A compositional intersective account of Heterofunctional Coordination[*]

Adam Przepiórkowski[1,2]
[1]*Faculty of Philosophy, University of Warsaw,* [2]*Institute of Computer Science, Polish Academy of Sciences*

Abstract The analysis presented in this paper extends the uniform intersective ("boolean") treatment of conjunctive coordinators to Heterofunctional Coordination (HC), i.e., coordination of different grammatical functions. A compositional account of HC based on mainstream derivational syntax is proposed, one that makes Champollion's (2015) "quantificational event semantics" compatible with derivational syntax. The analysis is based on the assumption, common in Minimalism, that traces of moved quantifiers denote domain restrictions rather than just variables.

1   Introduction

In **Heterofunctional Coordination** (HC), conjuncts – or at least what looks like conjuncts on the surface – have different grammatical functions, as in the following attested examples:

(1)   [Who and where] are the uncounted children?[1,2]

(2)   Unlike diets, intuitive eating does not provide guidelines for [how, when and what] to eat.[3]

While the great majority of work on HC – to be reviewed in §7 – concentrates on coordinated *wh*-phrases (as in (1)–(2)), it was noted early on that also other focus-sensitive and quantificational expressions may be so coordinated (Grosu 1987, 1985), as in the following attested examples:

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[1]https://equityhealthj.biomedcentral.com/articles/10.1186/s12939-017-0635-6
[2]All URLs last accessed on 19 July 2022.
[3]https://www.goodfoodmadesimple.com/blog/tag/all-foods-fit/

(3)   The 1.5 metre distance rule applies basically [to everybody and everywhere], also on a boat.[4]

(4)   A person with this disease can eat [anything and at any time].[5]

It is widely accepted that, inter- and – at least in some cases – intra-linguistically, there are at least two different syntactic structures underlying HC: multiclausal and monoclausal. Many languages, including English, are assumed to have at their disposal only the multiclausal HC, with the underlying coordination of clauses. For example, (1) has the underlying structure indicated in (5).

(5)   [Who ~~are the uncounted children~~] and [where are the uncounted children]?

Different syntactic works execute this idea differently: either invoking multidominance, or via backward ellipsis (so-called reverse sluicing), or employing Right Node Raising. Regardless of technical details, such analyses rightly predict that all surface conjuncts must be optional dependents (i.e., adjuncts or optional arguments), as otherwise some underlying clauses would be ill formed, as in (6).

(6)   a.   *[Who and what] fixed here?

        b.   *Who fixed here?

        c.   *What fixed here?

On the other hand, it is also generally accepted that at least Slavic languages and Hungarian have at their disposal monoclausal HC, in which what you see is what you get, i.e., in which surface conjuncts are actual underlying conjuncts. Among the many arguments found for this stance in the syntactic literature, the simplest – but definitely not the strongest – is that in these languages, unlike in English, particular conjuncts may be obligatory dependents, as in the following attested example:

(7)   Nie będą   musieli [niczego   i   nikomu]   udawadniać.
        NEG AUX.PL.FUT must.PL nothing.GEN and nobody.DAT prove.INF

                                                                (Polish)

        'They won't have to prove anything to anybody.'[6]

If – counterfactually – a multiclausal analysis were applicable to (7), one of the underlying clauses would be (8), which verges on being unacceptable. Perhaps it could marginally be uttered in spoken Polish if the missing definite direct object were very prominently indicated by the context. By contrast, (7) is fully acceptable in any variety of Polish, regardless of context. Hence, (7) illustrates the monoclausal

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[4]https://www.amstelveen.nl/home/nieuws/frequently-asked-questions-about-boating-and-water
[5]https://m.egwwritings.org/en/book/1668.5101
[6]https://krakow.naszemiasto.pl/puchar-toyota-anwa-2005/ar/c4-6282209 (simplified)

HC, in which the two quantifiers are coordinated directly.

(8) $^{?*}$Nie będą   musieli nikomu   udawadniać.   (Polish)
       NEG AUX.PL.FUT must.PL nobody.DAT prove.INF
       'They won't have to prove (it) to anybody.'

The aim of this paper is to provide a compositional semantic analysis of mono-clausal HC. (Multiclausal HC does not seem to create any problems for composition-ality.) As discussed in §7, there are only a couple of previous attempts at this task, and they are either only very weakly compositional, or technically compositional at the cost of substantial and otherwise unmotivated complications in the syntax. Moreover, they assume special semantics for conjunctive coordinators, resulting in systematic inter- and intra-linguistic ambiguity of such coordinators. By contrast, the fully compositional analysis proposed here assumes the standard intersective semantics of conjunctive coordinators (Partee & Rooth 1983; Winter 2001) and does not deviate from the generally accepted syntax of monoclausal HC. To this end, it assumes the quantificational event semantics framework of Champollion 2015 and the Minimalist approach to the meaning of traces, on which traces denote domain restrictions (see, e.g., Fox 1999 and Pasternak 2020).[7]

The outline of the remainder of this paper is as follows: §2 introduces the most commonly assumed syntactic analysis of monoclausal HC, §3 sketches Cham-pollion's (2015) approach to event semantics, §4 demonstrates that this approach, coupled with the standard intersective approach to conjunctive coordinators, gives *almost* correct results out of the box, §5 fine-tunes this analysis by providing the right interpretation of traces, and §6 discusses the limitations of the resulting analysis. Then §7 compares this account to previous analyses and §8 concludes.

2 Syntax of monoclausal HC

Most of the Minimalist analyses of monoclausal HC assume the sideward movement (Nunes 2001) approach to HC proposed in Zhang 2007; see, e.g., Haida & Repp 2011, Citko & Gračanin-Yüksek 2013, Jung 2018, and Bošković 2022.[8] A schematic monoclausal structure of the attested HC example in (9) is provided in Figure 1. (It ignores the locative adverbial.)

