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Donkeys without borders*

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Abstract Donkey sentences have existential and universal readings, but they are not often perceived as ambiguous. We extend the pragmatic theory of nonmaximality in plural definites by Križ (2016) to explain how context disambiguates donkey sentences. We propose that the denotations of such sentences produce truth-value gaps — in certain scenarios the sentences are neither true nor false — and demonstrate that Križ's pragmatic theory fills these gaps to generate the standard judgments of the literature. Building on Muskens's (1996) Compositional Discourse Representation Theory and on ideas from supervaluation semantics, the semantic analysis defines a general schema for quantification that delivers the required truth-value gaps. Given the independently motivated pragmatic theory of Križ 2016, we argue that mixed readings of donkey sentences require neither plural information states, contra Brasoveanu 2008, 2010, nor error states, contra Champollion 2016, nor singular donkey pronouns with plural referents, contra Krifka 1996, Yoon 1996. We also show that the pragmatic account improves over alternatives like Kanazawa 1994 that attribute the readings of donkey sentences to the monotonicity properties of the embedding quantifier.

Keywords: donkey sentences, homogeneity, nonmaximality, pragmatics, trivalence, truth-value gaps, weak/strong (existential/universal) ambiguity

1 Introduction

It is an old observation that some donkey pronouns seem to be understood as having existential force and others as having universal force. The following pair is adapted from Yoon 1996:

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(1) Usually, if a man has a garage with a window, . . .
   a. he keeps it open while he is away.
   b. he keeps it closed while he is away.

On the most plausible reading of (1a), the donkey pronoun *it* could be paraphrased as *one of the windows in his garage* (except that there is no implication that the garage actually has more than one window). This is sometimes referred to as a weak or existential interpretation; following Chierchia (1992, 1995), we will call it the ∃-reading. As for (1b), on its most plausible reading, the meaning of the pronoun is paraphraseable as *all of the windows in his garage*. This is the strong or universal interpretation, and we will refer to it as the ∀-reading.[1]

Yoon (1994, 1996) and Krifka (1996) link this behavior of donkey pronouns to maximal and nonmaximal interpretations of plural definites. Imagine the following sentences, adapted from Krifka 1996, uttered among bank robbers in a situation where the local bank has a safe that is accessible through any one of three doors.

(2) (I wasn't/was able to reach the safe because . . .)
   a. The doors are closed.
   b. The doors are open.

As Krifka observes, in the situation just described, sentence (2a) expresses the fact that all of the doors are closed (a *maximal* interpretation), while sentence (2b) expresses the fact that at least some of the doors are open (a *nonmaximal* interpretation). These two readings naturally correspond to the ∀-reading and to the ∃-reading of donkey pronouns. On the basis of this kind of similarity, Yoon and Krifka develop a sum-based analysis of donkey sentences, in which the pronoun *it* in (1) is analyzed as referring to the mereological sum of all the windows in the garage in question. It is interpreted as number-neutral, that is, it does not presuppose that there is more than one window or door. Apart from this, it is essentially synonymous with the plural definite *the doors* in (2).

However, Kanazawa (2001) convincingly shows that singular donkey pronouns, unlike plural definites, cannot refer to sums. For example, singular donkey pronouns are incompatible with collective predication, while plural definites are compatible:

(3) a. Every donkey-owner gathers his donkeys at night.
   b. *Every farmer who owns a donkey gathers it at night.

This poses a challenge for analyses of the ∃/∀ dichotomy that try to reduce the behavior of donkey pronouns to that of plural definite descriptions. The goal of this paper is to develop a theory that meets this challenge but succeeds at predicting how

1 As Kanazawa (1994) notes, the weak/strong terminology is misleading, because when the embedding

context disambiguates donkey sentences embedded by determiners, and to show that the apparent complexity of the ∃/∀ dichotomy follows from the interaction of two relatively simple independently motivated formal systems: a pragmatic account of how context disambiguates plural definites and donkey sentences, and a lean dynamic semantics that delivers truth-value gaps for the pragmatics to fill. To avoid the problems that arise from interpreting pronouns as referring to sums, we locate the parallel between donkey pronouns and plural definites in the pragmatics rather than in the semantics. We claim that the semantics does not draw a border between the area of semantic space where a donkey sentence is true and the area where it is false; rather, the two areas are separated by a no-man's-land that gets apportioned in different ways depending on the pragmatics. Instead of trying to locate the border between the two areas, we claim that there is no border to begin with. As our pragmatic component, we adopt the implementation developed in Križ 2016 for plural definites. We assume that these truth-value gaps are filled at the sentence level, not at the level of plural definites or donkey pronouns. Donkey pronouns are not similar to plural definites; it is donkey sentences as a whole that are similar to sentences with plural definites.

The paper is structured as follows. Section 2 highlights the pragmatic nature of the ∃/∀ dichotomy by focusing on the role of context in disambiguating it. Section 3 is a brief summary of the theory developed by Križ (2016) for plural definites. Section 4 applies this theory to donkey sentences. Section 5 presents a fragment that delivers truth-value gaps as needed by building on standard compositional approaches to dynamic semantics (in particular, Muskens 1995, 1996). Section 6 compares the present account with previous work. Section 7 concludes.

2 The ∃/∀ dichotomy and the role of context

It is easy to judge the truth of the donkey sentence in (4) if no man treats any two donkeys differently. In such scenarios, if every man beats every donkey he owns, it is clearly true; if instead some man beats none of the donkeys he owns, it is clearly false.

(4) Every man who owns a donkey beats it.

Truth conditions become more difficult to ascertain in scenarios we will call *mixed*, namely those where every man owns and beats one donkey, and at least some men own additional donkeys that they do not beat (e.g. Parsons 1978, Heim 1982, Rooth 1987).

determiner is downward monotone in its nuclear scope, as in the case of *no*, the weak reading is the logically stronger of the two.

We will say that a donkey sentence has a *heterogeneous* interpretation if it is readily judged true in relevant mixed scenarios; otherwise, we will speak of *homogeneous* interpretations. An example whose most salient interpretation is homogeneous is (5a), adapted from Rooth 1987. It is homogeneous because it is judged false as soon as some father lets any of his 10-year-old sons drive the car, even if he has other 10-year-old sons that he forbids from driving it. Two heterogeneous examples are (5b), adapted from Schubert & Pelletier 1989, and (5c), from Chierchia 1995.

(5) a. No man who has a 10-year-old son lets him drive the car.
b. Usually, if a man has a quarter in his pocket, he will put it in the meter.
c. No man who has an umbrella leaves it home on a day like this.

As for (4) itself, Chierchia (1995) reports that although it is most readily interpreted in terms of a (homogeneous) ∀-reading, it turns out to allow quite clearly for (heterogeneous) ∃-readings in suitable contexts. Chierchia gives this context as a tongue-in-cheek example and attributes it to Paolo Casalegno (see also Almotahari 2011 for a different context manipulation):

(6) The farmers of Ithaca, N.Y., are stressed out. They fight constantly with each other. Eventually, they decide to go to the local psychotherapist. Her recommendation is that every farmer who has a donkey should beat it, and channel his/her aggressiveness in a way which, while still morally questionable, is arguably less dangerous from a social point of view. The farmers of Ithaca follow this recommendation and things indeed improve.

The distinction between homogeneous and heterogeneous readings cuts across the one between ∃-readings, such as (5a) and (5b), and ∀-readings, such as (5c). It also cuts across the distinction between determiner-based donkey sentences, such as (5a) and (5c), and adverbial ones, such as (5b), and across the one between downward monotone embedding determiners, as in (5a) and (5c), and upward monotone ones, as in (5b). Hence it is not possible to reduce one of these distinctions to another.

The influence of context on donkey sentences has been noticed before:

(7) Anyone who catches a Medfly should bring it to me.

Gawron, Nerbonne & Peters (1991) observe that the interpretation of (7) is different depending on whether the speaker is a biologist looking for samples on a field trip, in which case the ∃-reading emerges, or a health department official engaged in eradicating the Medfly, in which case the ∀-reading surfaces.

The account of these facts that we will develop is based on the following intuition. Sentence (4) can be paraphrased in a context-independent way as *Things are equivalent for current purposes to the way they would be if every donkey-owner*

beat all of his donkeys. Just what it means to be equivalent for current purposes can be stated in a context-independent way only for two limiting cases: On the one hand, equivalence is reflexive, so that if every donkey-owner actually beats all of his donkeys, (4) is definitely true. On the other hand, we assume that if some donkey-owner doesn't beat any of his donkeys, (4) is definitely false, just as (2b) is definitely false when no door is open.

Between the scenarios in which a donkey sentence is definitely true and those where it is definitely false lies a no-man's-land of mixed scenarios. When hearers are pressed to assign a definite truth value to a donkey sentence in such a mixed scenario, they are in effect asked to draw a clear border where the semantics does not provide one. To do this, hearers may resort to various pragmatic strategies. In particular, when the context makes it clear that the scenario can be treated as equivalent for current purposes to scenarios in which the donkey sentence has a definite truth value, they will take that into account. Essentially, this will be the case whenever it is clear how farmers who beat some but not all of their donkeys should be classified for the purposes of the embedding determiner. Whenever the context fails to make this clear, speakers will either hesitate to give any judgments, or they will err on the side of not assuming more equivalence than they have to.

To formalize this theory, we need to make these notions more precise. We turn to the theory in Križ (2016), which provides the scaffolding on which the pragmatic part of our account rests.

3 Križ (2016) on plural definites

Sentences with plural definites can receive different interpretations in different contexts in a similar way to donkey sentences. In certain contexts, a predicate can be judged to hold of a plurality denoted by a plural definite even if the predicate is not strictly speaking true of the whole plurality. This phenomenon has been referred to as *non-maximality* (Brisson 1998, 2003, Lasersohn 1999, Malamud 2012). For example, as mentioned before, if one can reach a safe by going through any one of three doors arranged side by side, and if two of these doors are open, the sentence *The doors are open* is readily judged true. But this is no longer the case if the doors are arranged in a sequence and one needs to pass through all of them. Put in the terms of our view on donkey sentences, *The doors are open* communicates roughly that things are equivalent for current purposes to the way they would be if all the doors were open. Thus, *The doors are open* is definitely judged true if all the doors are open, and definitely judged false if all of them are closed, no matter how they are arranged. If some but not all of them are open, judgments will depend on whether *enough* of the doors are open for the purposes of the conversation. In other words,

they will have to decide whether the state of affairs is more like one in which all the doors are open or more like one in which none of them are.

We adopt the theory in Križ (2016) because it is recent and lean; for similar and more elaborate accounts, see van Rooij 2003 and Malamud 2012. To characterize how these different interpretations arise, Križ (2016) assumes a salient Current Issue I, a partition of the set of worlds which gives rise to an equivalence relation $\approx_I$. Intuitively, $w \approx_I w'$ means that the Current Issue is resolved in the same way in w and w', and any differences between these two worlds are irrelevant for current purposes. A sentence S is judged true in a given context just in case it is *true enough at w with respect to I*, where being "true enough" means being true either at w itself or at some $w' \approx_I w$ (see D. Lewis 1979, Lasersohn 1999, Malamud 2012).[2]

Križ assumes that sentences can have truth-value gaps (van Fraassen 1969, Schwarzschild 1993). In a scenario when some but not all doors are open, *The doors are open* is literally (at the semantic level) neither true nor false. These literal truth values are not intended to directly reflect native speakers' intuitions. They are merely an intermediate step on the way towards computing pragmatic truth values. Križ motivates truth-value gaps via the phenomenon known as *homogeneity* or *polarity* (Löbner 1987, 2000). These terms refer to the fact that sentences with definite plurals and negations of such sentences are "neither true nor false when the plurality in question is mixed with respect to the property ascribed to it (modulo the exceptions allowed by non-maximality)" (Križ 2016: 494). Consider for example the following sentences:

(8) a. The books were written in Dutch.
b. The books were not written in Dutch.

