

1 Review: Classical (Partial) Heim

- Model $\mathcal{M} = \langle \mathcal{O}, \mathcal{W} \rangle$. $\mathcal{O}$ is the set of objects, $\mathcal{W}$ is the set of worlds.
- Assignments g are partial functions from the set $\mathcal{V}$ of variables to $\mathcal{O}$.
- A **file** is a set F of assignment-world pairs such that for each $\langle g, w \rangle, \langle g', w' \rangle \in F$, $\text{dom}(g) = \text{dom}(g')$.
- The **domain** of F , $\text{dom}(F)$, is $\text{dom}(g)$ for $\langle g, w \rangle \in F$.

- **Random assignment:**

- $g[x]g'$ iff g and g' differ at most in the value of x .
- $F[x] := \{ \langle g', w \rangle \mid \text{for some } \langle g, w \rangle \in F, g[x]g' \}$

- Update with atomic sentences:

$$F[Px] = \begin{cases} \{ \langle g, w \rangle \in F \mid w(P)(g(x)) \} & \text{if } x \in \text{dom}(F) \\ \{ \langle g, w \rangle \in F[x] \mid w(P)(g(x)) \} & \text{if } x \notin \text{dom}(F) \end{cases}$$

More generally,

$$F[P^n(x_1, \dots, x_n)] = \{ \langle g, w \rangle \in F[x_{i_1}] \dots [x_{i_m}] \mid w(P^n)(g(x_1), \dots, g(x_n)) \} \\ \text{for each } x_{i_j} \notin \text{dom}(F[x_{i_1}] \dots [x_{i_{j-1}}]) \text{ such that } 1 \leq i_j \leq n$$

- Update with conjunction: $F[\phi \text{ and } \psi] = F[\phi][\psi]$
- $g \leq g'$ iff for all $x \in \text{dom}(g)$, $g(x) = g'(x)$.
- $F \ominus F[\phi] := \{ \langle g, w \rangle \in F \mid \text{there is no } \langle g', w \rangle \in F' \text{ such that } g \leq g' \}$
- Update with negation: $F[\text{not } \phi] = F \ominus F[\phi]$
- Unselective quantifiers:

$$F[\text{every } \phi \psi] = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \text{for every } \langle g', w \rangle \in F[\phi] \text{ such that } g \leq g', \\ \text{there is } \langle g''w \rangle \in F[\phi][\psi] \text{ such that } g' \leq g'' \end{array} \right\}$$

$$F[\text{most } \phi \psi] = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \text{for most } \langle g', w \rangle \in F[\phi] \text{ such that } g \leq g', \\ \text{there is } \langle g''w \rangle \in F[\phi][\psi] \text{ such that } g' \leq g'' \end{array} \right\}$$

- Unselective adverbs of quantification:

$$F[(\text{if } \phi) (\text{then } \psi)] \\ = F[\text{always } (\text{if } \phi) (\text{then } \psi)] \\ = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \text{for every } \langle g', w \rangle \in F[\phi] \text{ such that } g \leq g', \\ \text{there is } \langle g''w \rangle \in F[\phi][\psi] \text{ such that } g' \leq g'' \end{array} \right\}$$

$$F[\text{usually } (\text{if } \phi) (\text{then } \psi)] \\ = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \text{for most } \langle g', w \rangle \in F[\phi] \text{ such that } g \leq g', \\ \text{there is } \langle g''w \rangle \in F[\phi][\psi] \text{ such that } g' \leq g'' \end{array} \right\}$$

2 The Proportion Problem

- In Classical Heim, quantifiers are **unselective binders**. They quantify over assignment-world pairs. This causes the proportion problem.
- The Barwise-notation: D^x means x is a new variable that the determiner D introduces; D_x means x is an old variable that the noun phrases headed by D refers back to.
- Variable x is new with respect to F if $x \notin \text{dom}(F)$; x is old otherwise.
- Illustration of the problem:

- (1) a. Most^x farmers who own a y donkey beats it $_y$.
- b. Usually if a x farmer owns a y donkey, he $_x$ beats it $_y$.

$$F[(1)] = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \text{for most } \langle g', w \rangle \in F[x \text{ farmer owns a}^y \text{ donkey}], \\ g'(x) \text{ beats } g'(y) \text{ in } w \end{array} \right\}$$

For each $\langle g', w \rangle \in F[x \text{ farmer owns a}^y \text{ donkey}]$, $g'(x)$ is a farmer in w and $g'(y)$ is a donkey in w and $g'(x)$ owns $g'(y)$ in w .

(For (1a), it's syntactically stipulated that x is a new variable in F)

- So (1) are true iff for most farmer-donkey pairs, the farmer beats the donkey. (Recall that ϕ is true with respect to F iff $F[\phi] \neq \emptyset$).
- Problematic situation:
 - Farmer 1 owns 200 donkeys and beats all of them.
 - Farmer 2–Farmer 100 each own 1 donkey and don't beat their donkeys.

There are 200 farmer-donkey pairs that stand in the beating relation, and 100 pairs that don't. So the sentence is predicted to be true, while it's intuitively false.

- Any counting quantifier gives rise to the same problem.
 - (2) At least two farmers who own a donkey beat it. (Chierchia 1995:66)
- This is predicted to be true in the same situation, which is counter-intuitive.
- We'll first focus on the quantificational variant of the proportion problem like (1a). The standard solution to this problem is to make the quantifiers 'selective'. But as we'll see, it will lead to a different problem, the **weak-strong readings**.

