Donkey Anaphora through Choice Functions and Strengthening

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June 26, 2023 @ HUJI Semantics Workshop

Donkey anaphora have traditionally led to a surrender of classical static semantics in favor of either dynamic or situation semantics. If we admit a choice function analysis of indefinites, however, such surrender can be staved off. In this talk, we spell out how.

1 Donkey anaphora and its challenges

Donkey anaphora. An exceptional dependency between an indefinite and a pronoun:

(1) Every farmer who saw a donkey$_i$ fed it$_i$.

$\forall$y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

Substituting an indefinite/disjunction with another quantifier breaks the dependency:

(2) Every farmer who saw every donkey$_{*i}$ fed it$_{*i}$ / them.

The scope challenge. The indefinite (disjunctive) antecedent in (1) does not c-command the donkey pronoun. Moreover, it is trapped in what is otherwise an island for scope-shifting.

(3) $\forall$y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

The strength challenge. The dependency between the indefinite (disjunction) and the donkey pronoun is represented by universal, rather than existential, quantification (conjunction).

(4) $\forall$y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

(5) # $\exists$y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

An account in three steps, with two actors.

> Every farmer who saw a donkey fed it.
>
> $\forall$y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

- **Step 1:** Indefinites are subject to the scope challenge more generally. $\rightsquigarrow$ choice functions

> Every farmer who saw a donkey fed it.
>
> $\exists$y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

- **Step 2:** Indefinites are subject to the strength challenge more generally. $\rightsquigarrow$ strengthening

> Every farmer who saw a donkey fed it.
>
> $\forall$ y: $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x fed donkey y

- **Step 3:** Indefinites and functional readings ($\subseteq$ the strength challenge) $\rightsquigarrow$ choice functions^{+}

2 The scope challenge

2.1 Exceptional scope of indefinites

Exceptional scope. Certain indefinites (disjunction) allow for exceptional-scope construals:

(6) [*Context: people tended to be sad when they saw a donkey, as they are in captivity, but seeing Donald, a free donkey, put its seers in a good mood:*] Everyone who saw a donkey was happy.

(7) a. $\exists$y: donkey y $\wedge$ $\big($$\forall$x: person x saw donkey y $\rightarrow$ person x was happy$\big)$
b. # $\big($$\forall$x: $\exists$y: donkey y $\wedge$ person x saw donkey y $\rightarrow$ person x was happy$\big)$

Other quantifiers (conjunction) do not exhibit this kind of behavior:

(8) Everyone who saw every donkey was happy.

(9) # $\forall$y: donkey y $\rightarrow$ ($\forall$x: person x saw donkey y $\rightarrow$ person x was happy)

Choice functions.

(10) Let E be a non-empty set of individuals. A function f: $\mathscr{P}(E) \rightarrow E$ is a (simple) choice function, f ∈ CH, iff for every A ⊆ E: if A is not empty then f(A) ∈ A.

(11) A choice function variable introduced by an indefinite must be existentially closed. The existential closure, represented with ∃, may apply at the level of any clausal constituent.

Simple illustration:

(12) a. Gali saw a donkey.

b. [∃f [Gali saw f donkey]]

(13) ∃f∈CH: Gali saw f(donkey) (= ∃x: donkey x ∧ Gali saw x)

Turning now to our motivating example:

(14) a. Everyone who saw a donkey is happy.

b. [∃f [everyone who saw f donkey is happy]]

(15) ∃f∈CH: ∀x: person x saw f(donkey) → person x is happy
(= ∃y: donkey y ∧ ∀x: person x saw donkey y → person x is happy)

2.2 Pronouns and definites

CH can be, and have been, employed in the analysis of pronouns and definites:

(16) a. The student greeted the professor. He likes him.

b. [[f student] greeted [f professor]]. [[f ~~student~~] likes [f ~~professor~~]].

2.3 Towards deriving donkey anaphora: step 1 of 3

Possible reading, derived. But this is not the targeted reading.

(1) Every farmer who saw a donkey_i fed it_i.

(17) [∃f [every farmer who saw f donkey fed f donkey]]

(18) ∃f∈CH: ∀x: farmer x saw f(donkey) → farmer x fed f(donkey)

Targeted reading, not derived yet.

(19) $\forall f \in CH$: $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x fed f(donkey)

3 The strength challenge

3.1 Universal strengthening and its limits

Existential quantification can in some cases be strengthened to a universal one:

(20) Gali is allowed to feed a(ny) donkey.

$\Rightarrow$ $\forall x$: donkey x $\rightarrow \Diamond$(Gali fed donkey x) (*this is derived by* STR / EXH)

This strengthening is not always possible:

(21) Gali is required to feed a donkey.