The literal truth value of (8a) is true iff all the books are written in Dutch and false iff none of them are, while for (8b) it is the other way round; in all other cases, both sentences are neither true nor false.

Križ then proposes to relax the Gricean Maxim of Quality in the following way. A sentence S may be used at w to address an issue I even if it lacks a truth value at w, as long as it is true enough at w and not false at any $w' \approx_I w$. This means that speakers may utter a sentence even if they do not believe it to be true, as long as they do not believe it to be false at any world that is equivalent to the actual world. Sentences that are true enough are predicted to be judged true.

2 Current Issues are similar to questions under discussion (Roberts 2012) and to the way questions are modeled in Groenendijk & Stokhof 1984. Nevertheless, Križ (2016: Section 4.5) resists identifying Current Issues with questions under discussion. He sees the Current Issue as the overarching goal of the discourse participants, which is not necessarily equal to the last immediate question that has been explicitly asked in the conversation. We will remain neutral on how these two concepts are related.

Suppose for example that the Current Issue is whether there is a way to the safe. That is, suppose that $w' \approx_I w$ just in case the safe is reachable either in both w and w' or in neither w nor w'. Say the doors are arranged side by side. Consider two worlds w_{all}, where all the doors are open, and w_{some}, where two of three doors are open (a mixed scenario). These worlds are equivalent for current purposes, and *The doors are open* counts as true enough at both of them. Accordingly, it will be interpreted non-maximally (and hence, heterogeneously) as the proposition $\{w_{all}, w_{some}\}$. Now consider a context where the doors are arranged in sequence: w_{all} and w_{some} are no longer equivalent. Instead, w_{some} is equivalent to a world w_{none} where no door is open. Since w_{all} is the only world at which *The doors are open* is true enough, it is interpreted maximally (and hence homogeneously) as $\{w_{all}\}$.

4 Applying Križ 2016 to donkey sentences

As we have seen, for Križ (2016), instead of a clear semantic border, a truth-value gap divides the worlds in which a sentence with a definite plural is true from those in which it is false. At the worlds in this gap, the plurality in question is mixed with respect to the property ascribed to it. We have claimed that donkey sentences likewise lack a clear border between true and false scenarios. Let us now make this claim more precise by assuming that donkey sentences have truth-value gaps at worlds that correspond to mixed scenarios. Then we can apply the theory in Križ (2016) straightforwardly. Suppose the semantics assigns sentence (4), repeated here, the truth and falsity conditions below:

(9) Every man who owns a donkey beats it. = (4)

a. **true** iff every donkey-owner beats every donkey he owns;
b. **false** iff at least one donkey-owner does not beat any donkey he owns;
c. **neither** in all other cases, in particular, if every donkey-owner beats exactly one donkey and one of them owns a donkey he does not beat.

We will present a theory that delivers exactly these truth and falsity conditions in Section 5. For the purpose of exposition, though, pretend that there are only three possible worlds. Let w_{true} be a world where (9a) holds, w_{false} one where (9b) holds, and w_{mixed} one where (9c) holds. Assume that the Current Issue in scenario (6) is whether every farmer follows the recommendation to beat at least one donkey. Then $w_{true} \approx_I w_{mixed}$. Hence (4) is interpreted as $\{w_{true}, w_{mixed}\}$; this is a heterogeneous $\exists$-reading.[3] If we change the scenario so that the recommendation is to beat all one's

3 Note that this is shorthand. The account presented in Section 5 does not treat a sentence like (4) as denoting $\{w_{true}, w_{mixed}\}$ directly. Instead, at mixed worlds, (4) is mapped to the truth value **neither**. At this point, the pragmatics will treat this sentence as true just in case $w_{true} \approx_I w_{mixed}$.

donkeys, w_{mixed} and w_{false} are now equivalent to each other, but not to w_{true}. This time, (4) is not true enough at w_{mixed}. It is pragmatically interpreted as $\{w_{true}\}$. Since this proposition does not contain w_{mixed}, sentence (4) receives a homogeneous reading; and since at w_{true}, every donkey-owner beats all of his donkeys, this is a $\forall$-reading. Thus, this theory predicts that the pragmatic interpretation of (4) can be paraphrased roughly as *Things are equivalent to the way they would be if every man who owns a donkey beat all of his donkeys*, except that this paraphrase suggests that not every donkey owner actually beats all of his donkeys. For this paraphrase to make sense, the contribution of *equivalent* needs to be captured. This is precisely the role of our equivalence relation $\approx_I$.

Turning to sentences headed by *no*, we have seen that sentence (5c) has the $\forall$-reading. Assume that it has the following truth and falsity conditions:

(10) No man who has an umbrella leaves it home on a day like this. = (5c)

a. **true** iff no umbrella-owner leaves any of his umbrellas home;
b. **false** iff at least one umbrella-owner leaves all his umbrellas home;
c. **neither** in all other cases, in particular, if every umbrella-owner takes exactly one umbrella along, and someone also leaves one home.

As before, let w_{true}, w_{false} and w_{mixed} be worlds in which (10a), (10b), and (10c) are the case respectively. Suppose that the Current Issue is whether any man with an umbrella is getting wet. A man gets wet if he fails to take any umbrella along. This is the case at w_{false}. It is neither the case at w_{true} nor at w_{mixed}, so these two worlds are equivalent. Given this issue, (5c) is therefore true enough at both w_{true} and w_{mixed}. Since w_{true} is not equivalent to w_{false}, (5c) can be used to address the Current Issue at both w_{true} and w_{mixed}. This means (5c) will be pragmatically interpreted as $\{w_{true}, w_{mixed}\}$. Since this proposition contains w_{mixed}, this is a heterogeneous reading. Since the strongest thing we can say about both w_{true} and w_{mixed} is that no umbrella-owner left all of his umbrellas home, this is a $\forall$-reading.

Now let us consider a donkey sentence headed by *no* that has a homogeneous reading. Assume that sentence (5a) has the following truth and falsity conditions:

(11) No man who has a 10-year-old son lets him drive the car. = (5a)

a. **true** iff no man lets any son of his drive his car;
b. **false** iff at least one man has a son and lets all his sons drive his car;
c. **neither** in all other cases, for example, if every father allows one son to drive the car, and some of them have additional sons that they don't.

Let w_{true}, w_{false} and w_{mixed} match these propositions as before. Suppose that the Current Issue is whether there are reckless fathers. A father who allows just one of his sons to drive the car is just as reckless as one who gives permission to all of his

sons. Reckless fathers are absent from w_{true} but present at both w_{false} and w_{mixed}, so $w_{false} \approx_I w_{mixed}$. Hence (11) is true enough only at w_{true}. Since $w_{true} \not\approx_I w_{false}$, (11) can be used to address the Current Issue. This means (5a) will be pragmatically interpreted as $\{w_{true}\}$. Therefore, (11) receives a homogeneous reading. Since at w_{true}, no father lets any of his sons drive the car, this is the $\exists$-reading.[4]

The existential and universal reading are endpoints on a continuum whose interior is notoriously difficult to probe, particularly for embedding determiners like *most*. Thus, Rooth (1987) remarks: "Consider *Most farmers who own a donkey beat it*: does it mean that most farmers who own a donkey beat all of the donkeys they own, that most farmers who own a donkey beat most of the donkeys they own, or that most farmers who own a donkey beat some of the donkeys they own? I am simply not sure, and informants I have consulted have not expressed strong or consistent opinions." The theory we present here treats the $\exists/\forall$ dichotomy as a case of underspecification rather than ambiguity, and generates $\exists$-readings, $\forall$-readings, as well as intermediate interpretations. One case in which such intermediate interpretations are arguably attested is discussed by Kanazawa (1994: 116):

(12) a. Every student who took a course from Peter last year liked it.
b. Most students who took a course from Peter last year liked it.

As Kanazawa reports, native speaker judgments suggest that "while [(12a)] clearly requires every student to like every course he or she took from Peter, [(12b)] can be judged true even in situations where half of the students who took a course from Peter didn't like some of the courses they took from him. . . . Responses from [his] informants did not indicate that [(12b)] has the weak reading, however. The exact truth conditions of [(12b)] seem unclear." These judgments are expected under the assumption that (12a) evokes the Current Issue *Were Peter's courses universally well-liked?* while (12b) evokes *Were Peter's courses generally well-liked?* Given this assumption, our account predicts that (12b) is interpreted as *Things are equivalent for current purposes to the way they would be if most students in Peter's courses liked all of the courses they took from Peter*. On our account, the less-than-universal threshold that is inherent in the generic quantifier *generally* is transmitted to sentence (12b) via the Current Issue; although we do not attempt to formally capture this, it is natural to expect that uncertainty about that threshold results in uncertainty about what this Current Issue is, specifically uncertainty about which what proportion of classes one needs to like in order to count as a relevant class-liker.

4 Some donkey sentences are formulated in such a way as to make mixed scenarios logically or practically impossible, such as *Most farmers who own exactly one donkey beat it* or *Most men who have a Social Security number know it by heart* (see Kanazawa 1994: p. 113). For the latter sentence, the "mixed" scenarios would involve people who have more than one Social Security number (something impossible in the US American context).

Our account relies on the assumption that hearers interpret a sentence as addressing an issue that is made salient by the discourse. This is a common assumption in theories of information structure (Roberts 2012). There is evidence that both adults and children use this assumption to disambiguate sentences in context, even when no question has been explicitly asked (Gualmini et al. 2008). Following Križ (2016: 514), we take the formal notion of a *Current Issue* to represent the overarching goals of the discourse participants, as relevant to the conversation. These goals can but need not be determined by the immediate last question in the conversation. When the Current Issue cannot be easily identified or accommodated, sentences that are neither true nor false at the semantic level cannot be assigned a pragmatic truth value, and speakers may become confused and give guarded judgments. Hearers can try to infer from sentences and scenarios what the Current Issue might be; that is, they can *accommodate* issues. For example, Križ (2016) proposes an alignment principle that he relates to David Lewis's notion of Aboutness:

(13) **Addressing an issue**
A sentence S may not be used to address an issue I if there are w_1 and w_2 such that $w_1 \approx_I w_2$ and S is true at w_1 but false at w_2.

If hearers assume that speakers follow this principle, they will generally be able to infer many properties of the Current Issue from the sentence.