3 Selective Heim

- Van Eijck & De Vries (1992), Chierchia (1995), Van den Berg (1996) and Brasoveanu (2007) introduce **selective quantifiers** in dynamic systems. Their ideas are basically the same. We'll recast them in a Heimian setting.

Definition 1. (Selective assignment)

- $g[x/a]g'$ iff g and g' differ only in that $g'(x) = a$
- $g[x/a] :=$ the unique g' such that $g[x/a]g'$

• Rough idea:

(3) $\text{Every}^x (x \text{ boy}) (x \text{ left})$

- In Classical Generalised Quantifier Theory, this means: The set of boys (**the restrictor set**) is a subset of the set of boys who left (**the nuclear scope set**).
- The idea is to do this dynamically by updating a singleton file $\{\langle g[x/a], w \rangle\}$ at a time.
- The set of boys (the restrictor set) in with respect to $\langle g, w \rangle$ is:

$$(4) \quad \begin{aligned} & \{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [x \text{ boy}] \neq \emptyset\} \\ &= \{a \in \mathcal{O} \mid g[x/a](x) \text{ is a boy in } w\} \\ &= \{a \in \mathcal{O} \mid a \text{ is a boy in } w\} \end{aligned}$$

- The set of boys who left (the nuclear scope set) with respect to $\langle g, w \rangle$ is:

$$(5) \quad \begin{aligned} & \{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [x \text{ boy}] [x \text{ left}] \neq \emptyset\} \\ &= \{a \in \mathcal{O} \mid g[x/a](x) \text{ is a boy in } w \text{ and } g[x/a](x) \text{ left in } w\} \\ &= \{a \in \mathcal{O} \mid a \text{ is a boy in } w \text{ and } a \text{ left in } w\} \end{aligned}$$

- What we want is:

$$(6) \quad F[(3)] = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \{a \in \mathcal{O} \mid a \text{ is a boy in } w\} \\ \subseteq \{a \in \mathcal{O} \mid a \text{ is a boy in } w \text{ and } a \text{ left in } w\} \end{array} \right\}$$

- Then the meaning of every looks like (7) (With Heim, it is stipulated that x is a new variable in F).

$$(7) \quad F[\text{every}^x \phi \psi] = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] \neq \emptyset\} \\ \subseteq \{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] [\psi] \neq \emptyset\} \end{array} \right\}$$

- Generally, selective dynamic quantifiers can be defined in terms of classical generalised quantifiers (i.e. relations between two sets of individuals):

(8) *Classical Generalised Quantifiers*

- a. $\text{EVERY}(A)(B)$ iff $A \subseteq B$
- b. $\text{MOST}(A)(B)$ iff $|A \cap B| > |A - B|$
- c. $\text{AT.LEAST.TWO}(A)(B)$ iff $|A \cap B| \geq 2$

$F[\text{every}^x \phi \psi]$

$$= \{ \langle g, w \rangle \in F \mid \text{EVERY}(\{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} x[\phi] \neq \emptyset\})(\{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] [\psi] \neq \emptyset\}) \}$$

$F[\text{most}^x \phi \psi]$

$$= \{ \langle g, w \rangle \in F \mid \text{MOST}(\{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] \neq \emptyset\})(\{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] [\psi] \neq \emptyset\}) \}$$

$F[\text{at least two}^x \phi \psi]$

$$= \{ \langle g, w \rangle \in F \mid \text{AT.LEAST.TWO}(\{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] \neq \emptyset\})(\{a \in \mathcal{O} \mid \{\langle g[x/a], w \rangle\} [\phi] [\psi] \neq \emptyset\}) \}$$

For any dynamic selective quantifier Q and its corresponding classical generalised quantifier $\mathbb{Q}$,

$$F[Q^x \phi \psi] \\ = \{ \langle g, w \rangle \in F \mid \mathbb{Q}(\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [\phi] \neq \emptyset \}) (\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [\phi][\psi] \neq \emptyset \}) \}$$

- Notice ϕ is used twice, once for the restrictor set, and once for the nuclear scope set. Due to the **conservativity** of natural language quantifiers, this is truth-conditionally innocuous.

Definition 2. Classical generalised quantifier $\mathbb{Q}$ is **conservative** iff $\mathbb{Q}(A)(B) \Leftrightarrow \mathbb{Q}(A)(A \cap B)$.

But it has crucial dynamic effects: due to the sequential update in the nuclear scope, dynamic binding from the restrictor to the donkey pronoun is made possible.

$$(9) \quad F[\text{every}^x (x \text{ farmer who owns a}^y \text{ donkey}) (x \text{ beats it}_y)] \\ = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [x \text{ farmer who owns a}^y \text{ donkey}] \neq \emptyset \} \\ \subseteq \{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [x \text{ farmer who owns a}^y \text{ donkey}] [x \text{ beats it}_y] \neq \emptyset \} \end{array} \right\} \\ = \left\{ \langle g, w \rangle \in F \mid \begin{array}{l} \{ a \in \mathcal{O} \mid a \text{ is a farmer who owns a donkey in } w \} \\ \subseteq \left\{ a \in \mathcal{O} \mid \begin{array}{l} a \text{ is a farmer such that there is a donkey} \\ \text{which he owns and beats in } w \end{array} \right\} \end{array} \right\}$$

- Importantly, we are not quantifying over farmer-donkey pairs anymore! This solves (the quantificational variant of) the proportion problem.
- But notice that what is derived is a so-called **weak reading** (aka $\exists$ -reading), paraphrased by (10).

