (followed in this respect by Kotek 2008) thus posits a competition between reference to RefSet and CA, assuming that CA will occur only if (8) is met and using reference to RefSet would yield a contradiction. This is the case in (3b) above, but not in (9).

2.2 CA and CompSet reference

Whereas all existing proposals agree on (some version of) (8) and the more recent ones, Nouwen 2003 and Kotek 2008, also agree on the additional pragmatic factors addressed at the end of the previous section, analyses diverge when it comes to the actual referent of the anaphoric pronoun in instances of CA.

Kibble 1997 and Nouwen 2003 assume that all instances of CA pick out the CompSet. I. e. the antecedent for 'they' in (3a), repeated in (10), is the set of all MPs that did *not* attend the meeting (cf. Moxey & Sanford 1993 for experiments that seem to corroborate this stance). Note that as this set is not linguistically represented by any expression in the object language, it must be inferred by the speaker.⁵

- (10) Not all MPs came to the meeting. They were at the pub (instead).

⁵ From this perspective, the generalizations summed up in (8) follow the underlying intuition – made explicit by Nouwen 2003 – that we can only refer to CompSet if there is no possibility of it being empty: This is guaranteed if the quantifier is both downward-entailing and proportional. It will not be guaranteed if the quantifier is upward-monotone or non-upward monotone and not proportional (as in 'less than 30 boys') – as long as we don't know the extension of the entire set of boys.

If this is the underlying assumption about CA, then (8) can be restated as in (11); which can be subject to empirical scrutiny, as we will show later.

- (11) **Licensing conditions of CompSet reference** (first version):
CompSet reference is only licensed by quantificational structures allowing superset-to-subset inferences with proportional quantificational DPs.

Corblin 1996 and Kotek 2008, however, argue that that any proposal that views CA as CompSet reference is on the wrong track, given that pronouns in other contexts do not tend to pick up antecedents that have no linguistic representation in the object language, as witnessed by the famous minimal pair in (12):

- (12) a. One of the ten balls is missing from the bag. It's under the couch.
b. Nine of the ten balls are in the bag. # It's under the couch.
(Partee 1989: 363, fn.13), cf. also Heim 1982 for similar examples

What they suggest, instead, is that the antecedent of the pronoun is MaxSet, rather than CompSet. Hence, the antecedent of 'they' in (10) above is not the set of MPs that didn't come to the meeting, but the set of all MPs. This of course raises the question why the discourse in (10) is not contradictory: After all, the first sentence implicates that some of the MPs were at the meeting⁶, while in the second sentence the plural pronoun picks out the set of all MPs and attributes to it that its members were at the pub. Kotek 2008 answers this question by appealing to an independently attested phenomenon concerning plural definites, namely, non-maximality (cf. Brisson 1998 a. o.): The sentence in (13) can be true (in some contexts) even if not all of the MPs went to the bar. In analogy, we could assume that the second sentence in (10) involves non-maximality, being judged true even if not all of the MPs went to the bar (but cf. Nouwen 2003 for discussion).

- (13) The MPs went to the bar.

From such a perspective, then, (11) is false – there simply is no CompSet reference, and the more general formulation in (8) can be maintained.

In sum, there are two proposals for CA in the literature: One, where MaxSet acts as the antecedent and another one where CompSet acts as the antecedent. In the literature, these two approaches have usually been seen as 'all-or-nothing' (all instances of CA involve MaxSet reference vs. all instances of CA involve CompSet reference), but in principle, it is conceivable that speakers employ both strategies. In the following, we will identify a set of cases in German that involve true CompSet

⁶ A natural idea would be that in the case of CA, the *not-all to some* implicature is cancelled or suspended, which would make the discourse non-contradictory. Yet, CA is attested independent of or despite the implicature: We can contend that some of the MPs went to the meeting and still have CA.

reference, i. e. instances of CA that cannot be explained by appealing to MaxSet. Our main focus will be on describing and explaining the particular restrictions on such CompSet reference. Note that this set of cases – CA that involves true CompSet reference – is not absolutely congruent with the set of cases usually referred to as CA. It might thus well be that the ‘left-overs’ – those instances of CA that do *not* pass the test for CompSet reference are indeed cases of MaxSet reference – an issue we won’t have much to say about here.

3 Data from German

In the following, we address the distribution of CA in German. More precisely, we first disentangle the notion of CompSet reference from the more general notion of CA and show that German exhibits clear cases of CompSet reference. We then show that the distribution of the latter is much more restricted than has been claimed in the literature. In particular, (11) above is inadequate for German, as expressions that are equivalent w. r. t. (11) differ w. r. t. their ability to license CompSet-reference.