The question how interlocutors converge on the Current Issue given the state of the discourse is currently open in the literature on pragmatics. For relevant discussion on the constraints on question accommodation and pointers to the literature, see Beaver & Clark (2008: Section 2.7); a similar question is discussed in connection with plural definites in Križ (2016: Section 4.5). For example, Beaver & Clark propose that accommodated issues must maximize the relevance of the sentence and that they must be *calculable*; that is, they must be jointly identifiable by speaker and hearer as a common means to discourse goals. Calculability arguably prevents hearers of (4) from accommodating unusual Current Issues such as *Does every donkey-owning farmer beat at least one donkey he owns and moreover every male donkey he owns?*

A further possibility is that the relationship between Current Issues and the sentences that address them is constrained by question-answer congruence, i.e. the notion that the answer and its focus alternatives must match the possible answers of the question (e.g. Roberts 2012). This might be the reason why (12a) does not evoke Current Issues such as *Did all of Peter's students like more than half of the classes they took with him?* and cannot be used to answer such questions in the affirmative. Formalizing question-answer congruence would require clarifying what it means for

a trivalent proposition to match a possible answer to a question and what the focus alternatives of donkey sentences are; we leave this for future work.

To sum up this section, we have a simple pragmatic theory that expects the semantic component to pass it a trivalent proposition and a Current Issue (an equivalence relation over possible worlds). The theory maps the trivalent proposition to an ordinary bivalent proposition that is true in mixed scenarios whenever the Current Issue lumps those scenarios together with worlds at which the proposition is true.

5 A trivalent dynamic compositional semantics

With a pragmatic theory in place that combines trivalent meanings with Current Issues to deliver disambiguated readings, the next step consists in delivering these trivalent meanings compositionally. We will do so in a version of CDRT described in Muskens 1995. This fits our overall strategy of showing how the apparent complexity of the $\exists/\forall$ dichotomy follows from the interaction of two relatively simple independently motivated formal systems.

As mentioned earlier, many early theories assumed that donkey pronouns can pick up both atoms and sums as discourse referents, so that the donkey pronoun in (4) could be paraphrased as *the donkey or donkeys he owns* (Lappin & Francez 1994, Yoon 1994, 1996, Krifka 1996). But as we have seen, Kanazawa 2001 argues convincingly that singular donkey pronouns can only have atomic discourse referents. With this is mind, several frameworks have been proposed that do not interpret singular donkey pronouns as sum individuals, in particular, dynamic systems such in the tradition of Groenendijk & Stokhof 1991. An earlier version of this work, which we discuss in Section 6.6, relied on Brasoveanu's (2008) plural compositional discourse representation theory (plural CDRT or PCDRT) to generate and manage discourse referents (Champollion 2016). In this paper, we eschew PCDRT in favor of a simpler CDRT variant that does not make use of plural assignments. In Section 6, we argue that donkey ambiguities do not require the full power of PCDRT.

At the core of dynamic systems is the notion of assignment. Assignments keep track of anaphora by relating discourse referents d, e, f etc. to entities x, y, z etc. Muskens's (1995) Logic of Change situates dynamic semantics in a version of Ty2 (Gallin 1975) that includes a third basic type, s, in addition to the usual e, the type of entities, and t, the type of truth values. There are two common strategies for conceptualizing the way that s-type objects track anaphora (Janssen 1983, Muskens 1991). Either s is taken to be the type of discourse referents, in which case assignments are modeled as functions from discourse referents to their values, or s is taken to be the type of assignments, in which case discourse referents are modeled as functions from assignments to values. As long as these values all have the same type, such as individuals, the choice between these two options does not matter.

Since we are only interested in anaphora to individuals, we use the primitive type s for discourse referents (of which we assume that there are infinitely many) and we represent assignments as functions of type $\langle s,e\rangle$. The converse choice would also be possible and is in fact adopted in Muskens (1991, 1995, 1996) and in Brasoveanu (2007, 2008). Since those works treat assignments as primitive, they provide sets of axioms to ensure that these *assignment objects* behave in the way *assignment functions* do. Such axioms are unnecessary here.

Suppose i and j are assignments and d is a discourse referent. We want $i[d]j$ to mean that i and j agree on all things except possibly on the value they assign to d. This is guaranteed by the following definition:[5]

(14) $\quad i[d]j \equiv \forall d'_s.\, d' \neq d \rightarrow i\,d' = j\,d'$

Sentences denote relations over assignments. By convention, we will use i, i', etc. as variables over the first component of a main clause relation, and o, o', etc. as variables over the second. These letters are mnemonics for *input* and *output* respectively. When intermediate assignments are needed, we write j, j', etc. for them. We let d, e, f and primed versions thereof range over discourse referents. To make it easier for the reader to keep track of discourse referents, we use the letters d and f for discourse referents associated with the words *donkey* and *farmer*, respectively. Finally, $\mathbf{t}$ abbreviates the type $\langle se, \langle se, t\rangle\rangle$.

Like many other dynamic theories, CDRT assumes that anaphoric links are encoded in LFs through coindexation. Determiners are superscripted with the discourse referents they introduce, and anaphoric elements such as pronouns are subscripted with the discourse referents they pick up. For example, here is sentence (4) with the relevant annotations:

(15) every farmer who owns a^d donkey beats it$_d$

The lexical entries in Table 1 are based on Muskens (1995: section 5) with slight modifications. Determiners are not included in the table, with the exception of the indefinite *a*. In line with common practice in dynamic frameworks, we treat indefinites separately from other determiners. The restrictor and nuclear scope of sentence (4) reduce to the following by a series of lambda conversions and equivalent simplifications:

5 We use the following notational conventions. Dots separate binding operators — including λ, $\exists$, and $\forall$ — from the formulas that they quantify over. The scope of an operator extends as far to the right as possible (until the edge of the nesting group), so for instance, in the formula $(\exists x.\, Px \wedge Qx) \wedge Rx$, the variable x is bound in $Px \wedge Qx$, but free in Rx. Prefixal lambdas are collapsed: $\lambda f x.\, f\,x$ abbreviates $\lambda f.\, \lambda x.\, f\,x$. Finally, arguments are passed into functions without the aid of parentheses (which are used only for grouping), so that $f\,x$ represents f applied to x, $i\,d$ represents i applied to d, etc.

Phrase	*Type*	*Translation*
farmer	$\langle e,\mathbf{t}\rangle$	$\lambda xio.\, i = o \wedge \mathsf{farmer}\, x$
donkey	$\langle e,\mathbf{t}\rangle$	$\lambda xio.\, i = o \wedge \mathsf{donkey}\, x$
who	$\langle e\mathbf{t},\langle e\mathbf{t},e\mathbf{t}\rangle\rangle$	$\lambda PQxio.\, \exists j.\, Qxij \wedge Pxjo$
owns	$\langle\langle e\mathbf{t},\mathbf{t}\rangle,e\mathbf{t}\rangle$	$\lambda Gx.\, G(\lambda yio.\, i = o \wedge \mathsf{own}\, xy)$
beats	$\langle\langle e\mathbf{t},\mathbf{t}\rangle,e\mathbf{t}\rangle$	$\lambda Gx.\, G(\lambda yio.\, i = o \wedge \mathsf{beat}\, xy)$
a^d	$\langle e\mathbf{t},\langle e\mathbf{t},\mathbf{t}\rangle\rangle$	$\lambda PQio.\, \exists j \exists j'.\, i[d]j \wedge P(jd)jj' \wedge Q(jd)j'o$
it_d	$\langle e\mathbf{t},\mathbf{t}\rangle$	$\lambda Pio.\, i = o \wedge P(id)io$

Table 1 Basic translations

(16) a. $\lambda xio.\, \mathsf{farmer}\, x \wedge i[d]o \wedge \mathsf{donkey}\,(od) \wedge \mathsf{owns}\, x\,(od)$
b. $\lambda xio.\, \mathsf{beats}\, x\,(id) \wedge i = o$

In the restrictor, (16a), the indefinite *a donkey* introduces the discourse referent d and makes sure it picks out a donkey. The variable x ranges over individuals; its value must be a farmer who owns the donkey in question. It is the job of the embedding determiner to pass on the assignments obtained in this way to the nuclear scope, (16b), which examines each assignment as to whether the farmer beats the donkey picked out by d.

This sketch leaves open what happens if a farmer owns two or more donkeys. In such a case, the restrictor will have a different output assignment for each donkey the farmer owns. The question arises whether the nuclear scope of *every* should process only one of these assignments picked at random or all of them. Generalized quantifiers can be lifted into the dynamic setting in two ways, each corresponding to one of these options (Chierchia 1995).

We propose that both options are operative in the semantics of donkey sentences. An embedding determiner like *every*, *no* or *exactly two* checks whether they both lead to the same outcome. If they do, the sentence as a whole is assigned that outcome as a classical truth value; otherwise, it receives the truth value **neither**.

Our proposal is independently motivated by the findings in Experiment A3 of Križ & Chemla 2015, who asked participants to evaluate the truth of sentences like (17) with respect to pictures that involved four cells, all filled with shapes of different colors.

(17) In exactly 2 of the 4 cells, the shapes are blue.

The embedded plural definite *the shapes are blue* is the source of trivalence in this example. It is true in cells that contain only blue shapes (“all-blue cells”), false in cells that contain no blue shapes (“no-blue cells”) and neither true nor false in cells

that contain both blue and non-blue shapes ("mixed cells"). Križ & Chemla ran their experiment to determine the way in which this trivalent behavior projects to sentence (17). To this purpose, they varied the number of cells on display of each type, holding the sentence constant, and they gave participants the answer options *completely true*, *completely false*, and *neither*. On the whole, participants who saw two all-blue and two non-blue cells judged (17) completely true; those who were shown fewer than two cells with any blue shapes in them judged it completely false, as did those who saw more than two all-blue cells; and they judged (17) neither true nor false when exactly two cells had any blue shapes, but at most one of these cells was all-blue. In other words, whenever both (18a) and (18b) have the same truth value in a given scenario, participants judged (17) to have that truth value, and otherwise they judged (17) neither true nor false.

(18) a. In exactly 2 of the 4 cells, all the shapes are blue.
b. In exactly 2 of the 4 cells, at least some of the shapes are blue.

In the following, we generalize this pattern by abstracting away from the specific embedding quantifier and from the specific source of trivalence. To implement our proposal formally, we first define the two type shifters $\mathfrak{E}$ and $\mathfrak{A}$, which lift a static determiner D of type $\langle et, \langle et, t\rangle\rangle$ into its internally dynamic counterparts. These type shifters correspond to the schemata $\mathscr{Q}_w$ and $\mathscr{Q}_s$ in Kanazawa 1994: 138, where they are attributed to Chierchia; similar schemata are sketched in Heim (1990) and attributed to unspecified previous literature. Here we write R and N for the restrictor and nuclear scope of these dynamic determiners; these variables are both of type $\langle e, \mathbf{t}\rangle$ because they each take an individual and return a dynamic proposition.

