Proceedings of the LFG'24 Conference

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Miriam Butt, Jamie Y. Findlay, Ida Toivonen (eds.)

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Editors' note

This year's Conference on Lexical Functional Grammar was held at the University of Ghana, in Legon, Accra. The program committee for LFG24 were Tina Bögel and Stephen Jones. We would like to thank them for coordinating the review process and working with the local organisers, Adams Bodomo and Hasiyatu Abubakari, to put together this year's programme. This year's conference featured a very interesting workshop on West African languages, which was organized by Adams Bodomo and Miriam Butt. We would also like to thank the Executive Committee without whom the conference planning would not have been possible.

With this conference, Adams Bodomo has now officially organized the most LFG conferences to date and we would to thank him for bringing LFG to all corners of the world. This year's LFG conference was made particularly memorable by the verve and organizational skills Hasiyatu Abubakari and her team brought to the conference, serving up delicious food day after day and organizing a truly wonderful post-conference tour. We would also like to thank the Vice Chancellor of the University of Ghana for hosting our participants in her beautiful hill-top garden and the Linguistics Association of Ghana for giving us the opportunity to co-locate with the 16th Linguistics Association of Ghana Annual Conference (LAG 2024).

As usual, submission to the proceedings was open to all papers, posters, workshop presentations and invited talks given at the conference. Some of these presentations were not submitted to the proceedings. For these, we suggest contacting the authors directly. We note that all of the abstracts were peer-reviewed anonymously (double-blind reviewing) and that all of the papers submitted to the proceedings underwent an additional round of reviewing with the possibility of rejection from the proceedings. We would like to express our heartfelt thanks to all of the anonymous reviewers for the donation of their expertise and effort for detailed and constructive reviews in what is often a very short turn-around time.

— Miriam Butt, Jamie Y. Findlay and Ida Toivonen, Editors, LFG'24.

Kusaal interrogatives: discourse function and focus distinction

Hasiyatu Abubakari
University of Ghana

Adams Bodomo
University of Vienna, Austria

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Abstract

Crosslinguistically, interrogative structures exhibit inherent discourse interpretations. This study investigates two types of discourse interpretations marked in question forms in Kusaal, a Mabia language spoken in Ghana. It argues that speakers of Kusaal use morphological means to distinguish between questions that seek new information and others that require exhaustive interpretations on the focused constituent. Specifically, wh-questions in Kusaal manifest in two distinct forms: exhaustive wh-questions and non-exhaustive wh-questions each serving specific discourse functions. While exhaustive wh-questions require the use of the particles *ka* and *nɛ* in non-subject focus in both the question and answer pairs, the same is not the case in non-exhaustive wh-questions and their corresponding answer pairs. The study shows that exhaustive wh-questions express completeness and total exclusivity of the selected set. They are of the kind A, not B and nothing else. This finer-grained discourse distinction is accounted for using the i-structure of the Lexical-Functional Grammar framework.

Keywords: focused constructions, contrastive wh-questions, non-contrastive wh-questions, Kusaal, Mabia languages**.**

1 Introduction

Interrogative constructions are universal properties of all-natural languages used for seeking information which may either be new, contrastive or exhaustive (Dayal 2016).[1,2]Thus, interrogative constructions are conventionally linked with the speech act of requesting information that may or may not be familiar to the interrogator (König and Siemund 2007: 291; Caesar 2016: 35). This study looks at a less studied phenomenon in the literature on question and information packaging in Kusaal, a Mabia language spoken in three West African countries: Ghana, Burkina Faso and Togo. In this language, the discourse status of an interrogative construction defines the discourse status of the corresponding answer pair. Although all question types open alternative sets of answers from which the addressee is expected to choose from (Krifka 2008; Mycock 2006), there is a morphological distinction between questions that express exhaustive interpretation and narrow the expected response from the addressee to only one specific answer and nothing else as against questions that are open and can have a response that is A or B or something else. The semantic interpretation of a desired response, thus, influences the way information is packaged in a question in Kusaal. The question in (1a) can attract the response in (1b), where the new information is *suma* 'groundnut'. *Suma*, 'groundnut' can be replaced by other alternatives such as *kawena*, 'maize', *mui* 'rice' or any other item. The question

[1] This paper is crafted from Abubakari (2018a), a PhD dissertation, with some modifications.

