Incremental Quantification and the Dynamics of Pair-List Phenomena

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Universal Quantification

Classic View: generalized Boolean conjunction

$[\![\text{Every student left}]\!] =$

$$\text{left}\, x_1 \wedge \text{left}\, x_2 \wedge \cdots \wedge \text{left}\, x_k, \quad \text{for } x_1, \ldots, x_k \in \text{student}$$

The Proposal: generalized dynamic conjunction

$[\![\text{Every student left}]\!] =$

$$\text{left}\, x_1 \;;\; \text{left}\, x_2 \;;\; \cdots \;;\; \text{left}\, x_k, \quad \text{for } x_1, \ldots, x_k \in \text{student}$$

The Empirical Payoff:

- Pair-list readings
- Internal adjectives

Where we're heading

(1) Which book did every student read?

a. John read *AK*, Mary read *WP*, and Bill read *AK*

(2) If every student reads a certain book, they'll all pass the exam

a. If John reads *AK*, Mary reads *WP*, and Bill reads *AK*, they'll all pass the exam

(3) Every student read a different book

a. John read *AK*, Mary read *WP*, Bill read whatever other book Tolstoy wrote

Outline

1. Data on pair-lists and adjectives in English
2. Dynamic conjunction and relation composition
3. Applications of incremental quantification to data

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Universal quantification and internal adjectives

Internal readings of singular adjectives only possible with distributive universal quantifiers

(Carlson 87; Moltmann 92; Beck 00; Brasoveanu 11; …)

(4) Each guest brought a different/more elaborate dish

$^{\checkmark}\exists f : \mathsf{guest} \xrightarrow{1:1/+} \mathsf{dish} \,.\, \forall x \in \mathsf{guest} \,.\, \mathsf{brought}\,(f x)\, x$

(5) {These, Most, Several, No} guests brought a different/more elaborate dish

$^{\#}\exists f : \mathsf{guest} \xrightarrow{1:1/+} \mathsf{dish} \,.\, \iota/\exists_{\theta}/\neg\exists x : \mathsf{guest} \,.\, \mathsf{brought}\,(f x)\, x$

Universal quantification and internal adjectives

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Zooming in on ‘every’ vs. ‘no’

(6) No (subsequent) presenter talked about a {different, more agglutinating} language

$^{\#}\exists f : \mathsf{pres} \xrightarrow{1:1/+} \mathsf{lang}\,.\ \neg\exists x : \mathsf{pres}\,.\ \mathsf{talk\text{-}about}\,(f\,x)\,x$

(7) Every (subsequent) presenter talked about a {different, more agglutinating} language

$^{\checkmark}\exists f : \mathsf{pres} \xrightarrow{1:1/+} \mathsf{lang}\,.\ \forall x : \mathsf{pres}\,.\ \mathsf{talk\text{-}about}\,(f\,x)\,x$

Universal quantification and pair-list questions

Pair-list answers only possible for questions with distributive universal quantifiers

(G&S 84, Chierchia 92; Srivastav 92; Szabolcsi 93, 97; Krifka 01; ...)

(8) Which language did every boy study?

a. Japanese — *Individual answer*

b. His mother tongue — *Functional answer*

c. ✓ Al Arabic, Bill Basque, Carl Czech — *Pair-list answer*

(9) Which language did {these, most, several, no} boy(s) study?

a. Japanese

b. Their mother-tongue

c. # Al Arabic, Bill Basque, Carl Czech

Universal quantification and pair-list questions

Pair-list answers only possible for questions with distributive universal quantifiers

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Zooming in on ‘every’ vs. ‘no’

(10) Which language did no boy remember to study?

a. # Al Arabic, Bill Basque, Carl Czech

(11) Which language did every boy forget to study?

a. ✓ Al Arabic, Bill Basque, Carl Czech

(8)

wer

wer

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(9)

a. Japanese

b. Their mother-tongue

c. # Al Arabic, Bill Basque, Carl Czech

Universal quant and “arbitrary functional readings”

Pair-list witnesses for embedded clauses only possible with distributive universal quantifiers

