Telescope Anaphora
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1.0 Introduction

In this paper I am concerned with the analysis of a particular class of definite noun phrases known as 'telescope pronouns'. According to Poesio & Zucchi (1992: 347), a telescope pronoun is a singular pronoun that is anaphorically related to a universal quantifier in a previous clause. Some examples of telescope pronouns are given in (1). These examples are problematic because most theories of discourse semantics do not allow universal noun phrases to bind pronouns that are outside their scope. While this approach excludes the invalid examples in (2), it provides the wrong prediction for the telescope examples in (1).

1a. Each degree candidate$_i$ walked to the stage. *He$_i$* took his diploma from the dean and returned to his$_i$ seat.
b Each student$_i$ in the syntax class was accused of cheating on the exam and *he$_i$* was reprimanded by the dean.
c. Every story$_i$ pleases these children. If *it$_i$* is about animals, they are excited, if *it$_i$* is about witches, they are enchanted, and if *it$_i$* is about humans, they never want me to stop.

2a. #If every cat$_i$ purrs, it$_i$ is happy
b #John likes every dog$_i$ and Sam feeds it$_i$.
c. #If John owes every man$_i$ money then Sam pays him$_i$.

In this paper I deal with two issues concerning telescope anaphora. First, I provide a semantic analysis which avoids the problems found with previous analyses. Secondly, I consider the conditions under which a telescope interpretation is licensed. I assume an understanding of the basic constructs of Discourse Representation Theory (Kamp & Reyle 1993).

2.0 Previous Analyses of Telescope Anaphora

Previous attempts to account for telescope anaphora include the restrictor reconstruction approach of Roberts (1987, 1989) and Poesio & Zucchi (1992), the numberless pronoun approach of Neale (1990) and the scope extension approaches of Sells (1985) and Dekker (to appear).[1] In this section I introduce two problems with these previous analyses.[2]

Problem 1: Anaphora to an NP within the scope of the telescope antecedent

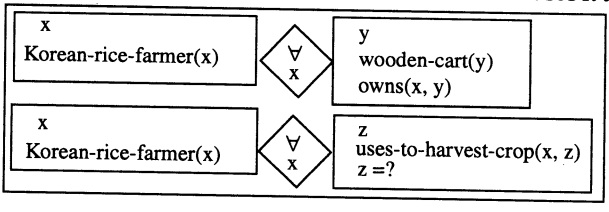
Both the numberless pronoun and restrictor reconstruction approaches provide incorrect analyses for examples that include two pronouns: one a telescope pronoun, and one a pronoun which is anaphoric on a noun phrase within the scope

of the telescope antecedent. Such an example is given in (3). In addition to the telescope pronoun *he*, there is a pronoun *it* which is anaphoric on the indefinite noun phrase *a wooden cart.*

3. Each Korean rice farmer$_i$ owns a wooden cart$_j$. *He$_i$* uses *it$_j$* to harvest the crop.

Poesio & Zucchi's DRT-based restrictor reconstruction analysis of this example produces an invalid DRS, illustrated in (4). Their analysis cannot provide an accessible antecedent for the discourse referent *z* that is introduced by the pronoun *it.*

4. Every Korean rice farmer owns a wooden cart. He uses it to harvest the crop.



Neale's numberless pronoun approach is similarly problematic as it provides incorrect truth conditions for this example. On Neale's analysis (3) is true only if each farmer uses *every* wooden cart he owns to harvest the crop. However, native speakers I have consulted consider this sentence to be true as long as each farmer uses *at least one* wooden cart he owns to harvest the crop.

Problem 2: Possible antecedents for the telescope pronoun

The examples in (5) have the same structure as the example in (1) except that the subject quantifier is different. Yet, the examples in (5) are not acceptable telescope examples. This indicates that there are restrictions on the type of noun phrase that can be the antecedent of a telescope pronoun. Ideally, this restriction should fall out naturally from an analysis of telescope anaphora. However, this is not the case with previous approaches to the telescope construction, all of which need to *stipulate* that only quantificational determiners which combine with a singular noun phrase can be the antecedent of a telescope pronoun.

5a. Most degree candidates walked to the stage. #He took his diploma from the dean.

b. All degree candidates walked to the stage. #He took his diploma from the dean.

