

Presented at the 18th Annual Meeting of the Linguistics Dept., Univ. of Thessaloniki, Greece; May 1997

Aspectual effects on donkey anaphora

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Donkey sentences exhibit universal (exhaustive) and existential (non-exhaustive) readings for the indefinites involved and the pronouns anaphoric to them. In this paper, we investigate the role of aspect in determining which of the two readings will be available in a given discourse. Our language of investigation is Greek, which marks perfective and imperfective aspect clearly in the morphology of the verb, and show that existential readings arise only with perfective aspect. Adopting an E-type analysis for donkey pronouns as functions from contextually salient sets of individuals to individuals, we treat the existential interpretation in sentences with perfective aspect as the default contribution of indefinites. The universal readings will be regarded as the result of imperfective aspect making it possible to quantify over situations. From our analysis it follows that universal readings will not be available with Q-adverbs (which only combine with imperfective aspect), and the prediction is made that the interpretation possibilities observed in Greek will also be visible in languages with parallel aspectual distinctions.

1. INTRODUCTION

Our goal in this paper is to account for the contrast we observe in the Greek sentences in (1) and (2) in a way that can be shown to follow from the general principles that govern donkey-anaphora:

- (1) *Kathe xorikos pou ixē enan gaidaro ton ederne.*
every farmer that had.3sg a donkey him.cl beat.past.imperf.3sg
Every farmer who owned a donkey (used to) beat it.
- (2) *Xthes to mesimeri, kathe xorikos pou ixē enan gaidaro ton edire.*
every farmer that have.3sg a donkey him.cl beat.perf.past.3sg
Yesterday at noon, every farmer who owned a donkey beat it.

The contrast, which does not follow from any of the current analyses, is evident in the differing interpretations these two sentences have. Although both sentences can be understood as having the logical form in (3) or (4), depending on what analysis one assumes for indefinites and donkey pronouns (see discussion below):

- (3) $\text{EVERY}_{x,y}$ (farmer(x) (donkey(y) (own(x,y)) [beat (x,y)] (unselective binding)
 (4) EVERY_x (farmer(x) ((y (donkey(y) (own(x,y) [beat(x, f(x))]
 (E-type analysis))

only (1) is true if and only if the pronoun *ton* it is interpreted exhaustively on the indefinite *enan gaidaro* a donkey, i.e. iff all the (contextually relevant) farmers beat all the donkeys they own. Sentence (2) is true in this exhaustive scenario but it can also be true in the situation where a farmer does not beat all the donkeys he owns but just some of them. So (1) can be paraphrased as (1) whereas (2) is compatible with (1) as well as (2):

- (1) Every farmer who owned donkeys beat all the donkeys he owned.
 (2) Every farmer who owned donkeys beat some of the donkeys he owned.

Rooth 1987 and Heim 1990, among others, analyze quantificational determiners (QDets) such as *every* as double quantifiers of the form in (5), where the first component corresponds to the quantificational force of the QDet and the second to the exhaustive interpretation of the indefinite, thus predicting, incorrectly for Greek, that only the reading which is paraphrasable by (1) will be possible:

- (5) [*every*x (y (| ($\mathcal{E} = 1$ iff {x: {y: ($\mathcal{E} = 1$)} ({y: ($\mathcal{E} = 1$, that is,
 every x (y [farmer(x) & [donkey (y) & x owned y]] [x beat y]

We will reject the double quantifier analysis in favor of a less *ad hoc* account which will predict the two readings attested in Greek in a natural way.

Obviously, the contrast in (1) and (2) must be understood in terms of an aspectual opposition between the imperfective (giving rise to (reading only), and the perfective which allows for (-readings. This aspectual contrast grammaticalizes the opposition between the habitual/generic (imperfective) and the eventive/episodic (perfective), we will thus account for its effect on donkey anaphora by appealing to the semantic contribution of the two aspects.

Episodic sentences are about events and involve quantification over the individuals participating in those events. Imperfective aspect, on the other hand, involves quantification over situations, thus a situation variable is introduced and quantified over. Assuming, for reasons that will become obvious in section 2, that indefinites contribute by default existential quantifiers, the difference will be crucial as it yields two possibilities in the interpretation of the relevant assignment functions. When quantifying over individuals, assignments can be understood and evaluated either individually or, alternatively, as equivalence classes (Root 1985). When assignments are understood as equivalence classes existential readings arise. When quantifying over situations, no equivalence classes of assignments can be formed, hence only exhaustive (readings will be possible.

The two ways of quantifying reflect two distinct possibilities of individuating quantificational domains: in terms of situations and in terms of individuals. English sentences like *Every farmer who owned a donkey beat it* are ambiguous between these two ways of individuating/quantifying. In Greek, the ambiguity is resolved by aspect. Naturally, it is expected that the disambiguating role of aspect will be traced in other languages that grammaticalize aspectual distinctions similar to Greek.

The paper is organized as follows. Section 2 provides some background necessary to understand the problem we are discussing and put it in the right perspective. In section 3 we outline the particular theory of donkey anaphora we will be assuming and account for the aspectual contrast in Greek. We also discuss of existential readings which arise due to world knowledge and show how they readily follow from our analysis. We conclude by pointing out the unavailability of existential readings with lexical stative verbs in section 4. We argue that if one analyzes lexical stative verbs as inherently generic, as in Chierchia 1995b, the exclusion of nonexhaustive readings is in fact predicted by the proposed analysis.