(10) Every farmer who owns a donkey beats one or more donkeys he owns.

The intuitively more accurate reading is the **strong reading** (aka $\forall$ -reading), paraphrased by (11).

(11) Every farmer who owns a donkey beats all of the donkeys he owns.

- Chierchia (1995) argues that this is not a bad result, given that weak readings are also possible, although a way to derive strong readings is necessary.

4 Weak vs. Strong Donkeys

- The standard donkey sentence preferentially receives a strong-reading.

(12) Every farmer who owns a donkey beats it.
 $\approx$ Every farmer who owns a donkey beats **all of the donkeys he owns**

- But some examples are known to prefer weak readings:

(13) Yesterday, every person who had a credit card paid his bill with it. (Cooper)

≠ Every person who had a credit card paid his bill with **all of the credit cards he has**

≈ Every person who had a credit card paid his bill with **one of the credit cards he has**

(14) Every person who has a dime will put it in the meter. (Pelletier & Schubert)

≠ Every person who has a dime put **all of the dimes he has** in the meter

≈ Every person who had a a dime put **one (or more) of the dimes he has**

(15) a. Most women that have a dime will put it in the meter.
b. Usually, if a man has a nice hat, he wears it to church. (Chierchia 1995:63)

- Chierchia (1995) points out that the classical donkey sentence also has a $\exists$ -reading in certain contexts:

(16) The farmers of Ithaca, NY, 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. (Chierchia 1995:64)

Every farmer who owns a donkey beats it.

≈ Every farmer who owns a donkey beats at least one of the donkeys he owns.

- Irene Heim's (p.c. to Gennaro Chierchia) argument for the existence of universal readings:

(17) Every man who owned a slave owned his offspring.

One counter-example is enough to falsify (17), suggesting that the reading is truly universal for (17).

- Kanazawa (1994): Existential quantifiers and decreasing quantifiers favour existential readings.

(18) a. No father who has a teenage son lends him the car on weekdays. (Rooth)

≠ No father who has a teenage son lends **all of his sons** the car on weekdays.

≈ No father who has a teenage son lends **any of his sons** the car on weekdays.

b. At least two boys who borrowed a book from me returned it on time. (Kanazawa 1994)

- ≈ At least two boys who borrowed a book from me returned **all of the books he borrowed from me** on time.
- ≈ At least two boys who borrowed a book from me returned **one (or more) books he borrowed from me** on time.

But this is just a tendency:

- (19) No one who has an umbrella leaves it home on a day like this.
(Kanazawa 1994)
- ≈ No one who has an umbrella leaves **all of their umbrellas** home on a day like this.

- Geurts (2002) reports on an experiment on weak-strong donkeys. He tested the judgments of 20 native speakers of Dutch on four determiners *every* (*iedere*), *not every* (*niet iedere*), *some* (*enkele*) and *no* (*geen*) each with six situations.
- Geurts' items:

- (20) 1) Some/No/Every/Not every railway line that crosses a road goes over it.

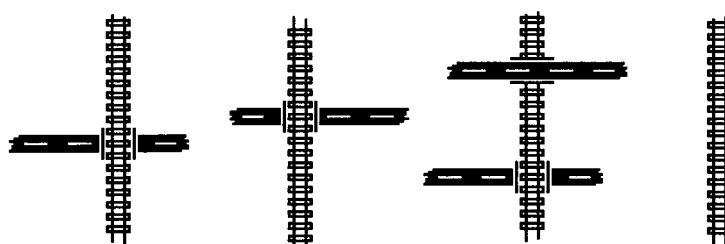


Figure 2. Every railway line that crosses a road goes over it.

- 2) Some/No/Every/Not every line that goes through a square divides it into two equal halves.
- 3) Some/No/Every/Not every O that is adjacent to a K is separated from it by a line.
- 4) Some/No/Every/Not every child that has a balloon is holding it in his right hand.
- 5) Some/No/Every/Not every girl that stands next to a dog keeps it on a leash.
- 6) Some/No/Every/Not every boy that stands next to a girl holds her hand.