3.1 CA and CompSet reference

As shown in Section 2.2 above, there are two different analyses of CA – one where the pronoun picks up MaxSet, one where it picks up CompSet. We also pointed out the possibility that languages allow for both strategies – i. e. that CA involves a MaxSet antecedent in some contexts and a CompSet antecedent. In order to disentangle these two (potential) strategies for CA, and to diagnose clear cases of CompSet reference and their distribution, we will therefore employ two tests.

The first one only tests for CA and corresponds to the standard test in the literature: We will consider discourses like (14), where a personal pronoun is attributed a property incompatible with the nuclear scope of the quantifier. If the resulting discourse is non-contradictory, we will have evidence for a CA-construal in the traditional sense, but not for CompSet reference: Given the discussion in Section 2.2, this result is compatible with either CompSet or MaxSet functioning as the antecedent of the anaphora.

- (14) **Test 1: Pronouns** – T is incompatible with S
 Q [R boys] [S ate their cake]. PRO [T threw it away]

The second paradigm will let us distinguish CompSet from MaxSet reference. It involves some fairly plausible assumptions about the interpretation of another anaphoric expression, ‘the others’. We assume that ‘the others’ presupposes that the MaxSet of some plural quantifier is divided between a salient subset and its complement. In principle, both RefSet and CompSet could function as the salient subset.

If the salient subset is RefSet, ‘the others’ will be anaphoric to the complement of RefSet, namely CompSet. This means that in all those cases where CA is not attested, as in (15), ‘the others’ should be the most natural expression for CompSet.

- (15) Most boys ate their cake. The others threw it away.
Salient subset: the boys that ate their cake
Complement: the boys that didn’t eat their cake

If the salient subset is CompSet, on the other hand, ‘the others’ should be anaphoric to the complement of CompSet, namely, RefSet. Accordingly, we will test whether ‘die anderen’ (‘the others’) in German can be attributed a property that is incompatible with the *complement* of the nuclear scope of the quantifier, as illustrated in (16).

- (16) **Test 2: ‘the others’** – T is incompatible with \bar{S}
 Q [R boys] [S ate their cake]. PRO-OTHER [T ate it very fast].

To see the rationale of test 2, consider the three possible salient antecedents determined by the first sentence: A = all the boys, B = all the boys who ate their cake, and C = all the boys who didn’t eat their cake. If only A is salient after the first sentence, the presupposition of ‘the others’ is not satisfied. If B (RefSet) is salient, the referent of ‘the others’ will be $A \setminus B = C$, which yields a contradiction. But if C (CompSet) is a salient antecedent, the referent of ‘the others’ will be $A \setminus C = B$, which yields no contradiction. So if the discourse is not contradictory, we can conclude that C was an available, salient antecedent and we will thus have evidence for CompSet reference. While indirect, this is very strong evidence for true CompSet reference, because it is impossible to generalize the MaxSet analysis to such examples.

3.2 CA in German: The basic distribution

We first consider positive sentences (sentences without any downward-entailing operator c-commanding the quantifier) with quantificational DPs denoting upward-monotone functions, exemplified by ‘viele Buben’ (‘many boys’) in (17a). (17a) cannot be followed up by (17b) or (17c), which means that it does not allow for CA.

- (17) a. Viele Buben haben ihren Kuchen gegessen.
 Many boys have their cake eaten
 ‘Many boys ate their cake.’
 b. #Sie haben ihn (stattdessen) weggeworfen.
 They have it (instead) thrown-away
 ‘They threw it away (instead).’

- c. #Die anderen haben ihn (aber) sehr schnell gegessen.
the others have it (PRT) very fast eaten
'The others ate it very fast (however).'

While (17) patterns with the predictions of the general constraint in (8), (18) represents a more interesting case. (18a) contains the downward-monotone, proportional quantifier ('(sehr) wenige (von den) Buben') ('(very) few (of the) boys'), accordingly, (8) would lead us to expect that CA is licensed. Furthermore, if CA involves true reference to CompSet, (11) would predict that reference to CompSet is licensed. However, this is the first case where we witness a dichotomy: While test 1 in (18b) suggests that, as in English, CA is licensed (albeit the discourse is not judged perfect, in analogy to the judgements reported by Kibble 1997 and some of the data discussed by Moxey & Sanford 1993), test 2 shows that this is not an instance of CompSet reference, as the continuation in (18c) will yield a contradictory discourse.

