Polyadic Quantification in Hybrid Coordination

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Hybrid Coordination 1

Some **examples**:

- [Kto i komu] pomog? (Russian)
  who.NOM and who.DAT helped
  'Who helped whom?' (Mel'čuk 1988)
- [Nikto i nikomu] ne pomogaet. (Russian)
  nobody.NOM and nobody.DAT NEG helps
  'Nobody helps anybody.' (Mel'čuk 1988)
- Obiecać można [wszystko i wszystkim]. (Polish)
  promise may.IMPS everything.ACC and everybody.DAT
  'One may promise everything to everyone.' (Patejuk 2015)

This kind of coordination is known under **various names**:

- **Heterofunctional Coordination** (Grosu 1987)
- **Lexico-Semantic Coordination** (Sannikov 1979, 1980, Mel'čuk 1988, Kallas 1993, Patejuk and Przepiórkowski 2012)
- **Hybrid Coordination** (HC; Chaves and Paperno 2007, Paperno 2012, Bîlbîie and Gazdik 2012)

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Hybrid Coordination 2

Most of the literature concentrates on **coordinated *wh*-phrases**, e.g.:

- [What and where] did you sing? (Citko and Gračanin-Yüksek 2013)
- [Komu a co] řekl? (Czech)
  who.DAT and what.ACC said.3SG.M
  'What did he say to whom?' (Skrabalova 2007)
- [Ki és mit] olvasott? (Hungarian)
  who.NOM and what.ACC read
  'Who read what?' (Lipták 2003)

In **English** (and Germanic in general), this is **ellipsis** (conjunction reduction); cf.:

- *[What and where] did you buy? (Citko and Gračanin-Yüksek 2013)

But **not ellipsis in Slavic** and some neighbouring languages (at least, Hungarian) – see, e.g., Kazenin 2001, Lipták 2003, Skrabalova 2007, Gribanova 2009, Paperno 2012, Bîlbîie and Gazdik 2012.

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Hybrid Coordination 3

Various kinds of quantificational expressions can occur in HC, e.g.:

- Ponjal li [kto-nibud' i čto-nibud']? (Russian)
  understood Q anyone.NOM and anything.ACC
  'Has anyone understood anything?' (Paperno 2012)
- Dopustim, [kto-libo i kogo-libo] pobedil. (Russian)
  assume someone.NOM and someone.ACC defeated
  'Assume that someone defeated someone.' (Paperno 2012)
- O nëm uže [mnogoe i mnogimi] napisano. (Russian)
  about him already much.ACC and many.INS write.IMPS
  'Many wrote a lot about him.' (Paperno 2012)
- Lično menja [vsë i počti vsegda] besit. (Russian)
  personally me everything.NOM and almost always drives.nuts
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Polyadic Quantification 1

Monadic quantifiers – relations **on sets** (i.e., on unary relations); e.g.:

- $\textsc{more}(A, B, C) \stackrel{\text{df}}{\equiv} |A \cap C| > |B \cap C|$
- *More men than women yawn.*
  - $A = \{x : man(x)\}$
  - $B = \{x : woman(x)\}$
  - $C = \{x : yawn(x)\}$

Polyadic quantifiers – relations **on any relations**, e.g.:

- $\textsc{different}(A, B, R) \stackrel{\text{df}}{\equiv}$
  $\forall x_1 \in A, x_2 \in A.\ x_1 \neq x_2 \rightarrow \{y_1 \in B : R(x_1, y_1)\} \neq \{y_2 \in B : R(x_2, y_2)\}$
- *Different people like different books.*
  - $A = \{x : person(x)\}$
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  - $R = \{\langle x, y\rangle : like(x, y)\}$

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Polyadic Quantification 2

Hypothesis (Keenan and Westerståhl 2011: 906):

> *Polyadic quantification in natural languages in general results from lifting monadic quantifiers.*