[2] I acknowledge comments and contributions from participants of the LFG 2024 conference and the reviewers and editors of this proceedings. Their suggestions have significantly enhanced the quality of this work.

in (2), on the other hand, specifically requires a response that has an exhaustive interpretation and singles out one item and nothing else.

(1) a. Aduk da' bɔɔ?
Aduk buy.PERF[3] what
'What did Aduk buy?'

b. Aduk da' suma
Aduk buy.PERF groundnut
'Aduk bought groundnut.'

(2) a. Aduk da' nɛ bɔɔ?
Aduk buy.PERF FOC what
'What (specifically) did Aduk buy?'
b. Aduk da' nɛ suma
Aduk buy.PERF FOC groundnut
'It is groundnut that Aduk bought (nothing else).'

Thus, to distinguish between question type (1a) and type (2a), we refer to the former as non-exhaustive wh-question and the latter as exhaustive wh-question. Exhaustive wh-questions, here refer to wh-questions that are marked using overt morphological focus markers with a semantic effect of exhaustivity while non-exhaustive wh-questions are interrogative constructions that are unmarked for focus but are inherently focused and used for new discourse information. While non-exhaustive questions can imply alternatives (A but not B), exhaustivity questions refer to one item (A and not B and nothing else). The main objective of this work is to show the discourse distinction between exhaustive and non-exhaustive interrogative forms in Kusaal using the i(nformation)-structure of Lexical-Functional Grammar (LFG). Additionally, the paper explores the asymmetry between exhaustive wh-questions and non-exhaustive wh-questions and their corresponding answer pairs in Kusaal. The main research questions guiding this study include: (i) What are the morphosyntactic strategies for interrogative constructions in Kusaal? (ii) How does Kusaal distinguish between exhaustive wh-questions and non-exhaustive wh-questions? (iii) How can the i-structure representation of LFG capture the distinction between exhaustive wh-questions and non-exhaustive wh-questions?

Although quite some work exists in the literature on the grammar of Kusaal, less can be traced of any comprehensive study that looks at the discourse structure of interrogative sentences in the language and specifically on exhaustive and non-exhaustive wh-questions. More importantly, there is as yet no LFG analysis for the discourse distinctions between exhaustive wh-questions and non-exhaustive wh-questions in the Mabia languages. This study enriches the literature on interrogative structures in questions and expands our knowledge on subtypes of focus exhibited in this grammatical domain. Previous

[3] Abbreviations used in this paper are as follows. CP: Complementizer phrase, NOM: Nominalized, COMP: Complementizer, NP: Noun Phrase, CONJ: Conjunction, PST: Past, COP: Copular, PERF: Perfective, DEF: Definite, PL: Plural, DP: Determiner phrase, Q: question marker, FOC: Focus, REL: Relativizer, FUT: Future, SG: Singular, HAB: Habitual, IPERF: Imperfective, DTYPE: discourse type, DFORM: discourse form, LOC: Locative , IP: Inflectional phrase, NEG: Negative.

studies on interrogative structures in Kusaal mainly focus on the basic characteristics of this grammatical concepts (Abubakari 2018a; Musah 2018:232-235; Eddyshaw 2019; Spratt and Spratt 1972: 83-87). They all agree that interrogative structure in Kusaal end with a low tone different from non-interrogative sentences and they also employ the use of interrogative words. Words in Kusaal come in long and short forms. The long forms end in vowels and the short forms which are argued to be derived from the long counterparts after the deletion of the final vowel. While the long forms are used in questions and negations because they are inherently emphatic, the short forms are used elsewhere (Abubakari 2018a; 2017). Musah (2018:232-235), for instance, discusses the relationship between polar questions and content questions in Kusaal highlighting that the former seeks a yes/no response whilst the latter uses question words. Spratt and Spratt (1972: 83-87), on their part, explain that interrogatives are marked using (i) intonation and (ii) interrogative question words that denote a query. They describe types of interrogatives as including "interrogatives, interrogative existential, interrogative imperative initiating, interrogative imperative non-initiating, interrogative conditional, and interrogative nominal". Some of the data for this study is taken from Abubakari (2018a), who describes the relationship between "focused and non-focused wh-questions". Since all types of questions are inherently focused and open up alternatives, the present discussion changes the nomenclature of "focused and non-focused wh-questions" to exhaustive and non-exhaustive wh-questions. It mainly focuses on the discourse distinction in interrogative constructions which are morphologically coded in the language. Readers are referred to Abubakari (2018a; 2022), which have extensive discussions on the grammar of questions in Kusaal. Abubakari (2018a, 2022) discusses the various types of interrogatives structures and their properties in the language: polar questions, alternative questions, content questions, among others. The work further discusses the constraints governing question formation among others. An extensive study on interrogative structures is a Mabia language is Issah (2013), who looks at the morphosyntactic processes involved in the formation of constituent interrogatives and the parallelism this shares with focus constructions in Dagbani. He observes that in the formation of constituent interrogatives in Dagbani, the interrogative word enters into a syntactic configuration with the focus particles *kà* or *n*. According to him, this syntactic configuration depends on the grammatical role of the argument that the interrogative word substitutes for. He adds that it involves putting the interrogative word clause initially and immediately following it with the appropriate focus marker. Based on the distribution of the interrogative word, Issah asserts that interrogative words and focused elements share morphosyntactic parallelism. Issah (2015) discusses polar questions, alternative questions, content questions among others. The structural features of question formation in Kusaal shows close similarities with the observations in Issah (2013; 2015).