- (18) a. (Sehr) wenige (von den) Buben haben ihren Kuchen gegessen.
(very) few (of the) boys have their cake eaten
'(Very) few (of the) boys ate their cake.'
b. ?Sie haben ihn (stattdessen) weggeworfen.
'They threw it away (instead).'
- c. #Die anderen haben ihn (aber) sehr schnell gegessen.
'The others ate it very fast (however).'

The same picture with other downward-monotone, proportional quantifiers, e.g. (19), which is parallel in all respects to (18).

- (19) a. Weniger als die Hälfte der Buben haben ihren Kuchen gegessen.
Less than the half of-the boys have their cake eaten
Less than half of the boys ate their cake.'
b. ?Sie haben ihn (stattdessen) weggeworfen.
'They threw it away (instead).'
- c. #Die anderen haben ihn (aber) sehr schnell gegessen.
'The others ate it very fast (however).'

We can obviously conclude from these data that it is not the case that downward monotone proportional quantifiers always allow CompSet reference (contrary to the claims by Kibble 1997 and Nouwen 2003 discussed in Section 2.2), even if they have a tendency to license CA (which must then probably be analysed as some weakened form of MaxSet reference). But this does not mean that CompSet reference is generally unavailable: A sentence with 'nicht alle' ('not all') like (20a) can not only be followed up by (20b) – our test 1 – but also by (20c) – our test 2. This latter property sets it apart from both (18) and (19).

- (20) a. Nicht alle Buben haben ihren Kuchen gegessen.
 Not alle boys have their cake eaten
 Not all (of the) boys ate their cake.’
- b. Sie haben ihn (stattdessen) weggeworfen.
 ‘They threw it away (instead).’
- c. Die anderen haben ihn (aber) sehr schnell gegessen.
 ‘The others ate it very fast (however).’

(20) is important in two respects. Recalling the empirical aims of this paper as stated in the introduction, it sufficiently shows that CompSet reference is possible, hence hypothesis B is false. Furthermore, while it may well be that CA in general is tied to the logical properties of quantificational structures, CompSet reference itself is not: The quantificational structures in (18), (19) and (20) are identical w. r. t. their logical properties and thus w. r. t. (11), yet only (20) licenses true CompSet reference; hence the claim A stated in the introduction is falsified as well.

But what exactly sets (20a) apart from (18a) and (19b)? The only significant difference appears to be that (20) involves an overt negation. We will suggest below that this is indeed a factor that plays a decisive role in the distribution of CompSet anaphora. Before we do so, however, we address two potential sources of confusion.

First, one could think of ‘nicht alle’ as a complex quantifier. While for certain purposes this may be a viable simplification, there is ample evidence that ‘nicht alle’ in German is not a complex quantifier – or at least that it needn’t be one to achieve the CompSet reference effect (cf. Section 2.1 above for related discussion). For example, negation does not have to be adjacent to ‘alle NP’, as shown in (21). In (21a) as well as in (21b), both continuations in (20b) and (20c) are perfectly acceptable, which means that CompSet is available even in these configurations.⁷

- (21) a. /ALLE Buben haben ihren Kuchen NICHT\ gegessen.
 All boys have their cake not eaten
 ‘It is not the case that all (of the) boys ate their cake.’
- b. Es ist nicht der Fall, dass alle Buben ihren Kuchen gegessen haben.
 EXPL is not the case that all boys their cake eaten have
 ‘It is not the case that all boys ate their cake.’

The second point is that it is not negation *per se* that licenses CompSet reference. In other words, it is not the case that CompSet reference is licensed in any context where a quantifier is c-commanded by a negation, irrespective of the nature of the

⁷ Cf. Buring 1997 for the correlation of this intonational contour and inverse scope in sentences like. The case of cardinals and negation is more complicated because intonation matters (even) more.

quantifier. (22), for instance, shows that a configuration where ‘wenige Buben’ (‘few boys’) is c-commanded by a negation does not license CompSet reference (or CA, for that matter): (22a) cannot be followed by either (22b) or (22c).

- (22) a. Es ist nicht der Fall, dass wenige Buben ihren Kuchen gegessen haben.
It is not the case that few boys their cake eaten have
‘It is not the case that few (of the) boys ate their cake.’
- b. #Sie haben ihn (stattdessen) weggeworfen.
‘They threw it away (instead).’
- c. #Die anderen haben ihn (aber) sehr schnell gegessen.
‘The others ate it very fast (however).’

