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The Event-Dependent Individuals and the Ambiguity of Donkey Sentences

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Abstract

This paper addresses multiple proportional readings in donkey sentences and deals with a question of why the disambiguation of proportional readings is affected by the topic structure of a sentence. The correlation between proportional readings and topic structure has been observed by Heim (1990) and Chierchia (1992) but has not been given a satisfactory explanation yet. Based on my previous study that indefinite NPs are ambiguous between quantificational and cardinal readings, and proper readings are determined by the topic structure, I will show how appropriate readings of donkey sentences are derived from the semantics of indefinite NPs and the syntactic representation of topic structure.

1. Introduction

In this paper I address the ambiguity of donkey sentences, namely multiple proportional readings. Kadmon (1987) notices that a conditional donkey sentence may have three different proportional readings, i.e., an asymmetric reading oriented to either a subject or an object, and a symmetric reading, while a relative-clause donkey sentence is unambiguously asymmetric to a head noun. Recently, it has been observed by Heim (1990) and Chierchia (1992) that the proportional readings of a conditional donkey sentence are disambiguated by the topic structure.

As always resonated in the literature of donkey sentences, a solution to the proportion problem hinges on the semantics of indefinite NPs and quantificational adverbs. Two main analyses have been suggested for this problem, i.e., Heim (1990) and Chierchia (1992). Both of the analyses assume that indefinite NPs are existential quantifiers, and quantificational adverbs are quantifiers over situations or events. Based on this assumption, they assign multiple proportional readings to donkey sentences; however, neither of them give a convincing explanation for the role of topic structure, namely disambiguating proportional readings.

I start with my previous study, Kwak (1995), about the ambiguity of indefinite NPs and the semantics of quantificational adverbs. For independent reasons, I have proposed that indefinite NPs are ambiguous between quantificational and cardinal readings, which are sensitive to topic structure, and cardinal readings of indefinite NPs are not generalized quantifiers but 'event-dependent' individuals. Quantificational adverbs are defined as quantifiers over events. Based on this study, I consider how proper readings of donkey sentences are derived from the semantics of indefinite NPs and the syntactic representations of topic

Section 2 concerns multiple proportional readings of donkey sentences and sensitivity to topic structure. In section 3, previous analyses will be critically reviewed. Finally, in section 4, I will summarize my previous study, and show how this work leads to an appropriate account for the current issue.

2. Multiple Proportional Readings of Donkey Sentences

The proportional reading of a relative-clause donkey sentence as in (1) has been first pointed out by Partee (1984).

(1) Most farmers who own a donkey beat it.

Partee argues that the correct truth condition of (1) concerns the proportion of donkey-owning farmers as to donkey-beating farmers. Inspired by Partee, Kadmon (1987) observes that the proportional readings of conditional donkey sentences are more complex than their relative-clause counterparts.

(2) If a farmer owns a donkey, he usually beats it.

In addition to the asymmetric reading as to farmers, (2) also has an asymmetric reading as to donkeys, i.e., most donkeys that are owned by a farmer are beaten, and a symmetric reading such that for most pairs of farmer and donkey standing in an owning relation, it is true that a farmer beats a donkey.

Later Heim (1990) and Chierchia (1992) argue that three proportional readings of a donkey sentence are not equally available, and that a preferred reading is determined by the topic structure. For instance, a sentence that is neutral to topic structure like (3) is ambiguous in three ways.

(3) If a drummer lives in an apartment complex, it is usually half empty.

(3) may be interpreted in an asymmetric reading as to drummers such that most drummers live in an apartment that is half empty, or in an asymmetric reading as to apartment complexes such that most apartment complexes where a drummer lives are half empty. In addition to these asymmetric readings, a symmetric reading is also available in (3), i.e., for most pairs of drummer and apartment complex standing in a living relation, it is true that the apartment is half empty.

The three readings of (3), however, are not equally available, when the sentence involves a marked topic NP.

(4) a. Do you think there are any vacancies in this apartment complex?
- Well, I heard that Fulano lives there, and if a DRUMMER lives in an apartment complex, it is usually half empty.
b. Drummers mostly live in crowded dormitories, but if a drummer lives in an APARTMENT COMPLEX, it is usually half empty.