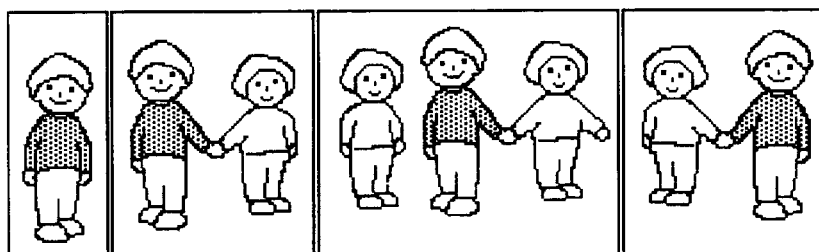
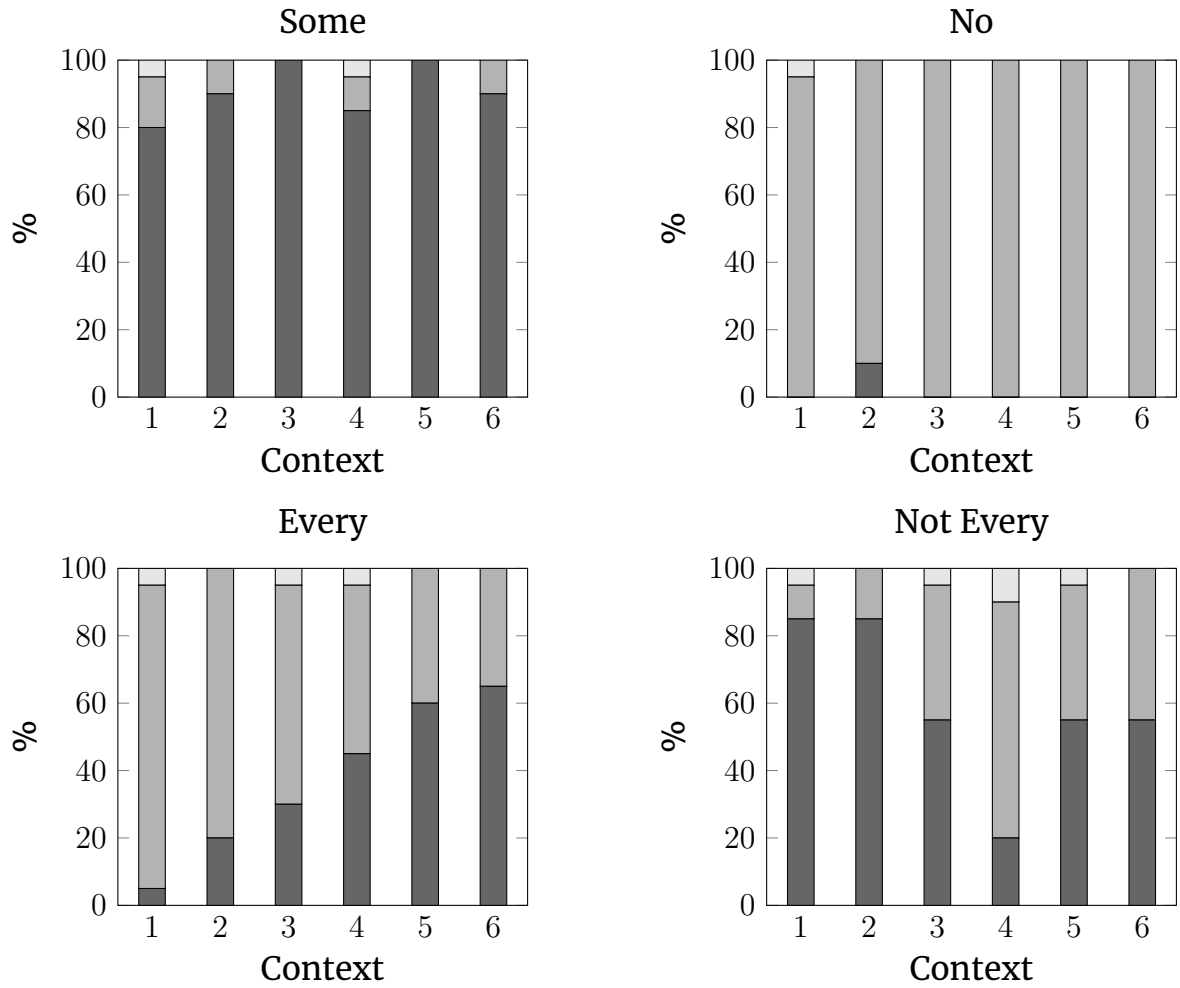


Figure 1. Every boy that stands next to a girl holds her hand.

- Results (■ TRUE, ■ FALSE, ■ ?,)



- *Some* and *no* almost always yield weak readings.
- *Every* and *not every* prefer strong readings, but may shift towards weak readings.
- Most theories of weak-strong donkeys allow any determiner to have both readings. Which reading is preferred is considered to be due to independent (and ill-understood) factors.

4.1 Ambiguous Determiner Approach

- The $\forall$ -reading can be derived by changing the definition of the determiner as follows:

$$\begin{aligned}
 (21) \quad & \text{a. } F[Q_{\exists}^x \phi \psi] \\
 & = \{ \langle g, w \rangle \in F \mid \mathbb{Q}(\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [\phi] \neq \emptyset \}) (\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [\phi][\psi] \neq \emptyset \}) \} \\
 & \text{b. } F[Q_{\forall}^x \phi \psi] \\
 & = \{ \langle g, w \rangle \in F \mid \mathbb{Q}(\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [\phi] \neq \emptyset \}) (\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [\phi \Rightarrow \psi] \neq \emptyset \}) \}
 \end{aligned}$$

where $\Rightarrow$ is ‘strong implication’, defined as:¹

$$\begin{aligned} F[\phi \Rightarrow \psi] &= F[\text{not } (\phi \text{ and not } \psi)] \\ &= F \ominus (F[\phi] \ominus F[\phi][\psi]) \end{aligned}$$

This ensures that *each* $\langle g, w \rangle$ that is updated by ϕ can be updated by ψ .