2. DONKEY ANAPHORA: BASIC ISSUES AND WAYS OF DEALING WITH THEM

The term *donkey anaphora* refers to the phenomenon in which an anaphoric link is established between a pronoun and an indefinite NP (singular indefinite, bare NP or weak NP preceded by a cardinal such as *three students*) which does not c-command the pronoun. The examples in (6) illustrate donkey anaphora in relative clauses and *if/when*-clauses. (7) illustrates that anaphoric links from such positions are impossible with quantified NPs such as *every student* (for more discussion on the empirical characteristics of donkey anaphora see Chierchia 1995a):

- (6) a Every student that borrowed *a book from the library* returned *it* on time.
 b Usually, if a student borrows *a book*, he returns *it* on time.
- (7) a * Most students that borrowed *every book* from the library returned *it* on time
 b * Usually, if a student borrows *every book from the library* he returns *it* on time.

The analytic problem posed by sentences like (6) is the following. If we take anaphora to involve binding and assume a Russellian representation of indefinites as existential quantifiers as in (8) for (6a,b) respectively:

- (8) a (x (student(x) ((y (book(y) (borrowed-from-the-library(x,y)) [returned-on-time(x,y)]
- b USUALLY_s ((x (student(x) (s)) ((y (book(y) (s)) (borrow-book-from-the-library (x,y) (s)) [returned-on-time(x,y) (s)]

How can we account for the fact that the variables *y* in the scope of (and *usually* [returned-on-time(x,y)] are bound by what appears to be their antecedent (y book(y) which is embedded in the restriction of (and cannot scope out of it? In order to deal with

this problem we must make crucial decisions about the status of the indefinite and pronoun. There are two ways to go. We either accept the Russelian analysis for the indefinite and reject the bound variable status of the pronoun (cf. Evans 1977, 1980, Cooper 1979, Heim 1990 and Lappin & Francez 1994), or we reject the Russellian analysis of the indefinite and adhere to the bound variable of the pronoun, following Lewis 1975, Kamp 1981, Heim 1982 and Kadmon 1987, among others in the *unselective binding* tradition. In the former *E-type* strategy, the indefinites antecede the pronoun is epiphenomenal: the indefinite does not antecede the pronoun in the syntactic sense but, rather, the link between the two is pragmatic: the pronoun contributes a free variable, the indefinite sets up a domain and the pronoun is interpreted as a function from members of that domain to the set associated with the pronoun. The E-type analysis is thus a functional analysis.¹

In the unselective binding approach, both the indefinite and the donkey pronoun contribute free variables; they are bound by a quantificational (Q-) operator (a Qdet or a Q-adverb as in (6)) which thus act as *unselective binder*. In this analysis, (6a) would then look like (6a) and the problem with binding *y* in the scope of (would no longer arise :

(6a) $(\lambda_{x,y} (\text{student}(x) (\text{book}(y) (\text{borrowed-from-library}(x,y)) [\text{returned-on-time}(x,y)]$

Unselective binding has been shown to encounter a number of problems most of which have been extensively pointed out in the literature. Putting aside the proportion problem and the related worries about symmetric and asymmetric readings (and how to compute them in a non-stipulative way), perhaps the most serious problem is that unselective binding predicts that indefinites will always be interpreted exhaustively. Existential readings are expected to arise in the scope of quantifiers, since existential closure applies

¹ Note that retaining the existential analysis for the indefinites does not really entail subscribing to a functional analysis of the pronouns. Groenendijk & Stokhof 1991, Kanazawa 1994 and Chierchia 1992, 1995 develop an account for donkey sentences where the pronouns are in fact bound by the existential quantifier contributed by the indefinites. Binding is possible in these cases because the indefinites are not ordinary existential quantifiers but *dynamic* and can thus bind variables outside their syntactic scope. (5a) would be represented as in (i) where superscript *d* stands for *dynamic*:

(i) $(\lambda^d x [(p [\text{student} (x) ((\lambda^d y [\text{book}(y) (\text{borrowed-from-the library} (x,y) (\text{p} (\lambda^d (p [\text{returned-on-time} (x,y) (\text{p}])$

Dynamic binding theories specify dynamic interpretations not only for indefinites but also for universal quantifiers and several connectives, as we see in (i). For these theories, the existential readings are not a problem, rather, it is what they can explain successfully. It is not immediately obvious, however, how the universal readings can be made to follow from dynamic binding. Some of these theories, for instance Chierchia 1992, 1995 derive the universal readings by an E-type strategy, they thus invoke an ambiguity in the interpretation of the pronouns.

there, but such readings are predicted to be unavailable in restrictions. It has been pointed out, however, by a number of authors (cf. Pelletier & Schubert 1989, Neale 1990, Groenendijk and Stokhof 1991, de Swart 1991, Lappin & Francez 1994, Chierchia 1992, 1995) that indefinites may be interpreted existentially in restrictions too and that in some cases, this is indeed the preferred interpretation. Two such cases are illustrated below:

- (9) a Yesterday, every person who had a credit card paid his bill with it. (Cooper 1979)
 b Every person who has a dime will put it in the meter. (Pelletier & Schubert 1989)

It is unlikely, although of course still possible, to take (9a) to mean that each person paid with all the credit cards he had. The most reasonable reading of this sentence is the one in which each person pays with one of the cards he had. Likewise, (9b) is more likely to be true in a scenario in which each person will put just some of the dimes he has in the meter (according to how long (s)he wants to park for) and not all. Examples like (9) suggest a default existential analysis of the indefinites and motivate the appeal to the classic Russellian approach with the ensuing functional analysis of the pronoun. Interestingly, what is characterized here as existential interpretation is not strictly speaking existential, but rather *nonexhaustive*; in the course of this paper we will use the terminology *exhaustive* vs. *nonexhaustive* to refer to the universal and existential readings respectively.²