With a strong phonological stress on one of the NPs, the discourse of (4a) is oriented to the vacancies of the apartment complex, while that of (4b) is oriented to drummers. Heim and Chierchia observe that (4a) is construed only in an asymmetric reading as to apartment complexes, whereas (4b) delivers only an asymmetric reading as to drummers. Therefore, I will consider how to derive an appropriate proportional reading from the topic structure of a donkey sentence.

3. Previous Analyses

Two main analyses have been proposed as to multiple proportional readings, i.e., Heim (1990) and Chierchia (1992). I will critically review each of these analyses, focusing on whether their analyses can derive an appropriate proportional reading from the topic structure.

3.1 Heim (1990)

In the framework of Kratzer (1989)'s situation theory, Heim (1990) defines quantificational adverbs (henceforth Q-adverbs) as quantifiers over situations and indefinite NPs as existential quantifiers, modifying her earlier theory of unselective binding. Based on this, Heim argues that multiple proportional readings are derived from different sets of minimal situations that Q-adverbs quantify over.

According to Kratzer (1989), situations are parts of a world and primitive objects partially ordered by the part-of relation '$\leq$', where worlds are maximal elements with respect to $\leq$. Predicates have an extra argument ranging over situations, as shown by the example of (5).

(5) a. man'(s, x)
 b. beat'(s, x, y)

(5a) says that *x* is a man in *s*, and (5b) says that *x* beats y in *s*. In the situation theory, Q-adverbs are considered as quantifiers over situations. For example, *usually* is defined as in (6b).

(6) a. usually'(ϕ)(φ)
 b. most (minimal) situations s in which ϕ is true are extendible to a situation s' where φ is true.

According to (6b), the Q-adverb *usually* is not an unselective binder any longer but constrained to bind only a situation variable. This establishes some relationship between the situations of a restrictive clause and those of a nuclear scope.

Given the notion of Q-adverbs as quantifiers over situations, multiple proportional readings of donkey sentences are explained as follows. First, (7b) is derived from (7a) by the rule of Quantifier Raising.

(7) a. if a man owns a donkey, he is usually happy
 b. usually$_s$ if [a man$_{s, 1}$ [a donkey$_{s, 2}$ [t_1 owns$_s$ t_2]]] $_{s'}$[he$_1$ is happy$_{s'}$]

According to the quantificational reading of *usually*, (7b) is interpreted as in (7c).

(7) c. most (minimal) situations s in which there is a pair of man and donkey standing in an owning relation are extendible to a situation s' where the man who owns a donkey in s is happy.

Second, multiple proportional readings of (7c) are derived from postulating different sets of minimal situations.

(8) a. {s: $\exists x \exists y$[x is a farmer in s $\wedge$ y is a donkey in s $\wedge$ x owns y in s]}
 b. {s: $\exists x$[x is a man in s $\wedge$ $\exists s'$[s $\leq$ s' $\wedge$ $\exists y$[y is a donkey in s' $\wedge$ x owns y in s']]]}
 c. {s: $\exists y$[y is a donkey in s $\wedge$ $\exists s'$[s $\leq$ s' $\wedge$ $\exists x$[x is a man in s' $\wedge$ x owns y in s']]]}

The symmetric reading of (7a) is derived from quantification over a set of situations as in (8a), where minimal situations include both a farmer and a donkey. On the other hand, (8b) feeds into a subject-asymmetric reading such that for most situations where there is a man x, and that are extendible to another situation where there is a donkey y owned by a man x, a man in s (i.e., x) is happy. Similarly, (8c) leads to an object-asymmetric reading, which quantifies over a set of situations s that include a donkey y and are extendible to another situation such that there is a man that owns a donkey y.

Heim's application of situations to donkey sentences gives a better account for the proportion problem than earlier theories. However, her analysis, first, cannot deal with the symmetric reading of a sentence that includes a symmetric predicate such as *meet*, *share*, etc. (e.g., *if a man shares an apartment with another man, he shares the housework with him*) Second, although Heim makes an observation that the proportional reading of a donkey sentence is determined by the topic structure, this observation is not incorporated in her analysis. She posits different sets of situations for multiple proportional readings, but the selection of a relevant set is made by the scopal relation of NPs rather than by the topic structure.

3.2 Chierchia (1992)

Based on 'Dynamic Montague Grammar (DMG)' as developed by Groenendijk & Stokhof (1990), Chierchia (1992) argues that multiple proportional readings of a donkey sentence can be derived from the topic structure, proposing the 'existential disclosure' of a topic NP.