3.0 An Alternative Approach

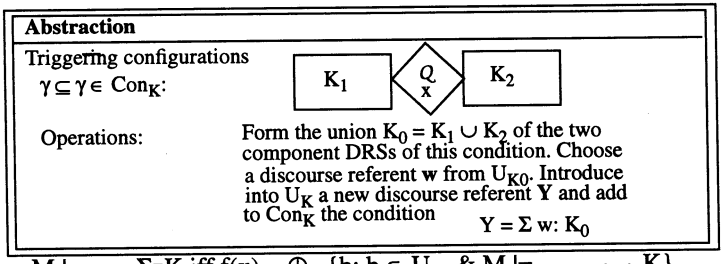
Various proposals have been made to account for the problems posed by telescope anaphora. Poesio & Zucchi accommodate an antecedent, Sells relocates the relevant conditions so that an antecedent is accessible, and Neale introduces a numberless operator that accesses predicates and variables from previous clauses. Each of these

analyses requires the addition of some special mechanism (accommodation/ relocation/ambiguous pronoun) to account for the behavior of telescope noun phrases. I propose instead to account for the telescope construction using minimally modified versions of two constructs already introduced in Discourse Representation Theory. As a first step I introduce these constructs. Following this I illustrate how these constructs can be combined to account for telescope anaphora.

3.1 Technical Apparatus

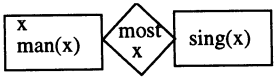
The first construct I assume is the process of abstraction. On Kamp & Reyle's interpretation, as given in the construction rule given in (6a), this process introduces a plural discourse referent that is derived in a specified way from a duplex condition already existing in the DRS. For example, given a duplex condition of the form found in (7a), abstraction introduces a plural discourse referent consisting of the set of men who sing. This is illustrated in (7b). The semantic interpretation rule for a condition of the form $Y=\Sigma w{:}K_0$ is given in (6b).

6a. Kamp & Reyle 1993: 344

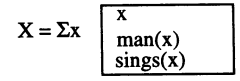


b. $M \models_f x = \Sigma z K$ iff $f(x) = \oplus_M \{b: b \in U_M \ \& \ M \models_{f \cup \{<z,b>\}} K\}$.

7a.



b.



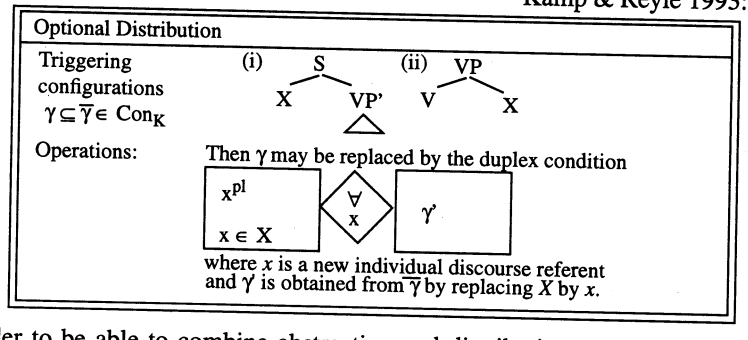
Implicit in Kamp & Reyle's rule is the assumption that abstraction only applies when it is needed. That is, this process only applies when there is the possibility that the sentence may be uninterpretable because there is no antecedent for a noun phrase.

The second construct I assume is the process of optional distribution. This process is required in order to obtain the distributed reading of a sentence like (8). Kamp & Reyle's default analysis of (8) produces the collective reading. On their approach, the distributive reading is obtained by applying an optional distribution rule. This rule is given in (9) and specifies that the discourse referent introduced by a plural noun phrase may be replaced by a duplex condition that quantifies over the individual members of the plural discourse referent.[3]

8. Several men bought a donkey.

9.