The availability of exhaustive and noneexhaustive readings in donkey sentences poses a challenge for any theory of donkey anaphora, and for any proposed theory to meet this challenge two things are required. First, the theory must provide a way of representing both readings, second, it should be able to explain the distribution of each reading. We need not discuss the current analyses in any detail here, in general terms, though, the unselective binding approach will have to be rejected given that it does not account for the existential readings. Heim 1990 proposes an E-type analysis which does away with the problem of the uniqueness presuppositions by invoking quantification over (minimal) situations for both nominal and adverbial quantifiers. This expresses a useful insight, but the existential readings remain still unaccounted for (for a detailed critique of Heim 1990 on precisely this point see Lappin & Francez 1994). Chierchia 1992, 1995 treats the existential/universal shift as a genuine case of ambiguity. On the existential reading, the donkey pronoun is a variable bound by the dynamic existential quantifier introduced by the indefinite (see fn. 1); on the universal reading, the pronoun is interpreted as an E-type function. Lappin & Francez 1994 (L&F) dismiss Chierchia's analysis for exactly this reason and develop a theory of E-type anaphora which explains the quantificational shift of donkey sentences without recourse to ambiguity.³ We will tackle

² The distinction has also been referred to as *weak* vs. *strong* readings (cf. Kanazawa 1994). We do not adopt this terminology because it seems very vague.

³ Another weak point of Chierchia and the theories of dynamic binding in general is that they envision the exhaustive / nonexhaustive contrast strictly speaking in terms of (vs. (.

this theory in some detail below because it provides the most articulate and successful analysis of the phenomenon to date.

L&F 1994 offer a novel analysis of E-type functions by adopting Links (1984) ontology of individuals. Link postulates that domains of individuals E contain atomic individuals as well as i(individual)-sums which are formed by the two place operation \cup which creates i-sums from the elements in E. L&F propose that donkey pronouns are functions which pick up, for each relevant individual a , an i-sum of individuals b such that a stands in a particular relation to b , noted as $*R$, a relation between an individual and an i-sum. An additional maximality constraint is assumed to apply in order to derive the universal reading as the default: the relevant E-type function selects the supremum among the i-sums that constitute its range. In this analysis, (5a) would have the truth conditions we see in (10):

- (10) \forall student who borrowed a book from the library returned it on time $\mid = 1$ iff
 $(\text{Students}(\{a: \{b: *borrowed-from-the-library(a,b)\} \cup \{1\}\}) \cup \{c: *returned-on-time(c, f(c))\})$

According to (10), (5a) is true iff every student who borrowed a sum of at least one book returned on time the entity which is the value of $f(c)$ where $f(c)$ is the denotation of the pronoun *it*. $f(c)$ is defined for individuals c such that c is a student who borrowed an i-sum of at least one book (i.e. $c \in (\text{Students}(\{a: \{b: *borrowed-from-the-library(a,b)\} \cup \{1\}\}))$). For each c , $f(c)$ is an i-sum in the set of $\{b: *returned-on-time(a,b) \cup \{1\}\}$. The supremum in this set is the maximal i-sum of at least one book which c borrowed from the library. If we apply the maximality constraint on $f(c)$ (which requires that for each argument c for which $f(c)$ is defined, $f(c)$ selects the supremum i-sum in its range, i.e. in this case the set of i-sums of at least one book that c borrowed from the library), then (10) specifies that (5a) is true iff every student that borrowed one book from the library returns on time the maximal i-sum of at least 1 book that he borrowed (for more discussion see L&F 1994).

The existential readings arise when the maximality constraint is suspended. When this happens, L&F claim that the E-type function is interpreted as a choice function from individuals to one of the non-maximal i-sums in its range. To illustrate, consider (9b) and its interpretation in (11):

- (11) \exists Every person who has a dime will put it in the meter $\mid = 1$ iff
 $(\text{Persons}(\{a: \{b: *have(a,b)\} \cup \{1\}\}) \cup \{c: *put-in-the-meter(c, f(c))\})$

$f(c)$ is a function which, for a person c who has an i-sum of dimes with the cardinality of at least 1, yields as its value one of the i-sums of dimes with a cardinality of at least 1

As we emphasized above, the quantificational shift is felt as a weakening of exhaustivity rather than as a polar opposition between a universal and an existential quantifier.

which *c* has.⁴ If we apply the maximality constraint to $f(c)$, this *i*-sum will be the supremum which contains all the dimes one has. If we suspend the constraint, $f(x)$ is a choice function which (arbitrarily) selects an *i*-sum of at least one dime that *c* has. What determines whether the maximality constraint will be suspended or not is pragmatics, more specifically, world knowledge. We know, for instance, that it is customary to just put only a few dimes in a parking meter at one time, and likewise, that we normally pay with one credit card at a time. L&F emphasize the role of the VP in encoding this world knowledge and they show that when the VP contains a predicate which does not carry this implicit cardinality restriction (i.e. that just one/some is enough), it is the universal reading that becomes dominant. This is shown in (12):

(12) Every person who has a credit card *pays a service charge for it*.

Paying a service charge for a credit card that one has is something one has to do for every credit card one possesses. Applying the maximality restriction is thus the unmarked value of the parameter associated with the condition expressed by the VP predicate. In other words, the default interpretation of donkey pronouns is the one which involves a functions from individuals to maximal *i*-sums.