Groenendijk and Stokhof implement the idea of the classical Discourse Representation Theory (DRT) in the intensional logic to develop DMG. In DMG, an intension operator ^ abstracts over so-called 'states', which behave as the assignments of values to 'discourse markers'. Then, the primary meaning of a sentence is its context change potential, i.e., the ability to constrain its subsequent discourse. In other words, the dynamic meaning of a sentence is a set of propositions which can be conjoined with the given proposition.

To formalize this idea, DMG makes use of two operators $\uparrow$ and $\downarrow$. A sentence that does not have a dynamic effect may be lifted to a dynamic sentence by means of the operator $\uparrow$. For example, $\uparrow$ changes a sentence ϕ of type t to a dynamic sentence $\uparrow\phi$ of type <<s,t>,t>, where s stands for a state.

(9) $\uparrow\phi = \lambda p[\phi \wedge {}^{\vee}p]$

$\lambda p[\phi \wedge {}^{\vee}p]$ is a function that accepts all and only the propositions that are compatible with ϕ's truth. To get the static interpretation of a sentence, we only have to wipe out the place holder of the corresponding dynamic interpretation, which amounts to discourse closure.

To derive the interpretation of a conditional donkey sentence, Chierchia follows the assumption of many researchers such as Kratzer (1989), Diesing (1992), de Swart (1991), etc. that the semantics of Q-adverbs involves quantification over events or situations (at least in some cases). For instance, a sentence like *when John is in the bathtub, he always sings* involves quantification over events such that for every event of John's being in the bathtub, there is an event of his singing. Then, the static interpretation of the sentence will look like (10).

(10) $\forall e[[\text{in\_the\_bathtub}'(j)(e)] \rightarrow \exists e'[\text{sing}'(j)(e')]]$

To implement this in a dynamic setting, Chierchia assumes an existential disclosure operation in the spirit of Dekker (1993), which is the reverse of existential closure advocated in the classical DRT.

(11) $\exists^{d}e\uparrow[\text{in\_the\_bathtub}'(j)(e)] \Rightarrow \lambda e\uparrow[\text{in\_the\_bathtub}'(j)(e)]$ [1]

Given the disclosure operation, the argument structure of the above sentence will be (12a).

(12) a. $\text{always}^{d}(\lambda e\uparrow[\text{in\_the\_bathtub}'(j)(e)])(\lambda e\uparrow[\text{sing}'(j)(e)])$

Now, the dynamic reading of (12a) will be as follows.[2]

(12) b. $\uparrow\forall e[[\text{in\_the\_bathtub}'(j)(e)] \rightarrow \exists e'[\text{sing}'(j)(e')]]$
$= \lambda p[\forall e[[\text{in\_the\_bathtub}'(j)(e)] \rightarrow \exists e'[\text{sing}'(j)(e)]] \wedge {}^{\vee}p]$

To account for the sensitivity of topic structure in proportional readings, Chierchia needs to have Q-adverbs quantify over topic NPs; otherwise, conditional sentences will have only symmetric readings. Thus, Chierchia suggests that existential disclosure may apply to topic NPs, abstracting over indefinite NPs.[3] He explains that existential disclosure in this case amounts to the process of topic selection.

(13) a. If a farmer owns a donkey, he always beats it.

b. $always^{d}(\lambda e \lambda x \uparrow [farmer'(x) \wedge \exists y[donkey'(y) \wedge own'(y)(x)(e)]])$
$(\lambda e \uparrow [beat'(y)(x)(e)])$

c. $always^{d}(\lambda e \lambda y \uparrow [donkey'(y) \wedge \exists x[farmer'(x) \wedge own'(y)(x)(e)]])$
$(\lambda e \uparrow [beat'(y)(x)(e)])$

d. $always^{d}(\lambda e \exists^{d} x \exists^{d} y \uparrow [farmer'(x) \wedge donkey'(y) \wedge own'(y)(x)(e)])$
$(\lambda e \uparrow [beat'(y)(x)(e)])$

For example, when *a farmer* of (13a) is marked as a topic NP (in syntax), existential disclosure applies to this NP to derive (13b). On the other side, the selection of *a donkey* as a topic NP gives an argument structure like (13c). When the sentence involves no topic NP (or an event is a topic), (13d) is the structure of the sentence. As shown in (13), existential disclosure driven by topic selection provides a mechanism to derive multiple proportional readings.