$$\begin{aligned} &F[x \text{ farmer who owns a}^y \text{ donkey} \Rightarrow x \text{ beats it}_y] \\ &= F \ominus (F[x \text{ farmer who owns a}^y \text{ donkey}] \ominus F[x \text{ farmer who owns a}^y \text{ donkey}][x \text{ beats it}_y]) \\ &= F \ominus \left(\left\{ \langle g', w \rangle \left| \begin{array}{l} \text{for some } \langle g, w \rangle \in F, \\ g[y]g', \\ g'(x) \text{ is a farmer in } w, \\ g'(y) \text{ is a donkey in } w, \\ g'(x) \text{ owns } g'(y) \text{ in } w, \end{array} \right. \right\} \ominus \left\{ \langle g', w \rangle \left| \begin{array}{l} \text{for some } \langle g, w \rangle \in F, \\ g[y]g', \\ g'(x) \text{ is a farmer in } w, \\ g'(y) \text{ is a donkey in } w, \\ g'(x) \text{ owns } g'(y) \text{ in } w, \\ g'(x) \text{ beats } g'(y) \text{ in } w, \end{array} \right. \right\} \right) \\ &= F \ominus \left\{ \langle g', w \rangle \left| \begin{array}{l} \text{for some } \langle g, w \rangle \in F, \\ g[y]g', \\ g'(x) \text{ is a farmer in } w, \\ g'(y) \text{ is a donkey in } w, \\ g'(x) \text{ owns } g'(y) \text{ in } w, \\ g'(x) \text{ does not beat } g'(y) \text{ in } w \end{array} \right. \right\} \\ &= \left\{ \langle g, w \rangle \in F \left| \begin{array}{l} \text{for no } g' \text{ such that } g[y]g', \\ g'(x) \text{ is a farmer in } w, \\ g'(y) \text{ is a donkey in } w, \\ g'(x) \text{ owns } g'(y) \text{ in } w, \\ g'(x) \text{ does not beat } g'(y) \text{ in } w \end{array} \right. \right\} \end{aligned}$$

So we have:

$$\begin{aligned} &\{ a \in \mathcal{O} \mid \{ \langle g[x/a], w \rangle \} [x \text{ farmer who owns a}^y \text{ donkey} \Rightarrow x \text{ beats it}_y] \neq \emptyset \} \\ &= \left\{ a \in \mathcal{O} \left| \begin{array}{l} a \text{ is a farmer in } w \text{ and} \\ \text{there is no donkey that } a \text{ owns and does not beat in } w \end{array} \right. \right\} \end{aligned}$$

- However, a problem for this analysis arises with examples containing both weak z and strong y donkeys, e.g. the following from Brasoveanu (2007:50) (see Van der Does 1993:18 for a similar example).

- (22) a. Every^x person who buys a^y book on Amazon and has a^z credit card uses it_z to pay for it_y.
b. Every^x man who wants to impress a^y woman and who has an^z Arabian horse teaches her_y how to ride _z.

4.2 E-type Pronoun Approach

- Chierchia (1995) proposes that pronouns can be interpreted as simple variables, or hidden definite descriptions (E-type interpretation).

¹It's actually possible to define ‘weak implication’ to derive weak readings in Classical Heim. See discussion in Groenendijk & Stokhof (1991:89), Chierchia (1995:87ff,111), and Brasoveanu (2007:fn.29).

- Due to the universal force of the, the E-type interpretation derives the strong reading. That is, the reading will be the same as (23).

(23) Every farmer who owns a donkey beats the donkeys (that he owns).

- But Chierchia crucially needs to assume that *it* in the donkey sentence is number neutral. This seems to be a dubious assumption. Clearly, (24) is bad (Kanazawa 2001).

(24) Every farmer who owns two or more donkeys beats it.

Also, collective interpretations are unavailable.

(25) #Every farmer who owns a donkey rounds it up at night.

(Kanazawa 2001:396)

(Kanazawa also shows that there's no cumulative interpretation with singular donkey pronouns)

- Chierchia himself points out another problem with split antecedents.

(26) Every boy that has a dog and every girl that has a cat will beat it.

(Chierchia 1995:116)

- Brasoveanu's (2008) example, (27), has a reading where one of the indefinites is strong and the other is weak but with one pronoun.

(27) Every company that hired a Moldavian man, but no company that hired a Transylvanian man promoted him within two weeks of hiring.

(Brasoveanu 2008:181)

This is problematic for any account that locates the ambiguity in the pronoun (Van der Does 1993, Lappin & Francez 1994).

5 Selective Heim with Plural Files

- Brasoveanu (2007, 2008, 2010) proposes that the weak-strong ambiguity is due to the indefinites, rather than the determiners.
- Partial support for this comes from the observation that *some* and bare plurals always receive a strong reading, unlike plural indefinites like *two NPs* (Brasoveanu 2008:fn.9): (28) has a weak reading but (29) only have strong readings.

(28) Every driver who had two dimes put them in the meter.

- (29) a. Every driver who had some dimes put them in the meter.
b. Every driver who had dimes put them in the meter.

- We reformulate his theory in our Heim system with selective quantifiers. This involves **pluralising files**, which has a number of nice consequences

beyond the weak-strong donkey problem, as we will see later (maybe next week?).

Definition 3. A (plural) file is a set F of pairs $\langle G, w \rangle$ consisting of a set of assignments G and a world w such that for each $g, g' \in G$, $\text{dom}(g) = \text{dom}(g')$.

