High and low readings in indicative donkeys[1]

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Abstract. In this paper, we extend existing accounts of high and low readings in counterfactual donkey sentences (van Rooij 2006, Walker and Romero 2015) to indicative donkey sentences. First, we generalize the account to indicative donkey sentences featuring modals that employ ordering sources. Then, we turn to indicative donkey sentences with adverbs of quantification. We discuss the relationship between high and low readings arising when a similarity measure is involved and symmetric and asymmetric readings arising with adverbs of quantification (Kadmon 1987) and present tentative data that suggests that they are two closely related phenomena.

Keywords: counterfactuals, donkey sentences, conditionals, dynamic semantics, proportion problem.

1. Introduction

1.1. Similarity and counterfactuals

A standard semantics for counterfactuals (Stalnaker 1968, Lewis 1973) considers them true if and only if their consequent holds in the closest antecedent-worlds, where closeness is analyzed in terms of overall similarity. The ordering of worlds by similarity is assumed to be provided by the context, but largely remains underspecified. In this paper, we pursue an insight from the recent literature on so-called 'counterfactual donkey sentences' (van Rooij 2006, Wang 2009, Walker and Romero 2015): the similarity ordering in counterfactuals interacts with indefinite noun phrases in the antecedent in an interesting and crucial way to select the closest worlds to be quantified over. By first investigating this particular interaction, we hope to ultimately shed light on the general pragmatics of similarity orderings. However, in this particular instance we pursue a pragmatic account that is closely tied to the semantics of the indefinite.

The sentences we consider have the form in (1), essentially combining the ingredients of a classical (indicative) donkey sentence (Geach 1962) as in (2) – indefinite noun phrases in the antecedent and pronouns referring back to these noun phrases in the consequent – with the morphological markings of a subjunctive counterfactual conditional[2] as in (3):

(1) If a farmer owned a donkey, he would beat it. *Counterfactual donkey sentence*

[1]We thank Irene Heim, Sven Lauer, Adrian Brasoveanu, Pranav Anand, Deniz Rudin and the audiences of SALT 25, SuB 20, S-Circle UC Santa Cruz, Syntax & Semantics Circle UC Berkeley and the Advanced Topics in Semantics course at Konstanz.

[2]We leave out non-counterfactual subjunctive conditionals discussed in Anderson (1951), Leahy (2011).

(2) If a farmer owns a donkey, he beats it. *Indicative donkey sentence*

(3) If Pedro owned Platero, he would beat it. *Counterfactual conditional*

van Rooij (2006) offers an account of sentences like (1) in which they are ambiguous between two readings that we call high and low respectively. In Walker and Romero (2015) we defend this account against a criticism by Wang (2009) and develop it further to account for the licencing of Negative Polarity Items (NPIs) in the antecedents of low counterfactual donkey sentences. In the present paper, we will present a brief overview and elaboration on these developments in Section 2 and proceed to extend the analysis in a new direction in Sections 3 and 4. In Section 3, we show that high and low readings also appear in indicative donkey sentences that employ some form of ordering source in their semantics. In Section 4, we relate our account of this phenomenon to the well-known problem of symmetric and asymmetric readings of indicative donkey sentences with quantificational adverbs like *usually* (e.g. Kadmon (1987)). Section 5 concludes.

1.2. Theoretical preliminaries

van Rooij's (2006) analysis of counterfactual donkey sentences combines a standard dynamic account of donkey sentences —namely, dynamic predicate logic (DPL, Groenendijk and Stokhof (1991))— with a standard variably strict analysis of counterfactuals (Stalnaker 1968, Lewis 1973)[3]. The truth conditions of a plain counterfactual conditional like (3) in the Stalnaker-Lewis semantics can be spelled out as follows:

(4) $[\![\phi > \psi]\!]^{f,\leq}(w) = 1$ iff $\forall w' \in f_w([\![\phi]\!]^{f,\leq}) : w' \in [\![\psi]\!]^{f,\leq}$

(5) $f_w([\![\phi]\!])^{f,\leq}) = \{v \in [\![\phi]\!]^{f,\leq} | \neg\exists u \in [\![\phi]\!]^{f,\leq} : u <_w v\}$

That is, the counterfactual *if* ϕ*, would* ψ is true iff all worlds returned by a selection function f when applied to the world of evaluation w and the antecedent ϕ are such that they also verify the consequent ψ. The function f returns all worlds v that satisfy the antecedent and for which there is no other world u that also satisfies the antecedent and that is more similar to the actual/evaluation world than v. The ordering of worlds $\leq$ is assumed to be provided by the context.

Groenendijk and Stokhof's (1991) DPL is a standard solution to the problem of establishing the correct binding relations in donkey sentences. It assumes that donkey sentences are standardly translated into a formula with open variables, as in (6), but modifies the underlying logic such

[3]In Walker and Romero (2015) we argue for using a strict conditional framework with a modal horizon (von Fintel 2001) instead of the variably strict analysis. This allows us to derive the correct facts about NPI licensing in low counterfactual donkeys. As this analysis is independent of the discussion in this paper, we use the simpler variably strict analysis for the purpose of exposition here.

that this formula turns out to be equivalent to the correct reading of donkey sentences that native speakers report, i.e. it ensures that (7) holds. This is achieved by making the meanings of sentences dynamic, that is, by passing the modifications made to assignment functions by a formula on as input to the next formula instead of discarding them, as in (8) - (12) (where $h[x]g$ means that assignment h differs from g at most with respect to the value it assigns to x).