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[7]The analysis presented below assumes – but does not endorse – the Chomskyan derivational approach to syntax. As discussed, e.g., in Pullum & Scholz 2001, 2005, as well as in Langendoen & Postal 1984 and Postal 2004, 2022, there are good reasons to prefer model-theoretic approaches, such as Head-driven Phrase Structure Grammar (Pollard & Sag 1994, Müller, Abeillé, Borsley & Koenig 2021) or Lexical Functional Grammar (Kaplan & Bresnan 1982, Dalrymple, Lowe & Mycock 2019, Dalrymple 2022), to derivational approaches such as Minimalism (Chomsky 1995, 2001) or Categorial Grammar (Ajdukiewicz 1935; Lambek 1958; Steedman 1996).

[8]A somewhat different analysis is proposed in Potter & Frazier 2021.

(9)   Tu   krytykują   [wszyscy   i   wszystkich].   (Polish)
      here criticize.PL all.NOM.PL and all.ACC.PL
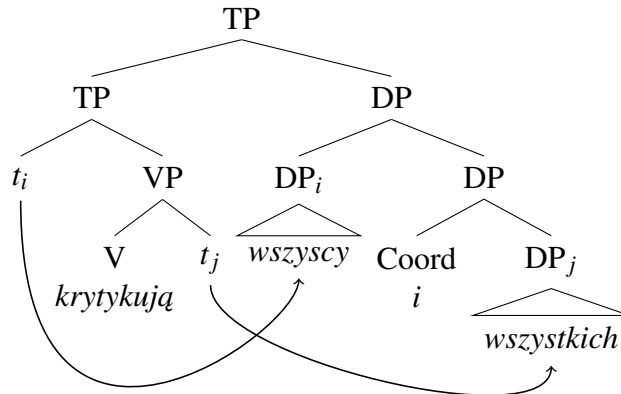   'Here everybody criticizes everybody.'[9] (inaccurate translation; see §4 below)

Figure 1   Schematic syntactic structure of (9)

On this approach, the conjuncts are first merged into the positions they would normally occupy as dependents – in the case of Figure 1, into the positions of the object and the subject of the verb. Then, however, they move into a separate workspace and merge with the coordinator, creating a coordinate phrase, which subsequently adjoins back to the verbal spine – the TP, in Figure 1.

There are many possible variants of this schematic analysis. Trivially, the verbal spine may contain other functional projections apart from those indicated in Figure 1. Less trivially, Haida & Repp 2011 and Bošković 2022 argue that the eventual conjuncts move up along the verbal spine before they move sidewards. Also, there are different approaches to the structure of coordination, with the most common one – which assumes that coordination is headed by Conj and, hence, that it is ConjP (see, e.g., Munn 1987, Johannessen 1988, Zoerner 1995, among many others), and that it is strictly binary – being almost certainly wrong (see, e.g., Borsley 2005 and Neeleman, Philip, Tanaka & van de Koot 2022). The exact details of the syntactic analysis are not important here, as long as the eventual conjuncts start up in positions reflecting their grammatical functions and end up in positions in which their meanings may be semantic arguments to the meaning of the coordinator.

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[9]http://szymonadamus.pl/cala-prawda-o-kupowaniu-komentarzy/ (simplified)

3   Quantificational event semantics

Champollion (2015) aims to reconcile neo-Davidsonian event semantics (Davidson 1967; Parsons 1990) with standard compositional semantics in a way that solves certain scoping paradoxes and does not need to assume Quantifier Raising (May 1985) to establish scope dependencies. The crucial technical innovation here is that verbs do not denote properties of events, as normally assumed (see (10)), but rather sets of properties of events (see (11)).[10]

(10)   *dance* ⤳ $\lambda e_v.dance(e)$ (standard approach)

(11)   *dance* ⤳ $\lambda f_{vt}.\exists e_v.dance(e) \wedge f(e)$ (Champollion 2015)

Thus, according to (11), the verb *dance* denotes the set of properties such that each holds of at least some dancing events. This corresponds to the set of those sets of events which contain some dancing events. Note that on this approach events are existentially bound in the lexicon, rather than via sentence-level existential closure. However, there is a sentence-level closure operator, given in (12), which has the effect of "closing" representations such as (11): the result of combining the representation of *dance* in (11) with the closure operator in (12) would be as shown in (13).

(12)   [closure] ⤳ $\lambda e_v.true$

(13) $[\lambda f.\exists e.dance(e) \wedge f(e)](\lambda e.true) \;=\; \exists e.dance(e) \wedge true \;=\; \exists e.dance(e)$

The verb *dance* alone does not constitute a complete sentence, it minimally needs to combine with an agentive subject, such as *Marge* or *every student*. Champollion (2015) assumes standard quantificational denotations of such arguments, as in (14)–(15).

(14)   *Marge* ⤳ $\lambda P_{et}.P(m)$

(15)   *every student* ⤳ $\lambda P_{et}.\forall x_e.student(x) \rightarrow P(x)$

Such arguments do not combine with (projections of) verbs directly, but rather via thematic role operators, such as [ag] in (16).

(16)   [ag] ⤳ $\lambda Q_{\langle et,t\rangle}\lambda V_{\langle vt,t\rangle}\lambda f_{vt}.Q(\lambda x.V(\lambda e.f(e) \wedge agent(e) = x))$

The resulting structures for *Marge danced* and *Every student danced* are given in Figures 2–3.