Definition 4. Non-deterministic random assignment²

- $g[x]g'$ iff g and g' differ at most in the value of x .
 - $G[x]G'$ iff for each $g \in G$, there is $g' \in G'$ such that $g[x]g'$ and for each $g' \in G'$ there is $g \in G$ such that $g[x]g'$ and $G' \neq \emptyset$.
 - $F[x] := \{ \langle G', w \rangle \mid \text{for some } \langle G, w \rangle \in F, G[x]G' \}$
- A weak indefinite a_{wk} performs random assignment and sieves out the assignments individually.

$$(30) \quad F[a_{\text{wk}}^x \text{ man came in}] = \left\{ \langle G', w \rangle \in F[x] \mid \begin{array}{l} \text{for each } g' \in G', \\ g'(x) \text{ is a man in } w \text{ and} \\ g'(x) \text{ came in in } w \end{array} \right\}$$

Example: $\mathcal{O} = \{a, b\}$, $\mathcal{W} = \{w_1, w_2, w_3, w_4\}$, and a is the only man who came in in w_1 and b is the only man who came in in w_2 , a and b are the only men who came in in w_3 , and no man came in in w_4 .

(31)

$$\left\{ \begin{array}{l} \langle \emptyset, w_1 \rangle, \\ \langle \emptyset, w_2 \rangle, \\ \langle \emptyset, w_3 \rangle, \\ \langle \emptyset, w_4 \rangle \end{array} \right\} [x] = \left\{ \begin{array}{lll} \langle \{ [x \rightarrow a] \}, w_1 \rangle, & \langle \{ [x \rightarrow b] \}, w_1 \rangle, & \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_1 \rangle, \\ \langle \{ [x \rightarrow a] \}, w_2 \rangle, & \langle \{ [x \rightarrow b] \}, w_2 \rangle, & \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_2 \rangle, \\ \langle \{ [x \rightarrow a] \}, w_3 \rangle, & \langle \{ [x \rightarrow b] \}, w_3 \rangle, & \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_3 \rangle, \\ \langle \{ [x \rightarrow a] \}, w_4 \rangle, & \langle \{ [x \rightarrow b] \}, w_4 \rangle, & \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_4 \rangle \end{array} \right\}$$

$$\begin{aligned} & \left\{ \begin{array}{l} \langle \emptyset, w_1 \rangle, \\ \langle \emptyset, w_2 \rangle, \\ \langle \emptyset, w_3 \rangle, \\ \langle \emptyset, w_4 \rangle \end{array} \right\} [a_{\text{wk}}^x \text{ man came in}] \\ &= \left\{ \begin{array}{lll} \langle \{ [x \rightarrow a] \}, w_1 \rangle, & & \\ & \langle \{ [x \rightarrow b] \}, w_2 \rangle, & \\ \langle \{ [x \rightarrow a] \}, w_3 \rangle, & \langle \{ [x \rightarrow b] \}, w_3 \rangle, & \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_3 \rangle \end{array} \right\} \end{aligned}$$

Importantly, it's possible that there is $\langle G', w \rangle \in F[a_{\text{wk}}^x \text{ man came in}]$ such that $\{g'(x) \mid g' \in G'\}$ does not contain all the men who came in (e.g. $\langle \{ [x \rightarrow a] \}, w_3 \rangle$, $\langle \{ [x \rightarrow b] \}, w_3 \rangle$ above). This will lead to a weak reading of the donkey sentence.

- A strong indefinite a_{str} , on the other hand, requires exactly this. This is achieved by the **max**-operator.³ Let $F[a_{\text{wk}}^x \text{ man came in}] = F'$.

²The systems proposed by Van den Berg (1996) and Nouwen (2003, 2007) use 'deterministic' random assignment. The non-determinicity is important for our purposes, because we want to be able to have different credit cards for different books for Brasoveanu's example.

³Van den Berg's (1996) **max**-operator takes the maximality at the individual level, rather than at the discourse level.

$$(32) \quad F[a_{\text{str}}^x \text{ man came in}] = \mathbf{max}^x(F') \\ = \{ \langle G', w' \rangle \in F' \mid \text{for each } \langle G'', w' \rangle \in F', \{ g''(x) \mid g'' \in G'' \} \subseteq \{ g'(x) \mid g' \in G' \} \}$$

So for every $\langle G', w \rangle \in F[a_{\text{str}}^x \text{ man came in}]$, $\{ g'(x) \mid g' \in G' \}$ is the set of all men who came in in w .

$$(33) \quad \mathbf{max}^x \left(\left\{ \begin{array}{l} \langle \{ [x \rightarrow a] \}, w_1 \rangle, \\ \langle \{ [x \rightarrow b] \}, w_2 \rangle, \\ \langle \{ [x \rightarrow a] \}, w_3 \rangle, \langle \{ [x \rightarrow b] \}, w_3 \rangle, \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_3 \rangle \end{array} \right\} \right) \\ = \left\{ \begin{array}{l} \langle \{ [x \rightarrow a] \}, w_1 \rangle, \\ \langle \{ [x \rightarrow b] \}, w_2 \rangle, \\ \langle \{ [x \rightarrow a], [x \rightarrow b] \}, w_3 \rangle \end{array} \right\}$$

This is going to yield a strong reading.