(6) $\exists x[Px] \to Qx$

(7) $\exists x[Px] \to Qx \quad \Leftrightarrow \quad \forall x[Px \to Qx]$

(8) $[\![Rt_1...t_n]\!] = \{\langle g, h\rangle \mid h = g \wedge \langle [\![t_1]\!]_h...[\![t_n]\!]_h\rangle \in F(R)\}$

(9) $[\![\exists x\phi]\!] = \{\langle g, h\rangle \mid \exists k : k[x]g \wedge \langle k, h\rangle \in [\![\phi]\!]\}$

(10) $[\![\phi \wedge \psi]\!] = \{\langle g, h\rangle \mid \exists k : \langle g, k\rangle \in [\![\phi]\!] \wedge \langle k, h\rangle \in [\![\psi]\!]\}$

(11) $[\![\phi \to \psi]\!] = \{\langle g, h\rangle \mid h = g \wedge \forall k : \langle h, k\rangle \in [\![\phi]\!] \to \exists j : \langle k, j\rangle \in [\![\psi]\!]\}$

(12) $[\![\forall x\phi]\!] = \{\langle g, h\rangle \mid h = g \wedge \forall k : k[x]g \to \exists j : \langle k, j\rangle \in [\![\phi]\!]\}$

The reader is referred to the original paper by Groenendijk and Stokhof (1991) for a detailed discussion of the underlying mechanisms and a proof that this apparatus derives the crucial equivalence in (7). In this paper, we follow van Rooij (2006) in assuming DPL as the framework of our analysis.

2. High and low readings in counterfactual donkey sentences

2.1. The data

Under a standard analysis of counterfactuals, we would expect the truth of a sentence like (13) to only depend on John's attitude towards donkeys in the closest worlds. However, as van Rooij (2006) points out, this is not necessarily the reading that we obtain. Rather, the most salient reading seems to be one that inherits the 'universal flavour' of indicative donkey sentences in that we understand it as entailing the conjunction of (14a)-(14d):

(13) If John owned a donkey, he would beat it. *High reading*

(14) a. If John owned donkey a, John would beat a.
b. If John owned donkey b, John would beat b.
c. If John owned donkey c, John would beat c.
d. ...

We call this reading the *high* reading of counterfactual donkey sentences. It essentially transfers the equivalence assumed for the indicative conditional, see (7), to the counterfactual conditional:

(15) $\exists x[Px] > Qx \quad \Leftrightarrow \quad \forall x[Px > Qx]$

However, we cannot assume that this is the only reading of counterfactual donkey sentences. There are some cases where we clearly do not want the equivalence in (15) to hold:

(16) If Alex were married to a girl from his class, it would be Sue. *Low reading*

(17) a. $\not\Rightarrow$ If Alex were married to Ann, Ann would be Sue.
b. $\not\Rightarrow$ If Alex were married to Betty, Betty would be Sue.
c. $\not\Rightarrow$ If Alex were married to Carol, Carol would be Sue.
d. ...

We call this reading the *low* reading of counterfactual conditionals[4].

2.2. The account

In order to derive the high / low reading, we follow van Rooij (2006) in assuming that the semantics of the indefinite interacts with the similarity relation. That is, we assume that similarity is not the only factor in deciding which worlds a counterfactual quantifies over. At the core of this account is the move to a dynamic framework in which a counterfactual quantifies not just over worlds, but over pairs of worlds and assignments. The selection function f that was employed in the Stalnaker-Lewis account, see (5), is modified to return such pairs, as in (18). Crucially, in selecting the world-assignment pairs it returns, it optionally partializes the classical similarity ordering by the individuals an indefinite in the antecedent ranges over. The optionality is implemented by a contextually given set X of variables, a subset of the variables introduced by indefinites in the antecedent: if an indefinite noun phrase is interpreted as high, the variable x it introduces will be in set X; if the indefinite is interpreted as low, its variable will not be in X. The impact of X in the ordering of pairs is defined in (19)-(20).

(18) $f^X_{\langle w,g\rangle}(/\phi/_g) = \{\langle v,h\rangle \in /\phi/_g : \neg\exists\langle u,k\rangle \in /\phi/_g : \langle u,k\rangle <^X_{\langle w,g\rangle} \langle v,h\rangle\}$

(19) $\langle v,h\rangle <^X_{\langle w,g\rangle} \langle u,k\rangle$ iff $h,k \supseteq g,\ \ h\uparrow^X = k\uparrow^X$ and $v <_w u$

(20) $h\uparrow^X = k\uparrow^X$ iff $\forall x \in X : h(x) = k(x)$

[4]In Walker and Romero (2015) we show that this analysis needs to be supplemented by an analysis of the *it* in the consequent of (16) as either a cleft-construction or a concealed question to account for the invariably neuter form of the pronoun. We also demonstrate that the low reading appears with standard donkey pronouns as well, given rich enough contexts.

The counterfactual then quantifies over the pairs returned by the selection function f, just as in the standard counterfactual semantics[5]:

(21) $[\![\phi >^X \psi]\!]^{\leq}(\langle w, g\rangle) = 1$ iff $\forall \langle v, h\rangle \in f^X_{\langle w,g\rangle}(/\phi/_g) : \langle v, h\rangle \in /\psi/_g$

That is, the counterfactual is true if and only if, for each individual, the most similar world-assignment pairs that assign this individual to a variable in X is also one that satisfies the consequent.