Given the argument structure of (13b), the dynamic semantics of Q-adverbs derives (14) as the subject-asymmetric reading of the sentence.

(14) $\uparrow \forall e \forall x[[farmer'(x) \wedge \exists y[donkey'(y) \wedge own'(y)(x)(e)]] \rightarrow \exists e' \exists y[beat'(y)(x)(e)]]$
$= \lambda p[\forall e \forall x[[farmer'(x) \wedge \exists y[donkey'(y) \wedge own'(y)(x)]] \rightarrow$
$\exists e' \exists y[donkey'(y) \wedge beat'(y)(x)(e')]] \wedge {}^{\vee}p]$

Since the non-topic NP *a donkey* is existentially closed in the scope of the topic NP *a farmer*, the quantification of the Q-adverb *always* will lead to the subject-asymmetric reading of the sentence. Similarly, (13c) will deliver the object-asymmetric reading, and (13d) carries the symmetric reading.

Chierchia (1992) derives proportional readings from topic structure, assuming that topic NPs in a Q-adverb sentence are existentially disclosed and bound by the Q-adverb. However, it is not well justified why Q-adverbs should bind topic NPs. Since Q-adverbs have either temporal or atemporal quantificational readings, Chierchia claims that Q-adverbs may bind either events or indefinite NPs. To deliver multiple proportional readings, only topic NPs are subject to existential disclosure and bound by Q-adverbs. Given that, it needs to be answered what kind of similarities hold between events and topic NPs to be bound together by Q-adverbs. If he does not want to claim that events are always the topics of sentences, the binding properties of Q-adverbs look very ad hoc.

4. The Proportion Problem under the Event-Dependency

4.1 The Semantics of Indefinite NPs and Q-adverbs

To provide a proper account for the proportion problem, the semantics of indefinite NPs and Q-adverbs needs to be reconsidered. In this section, therefore, I discuss the interpretations of indefinite NPs and Q-adverbs. I will argue for the ambiguity of indefinite NPs between quantificational and cardinal readings, proposing that cardinal readings of indefinite NPs are 'event-dependent' individuals. I assume that Q-adverbs are quantifiers over events, binding only event variables.

Inspired by Milsark (1974), a number of researchers such as Enç (1991), Diesing (1992), Ladusaw (1994), and de Hoop (1995) defend the ambiguity of weak quantifiers between quantificational and cardinal readings, which may be phonologically distinguished by strong and weak forms.

(15) a. Some cats entered the backyard last night.
b. Sm cats entered the backyard last night.

A strong form *some cats* as in (15a) quantifies over a set of cats whose existence is already presupposed in the context, while a weak form *sm cats* introduces a new entity in the discourse, i.e., a set of cats entering the backyard last night. Hence, the interpretations of weak quantifiers are disambiguated by the presuppositionality of their denotations.

This difference is affirmed in various constructions.

(16) a. Sm/ ?? some cats, whatever cats they are, entered the backyard last night.
  b. There were sm/ ?? some cats in the backyard.
  c. Some/ ?? sm cats entered the backyard, but the others stayed outside.
  d. A: Some/?? sm cats entered the backyard last night.
  B: Which cats do you mean?

First, since a *WH-ever* clause induces an object-independent reading, canceling the restriction of a domain, a *some*-NP, which is restricted by the discourse, cannot occur with it. Second, Milsark (1974) notes that a strong form of a weak quantifier does not fit in a *there*-sentence because a *there*-sentence introduces the existence of a new entity in the discourse. Third, as observed by Diesing (1990) and Ladusaw (1994), a *some*-NP may be followed by *the others* due to its discourse antecedent, but a *sm*-NP may not. Finally, a weak form like *sm cats* may not occur with a discourse-linked question led by a *which*-NP.

The presuppositional property of *some cats* also provides an account for why it occurs as the topic of a sentence, but *sm cats* does not.

(17) a. As for some/ ?? sm ghosts, they haunted this house.
  b. It was this house that some/?? sm ghosts haunted.
  c. What some/?? sm ghosts haunted was this house.

In topic-marked sentences such as *as for* sentences and cleft and pseudo-cleft sentences, strong forms of weak quantifiers can occur, but weak forms may not.

Based on these observations, in Kwak (1995), I have considered the ambiguity of indefinite NPs in the framework of event semantics. I assume that the domain of individuals contains both singular and plural individuals, which are ordered by the part-of relation $\leq$ in the lattice structure. In this framework, the syntax and semantics of a strong and a weak forms have been defined as in (18a-b).