(19) a. $\mathfrak{E} \stackrel{\text{def}}{=} \lambda DRNi.\, D\,(\lambda x.\, \exists j.\, Rxij)\,(\lambda x.\, \exists j.\, Rxij \wedge \exists o.\, Nxjo)$
b. $\mathfrak{A} \stackrel{\text{def}}{=} \lambda DRNi.\, D\,(\lambda x.\, \exists j.\, Rxij)\,(\lambda x.\, \forall j.\, Rxij \rightarrow \exists o.\, Nxjo)$

On the basis of these type shifters, we define a new type shifter that takes a static determiner D and returns an internally dynamic determiner that behaves as desired:

(20) $$\mathfrak{D} \stackrel{\text{def}}{=} \lambda DRNio.\, \begin{cases} \textbf{true} & \text{if } i = o \wedge \mathfrak{E}DRNi \wedge \mathfrak{A}DRNi \\ \textbf{false} & \text{if } i = o \wedge \neg\mathfrak{E}DRNi \wedge \neg\mathfrak{A}DRNi \\ \textbf{neither} & \text{otherwise} \end{cases}$$

In particular, this determiner returns **true** when $\mathfrak{E}$ and $\mathfrak{A}$ are both true; it returns **false** when they are both false; and it returns **neither** when they disagree. In order to maintain compatibility with the rest of the grammar, we also equip the lifted determiner with two lambda slots for input and output assignments. To keep things simple, and because this paper does not deal with discourses, we require these

assignments to be identical, making the lifted determiner externally static. For the same reason, we omit the treatment of discourse referents introduced by embedding determiners.

In many cases, the truth conditions that result from the $\mathfrak{D}$ type shifter can be presented in a simplified way. For example, in the case of *every*, the $\mathfrak{A}$ proposition asymmetrically entails the $\mathfrak{E}$ proposition; for *no*, it is the other way around. Taking this into account, the output of $\mathfrak{D}$ for these two determiners can be represented as follows:

(21) $$\mathfrak{D}_{every} \stackrel{\text{def}}{=} \mathfrak{D}\,(\llbracket\text{every}\rrbracket) = \lambda RNio.\begin{cases} \textbf{true} & \text{if } i = o \wedge \\ & \quad \forall x.\,(\exists j.\,Rxij) \rightarrow \forall j.\,Rxij \rightarrow \exists o'.\,Nxjo' \\ \textbf{false} & \text{if } i = o \wedge \\ & \quad \exists x.\,(\exists j.\,Rxij) \wedge \neg\exists j.\,Rxij \wedge \exists o'.\,Nxjo' \\ \textbf{neither} & \text{otherwise} \end{cases}$$

(22) $$\mathfrak{D}_{no} \stackrel{\text{def}}{=} \mathfrak{D}\,(\llbracket\text{no}\rrbracket) = \lambda RNio.\begin{cases} \textbf{true} & \text{if } i = o \wedge \\ & \quad \forall x.\,(\exists j.\,Rxij) \rightarrow \forall j.\,Rxij \rightarrow \neg\exists o'.\,Nxjo' \\ \textbf{false} & \text{if } i = o \wedge \\ & \quad \exists x.\,(\exists j.\,Rxij) \wedge \forall j.\,Rxij \rightarrow \exists o'.\,Nxjo' \\ \textbf{neither} & \text{otherwise} \end{cases}$$

In the case of nonmonotonic determiners like *exactly one* or *an even number of*, the $\mathfrak{A}$ and $\mathfrak{E}$ propositions do not stand in an entailment relation. As a result, these determiners look somewhat more complex when they have been lifted. For example, here is $\mathfrak{D}_{ex.one}$:

(23) $\mathfrak{D}_{ex.one} \stackrel{\text{def}}{=} \mathfrak{D}(\llbracket\text{exactly one}\rrbracket) =$

$$\lambda RNio.\begin{cases}\textbf{true} & \text{if } i=o \wedge \\ & \quad \left(\begin{array}{l} 1=\left|\{x \mid \exists j.Rxij \wedge \exists o'.Nxjo'\}\right| \wedge \\ 1=\left|\{x \mid (\exists j.Rxij) \wedge \forall j.Rxij \rightarrow \exists o'.Nxjo'\}\right| \end{array}\right) \\ \textbf{false} & \text{if } i=o \wedge \\ & \quad \left(\begin{array}{l} 1>\left|\{x \mid \exists j.(Rxij \wedge \exists o'.Nxjo')\}\right| \vee \\ 1<\left|\{x \mid (\exists j.Rxij) \wedge \forall j.Rxij \rightarrow \exists o'.Nxjo'\}\right| \end{array}\right) \\ \textbf{neither} & \text{otherwise}\end{cases}$$

To understand the behavior of nonmonotonic quantifiers, it is helpful to keep in mind that the output of $\mathfrak{D}$ produces a definite truth value whenever it does not matter how doubtful cases are resolved. For example, *An even number of farmers who have a donkey beat it* is interpreted as definitely true just in case the number of farmers who beat all their donkeys, and the number of farmers who beat at least one donkey, are both even; and definitely false just in case these numbers are both odd. This reflects our intuition that a donkey sentence embedded by a cardinality quantifier has a definite truth value just in case nothing hinges on the counting scheme that is adopted.

To bridge the gap between semantics and pragmatics, we define truth and falsity relative to an assignment as follows:

(24) **Bridging Principle 1**
Let i be an assignment and ϕ be a term of type **t**.

a. ϕ is true relative to i iff there is an assignment o such that $\phi\, i\, o$ is true.
b. ϕ is false relative to i iff it is not true relative to i and there is an o such that $\phi\, i\, o$ is false.
c. In all other cases, ϕ is neither true nor false relative to i.

There is an asymmetry in the definition of truth relative to an assignment. Falsity requires non-truth relative to i, while truth does not require non-falsity. This is so that externally dynamic sentences like *A man arrived* come out true but not false in models that contain a man who arrived and some other entity, such as another man, who did not arrive.

For sentences and discourses without unresolved anaphoric dependencies, we define truth and falsity simpliciter by universally quantifying over input assignments:

(25) **Bridging Principle 2**
Let ϕ be a term of type **t**.

a. ϕ is true iff it is true relative to every input assignment.
b. ϕ is false iff it is false relative to every input assignment.
c. In all other cases, ϕ is neither true nor false.

We restrict Bridging Principle 2 to sentences that do not have unresolved anaphoric dependencies in order to avoid collapsing the truth conditions of pronouns and corresponding universals. That is, a sentence like *He sat down* would have the same truth conditions as *Every man sat down* under this second principle.

These entries and principles deliver the desired truth and falsity conditions for our examples. As we have seen, the restrictor phrase *farmer who owns* a^d *donkey* reduces to (16a), and the nuclear scope phrase *beats* it_d reduces to (16b). After plugging these terms into the entry in (21) and appealing to the two bridging principles, we obtain the following truth and falsity conditions:

$$
(26)\quad \begin{cases}
\textbf{true} & \text{if } \forall i \forall x.\ (\exists j.\ \mathsf{frm}\, x \wedge i[d]j \wedge \mathsf{dnk}\,(j\,d) \wedge \mathsf{own}\, x\,(j\,d)) \\
& \qquad \rightarrow \left(\begin{array}{l} \forall j.\ (\mathsf{frm}\, x \wedge i[d]j \wedge \mathsf{dnk}\,(j\,d) \wedge \mathsf{own}\, x\,(j\,d)) \\ \qquad \rightarrow \mathsf{beat}\, x\,(j\,d) \end{array}\right) \\
\textbf{false} & \text{if } \forall i \exists x.\ (\exists j.\ \mathsf{frm}\, x \wedge i[d]j \wedge \mathsf{dnk}\,(j\,d) \wedge \mathsf{own}\, x\,(j\,d)) \\
& \qquad \wedge \left(\begin{array}{l} \forall j.\ (\mathsf{frm}\, x \wedge i[d]j \wedge \mathsf{dnk}\,(j\,d) \wedge \mathsf{own}\, x\,(j\,d)) \\ \qquad \rightarrow \neg\, \mathsf{beat}\, x\,(j\,d) \end{array}\right) \\
\textbf{neither} & \text{otherwise}
\end{cases}
$$

These are the desired truth and falsity conditions. That is, the sentence is true only if every donkey-owning farmer beats all of their donkeys, and false only if some donkey-owning farmer beats none of their donkeys. Analogously for sentence (11), we obtain the following result from the entry in (22) and the bridging principles:

$$
(27)\quad \begin{cases}
\textbf{true} & \text{if } \forall i \forall x.\ (\exists j.\ \mathsf{man}\, x \wedge i[d]j \wedge \mathsf{son}\, x\,(j\,d)) \\
& \qquad \rightarrow \left(\begin{array}{l} \forall j.\ (\mathsf{man}\, x \wedge i[d]j \wedge \mathsf{son}\, x\,(j\,d)) \\ \qquad \rightarrow \neg\, \mathsf{lets\text{-}drive}\, x\,(j\,d) \end{array}\right) \\
\textbf{false} & \text{if } \forall i \exists x.\ (\exists j.\ \mathsf{man}\, x \wedge i[d]j \wedge \mathsf{son}\, x\,(j\,d)) \\
& \qquad \wedge \left(\begin{array}{l} \forall j.\ (\mathsf{man}\, x \wedge i[d]j \wedge \mathsf{son}\, x\,(j\,d)) \\ \qquad \rightarrow \mathsf{lets\text{-}drive}\, x\,(j\,d) \end{array}\right) \\
\textbf{neither} & \text{otherwise}
\end{cases}
$$

Once again, these are the desired conditions. The **true** case states, roughly, that there is no way of assigning a man to any son of his such that the man in question lends

the son in question his car. The **false** case states that there is a man who has at least one son and who lends every one of his sons the car.

Our fragment attributes trivalence in donkey sentences to their embedding determiners, such as *every* in the classical example. This raises the question of whether the indefinite determiners that antecede donkey pronouns should be taken to be trivalent as well. We expect the answer to this is no. In our fragment, trivalence is introduced by the $\mathfrak{D}$ schema, a mechanism for reinterpreting static relations between properties (generalized quantifiers) in such a way that they accommodate context updates in their restrictors and nuclear scopes. But in all dynamic frameworks, indefinites are *inherently* dynamic; at their core, they denote operations that introduce discourse referents into contexts. Thus there is never any need to apply $\mathfrak{D}$ to indefinite determiners, since they are already dynamic, and thus never any resulting trivalence. In fact, since $\mathfrak{D}$ is only defined on static generalized quantifiers, we predict not only that there is no *need* to apply $\mathfrak{D}$ to indefinites, but that there is no *opportunity* to do so in any case. For example, the only reading that our fragment predicts for sentence (28a) is described by the formula in (28b).

(28) a. A farmer who owns a donkey beats it.

b. $\lambda io.\exists j.i[f]j \wedge \mathsf{farmer}(jf) \wedge$
$j[d]o \wedge \mathsf{donkey}(od) \wedge \mathsf{own}(of)(od) \wedge \mathsf{beat}(of)(od)$

This corresponds to an $\exists$-reading of the sentence. It is true just in case some farmer owns and beats some donkey, and false otherwise. The $\forall$-reading would additionally require that farmer to beat every donkey he owns. We predict this reading to be absent. While this appears to be correct, we will see in Section 6.3 that any putative $\forall$-readings of upward entailing embedding determiners would be very hard to detect anyway (Geurts 2002). In any case, no problem arises from the fact that $\mathfrak{D}$ cannot apply to embedding instances of *a*.