To demonstrate the way this semantics works, consider the following example sentence (22), where x is the variable introduced by the indefinite *a donkey*, and the toy model in Table 1:

(22) If John owned a^x donkey, he would beat it.

	donkey	own	beat
w_0	$\{a, b, c\}$	$\emptyset$	$\emptyset$
w_1	$\{a, b, c\}$	$\{\langle j, a\rangle\}$	$\{\langle j, a\rangle\}$
w_2	$\{a, b, c\}$	$\{\langle j, b\rangle\}$	$\{\langle j, b\rangle\}$
w_3	$\{a, b, c\}$	$\{\langle j, c\rangle\}$	$\emptyset$
w_4	$\{a, b, c\}$	$\{\langle j, a\rangle\}$	$\emptyset$

Table 1: A sample model for (22), with worlds ranked as follows: $w_0 < w_1 < w_2 < w_3 < w_4$

Under the low reading of the indefinite *a donkey* in (22), its variable x is not in set X. This means that, when selecting the closest pairs to $\langle w_0, g\rangle$, we rank any two pairs $\langle w', h\rangle$ and $\langle w'', k\rangle$ (where $h, k \supseteq g$) that make the antecedent true regardless of what value h and k assign to x. Then, we only quantify over those world-assignment pairs that make the antecedent true and that, according to that global ranking, have as their world the world closest to w_0. In the toy model in Table 1, this amounts to the pair $\langle w_1, g^{a/x}\rangle$, as w_1 is most similar to the actual world. As this pair also verifies the consequent, the counterfactual comes out as true.

Now consider the high reading of (22), where the variable x introduced by *a donkey* is in set X. Under this reading, we rank two world-assignment pairs with respect to each other only if their assignments differ at most in the values of variables introduced in the antecedent that are not in X. Since X=$\{x\}$ in our example (22), only pairs whose assignments are identical with respect to x will be ranked with respect to each other. This means that $\langle w_2, g^{b/x}\rangle$ and $\langle w_3, g^{c/x}\rangle$ will not be ranked with respect to $\langle w_1, g^{a/x}\rangle$, since they do not share an assignment with it, and that $\langle w_2, g^{b/x}\rangle$ and $\langle w_3, g^{c/x}\rangle$ will also count as closest pairs to $\langle w_0, g\rangle$ and thus as candidates for quantification.

[5]The account in van Rooij (2006) introduces some additional machinery in order to deal with weak readings of the pronoun. For simplicity, we leave this out of the presentation in this paper.

Quantifying over these three pairs, we can see that $\langle w_3, g^{c/x}\rangle$ does not verify the consequent, rendering the counterfactual false. The pair $\langle w_4, g^{a/x}\rangle$ remains irrelevant for the computation: as it shares an assignment with $\langle w_1, g^{a/x}\rangle$, we only quantify over the pair with the closer world, w_1.

2.3. Wang's challenge

Wang (2009) contends that the appearance of high readings in sentences like (13) is in fact illusory and argues for a unified account that only generates the (standardly expected) low reading for counterfactual donkey sentences. It is, in fact, true that in the standard examples high readings entail low readings. This is so because the set of worlds-assignment pairs quantified over in the high reading – which includes the closest world-assignment pair for each relevant individual – is a superset of that quantified over in the low reading – which includes just the closest world-assignment pair in absolute terms. Hence, universal quantification over the former set entails universal quantification over the latter set. This raises the possibility that there is only one genuine reading generated by the grammar – the low reading – and that what is perceived as a high interpretation is simply a subcase of the low reading.

Furthermore, depending on the order among worlds, the high reading does not only (properly) entail the low reading but the two yield in fact the exact same truth conditions. As shown in Walker and Romero (2015), there is a specific condition under which the low reading and the high interpretation end up quantifying exactly over the same world-assignment pairs: when all candidate worlds for a high reading (namely, the closest world for each individual that the indefinite is ranging over) happen to be equally close to the actual world. In the example scenario in Table 1 above, this would amount to assuming that the ordering of worlds is as shown in (23). With this ordering, the low reading and the putative high reading of (22) are indistinguishable.

(23) $w_0 < w_1 = w_2 = w_3 < w_4$

2.4. Contra Wang

In order to test Wang's approach, we proceed in two steps. First, we set up contexts that make an ordering like the one in (23) implausible. This guarantees that the two readings do not converge in the exact same truth conditions[6]. Second, we modify the syntax of the donkey sentence so

[6]There exists, however, the possibility of designing an account that assumes that similarity is coarse-grained, and that we quantify not only over the closest worlds, but over all that are close enough. The high/low distinction would then be modelled by a shifting threshold of sufficient closeness. However, in the absence of a fully specified version of such an account, we note that modelling the dynamics of the threshold presumably would coincide with our analysis in many, if not all cases. For further discussion of this option, see our conclusion.

that the entailment relation between high and low readings is inverted. We will use two means to achieve this: negation of the entire counterfactual (elaborating on Walker and Romero (2015)) and *might*-counterfactuals.

Let us start with negation. Consider scenario (24), slightly modified from Walker and Romero (2015), which sets a clear distance between the closest worlds in which Onophilos and Onophobos are donkey-owners respectively. The crucial test sentence is the underlined negated counterfactual uttered by the advisor in the dialogue in (25b):

(24) *Scenario*: There are two farmers in the kingdom of King Kakos, called Onophilos and Onophobos. Both are very poor and do not own a donkey. Onophobos is a cruel man who would love to own and beat a donkey. He has been saving money all his life and has nearly enough to buy a donkey. Onophilos is a mild-mannered vegan who has no means or interest in owning a donkey, much less so in beating it. King Kakos only knows Onophobos and is convinced that all inhabitants of his kingdom are just as cruel and evil as Onophobos. He discusses this with his advisor, who is well-informed about all the farmers and their dispositions.