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[10]For clarity and compatibility with Champollion 2015, I assume in this paper that events have the semantic type *v*, without committing myself to the distinctness of *v* and *e*, i.e., to the necessity of adding this third basic type to the system, on top of *e* and *t*.
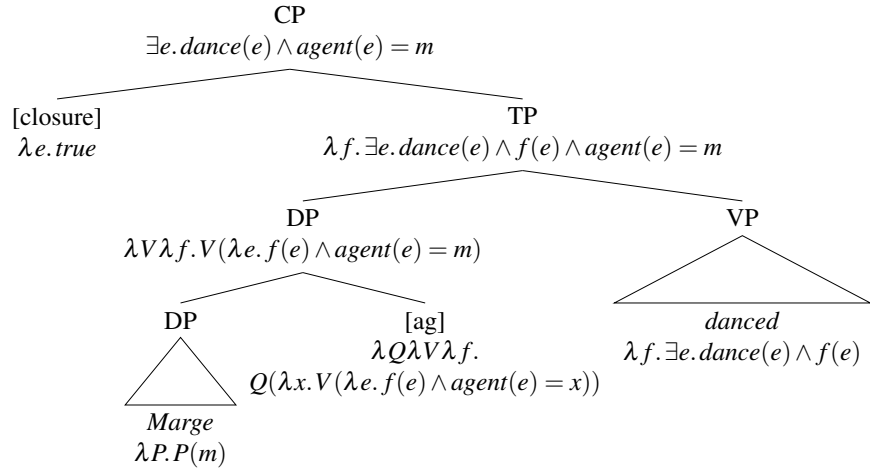
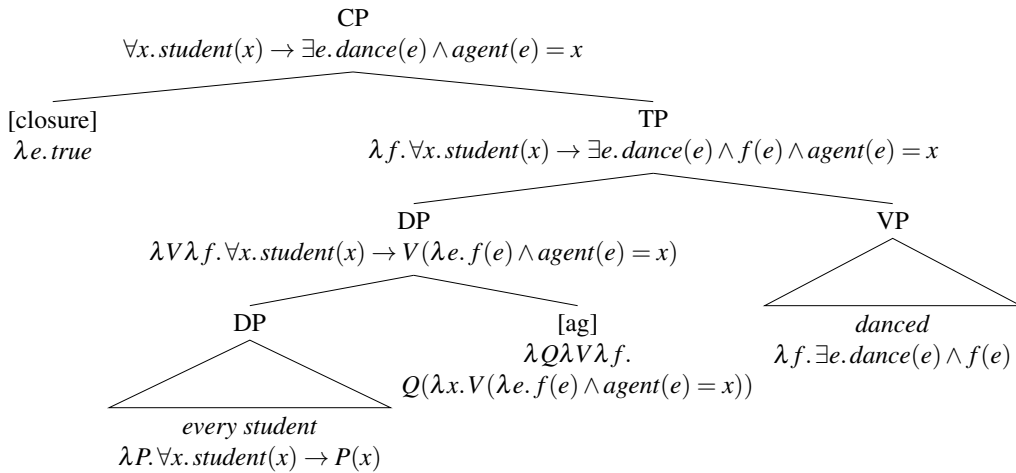**Figure 2**   The representation of *Marge danced*

Figure 3   The representation of *Every student danced*

4   Compositional semantic analysis of monoclausal HC

Let us now apply Champollion's event semantics sketched in the previous section to the syntax of monoclausal HC outlined in §2. Let us assume, as does Champollion (2015), the standard boolean ('intersective') meaning of conjoining coordinators, given in (17) (Partee & Rooth 1983; Winter 2001; Champollion 2016).

(17)   *and* $\rightsquigarrow \sqcap_{\langle \tau, \tau\tau \rangle} \overset{def}{=} \begin{cases} \lambda q_t \lambda p_t . p \wedge q & \text{if } \tau = t \\ \lambda Y_\tau \lambda X_\tau \lambda Z_{\sigma_1} . X(Z) \sqcap_{\langle \sigma_2, \sigma_2 \sigma_2 \rangle} Y(Z) & \text{if } \tau = \langle \sigma_1, \sigma_2 \rangle \end{cases}$

Champollion (2015) does not assume movement, so the issue of the interpretation of traces does not arise there. Here, I will initially make the simplest possible assumption (to be revised in §5), namely, that traces do not contribute to the meaning at all. That is, in contradistinction to the standard approach (e.g., in Heim & Kratzer 1998), traces do not correspond to variables and lambda abstraction is not needed. I will implement this idea by making traces denote the identity function on denotations of verbs:

(18) $t \rightsquigarrow \lambda V_{\langle vt,t \rangle}.V$

Given this set of assumptions, the compositional semantics of the running example (9), repeated below as (19), works as illustrated in Figure 4.

(19)   Tu   krytykują   [wszyscy   i   wszystkich].   (Polish)
        here criticize.PL all.NOM.PL and all.ACC.PL
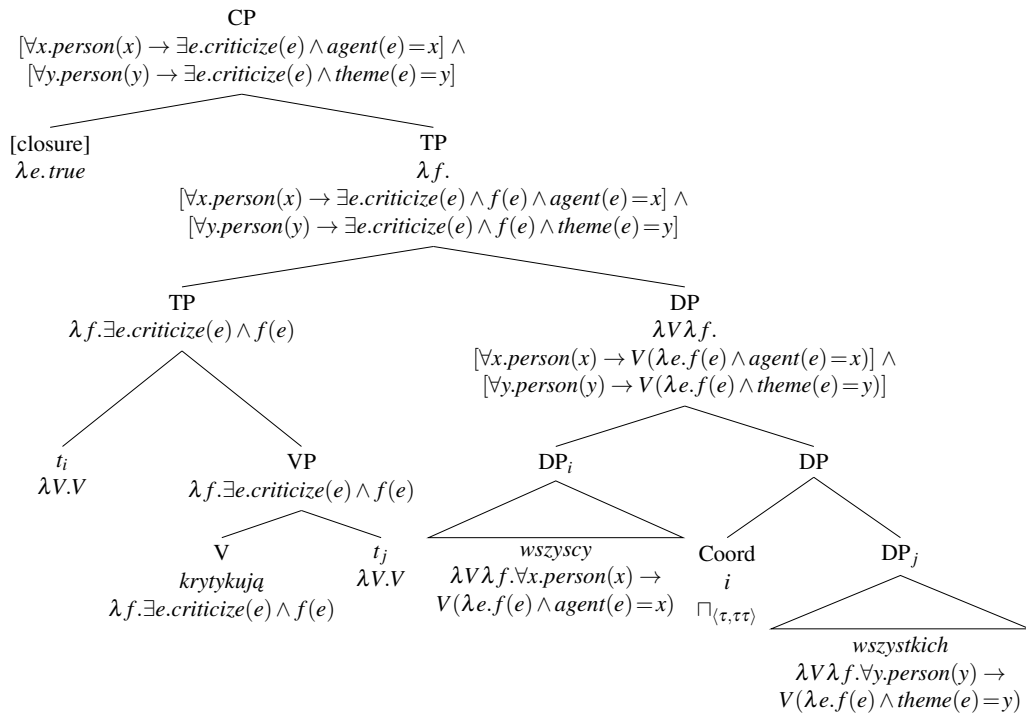   'Here everybody criticizes everybody.' (inaccurate translation; see below)