(18) a. $<$"some/a", $(V/_R(V/_I NP_{[+TOP]}))/_R N$, $\lambda P \lambda E \lambda e \exists x[P(x) \wedge E(x)(e)]>$
  (where V is a syntactic category for sets of events, and E is a variable for verbal predicates)
  b. $<$"sm/a", $DNP_{[-TOP]}/_R N$, $\sum>$
  (where DNP is a syntactic category for event-dependent NPs, and $\sum$ is defined as a function '$\lambda P \lambda e \iota x[\exists \theta[\forall e' \forall x'[[e' \leq e \wedge \theta(e') = x' \wedge P(x')] \rightarrow x' \leq x]]]$')

A strong form, *some* or *a*, is syntactically defined to make a topic NP and semantically interpreted as a generalized quantifier. On the other hand, a weak form, *sm* or *a*, makes a non-topic NP syntactically, and refers to a function $\sum$. Taking a property as an argument, $\sum$ denotes the supremum of individuals that have a property P and bear some thematic role of an event e, taking P and e as arguments. In other words, it is a function retrieving a maximal individual of participants occurring in some event. Hence, an indefinite NP in the weak form denotes a maximal plural individual occurring in a given event. Therefore, in this proposal, the topicality of an NP is encoded in the syntax, and the semantics of an indefinite NP is determined by the syntactic property.

Given the ambiguity of weak determiners, *a farmer* is ambiguous between the quantificational reading of (19a) and the cardinal reading of (19b) depending on its topicality.

(19) a. $<$"a farmer" $V/_R(V/_I NP_{[+TOP]})$, $\lambda E \lambda e \exists x[farmer'(x) \wedge E(x)(e)]>$
  b. $<$"a farmer", $DNP_{[-TOP]}$, $\lambda e[\sum(e)(farmer')]>$

Combining with a verbal predicate that takes a topic NP, *a farmer* is construed as an existential quantifier. As a DNP, on the other side, *a farmer* makes a non-topic NP and denotes a maximal sum of farmers having some thematic role of the event, taking an event as an argument.

Now, let's turn to the semantics of Q-adverbs. As for the semantics of Q-adverbs, de Swart (1991), Chierchia (1995), Rothstein (1995), and Bayer (1995) all agree that Q-adverbs are quantifiers over events, mapping the events of a conditional clause to those of a matrix clause. Given that, the question is what kind of mapping relations Q-adverbs establish. Rothstein properly points out that these mapping relations cannot be arbitrary functions. Rather, they denote specific relations such as temporal relations, cause-effect relations, etc., which will be finally determined by the context. Hence, Rothstein argues that the semantics of Q-adverbs should involve some matching functions, the content of which will be determined by the context.

Adopting Rothstein's argument, I propose the semantics of a Q-adverb, e.g., *always*, as follows.

(20) $<$"always", $(S/_RV)/_RV$, $\lambda E \lambda E' \forall e[[E(e) \wedge \tau(e) = t_e \wedge \sigma(e) = s_e] \rightarrow$
$\exists e'[E'(e') \wedge M(e) = (e') \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]]>$

(where E and E' are variables of sets of events, and τ and σ are temporal and spatial trace functions in the spirit of Krifka (1989))

Taking two sets of events, a Q-adverb *always* maps every event of the conditional clause to some event of the matrix clause which is matched by the matching function M. The quantification of the conditional clause and the existential closure of the matrix clause assign specific reference time and space to each event so that each event in both of the clauses is restricted by the reference time and space that are instantiated by the context. Notice that the Q-adverb is defined as a selective binder of events, while Chierchia (1992) defines it as an unselective binder.

4.2 The Proportion Problem

In this section, I will consider the proportion problem of donkey sentences under the revised notion of indefinite NPs and Q-adverbs. I will show how a proper meaning of a donkey sentence is derived from its topic structure.

Under the ambiguity of indefinite NPs, let us consider the proportional readings of a donkey sentence such as (21).

(21) If a farmer owns a donkey, he usually beats it.