Although the *i*-sum analysis of E-type functions affords an empirical coverage greater than any other analysis in that tradition and captures successfully our intuition about the interpretation of exhaustivity as a weakening effect, it is unable to handle the aspectual contrast we observe in Greek. Suspension of the maximality constraint in L&F is entirely a matter of pragmatics, and semantic interferences such as the one with aspect are entirely unexpected. The locus of aspect is the VP, but the effect is semantic, not pragmatic. Note that the pragmatic effects involving world knowledge are also available in Greek:

- (13) a *Kathe anthropos pou exi mia pistotiki karta plironi m aftin.*
every person that has a credit card pay.3sg with it
 Every person who has a credit card pays with it.
- b *Kathe anthropos pou exi mia pistotiki karta plironi ja tin ekdosi tis*
every person who has a credit card pay.3sg for the issue hers
 Every person who has a credit card pays a service charge for it.

Both sentences in (13) are in imperfective aspect, which normally excludes nonexhaustive readings, yet, (13a) is most naturally read with the existential reading. This shows that the aspectual effect we observed in (1) and (2) is independent of the

⁴ It should be obvious that the function we are dealing with here, although characterized as a choice function, does not seem to be a choice function proper (cf. Egli 1991, and for more recent applications Reinhart 1996 and Winter 1996). These authors define choice functions as functions which take a set of individuals as their domain and yield an individual member of that set as their value. The function of L&F which maps an individual to a nonmaximal *i*-sum assigns different types of values.

credit card-cases in (13) where world knowledge is the decisive factor. L&F can account for the latter but not for the former. One could, of course, *describe* the phenomenon in their terms and say that it is not only pragmatic world knowledge but also aspect that allows for suspension of the maximality constraint but an explanation of the role of aspect would still be missing.

In the next section we propose an E-type account of donkey anaphora which expands on the the insights of the previous literature in order to account for the aspectual effect we observe in Greek. Unlike L&F, we take the existential reading of donkey sentences to be their basic reading and derive the universal as the result of the nature of quantification over situations, building on Lewis 1975, Heim 1990 and Krifka et al. 1995. We assume in advance that problems relating to uniqueness presuppositions can be dealt with along the lines of Heim 1990 and ignore them here.⁵

3. ASPECT AND E-TYPE ANAPHORA

Summarizing the discussion in the preceding section, we want a theory of donkey-anaphora from which we will be able derive the following facts:

(i) The availability of exhaustive and nonexhaustive readings and a way of predicting which reading will be available when, and why.

(ii) The connection between nonexhaustive readings and episodic aspect.

(iii) The connection between nonexhaustive readings and world knowledge.

The account will also have to capture the connection between exhaustive and nonexhaustive readings and the fact that the contrast arises as a weakening effect and not as a clear-cut opposition between an existential and a universal quantifier.

We examine episodic sentences first.

3.1. Episodic sentences

An episodic sentence with perfective aspect in Greek, as in (14), means either (15) or (16):

(14) *Kathe ksenos fititis pu dhanistike ena vivlio apo ti vivliothiki to epestrepse egeros.*
every foreign student that borrowed.perf.3sg a ook from the library it
returned.perf.3sg on-time

Every foreign student who borrowed a book from the library returned it on time.

(15) {x: x is a foreign student who borrowed at least one book y} ({x: x is a foreign student who borrowed at least one book y and returned the total number of the book(s) he borrowed on time}

⁵ Note that L&F ultimately resort to situations too in order to deal with donkey anaphora with Q-adverbs.

(16) $\{x: x \text{ is a foreign student who borrowed at least one book } y\}$ ($\{x: x \text{ is a foreign student who borrowed at least one book } y \text{ and returned some of the book(s) he borrowed on time}\}$)

(15) tells us that each foreign student (from a contextually relevant set of foreign students) who borrowed at least one book returned on time all the books he borrowed; (16) states that each student returned on time just some of the books he borrowed (and possibly all). Without any previous context both meanings are equally possible or impossible but an interpretation like (16) becomes more salient against a context like the one described in (17):

(17) There are rumors that the librarians of the *Letteren Bibliotheek* of the University of Groningen are very lenient towards foreign visiting students. There are reasons to believe that the two librarians working there let foreign students get away with not returning the books they borrow on time (for instance they do not force them to pay the required fine, and in effect, a lot of books are not returned on time since the foreign students feel safe in keeping them longer than a month (which is the maximum) without renewing the borrowing date). Today, April 22, there is going to be an official inspection and the two librarians are trying to figure out how to convince the inspection committee that they are doing their job right. They come up with a list of all the foreign students that borrowed some book or other on March 22 and luckily it turns out that each one of them had returned at least one of the borrowed books already. They print out the list with the exact dates and they present it to the committee.

In such a situation, the librarian may utter (14) and the inspection committee members can check the list for themselves and verify. In other words, for a reading like (16) there is distinction between borrowings of books by foreign students and returnings that count and borrowings and returnings that do not count and can therefore be ignored.