Figure 4   Preliminary representation of (19)

The first thing to note about Figure 4 is that – because traces do not contribute to meaning – the VP and lower TP nodes have the same semantic representation as the verbal node V. The second thing is that the sidewards moved DPs, which

incorporate the contribution of the thematic operators [ag] and [th] (not shown explicitly in Figure 4), have conjoinable types "ending in *t*", namely, $\langle\langle vt,t\rangle,\langle vt,t\rangle\rangle$, so they may act as arguments to the intersective coordinator *i* 'and'.

According to this analysis, the predicted meaning of the whole CP in (19) is that everybody is an agent in some criticizing event or other and everybody is a theme in some criticizing event or other, i.e., that everybody criticizes and everybody is criticized. Is this what (19) really means?

As discussed in §7, two of the three previous semantic analyses of monoclausal HC, those in Paperno 2010, 2012, predict rather different interpretations: resumptive and (roughly) branching. On the resumptive analysis in Paperno 2010, 2012: ch.3–4, the predicted meaning of (19) is that all ⟨person, person⟩ pairs are in the *criticize* relation, which is equivalent to the distributive reading on which everybody criticizes everybody. On the game-theoretical analysis in Paperno 2012: ch.5, which amounts to branching quantification (with the option of collective interpretation of quantifiers), the predicted meaning is again equivalent to everybody criticizing everybody.

The third account, in Przepiórkowski 2022b, demonstrates on the basis of multiple attested examples that the interpretation of monoclausal HC is much weaker, namely cumulative. On that interpretation, the meaning of (19) is that everybody is an agent in an event of criticizing somebody or other and everybody is a theme in an event of being criticized by somebody or other. Such interpretations are derived there by postulating a specialized meaning of coordinators in HC (as denoting the cumulative polyadic lift or, more precisely, the cover polyadic lift of Robaldo 2011) and by assuming a very weakly compositional approach to the syntax–semantics interface, based on a syntactic analysis couched in Head-driven Phrase Structure Grammar.

What is striking is that, as I just demonstrated (see Figure 4), almost the same interpretation may be fully compositionally obtained out of the box by assuming the standard intersective meaning of conjunctive coordinators, standard syntax, and the approach to event semantics of Champollion 2015, which is amply justified independently of coordination.

However, the two interpretations are not exactly the same. Let us juxtapose them:

(20)   interpretation of (19) according to Figure 4:
$$[\forall x.person(x) \to \exists e.criticize(e) \wedge agent(e){=}x] \wedge$$
$$[\forall y.person(y) \to \exists e.criticize(e) \wedge theme(e){=}y]$$

(21)   interpretation of (19) according to Przepiórkowski 2022b (roughly):
$$[\forall x.person(x) \to \exists e.criticize(e) \wedge agent(e){=}x \wedge \exists y.person(y) \wedge theme(e){=}y] \wedge$$
$$[\forall y.person(y) \to \exists e.criticize(e) \wedge theme(e){=}y \wedge \exists x.person(x) \wedge agent(e){=}x]$$

So, according to the analysis of this section, but unlike in Przepiórkowski 2022b, the running example (19) is true in a situation in which everybody criticizes *a film*,

one person criticizes everybody, and no other criticizing takes place. Intuitively, this is not a situation that may be truthfully described by (19); this sentence is strictly about *people* criticizing *people*, as indicated in (21).

The next section revisits the semantic contribution of traces and proposes that they be interpreted as domain restrictions, resulting in interpretations similar to (21).

5   Interpretation of traces

Within the Minimalist literature, there is a long tradition – originating in Fox 1999, 2002 – of treating traces (or lower copies) of moved quantifiers as expressing the restrictors of these quantifiers, rather than just bound variables.[11] On this approach, the Logical Form representation of (22) may be paraphrased not just as (23a) but rather as (23b) or (23c) (cf. Fox 2002: §2).

(22)   Every student danced.

(23)   a.   For every student x, x danced.

      b.   For every student x, x: $student(x)$ danced.

      c.   For every student x, the student x danced.