The data presented here lead to the following conclusions: First, some instances of CA involve true CompSet reference. Second, the availability of CompSet reference is not sufficiently captured by appealing to the logical properties of the quantificational structure, i. e. the descriptive generalization in (11) is false. Third, the syntactic context of the quantifier – the presence of a c-commanding negation – matters for the availability of CompSet reference. And fourth, it matters *which* quantifier occurs in the scope of negation – as shown by the contrast between (20)/(21) and (22).

4 Proposal

In this section, we present an alternative analysis of CompSet anaphora. We start with a very brief intuitive outline of the proposal, followed by a more technical version and a test of its empirical predictions.

Intuitively, one of the problems with plural quantifiers is that they are complicated, and presumably they are, therefore, costly to represent in short term memory. As compared to this, it is easy to represent statements about discourse referents – understood here in a theory-neutral way which is compatible with any flavor of dynamic semantics –, be it individuals or sum-individuals.⁸ We therefore assume that when speakers interpret a sentence involving a plural quantifier, they attempt to develop a simple representation of the sentence and this simple representation involves – whenever possible – a discourse referent that the statement is about.

In order to do so, they attempt to find a suitable discourse referent, such that they can replace the original and more complex plural quantifier with that discourse

⁸ This is part of the intuition behind File Change Semantics, (Heim 1982), in which discourse referents are analogous to files that store information (cf. also Reinhart 1981). Similarly, it is a well-known fact that even in Discourse Representation Theory, (Kamp 1981, Kamp & Reyle 1993), quantificational structures involving ‘duplex conditions’ have been criticized and plural quantification tends to get remarkably baroque.

referent in the LF they attempt to represent without altering the truth conditions of the sentence. Now, the notion of replacement is, by necessity, a tricky one. The reason is that a discourse referent is arguably in the domain of meanings while LFs are more in the domain of syntactic entities; and by any stretch of imagination it would seem a category error to mix them up. We suggest that replacement is actually a syntactic replacement, i. e. the quantifier is replaced by a pronoun. That pronoun is then interpreted as being co-referent with the discourse referent in question.

Consider a trivial but instructive example in (23). The example is trivial because we essentially replaced a quantifier with itself; hence it is easy to see that the truth conditions will not change. But it shows the mechanism involved fairly clearly.

- (23) *Original sentence:* [[All the boys] [drank tea]]
- a. *Discourse referent:* There is a sum individual containing all the boys
- b. *Replacement with a pronoun:*
 [[**All the boys**] [drank tea]] \rightsquigarrow [[**They**] [drank tea]]
- c. *Binding of the pronoun:* There is a sum individual_i containing all the boys.
 They_i drank tea.

With this in mind, we neither claim that such a replacement is always possible nor that this is the only strategy to represent plural quantifiers; for example the representation using duplex quantifiers in DRT (Kamp & Reyle 1993) may well be an alternative (cf. also Nouwen 2003). What we do claim instead, is that when this strategy is available, the discourse referent to which the pronoun gained by replacing the original quantifier is anaphorically linked to will be a suitable discourse antecedent for plural pronouns in the immediately following discourse as well. In those cases in which this discourse referent amounts to the CompSet, CompSet reference will be predicted. So, in essence, we take CompSet anaphora to be a direct consequence of an automatic and probably hard-wired mechanism humans use to efficiently represent complex quantifiers as statements about discourse referents.

4.1 The analysis spelled out

As a spell-out of the idea suggested above, we suggest the principle of plural quantifier verification spelled out in (24).

- (24) **Principle of plural quantifier verification:**
 When interpreting an LF l containing a plural quantificational DP α , interpret $l^{[\alpha \rightarrow pro_i]}$ instead, where pro_i is co-referent with a discourse referent X_i , iff the resulting truth conditions are unchanged.

The operation $[\alpha \rightarrow \text{pro}_i]$ is analogous to the case of syntactic movement, i. e. we replace a DP with a trace/pronoun. In fact, the principle of plural quantificational verification is very similar to a syntactic movement analysis, albeit with the difference that we do not actually move the quantifier DP but we replace it with some other quantifier that is required to be existential. In a sense, the operation required is an attempt to rephrase complex quantificational structures into a list of existential statements. The only difficulty is finding a suitable existential quantifier/ discourse referent. Providing the corresponding heuristics is not our current focus, but certainly an important part of future research. The point which is important with respect to our present concerns is that it is easy to show that if a discourse referent exists such that the truth conditions of the resulting structure after replacement are the same as before the replacement, it will be unique (disregarding issues like the modulation of contextual variables determining what counts as many, few etc.)