(25) a. KING KAKOS: Here's what I think about the farmers in my kingdom. If a farmer in my kingdom was a donkey-owner, he would be a donkey-beater.

b. ADVISOR: You are wrong. It's not the case that if a farmer in your kingdom was a donkey-owner, he would be a donkey-beater. Onophilos, for example, is a vegan and would never beat a donkey if he owned one.

Under the low reading, this sentence is false in scenario (24). If Wang is right and only the low reading is generated by the grammar, the sentence should be judged false. Under a high reading, the sentence is true. If the grammar makes the high reading available, the sentence should be judged true. Crucially, the empirical intuition is that the sentence is true in this scenario, hence showing that the high reading is generated by the grammar.

Another way of having negation scoping over the entire counterfactual – and perhaps a more natural way to do so – is by making the universal modal operator phonologically overt and letting negation directly precede it. This is done in (26) - (27). The reasoning is the same: the underlined sentence in (27b) is intuitively judged true and thus the high reading is generated by the grammar.

(26) *Scenario*: Adiaforos doesn't own a donkey but is saving money to buy one. He's most likely to buy affordable Melissa, a stubborn old donkey that Adiaforos would have to beat. Excepting stubborn donkeys, Adiaforos has no inclination to beat donkeys. King Kakos sees that Adiaforos is fetching a stick from the forest.

(27) a. KING KAKOS: I see that Adiaforos likes beating donkeys and is preparing for it.

b. ADVISOR: If Adiaforos owned a donkey, he wouldn't necessarily beat it. It depends on which one he buys.

Let us now consider *might*-counterfactuals, which are standardly analysed as existentially quantifying over the closest worlds that make the antecedent clause true (Lewis 1973). By using existential rather than universal quantification, the entailment relation between the two readings is reversed: existential quantification over the subset set arising in the low reading – the set containing the closest world-assignment pairs in absolute terms – will always entail existential quantification over the superset set arising in the high reading – the set containing the closest world-assignment pairs per individual. The relevant scenario and sentence are given in (28) - (29):

(28) *Scenario*: Adiaforos doesn't own a donkey but is saving money to buy one. He's most likely to buy Platero, a sweet- tempered donkey that Adiaforos would never beat. Other than that, Adiaforos has nothing against beating regular stubborn donkeys. King Kakos sees that Adiaforos is preparing a comfortable donkey stable.

(29) a. KING KAKOS: I see that Adiaforos loves donkeys.

b. ADVISOR: If Adiaforos owned a donkey, he might very well beat it. It depends on which one he buys.

Again, if the grammar only generates the low reading, the underlined counterfactual in (29b) should be judged false in scenario (28). If the grammar also generates the high reading, the sentence should be judged true. Since the sentence is in fact intuitively true, the grammar generates the high reading.

We conclude from this data that our semantics needs to account for both high and low interpretations of counterfactual donkey sentences independently.

3. High and low readings in indicative donkey sentences with modals

3.1. The data

Although the semantics we have presented so far is derived from a semantics for counterfactual conditionals, we note that the observations extend to indicative donkey sentences, as long as they contain some form of modality that employs an ordering source. This is expected under a Kratzer-style analysis of conditionals: the similarity ordering we employ in counterfactual conditionals is simply a specific case of an ordering source (specifically, a totally realistic ordering source over an empty modal base.) Some examples for this are the following:

(30) Epistemic modality:

a. I don't know if Tino owns a donkey, but if he owns a donkey, he beats it. *High*

b. I don't know if Tino owns a donkey, but if he owns a donkey, it is Grisella. *Low*

Example (30a) readily allows for a high reading. Note that, while keeping with the high reading of the indefinite, (30a) is ambiguous between a weak and a strong reading of the donkey pronoun, where Tino either beats all of his donkeys (strong) or one/some of his donkeys (weak). The reading in (30b) is distinct from both of these, however: we neither convey that all of his donkeys are Grisella, nor that one of his donkeys is Grisella. Rather, it has a low reading of the indefinite indicating that Grisella is the most likely donkey to be owned by Tino (if he owns any.)

Parallel examples can be constructed with deontic modality, witness (31a)-(31a):

(31) Deontic modality:

a. If Afiadoros buys a donkey, he has to treat it well. *High*

b. If Afiadoros buys a donkey, it has to be Platero. *Low*

3.2. A generalized account

Assuming that conditionals have a roughly unified analysis, with the counterfactual as a subcase with a realistic ordering source and an empty modal base (Kratzer 1991, Portner 2009), we straightforwardly generalize to other modals with any modal base and ordering source:

(32) $[\![\phi \rightarrow^{X} \psi]\!]^{\leq^{\mathrm{OS}},\mathrm{MB}}(\langle w,g\rangle) = 1 \text{ iff } \forall\langle v,h\rangle \in f^{X,\mathrm{MB},\leq^{\mathrm{OS}}}_{\langle w,g\rangle}(/\phi/_g) : \langle v,h\rangle \in /\psi/_g$

(33) $f^{X,\mathrm{MB},\leq}_{\langle w,g\rangle}(/\phi/_g) = \{\langle v,h\rangle \in (\mathrm{MB}\cap/\phi/_g) : \neg\exists\langle u,k\rangle \in (\mathrm{MB}\cap/\phi/_g) : \langle u,k\rangle <^{X}_{\langle w,g\rangle} \langle v,h\rangle\}$

That is, for any given ordering source *OS* and modal base *MB*, we intersect the antecedent-worlds with the modal base and use the ordering $\leq$ induced by the ordering source, partialized by the values of X. For the counterfactual case, the modal base is empty (i.e. contains all possible worlds) – rendering the intersection vacuous –, and the ordering induced is our familiar similarity ordering, yielding the semantics we discussed above.