$\not\Rightarrow$ $\forall x$: donkey x $\rightarrow \Box$(Gali fed donkey x)

(22) Gali fed a donkey.

$\not\Rightarrow$ $\forall x$: donkey x $\rightarrow$ Gali fed x

Strengthening generalization. The availability of strengthening depends on the alternatives.

(23) **The Condition (simplified):** Universal strengthening of an existential quantification sentence is possible when the universally strengthened meaning is not among the sentence's alternatives. (that is, only if it is compatible with the negation of excludable alternatives)

(24) a. Gali is allowed to feed a(ny) donkey.

b. $\forall x$: donkey x $\rightarrow \Diamond$(Gali fed donkey x)

$\notin$ {$\Diamond(\exists x$: Gali fed donkey x), $\Diamond(\forall x$: donkey x $\rightarrow$ Gali fed donkey x), ...}

The Condition is satisfied, universal strengthening is possible

(25) a. Gali is required to feed a donkey.

b. $\forall x$: donkey x $\rightarrow \Box$(Gali fed donkey x)

$\in$ {$\Box(\exists x$: Gali fed donkey x), $\Box(\forall x$: donkey x $\rightarrow$ Gali fed donkey x), ...}

The Condition is not satisfied, universal strengthening is not possible

(26) a. Gali fed a donkey.

b. $\forall$x: donkey x $\rightarrow$ Gali fed donkey x

$\in$ {($\exists$x: Gali fed donkey x), ($\forall$x: donkey x $\rightarrow$ Gali fed donkey x), ...}

The Condition is not satisfied, universal strengthening is not possible

3.2 Strengthening with choice functions

Missing alternatives.

(27) a. Every farmer who sees a donkey is happy.

b. [$\exists$f [every farmer who sees f donkey is happy]]

(28) ALT([$\exists$f [every farmer who sees f donkey is happy]]) =

{ $\exists$f$\in$CH: $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy,

$\forall$x: ($\exists$f$\in$CH: farmer x saw f(donkey)) $\rightarrow$ farmer x happy,

$\forall$x: ($\forall$y: donkey y $\rightarrow$ farmer x saw donkey y) $\rightarrow$ farmer x happy,

~~$\forall$y: donkey y $\rightarrow$ $\forall$x: farmer x saw donkey y $\rightarrow$ farmer x happy~~, ... }

Given these alternatives, the Condition is not satisfied:

(29) $\forall$f$\in$CH: $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy

$\in$ { $\exists$f$\in$CH: $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy,

$\forall$x: ($\exists$f$\in$CH: farmer x saw f(donkey)) $\rightarrow$ farmer x happy,

$\forall$x: ($\forall$y: donkey y $\rightarrow$ farmer x saw donkey y) $\rightarrow$ farmer x happy,

~~$\forall$y: donkey y $\rightarrow$ $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy~~, ... }

The Condition is not satisfied, universal strengthening is not possible

Other inferences. Exceptional indefinites can give rise to other scalar implicatures (SIs):

(30) STR ($\exists$f$\in$CH: $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy) = *(weaker SI)*

$\exists$f$\in$CH: $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy $\wedge$

$\neg\forall$x: ($\exists$f$\in$CH: farmer x saw f(donkey)) $\rightarrow$ farmer x happy

(31) $\exists$f$\in$CH: STR ($\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy) = *(stronger SI)*

$\exists$f$\in$CH: $\forall$x: farmer x saw f(donkey) $\rightarrow$ farmer x happy $\wedge$

$\forall$f'$\in$CH: f(donkey)$\neq$f'(donkey) $\rightarrow$ $\neg\forall$x: farmer x saw f'(donkey) $\rightarrow$ farmer x happy

3.3 Towards deriving donkey anaphora: step 2 of 3

Yet further missing alternatives.

(32) a. Every farmer who sees a donkey feeds it.

b. [∃f [every farmer who sees f donkey feeds f donkey]]

(33) ALT([∃f [every farmer who sees f donkey feeds f donkey]]) =

{ $\exists f \in CH$: $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x feeds f(donkey),

~~$\forall x$: ($\exists f \in CH$: farmer x saw f(donkey)) $\rightarrow$ farmer x feeds f(donkey),~~

~~$\forall x$: ($\forall y$: donkey y $\rightarrow$ farmer x saw donkey y) $\rightarrow$ farmer x feeds f(donkey),~~

~~$\forall y$: donkey y $\rightarrow$ $\forall x$: farmer x saw donkey y $\rightarrow$ farmer x feeds donkey y~~, ... }

This absence of alternatives allows for a satisfaction of the Condition:

(34) $\forall f \in CH$: $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x feeds f(donkey)

$\notin$ { $\exists f \in CH$: $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x feeds f(donkey),

~~$\forall x$: ($\exists f \in CH$: farmer x saw f(donkey)) $\rightarrow$ farmer x feeds f(donkey),~~

~~$\forall x$: ($\forall y$: donkey y $\rightarrow$ farmer x saw donkey y) $\rightarrow$ farmer x feeds f(donkey),~~

~~$\forall y$: donkey y $\rightarrow$ $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x feeds f(donkey)~~, ... }

The Condition is satisfied, universal strengthening is possible

Strong readings of donkey anaphora.