This idea can be formalized in the following way. Quantificational statements with QDets, in this case with *every*, involve subject-asymmetric quantification (thus they quantify over the prominent x variable bound by the QDet, in this case *every*) and are interpreted with respect to an assignment function g which assigns values to variables as in (18):⁶

(18) $\text{every } x (\mathcal{E} = 1 \text{ iff every assignment function } g \text{ that verifies the restrictor } (\text{ also verifies the scope } (.$

We assume furthermore that indefinites contribute existential quantifiers and that donkey pronouns are interpreted as E-type functions $f(x)$ where x is a member of a (contextually

⁶ One can prime the prominent variables which yield the asymmetric reading, as is done in Barker 1996. We do not follow this practice here since nothing crucial hinges on doing it.

salient) set of individuals and $f(x)$ assigns to x as a value an individual belonging to the set denoted by the indefinite. (14) would then instantiate the logical form in (19):

(19) $(x (\text{foreign-student}(x) ((y (\text{book}(y) (\text{borrowed-from-the-library}(x,y)) [\text{returned-on-time}(x, f(x))])$

We assign a value to interpret $f(x)$ when we proceed to verify the scope $($. Now, to see how (18) assigns the correct truth conditions to (14), that is, how it yields both exhaustive and nonexhaustive readings, consider the partial assignment functions specified in (20):

(20) $($: there are foreign students that borrowed at least one book from the library
 $($: the foreign students that borrowed at least one book from the library returned the book(s) they borrowed on time.

	x : foreign student	y :book	verifies $($	verifies $($
a.	st ₁	b ₁	yes	yes
b.	st ₂	b ₂	yes	yes

c.	st ₃	b ₃	yes	yes
d.	st ₃	b ₄	yes	yes
e.	st ₃	b ₅	yes	no
f.	st ₃	b ₆	yes	no

We have six distinct assignment functions here defined for the prominent variable x : one for each book. Four of these verify both $($ and $($ but two of them, namely e and f , do not verify the scope $($. Yet (14) is true in this situation under the nonexhaustive reading. What is then that enables this reading? We propose that it is the fact that assignments c to f form an equivalence class. We define equivalence classes of assignment functions in (21) (see also Root 1985, Barker 1996):

(21) Given a formula $($, two assignment functions g and g are members of the same equivalence class relative to $($ iff they agree on what they assign to all x variables that are free in $($.

Recall that for the truth of $every_x (($ it is crucial to have every assignment verifying both the restriction and the scope. In (20) there is (at least) one assignment in the equivalence class which does so. For the purposes of nonexhaustive readings, then, individual assignments and equivalence classes count the same, i.e. quantificational cases can be defined either in terms of the former or in terms of the latter, as suggested already in Root 1985 for adverbial quantifiers.

To phrase it otherwise, when we quantify over individuals the possibility is created to have equivalence classes of functions and we look at individual assignments

and equivalence classes to check for verification of (and (. Non-exhaustiveness thus arises as a by-product of the fact that quantification over individuals makes equivalence classes of assignments available, and hence individual assignments and equivalence classes constitute equally legitimate quantificational cases (cf. Lewis 1975). Some assignments in an equivalence class can be simply left out as irrelevant as long as at least one assignment behaves the way we expect it to (depending on the truth conditions of the relevant QDet). We record this in what we call the *Individual-based Quantification Principle* below (cf. Root 1985):

(22) *Individual-based quantification Principle*

In individual-based quantificational domains quantificational cases are provided by individual assignments and/or equivalence classes of assignments.

Root 1985 in fact proposes that equivalence classes replace individual assignments in the definition of what constitutes a quantificational case: individual assignments present the simplest case of equivalence class.

Note that (23), where there is no assignment relevant to the st_3 verifying the scope, does not assign the correct truth conditions to (14):

(23)	<i>x: foreign student</i>	<i>y: book</i>	<i>verifies (</i>	<i>verifies (</i>
a.	st_1	b_1	yes	yes
b.	st_2	b_2	yes	yes

c.	st_3	b_3	yes	no
d.	st_3	b_4	yes	no
e.	st_3	b_5	yes	no
f.	st_3	b_6	yes	no

This is so because with *every* it is expected that for each quantificational case there will be at least one assignment that will verify the restriction and the scope. With *i perisoteri* most, which has the truth conditions in (24), it is expected that the number of cases that verify both (and (is greater than the number of cases that do not:

$$(24) \text{ most}_x ((\mathcal{G} = 1 \text{ iff } |(\mathcal{G}| > |(\mathcal{G}|$$

Hence a sentence like (25) below is true under the assignments in (23):

(25) I perisoteri kseni fitites pu dhanistikan ena vivlio apo ti vivliothiki to epestrepsan egeros.
most foreign students that borrowed.perf.3pl a ook from the library it returned.perf.3pl on-time

Most foreign student who borrowed a book from the library returned it on time.

Interestingly, (25) is true under the assignments in (23) despite the fact that, ultimately, the number of books returned on time is smaller than the number of books that were not returned on time. This should be attributed to the subject asymmetric nature of the quantification in conjunction with the equivalence classes and individual assignments counting as equivalence classes.

Nonexhaustive readings in the credit card cases are derived exactly the same way. In the event that a person x has more than one credit cards, an equivalence class is created and therein it is required that there be at least (and, under realistic assumptions, at most) one assignment that satisfies (((cf. examples (9a,b)).

From the assumption that nonexhaustiveness arises because equivalence classes are made available when quantifying over individuals, it follows that nonexhaustiveness will come about as a weak effect: depending on the context, in any given equivalence class we are free to ignore assignments, and in some cases we just look at only one. Exhaustive and nonexhaustive readings are then naturally connected; exhaustive readings present the case where we look at all assignments and we do not ignore any of them. This choice too will be determined by the context of utterance. We will argue in 3.3. that the exhaustive readings imposed by world knowledge (e.g. the credit card cases) come about as the result of world knowledge preventing us from ignoring any assignment..

Let us see now how this account explains why nonexhaustive readings will not arise in habitual/generic sentences with imperfective aspect.