(Sharvit 97; Chierchia 01; Schwarz 01; Schlenker 06; Solomon 11, …)

(12) If each boy studied a certain language, then the exam was a sure success

$^{\checkmark}\exists f : \mathsf{boy} \to \mathsf{lang}\,.\, \big(\forall x : \mathsf{boy}\,.\, \mathsf{study}\,(f x)\, x\big) \Rightarrow \ldots$

(13) If {these, most, several, no} boy(s) studied a certain language, then the exam was a sure success

$^{\#}\exists f : \mathsf{boy} \to \mathsf{lang}\,.\, \big(\iota / \exists_\theta / \neg\exists x : \mathsf{boy}\,.\, \mathsf{study}\,(f x)\, x\big) \Rightarrow \ldots$

Universal quant and “arbitrary functional readings”

Pair-list witnesses for embedded clauses only possible with
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Zooming in on ‘every’ vs. ‘no’

(14) If every slot lands on a certain item, you’ll win a prize
$^{\checkmark}\exists f : \text{slot} \to \text{item} \,.\, (\forall x : \text{slot} \,.\, \text{land}\,(f\,x)\,x) \Rightarrow \ldots$

(15) As long as no slot lands on a certain item, you’ll win a prize
$^{\#}\exists f : \text{slot} \to \text{item} \,.\, (\neg\exists x : \text{slot} \,.\, \text{land}\,(f\,x)\,x) \Rightarrow \ldots$

$^{\#}\exists f : \text{boy} \to \text{lang} \,.\, (\iota/\exists_\theta/\neg\exists x : \text{boy} \,.\, \text{study}\,(f\,x)\,x) \Rightarrow \ldots$

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Dynamic semantics, the idea

Many flavors of dynamic semantics. Here's the classic.
(Kamp 81, Heim 82, G&S 91, Muskens 96, Brasoveanu 07, …)

Propositions Relations over "contexts"
$[\![\text{John left}]\!] \rightsquigarrow \lambda s\,.\,\{s{\cdot}\mathsf{j} \mid \mathsf{left}\,\mathsf{j}\}$

Indefinites Potential multiplicity of output contexts for any input
$[\![\text{A man left}]\!] \rightsquigarrow \lambda s\,.\,\{s{\cdot}x \mid \mathsf{left}\,x \wedge \mathsf{man}\,x\}$

Conjunction Relation composition
$[\![\phi\,;\,\psi]\!] \equiv \lambda s\,.\,\bigcup\{[\![\psi]\!]\,s' \mid s' \in [\![\phi]\!]\,s\}$

A modern take (Charlow 14)

Expressions denote functions from input contexts to sets of values tagged with output contexts

Phrase	*Type*	*Denotation*
John	$\sigma \to \{\langle e, \sigma\rangle\}$	$\lambda s\,.\,\{\langle \mathsf{j},\ s\cdot \mathsf{j}\rangle\}$
a book	$\sigma \to \{\langle e, \sigma\rangle\}$	$\lambda s\,.\,\{\langle x,\ s\cdot x\rangle \mid \mathsf{book}\,x\}$
read	$\sigma \to \{\langle e \to e \to t, \sigma\rangle\}$	$\lambda s\,.\,\{\langle \mathsf{read},\ s\rangle\}$
read a book	$\sigma \to \{\langle e \to t, \sigma\rangle\}$	$\lambda s\,.\,\{\langle \mathsf{read}\,x,\ s\cdot x\rangle \mid \mathsf{book}\,x\}$
John read a book	$\sigma \to \{\langle t, \sigma\rangle\}$	$\lambda s\,.\,\{\langle \mathsf{read}\,x\,\mathsf{j},\ s\cdot \mathsf{j}\cdot x\rangle \mid \mathsf{book}\,x\}$

A modern take (Charlow 14)

Phrase	*Type*	*Denotation*
and	$\sigma \to \{\langle t \to t \to t,\ \sigma\rangle\}$	$\lambda s\,.\,\{\langle \lambda pq\,.\,q \wedge p,\ s\rangle\}$
$\phi\,;\psi$	$\sigma \to \{\langle t,\ \sigma\rangle\}$	$\lambda s\,.\,\{\langle q \wedge p,\ s''\rangle \mid \langle q,\ s'\rangle \in \phi\, s,\ \ \langle p,\ s''\rangle \in \psi\, s'\}$