On the current approach, the sidewards moved DPs are not the usual quantifiers of type $\langle et, t \rangle$, but rather – despite being syntactic arguments in the running example – they are semantic modifiers of type $\langle \langle vt, t \rangle, \langle vt, t \rangle \rangle$, containing the bound variable, as in the following representation of the DP *wszyscy* 'all.NOM (people)':

(24)   *wszyscy* 'all.NOM' $\rightsquigarrow \lambda V_{\langle vt, t \rangle} \lambda f_{vt}. \forall x. person(x) \rightarrow V(\lambda e. f(e) \wedge agent(e) = x)$

This means that traces should not be interpreted as variables – these are already bound within the DP – but rather as pure domain restrictions; instead of being interpreted as identity functions, the trace t_i of the sidewards moved subject DP$_i$ *wszyscy* 'all.NOM (people)' in the running example should provide the information that the agent is a person, while the trace t_j of the moved object DP$_j$ *wszystkich* 'all.ACC (people)' should be interpreted as saying that the theme is a person. Technically, the traces in the running example should have the following interpretations, instead of $\lambda V_{\langle vt, t \rangle}. V$:

(25) $t_i \rightsquigarrow \lambda V_{\langle vt, t \rangle} \lambda f_{vt}. V(\lambda e. f(e) \wedge person(agent(e)))$

(26) $t_j \rightsquigarrow \lambda V_{\langle vt, t \rangle} \lambda f_{vt}. V(\lambda e. f(e) \wedge person(theme(e)))$

This modification results in the derivation of the running example given in Fig-

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[11]See Pasternak 2020 and references therein for other works assuming or arguing for this position and for one way to derive this effect compositionally.
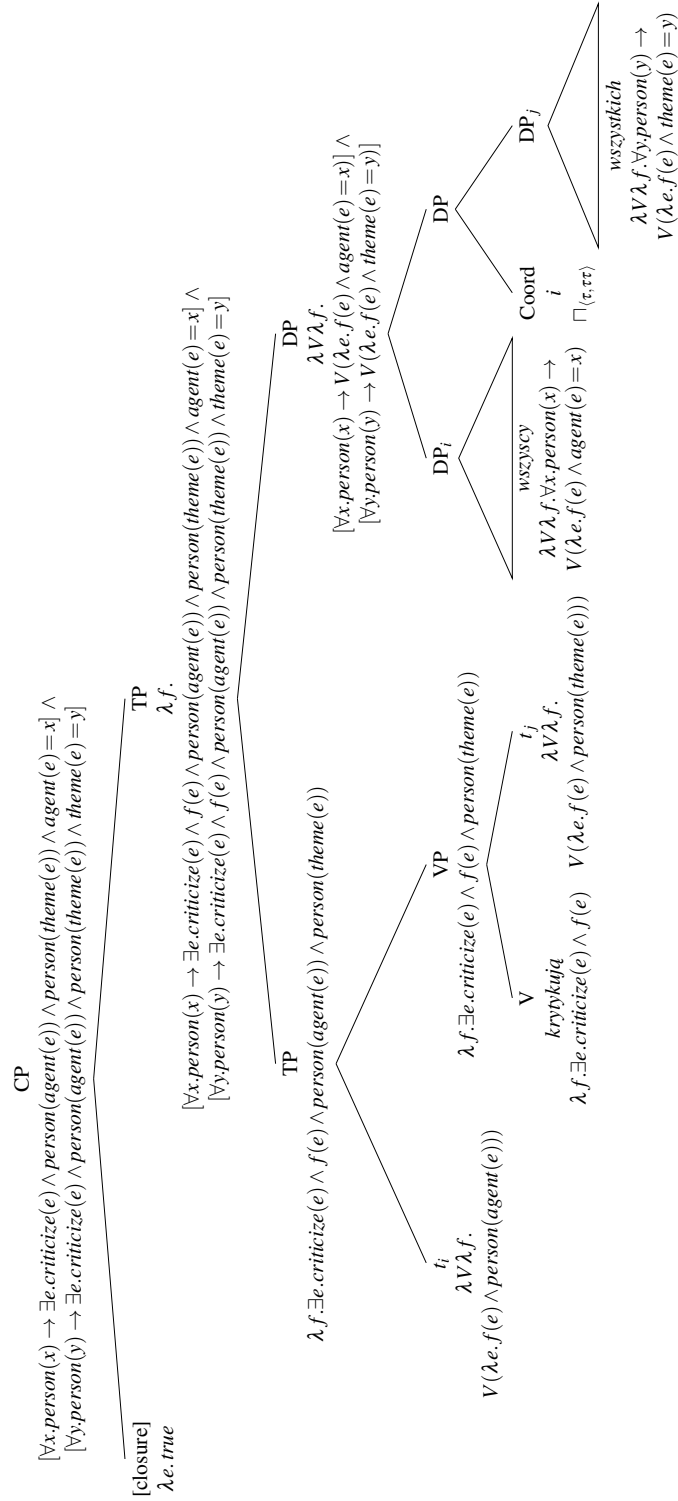
CP
$[\forall x.person(x) \to \exists e.criticize(e) \land person(agent(e)) \land person(theme(e)) \land agent(e)=x] \land$
$[\forall y.person(y) \to \exists e.criticize(e) \land person(agent(e)) \land person(theme(e)) \land theme(e)=y]$

[closure]
$\lambda e.true$

TP
$\lambda f.$
$[\forall x.person(x) \to \exists e.criticize(e) \land f(e) \land person(agent(e)) \land person(theme(e)) \land agent(e)=x] \land$
$[\forall y.person(y) \to \exists e.criticize(e) \land f(e) \land person(agent(e)) \land person(theme(e)) \land theme(e)=y]$

TP
$\lambda f.\exists e.criticize(e) \land f(e) \land person(agent(e)) \land person(theme(e))$

t_i
$\lambda V \lambda f.$
$V(\lambda e.f(e) \land person(agent(e)))$

VP
$\lambda f.\exists e.criticize(e) \land f(e) \land person(theme(e))$

V
krytykują
$\lambda f.\exists e.criticize(e) \land f(e)$

t_j
$\lambda V \lambda f.$
$V(\lambda e.f(e) \land person(theme(e)))$

DP
$\lambda V \lambda f.$
$[\forall x.person(x) \to V(\lambda e.f(e) \land agent(e)=x] \land$
$[\forall y.person(y) \to V(\lambda e.f(e) \land theme(e)=y)]$