After this introduction, section 2 gives a brief background information on Kusaal and its speakers. Section 3 discusses interrogative structures in Kusaal, while section 4 analyses wh-questions and alternative questions as focus diagnostic tools in Kusaal. Section 5 looks at exhaustive and non-exhaustive wh-questions with their corresponding answer pair in the language. Section 6 examines information structure, interrogative constructions and the LFG Framework. Section 7 analyses LFG representations of exhaustive wh-questions and non-exhaustive wh-questions and section 8 presents a conclusion.

2 The Kusaal language and its speakers

The Kusaal language is spoken by the people called the Kusaas (PL) or Kusaa (SG) (Abubakari 2018a). It belongs to the Central Mabia subgroup of Mabia languages (Bodomo 2020), previously referred to as the Western Oti-Volta subgroup of Gur languages (Westermann & Bryan 1952; Greenberg 1963; Bendor-Samuel 1971) of the Niger-Congo language family. The term Mabia is a compound word which is composed of the two morphemes *ma* 'mother' and *bia* 'child'. According to Bodomo (2020), the endonym Mabia is more representative of the languages under this group since these two morphemes that combine to derive it can be traced in almost all the languages as compared to the term 'Gur', which is derived from the initial syllables of only three/four of the languages in this group: Gurensi, Gurma and Gurenɛ.

Kusaal is spoken in Ghana, Burkina Faso and Togo with 534, 681 speakers in Ghana as at the 2010 population and housing census (GSS 2012, 2016). In Ghana, Kusaal is spoken in the Upper East Region of the country with its main speaking areas including Bawku, Garu, Tempani, Pusiga, Zebilla, and Binduri. There are two dialects of Kusaal: Atoende and Agolle dialects. The data gathered for this work is from the Agolle dialect of Kusaal.)

3 Interrogative structures in Kusaal

Question words (Q-words) in Kusaal do not mark animacy. The only distinction is human/non-human which is also limited to the words: *anɔ'ɔn*, 'who (sg)', *anɔ'ɔnnama* 'who' (pl) used for human beings as against all the other words which are non-human. *Anɔ'ɔn* is also the only subject Q-word. It cannot be used as an object pronoun.

(3) Anɔ'ɔn da da' yir la?
who-SG PST buy house DEF
'Who bought the house?'

Below are contextual illustrations of the use of the Q-words in Kusaal in their canonical in-situ position and in extraposed left periphery positions.

(4) a. Ba sa di bɔɔ?
3PL PST eat what
'What did they eat yesterday?'

b. Bɔ ka ba sa díí?
what FOC 3PL PST eat
'What did they eat yesterday?'

(5) a. O di diib la bɔzʋgɔ
3SG eat.PERF food DEF why
'S/he ate the food for what reason?'

b. Bɔzʋg ka o di diib la?
why FOC 3SG eat food DEF
'Why did he eat the food?'

(6) a. Buug la an ala?
goat DEF COP how.much
'How much is the goat?'

b. #Ala an buug la?
how.much COP goat DEF
'How much is the goat?'

c. Ba di'esid tʊʊmkaŋa ligidi ala?
3PL charge.HAB work.this money how.much
'They charge how much for this work?'

d. Ala ka ba di'esid tʊʊmkaŋa ligidi?
how.much FOC 3PL charge.HAB work.this money
'They charge how much for this work?'