(16) John sneezed and Mary laughed

$$\underbrace{\lambda s\,.\,\{\langle \mathsf{sneeze\,j},\ s{\cdot}\mathsf{j}\rangle\}}_{\text{John sneezed}} \ ; \ \underbrace{\lambda s\,.\,\{\langle \mathsf{laugh\,m},\ s{\cdot}\mathsf{m}\rangle\}}_{\text{Mary laughed}}$$

$$\rightsquigarrow \quad \underbrace{\lambda s\,.\,\{\langle \mathsf{sneeze\,j} \wedge \mathsf{laugh\,m},\ s{\cdot}\mathsf{j}{\cdot}\mathsf{m}\rangle\}}_{\text{John sneezed; Mary laughed}}$$

Iterated conjunction and alternatives

(17) John read a book and Tom read a book

$$\overbrace{\lambda s.\ \{\langle \mathsf{read}\, x\, \mathsf{j},\ s\cdot\mathsf{j}\cdot x\rangle \mid \mathsf{book}\, x\}}^{\text{John read a book}}\ ;\ \overbrace{\lambda s.\ \{\langle \mathsf{read}\, y\, \mathsf{t},\ s\cdot\mathsf{t}\cdot y\rangle \mid \mathsf{book}\, y\}}^{\text{Tom read a book}}$$

$$\rightsquigarrow\quad \underbrace{\lambda s.\ \{\langle \mathsf{read}\, x\, \mathsf{j} \wedge \mathsf{read}\, y\, \mathsf{t},\ s\cdot\mathsf{j}\cdot x\cdot\mathsf{t}\cdot y\rangle \mid x, y \in \mathsf{book}\}}_{\left\{\begin{array}{lll}\text{John read } \textit{WP} & \text{and} & \text{Tom read } \textit{WP}\\ \text{John read } \textit{WP} & \text{and} & \text{Tom read } \textit{AK}\\ & \vdots & \\ \text{John read } \textit{AK} & \text{and} & \text{Tom read } \textit{AK}\end{array}\right\}}$$

A set of alternatives each pairing John and Tom with books; true if one such pairing is a subset of the read relation

Universal quantification as iterated conjunction

(18) Every student read a book

$$\lambda s.\ \{\langle \mathsf{read}\, x\, \mathsf{j},\ s{\cdot}\mathsf{j}{\cdot}x\rangle \mid \mathsf{book}\, x\}\ \ ;$$

$$\lambda s.\ \{\langle \mathsf{read}\, y\, \mathsf{t},\ s{\cdot}\mathsf{t}{\cdot}y\rangle \mid \mathsf{book}\, y\}\ \ ;$$

$$\lambda s.\ \{\langle \mathsf{read}\, z\, \mathsf{f},\ s{\cdot}\mathsf{f}{\cdot}z\rangle \mid \mathsf{book}\, z\}\ \ ;$$

$$\ldots$$

$$\rightsquigarrow\quad \lambda s.\ \{\langle \mathsf{read}\, x\, \mathsf{j} \wedge \mathsf{read}\, y\, \mathsf{t} \wedge \mathsf{read}\, z\, \mathsf{f},\ s{\cdot}\mathsf{j}{\cdot}x{\cdot}\mathsf{t}{\cdot}y{\cdot}\mathsf{f}{\cdot}z\rangle \mid x, y, z \in \mathsf{book}\}$$

A set of alternatives that each pair every student with a book;
true if one of those alternatives is a subset of read

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Internal adjectives

(19) John read a book.
Mary read a {different, bigger} book.