DP_i
wszyscy
$\lambda V \lambda f.\forall x.person(x) \to$
$V(\lambda e.f(e) \land agent(e)=x)$

DP
$\lambda V \lambda f.$

Coord
i
$\sqcap_{\langle \tau, \tau\tau \rangle}$

DP_j
wszystkich
$\lambda V \lambda f.\forall y.person(y) \to$
$V(\lambda e.f(e) \land theme(e)=y)$

Figure 5   Final representation of (19)

ure 5, which replaces the previous derivation in Figure 4. Note that now the lower TP does not have the same interpretation as the verb: instead of representing (sets of properties of) *any* criticizing events, it represents (sets of properties of) *people* critizing *people* events. As a result, the interpretation of the whole sentence is that everybody criticizes *somebody or other* and everybody is criticized *by somebody or other*. Even though the resulting meaning representation of the CP in Figure 5 is a little redundant, this is the correct interpretation of the running example, equivalent to (21).

6 Limitations and loose ends

There are some syntactic and semantic loose ends and an empirical limitation of the current account, which I leave for future research.

The syntactic loose end concerns sideward movement, which is sometimes perceived as controversial and not sufficiently motivated (see, e.g., Larson 2015). One particular problem is what exactly motivates the sideward movement of the quantificational dependents to the workspace in which the coordinate structure is derived. Haida & Repp 2011 assume that this movement is focus-driven and that the coordinator has the Attract All F feature, in the sense of Bošković 1999, and this assumption may also be adopted for the analysis presented above.[12]

The semantic loose end is that it is not clear how exactly traces are assigned domain restriction interpretations, such as those in (25)–(26). I can see two paths that seem worth pursuing here. The first is to adapt the machinery of compositional trace conversion proposed in Pasternak 2020, whose effect is the interpretation of (22), repeated below as (27), as paraphrased in (23c), repeated as (28), with the actual syntactic structure indicated in (29).

(27)   Every student danced.

(28)   For every student x, the student x danced.

(29)   [Every$_1$ student λ_1 [~~every$_1$ student~~ danced]].

The way this is achieved is that lambda abstraction effectively replaces ("swaps") the usual interpretation of the determiner *every* with the interpretation equivalent to that of the determiner *the*. A disadvantage of this approach is that it requires reintroducing lambda abstraction to the system. Another is that it would necessi-

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[12]Some of the other aspects of Haida & Repp's analysis are more controversial. For example, they crucially "assume that elements coordinated in a coordination phrase must be alike as far as their feature setup is concerned" (Haida & Repp 2011: §2.3), i.e., they assume a strong version of the Law of the Coordination of Likes (LCL; Williams 1981: §2). See Przepiórkowski 2022a for arguments against LCL and Patejuk & Przepiórkowski 2022 for a critique of a recent implementation of LCL.

tate syntactic decomposition of Lindström (1966) type $\langle 1 \rangle$ (i.e., $\langle et, t \rangle$) quantifiers such as *wszyscy* 'all.NOM (people)' into a determiner expressing a type $\langle 1, 1 \rangle$ (i.e., $\langle et, \langle et, t \rangle \rangle$) quantifier (here, the universal quantifier) and a restriction (here, *person*), even where such a decomposition is not morphologically justified (as in the case of *wszyscy*).

A more interesting path to take would be to adopt Glue Semantics (Dalrymple 1999; Kokkonidis 2008) to Minimalism, as proposed in Gotham 2018. Glue Semantics gives more flexibility in how many bits of meaning representation a given item may introduce and how they may combine. For example, both *wszyscy* 'all.NOM (people)' and [ag] could each introduce two meaning representations: one to be used in the final syntactic position, leading to the corresponding representations of the two DPs in the tree in Figure 5, and another to be used in non-final ('trace') positions, leading to the desired interpretations of traces. This, however, would require modifications of the particular implementation of Glue in Minimalism in Gotham 2018, so that traces (lower copies) may be distinguished from heads of chains (top copies).

Finally, the analysis proposed here has an empirical limitation: it assumes that conjuncts in monoclausal HC are dependents of the same head. This assumption is satisfied in the vast majority of naturally occurring cases of HC, including all examples in the previous sections and in §7, but – as noted for example in Patejuk & Przepiórkowski 2012, 2019 – it is not universally true. In fact, it is even possible for one conjunct to be headed by another one, as in the following attested sentence:

(30) Notuj,   [ile   i   czego]   zjadasz.   (Polish)
      note.IMP.2SG how.much.ACC and what.GEN eat.2SG

'Make a note of how much of what you eat.'[13]

The first conjunct in (30) is the numeral head *ile* 'how much' in the accusative, as expected of the direct object of *zjadasz* 'eat.2SG', while the second conjunct is the noun *czego* 'what' in the genitive, as expected of the complement of the numeral.[14] It is not clear to me how to conservatively modify the analysis proposed above to handle such cases.

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[13]https://www.myline.pl/jak-skutecznie-schudnac/ (simplified)

[14]This is an example of *monoclausal* HC, as one of the hypothetical clausal conjuncts in the multiclausal analysis would be ungrammatical:

(i)   *Notuj,   czego   zjadasz.   (Polish)
       note.IMP.2SG what.GEN eat.2SG

The problem with (i) is that the genitive *czego* cannot be interpreted as the direct object of *zjadasz*.