Since the conditional clause of (21) contains two indefinite NPs, and indefinite NPs are ambiguous between a generalized quantifier and a DNP, four interpretations are imaginable for this conditional clause. First, suppose that both *a farmer* and *a donkey* are syntactically marked as topic NPs. Then, the corresponding semantics will be as follows. [4]

(22) a. [[if a farmer^T owns a donkey^T, he usually beats it]] =
$most_e\, \exists x \exists y[farmer'(x) \wedge donkey'(y) \wedge own'(e) \wedge AG(e) = x \wedge PT(e) = y \wedge$
$\tau(e) = t_e \wedge \sigma(e) = s_e]\ \exists e'[$he beats it at $e' \wedge M(e) = (e') \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}\,]$

In (22a), since the syntax of the sentence restricts the interpretations of *a farmer* and *a donkey* to topic NPs, these NPs are interpreted as generalized quantifiers. This means that the Q-adverb *usually* quantifies over a set of events e such that there are some farmer x and some donkey y standing in the owning relation e at t_e and s_e. In other words, it quantifies over a set of events that involve a pair of farmer and donkey in the owning relation. Thus (22a) yields the symmetric reading of the sentence. Here, I will put aside temporally the semantics of a donkey pronoun and that of the matrix clause for the expository purpose.

Second, when only one of the NPs is syntactically marked as topic NP, the interpretation of the sentence will be either (22b) or (22c).

(22) b. [[if a farmer^T owns a donkey, he usually beats it]] =
$most_e\, \exists x[farmer'(x) \wedge own'(e) \wedge AG(e) = x \wedge PT(e) = \sum(e)(donkey') \wedge \tau(e) = t_e \wedge \sigma(e) = s_e]\, \exists e'[\text{he beats it at } e' \wedge M(e) = e' \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]$

c. [[if a farmer owns a donkey^T, he usually beats it]] =
$most_e\, \exists y[donkey'(y) \wedge own'(e) \wedge AG(e) = \sum(e)(farmer') \wedge PT(e) = y \wedge \tau(e) = t_e \wedge \sigma(e) = s_e]\, \exists e'[\text{he beats it at } e' \wedge M(e) = e' \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]$

One of the NPs is a quantifier and the other is a DNP in (22b) and (22c). (22b) concerns a set of events e such that there is a farmer x that is the agent of an owning event e at time t_e and space s_e, and the patient of e is a maximal sum of donkeys occurring in some thematic role of the event e, i.e., all the donkeys that a farmer x owns at t_e and s_e. In other words, this is a set of events e that include a farmer and all his donkeys in the owning relationship at t_e and s_e. Thus (22b) leads to the subject-asymmetric reading of the sentence. (22c) is the reverse case of (22b), taking *a donkey* as a topic NP and *a farmer* as a non-topic DNP. Thus (22c) delivers the object-asymmetric reading.

Finally, when both of the NPs are marked as non-topic NPs, the truth-condition will be as follows.

(22) d. [[if a farmer owns a donkey, he usually beats it]] =
$most_e\, [own'(e) \wedge AG(e) = \sum(e)(farmer') \wedge PT(e) = \sum(e')(donkey') \wedge \tau(e) = t_e \wedge \sigma(e) = s_c]\, \exists e'[\text{he beats it at } e' \wedge M(e) = (e') \wedge \tau(e') = t_{c'} \wedge \sigma(e') = s_{e'}]$

Both of the NPs are event-dependent in (22d), and thus the topic of (22d) should be the event of farmers' owning a donkey. In Kwak (1996), I have discussed independently the fact that in most cases an individual-level predicate cannot be a topic event due to the non-specificity of the event type. Hence (22d) does not seem to be a legitimate reading of (21) because of the predicate type.

Note, however, that when the conditional clause of a donkey sentence involves a stage-level predicate, the sentence yields much easily a symmetric reading with a topic event.

(23) If students make an experiment on frogs, they usually kill them (without getting a result).

Suppose that each experimental group in the domain consists of four students and uses two frogs. When both *students* and *frogs* are DNPs, the interpretation of (23) is clearly oriented to the experiments rather than to students or frogs. Then how many students made a mistake or how many frogs were accidentally killed are not the concern. What is more important is how many experiments failed by the mistake of students. In this situation, the context will set the reference time of each event to the experiment time, and the reference space to an experiment group, each of which includes four students and two frogs. Hence, *usually* of (23) will quantify over a set of events that include four students and two frogs each. This is a symmetric reading in a collective version, contrasting with a symmetric reading in a distributive sense, e.g., (22a), where both of the NPs are considered as topic NPs.

