Polyadic Cover Quantification in Heterofunctional Coordination

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Problem Heterofunctional coordination (HC) is a term (adapted from Grosu 1987: 426) referring to coordination of different grammatical functions, e.g.:

(1) [What and why] did you eat? (Citko and Gračanin-Yüksek 2013: 11)

(2) John has written [*five* books and to *fifteen* publishers] already! (Grosu 1987: 446)

(3) Vam [nikto i ničego] ne predlagal eščë. (Russian)
you.DAT nobody.NOM and nothing.GEN NEG offered yet
'Nobody has offered you anything yet.' (attested; Paperno 2012: 77)

(4) Lično menja [vsë i počti vsegda] besit. (Russian)
personally me everything.NOM and almost always drives.nuts
'Everything almost always drives me nuts.' (Paperno 2012: 155)

(5) O nëm uže [mnogoe i mnogimi] napisano. (Russian)
about him already much and many.INS write.IMPS
'Many wrote a lot about him.' (Paperno 2012: 143)

(6) W pracy [mało kto i mało kogo] tak naprawdę lubi. (Polish)
at work few someone.NOM and few someone.ACC so really likes
'Hardly anybody really likes hardly anyone at work.' (attested; Patejuk 2015: 140)

The common view is that HC in English and other Germanic languages is confined to elliptical structures, while Slavic languages (as well as Hungarian and Romanian) allow for coordinating different grammatical functions *in situ*, at least as one of the options (see, e.g., Citko and Gračanin-Yüksek 2013 and references therein). Most of the literature on HC concentrates on *wh*-phrases, as in (1), but many other kinds of quantificational expressions may occur in HC (see, especially, Grosu 1987 on English, Paperno 2012 on Russian, and Patejuk 2015 on Polish).

Apparently, the only worked out compositional semantic analysis of HC is that of Paperno 2012: ch.3–4, in terms of resumptive quantification. The resumptive lift (Peters and Westerståhl 2006: §10.2) combines monadic quantifiers of the same kind into a polyadic quantifier of this kind, quantifying over tuples. For example, when applied to (3), the two type $\langle 1, 1\rangle$ quantifiers $\neg\exists$ are lifted to the type $\langle 1, 1, 2\rangle$ quantifier $Res^2(\neg\exists)$, resulting in the meaning of (3) on which there are no pairs $\langle x, y\rangle$ of a man x and a thing y such that x has offered y. However, as Paperno notes, this analysis is not applicable to (4), which involves related but different quantifiers *all (things)* and *almost all (times/events)*, and it also gives wrong truth conditions of (5). For this sentence to be true, it is not sufficient that there be many pairs of $\langle$author, content$\rangle$; on the scenario on which a couple of people produced vast amounts of content each, it is intuitively false, even though there are many $\langle$author, content$\rangle$ pairs. (We simplify here by treating content as count rather than mass.) Rather, for (5) to be true there must be both many authors and many bits of content produced by these authors. (A similar argument can be made on the basis of the attested (6).) For these reasons Paperno 2012: ch.5, abandons the resumptive analysis in favour of a sketch of a game-theoretic approach. Unfortunately, that approach produces branching (or, as a special case, fully collective) interpretations; e.g., (5) is wrongly predicted to mean that each of the many authors wrote each of the many bits, or that they all collectively wrote the whole collection. Also, it does not fully extend to non-upward-monotone quantifiers (e.g., to (6)).

Solution We defend and substantiate an analysis of HC in terms of polyadic quantification. In doing so, we extend the repertoire of standard polyadic lifts (resumptive, branching, cumulative, etc.; Peters and Westerståhl 2006: ch.10; Keenan and Westerståhl 2011: §19.3) to *Cov*, corresponding to cover readings (Schwarzschild 1996). That this kind of lift is needed in an analysis of HC is clear from (5): this sentence is true in situations in which various configurations of people authored jointly various bits of content, for example: a_1, a_2, a_3 co-authored the book c_1, a_2 also wrote the pamphlet c_2, a_4 wrote a collection of essays c_3, c_4, c_5, c_6, etc., where both sets – $\{a_1, a_2, \dots\}$ and $\{c_1, c_2, \dots\}$ – are large. As branching, collective and cumulative readings are particular instances of cover readings, and resumptive readings are often implied by them, other cases of HC – including those above – are also amenable to an analysis in terms of covers.

We follow the line of work of Sher 1990, 1997 and Robaldo 2010, 2011 and assume an approach to polyadic quantification which is based on maximisation of witness sets (see also Robaldo *et al.* 2014; cf. Bott *et al.* 2019). One advantage of this approach is that it does not depend on monotonicity, i.e., it works not only in the case of lifted upward monotone quantifiers (as in (4)–(5) and possibly (1)), but also downward monotone quantifiers (as in (3) and (6)) and non-monotone quantifiers (as in (2), on the *exactly* readings of the numerals). Simplifying a little (see Robaldo 2011 for technical details regarding a similar cumulative lift), the *Cov* lift, when applied to $\langle 1, 1\rangle$ quantifiers Q_1 and Q_2, creates the $\langle 1, 1, 2\rangle$ quantifier $Cov(Q_1, Q_2)$ such that, for restrictions R_1 and R_2 and scope S, $Cov(Q_1, Q_2)(R_1, R_2)(S)$ is true iff there are witness sets P_1 and P_2 such that 1) $Q_1(R_1, P_1)$ and $Q_2(R_2, P_2)$, 2) $P_1 \subseteq R_1$ and $P_2 \subseteq R_2$, 3) C is a paired cover of $\langle P_1, P_2\rangle$ (Schwarzschild 1996: 84), 4) $\forall xy\, C(x, y) \rightarrow S(x, y)$, and 5) P_1 and P_2 are maximal sets jointly satisfying 2), 3), and 4). In the scenario for (5) sketched in the previous paragraph, Q_1 and Q_2 are the quantifier *many*, R_1 is the set of people, R_2 is the set of contents, S is the binary relation *write*, the witness sets are $P_1 = \{a_1, a_2, \dots\} \subseteq R_1$ and $P_2 = \{c_1, c_2, \dots\} \subseteq R_2$, and the cover of $\langle P_1, P_2\rangle$ is $C = \{\langle a_1 \oplus a_2 \oplus a_3, c_1\rangle, \langle a_2, c_2\rangle, \langle a_4, c_3 \oplus c_4 \oplus c_5 \oplus c_6\rangle, \dots\}$ (the mereological sum operator $\oplus$ is understood as in Link 1983).