Any comparative adjective that can be used quantifier-internally can also be used anaphorically
(Brasoveanu 2011)

Phrase	*Type*	*Denotation*
different	$\sigma \to \{\langle (e \to t) \to e \to t,\ \sigma \rangle\}$	$\lambda s\,.\,\{\langle \lambda P x\,.\,P\,x \wedge x \notin s,\ s \rangle\}$
a diff book	$\sigma \to \{\langle e,\ \sigma \rangle\}$	$\lambda s\,.\,\{\langle x,\ s \cdot x \rangle \mid \text{book}\,x,\ x \notin s\}$

Internal adjectives

(20) Mary read a different book

$\lambda s.\, \{\langle \text{read}\, x\, \text{m},\ s{\cdot}\text{m}{\cdot}x \rangle \mid \text{book}\, x,\ x \notin s\}$

(21) Every boy read a different book

$\lambda s.\, \{\langle \text{read}\, x\, \text{j},\ s{\cdot}\text{j}{\cdot}x \rangle \mid \text{book}\, x,\ x \notin s\}\ ;$

$\lambda s.\, \{\langle \text{read}\, x\, \text{t},\ s{\cdot}\text{t}{\cdot}x \rangle \mid \text{book}\, x,\ x \notin s\}\ ;$

$\lambda s.\, \{\langle \text{read}\, x\, \text{f},\ s{\cdot}\text{f}{\cdot}x \rangle \mid \text{book}\, x,\ x \notin s\}\ ;$

$\ldots$

$$\rightsquigarrow \quad \lambda s.\, \left\{ \langle \text{read}\, x\, \text{j} \wedge \text{read}\, y\, \text{t} \wedge \text{read}\, z\, \text{f},\ s{\cdot}\text{j}{\cdot}x{\cdot}\text{t}{\cdot}y{\cdot}\text{f}{\cdot}z \rangle \ \middle|\ \begin{array}{l} x, y, z \in \text{book}, \\ x \notin s, \\ y \notin s{\cdot}\text{j}{\cdot}x, \\ z \notin s{\cdot}\text{j}{\cdot}x{\cdot}\text{t}{\cdot}y \end{array} \right\}$$

Internal adjectives

(22) In 2010, John bought a faster computer

$$\lambda s.\ \left\{ \langle \text{buy}\, x\, \text{j}\, 10,\ s \cdot 2010 \cdot x \rangle \;\middle|\; \begin{array}{l} \text{comp}\, x, \\ \text{speed}\, x > \max\{\text{speed}\, u \mid \text{comp}\, u \ \wedge\ u \in s\} \end{array} \right\}$$

(23) Every year, John bought a faster computer

$[\![$In 09, John bought a faster computer$]\!]$;
$[\![$In 10, John bought a faster computer$]\!]$;
$[\![$In 11, John bought a faster computer$]\!]$;
...

$$\rightsquigarrow \quad \lambda s.\ \left\{ \left\langle \begin{array}{ll} \text{buy}\, x\, \text{j}\, 09 & s \cdot 09 \cdot x \\ \text{buy}\, y\, \text{j}\, 10, & \cdot 10 \cdot y \\ \ldots & \ldots \end{array} \right\rangle \;\middle|\; \begin{array}{l} x, y, z, \ldots \in \text{comp}, \\ \text{speed}\, x > \max\{\text{speed}\, u \mid \text{comp}\, u \ \wedge\ u \in s\} \\ \text{speed}\, y > \max\{\text{speed}\, u \mid \text{comp}\, u \ \wedge\ u \in s \cdot 09 \cdot x\} \\ \text{speed}\, z > \max\{\text{speed}\, u \mid \text{comp}\, u \ \wedge\ u \in s \cdot 09 \cdot x \cdot 10 \cdot y\} \end{array} \right\}$$

Pair-list questions

All speech acts, including questions, can be conjoined (i.e. performed in sequence)
(Krifka 01)

(24) a. Which dish did Al make? And which dish did Bill make?
b. Eat the chicken soup! And drink the hot tea!
c. How beautiful this is! And how peaceful!

So distributing ‘every’ over a question radical will build a composite question, equivalent to a sequence of speech acts like (24a)

Pair-list questions

(25) Which book did every student read?