Consider first a worked out version of the example (23) that also introduces the notation we will use in the rest of the paper in (25).⁹ Here, the discourse referent the statement is about is the same as the MaxSet. The resulting interpretation adds the scope interpretation, hence, we end up with a classical intersection between scope and restrictor, which predicts an available RefSet antecedent. From this, it indirectly follows that a CompSet reference is not possible. The reason is that the discourse referent to which the replaced pronoun is anaphoric is unique, hence, there is no alternative discourse referent one could use instead as part of this procedure. But since we assume that true CompSet reference only comes about by virtue of this verification strategy, we can conclude that it is unavailable here.

- (25) [[**Alle Buben**] [haben ihren Kuchen gegessen]]
 ‘All (of the) boys ate their cake’
Syntactic Replacement: [[**pro_X**] [ate their cake]]
Discourse Referent: $\exists X : *boy(X) \wedge \forall y. *boy(y) \rightarrow y \leq_i X$
Resulting interpretation: $\exists X : *boy(X) \wedge \forall y. *boy(y) \rightarrow y \leq_i X \wedge \text{ate-cake}(X)$

As opposed to this, applying the very same mechanism in (26) will provide a CompSet antecedent. While the originally introduced discourse referent X refers to some boys, the resulting interpretation involves a discourse referent X referring to some boys who did not ate their cake. Note that in this case, we cannot conclude that RefSet is not available, or that some other version of CA not involving true CompSet anaphora may show up using an alternative strategy. It is not part of the aims of this paper to discuss those cases.

⁹ In particular, we will use plain existential quantifiers for discourse referents for reasons of space economy, but any alternative notation would work. Further more, * indicates the cumulation operation, i. e. for any $P \in D_{(et)}$, $*P = \lambda x_e. P(x) \vee \exists y, z [y \oplus z = x \wedge *P(y) \wedge *P(z)]$.

- (26) [Nicht [[**alle Buben**] [haben ihren Kuchen gegessen]]]
 ‘Not all (of the) boys ate their cake’
Syntactic Replacement: [not [[pro_X] [ate their cake]]]
Discourse Referent: $\exists X : * \text{boy}(X)$
Resulting interpretation: $\exists X : * \text{boy}(X) \wedge \neg(\text{ate-cake}(X))$

4.2 Examples

In this section, we schematically present a number of examples showing the predictions the principle of plural quantifier verification in (24) makes.

We start with those configurations from German where (24) correctly predicts CompSet reference to be unavailable. Consider first (17a), repeated in (27) below. As shown in (17), it doesn’t allow for CompSet reference and this is predicted by (24). The only discourse referent available given (24) is one that will yield RefSet.

- (27) **Viele Buben** haben ihren Kuchen gegessen.
 ‘Many boys ate their cake’
 $\exists \mathbf{X} : * \text{boy}(\mathbf{X}) \wedge |\mathbf{X}| > \mathbf{k} \wedge \text{ate-cake}(X)$ ¹⁰

Crucially, we also correctly predict that (18a) and (19a) – repeated in (28a) and (28c), respectively – won’t allow for CompSet reference. The reason is that (24) appeals to the syntactic context of the quantifier. Plugging in the pronoun in the original slot of the quantifier, as in (28c), will yield a structure that will only consider discourse referents that have the property of having eaten their cake. Hence, we will never even consider discourse referents that have *not* eaten their cake.

- (28) a. [[(**Sehr**) **wenige (von den) Buben**] [haben ihren Kuchen gegessen]].
 ‘(Very) few (of the) boys ate their cake.’
 b. [[**Weniger als die Hälfte der Buben**] [haben ihren Kuchen gegessen]].
 ‘Less than half boys ate their cake.’
 c. [[pro_X] [have their cake eaten]]

It should become clear at this point that by assuming (24) we essentially predict that we will only ever find CompSet reference if the quantifier – i. e. the expression that will be replaced by the pronoun according to (24) – is in the scope of negation at LF. However, we crucially do *not* predict that any structure where a quantifier is c-commanded by negation will allow for CompSet reference – and this is desirable, given examples like (22a) above, repeated in (29) below, which exhibit a quantifier c-commanded by negation but do not license CompSet anaphora. Note that by (24)

¹⁰ This is the resulting interpretation. The discourse referent the statement is ‘about’ is in bold face.

we need to find a discourse referent such that if X is bound by it, (29b) will be truth-conditionally equivalent to (29a) – but there is no such discourse referent. The reason is that the desired truth conditions entail that some boys did eat their cake, however the pattern we can get by our verification strategy will, by definition, be paraphrasable as: $\exists X.R(X) \wedge \neg \text{ate-cake}(X)$, where R is some property; from this one can never conclude the existence of cake-eating boys. This pattern extends to all downward-monotone and non-monotone quantifiers under negation.