Assigning *a* an inherently dynamic type and thereby putting it into a separate semantic class from other determiners is common in dynamic frameworks, and is usually motivated at least in part by the different behavior of indefinite determiners, which can bind and take scope out of islands, and quantificational operators, which cannot. Admittedly, it is not always easy to draw the line between these two classes; for relevant discussion, see for example Kamp & Reyle (1993: Chapter 4) and Szabolcsi (1997). That said, we suggest treating the word *some* the same way as *a*. Other indefinite determiners, such as bare numerals, can be treated as ambiguous between the two types. As for true quantifiers like *every* and *no* and modified numerals like *at most two*, we assume that they only have the static type, which requires $\mathfrak{D}$ for any sort of dynamicity. When such modified numerals do introduce

(external) discourse referents, we assume that this is due to an abstraction operation that is compatible with static types (Kamp & Reyle 1993, Nouwen 2003).

To summarize, this section has shown how a simple variant of CDRT can be used to deliver trivalent meanings to a pragmatic component, independently motivated by Križ 2016, that can disambiguate those sentences that are neither true nor false relative to the Current Issue.[6] The following section compares our approach to previous accounts of the interpretation of donkey sentences. In each case, we argue that the account presented here is preferred, either in terms of its formal simplicity or conceptually in how it assigns work to the semantics and pragmatics.

6 Comparison with previous work

There are factors other than the Current Issue that are involved in the interpretation of donkey sentences. Different donkey sentences seem to differ in the clarity of people's intuitions about them in neutral contexts and in the degree to which they are susceptible to manipulation by context. The exact nature of such differences is far from an established fact. The question of which factors affect the $\exists/\forall$ dichotomy has been taken on by many authors (Heim 1990, Gawron, Nerbonne & Peters 1991, Chierchia 1992, 1995, Geurts 2002, Foppolo 2012). We first focus on three proposals that are similar in spirit to ours in that they do not postulate a semantic ambiguity: Kanazawa 1994, Barker 1996, and Geurts 2002. The related question of how to formally represent the ambiguity has been addressed thoroughly as well (e.g. Groenendijk & Stokhof 1991, Dekker 1993). In this respect, our theory is similar to many accounts couched in ordinary dynamic predicate logic or compositional versions thereof, such as compositional DRT (Muskens 1995, 1996). We focus our comparison on more recent accounts that use Plural Compositional DRT to represent the ambiguity (Brasoveanu 2008, 2010, Champollion 2016).

6.1 Kanazawa 1994

Kanazawa 1994 investigates the properties of donkey sentences with determiners and relative clauses, focusing on the monotonicity properties of the static version of the embedding determiner. He aims to describe and explain generalizations about

6 While we treat Križ's (2016) pragmatics as a separate component by which trivalent meanings are (potentially) disambiguated, there are other interesting options that collapse these separate components into a single semantic system. For instance, a reviewer suggests we could treat the notion "true enough" as a modal operator with an accessibility relation given by $\approx_I$, which could interact compositionally in donkey sentences as we have interpreted them here. This would be an interesting formal system to explore in future work; we believe, though, that the result would only differ architecturally with the account presented here.

how existential and universal readings correlate with these monotonicity properties. He models the $\exists/\forall$ dichotomy by defining two dynamic generalized quantifiers for each determiner, derived via the type shifters we have referred to as $\mathfrak{A}$ and $\mathfrak{E}$, and by postulating interpretive principles that motivate these type shifters and constrain the choice between them. While subsequent authors have sometimes understood this as a claim that determiners are ambiguous, King & K. S. Lewis (2016: n. 31) point out that Kanazawa takes himself to be simply "modeling" the readings of donkey sentences and not actually proposing a semantics.

While Kanazawa acknowledges the role of context in selecting an interpretation of a given donkey sentence, he addresses the way this happens only briefly in the last paragraph of his paper. His tentative suggestion is that when the speaker's meaning is clear from the beginning, the hearer does not have to figure out what is meant, and consequently will not go into the trouble of invoking inference. For a critique of this view, see Geurts (2002: 150f.).

With respect to the distribution of existential and universal readings, Kanazawa notes that the effect of the determiner *every*, at least relative to other determiners like *most*, *no*, and *at least two*, is to make the $\forall$-reading more readily available. In fact, his sense is that sentences with *every* have a default preference for the $\forall$-reading, though he acknowledges that there are clear examples of the $\exists$-reading with *every* as well. As for the determiners *no*, *some*, *several*, and *at least n*, he claims that they have only $\exists$-readings. In a static framework, the difference between these quantifiers and *every* can be characterized in terms of their monotonicity conditions (Barwise & Cooper 1981): *every* is downward monotone on its restrictor but upward monotone on its nuclear scope; *no* is downward monotone on both sides; and *some* and *at least two* are upward monotone on both sides. Based on these and other examples, Kanazawa claims that all other things being equal, the availability of $\exists$-readings and $\forall$-readings of donkey sentences headed by a determiner is systematically related to the monotonicity properties of that determiner. While the strength of these defaults, especially the $\exists$-reading preference for *no*, has not gone unchallenged, our analysis can make sense of these preferences.

We propose that donkey sentences often appear to have a default reading because sentences presented in absence of any clues as to what the Current Issue might be are typically interpreted as if they had been uttered in what we call a fact-finding context. For us, a fact-finding context for a sentence S is a context that is focused on truth simpliciter; that is, the issue I in the context is such that for all w and w', if $S(w) = \textbf{true}$ and $S(w') = \textbf{neither}$ then $w \not\approx_I w'$. Our notion of a fact-finding context is inspired by what Roberts (2012) calls the Big Question ("What is the way things are?") and what van Rooij (2003) calls "What is the world like?"; see also Malamud (2012). The Big Question is an extreme case of a fact-finding context. A donkey sentence that is interpreted in a fact-finding context will always be interpreted as

having a homogeneous reading. For donkey sentences headed by *every*, this is the ∀-reading. This accounts for Kanazawa's generalization that the default interpretation of a determiner that is downward monotone on its restrictor and upward monotone on its nuclear scope is the ∀-reading.[7]

We can also make sense of another generalization proposed by Kanazawa, namely that determiners that are downward monotone on both their restrictor and their nuclear scope (such as *no*, *few*, and *at most n*) only have the ∃-reading.[8] This follows immediately by assuming that the default context is fact-finding, because fact-finding contexts give rise to ∃-readings for these kinds of determiners. Kanazawa discusses exceptions from this generalization; on our account, such exceptions are expected in non-default (that is, non-fact-finding) contexts. The sentences in (29) are precisely this kind of exception because, in virtue of world knowledge and their truth conditions, they make Current Issues salient that are not fact-finding, such as: *Did every card-owner pay by card?* and *Did Peter get all of his books back?* In both these sentences, to the extent that intuitions are clear, the ∀-reading is the most prominent, as noted in Kanazawa (1994).

(29) a. No man who had a credit card failed to use it.
b. Not all students who borrowed a book from Peter returned it.

While our proposal that default readings of donkey sentences arise from fact-finding contexts is novel, the idea that special contexts can override default readings of donkey sentences is not new. Kanazawa (1994) attributes this example to David Beaver (p.c.):

(30) A: John has a silver dollar. He didn't put it in the charity box.
B: No, everybody who had a coin put it in the box.

As he notes, the context created by A's utterance makes the ∀-reading of B's response the only sensible interpretation.[9] This makes sense on the present account if we

7 Kanazawa extends this generalization to determiners such as *not every* and *not all* that are upward monotone on their restrictor and downward monotone on their nuclear scope. We discuss these determiners in Section 6.3.

8 Kanazawa extends this generalization to determiners that are *upward* monotone on both their restrictor and their nuclear scope, and his formal account further generalizes it to all intersective determiners. We discuss these determiners later in this section.

9 Barker 1996 provides a similar example, a tweak on the classic quarter example, shown in (31), which prefers the ∀-reading for contextual reasons. In particular, the question of whether the meter is fed does not apply to slot machines, and so the ∀-reading emerges.

(31) *Scenario:* We are talking about the behavior of men in gambling casinos.
Usually, if a man has a quarter in his pocket, he will put it in the slot machine.

assume that A's utterance gives rise to the Current Issue *Did anybody keep any of their coins?* More generally, we can recast questions about the availability of various readings as questions about the availability of various Current Issues. This can shed light on certain examples that Kanazawa raises that appear to resist modification by context. For example, (32) does not have the ∃-reading, even though the surrounding material supports it and it is the weakest way for B to contradict A.

(32) A: John doesn't have any quarters. He used all his quarters to buy a Coke.
B: No, everybody who had a quarter kept it, so he must have at least one quarter left.

Our account makes sense of this because the dispute between A and B concerns the question *Did John use all his quarters?*, which speaker B denies by answering the stronger question *Which quarter-owners, if any, used all their quarters?* with *None of them*. Against this Current Issue, though, B's utterance in (32) is expected to have the ∀-reading because it resolves the issue in the same way whether the semantics assigns it **true** or **neither**. That is to say, as long as every quarter-owner kept at least one quarter, it already follows that none of them used all their quarters; and this remains the case regardless of how many quarter-owners kept all their quarters.

One benefit of the theory developed here is that it accounts for the observation that "people have firm intuitions about situations where farmers are consistent about their donkey-beating" while they give "varied and guarded judgments" in mixed scenarios (Rooth (1987); see also Parsons (1978)). This behavior is expected on the natural assumption that hearers will hesitate just in case (i) they cannot easily identify a Current Issue, and (ii) they are given a donkey sentence and a scenario that leads to a truth-value gap. Consistent situations will not give rise to truth-value gaps. It has been proposed that donkey pronouns carry uniqueness conditions of various sorts (Parsons 1978, Cooper 1979, Kadmon 1990). One class of consistent situations includes those where uniqueness conditions are met, for example if every farmer owns at most one donkey. Another class of consistent situation is the following:

(33) *Scenario:* Sage plants are sold in batches of nine.
Everybody who bought a sage plant here bought eight others along with it.