Now, let us consider the non-ambiguity of relative-clause donkey sentences such as *most farmers who own a donkey beat it*, which are interpreted asymmetrically only as to the head noun. To consider this issue, I need to redefine the semantics of relative pronouns in the framework of event semantics. In the event-free semantics, a relative pronoun denotes the intersection of a relative clause and a head noun. In the event semantics, however, since every verbal predicate involves an implicit argument of event, it needs to be studied how the event of a relative clause is existentially bound. It has been argued in syntax and semantics that sentences are scopal boundaries, and thus in much literature, events are assumed existentially closed at the sentential level. In the same spirit, I assume that NPs are another level in which existential closure applies to events, because NPs also play the role of a scopal boundary. Based on this assumption, I build existential closure in the lexical meanings of relative pronouns.

(24) $\langle$"who", $(N/_{L}N)/_{R}(V/_{L}NP)$, $\lambda E \lambda P \lambda x[P(x) \wedge \exists e[E(x)(e) \wedge \tau(e) = t_e \wedge \sigma(e) = s_e]]\rangle$

For example, taking a verbal predicate E and a property P, *who* denotes a set of individuals x such that x has the property P and there is an event e such that e and x stand in relation E, and e is restricted by the reference time t_e and space s_e.

Under the revised notion of a relative pronoun, let us consider the proportion problem of a relative-clause donkey sentence. A relative-clause donkey sentence such as *most farmers who own a donkey beat it* may be interpreted as either (25a) or (25b) depending on the topicality of *a donkey*.

(25) a. [[most farmers who own a donkey beat it]] =

$most_x[farmer'(x) \wedge \exists e'[own'(e') \wedge AG(e') = x \wedge PT(e') = \sum(e')(donkey') \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]]\ \exists e[x \text{ beats it at } e \wedge \tau(e) = t_e \wedge \sigma(e) = s_e]$

b. [[most farmers who own a donkey^T beat it]] =

$most_x[farmer'(x) \wedge \exists e'\exists y[donkey'(y) \wedge own'(e') \wedge AG(e') = x \wedge PT(e') = y \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]]\ \exists e[x \text{ beats it at } e \wedge \tau(e) = t_e \wedge \sigma(e) = s_e]$

Most of (25a) quantifies over a set of farmers x such that there exists an event e' such that x owns a maximal sum of donkeys occurring in some thematic role of the event e' at time t_e and space s_e. Thus the sentence will have an asymmetric reading as to farmers. *Most* of (25b) quantifies over the same set of farmers. The only difference between (25a) and (25b) is that the patient of the owning event of (25a) is all the donkeys that a farmer owns, while that of (25b) is any donkey(s) that a farmer owns. This shows that regardless of the interpretation of *a donkey*, the sentence has an asymmetric reading as to farmers, quantifying over a set of donkey-owning farmers. Therefore, it is explained why the proportional readings of relative clause donkey sentences are unambiguously biased to the head noun and why they are not affected by topic structure.

Before leaving this section, I discuss briefly how the semantics of donkey pronouns should look like in this framework. In Kwak (1996), I argue for the event-dependent interpretation of a donkey pronoun for several independent reasons. In this proposal, the semantics of a donkey pronoun is exactly like that of a cardinal NP, except that a relevant property is contextually provided.

(26) $\langle$"it", $DNP_{[-TOP]}$, $\lambda e[\sum(e)(P_n)]\rangle$

Compared with the semantics of an indefinite NP in (19b), the semantics of a donkey pronoun in (26) is exactly the same except that a relevant property is supplied by the context here. This is in the same line as the E-type approach of Cooper (1979).

Given that, the truth-condition of (22a) is represented as in (27).

(27) [[if a farmer^T owns a donkey^T, he usually beats it]] =

$most_e[\exists x \exists y[farmer'(x) \wedge donkeyt'(y) \wedge own'(e) \wedge AG(e) = x \wedge PT(e) = y \wedge \tau(e) = t_e \wedge \sigma(e) = s_e]\ \exists e'[beat(e') \wedge AG(e') = \sum(e')(P_0) \wedge PT(e') = \sum(e')(P_1) \wedge M(e) = e' \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]]$

The sentence is interpreted in a way that for most owning events at t_e and s_e such that the agent is a farmer and the patient is a donkey, there is a beating event e' matched with e such that the agent is all the individuals having a property P_0 in e' and the patient is all the individuals having a property P_1 in e', at $t_{e'}$ and $s_{e'}$. In the donkey sentence reading, P_0 and P_1 are assigned the properties of 'farmer' and 'donkey', respectively, and $t_{e'}$ and $s_{e'}$ are assigned the values of t_e and s_e, respectively, with respect to the event type of beating. This means that each event of the conditional clause is matched with another event of the matrix clause that includes the same participants. So (27) yields a reading that for most events involving a pair of farmer and donkey in the owning relation, there is an event of his beating his donkey.