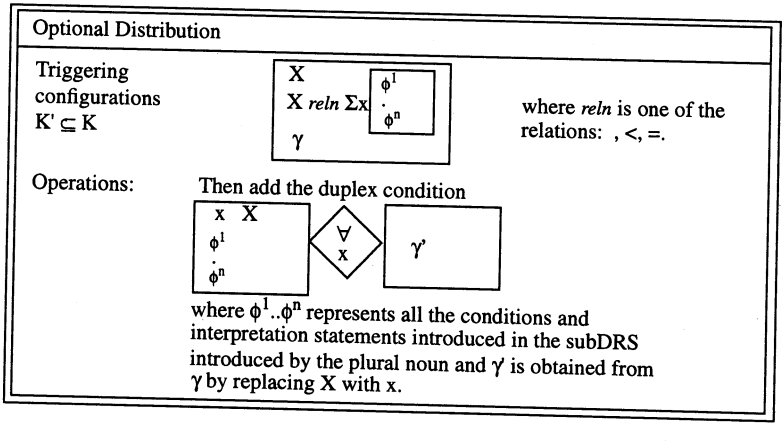
Kamp & Reyle 1993: 348



In order to be able to combine abstraction and distribution, I make two minimal modifications to Kamp & Reyle's rule. Firstly, the original rule is triggered by the existence of a plural discourse referent in a certain structural position. On the analysis I propose the distribution rule is triggered by the existence of an *abstraction condition*, like that introduced by the abstraction process or by a cardinality determiner.[4, 5] This is illustrated in the triggering conditions in the modified distribution rule given in (10).

Secondly, I modify the format of the duplex condition that the rule introduces. On my analysis the restrictor DRS contains all the conditions found in the abstraction subDRS that licensed the rule. In addition, it contains a condition of the type $x\ X$, where x is the discourse referent that is summed over in the abstraction condition and X is the individual on the left hand side of the abstraction condition. These changes are found in the updated rule given in (10).

10.



3.2 Accounting for the Telescope Construction

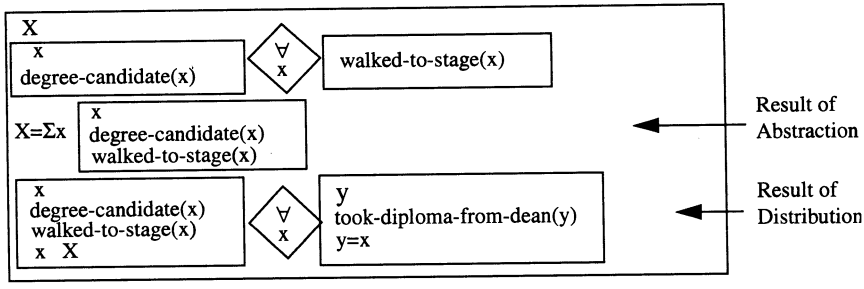
I now illustrate how the processes of abstraction and distribution can be used to account for telescope constructions. In section 3.1 it was noted that abstraction applies only when there is no other antecedent for a definite noun phrase. A telescope construction meets this condition since there is no apparent antecedent for the telescope pronoun.

However, applying abstraction does not solve the problems posed by the telescope example since the *plural* discourse referent introduced by the abstraction process is not a possible antecedent for the *singular* discourse referent introduced by the telescope pronoun. For example, although the process of abstraction in (11b) introduces a plural discourse referent X which consists of the set of degree candidates who walked to the stage, this discourse referent cannot be the antecedent for the singular discourse referent *y* (the discourse referent introduced by the telescope pronoun).

However, as a result of abstraction, the triggering conditions for the revised distribution rule are met. Applying the distribution rule produces a duplex condition that distributively quantifies over the individual members of the plural discourse referent. This provides a singular discourse referent that can be the antecedent for *y*. As can be seen from the third condition in (11b), the singular discourse referent introduced by the distribution rule is an appropriate antecedent for the telescope pronoun.

11a. Each degree candidate walked to the stage. He took his diploma from the dean.

b.



The truth conditions for this DRS are met whenever each degree candidate both walked to the stage and took his diploma from the dean. These truth conditions match those that native speakers associate with the telescope example in (11a). Hence, by applying abstraction and distribution we have provided an antecedent for the telescope noun phrase and produced truth conditions that match native speaker intuitions.[6]

3.3 Accounting for Previous Problems

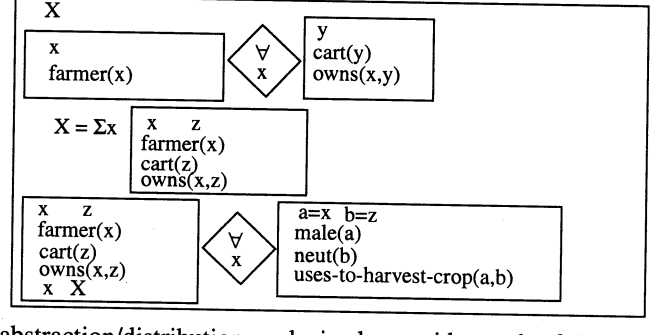
In the previous section I illustrated the means by which abstraction and distribution provide an appropriate antecedent for a telescope noun phrase. In this section I evaluate this analysis with respect to the two problems introduced in section 2.0.