This example was brought up by Heim (1982) to argue against certain types of uniqueness conditions on pronouns. Kadmon (1990) argues that speakers who accept

10 This idea foreshadows our supervaluationist treatment of quantifiers. The connection to supervaluation treatments of vagueness was noted by Mats Rooth (p.c.) in Heim 1990: n. 11. Heim argues against Kadmon's supervaluationist idea by pointing out that judgments on a variant of the car-driving example (11) are more secure than Kadmon predicts them to be. We take it that this is because example (11) makes it easy to accommodate a Current Issue, namely whether there are reckless fathers.

it do so in spite of uniqueness conditions because it cannot make any difference to truth conditions which sage plant the pronoun stands for.[10]In the two classes of consistent situations described, our semantics delivers a classical truth value, so there is no need for the hearer to accommodate or default to a Current Issue. We consequently predict that speakers should not hesitate to give clear judgments in these situations. This is in line with a speculation by Kanazawa (1994):

> [P]eople are capable of assessing the truth value of a donkey sentence without resolving the 'vagueness' of the meaning given by the grammar when there is no need to do so. For our purposes, it is enough to assume that underspecification causes no problem for people in assigning a truth value to a donkey sentence in situations where the uniqueness condition for the donkey pronoun is met. These are a special class of consistent donkey-beating situations, and the uniqueness condition can be checked just by looking at the extensions of the predicates in the N' of the sentence. (Kanazawa 1994: p. 152)

The present account extends Kanazawa's perspective to all consistent donkey-beating situations. Consider for example the sage-plant scenario in (33). Even though the uniqueness condition for the pronoun in (33) is not met, the present account still predicts that sentence (33) is true in that scenario no matter what the Current Issue is, because the scenario does not give rise a truth-value gap.[11]

There is a conceptual difference between our account and that of Kanazawa (1994). We have accounted for the fact that a donkey sentence is readily judged true just in case both its $\exists$-reading and its $\forall$-reading is true, and false just in case both of them are false, by assuming that determiners are lifted into a dynamic framework via the type shifter $\mathfrak{D}$ in (20). Of course a different type shifter would have led to different predictions; for example, we could have defined $\mathfrak{D}$ based on some other Boolean combination of $\mathfrak{E}$ and $\mathfrak{A}$ than the one we actually used. Thus, the question arises why the $\mathfrak{D}$ type shifter as we defined it is the operative one in natural language. Kanazawa 1994 asks an analogous question for the type shifters he proposes. His own explanation is in terms of the monotonicity properties of the embedding determiners. Specifically, Kanazawa claims that his interpretive principles reflect a tendency for donkey sentences to preserve valid inferential

11 On the present account, even some mixed scenarios are assigned a classical truth value by the semantics and are therefore not dependent on the Current Issue for their interpretation. Thus if every man owns two donkeys, John beats neither of his donkeys, and everyone else beats only one of his donkeys, the semantics predicts sentence (4) to be false no matter what the Current Issue is. This leads us to expect that speakers should not hesitate to judge such a sentence false. We believe that this is on the whole correct (but see Kanazawa 2001: Section 6.2 for a different perspective, and Brasoveanu 2008: Section 5.2 for further discussion).

patterns that result from properties such as monotonicity and conservativity of non-donkey sentences and their underlying static determiners. Based on this, he suggests that the interpretation of donkey sentences can also be characterized implicitly by various conditions that formalize this tendency, and without resorting to his explicit interpretive principles. For example, on his view, the process that maps static determiners to dynamic determiners should guarantee that monotonicity inferences such as the following are valid by default.

(34) Every farmer who owns a donkey beats it.
   a. So, every farmer who owns a female donkey beats it.
   b. So, every farmer who owns and feeds a donkey beats it.

The problem with this view is that there are clear counterexamples to these inference patterns. Once $\exists$-readings of donkey pronouns are taken at face value, restrictors of universal quantifiers are no longer downward monotone. For example, imagine that a funeral took place in a small college town. All the townsmen showed up, and they all appropriately dressed in black suits except for a few graduate students who do not own suits. Imagine also that a number of townsmen own other suits that they did not wear to the funeral. For example, some townsmen also own tan suits, and some others own suits that they misplaced. Then (35) is true while (35a) and (35b) are both false. Thus, the inference from (35) to (35a) and (35b) is invalid.

(35) Every townsman who owns a suit wore it at the funeral.
   a. So, every townsman who owns a tan suit wore it at the funeral.
   b. So, every townsman who owns and misplaced a suit wore it at the funeral.

The difference between the valid inference in (34) and the invalid inference in (35) suggests that the inference pattern is context-dependent; thus, it does not provide evidence about semantic validity. While Kanazawa (1994) might see cases (35) as mere exceptions to a general tendency of preservation of inferential patterns, this kind of example weakens the motivation for his account: indeed, on his proposal it would be unclear why these examples are not semantically valid independently of context.

While there is reason to doubt the underlying generalization Kanazawa posits and thus the explanation he offers for it, the question itself remains: why is the $\mathfrak{D}$ type shifter as we defined it the operative one in natural language? To answer this question, we note that $\mathfrak{D}$ arises naturally from a supervaluationist view on generalized quantifiers (van Eijck 1996), which in turn is a natural extension of the original supervaluationist treatment of truth-value gaps in van Fraassen (1969). A supervaluationist generalized quantifier such as *every man who owns a donkey*

behaves analogously to its classical counterpart whenever its nuclear scope denotes a classical predicate (e.g. *is happy*); but when it is given a nonclassical predicate whose interpretation depends on the context, it returns *definitely true* whenever every precisification of the predicate makes the classical quantifier true; *definitely false* whenever every precisification of the predicate makes the classical quantifier false; and *neither true nor false* in all other cases. We treat irreducibly dynamic predicates such as *beats it* as nonclassical and as having two different precisifications: one is obtained by applying $\mathfrak{E}$ and the other one by applying $\mathfrak{A}$.

Finally, the present theory parts ways with Kanazawa's in its treatment of donkey sentences with intersective quantificational determiners such as *some*, *at least n*, and *no*, which he claims to only have the $\exists$-reading. The account here predicts that their meaning will depend completely on the Current Issue. Now, while $\forall$-readings are difficult to observe in intersective determiners, some examples have already been noted in the literature:

(36) At least one boy who had an apple for breakfast didn't give it to his best friend. (Chierchia 1995: 65)[12]

(37) No man who had a credit card failed to use it. =(29)

(38) No man who has an umbrella leaves it home on a day like this. =(5c)

Why, then, do Kanazawa (1994) and some other authors assume that intersective determiners can only have the $\exists$-reading? One reason may simply be the fact that relevant examples are hard to find (Geurts 2002: 131). Scenarios that give rise to $\forall$-readings in donkey sentences with upward monotone embedding determiners need to be carefully constructed, and it is easy to overlook their existence unless one specifically tries to find them. Another reason may be the role of negation. Geurts (2002), who considers (36) and (37), comments that such examples should not be taken at face value because they always seem to involve some kind of negation, and because negative sentences are often interpreted by removing the negation before evaluation and flipping the resulting truth value afterwards. That may be true for the examples Geurts is considering; but for the following examples it is less clear. Our scenarios are meant to prevent any uniqueness implicatures from arising, so that the $\exists$-reading and the $\forall$-reading do not coincide.

(39) *Scenario:* To follow the traffic law, drivers need to put exactly one dime into the parking meter. Some drivers have more than one dime in their pocket, but nobody overpays.
Current Issue: Did everyone follow the traffic laws?
a. Yes, every man who had a dime put it in the parking meter.

12 Chierchia attributes this example to van der Does (1993), but that article does not mention it.

b. No, at least one man who had a dime kept it in his pocket.
c. No, one man who had a dime kept it in his pocket.

(40) *Scenario:* Carrying an umbrella allows you to stay dry. Some people own more than one umbrella, but in that case they take just one of them along and leave the other ones at home.
Current Issue: Did any umbrella-owner get wet on this rainy day?
a. No, every man who had an umbrella took it with him today.
b. Yes, at least two men who had an umbrella left it at home today.
c. Yes, two men who had an umbrella left it at home today.

(41) *Scenario:* To enter the secret society's meeting, you need to remember password 1 or password 2. Most new members are given just one of the passwords, but some are given both.
Current Issue: Was any member prevented from accessing the meeting?
a. No, every man who had been given a password remembered it.
b. Yes, at least one man who had been given a password forgot it.
c. Yes, one man who had been given a password forgot it.

In all these examples, the a. sentences have the ∃-reading and the b. and c. sentences have the ∀-reading as their preferred interpretation.[13] In line with Yoon (1996), these examples have been constructed from pairs of opposite predicates. It would be difficult to claim that one of these predicates but not the other contains an implicit negation (though see Brasoveanu (2008: 178) for a different perspective), because the choice seems arbitrary in certain cases. For example, to remember is to not forget, and to forget is to not remember.

The embedding determiners in b. and c. are both intersective and upward monotone on both arguments. The monotonicity principle in Kanazawa 1994 predicts that determiners that are upward monotone on both arguments prefer the ∃-reading, and an additional principle he postulates, which he calls the Intersection Principle, ensures that intersective determiners do not generate the ∀-reading. As noted by Yoon (1996) and King & K. S. Lewis (2016: Note 30), this latter principle cannot hold in an categorical way, given that *no* is intersective yet clearly receives the ∀-reading in sentence (38). The b. and c. sentences in (39) through (41) make the same point for other intersective determiners. This shows that intersective donkey sentences

13 We account for the ∀-readings of the b. and c. examples by assuming that modified and bare numerals have static lexical entries that are type-shifted by $\mathfrak{D}$ (e.g., $[\![\text{at least two}]\!] = [\![\text{two}]\!] = \lambda PQ.\,|P \cap Q| \geq 2$). As explained in Section 5, we assume that bare numerals also have dynamic lexical entries that parallel that of the indefinite article *a*. This parallel is motivated by the common abilities of bare numerals and indefinites as regards exceptional scope and binding; however, to keep our fragment simple, we do not model these phenomena. For more discussion on plural pronominal anaphora in a dynamic context, see Kanazawa (2001) and Nouwen (2003).

can allow ∀-readings in contexts where the entire model is relevant. That said, a weakened version of the Intersection Principle that results from ignoring irrelevant individuals is consistent with our theory and has been argued to be psychologically plausible (Geurts 2002). See Section 6.3 for more discussion of this point.

6.2 Barker 1996

Barker 1996 shares many aspects and predictions of the present theory and has in part inspired it. However, it only briefly touches on donkey sentences headed by determiners. The main focus is on adverbial donkey sentences, such as these:

(42) a. Usually, if a woman owns a dog, she is happy.
b. Usually, if an artist lives in a town, it is pretty.
c. Usually, if a linguist hears of a good job, she applies for it.

Following earlier work, Barker distinguishes between symmetric and asymmetric interpretations of donkey sentences. Sentence (42a) is naturally understood as making a claim about how many dog-owning women are happy. If a woman owns more than one dog, she is counted only once. Barker refers to this as a subject-asymmetric reading. Sentence (42b) is about the number of towns that have artists living in them (an object-asymmetric reading), and sentence (42c) is about linguist-job pairs (a symmetric reading). Barker's main claim is that asymmetrically interpreted adverbial donkey sentences come with a homogeneity presupposition:

(43) *The homogeneity hypothesis* (HH, Barker 1996):
The use of a proportional adverbial quantifier when construed under a particular proportional reading presupposes that members of the same quantificational case all agree on whether they satisfy the nuclear scope.

Barker defines quantificational cases as equivalence classes of variable assignments that agree on what they assign to those variables that are bound by the adverbial quantifier. In (42a), each woman corresponds to a quantificational case. According to HH, (42a) presupposes that any woman is happy either about all of her dogs, or about none of them. Likewise, (42b) presupposes that any town is pretty or not no matter which artists live in it. No asymmetric readings are available for (42c), because the homogeneity presuppositions of these readings fail. In effect, homogeneity presuppositions neutralize the difference between ∀-readings and ∃-readings by ruling out any scenarios in which this difference could be observed.

Although HH is formulated so as to apply only to adverbial quantifiers, Barker tentatively assumes that it governs nominal quantifiers as well. If so, the subject-

asymmetric reading of example (44) presupposes that every man who owns several donkey beats all or none of them.

(44) Most men who own a donkey beat it.

HH differs from the present account in that it predicts a presupposition failure for all those cases in which we assume a donkey sentence that is not literally true can be "true enough". An obvious challenge for HH arises from heterogeneous readings. Take sentence (5b), repeated here:

(45) Usually, if a man has a quarter in his pocket, he will put it in the meter.