4. High and low readings in indicative donkey sentences with adverbs of quantification: Symmetric and asymmetric readings

A familiar puzzle in indicative donkey sentences is the so-called proportion problem (Kadmon 1987): a sentence like (35) comes out as true in the scenario in (34) under the standard analyses, because its consequent is true for most farmer-donkey pairs. However, in its most salient reading, the sentence is judged false, because we are counting farmers instead of farmer-donkey pairs.

(34) *Scenario*: There are ten farmers in this village. One is rich and owns ninety donkeys. The others are poor and own one donkey each.

(35) If a farmer in this village owns a donkey, he is usually rich.

There is a familiar solution to this puzzle as well (at least in dynamic semantics[7]): give up on the idea of unselective binding and assume that indefinites are marked as either relevant or irrelevant to the counting procedure of the quantificational adverb. This is parallel to the way that indefinites are marked as either relevant or irrelevant for interacting with similarity (i.e., by either being or not being included in a contextually given set X, a subset of the variables introduced in the antecedent). In fact, in developing the mechanism for the latter, van Rooij (2006) directly refers to the former mechanism (e.g. Dekker (1993)). This raises two questions: (i) whether this similarity in theoretical machinery is purely accidental or whether there is an actual empirical connection between the symmetric/asymmetric ambiguity and the high/low ambiguity, and (ii), assuming that there is an empirical connection between the two phenomena, whether the two formal apparatus can be reduced to a single quantificational schema.

We tackle these two questions in the following subsections. As the reader will see, the results in subsection 4.1 are tentative. The merging of the two formal systems in subsection 4.2 is an exercise.

4.1. The empirical question

On the one hand, the symmetric/asymmetric ambiguity is attested with adverbs of quantification but not with modal quantification. This is because, by definition, symmetric and asymmetric readings concern merely quantification over individuals (via assignments), and modals necessarily bring in a world quantification component. On the other hand, the high/low ambiguity arises with modal quantification but not with quantificational adverbs. This is due to the fact that, by definition, the labels 'high' and 'low' identify two ways in which a similarity ordering may be affected by a given indefinite, and quantificational adverbs intuitively make use of no similarity orderings. This means that the two kinds of ambiguity are in complementary distribution. But, then, how can we test whether they are, empirically, the same phenomenon?

Here is an idea. There are some linguistic devices that enforce or at least prime one of the two readings in one of the two quantificational environments. Now, if the same linguistic device that forces or primes the indefinite to be irrelevant (for similarity/for counting) in one environment also

[7]For a related solution in D-type theory, see Walker (2014).

forces or primes the indefinite to be irrelevant (for similarity/for counting) in the other environment, then it would be most parsimonious to assume that the two kinds of ambiguity are two surface exponents of the same underlying phenomenon.

We will examine two such linguistic devices. The first one is identificational sentences like (36). As discussed in section 2.1, in modalized (counterfactual) conditionals, an identificational consequent identifying the referent of an indefinite (*a girl from his class* in the antecedent clause) enforces the low reading of that indefinite, i.e., it forces the indefinite to be irrelevant for interacting with similarity, so that the high reading and its entailments in (37) are lost:

(36) If Alex were married to a girl from his class, it would be Sue. ** High / ✓ Low*

(37) a. $\not\Rightarrow$ If Alex were married to Ann, Ann would be Sue.
b. $\not\Rightarrow$ If Alex were married to Betty, Betty would be Sue.
c. $\not\Rightarrow$ If Alex were married to Carol, Carol would be Sue.
d. ...

Now let us take a non-modalized example with an adverb of quantification and make the consequent clause identificational: (38). The question is whether this device —which triggers irrelevance for similarity in modal contexts— triggers irrelevance for counting in quantificational adverb contexts as well. The answer is 'yes': (38) cannot be paraphrased as in (38a).

(38) If(/when) a man calls, it is usually John.
a. # 'For most x: if x calls, x is John.'

The second linguistic device is topicality. It has been noted that, in indicative donkey sentence with adverbs of quantification, making a given indefinite topical favours an asymmetric reading where the topical indefinite is relevant for counting and non-topical indefinites irrelevant (Chierchia 1992). This is illustrated in (39). The small discourse makes farmers topical. As a result, the donkey sentence readily has the asymmetric reading (39a) counting farmers but, crucially, not the asymmetric reading (39b) counting donkeys. That the latter reading is not (readily) available is shown by judging the sentence in scenario (40): scenario (40) would verify the donkey-counting asymmetric reading (39b) —and falsify (39a)—, but the sentence is judged false in it.

(39) Let me tell you something about farmers in this county. If a farmer knows a donkey well, he usually respects it.
a. 'Most donkey-knowing farmers respect those donkeys.'
b. # 'Most known-to-farmers donkeys are respected by those farmers.'

(40) Scenario: There are five donkeys and five farmers. The first four donkeys are known to farmer Bill, who respects them. The fifth donkey is known to the other four farmers, who disrespect it.

Now let us take an example of modalized (counterfactual) conditional and mix it with topicality. This gives us (41). The question is, again, whether this device —which triggers irrelevance of the non-topical indefinite for counting in adverb-of-quantification contexts— triggers irrelevance for similarity in modal contexts as well. Though the judgments are somewhat subtle, the answer seems to be 'yes': (41) can be readily understood as having the entailments in (41a), but not so the entailments in (41b). This is apparent when the sentence is judged against scenario (42). In this scenario, the entailments in (41b) are verified: for each individual donkey, it is most likely that it is known by farmer Bill, who would also respect it. But (41) is judged false in this context, showing that the reading is unavailable.