Firstly, the abstraction/distribution approach avoids the problems previous analyses have with sentences that have two pronouns. The example discussed in section 2.0 is repeated in (12a). Recall, Poesio & Zucchi's analysis produces an invalid DRS for this example while Neale's analysis provides incorrect truth conditions: on Neale's approach (12a) is true only if each Korean rice farmer uses *every* cart he owns to harvest the crop.

The abstraction/distribution analysis of this sentence avoids this problem and produces a valid DRS that is true if each Korean rice farmer uses at least one of his carts to harvest the crop. The DRS for the discourse in (12a) is given in (12b) (abstraction and distribution have applied). This DRS has the same structure as (11b). The first condition is derived from the first sentence in (12a) in the standard manner. The second condition is the result of abstracting over the duplex condition. In turn, the existence of the abstraction condition licenses distribution. The final duplex condition is the result of applying distribution. This DRS is true if each Korean rice farmer uses at least one cart he owns to harvest the crop. Thus, the abstraction/distribution approach readily accounts for examples which include an additional pronoun anaphoric on a noun phrase within the subject relative clause.

12a. Each Korean rice farmer owns a cart. He uses it to harvest the crop.

b.



The abstraction/distribution analysis also avoids much of the stipulation that was necessary in previous accounts. For example, previous analyses have to stipulate which noun phrases can be the antecedent of a telescope noun phrase and which cannot. Recall, in section 2 we saw that a noun phrase such as *each man* or *every man* can be a telescope antecedent while a noun phrase such as *most men* or *all men* cannot. The examples used to illustrate this point are found in (5).

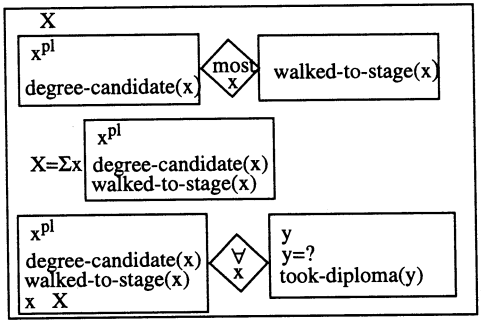
However, if Kamp & Reyle's (1993) approach to plural noun phrases is incorporated into the abstraction/distribution approach then it is not necessary to

make such stipulations about the antecedent of a telescope noun phrase. In order to account for the behavior of pronouns in sentences like (13), Kamp & Reyle mark an *individual* discourse referent that is introduced by a *plural* noun phrase with the addition of a superscript *pl* (1993: 347). A discourse referent with a *pl* superscript can only be the antecedent for a plural noun phrase. Hence, the sentence in (13a) with a plural pronoun is grammatical while the sentence in (13b) with a singular anaphoric pronoun is not.

13a. Few lawyers hired a secretary they liked.
b t #Few lawyers$_i$ hired a secretary he$_i$ liked.

If we assume Kamp & Reyle's approach to plural noun phrases then it is not necessary to stipulate that only singular quantified noun phrases can be the antecedent of a telescope noun phrase. A proportionally quantified noun phrase such as *most men* cannot be a telescope antecedent because, even with abstraction and distribution, there is no accessible antecedent for the telescope noun phrase. For example, the DRS for the sentence in (5a) is given in (14). In this DRS abstraction and distribution have applied in an attempt to provide an accessible antecedent for the telescope noun phrase. However, the only potential antecedent is x^{pl} and this discourse referent cannot be the antecedent for the singular pronoun. Since there is no accessible antecedent, there is no valid interpretation for this example.

14.



In sum, the semantic interpretation of telescope constructions can be accounted for by combining the previously motivated constructs of abstraction and distribution. This approach provides the correct semantic interpretation for telescope examples and avoids the problems found with previous analyses.

4.0 Towards Licensing Conditions

In previous sections I have argued that a telescope interpretation is available when the processes of abstraction and distribution can apply to produce an appropriate antecedent for the telescope anaphor. While this accounts for the data we have discussed so far, this licensing condition is much too general because it allows abstraction (and subsequently distribution) in examples that do not have a telescope

interpretation. For example, the current analysis predicts that the example in (15) should have a telescope interpretation. However, the pronoun in this sentence cannot be interpreted as a telescope noun phrase.

15. #John likes every dog and it likes cheese.