- (29) a. [Es ist nicht der Fall, [dass [**wenige Buben**] [ihren Kuchen gegessen haben]]]
 ‘It is not the case that few (of the) boys ate their cake.’
 b. [not [[**pro_X**] [ate their cake]]]

At the same time, (24) predicts CompSet reference to be available for all upward-monotone quantifiers under negation – as long as the quantifier is proportional or the size of the restrictor is known. We illustrate this for *viele* (‘many’) in (30) below: In order to find a suitable discourse referent, the cardinality of the set of boys must be known. Accordingly, in cases in which the cardinality of the set of boys in the restrictor is explicitly stated, the CompSet reading should be easier to get. While the judgment is very subtle, it seems to us that this prediction correct, as shown in (31).

- (30) [Nicht [[**viele Buben**] [haben ihren Kuchen gegessen]]]
 ‘Not many boys ate their cake’
 $\exists \mathbf{X} : * \text{boy}(\mathbf{X}) \wedge |\mathbf{X}| > \mathbf{k} \wedge \neg \text{ate-cake}(X)$

- (31) a. Nicht viele Buben haben ihren Kuchen gegessen.
 Not many boys have their cake eaten
 ‘Not many boys ate their cake.’
 b. ?? Die anderen haben ihn (aber) sehr schnell gegessen.
 ‘The others ate if very fast, however’
 c. Nicht viele von den zwanzig Buben haben ihren Kuchen gegessen.
 Not many of the twenty boys have their cake eaten
 Not many of the twenty boys ate their cake.’
 d. ?Die anderen haben ihn (aber) sehr schnell gegessen.

5 Discussion and outlook

This paper made two empirical points: First, we argued that some instances of CA involve true CompSet reference. The second point was that the availability

of CompSet reference is not determined exclusively by logical properties of the quantifier but that the syntactic context of the quantifier also matters. We then proposed an analysis based on what we called the ‘principle of plural quantifier verification’. This principle essentially encodes a particular inference mechanism, namely, a verifying strategy where a ‘test’ discourse referent is inserted in the ‘syntactic slot’ the plural quantifier originally occurs in. A discourse referent which, when inserted in this slot, yields truth-conditions for the resulting form that are equivalent to those of the original sentence can be used as an antecedent for anaphora.

The proposal raises several conceptual and empirical issues that were already mentioned in passing above: On the conceptual side, the status of the principle in (24) and the question of when exactly it applies require further clarification. On the empirical side, one particularly relevant issue is the distinction we made between the cases that qualify as true CompSet anaphora and other instances of CA. Future research should establish the empirical corroboration of our tentative suggestion (following parts of the literature) that the latter involve MaxSet reference.

We wish to conclude our paper with a final observation, which concerns both the conceptual set-up and the empirical predictions of our analysis. In Section 4.2 above we showed that we correctly predict the (un)availability of CompSet reference. Yet, the principle, as stated, is not limited to CompSet anaphora – it is a general mechanism for providing antecedents for anaphora. Yet while our principle seems to make the correct predictions for CompSet anaphora, it fails to derive the observed distribution for RefSet anaphora. In particular, our principle in (24) predicts that RefSet anaphora should never occur with non-upward monotone quantifiers – contrary to fact, as witnessed for example in (9) above. We end up with this wrong prediction since our principle replaces quantifiers by existential quantifiers over plural individuals – but such existential statements will in such cases be weaker than the original quantified statement they are supposed to replace (i. e. we run into a version of what is known as ‘van Benthem’s problem’ (van Benthem 1986)). This might be a problem for our analysis, however, it could also suggest that there are more strategies for RefSet anaphora than there are for CompSet anaphora – which in turn could correlate with the observation by Nouwen (2003) that the distribution of RefSet anaphora is much less restricted than that of CompSet anaphora.

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