For example, the **resumptive lift** ($Q \rightsquigarrow Res^2(Q)$):

- $Res^2(Q)(A, B, R) \stackrel{\text{df}}{\equiv} Q(A \times B, R)$
- **monadic** *no*:
  - $\textsc{no}(A, B) \stackrel{\text{df}}{\equiv} A \cap B = \varnothing$
  - *No man yawned.*
    - $A = \{x : man(x)\}$
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- **after resumptive lift**:
  - $Res^2(\textsc{no})(A, B, R) \stackrel{\text{df}}{\equiv} (A \times B) \cap R = \varnothing$
  - *No man loves no woman.*
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(Practically) the only **worked out** **semantic analysis of HC** is that of Paperno 2012: ch.4 – in terms of **resumptive polyadic lift**. It makes many **good predictions**, e.g.:

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However, **Paperno 2012 abandons this analysis**, and for two good reasons.

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2. The **resulting meaning** is not always correct, e.g.:

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Situation: a couple of people each wrote huge amounts of content about him; then

- **the above sentence is intuitively false** in this situation – there should be many people producing content for it to be true,
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Another standard lift, **cumulative lift** ($Q_1, Q_2 \rightsquigarrow Cum(Q_1, Q_2)$):

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- *...many books and by many linguists were written...*
  - $Q_1 = Q_2 = \text{MANY}$
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- $Cum(\text{MANY}, \text{MANY})(A, B, R) \stackrel{\text{df}}{\equiv}$ *in* $R' = R \cap (A \times B)$, *there are many As in the domain and many Bs in the range*

This gives **almost the right truth conditions** for HC. See the accompanying abstract for *Sinn und Bedeutung 2021* for a better solution, in terms of a new lift – **cumulative lift with covers** (in the sense of Schwarzschild 1996).

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The **basis of the analysis**:

- resumptive quantification analysis of Negative Concord: Iordăchioaia and Richter 2009, 2015 and Iordăchioaia 2010
- polyadic DIFFERENT: Richter 2016

Here: an attempt to **generalise these analyses to any polyadic lifts**.

Lexical Resource Semantics (LRS; Richter and Sailer 2004):

- **lexical entries** (and constructions) **contribute descriptions of components of meaning**,
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Analysis 2

- Obiecać można [wszystko i wszystkim]. (Polish)
  promise may.IMPS everything.ACC and everybody.DAT
  'One may promise everything to everyone.' (Patejuk 2015)

Underspecified quantifiers:

- *wszystko* 'everything': $\ldots\forall_x\ldots(\ldots thing(x)\ldots)(R(\ldots x\ldots))$,
- **underspecified** whether it is a part of a larger (polyadic) quantifier,
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Main ideas:

- *wszystko* 'everything': $\ldots\forall_x\ldots(\ldots thing(x)\ldots)(R(\ldots x\ldots))$
- *wszystkim* 'everybody': $\ldots\forall_y\ldots(\ldots person(y)\ldots)(R(\ldots y\ldots))$
- *i* 'and' specifies the adjoining conjunct as **cumulative**:
  i wszystkim 'and everybody': $Cum(\ldots\forall_y\ldots)(\ldots person(y)\ldots)(R(\ldots y\ldots))$,
- ...and the **two quantifiers are identified**:
  wszystko i wszystkim 'everything and everybody':
  $Cum(\ldots\forall_x,\forall_y\ldots)(\ldots thing(x), person(y)\ldots)(R(\ldots x, y\ldots))$;
- **minimal solution** (no further quantifiers, etc.):
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- *wszystko* 'everything': $...\forall_x...(...thing(x)...)(R(...x...))$
- *wszystkim* 'everybody': $...\forall_y...(...person(y)...)(R(...y...))$
- *i* 'and' specifies the adjoining conjunct as **cumulative**:
  i wszystkim 'and everybody': $Cum(...\forall_y...)(...person(y)...)(R(...y...))$,
- ...and the **two quantifiers are identified**:
  wszystko i wszystkim 'everything and everybody':
  $Cum(...\forall_x,\forall_y...)(...thing(x),person(y)...)(R(...x,y...))$;
- **minimal solution** (no further quantifiers, etc.):
  wszystko i wszystkim 'everything and everybody':
  $Cum(\forall_x,\forall_y)(thing(x),person(y))(R(x,y))$