Unfortunately, the development of licensing conditions is no easy matter. One issue that becomes apparent when dealing with telescope anaphora is that there is considerable variation among native speaker intuitions as to whether a particular example can be interpreted telescopically or not. Although the literature contains no mention of telescope intuition variation, among my colleagues are people who find the examples in (16) acceptable, which I do not. Similarly, I find the examples in (17) acceptable whereas others I have consulted do not.

16a. If every cat purrs, it is happy. [self-constructed]
b t If each candidate for the space mission meets all our requirements then he has a Ph.D. in physics and extensive flight experience. [self-constructed]

17a. Each candidate for the space mission meets all our requirements. He has a Ph.D. in physics and extensive flight experience. [Poesio & Zucchi 1992]
b t Every dog came in. It lay down under the table. [Poesio & Zucchi 1992]

A further confounding issue is the fact that intuitions are almost always obtained from examples in isolation. However, Poesio & Zucchi point out that the example in (17b) is often deemed more acceptable when it is put in a context, like (18), which emphasizes the sequential nature of the dogs' actions. Hence, the intuitions that informants are providing may depend to some extent on the ability of the informant to come up with a suitable context in which to distributively interpret the telescope noun phrase. The problem of intuition variation is exacerbated by the fact that all of the examples discussed in the literature are constructed examples.[7]

18. I went to the circus last night. They had a number involving dogs that went like this: The circus performers put a table on some supports. Then, every dog came in. It lay down under the table, stood on its back paws, and lifted the table with its front paws.

This variation poses a problem for the development of licensing conditions since no licensing conditions will account for all native speakers' intuitions (or even for the intuitions of the small set of people who publish on this topic). These problems led me to take an alternate approach. As an initial step towards developing licensing conditions I chose to review the characteristics of a collection of naturally occurring telescope examples.[8] My premise being that features of these examples may provide clues to their licensing conditions.

Indeed, this review proved enlightening. Whereas there was considerable variation among informants in their judgements of the constructed examples, the judgements on the naturally occurring examples were unanimous: in every case, the informants judged the naturally occurring examples to be perfectly acceptable. In addition, the

characteristics of these sentences do provide some clues towards the factors which license a telescope reading. I make three observations below.

The Telescope NP

Firstly, a review of the telescope examples discussed in the literature gives the impression that it is only pronouns that can occur in a telescope construction. Indeed, Neale's analysis explicitly restricts this type of construction to pronouns. However, a study of naturally occurring examples indicates that other definite noun phrases can also occur in telescope constructions. This is illustrated in (19) where the telescope NP *the group* is anaphoric on the universally quantified subject noun phrase *each group*.

19. Each group has a leader, a project and a budget. The group is free to spend its budget with virtually no upper-management control, provided it stays within its allotment.

Verb Feature Parallelism

Secondly, the telescope examples that I reviewed exhibit parallel tense, aspect, and voice. I define an example as having parallel tense/aspect/voice if the main clause containing the antecedent and the main clause containing the telescope noun phrase have the same values. That is, they have the same tense, are both progressive or both non-progressive, both perfective or both non-perfective, and both active or both passive. This parallelism can be seen in the naturally occurring example in (20a). In contrast, the unacceptable example in (20b) does not have parallel tense.[9]

20a. Each group *has* a leader, a project and a budget. The group *is* free to spend its budget with virtually no upper-management control, provided it stays within its allotment.

b t Every rice farmer in Korea *owns* a wooden cart. #Usually, he *got* it from his father.

Most interestingly, it is the verb in the main clause that exhibits the parallelism, not the verb of the clause that contains the telescope anaphor/antecedent. This is illustrated by the examples in (21). The verbs in the main clauses are italicized and the verbs in the antecedent/anaphor clauses are underlined. The underlined verbs do not have the same features. The underlined verb in the antecedent clause in (21a) is in the subjunctive, while the underlined verb in the anaphor clause is not. In (21b) the underlined verbs differ in their tense feature. The antecedent verb is present tense while the anaphor verb is in the past tense. In contrast, the italicized verbs share the same features.

21a. Hungarian law, it seems, *requires* that every child <u>have</u> a recognized father. If he <u>doesn</u>'t, the state simply *invents* one.

b t When a magnetic field is applied, each mobile electron <u>*is forced*</u> to spiral about the field's direction, although its energy is not changed. This additional angular motion imposed by the field *is quantised*, exactly as if the electron <u>was constrained</u> in an orbit around an atom.