3.2. Habitual/generic sentences

Habitual/generic, or *characterizing* sentences (in the sense of Krifka et al. 1995) express generalizations over situations of the form in (26):

- (26) HAB/GEN_{s,s} ((...s...)) ((...s...))
where s , s are situation variables

HAB/GEN stands for the (abstract) habitual or generic operator which is taken to be an adverbial-like dyadic quantifier with a restriction (and a scope (and which binds a situation variable in (and/or ((along with individual variables under unselective binding assumptions). HAB/GEN may be implicit or explicit; Q-adverbs are overt realizations of it. In habitual/ generic sentences, then, the domain of quantification is individuated based on situations and every situation constitutes an individual quantificational case. Given the definition of an equivalence class of assignment functions in (21), it follows that equivalence classes of situations will not be possible: two assignments may agree on what they assign to x , but they cannot agree on what they assign to s ; any s will be distinct from any other s as long as an assignment to individual variables in s assigns a different value to at least one individual variable in s . We call this the *situation-based individuation principle* and we state it below (in a preliminary version; cf. 3.3 for the final, augmented version):

(27) *The Situation-based Individuation Principle*
(preliminary)

A situation s is distinct from a situation s just in case there is at least one individual in s that is not in s .

The intuition behind (27), namely that any two situations are identical iff they involve exactly the same individuals otherwise they are not, is often voiced in the literature (cf. Kratzer 1989, Heim 1990, Krifka et al. 1995, among others). Containment relations between situations are naturally assumed to exist among situations: it is possible to have $s < s$, where $<$ is the part-of relation, but this would not make the two situations equal: s would be a larger situation containing s , but still it would be different from it.

In the previous section we saw that nonexhaustive readings arise because individual-based quantification (a) makes equivalence classes of assignments available, and (b) allows us to consider all or just some of the assignment in a class. Because generalizations over situations are subject to (27) equivalence classes among situations will not be possible.⁷ From this, it follows that nonexhaustive readings in situation-based individuated domains will be impossible. Imperfective aspect in Greek flags a situation-based individuated domain, it is therefore expected that imperfective sentences will exclude nonexhaustive readings. That this is the case becomes evident in sentences with Q-adverbs (which obligatory take the imperfective), as well as in sentences with QDets with imperfective aspect. We illustrate both cases below.

Consider first a sentence like (28), with the Q-adverb *panda* always:

- (28) (Ekini tin epoxi), otan enas fititis danizondan ena vivlio, to epestrefe panda egeros.
(*that the era*) *when a student borrowed.imperf.3sg a book, it returned.imperf.3sg*
always on time

At that time, when a student borrowed a book, he always (used to) return it on time.

That we are dealing with a statement about situations becomes apparent in English by the well-formedness of *used to* in the translation. (28) has the logical form in (29): it tells us that all of the situations in which students borrowed books, students returned on time all the books they borrowed. In (29), the Q-adverb is assumed to bind only s , but an unselective binding representation would give the same truth conditions. We adhere to the E-type analysis here for uniformity with the QDet cases; $f(x)$ is the E-type function for students and $f(x)$ the E-type function for books:

- (29) ALWAYS_{s, s} ((x (student(x) in s) ((y (book (y) in s) (borrowed ((x,y) in s))
[returned-on-time (f(x), f(x)) in s]), that is,
{s: there is at least one student x and one book y in s, such what x borrowed y in s}
({s: the student x from s returned on time in s the book(s) he borrowed in s}⁸

⁷ Although, as we said, containment relations are. Crucially, if a situation contains or is contained in another situation, the two situations are not equivalent.

⁸ This expresses the same with Heimss 1990 condition formulated in terms of minimal situations.

Sentence (28), then, will be true under the assignments in (30) but not under the ones in (31), because there are two assignments in (31), namely d and e, which do not verify (:

(30) (: when a student borrowed a book
(: returned it on time

	<i>s:situation</i>	<i>x: student</i>	<i>y:book</i>	<i>verifies (</i>	<i>verifies (</i>
a.	s ₁	st ₁	b ₁	yes	yes
b.	s ₂	st ₂	b ₂	yes	yes
c.	s ₃	st ₃	b ₃	yes	yes
d.	s ₄	st ₃	b ₄	yes	yes
e.	s ₅	st ₃	b ₅	yes	yes

	<i>s:situation</i>	<i>x: student</i>	<i>y:book</i>	<i>verifies (</i>	<i>verifies (</i>
a.	s ₁	st ₁	b ₁	yes	yes
b.	s ₂	st ₂	b ₂	yes	yes
c.	s ₃	st ₃	b ₃	yes	yes
d.	s ₄	st ₃	b ₄	yes	no
e.	s ₅	st ₃	b ₅	yes	no

Likewise, a sentence like (32) with *kathe* every will be true under (30) but false under (31):

(32) (Ekini tin epoxi), *kathe* fititis pu danizondan ena vivlio, to epestrefe egeros.
(*that the era*) every student that borrowed.imperf.3sg a book, it returned.imperf.3sg
on time
At that time, when a student borrowed a book, he always (used to) return it on time.

We can analyze (32) as involving an implicit adverbial like *panda* always which takes wide scope, subordinating thus the quantification of *kathe* every under it, as in (33):

(33) ALWAYS_{s,s} ((x ((student(x) in s) ((y ((book(y) in s) (borrowed-from-the-library ((x,y) in s))) [returned-on-time(x, f(x) in s])

The exhaustive reading for (32) arises as a consequence of the embedding under the implicit Q-adverb. Given our discussion in the previous section, the analysis here entails that exhaustive readings with QDets come about as results of two distinct strategies. In individual-based individuated domains, exhaustiveness is the result of considering all the assignments in a given equivalence class, but in situation-based individuated domains,

exhaustiveness is the result of quantifying over situations and embedding under an implicit habitual operator.