Analysis 3

- Obiecać można [wszystko i wszystkim]. (Polish)
  promise may.IMPS everything.ACC and everybody.DAT
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Hence, the **final representation** (very schematically, with semantic contributions of particular components in blue):

Analysis 4

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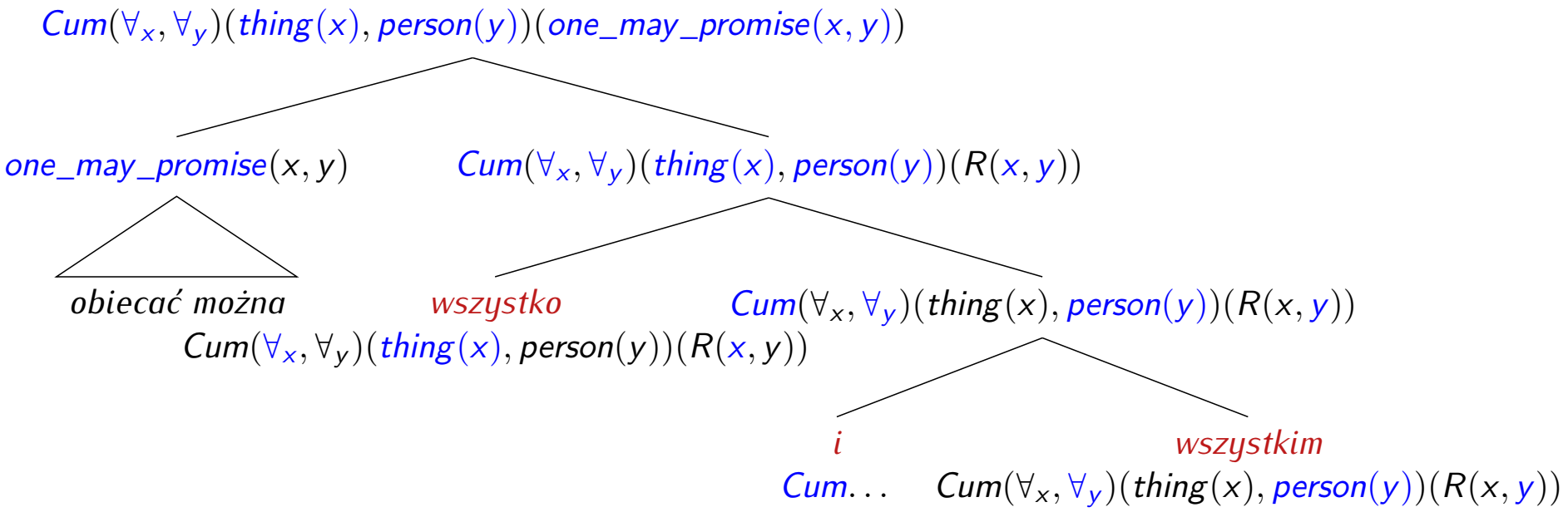

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- unique approach to **polyadic quantification via underspecification**
- **monotonic** implementation of seemingly non-monotonic operations of polyadic lifts

Where are AVMs, sorts, attributes?

- for a brief sketch of the assumed signature, etc. – see the **abstract**
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Thank you for your attention!