- Notice that each sentence ϕ always ‘distributively updates’ the input plural file, i.e. it updates each assignment separately.

$$(34) \quad F[\text{he}_x \text{ sat down}] = \{ \langle G, w \rangle \in F \mid \text{for each } g \in G, g(x) \text{ sat down in } w \}$$

Consequently, each possible value of x stored in G will be referred to, i.e. we only have the ‘strong version’ of the quantifiers, so to speak.⁴

- Here is the meaning of every in this setting.⁵

$$(35) \quad F[\text{every}^x \phi \psi] = \left\{ \langle G, w \rangle \in F \mid \begin{array}{l} \{ a \in \mathcal{O} \mid \{ \langle G[x/a], w \rangle \} [\phi] \neq \emptyset \} \\ \subseteq \{ a \in \mathcal{O} \mid \{ \langle G[x/a], w \rangle \} [\phi][\psi] \neq \emptyset \} \end{array} \right\}$$

- Weak reading:

$$(36) \quad F[\text{every}^x (x \text{ farmer who owns } a_{\text{wk}}^y \text{ donkey}) (x \text{ beats it}_y)]$$

⁴This universal quantification takes scope over everything in the VP:

- (i) a. Every man who brought a friend to the party introduced him to at least four people. (Kanazawa 2001:397)
- b. Every man who brought a friend to the party introduced him to exactly two movie stars. (Brasoveanu 2008:187)

⁵Recall:

- $g[x/a]g'$ iff g and g' differ only in that $g'(x) = a$
- $G[x/a] := \{ g' \mid \text{for some } g \in G, g[x/a]g' \}$

$$= \left\{ \langle G, w \rangle \in F \mid \left\{ \begin{array}{l} a \in \mathcal{O} \mid \begin{array}{l} \text{for some } G'' \text{ such that } G[x/a][y]G'', \\ \text{for each } g'' \in G'', \\ a \text{ is a farmer in } w \text{ and} \\ g''(y) \text{ is a donkey in } w \text{ and} \\ a \text{ owns } g''(y) \text{ in } w \end{array} \end{array} \right\} \subseteq \left\{ \begin{array}{l} a \in \mathcal{O} \mid \begin{array}{l} \text{for some } G'' \text{ such that } G[x/a][y]G'', \\ \text{for each } g'' \in G'', \\ a \text{ is a farmer in } w \text{ and} \\ g''(y) \text{ is a donkey in } w \text{ and} \\ a \text{ owns } g''(y) \text{ in } w \text{ and} \\ a \text{ beats } g''(y) \text{ in } w \end{array} \end{array} \right\} \right\}$$

In the output, there might be $\langle G, w \rangle$ where there is a farmer that does not beat all of his donkeys.

- Strong reading (notice the maximality in the restrictor is essentially vacuous):

$$(37) \quad F[\text{every}^x (x \text{ farmer who owns a}_{\text{str}}^y \text{ donkey)} (x \text{ beats it}_y)]$$

$$= \left\{ \langle G, w \rangle \in F \mid \left\{ \begin{array}{l} a \in \mathcal{O} \mid \begin{array}{l} \text{for some } G'' \text{ such that } G[x/a][y]G'', \\ \text{for each } g'' \in G'', \\ a \text{ is a farmer in } w \text{ and} \\ g''(y) \text{ is a donkey in } w \text{ and} \\ a \text{ owns } g''(y) \text{ in } w \text{ and} \\ \{ g''(y) \mid g'' \in G'' \} = \left\{ d \mid \begin{array}{l} d \text{ is a donkey in } w \text{ and} \\ a \text{ owns } d \text{ in } w \end{array} \right\} \end{array} \end{array} \right\} \subseteq \left\{ \begin{array}{l} a \in \mathcal{O} \mid \begin{array}{l} \text{for some } G'' \text{ such that } G[x/a][y]G'', \\ \text{for each } g'' \in G'', \\ a \text{ is a farmer in } w \text{ and} \\ g''(y) \text{ is a donkey in } w \text{ and} \\ a \text{ owns } g''(y) \text{ in } w \text{ and} \\ a \text{ beats } g''(y) \text{ in } w \text{ and} \\ \{ g''(y) \mid g'' \in G'' \} = \left\{ d \mid \begin{array}{l} d \text{ is a donkey in } w \text{ and} \\ a \text{ owns } d \text{ in } w \end{array} \right\} \end{array} \end{array} \right\} \right\}$$

- Brasoveanu's mixed examples can be accounted for in this system.
- To reiterate the crucial point, by using sets of assignments G , we can make sure that G covers all the donkeys in the strong reading via the **max**-operator, which is introduced by a strong indefinite.
- By assuming some only has a strong denotation, we account for the observation in (29).

6 Conditional Donkeys

- A conditional donkey from Chierchia (1995:67) with (what he takes to be) the dominant reading:

(38) If a village is inhabited by a painter, it is usually pretty.

(Kadmon 1990)

$\approx \text{Most}^x (x \text{ is a village inhabited by a painter}) (x \text{ is pretty})$

This sentence is true in the following scenario, while the unselective reading would be false.

- (39) There are 10 villages:
- 8 are inhabited by two painters and pretty.
 - 1 is inhabited by on 1 painter and ugly.
 - 1 is inhabited by 20 painters and ugly.

Similarly,

- (40) If a woman has a son with a man, she usually keeps in touch with him. (Irene Heim)
 $\approx \text{Most}^{x,y} (\text{a woman } x \text{ has a son with a man } y) (x \text{ keeps in touch with } y)$

- (41) There are 20 couples with kids.
- 18 have 1 child and do not keep in touch.
 - 2 have 15 children each, and do keep in touch.