(41) Let me tell you something about farmers in this county. If a farmer knew a donkey well, he would respect it.

a. Reading with *a farmer* as high indefinite and *a donkey* as low indefinite:
   i. $\Rightarrow$ If farmer f_1 knew a donkey well, f_1 would respect it.
   ii. $\Rightarrow$ If farmer f_2 knew a donkey well, f_2 would respect it.
   iii. $\Rightarrow$ If farmer f_3 knew a donkey well, f_3 would respect it.
   iv. ...

b. Reading with *a farmer* as low indefinite and *a donkey* as high indefinite:
   i. $\Rightarrow$ If a farmer knew donkey d_1 well, he would respect d_1.
   ii. $\Rightarrow$ If a farmer knew donkey d_2 well, he would respect d_2.
   iii. $\Rightarrow$ If a farmer knew donkey d_3 well, he would respect d_3.
   iv. ...

(42) Scenario: None of the farmers knows any donkey well. But farmer Bill is the farmer that knows donkeys best and, since he has a lot of respect for intelligent animals, he would have a lot of respect for a donkey if he knew it well. All the other farmers are much less knowledgeable about donkeys and, as they don't respect smart animals, they wouldn't respect donkeys if they knew them.

These preliminary data suggest that (ir)relevance for similarity and (ir)relevant for counting are, empirically speaking, not unrelated. Of course, it remains an open question whether the two phenomena are truly underlyingly the same or whether they correspond to two different semantic processes that happen to be affected in the same way by the same linguistic devices. But, in the absence of evidence to the contrary, it seems most economical to aim at a unified analysis of the two. This takes us to our next section, where the two formal mechanisms are unified.

4.2. The formal exercise: Towards a unified analysis

Dekker (1993) assumes that adverbs of quantification take two propositions and use them to construct two sets of assignments that are related by the respective set-theoretic interpretation of that adverb of quantification. This is shown in (43). Crucially, each assignment j in the first set of assignments is an extension of an input assignment i and differs from it only in that values for the variables contained in the contextually supplied variable X have been added ($i \sqsubseteq_X j$). These extended assignments j, if they also verify the antecedent, are then compared with the assignments that survive updates with both the antecedent and the consequent. If the quantificational adverb is *always*, all the assignments in the first set are required to also be in the second set, as defined in (44).

(43) $s[A_X(\phi, \psi)] = \{i \in s \mid [A]\ (\{j \mid i \sqsubseteq_X j \wedge j \lessdot s[\phi]\})\ (\{j \mid j \lessdot s[\phi][\psi]\})\}$

(44) $[\text{always}](J, K) = 1$ iff $\forall j \in J : j \in K$

The goal of this subsection is to unify the two formal apparatus of donkey quantification: Dekker (1993)'s approach via adverbs of quantification and the present account in sections 2 and 3 via modal quantification. We will proceed in three quick steps. First, we will extend and modify Dekker's idea to account for counterfactual donkeys. Once we have the modified interpretation template, we will go back to indicatives donkeys with adverbs of quantification and minimally enrich them. Finally, we put all the ingredients together in a unified account of high/low and symmetric/asymmetric readings across counterfactual and indicative donkeys.

First, to extend Dekker's idea to our counterfactual case, we treat *would* (or the universal modal behind it) in a parallel way to quantificational adverbs. However, since we are dealing with an intensional framework, we have to enrich Dekker's (1993) proposal and assume that the information states are not simply sets of assignments, but instead sets of world-assignment pairs, as in van Rooij (2006)[8]. We can then give the semantics as follows:

(45) $s[\text{would}_X(\phi, \psi)] = \{\langle w, i\rangle \in s \mid [\text{would}]_{\langle w,i\rangle}(\{\langle w', j\rangle \mid i \sqsubseteq_X j \wedge \langle w', j\rangle \lessdot s[\phi]\})$
$(\{\langle w', j\rangle \mid \langle w', j\rangle \lessdot s[\phi][\psi]\})\}$

(46) $[\text{would}]_{\langle w,i\rangle}(J, K) = 1$ iff
$\forall \langle w', j\rangle \in J : (\neg\exists \langle w'', j\rangle \in J : w' <_w w'') \rightarrow \langle w', j\rangle \in K$

That is, *would* behaves in a parallel way to quantificational adverbs and only differs in the way it relates the two sets of world-assignment pairs provided to it. Specifically, it asserts that all the

[8]Dekker (1993) sketches a possible extension of his system that essentially makes this move by adding a designated world variable to every assignment.

closest antecedent-verifying pairs in the set J are also in the set K. Note that —differently from our semantics in sections 2 and 3— there is no need to make the ordering relation itself sensitive to X, as we did with $\leq^X_{\langle w,g\rangle}$ in (19). Rather, we simply compare pairs that share an assignment, as defined in (46). This is because the sensitivity to X is already encoded in the construction of the set J in (45), as in Dekker's (1993) account of asymmetric quantification.

Second, let us go back to adverbs of quantification. Since we have modified our information states so that they are now sets of world-assignment pairs, we need to recast the interpretation template for adverbs of quantification as involving such pairs. We propose (47)-(48). The idea is that adverbs of quantification like $always$ are grounded to the actual/evaluation world and thus only quantify over world-assignment pairs whose first member is the evaluation world.