Our account predicts that the sentence has these truth and falsity conditions:

(46) a. **true** iff most quarter-owning men put all their quarters into the meter
b. **false** iff most quarter-owning men put none of their quarters into the meter
c. **neither** in all other cases, for example, if every quarter-owning man puts exactly one quarter into the meter, and most of these men have additional quarters that they hold on to

Let w_{true}, w_{false}, and w_{mixed} be worlds described by (46a), (46b), and (46c) respectively. Suppose that the Current Issue is whether most men who have a quarter follow the law by putting at least one quarter into the meter. This is the case both at w_{true} and at w_{mixed}. Hence (45) is true enough at w_{mixed}, and the present account will correctly predict that (45) on its asymmetric reading is interpreted heterogeneously as $\{w_{true}, w_{mixed}\}$, the $\exists$-reading.

By contrast, HH as presented so far wrongly rules out the asymmetric $\exists$-reading due to presupposition failure at w_{mixed}. Barker is aware of this and assumes that contextual domain narrowing prevents this presupposition failure by removing those quarters from consideration that remain in a man's pocket at w_{mixed} after the parking laws have been satisfied. While Barker proposes no formal theory of domain narrowing, the general idea is that any entities that do not settle the Current Issue can be removed from the domain. In the restricted domain, the homogeneity presupposition is satisfied, and (45) is predicted true.

In the absence of an explicit theory of domain narrowing, it is difficult to find examples for which Barker 1996 and the present account differ clearly in their predictions. That said, our theory is not merely a formalization of HH because the two theories differ in how heterogeneity arises. In particular, Barker assumes that homogeneity is a presupposition and that domain narrowing is always available to step in and rescue sentences from presupposition failure; but this does not always

seem to be the case, as the following example shows (a variation of an example attributed to Barbara Partee in Heim (1982)):

(47) #I dropped ten marbles and found only nine of them. The marble I dropped is under the sofa.

In this example, the definite description *the marble I dropped* cannot refer anaphorically; the fact that it is ruled out indicates that its uniqueness presupposition is not satisfied either. If domain narrowing was available, we would expect it to rescue the example by removing the nine marbles the speaker found, so that the uniqueness presupposition is satisfied.

By contrast, the present account does not treat donkey sentences as presuppositional and need not appeal to domain narrowing. While we cannot directly compare our approach to HH without an explicit theory of domain narrowing, we do think there are reasons to prefer our account. In particular, HH is tailored to donkey sentences and does not seem to apply elsewhere, while the core ingredients of our account are independently motivated by analyses of plural definites (i.e., Križ 2016).

6.3 Geurts 2002

Geurts (2002) experimentally investigated the behavior of the four Dutch determiners *iedere* 'every', *niet iedere* 'not every', *enkele* 'some' and *geen* 'no' in mixed scenarios. Twenty native speakers were given truth value judgment tasks consisting of donkey sentences with pictorial representations. Aside from true and false, participants were also given a third option in case they could not make up their minds, but this option was almost never chosen. Geurts also varied the scenarios and sentences with an eye towards whether the embedding determiner combined with a "prototypical" concept such as *boy*, or with a "marginal" concept such as *railway line*, in the sense that the more marginal a concept is, the more leeway there is in individuating its tokens. For example, *railway line* is marginal because the Amsterdam-Brussels and the Brussels-Paris connection may be considered either two railway lines (we will call this the "split" interpretation) or parts of one and the same line, the Amsterdam-Paris line (the "joint" interpretation). Geurts found that sentences embedded by *some* were almost always judged true (suggesting the $\exists$-reading), and those embedded by *no* were almost always judged false (suggesting the $\exists$-reading as well), independently of differences in prototypicality. In the case of

14 The symmetry between *every* and *not every* is striking. Transcripts from think-aloud sessions in a pretest suggested that at least one interpretive strategy that was used for sentences with *not every* consisted in evaluating the sentence without *not* and then flipping the result (see also Krifka (1996) for arguments supporting this view). This is the reason Geurts 2002 cautions against taking judgments for donkey sentences with negation at face value.

every, participants' responses slightly tended towards the ∃-reading for more prototypical individuals and strongly tended towards the ∀-reading with more marginal individuals. The results for *not every* pattern exactly the opposite way as those for *every*.[14]

Geurts 2002 argues that mixed scenarios trigger what he terms an "interpretive crisis" and that hearers resolve it using different strategies, such as declaring the sentence infelicitous, shifting from a "joint" to a "split" interpretation where possible, or using plausibility considerations to remove individuals from the domain. Our proposal can be seen as adding a strategy to this list: resolve the truth-value gap by using the Current Issue.

With respect to the effect of marginal individuals, Geurts (2002) convincingly argues that they are readily viewed as several "cases". Thus the "split" interpretation of a sentence like (48a) can be paraphrased as in (48b).

(48) a. Every railway line that crosses a road goes over it.
b. In every case where a^1 railway line crosses a^2 road, it_1 goes over it_2.

In (48b), the ∃-reading and the ∀-reading coincide; and they are both equivalent to the ∀-reading of the "joint" interpretation of (48a). In this sense, "split" interpretations are a confound that is caused by marginal individuals and that causes spurious ∀-readings to appear. Most of the examples we discuss in the paper involve prototypical individuals such as farmers and townsmen; we therefore expect to have avoided this confound.

One of Geurts's findings is that the donkey sentences with *some* and *no* that he tested robustly get ∃-readings independently of whether the individuals were prototypical or marginal. Given examples like (37) and (36), he concedes that it may be an overstatement to claim that these determiners only lead to ∃-readings, but he suggests that there is a distinct asymmetry between donkey sentences with such determiners on the one hand, and those with universal determiners like *(not) every, (not) all*, on the other.

Geurts explains this pattern by assuming that determiners like *some* can influence the way a scene is interpreted: as he puts it, because they are intersective, they "allow us to concentrate on positive evidence, and ignore all else".[15] While stressing that he should not be taken to imply that hearers have one strategy for verifying universal sentences and another one for existential sentences, he proposes in effect that intersective determiners may under certain circumstances be interpreted on

15 Although Geurts focuses on the determiner *some*, he intends his reasoning to apply to other weak determiners as well, including, *mutatis mutandis*, to *no*. By weak determiners, he means *some, a few, at least n, at most n, (exactly) n, no* and possibly also *few* and *many*. Because the submodel selection procedure is only available for intersective quantifiers, it differs from domain narrowing as understood, for example, by Barker (1996).

submodels of the model in question. If they are judged true in the submodel, this can replace whatever truth value they might have in the entire model. For example, Geurts suggests that in a context he describes as in (49a), it is psychologically natural to understand (49b) as true:

(49) a. *Context:* We have 4 boys altogether; 1 boy is standing alone; 1 boy is standing next to 1 girl and not holding her hand; 1 boy is standing next to 1 girl and holding her hand; 1 boy ('Fred', to give him a name) is standing between 2 girls, holding hands with 1 of them but not with the other ('Mary').

b. Some of the boys that stand next to a girl hold her hand.

The relevant submodel here consists of all the boys and girls in (49a) except for Mary. While in the original model (49a) including Mary, the ∀-reading of (49b) is false and its ∃-reading is true, in the submodel without Mary both readings are true.

Now, Geurts' claim entails that in situations where we can ignore parts of a model while we interpret an intersective determiner, it is unobservable whether that determiner gives rise to the ∀-reading or the ∃-reading on the original model. This claim is compatible with the theory presented here, as well as with other theories. If correct, it may be one of the factors that explain why ∀-readings are hard to observe in intersective determiners, as we noted in Section 6.1.

6.4 Brasoveanu 2008

Brasoveanu 2008 argues that an account of anaphora and quantification requires a richer notion of information state than that provided by ordinary dynamic semantics or compositional DRT. He introduces PCDRT, a system in which information states are sets of assignments rather than just assignments, and motivates it in part by donkey sentences with multiple instances of donkey anaphora such as the following:

(50) Everyone who buys a^d book online and has a^e credit card uses it_e to pay for it_d.

(51) Every boy who bought a^d Christmas gift for a^e girl in his class asked her_e deskmate to wrap it^d.

Brasoveanu proposes that indefinites are ambiguous between a maximal or "strong" and a nonmaximal or "weak" interpretation. Donkey pronouns whose antecedents are strong receive the ∀-reading, those whose antecedents are weak receive the ∃-reading. For example, in (50), the indefinite *a book* is easily understood as strong and the indefinite *a credit card* as weak; in (51), the indefinites *a Christmas gift* and *a girl* are both strong. Brasoveanu refers to the weak-strong contrast as a scalar

implicature; however, in his system it is not modeled as a scalar implicature but as a lexical ambiguity. Maximal indefinites simultaneously introduce as many values as possible, while nonmaximal indefinites are free to assign a smaller set. For example, the assignments in any output state of a^d *donkey* map d to farmer-owned donkeys. If a^d is maximal, these assignments do this in such a way that no farmer-owned donkey is left out. If a^d is nonmaximal, among the output states of the indefinite there will be some whose assignments leave out some donkeys. Pronouns check that all assigments in their input state agree on the value of their discourse referent.

In Brasoveanu 2008, the main purpose of this ambiguity is to account for the $\exists/\forall$ dichotomy. Brasoveanu (2008: 148) claims that the contrast between maximal and nonmaximal interpretations of indefinites surfaces only if two conditions are fulfilled: (i) there is anaphora to the indefinites and (ii) the indefinites and the anaphoric expressions are embedded in quantificational contexts. However, as Brasoveanu (2008: 164) points out, in his system condition (i) is sufficient for the contrast to emerge. For example, a discourse like A^d *man came in. He*$_d$ *sat down.* is predicted to be ambiguous between *There is a man who came in and who sat down* and *Exactly one man came in, and he sat down*. The uniqueness inference in the latter reading arises from the interaction of the maximal indefinite and the uniqueness condition of the pronoun.

While there are worries about overgeneration outside of donkey sentences in Brasoveanu 2008, we believe our analysis offers more fundamental improvements. In particular, we have shown that in the presence of a pragmatic theory such as the one we have proposed, one can analyze most if not all phenomena involving donkey anaphora with only ordinary CDRT, without having to resort to full PCDRT. Because we delegate the work of disambiguating between readings to the pragmatics, we no longer require the semantics to model the ambiguity at the level of the pronouns or the indefinites. This allows us to rely on simpler semantic theories such as Muskens (1995). There are certainly other arguments for PCDRT in Brasoveanu 2008, but our work shows that the variety of readings available for donkey anaphora does not necessitate a move to plural assignments.

6.5 Brasoveanu 2010

The main focus of Brasoveanu 2010 is on the truth-conditional and anaphoric components of quantificational and modal subordination, but the paper contains a discussion and an implementation of donkey anaphora. Brasoveanu (2010) treats indefinites as ambiguous, but takes a different route than Brasoveanu (2008) did. Indefinites can still introduce their own discourse referents; when they do, they are always interpreted nonmaximally, resulting in existential readings. To model universal readings, Brasoveanu now assumes that an indefinite can be translated

identically to a singular anaphoric definite. In that case, instead of introducing a discourse referent the indefinite is anaphoric. To that purpose, embedding determiners are given the ability to introduce additional discourse referents, on which indefinites can be anaphoric. As Brasoveanu notes, this move is in the spirit of Dekker 1993; the necessary adjustments to the translations of embedding determiners make them multiply selective instead of singly selective. Simplifying somewhat, the LFs for the existential and universal reading of sentence (4) are assumed to be as follows:

(52) a. Every^{f} farmer who owns a^{d} donkey beats it$_{d}$. *existential reading*
b. Every^{f,d} farmer who owns a$_{d}$ donkey beats it$_{d}$. *universal reading*

The multiply selective quantifier *every*^{f,d} in (52b) quantifies in effect over farmer-donkey pairs; the indefinite a_d *donkey* receives the interpretation of the anaphoric definite *the*$_d$ *donkey*.