5. Conclusion

I have discussed multiple proportional readings of donkey sentences and their sensitivity to topic structure. Before suggesting my proposal, I have critically reviewed previous analyses of Heim (1990) and Chierchia (1992). To derive multiple proportional readings, Heim postulates different sets of minimal situations for different proportional readings, and Chierchia proposes that Q-adverbs quantify over topic NPs. Both of the analyses provide a way to obtain multiple proportional readings; however, they have no explanation for why proper readings are determined by topic structure.

Based on my earlier study that indefinite NPs in topic positions are generalized quantifiers, and those of non-topic positions are event-dependent individuals, I have shown that the interpretations of donkey sentences are the result of the interaction between the semantics of indefinite NPs and the syntactic representations of topic structure.

The advantages of the present proposal over the previous analyses, are, first, topic sensitivity of donkey sentences is naturally explained from the semantics of indefinite NPs, which is independently motivated. Second, this proposal not only accounts for multiple proportional readings, but also shows that donkey sentences with a stage-level predicate may have an additional reading, namely a symmetric reading in a collective version.

Endnotes

1. Chierchia argues that the operation of disclosing the existentially bound event is to add an equation of the form e = e', i.e., to turn (ia) into (ib).

(i) a. $\exists^d e\uparrow[\text{in\_the\_bathtub}'(j)(e)]$

b. $\exists^d e\uparrow[\text{in\_the\_bathtub}'(j)(e)] \wedge^d \uparrow[e = e']$

$= \lambda e'[\exists^d e\uparrow[\text{in\_the\_bathtub}'(j)(e)] \wedge^d \uparrow[e = e']]$

$= \lambda e\uparrow[\text{in\_the\_bathtub}'(j)(e)]$

2. Chierchia (1992) proposes that the conservativity of a quantifier should be built into its lexical meaning.

(i) $D^d(P)(Q) = \uparrow D(\lambda x\downarrow[{}^\frown P(x)])(\lambda x\downarrow[{}^\frown P(x) \wedge^d {}^\smile Q(x)])$ (where P and Q are dynamic predicates)

Given that, (10) is rather interpreted as (ii).

(ii) $\uparrow\forall e[[\text{in\_the\_bathtub}'(j)(e)] \rightarrow \exists e'[\text{overlap}(e)(e') \wedge \text{in\_the\_bathtub}'(j)(e) \wedge \text{sing}'(j)(e')]]$

$= \lambda p[\forall e[[\text{in\_the\_bathtub}'(j)(e)] \rightarrow \exists e'[\text{overlap}(e)(e') \wedge \text{in\_the\_bathtub}'(j)(e) \wedge \text{sing}'(j)(e')]] \wedge {}^\smile p]$

3. The status of the existential disclosure of topic NPs is not quite convincing in Chierchia's article. The proposal of Dekker (1993) is based on the semantic consideration of implicit arguments. However, Chierchia's proposal of disclosing topic NPs is a semantic operation driven by a syntactic consideration, and has much departed from the original insight of Dekker's existential disclosure. Thus his proposal seems to need more semantic justification.

4. Here is the interpretation of (22a) according to the definition of *most* as a generalized quantifier.

(22a) is true iff $|A \cap B| > |A \cap B^{-}|$, where

$A = \{e: [[\exists x\exists y[\text{farmer}'(x) \wedge \text{donkey}'(y) \wedge \text{own}'(e') \wedge AG(e') = x \wedge PT(e') = y \wedge \tau(e') = t_{e'} \wedge \sigma(e') = s_{e'}]]]^{e'/e} = 1\}$, and $B = \{e: [[\exists e''[\text{he beats it at } e'' \wedge M(e') = (e'') \wedge \tau(e'') = t_{e''} \wedge \sigma(e'') = s_{e''}]]]^{e'/e} = 1\}$

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