Grammatical Function Parallelism

Finally, the naturally occurring examples also exhibit a certain amount of parallelism in the grammatical function of the anaphor and antecedent. If the antecedent is a subject, the telescope anaphor will be a subject. If the antecedent is the object of a preposition, the anaphor will be the object of a preposition, etc. These two specific examples are illustrated in (22).

22a. Under Mr. Harel's system, *each business* must operate as a free-standing unit. *It* must assign a value to each job, recognizing that a manager costs more than a laborer. [WSJ]

b t In our tests, the hobs were dirtied by letting milk boil over on two burners of *each cooker.* All the milk was then cleaned from *the cooker*, and whatever parts were necessary to do this were moved. [LOB]

The only exception to this claim is the example in (23). In this example the antecedent functions as the subject of the subordinate clause while the anaphor functions as a possessive. However, it is still possible to claim a certain amount of grammatical parallelism since the anaphor, while possessive, is within the subject noun phrase, *the taxi's memory.*

23. At the centre, dispatchers keep track of taxis on monitor screens, which can display up to five cabs per pole. Colour codes show how far *each cab* is from each pole. The system updates the information every 30 seconds, and *the taxi's* memory can retain a pole's code for up to three minutes. [BC]

It is this feature of the naturally occurring examples that allows us to explain why (15) is not an acceptable telescope example, i.e. this example is not an acceptable telescope construction because it does not have grammatical function parallelism.

5.0 Conclusion

To account for the analysis of telescope noun phrases I proposed that the potential lack of interpretation for the telescope noun phrase licenses the antecedent-forming process of abstraction. In turn, abstraction licenses the optional rule of distribution. When combined these two previously motivated processes provide an antecedent for the telescope noun phrase.

This approach avoids the problems that were identified with previous analyses.It provides the correct analysis for a class of more complex examples which contain an additional noun phrase anaphoric on a noun phrase within the scope of the telescope NP's antecedent. Furthermore, with the abstraction/distribution approach it is not necessary to stipulate the type of noun phrase that can be a telescope antecedent.

As a first step towards developing licensing conditions, in the second part of the paper I reviewed some of the characteristics of naturally occurring telescope examples. My analysis revealed (i) that the telescope NP is not restricted to pronouns, other definite noun phrases can also be interpreted telescopically, (ii) telescope constructions exhibit verb feature parallelism and (iii) telescope

constructions exhibit grammatical function parallelism. We saw that even these initial observations go partway towards providing an account of when a telescope construction is licensed.

Endnotes:

1. The analyses of Roberts, Poesio & Zucchi, and Dekker are the only ones which deal specifically with telescope noun phrases. The other papers have in common the fact that examples of the telescope construction are included in their discussion (although they are not recognized as such).
2. For further discussion of problems with previous analyses see Toole (1997).
3. The use of the *pl* superscript in this rule can be ignored for the present. Its function will be discussed later in this paper.
4. I call a statement of the form *x reln* ΣxK an abstraction condition because this is the type of condition introduced by the process of abstraction.
5. The term 'cardinality quantifier' was introduced by Partee (1988) and identifies those quantifiers that assert that a certain set meets specific cardinality conditions (e.g. that it contains one member, no members etc.). Determiners which introduce cardinality quantifiers are referred to as cardinality determiners. On Kamp & Reyle's analysis cardinality determiners introduce conditions of the form *x reln* Σ *K*.
6. One disadvantage of the analysis described above is that, like Kamp & Reyle's approach in general, it is not compositional. However, this same analysis can be represented compositionally by incorporating Reyle's (1993, 1995, 1996) Underspecified Discourse Representation Theory. See Toole (1997) for further details.
7. I make this assumption since no sources are provided for the examples in the literature (the nature of the examples seems to confirm this assumption).
8. As a first step it was necessary to compile a set of naturally occurring examples. I examined the London-Oslo Burgen corpus, the Brown Corpus, the Associated Press corpus, and a section of the Wall Street Journal corpus. The London-Oslo Burgen, Brown, and Associated Press corpora were kindly made available by the Oxford text Archive. The examples were found by searching the corpora for the words *every* and *each*. I then manually examined the surrounding context to see if there were any singular pronouns antecedent on the universally quantified NP.
9. I classify this example as unacceptable since, given a scale of *fine-mediocre-no good*, three native speaker informants judged this sentence to be mediocre and one native speaker informant judged the sentence to be *no good*.

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