- Chierchia (1995): Topic/Focus matters. In (42), the reading that quantifies over dolphins is prominent:

- (42) Dolphins are truly remarkable. When a trainer trains a dolphin, she usually makes it do incredible things. (Chierchia 1995:68)

In (43), the the reading that quantifies over trainers is more prominent:

- (43) Trainers from here are absolutely remarkable with all sorts of animals. If a trainer from here trains a dolphin, she usually makes it do incredible things. (Chierchia 1995:68)

- (44) If a VILLAGE is inhabited by a painter, it is usually pretty (while if a CITY is, it is dirty and ugly). (Chierchia 1995:69)

- Brasoveanu-style mixed conditional donkey (Brasoveanu 2008:fn.1):

- (45) If a man has a dime in his pocket, he throws it in the parking meter. (Dekker 1993:183)

- Brasoveanu (2008) does not provide an analysis of conditional donkeys, but we can combine his account and Chierchia's analysis.

- Chierchia (1995) proposes that

- adverbs of quantification are (n -ary) dynamic generalised quantifiers over individuals or events; and

$$(46) \quad F[\text{always}_1^x \phi \psi] = \left\{ \langle G, w \rangle \in F \mid \begin{array}{l} \{ a \in \mathcal{O} \mid \{ \langle G[x/a], w \rangle \} [\phi] \neq \emptyset \} \\ \subseteq \{ a \in \mathcal{O} \mid \{ \langle G[x/a], w \rangle \} [\phi][\psi] \neq \emptyset \} \end{array} \right\} \\ = F[\text{every}^x \phi \psi]$$

– Existential Disclosure applies to topics.

- Existential Disclosure (Dekker 1993) amounts to inserting $x = y$ where x will be bound by the adverb of quantification and y is typically bound by some indefinite in the *if*-clause:

$$(47) \quad F[x = y] = \{ \langle G, w \rangle \in F \mid \text{for each } g \in G, g(x) = g(y) \}$$

- Example (assume *if* and *then* are semantically null):

$$(48) \quad \text{always}_1^x (\text{a}_{\text{wk}}^y \text{ farmer owns a}_{\text{wk}}^z \text{ donkey}) (\text{he}_y \text{ beats it}_z)$$

$$\begin{aligned} & \{ \langle G[x/a], w \rangle \} [\text{a}_{\text{wk}}^y \text{ farmer owns a}_{\text{wk}}^z \text{ donkey}] \\ &= \left\{ \langle G', w \rangle \left| \begin{array}{l} G[x/a][y][z]G' \\ \text{for each } g' \in G', \\ g'(y) \text{ is a farmer in } w \text{ and} \\ g'(z) \text{ is a donkey in } w \text{ and} \\ g'(y) \text{ owns } g'(z) \text{ in } w \end{array} \right. \right\} \\ & \{ \langle G[x/a], w \rangle \} [\text{a}_{\text{wk}}^y \text{ farmer owns a}_{\text{wk}}^z \text{ donkey}][x = y] \\ &= \left\{ \langle G', w \rangle \left| \begin{array}{l} G[x/a][y][z]G' \\ \text{for each } g' \in G', \\ g'(y) \text{ is a farmer in } w \text{ and} \\ g'(z) \text{ is a donkey in } w \text{ and} \\ g'(y) \text{ owns } g'(z) \text{ in } w \text{ and} \\ g'(x) = a = g'(y) \end{array} \right. \right\} \end{aligned}$$

$$\begin{aligned} & \{ \langle G[x/a], w \rangle \} [\text{a}_{\text{wk}}^y \text{ farmer owns a}_{\text{wk}}^z \text{ donkey}][x = y][\text{he}_y \text{ beats it}_z] \\ &= \left\{ \langle G', w \rangle \left| \begin{array}{l} G[x/a][y][z]G' \\ \text{for each } g' \in G', \\ g'(y) \text{ is a farmer in } w \text{ and} \\ g'(z) \text{ is a donkey in } w \text{ and} \\ g'(y) \text{ owns } g'(z) \text{ in } w \text{ and} \\ g'(x) = a = g'(y) \text{ and} \\ g'(y) \text{ beats } g'(z) \text{ in } w \end{array} \right. \right\} \end{aligned}$$

- Chierchia assumes that adverbs of quantification, unlike quantificational determiners, can be polyadic.

$$(49) \quad \text{always}_2^{x,y} (\text{a}_z^x \text{ woman has a}_w^y \text{ child with a}_v^y \text{ man}) (\text{she}_z \text{ keeps in touch with him}_v)$$

$$(50) \quad F[\text{always}_n^{x_1, \dots, x_n} \phi \psi] \\ = \left\{ \langle G, w \rangle \in F \left| \begin{array}{l} \{ \langle a_1, \dots, a_n \rangle \in \mathcal{O}^n \mid \{ \langle G[x_1/a_1] \dots [x_n/a_n], w \rangle \} [\phi] \neq \emptyset \} \\ \subseteq \{ \langle a_1, \dots, a_n \rangle \in \mathcal{O}^n \mid \{ \langle G[x_1/a_1] \dots [x_n/a_n], w \rangle \} [\phi][\psi] \neq \emptyset \} \end{array} \right. \right\}$$

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