(47) $s[A_X(\phi,\psi)] = \{\langle w,i\rangle \in s \mid [A]_{\langle w,i\rangle}\,(\{\langle w',j\rangle \mid i \sqsubseteq_X j \,\wedge\, \langle w',j\rangle \lessdot s[\phi]\})$
$(\{\langle w',j\rangle \mid \langle w',j\rangle \lessdot s[\phi][\psi]\})\}$

(48) $[\text{always}]_{\langle w,i\rangle}(J,K) = 1$ iff
$\forall\langle w',j\rangle \in J : w' = w \rightarrow \langle w',j\rangle \in K$

Finally, generalizing this to the whole range of phenomena – i.e. symmetric/asymmetric quantification with adverbs of quantification, low/high readings in counterfactuals and low/high readings in modal indicative donkeys –, we propose the tentative analysis in (49)-(51). Quantifiers on the verbal spine – in this case, modals and adverbs of quantification – are uniformly interpreted via the template (49). Sensitivity to the set X of selected variables is handled here, so that, depending on what shape X has, we will get a different set of world-assignments pairs J. Modals and adverbs of quantification operate on the sets J and K built in (49). On the one hand, modals filter the world-assignment pairs in J with the help of their respective modal bases, order the results via the ordering source and check whether the best of the so ordered pairs are also in set K. On the other hand, adverbs of quantification filter the world-assignment pairs in J so that only those pairs remain where the first element is the evaluation world (as if we had a totally realistic modal base) and then they check whether these remaining pairs are also in K.

(49) $s[\text{Quant}_X(\phi,\psi)] = \{\langle w,i\rangle \in s \mid [\text{Quant}]_{\langle w,i\rangle}\,(\{\langle w',j\rangle \mid i \sqsubseteq_X j \,\wedge\, \langle w',j\rangle \lessdot s[\phi]\})$
$(\{\langle w',j\rangle \mid \langle w',j\rangle \lessdot s[\phi][\psi]\})\}$

(50) $[\forall\text{-Modal}]^{\leq^{\text{OS}},\text{MB}}_{\langle w,i\rangle}(J,K) = 1$ iff
$\forall\langle w',j\rangle \in J : (\langle w',j\rangle \in \text{MB} \wedge \neg\exists\langle w'',j\rangle \in J \cap \text{MB} : w'' <^{\text{OS}}_w w') \rightarrow \langle w',j\rangle \in K$

(51) $[\forall\text{-Adverb}]_{\langle w,i\rangle}(J,K) = 1$ iff
$\forall\langle w',j\rangle \in J : w' = w \rightarrow \langle w',j\rangle \in K$

To see the system in action, consider the example in (53) and the scenario described in (52) and detailed in Table 2. If we assume that all the pairs in s have an empty assignment g, *a farmer* introduces the variable x and *a donkey* the variable y, and that $X = \{x\}$ (that is, a high reading for farmers and a low reading for donkeys), we obtain the result in (54). *Would* relates two sets of world-assignment pairs. One contains pairs which differ from the input pairs in that their assignment assigns a value to x and which can be extended to verify the antecedent. This amounts to pairs with worlds w_1, w_2, w_3 and w_4, with g modified to assign the respective donkey-owning farmers a, b and c to x. The other set contains pairs that can be extended to verify both the antecedent and the consequent. Since this is a relatively weak condition, the set in question is much larger, because it contains both extended and non-extended assignments; however, only those that can be extended to verify the consequent are included in this second set (i.e. no pair with world w_2). In the last equation in (54), we can see how *would* relates these two pairs: it requires all closest members of the first set to be included in the second set. As the closeness requirement eliminates the pair $\langle w_2, g^{a/x}\rangle$ – but not the other pairs, as they have distinct assignments –, the condition is fulfilled.

(52) *Scenario*: Of all the farmers a, b and c, farmer a is most likely to own a donkey, no matter which one. Donkey d is very stubborn and would be beaten by its owner, but e is well-behaved and would not be beaten by its owner.

	farmer	donkey	own	beat
w_0	$\{a, b, c\}$	$\{d, e\}$	$\emptyset$	$\emptyset$
w_1	$\{a, b, c\}$	$\{d, e\}$	$\{\langle a, d\rangle\}$	$\{\langle a, d\rangle\}$
w_2	$\{a, b, c\}$	$\{d, e\}$	$\{\langle a, e\rangle\}$	$\emptyset$
w_3	$\{a, b, c\}$	$\{d, e\}$	$\{\langle b, d\rangle\}$	$\{\langle b, d\rangle\}$
w_4	$\{a, b, c\}$	$\{d, e\}$	$\{\langle c, d\rangle\}$	$\{\langle c, d\rangle\}$

Table 2: A sample model for (53), with worlds ranked as follows: $w_0 < w_1 < w_2 < w_3 < w_4$

(53) If a farmer owned a donkey, he would beat it.

(54) $s[\text{would}_{\{x\}}(\text{a farmer owns a donkey})(\text{he beats it})]$
$= \{\langle w, i\rangle \in s \mid [\text{would}]_{\langle w,i\rangle}$
$(\{\langle w', j\rangle \mid i \sqsubseteq_{\{x\}} j \wedge \langle w', j\rangle \lessdot s[\text{a farmer owns a donkey}]\})$
$(\{\langle w', j\rangle \mid \langle w', j\rangle \lessdot s[\text{a farmer owns a donkey}][\text{he beats it}]\})\}$
$= \{\langle w, i\rangle \in s \mid [\text{would}]_i$
$(\{\langle w_1, g^{a/x}\rangle, \langle w_2, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle\})$
$(\{\langle w_1, g\rangle, \langle w_3, g\rangle, \langle w_4, g\rangle, \langle w_1, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle,$
$\langle w_1, g^{a/x,d/y}\rangle, \langle w_3, g^{b/x,d/y}\rangle, \langle w_4, g^{c/x,d/y}\rangle\})\}$
$= \{\langle w, i\rangle \in s \mid \forall \langle w', j\rangle \in \{\langle w_1, g^{a/x}\rangle, \langle w_2, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle\} :$
$(\neg\exists \langle w'', j'\rangle \in \{\langle w_1, g^{a/x}\rangle, \langle w_2, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle\} : j' <^{\text{OS}}_w j) \rightarrow$
$\langle w', j\rangle \in \{\langle w_1, g\rangle, \langle w_3, g\rangle, \langle w_4, g\rangle, \langle w_1, g^{a/x}\rangle, \langle w_3, g^{b/x}\rangle, \langle w_4, g^{c/x}\rangle,$
$\langle w_1, g^{a/x,d/y}\rangle, \langle w_3, g^{b/x,d/y}\rangle, \langle w_4, g^{c/x,d/y}\rangle\}\}$