$[\![\text{which book did John read}]\!]$;
$[\![\text{which book did Mary read}]\!]$;
$[\![\text{which book did Fred read}]\!]$;
$\ldots$

Popular simplifying assumption

Formally, no difference between an indefinite DP, a disjunctive DP, and a *wh*-DP; all just generate alternatives

(Kratzer & Shim. 02; Alonso-Ovalle 06; Groenendijk and Roelefson 09, ...)

$$\rightsquigarrow \quad \lambda s.\, \{\langle \text{read}\, x\, \text{j} \wedge \text{read}\, y\, \text{m} \wedge \text{read}\, z\, \text{f},\; s{\cdot}\text{j}{\cdot}x{\cdot}\text{m}{\cdot}y{\cdot}\text{f}{\cdot}z \rangle \mid x, y, z \in \text{book}\}$$

Pair-lists in embedded clauses

Recall one more time,

(26) Each slot lands on a certain item
$\lambda s.\ \{\langle \text{land}\, x\, 1 \wedge \text{land}\, y\, 2 \wedge \text{land}\, z\, 3,\ s{\cdot}1{\cdot}x{\cdot}2{\cdot}y{\cdot}3{\cdot}z \rangle \mid x, y, z \in \text{item}\}$

The denotation of (26) is actually nonndeterministic, like an indefinite or a disjunction. In fact, it just *is* a big disjunction of all the ways guests might be paired with dishes.

This has ramifications for scope …

Pair-lists in embedded clauses

Indefinites and disjunctions can take "exceptional" scope out of islands like tensed embedded clauses
(Farkas 81; Rooth & Partee 82; Ruys 92; Abusch 94; Reinhart 97; …)

(27) a. If a relative of mine dies, I'll inherit a house
b. Bill hopes that someone will hire a maid or a cook

Nondeterminism can percolate over clause boundaries in ways that genuine quantification cannot
(Kratzer & Shimoyama 02; Alonso-Ovalle 06; Charlow 14)

Pair-lists in embedded clauses

Wide scope for 'a'

(28) If a relative of mine dies, I'll inherit a house

$\text{If } \big(\lambda s.\, \{\langle \text{die}\, x,\ s \cdot x\rangle \mid \text{rel me}\, x\}\big),\ \text{I'll inherit a house}$

$\rightsquigarrow \quad \lambda s.\ \{\langle \text{die}\, x \Rightarrow \exists y : \text{house}.\, \text{inherit me}\, y,\ s \cdot x\rangle \mid \text{rel me}\, x\}$

No wide scope for 'most'

(29) If most of my relatives die, I'll inherit a house

$\text{If } \big(\lambda s.\, \{\langle \text{Most}\, x : \text{rel me}.\, \text{die}\, x,\ s\rangle\}\big),\ \text{I'll inherit a house}$

$\rightsquigarrow \quad \lambda s.\ \{\langle \text{Most}\, x : \text{rel me}.\, \text{die}\, x \Rightarrow \exists y : \text{house}.\, \text{inherit me}\, y,\ s\rangle\}$

Pair-list readings in embedded clauses

In exactly the same way, the alternatives generated by universals can take exceptional scope

(30) Every slot lands on a certain item

$\lambda s.\ \{\langle \text{land}\, x\, 1 \wedge \text{land}\, y\, 2 \wedge \text{land}\, z\, 3,\ s{\cdot}1{\cdot}x{\cdot}2{\cdot}y{\cdot}3{\cdot}z \rangle \mid x, y, z \in \text{item}\}$

(31) If every slot lands on a certain item, you'll win a prize

If ⟦(30)⟧, you'll win a prize

$\lambda s.\ \{\ \langle p \Rightarrow \exists y\!:\text{prize}.\ \text{win}\ y\ \text{you},\ s' \rangle\ \mid\ \langle p,\ s' \rangle \in [\![(30)]\!]\ s\}$

Taking stock

- Only thing new: universals conjoin dynamically, incrementally. Pair-list and internal readings fall out from plugging that back into a scope-friendly grammar

- Uniform dependence of pair-lists and internal readings accounted for

- No need to resort to choice functions or quantification over pairs (Schwarz 2001; Schlenker 2006; Brasoveanu 2011; a.o.)

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Thanks!