7 Previous work

Almost all previous formal work on HC is limited to the syntax of constructions with *wh*-phrases (e.g., Browne 1972, Grimshaw 1978, Kazenin 2001, Lipták 2003, 2011, Gračanin-Yüksek 2007, Skrabalova 2007, Zhang 2007, Gribanova 2009, Raţiu 2011, Sinopoulou 2011, 2020, Tomaszewicz 2011, 2012, Bîlbîie & Gazdik 2012, Citko 2013, Citko & Gračanin-Yüksek 2013, 2016, Larson 2013, Ishii 2014, Kasai 2016, Merchant 2017, Melchin & Toivonen 2018, Jung 2018, Zyman 2020, Kwon 2021, Potter & Frazier 2021).[15] Some (e.g., Gribanova 2009 and Merchant 2017) invoke Quantifier Absorption (Higginbotham & May 1981) to explain why questions involving HC of *wh*-phrases, unlike ordinary multiple *wh*-questions, seem to only have the single-pair (and not the pair-list) interpretation. A more comprehensive syntactico-semantic analysis of such questions may be found in Haida & Repp 2011.

Empirically comprehensive but relatively informal discussions of the syntax – and, to a much lesser extent, semantics – of HC going beyond *wh*-phrases may be found in Sannikov 1979–1980, 1989 (all on Russian and written in Russian), in Grosu 1987, 1985 (on English), and in Kallas 1993 and Przepiórkowski & Patejuk 2014 (both on Polish and written in Polish). Apparently the only formal syntactic analyses of HC going beyond *wh*-phrases are offered in Chaves & Paperno 2007 (on Russian, within Head-driven Phrase Structure Grammar) and in Patejuk & Przepiórkowski 2012 and, especially, Patejuk 2015 (on Polish, within Lexical Functional Grammar). To the best of my knowledge, the only relatively comprehensive formal syntactico-semantic analyses of HC are those of Paperno 2010, 2012 and Przepiórkowski 2022b, 2021.

The main semantic analysis of Paperno 2010, 2012: ch.3–4 assumes that the right meaning of HC is given by the resumptive polyadic lift. As noted in passing in Paperno 2012 and discussed at length in Przepiórkowski 2022b, this analysis leads to wrong truth conditions in some cases. For example, it predicts that, for the attested (31) to be true, there should be many ⟨format, codec⟩ pairs, e.g., just one format and many codecs for this format. But in such a scenario (31) is clearly false: it requires *both* the multitude of codecs *and* the multitude of formats.

(31) Konwertowałem   [na wiele formatów i   wieloma kodekami]. (Polish)
      converted.1SG.MASC   on many formats   and many.INS codecs.INS
      'I used to convert to many formats and using many codecs.'[16]

Moreover, the resumptive lift requires the complete identity of the underlying quanti-

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[15]Some of these works, including Kazenin 2001, Lipták 2003, and Gribanova 2009, mention some of the other types of HC in passing, especially the possibility to coordinate negative quantifiers, but do not attempt to formally analyse them.

[16]https://xboxforum.pl/threads/problem-z-przesylaniem-filmow-na-youtube.58989/

fiers of type $\langle 1, 1 \rangle$. This condition is met in the vast majority of cases, including (31), which involves identical quantifiers *many*, but there are exceptions, such as the attested (32), involving the type $\langle 1, 1 \rangle$ quantifiers *all* and *almost all*.

(32) Żują   [wszyscy i   prawie wszędzie].   (Polish)
      chew.3PL all   and almost everywhere
      'Everybody chews and it is done almost everywhere.'[17]

And even if such cases were somehow accommodated by the resumptive analysis, the resulting meaning would be too strong: it would say that for (almost) all $\langle \text{person}, \text{place} \rangle$ pairs, this person chews at this place. However, (32) – from a newspaper article about about khat chewing in Yemen – is clearly meant as having the weaker cumulative interpretation indicated in the translation.

Paperno (2010, 2012: ch.3–4) provides two syntax–semantics interfaces for this resumptive analysis, which are claimed to be compositional, but – as discussed in Przepiórkowski 2022b – this technical compositionality comes at a steep price. In the first proposal, based on derivational syntax, Paperno (2010, 2012: §4.5.2) assumes that quantificational determiners (e.g., *wiele* and *wieloma* in (31)) are semantically vacuous, but – for agreement purposes – require the presence of a corresponding phonologically empty quantifier (in (31), one expressing the meaning of *many*). When multiple phrases based on the same *apparent* $\langle 1, 1 \rangle$ quantifier are coordinated (as in the bracketed constituent in (31)), a single phonologically empty *actual* quantifier of the corresponding type (here, *many*) scopes over and agrees with the whole coordination. No independent evidence is offered for the claim that apparently quantificational expressions are not quantificational at all and require an agreeing phonetically empty quantifier.

In the second proposal, based on categorial syntax, Paperno (2012: §§3.7–3.8, 4.5.1) builds on the observation that conjuncts in Slavic HC often contain *wh*-roots, as in *niczego* 'nothing.GEN' and *nikomu* 'nobody.DAT' in (7), containing *czego* 'what.GEN' and *komu* 'who.DAT'. Paperno proposes an inherently non-compositional operation which takes a coordination of such *wh*-roots, e.g., *czego i komu*, and converts it into a coordination of appropriate quantifiers, e.g., *niczego i nikomu*, changing not only the syntactic and semantic representation of the coordination, but also the phonological representation of each conjunct. Both proposals run into multiple empirical and theoretical difficulties, and both assume a specialized meaning of the coordinating conjunction responsible for the intended resumptive interpretation.

Noting some of these problems, Paperno (2012: ch.5) abandons the resumptive analysis and sketches a game-theoretic account of HC, in which a relatively standard game-theoretic coordinating conjunction is employed. Unfortunately, this

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[17]https://www.rp.pl/swiat/art8299891-przekleta-roslina-zrodlem-rzadkiej-przyjemnosci

outline is illustrated with only a couple of examples of HC and it does not refer to some of the problematic examples mentioned in earlier chapters, so it is difficult to evaluate it. Suffice it to say that it does not predict the cumulative interpretations observed in naturally occurring examples of HC (instead, it assumes branching quantification, with the option of treating a quantifier collectively) and that it is not immediately compatible with downward-monotone quantifiers (as in (7)) and with the coordination occurring post-verbally (as in the running example (19) or in (31)–(32)).