As we noted already, Greek distinguishes the two ways of individuation by means of aspectual marking. A perfective donkey sentence involves quantification over individuals, whereas an imperfective one involves quantification over situations. The absence of perfective vs. imperfective marking in English, and perhaps more concretely, the absence of perfective marking, makes it possible to analyze all donkey sentences as quantifying over situations. It is because of this, we believe, that donkey sentences with QDets do not have salient nonexhaustive readings in English.

3.3. *Nonexhaustive readings and world knowledge*

As we noted in section 2, nonexhaustive readings are allowed in donkey sentences due to world knowledge. We provide here the relevant examples in Greek:

- (35) *Kathe anthropos pou exi mia pistotiki karta plironi m aftin.*
every person that has a credit card pay.imperf.3sg with it
Every person who has a credit card pays with it.
- (36) *Xthes to vradi, kathe fititis pou ixh mia pistotiki karta plirose m aftin.*
yesterday the night every student that had a credit card paid.perf.3sg with it
Last night, every student who had a credit card paid with it.

Sentence (35) has imperfective aspect and sentence (36) is in the perfective. Both sentences exhibit nonexhaustive readings, in fact in both sentences nonexhaustive readings are the preferred ones: one usually pays with just one of them, and likewise, every student last night. Recall that, as pointed out in Lappin and Franchez 1994, sentences like (35), (36) contrast with cases like (37), where nonexhaustive readings are excluded:

- (37) *Kathe anthropos pou exi mia pistotiki karta plironi ja tin ekdosi tis.*
every person who has a credit card pay.3sg for the issue hers
Every person who has a credit card pays a service charge for it.

L&F attribute the contrast to world knowledge: in (37) we know that, normally, if one has credit cards, one pays a service charge for each one of them. In our analysis, the question is how to capture the world knowledge effect, and more specifically, how to account for the fact that nonexhaustive readings arise in situation-individuated domains where the analysis predicts that they would not.

As regards the first question, our answer would be that there is a pragmatic constraint associated with the predicates like *pay a service charge* which would impose exhaustiveness by forcing us to consider all assignments in the relevant equivalence classes. Remember that this option is indeed open in individual-based individuated domains, and that it is ultimately the context that decides whether assignments will be ignored or not. Thus, in a way, the effect of the context we observe in (37) is the reverse of the effect of context (17): world knowledge determines that no assignments should be

ignored. Every assignment in this case will count as a quantificational case and this follows naturally from our individual-based quantification principle in (22).

Consider now the second question, i.e. why (35) exemplifies the nonexhaustive reading in a situation-based individuated domain where, according to our analysis, only exhaustive readings are expected. This appears to be a problem if we assume that the assignments for (35) would run as in (38):

- (38) (: there are students who have at least one credit card
 (: the students who have at least one credit card pay with the credit card they own

	<i>s:situation</i>	<i>x:person</i>	<i>y:credit card</i>	<i>verifies (</i>	<i>verifies</i>
(
a.	s ₁	p ₁	cr ₁	yes	yes
b.	s ₂	p ₂	cr ₂	yes	yes
c.	s ₃	p ₃	cr ₃	yes	yes
d.	s ₄	p ₃	cr ₄	yes	no
e.	s ₅	p ₃	cr ₅	yes	no

We see in (38) that p₃ owns three credit cards but (s)he doesn't pay with all three of them in all given situations. (S)he pays with just one, namely cr₃. Is this, however, the correct reading for sentence (35)? The answer is negative: in a setup like (38), (35) would have to mean that p₃ always pays with cr₃, but what is understood in (35) is not that the credit card owner uses just one credit card in general, but rather that (s)he uses one credit card at a time, and possibly a different one each time. So, the weakening effect is not of the type we observed in the episodic cases, but rather, it is felt as pseudo-effect: the person who owns three credit cards normally pays with one of them in a specific situation, but (s)he probably uses a different one from one situation to the other, ending up using all the credit cards across situations. Pragmatic world knowledge imposes the constraint that it is normal to pay with just one credit card at a time, but what happens is that the more-than-one credit card owner uses all of his/her cards in some situation or other. Such a state of affairs would correspond to the assignments in (39):

	<i>s:situation</i>	<i>x:person</i>	<i>y:credit card</i>	<i>verifies (</i>	<i>verifies</i>
(39)					
(
a.	s ₁	p ₁	cr ₁	yes	yes
b.	s ₂	p ₂	cr ₂	yes	yes
c.	s ₃	p ₃	cr ₃	yes	yes
d.	s ₄	p ₃	cr ₃	yes	...no
e.	s ₅	p ₃	cr ₄	yes	yes
c.	s ₆	p ₃	cr ₄	yes	no

f.	s ₇	p ₃	cr ₅	yes	...yes
g.	s ₈	p ₃	cr ₅	yes	no

For each one of the credit cards p₃ owns, there exist assignments which do and do not verify the scope. This captures the intuition that in some situations p₃ uses one credit card, say cr₃, and in some other situations he does not use this particular card, and likewise for each card he owns. This gives us indeed the correct truth conditions for (35) capturing the weakening effect and exhaustiveness vis-a-vis the involved individuals at the same time. (39) does not give us exhaustiveness with regard to situations (as in the cases discussed in 3.2), but this should be seen as a relaxing constraint on exhaustiveness allowed by world knowledge: world knowledge makes equivalence classes of individual assignments visible inside distinct situations.