(35) STR ($\exists f \in CH$: $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x feeds f(donkey)) =

$\forall f \in CH$: $\forall x$: farmer x saw f(donkey) $\rightarrow$ farmer x feeds f(donkey)

($\Leftrightarrow$ $\forall y$: donkey y $\rightarrow$ $\forall x$: farmer x saw donkey y $\rightarrow$ farmer x feeds donkey y)

Note that the derived reading corresponds to a so-called strong reading of donkey anaphora: every farmer who sees one or more donkeys feeds all of the donkeys he sees.

Formal link condition. One immediate consequence of the proposal:

(36) a. Everyone who is a parent loves them. no donkey anaphora construal

b. Everyone who has a child loves them. donkey anaphora construal possible

As the account piggybacks on the exceptional scope of the antecedents to anaphora, only an exceptional scope-taking element (= an indefinite) can serve as an antecedent (though see below).

Sage plant examples. Another immediate consequence of the proposal:

(37) Everyone who owns a donkey owns another donkey in addition to it.

(38) $\forall$f: $\forall$x: person x owns f(donkey) $\rightarrow$ $\exists$y: person x owns donkey y $\wedge$ y $\neq$ f(donkey)

Although we adopted an analysis that takes pronouns to have descriptive content akin to definite descriptions, uniqueness was obviated by using (bound) choice functions in their interpretation.

Other scope-shifting strategies. The descriptive content of the indefinite must be interpreted low.

(39) Everyone$_k$ [who saw a donkey$_i$ of their$_k$ uncle's] fed it$_i$.

(40) $\forall$f$\in$CH: $\forall$x: person x saw f donkey of x's uncle $\rightarrow$ person x fed f donkey of x's uncle

4 Discourse anaphora

Donkey anaphora are found also in non-quantificational environments. In these environments, the dependency between the indefinite and the pronoun can be expressed with existential quantification:

(41) a. Gali met a phonologist$_i$ and they$_i$ were nice.

b. [$\exists$f [[Gali met f phonologist] [and [f phonologist was nice]]]

(42) $\exists$x: phonologist x $\wedge$ G met x $\wedge$ x was nice / # $\forall$x: phonologist x $\rightarrow$ G met x $\wedge$ x was nice

Alternatives and the Condition. Some alternatives that were safely ignored above become consequential in the absence of a quantificational host configuration:

(43) ALT([[Gali talked to f phonologist] [and [f phonologist was nice]]]) =

{ $\exists$f: Gali met f(phonologist) $\wedge$ f(phonologist) was nice,

~~($\exists$f: Gali met f(phonologist)) $\wedge$ f(phonologist) was nice,~~

~~($\forall$x: phonologist x $\rightarrow$ Gali met x) $\wedge$ f(phonologist) was nice,~~

($\forall$x: phonologist x $\rightarrow$ Gali met x) $\wedge$ ($\forall$x: phonologist x $\rightarrow$ x was nice), ... }

The Condition plays out differently given this set of alternatives:

(44) $\forall$x: phonologist x $\rightarrow$ Gali met x $\wedge$ x was nice

$\in$ { $\exists$f: Gali met f(phonologist) $\wedge$ f(phonologist) was nice,

~~($\exists$f: Gali met f(phonologist)) $\wedge$ f(phonologist) was nice,~~

~~($\forall$x: phonologist x $\rightarrow$ Gali met x) $\wedge$ f(phonologist) was nice,~~

($\forall$x: phonologist x $\rightarrow$ Gali met x) $\wedge$ ($\forall$x: phonologist x $\rightarrow$ was nice), ... }

The Condition is not satisfied, universal strengthening is not possible

Text-level existential closure.

(45) a. Gali met a phonologist$_i$. They$_i$ were nice.

b. [[$\exists$f [[Gali met f phonologist]. [f phonologist was nice].]

5 Quantificational variability

5.1 An issue of apparent undergeneration, but not of misgeneration

The good: *some, most*? A desirable (?) interpretation for some occurrences of donkey anaphora:

(46) a. Most farmers who saw a donkey fed it.

b. Most farmers who saw Donald or Eeyore fed it.