While the actual analyses proposed in Paperno 2010, 2012 cannot be maintained, Paperno's dissertation is a rich source of empirical data and theoretical observations that inspired the analysis in Przepiórkowski 2022b, whose gory technical details are presented in Przepiórkowski 2021. It is argued in Przepiórkowski 2022b: §2 – on the basis of multiple attested examples – that HC should be understood cumulatively, and an analysis is proposed in terms of the cumulative polyadic lift (or, more precisely, its mereological extension – cover lift; cf. Robaldo 2011). The analysis, couched in Head-driven Phrase Structure Grammar (HPSG), relies on the approach to semantics within HPSG which is known as Lexical Resource Semantics (LRS; Richter & Sailer 2004), and especially on the LRS analyses of polyadic quantification presented in Iordăchioaia & Richter 2015, Sailer 2015, and Richter 2016. On this approach, quantifiers are lexically underspecified and a number of quantifiers may end up contributing to the representation of a single polyadic quantifier. For example, *wszyscy* 'all.NOM (people)' and *wszystkich* 'all.ACC (people)' may have the equivalent representations in (33)–(34), in which it is underspecified whether there are other type $\langle 1, 1 \rangle$ quantifiers involved (see ellipses around *all*) and, hence, whether there are more restrictions involved (see ellipses around *person*), as well as what the nuclear scope is (see the placeholders S and T) and what arity it has (see ellipses around the bound variables).

(33)   *wszyscy* 'all.NOM' $\rightsquigarrow \ldots all_x \ldots (\ldots person(x) \ldots)(S(\ldots x \ldots))$

(34)   *wszystkich* 'all.ACC' $\rightsquigarrow \ldots all_y \ldots (\ldots person(y) \ldots)(T(\ldots y \ldots))$

In this analysis, the conjunctive coordinator has a specialized meaning, introducing the cumulative lift, as in (35), and it is underspecified for the actual underlying quantifiers involved (see the first $(\ldots)$), their restrictions (the second $(\ldots)$), and the nuclear scope (the third $(\ldots)$).

(35)   *i* 'and': $Cum(\ldots)(\ldots)(\ldots)$

Appropriate principles make sure that all these underspecified representations are unified, resulting in the meaning representation of *wszyscy i wszystkich* 'all.NOM (people) and all.ACC (people)' given in (36), with the placeholder R to be eventually filled by an appropriate relation expressing the nuclear scope, as in (37) (in the case

of the running example (19)).[18]

(36) $Cum(all_x, all_y)(person(x), person(y))(R(x, y))$

(37) $Cum(all_x, all_y)(person(x), person(y))(criticize(x, y))$

On this account, all syntactic constituents introducing the underspecified representations in (33)–(35) end up having the fully specified representation in (37), so the analysis leads to a reasonable representation of the sentence, but particular constituents end up having bits of meaning representation introduced outside of these constituents.

The analysis of Przepiórkowski 2022b, 2021 does not suffer from the empirical limitation discussed at the end of §6 – it does not assume that the conjuncts in HC must originate as co-dependents – and in this sense it is superior to the analysis proposed in the current paper, but only at the cost of introducing systematic ambiguity of conjunctive coordinators, which must have a specialized polyadic meaning in HC; the current analysis is free from this problem. Moreover, the analysis in Przepiórkowski 2022b, 2021 is only weakly compositional, in the sense that the meaning of a sentence is a function of the meanings of the words in it and the way they are combined syntactically (this is sometimes called Frege's Principle; cf. Dowty 2007: 23), but it does not satisfy the additional requirement that "each linguistic constituent has a well-formed and complete denotation that does not depend on any linguistic element external to that expression" (Dowty 2007: 48–49); see Przepiórkowski 2022b: §4 for discussion. Also, from the Minimalist point of view, a disadvantage of this analysis is that the syntax–semantics interface it assumes relies on the model-theoretic ("constraint-based") character of HPSG and on a specific representational approach to semantics within HPSG.

By contrast, the analysis presented in the current paper builds on the empirical observations of Przepiórkowski 2022b, but it assumes the usual semantics of conjunctive coordinators and it seeks to derive the cumulative meanings in a more traditionally compositional way, via a syntax–semantics interface which builds on the mainstream generative approach to syntax.

8   Conclusion

Heterofunctional Coordination is an intriguing phenomenon, which – despite being brought to the attention of generative linguists some 50 years ago (Browne 1972) – still remains ill understood. Almost all syntactic literature focuses on – and fine-tunes analyses to – a single particular instance of this phenomenon, namely, coordination of fronted *wh*-phrases. Semantic literature – with the exception of Paperno 2010,

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[18]For simplicity, representations without events are assumed here.

2012 – ignores the phenomenon altogether, even though it may shed new light on the semantics of coordination and on compositionality.

The analysis presented in the current paper, as well as the one in Przepiórkowski 2022b, 2021, aim to go some way towards filling this gap. However, as discussed in §§6–7, they have some empirical limitations (in particular the assumption of the current analysis that conjuncts are dependents of the same verb), theoretical weaknesses (including the need for specialized coordinators in the analysis of Przepiórkowski 2022b, 2021), and properties that may be perceived as detrimental, depending on one's views on the syntax–semantics interface and the exact nature of compositionality (this especially applies to the analysis in Przepiórkowski 2022b, 2021). It is my hope that these two attempts will provide impetus for future work on Heterofunctional Coordination, leading to more satisfactory analyses of this phenomenon.

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A compositional intersective account of Heterofunctional Coordination

Adam Przepiórkowski
IPI PAN
ul. Jana Kazimierza 5
01-248 Warszawa, Poland
adamp@ipipan.waw.pl