We can run a parallel example for a non-modal indicative sentence. Consider the example (56) and the scenario described in (55) and detailed in Table 3. Assuming again that all pairs in s have an empty assignment g, that *a farmer* introduces the variable x, that *a donkey* introduces the variable y and that $X = \{x\}$ (i.e. farmers are to be counted, but donkeys are not), we obtain the following. The first set contains pairs with both the actual world w_0 and world w_1, and assignments extended to assign either a or b to x. Since no beating happens in w_1, the second set only contains pairs with the actual world w_0, but again, a larger number of assignments. In the last equation in (57), we see that *always* enforces the following condition: if the world of a pair in the first set is the actual world, then that pair has to be contained in the second set. This removes all the pairs with w_1 and ensures that the conditional is true. Note that only farmers have been counted, as we ignore the fact that donkey e remains unbeaten.

(55) *Scenario*: There are two farmers, a and b, who co-own two donkeys d and e. Both farmers beat stubborn d but not e in the actual world w_0. The same owning relations hold in w_1 but there is no beating in w_1.

	farmer	donkey	own	beat
w_0	$\{a, b\}$	$\{d, e\}$	$\{\langle a, d\rangle, \langle a, e\rangle, \langle b, d\rangle, \langle b, e\rangle\}$	$\{\langle a, d\rangle, \langle b, d\rangle\}$
w_1	$\{a, b\}$	$\{d, e\}$	$\{\langle a, d\rangle, \langle a, e\rangle, \langle b, d\rangle, \langle b, e\rangle\}$	$\emptyset$

Table 3: A sample model for (56), with worlds ranked as follows: $w_0 < w_1$

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

(57) $s[\text{always}_{\{x\}}(\text{a farmer owns a donkey})(\text{he beats it})]$
$= \{\langle w, i\rangle \in s \mid [\text{always}]_{\langle w,i\rangle}$
$(\{\langle w', j\rangle \mid i \sqsubseteq_X j \wedge \langle w', j\rangle \lessdot s[\text{a farmer owns a donkey}]\})$
$(\{\langle w', j\rangle \mid \{\langle w', j\rangle \lessdot s[\text{a farmer owns a donkey}][\text{he beats it}]\})\}$
$= \{\langle w, i\rangle \in s \mid [\text{always}]_{\langle w,i\rangle}$
$(\{\langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_1, g^{a/x}\rangle, \langle w_1, g^{b/x}\rangle\})$
$(\{\langle w_0, g\rangle, \langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_0, g^{a/x,d/y}\rangle, \langle w_0, g^{b/x,d/y}\rangle\})\}$
$= \{\langle w, i\rangle \in s \mid \forall\langle w', j\rangle \in \{\langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_1, g^{a/x}\rangle, \langle w_1, g^{b/x}\rangle\} : w' = w \rightarrow$
$\langle w', j\rangle \in \{\langle w_0, g\rangle, \langle w_0, g^{a/x}\rangle, \langle w_0, g^{b/x}\rangle, \langle w_0, g^{a/x,d/y}\rangle, \langle w_0, g^{b/x,d/y}\rangle\}\}$

5. Conclusions

We have shown that similarity orderings in counterfactuals – and, more generally, ordering sources in modals – are sensitive to some linguistic material in the antecedent of the counterfactual, specifically indefinite noun phrases. This sensitivity gives rise to two different readings, high and low, which can be found in both counterfactual and indicative donkey sentences, contra Wang's (2009) challenge. We tentatively propose that this phenomenon is closely related to the proportion problem and sketch a unified analysis of both phenomena, but leave further exploration of this issue to future research.

This is only a partial account of ordering sources in that there may be many other factors that pragmatically interact with the orderings we use. But it isolates one specific interaction and gives a systematic account of it. This distinguishes it from a potential account that would explain the data by appealing to the granularity of similarity, e.g. by selecting not just the closest worlds, but the closest worlds up to a contextually determined threshold of similarity. Note that an account of this type could only quantitatively shift the domain of quantification: where our account predicts that we can target specific worlds that are less similar if they are closest for a particular individual, a threshold-based account, if it wanted to include this world in the quantification, would have to include all other worlds that are equally or more similar, in terms of overall similarity.

If the question of asymmetric readings and the high/low distinction are as closely related as our data suggests, we are faced with the challenge of further developing these results, not only in terms of a formal account, but also in terms of interpreting it. Both issues can indeed be viewed as showing a certain kind of granularity in our quantificational behaviour, although different from the threshold-based view: what we observe here is a complex partitioning of quantificational domains (of both individuals and worlds) based on more or less fine-grained classes of assignments, not just a question of including more or less worlds in the quantification.

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