Note, however, that a set of assignments like (39) appears to contradict our principle in (27) which postulated that any two situations differ from each other just in case they involve distinct individuals. In (39), we have three pairs of situations which involve the same individuals: s₃ and s₄, s₅ and s₆, and s₇ and s₈, yet we have individuated the state of affairs they represent as distinct situations. We did so based on the fact they involve different relations: in each pair, in one situation (holds, and in the other it holds that ((. This presents a clear intuition about what situations are (cf. Barwise and Perry 1983). We incorporate this idea in our Situation-based Individuation Principle whose final version we give below:

(40) *The Situation-based Individuation Principle* (final)

Two situations s and s are distinct from each other iff they involve different individuals and/or different relations between those individuals.

Next, we consider the stative vs. episodic distinction as an extension of our analysis.

4. LEXICAL STATIVES

In this section we elaborate on what appears to be a welcome consequence of our analysis: that nonexhaustive readings are not licensed in donkey sentences with lexical stative verbs. This fact relates to the general observation concerning the interaction between *partial* and *total* interpretations of verbs and plural NPs which goes back to Link 1984 (see also Rossdeutcher & Kamp 1992, Krifka 1996, and Yoon 1996 among others). The key observation is that with lexical statives predication distributes over the individuals in the denotation of the plural NP, but with episodic verbs it does not.⁹ The contrast is exemplified in (41) and (42) (from Yoon 1996):

⁹ In the category of lexical statives we place individual-level predicates and dispositional ones like *know French* or *love Amy*. Under episodic predicates, on the other hand, we

- (41) The children (who ate pizza last night) got food poisoned.
 (42) The children (who are playing in the garden) are eight years old.

Sentence (41) contains an episodic predicate which may or may not hold for each one of the relevant children. Sentence (42), on the other hand, contains a lexical stative predicate which must hold of each one of the them. Consequently, (41) is true in a situation where some of the children did not get food poisoned, whereas (42) would be false in case at least one of the children is not eight years old.¹⁰ Episodic predicates are, then, *partial* and lexical stative *total*.

The partiality effect is reminiscent of the nonexhaustiveness we have observed in donkey sentences with episodic aspect in Greek. As far as lexical stative predicates are concerned, what seems to be extremely important for the analysis we outlined in the previous sections is that these verbs combine only with imperfective aspect and they thus give rise to only exhaustive readings. The first point is illustrated in (43):

- (43) a Gnorizo tin Theodra apo palia.
 know.imperf.1sg the Th. from old
 I know Theodora from long ago.
 b Gnorisa ti Theodora xthes.
 know.perf.1sg the Th. yesterday
 I met Theodora yesterday.

Sentence (43a) contains *gnorizo* to know and it means that I have the property of knowing Theodora from long ago. In (43b), perfective aspect has applied on *gnorizo* and a meaning shift has occurred: from know, an individual-level predicate, to meet, a stage-level. The behavior of *gnorizo* is indicative of how lexical statives and aspect interact in Greek and the meaning shift we witness here is typical for the whole class.

In (44), the main predicate is lexical stative and only the exhaustive reading is possible:

- (44) Kathe fititis pu milise menan kathijiti xthes to vradi , ton gnorize apo palia.
 every student that talked.perf.3sg with a professor yesterday the night, him
 knew.imperf.3sg
 Every student who talked to a professor last night knew him from long ago.

(44) will be true only if all the professors that were talked to last night were known from long ago by the students who talked to them. That this will be the only reading of (44) is expected under our analysis because of imperfective aspect, but in what sense do sentences with lexical stative predicates involve quantification over situations? We

assume stage-level predicates.

¹⁰ Sometimes there are issues pertaining to collectivity involved as in Links original example *The children built the raft*. In such cases one can claim that it is collectivity that disallows the predicate to distribute over the individual parts. With a predicate like *get food poisoned*, however, no interference of collectivity can be invoked.

believe that the answer to this question should be sought towards the direction of Chierchia 1995b, where it is argued that lexical statives are inherently generic predicates of the form in (45) where the situation variable is bound by the generic operator:

(45) know \Rightarrow $(x_1 (x_2 \text{GENs} (\text{in}(x_1, x_2, s)) [\text{know}(x_1, x_2, s)])$

In expresses a general locative relation which corresponds to the felicity conditions of the activity denoted by the predicate (for instance in the case of *know* the conditions under which one arrives at possessing knowledge). We will not present the analysis here, one can look at Chierchia 1995b for details. Suffice it to emphasize that the data from aspectual effects on donkey sentences and the link between statives and imperfective aspect presented here support the view of stative predicates as inherently generic.

5. CONCLUSION

In this paper, we have shown that aspect affects donkey anaphora: nonexhaustive readings are available only with imperfective aspect. We argued that the effect can be explained if we assume that aspectual marking makes visible two distinct ways of individuating quantificational domains: (a) individuation with respect to individuals (perfective), and (b) individuation with respect to situations (imperfective). In the former domains, nonexhaustiveness was shown to be a consequence of the fact that individual assignments and equivalence classes constitute equally legitimate quantificational cases. Nonexhaustive readings arise when the context forces us to ignore assignments in the equivalence classes. Situation-based individuated domains, on the other hand, do not make equivalence classes of assignments available. This was shown to explain why nonexhaustive readings are excluded from donkey sentences with nominal quantifiers and imperfective aspect, donkey sentences with adverbial quantifiers, and finally, lexical stative predicates.

Our analysis is cast in E-type terms, because the unselective binding approach is unable to account for the existence of nonexhaustive readings altogether. It is our contention that other languages with aspectual marking parallel to Greek will exemplify the same affect.

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