For the syntactico-semantic analysis of HC, we generalise the constraint-based analysis of polyadic quantification in Iordăchioaia and Richter 2015 (resumptive quantification in an analysis of Negative Concord) and Richter 2016 (analysis of the polyadic *different*) to arbitrary polyadic lifts. The gist of the analysis (see the works just cited for technical details) is that particular apparently monadic quantifiers are underspecified in the lexicon as possibly parts of polyadic quantifiers. In order to satisfy constraints at the syntax–semantics interface, different apparently monadic quantifiers may need to 'unify' to a single polyadic quantifier. We assume that either HC constructionally or the conjunction within HC lexically triggers the obligatory *Cov* polyadic lift. For example, in (5) the two quantifiers *mnogimi* and *mnogoe* are underspecified as $\dots many_x \dots (\dots R_1(x) \dots)(S_1(\dots x \dots))$ and $\dots many_y \dots (\dots R_2(y) \dots)(S_2(\dots y \dots))$, and HC triggers their 'unification' to the polyadic $Cov(many_x, many_y)(R_1(x), R_2(y))(S(x, y))$, resulting in (ignoring *about him*, etc.): $Cov(many_x, many_y)(person(x), content(y))(wrote(x, y))$. This analysis of Slavic HC extends to Germanic HC, but – given the obligatory ellipsis – the resulting paired cover interpretations boil down to conjunctions of single cover interpretations; e.g., (2) results in: $Cov(5_x, 15_y)(book(x), publisher(y))(wrote(j, x) \wedge wrote\_to(j, y))$, equivalent to: $5_x(book(x))(wrote(j, x)) \wedge 15_y(publisher(y))(wrote\_to(j, y))$ (assuming singularity covers).

References

Bott, O., Schlotterbeck, F., and Klein, U. (2019). Empty-set effects in quantifier interpretation. *Journal of Semantics*, **36**, 99–163.

Citko, B. and Gračanin-Yüksek, M. (2013). Towards a new typology of coordinated *wh*-questions. *Journal of Linguistics*, **49**(1), 1–32.

Grosu, A. (1987). On acceptable violations of parallelism constraints. In R. Dirven and V. Fried, editors, *Functionalism in Linguistics*, pages 425–457. John Benjamins, Amsterdam/Philadelphia.

Iordăchioaia, G. and Richter, F. (2015). Negative concord with polyadic quantifiers: The case of Romanian. *Natural Language and Linguistic Theory*, **33**, 607–658.

Keenan, E. L. and Westerståhl, D. (2011). Generalized quantifiers in linguistics and logic. In J. van Benthem and A. ter Meulen, editors, *Handbook of Logic and Language*, pages 859–910. Elsevier, Amsterdam, 2nd edition.

Link, G. (1983). The logical analysis of plurals and mass terms. In R. Bäuerle, C. Schwarze, and A. von Stechow, editors, *Meaning, Use and Interpretation of Language*, pages 302–323. Walter de Gruyter, Berlin.

Paperno, D. (2012). *Semantics and Syntax of Non-Standard Coordination*. Ph.D. dissertation, University of California, Los Angeles.

Patejuk, A. (2015). *Unlike coordination in Polish: an LFG account*. Ph.D. dissertation, Institute of Polish Language, Polish Academy of Sciences, Cracow.

Peters, S. and Westerståhl, D. (2006). *Quantifiers in Language and Logic*. Oxford University Press, Oxford.

Richter, F. (2016). Categorematic unreducible polyadic quantifiers in Lexical Resource Semantics. In D. Arnold, M. Butt, B. Crysmann, T. H. King, and S. Müller, editors, *The Proceedings of the Joint 2016 Conference on Head-driven Phrase Structure Grammar and Lexical Functional Grammar*, pages 599–619, Stanford, CA. CSLI Publications.

Robaldo, L. (2010). Independent set readings and generalized quantifiers. *Journal of Philosophical Logic*, **49**, 23–58.

Robaldo, L. (2011). Distributivity, collectivity, and cumulativity in terms of (in)dependence and maximality. *Journal of Logic, Language and Information*, **20**, 233–271.

Robaldo, L., Szymanik, J., and Meijering, B. (2014). On the identification of quantifiers' witness sets: A study of multi-quantifier sentences. *Journal of Logic, Language and Information*, **23**, 53–81.

Schwarzschild, R. (1996). *Pluralities*. Springer-Verlag, Dordrecht.

Sher, G. Y. (1990). Ways of branching quantifiers. *Linguistics and Philosophy*, **13**, 393–422.

Sher, G. Y. (1997). Partially-ordered (branching) generalized quantifiers: A general definition. *Journal of Philosophical Logic*, **26**(1), 1–43.