A problem with this approach is that since indefinites and definites share a reading, their distribution must be stipulated and cannot be explained in semantic terms. Brasoveanu assumes that only embedding determiners can be antecedents of definite-like indefinites. A similar stipulation is required to rule out discourse-initial sentences like the following:

(53) Every^{f,d} farmer who owns the$_{d}$ donkey beats it$_{d}$.

If the definite was able to pick up the discourse referent d introduced by the embedding determiner, the resulting reading would be indistinguishable from the universal reading of sentence (4).

Setting these points aside, a more general problem with approaches that locate the ambiguity in the indefinite arises from mixed existential-universal sentences in which the same indefinite antecedes two pronouns:

(54) Every man who has an umbrella takes it along on rainy days but leaves it home on sunny days.

On the most natural reading of this sentence, what is required for its truth is for every umbrella-owner to take one umbrella along when it is raining, and to leave all of his umbrellas at home when the sun is shining. In other words, the first donkey pronoun is naturally interpreted existentially and the second one universally. No matter if the antecedent is interpreted strongly or weakly, one of the pronouns will be assigned the wrong meaning on both Brasoveanu (2008) and Brasoveanu (2010).

On the present account, the ambiguity is located in the pragmatics, and generating the plausible reading poses no particular problem. The semantics treats sentence (54) as true only if every umbrella-owner takes all his umbrellas with him when it is rainy (even though one would suffice to stay dry). While this is not the case in the

situation of interest, a Current Issue such as *Did everyone stay dry when it rained and unburdened when it was sunny?* will lump this situation together with those where everyone took multiple umbrellas with them.

6.6 Champollion 2016

With essentially the same goals in mind as in the project here, Champollion (2016) sketched a dynamic fragment intended to generate effective truth-value gaps for donkey readings in mixed scenarios. But where the current approach fairly directly lifts Križ's (2016) semantic clauses into a simple compositional dynamic framework (Muskens 1995), Champollion leaned on the quite powerful plural dynamic semantics of Brasoveanu 2010 — augmented with designated "error" discourse referents and objects — combined explicitly supervaluationist lexical entries for determiners. Not only is plural dynamic semantics unnecessary, as we hope to have shown with the fragment in Section 5, it leads to several empirical issues.

First, Champollion relies on the *strong* entry for indefinites proposed in Brasoveanu 2010. This corresponds to an update that introduces as many potential referents for its restrictor as possible, across the various output assignments of the sentence. But that kind of update overgenerates evaluation pluralities when not in the restrictor of a dynamic quantifier. For instance, given the maximality of a, the assignments coming out of sentence in (55b) will contain, between them, as many sandwiches as were eaten by girls. The subsequent pronoun ought then to be able to refer to this discourse plurality, as it can in (55a), but this is impossible.

(55) a. Every girl ate a^d sandwich. They_d were tasty.
b. A girl ate a^d sandwich. #They_d were tasty.

Brasoveanu (2010) can at least avoid this possibility by stipulating that indefinites outside the arguments of generalized quantifiers are necessarily interpreted *weakly*, but since Champollion is in part motivated by a desire to avoid semantic ambiguity in the elements that comprise donkey sentences, he is committed to a single maximal indefinite everywhere.

As a corollary of this, plural pronouns in the *scope* of generalized quantifiers also ought to have no trouble picking up the evaluation pluralities introduced by maximal indefinites. The example in (56a) shows that such evaluation pluralities can in general be interpreted collectively: it is true if the collection of backpacks brought by girls forms a pile out back. But as mentioned in Section 1, donkey pronouns cannot be interpreted collectively. Thus in (56b), *it* cannot refer collectively to the set of backpacks that the set of girls brought.

(56) a. Every girl brought a^d backpack. They_d are piled up out back.

b. *Every girl who brought a^d backpack piled it$_d$ up out back.

Second, Champollion assigns to the singular donkey pronoun a meaning that tests the outputs of its local update for uniformity across a certain index. For instance, in the sentence *Every farmer who owns a^d donkey beats it$_d$*, the pronoun will be in charge of inspecting whether the discourse referent associated with the subject of the predicate *beats* — which will in each distributive cycle refer to some particular donkey-owning farmer — behaves uniformly with respect to the values stored in the discourse referent d — which will pick out all of the donkeys owned by whoever the particular farmer of the moment is. In other words, when considering Farmer John, it_d will test the incoming sets of assignments to see whether John either beats all/none of the donkeys injected by the maximal a^d.

To make this work, the pronoun must take scope over the predicate that it uses as the basis of its uniformity test. In the presence of scope islands, this leads to both under- and over-generation issues.[16] Consider the sentence in (57):

(57) Every girl who brought a^d backpack got in a fight with somebody who insulted it$_d$.

Its ∀-reading, for example, is true just in case every girl defended the honor of each of her backpacks. The property that it_d would need to test for uniformity in this case is the entire nuclear scope of the quantifier: the property of getting in a fight with somebody who insulted d. But since the pronoun is embedded in the relative clause island, it cannot scope high enough to see all of this information. This is the undergeneration worry. The overgeneration worry is that instead, the pronoun *can* scope just within the relative clause. But (57) has no reading which would correspond to the truth conditions obtained by throwing an error just in those cases where girls' behaviors are mixed with respect to whether they were insulted; all of its readings ought to depend on whether girls are mixed with respect to whether they got in fights with their insulters.

Another consequence of treating the pronouns like dynamic tests is that they throw out all dynamic information in the constituents in their scope. This means that indefinites in the nuclear scopes of donkey sentences will be dynamically inert. So even if the pronoun *could* scope over the entire verb phrase of (57), it would prevent the indefinite from anteceding discourse anaphora. But the felicity of (58a) shows that this is a bad prediction. The discourse in (58b) makes the same point but is perhaps easier to process. The pronoun *it* needs to inspect each secret-keeper for homogeneity with respect to their various secrets; that is, did they sell all/none of them to reporters. But to do that, it needs to scope over the property denoted by

16 Thanks to Simon Charlow for pointing this out.

VP, $\lambda d\,.\,$*sell d to a reporter*, which will capture and eliminate the discourse referent introduced by *a reporter*. Yet anaphora to reporters is fine here. An even simpler case is given in (58c). If the pronoun in the second clause outscopes the indefinite, then cross-sentential anaphora to *a stool* should fail. But of course it doesn't.

(58) a. Every girl who brought a backpack got in a fight with somebody^e who insulted it. The fights were mostly quite intense, but still, none of them$_e$ regretted what they had said.
b. Everybody who had a secret sold it to a^e reporter. Most of them$_e$ were very grateful for the gossip.
c. John walked in. He sat on a^e stool. He said it$_e$ was comfy.

7 Conclusion

This work has shown that the apparent complexity of the $\exists/\forall$ dichotomy follows from the interaction of two relatively simple independently motivated formal systems: a pragmatic account of how context disambiguates plural definites and donkey sentences, and a lean dynamic semantics which abstains from drawing borders between true and false scenarios, and leaves truth-value gaps for the pragmatics to fill. As suggested by Yoon (1994, 1996) and Krifka (1996), we have given plural definites and donkey anaphora a uniform pragmatic treatment. Just as Križ (2016) treats *The doors are open* as *Things are equivalent for current purposes to the way they would be if all the doors are open*, we propose to treat the classical donkey sentence as *Things are equivalent for current purposes to the way they would be if every farmer who owns a donkey beat all the donkeys he owns*, modulo the contrary-to-fact implication that these paraphrases suggest. Our account captures the exception tolerance of both plural definites and donkey sentences in a simple and uniform way.

To specify what it means to be equivalent for current purposes, we have modeled this notion as an equivalence relation between worlds that is left underspecified by the semantics and determined by the pragmatics. Following Križ (2016), we have identified this equivalence relation with an implicit question that represents the overarching goal towards which the conversation participants are working. This accounts for the fact that when the context is held fixed, a donkey sentence is typically not perceived as ambiguous between the $\exists$-reading and the $\forall$-reading. Because different donkey sentences are used in different conversational settings (or naturally evoke different settings when presented in isolation), this implicit question may well vary from one donkey sentence to another. This explains why the $\exists$-reading and the $\forall$-reading can flip-flop when one switches between predicates like *open* and *closed* while keeping the context constant (Yoon 1996) and when one switches between contexts while keeping the sentence constant (Gawron, Nerbonne & Peters

1991). The pragmatic component of our account is broadly similar to Barker (1996), but does not assume that donkey sentences involve a uniqueness or homogeneity presupposition and does not rely on an ill-understood notion of domain narrowing.

By moving the explanatory burden from the semantics to the pragmatics, we have avoided problems that arise from trying to make plural definites and donkey anaphora semantically uniform. In particular, Yoon and Krifka relied on the problematic assumption that *it* and *the donkey(s) he owns* can be given a parallel analysis in terms of plural individuals. However, Kanazawa (2001) showed that plural individuals cannot be involved in the semantics of *it*. Our account avoids the need for plural individuals in the interpretation of singular donkey pronouns. That said, our account is fully compatible with assuming plural individuals as referents of *plural* donkey pronouns, as suggested by Kanazawa (2001).

Our semantic component also allows us to keep the semantics streamlined to a fragment of CDRT (Muskens 1995, 1996). We have shown that accounting for the $\exists/\forall$ dichotomy in donkey sentences does not require moving to systems that treat donkey anaphora in terms of evaluation-level pluralities and plural information states like those in Brasoveanu 2008, 2010. By not relying on plural information states, we were able to avoid a number of empirical issues we identified in Champollion 2016, a precursor of the present work.

The system we have explored is theoretically parsimonious. Not only does it rely on lean and independently motivated components, it also avoids the need to postulate any sort of semantic ambiguity. This sets it apart from systems such as Chierchia (1995), where the $\exists/\forall$ dichotomy is attributed to an ambiguity of the donkey pronoun; Kanazawa (1994), where it is modeled at the level of the embedding determiner; or Brasoveanu (2008, 2010), where it is traced back to an ambiguity of the indefinite antecedent. Problems with the first and second types of systems have been laid out in Brasoveanu (2008: Section 6.1). As we have shown, the third type of system has problems with sentences like (54) in which the same indefinite serves as an antecedent to two donkey pronouns.

Finally, our account explains why hearers give varied and guarded judgments in mixed scenarios: these are precisely the scenarios in which the semantics does not deliver a definite truth value. The variation in their judgments is traced to variation in Current Issues, and the hesitation stems from hearers' reluctance to accommodate one of several possible Current Issue when the common ground does not provide sufficient evidence to narrow down the choice between them.

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