Technicalities (work in progress) 1

Signature of *Ty1* terms, based on Iordăchioaia 2010: §5.2:

```
ty1
  integer
    zero
    non-zero PRE integer
  me TYPE type
    variable NUM-INDEX integer
    constant NUM-INDEX integer
    application FUNCTOR me
                ARG me
    abstraction VAR me
                BODY me
    equation ARG1 me
             ARG2 me
    negation ARG me
    l-const ARG1 me
            ARG2 me
      disjunction
      conjunction
      implication
      bi-implication
    gen-quantifier QUANT-RESTRS nelist
      bi-implication
    gen-quantifier QUANT-RESTRS nelist
                   SCOPE me
      mq
      lq LIFT lift
    lift
      res
      cum
      diff
quant-restr VAR variable
            RESTR me
  every
  some
  no
type
  atomic-type
    entity
    truth
  complex-type IN type
               OUT type
```

Technicalities (work in progress) 2

The usual constraints (Iordăchioaia 2010: §5.2) apply, with the following new constraint on *gen-quantifier*:

- $\textit{gen-quantifier} \rightarrow \left(\begin{bmatrix} \textsc{type} & \textit{truth} \\ \textsc{quant-restrs} & \boxed{1} \\ \textsc{scope}|\textsc{type} & \textit{truth} \end{bmatrix} \wedge \texttt{quant-restr-list}(\boxed{1}) \right)$
- $\forall\boxed{1}(\texttt{quant-restr-list}(\boxed{1}) \leftrightarrow (\boxed{1}\textit{elist} \vee \exists\boxed{2}\exists\boxed{3}(\boxed{1}\begin{bmatrix} \textsc{first} & \boxed{2}\textit{quant-restr} \\ \textsc{rest} & \boxed{3} \end{bmatrix} \wedge \texttt{quant-restr-list}(\boxed{3}))))$

Monadic quantifiers have exactly one restriction, lifted – at least two:

- $\textit{mq} \rightarrow [\textsc{quant-restrs}|\textsc{rest}\ \textit{elist}]$
- $\textit{lq} \rightarrow [\textsc{quant-restrs}|\textsc{rest}\ \textit{nelist}]$

Note that *quant-restr* is *not* a subsort of *me*, so it does not have a type. The constraint on *quant-restr* is:

- $\textit{quant-restr} \rightarrow [\textsc{restr}|\textsc{type}\ \textit{truth}]$

Technicalities (work in progress) 2

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Technicalities (work in progress) 3

Schematic lexical contributions of *wszystko* 'everything.ACC', *wszystkim* 'everybody.INS', and the lifting cumulative *i* 'and':

- *wszystko*: $\begin{bmatrix} \textit{gen-quantifier} \\ \textsc{quant-restrs} \ \langle \ldots \begin{bmatrix} \textit{every} \\ \textsc{var} \ x \\ \textsc{restr} \ \textit{thing}(x) \end{bmatrix} \ldots \rangle \end{bmatrix}$
- *wszystkim*: $\begin{bmatrix} \textit{gen-quantifier} \\ \textsc{quant-restrs} \ \langle \ldots \begin{bmatrix} \textit{every} \\ \textsc{var} \ y \\ \textsc{restr} \ \textit{person}(y) \end{bmatrix} \ldots \rangle \end{bmatrix}$
- *i*: $\begin{bmatrix} \textit{lq} \\ \textsc{lift} \ \textit{cum} \end{bmatrix}$

Combining *i* and *wszystkim* into a single quantifier:

- *i wszystkim*: $\begin{bmatrix} \textit{lq} \\ \textsc{lift} \ \textit{cum} \\ \textsc{quant-restrs} \ \langle \ldots \begin{bmatrix} \textit{every} \\ \textsc{var} \ y \\ \textsc{restr} \ \textit{person}(y) \end{bmatrix} \ldots \rangle \end{bmatrix}$

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Technicalities (work in progress) 4

Combining *wszystko* 'everything.ACC' and *i wszystkim* 'and everybody.INS' into a single minimal quantifier:

- *wszystko i wszystkim*:

$$\begin{bmatrix} lq \\ \text{LIFT } cum \\ \text{QUANT-RESTRS } \left\langle \begin{bmatrix} every \\ \text{VAR } x \\ \text{RESTR } thing(x) \end{bmatrix}, \begin{bmatrix} every \\ \text{VAR } y \\ \text{RESTR } person(y) \end{bmatrix} \right\rangle \end{bmatrix}$$

Full sentence – adding the scope *obiecać można* 'one may promise':

- *Obiecać można wszystko i wszystkim*
  'One may promise everything and to everybody':

$$\begin{bmatrix} lq \\ \text{LIFT } cum \\ \text{QUANT-RESTRS } \left\langle \begin{bmatrix} every \\ \text{VAR } x \\ \text{RESTR } thing(x) \end{bmatrix}, \begin{bmatrix} every \\ \text{VAR } y \\ \text{RESTR } person(y) \end{bmatrix} \right\rangle \\ \text{SCOPE } one\_may\_promise(x, y) \end{bmatrix}$$

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Technicalities (work in progress) 5

For this to work, I am making the following assumptions:

- coordinate structures are *multi-headed-phrases*:

```
phrase
  non-headed-ph DTRS nelist
  headed-ph HD-DTRS nelist
    multi-headed-ph
    singly-headed-ph NHD-DTRS nelist
      hd-subj-ph
      hd-comp-ph
      ...
```

- there are constraints to the effect that the length of HD-DTRS in *singly-headed-ph* is one and in *multi-headed-ph* – greater than one

Technicalities (work in progress) 6

By the way, then Head-Feature Principle:

- for believers in the Law of the Coordination of Likes:

$$\left[\begin{array}{l}\textsc{ss|loc|cat|head}\ \boxed{1} \\ \textsc{hd-dtrs}\ \langle \ldots, \left[\textsc{ss|loc|cat|head}\ \boxed{2}\right], \ldots \rangle\end{array}\right] \rightarrow \boxed{1} = \boxed{2}$$

- for us:

$$\left[\begin{array}{l}\textsc{ss|loc|cat|head}\ \boxed{1} \\ \textsc{hd-dtrs}\ \langle \left[\textsc{ss|loc|cat|head}\ \boxed{2}\right] \rangle\end{array}\right] \rightarrow \boxed{1} = \boxed{2}$$

(and assume something like Yatabe 2004 for HEAD values of coordinate structures)

Technicalities (work in progress) 7

Assumptions about the structure of coordination (contd.):

- coordination has flat structure, but not "totally flat" (in the sense of Abeillé and Chaves 2021)
- conjunction is a functor combining directly with the adjacent conjunct

LRS principles (page numbers refer to Iordăchioaia and Richter 2015):

- assume the standard Incont Principle (p.630)
- assume the standard Excont Principle (p.630)
- modify the standard LRS Projection Principle (p.630) by replacing *the head* with *each head*

This last modification ensures that quantifiers introduced by particular conjuncts are "merged" into a single polyadic quantifier.

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Technicalities (work in progress) 8

LRS principles (contd.):

- Semantics Principle (p.631):
  - Clause 1 must be modified to reflect the fact that, in Slavic, quantifiers are sometimes syntactic heads; i.e., it should say something like: *If one daughter is quantificational and the other is nominal, then...*; also, in the actual HPSG formalisation, RESTR must be replaced by QUANT-RESTRS, to reflect the modified signature
  - Clause 2 remains as it is

New clause must be added to handle *hd-functor-ph* (responsible for combining the conjunction and one conjunct):

- Semantics Principle, Clause 3: In *hd-functor-ph*:
  1. the EXCONT values of the mother and both daughters are identical,
  2. the INCONT values of the mother and both daughters are identical,
  3. the PARTS value contains all and only the elements of the PARTS values of the daughters.

This is fully analogous to the LRS Projection Pricniple, so probably it is better to extend that PROJECTION PRINCIPLE to functors.

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