(47) $\forall$f$\in$CH: $\frac{|\{x \mid \text{farmer x saw f(donkey)} \wedge \text{farmer x fed f(donkey)}\}|}{|\{x \mid \text{farmer x saw f(donkey)}\}|} \geq \frac{1}{2}$

(48) a. Some farmers who saw a donkey fed it.

b. Some farmers who saw Donald or Eeyore fed it.

(49) $\forall$f$\in$CH: $\exists$x: farmers x saw f(donkey) $\wedge$ farmers x fed f(donkey)

The bad.

(50) Five farmers who saw a donkey fed it.

(51) #$\forall$f$\in$CH: $|\{x \mid \text{farmer x saw f(donkey)} \wedge \text{farmer x fed f(donkey)}\}| \geq 5$

But, fortunately, this reading might not actually be generated. Consider the alternatives:

(52) ALT([∃f [five farmers who_x saw f donkey fed f donkey]]) =

{ ... ,

$|\{x \mid (\exists f\text{: farmer x saw f(donkey)}) \wedge (\exists f\text{: farmer x fed f(donkey)})\}| \geq 6$,

$|\{x \mid (\exists f\text{: farmer x saw f(donkey)}) \wedge (\forall y\text{: donkey y} \rightarrow \text{farmer x fed y})\}| \geq 5$,

... }

A donkey anaphora resolution is not generated. The system thus undegenerates.

5.2 Generalized choice functions

More than simple CH is sometimes needed anyway. Schlenker's example:

(53) [*Context: Every student in my syntax class has one weak point—John doesn't understand Case Theory, Mary has problems with Binding Theory, etc. Before the final, I say:*] If every student makes progress in some area, nobody will flunk the exam.

(54) a. #(∀x: student x → ∃f: x makes progress in f(area)) → nobody flunks

b. #∃f: ((∀x: student x → x makes progress in f(area)) → nobody flunks)

Skolemization. A resolution involving a generalization of choice functions:

(55) Let E be a non-empty set of individuals. A function f: E → ($\mathscr{P}$(E) → E) is a (1-ary Skolem) choice function, f ∈ CH^+, iff for every A ⊆ E: if A is not empty then f(x)(A) ∈ A.

This allows us to assign the sentences in (53), the representations and meanings below:

(56) a. [∃f [if every $student_x$ makes progress in f x area , no student flunks]]

b. ∃f∈CH^+: (∀x: student x → x makes progress in f(x)(area)) → no student flunks

5.3 Towards deriving donkey anaphora: step 3 of 3

(57) a. Five farmers who saw a donkey fed it.

b. [∃f [five $farmers_x$ x saw f x donkey x fed f x donkey]]

(58) $\exists f \in CH^{+}: |\{x \mid \text{farmer } x \text{ saw } f(x)(\text{donkey}) \wedge \text{farmer } x \text{ fed } f(x)(\text{donkey})\}| \geq 5$

The interpretations of these structures corresponds to weak readings of donkey anaphora: five farmers who saw one or more donkeys fed at least one of the donkeys they saw.

6 Two wrinkles

Downward-entailingness. A special parse is needed for sentences with DE quantifiers:

(59) Few people who saw a donkey$_i$ fed it$_i$.

(60) $\#\exists f/\forall f: |\{y \mid \text{person } y \text{ saw } f(y)(\text{donkey}) \wedge y \text{ fed } f(y)(\text{donkey})\}| < n_{few}$

The parse must have an intermediate existential closure:

(61) few$_n$ ($\exists f \in CH$: $|\{y \mid \text{person } y \text{ saw } f(y)(\text{donkey}) \wedge y \text{ fed } f(y)(\text{donkey})\}| \geq$ n)

Complex indefinites. Complex indefinites don't admit exceptional scope (deg-modifier binding!):

(62) If more than two people smile, Gali is happy.

(63) [$\exists$f [if more than 2$_n$ f n-many people smile, Gali is happy]]

But they may serve as antecedents of donkey anaphora:

(64) If more than two people$_i$ smile, they$_i$ are happy.

(65) [$\forall$f [if more than 2$_n$ f n-many people smile, f n -many people are happy]]

Option 1: We could subsume this under cases where plural pronouns get maximal (refset) meanings:

(66) they = λw. the more than two people who smiled in w

Option 2: Or perhaps this could be attributed to having even more material in the pronoun:

(67) [$\forall$f [if more than 2$_n$ f n-many people smile, ~~more than 2$_n$~~ f ~~n-many people~~ are happy]]

To be continued ...

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