(7) a. Fʊ sɔb gbaʊŋ la wɛla/wala?
2SG write book DEF how
'How did you write the book?'

b. Wɛla/wala ka fʊ sɔb gbaʊŋ la?
how FOC 2SG write book DEF
'How did you write the book?'

(8) a. Ba kul nɔɔrʊm bʊla?
3PL go.home times how
'How many times do they go home?'

b. #Nɔɔrʊm bʊla ka ba kulɛ?
time how FOC 3PL go.home
Intended: 'How many times do they go home?'

The constructions in (6b) and (8b), although understandable, are not natural in casual speech. These examples also show that almost all the Q-words in Kusaal can be used in-situ positions and can also be extraposed to the left periphery followed by the focus particle *ka*. In the environment of the copular *ala* 'how much' must always be used clause finally. This is the reason why (6b) is ungrammatical. As can be gleaned from the examples in (3) to (8), the canonical word order of Kusaal is SVO where the subject or object may be a definite or an indefinite NP. NPs take final determiners. Indirect or embedded questions also employ the clause initial wh-phrases as demonstrated in (9) (Abubakari 2018a: 194).

(9) a. M bɔɔd ye m baŋ ye anɔˈɔn ka
1SG want COMP 1SG know COMP who FOC
biig la sa bu.
child DEF PAST see
'I want to know who the child beat.'

b. Aduk yaˈamisidnɛ bɔɔ daamid pua la.
Aduk doubt.IMPERF what worry.IMPERF woman DEF
'Aduk wonders what is wrong with the woman.

Several syntactic categories: verbs, nouns, adverbs among others can be replaced with wh-words in their respective canonical positions or be extraposed for discourse effect. When a verb is questioned, it is replaced by another verb: *mal*, 'do' and the Q-word, in that context, occurs sentence finally, as in (10d) and (11d):

(10) a. Biig la gbisid dɔɔgin la
child DEF sleep.IMPERF room.LOC DEF
'The child is sleeping in the room.'

b. Anɔ'ɔn gbisid dɔɔgin la?
who sleep.IMPERF room.LOC DEF
'Who is sleeping in the room?'

c. Biig la gbisid yaanɛ?
child DEF sleep.IMPERF where
'The child is sleeping where?'

d. Biig la malnɛ bɔ dɔɔginl a
child DEF do.IMPERF what room.LOC DEF
'What is the child doing in the room?'

(11) a. Dau la da' yir.
man DEF buy.PERF house
'The man bought a house'

b. Anɔ'ɔn da' yir la
who buy.PERF house DEF
'Who bought a house?'

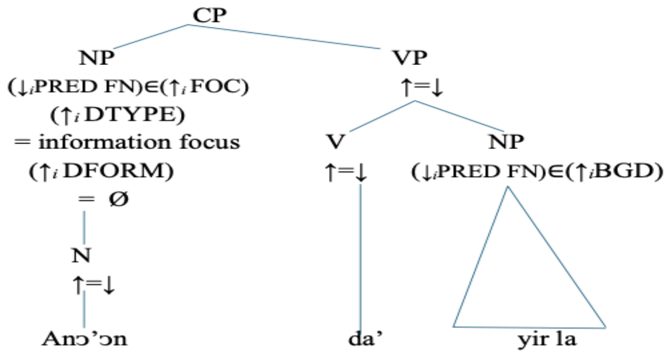
c. Dau la da' bɔ
man DEF buy.PERF what
'The man bought what?'

d. Dau la mal yir la bɔ
man DEF do.PERF house DEF what
'The man did what to the house?'

The c- and f-structure of the interrogative construction in (3), repeated here as (12), is shown below. A question phrase bears the discourse function of focus which has previously been modelled in terms of f-structure (Dalrymple 2001; Mycock 2006, among others) and recently at i-structure (Butt et al. 2016, Abubakari 2018a, b, among others). It occupies the syntactic "focus position", SpecCP, rather than the canonical position associated with its grammatical function (Mycock 2006:202).

(12) a. Anɔ'ɔn da da' yir la?
who-SG PST buy house DEF
'Who bought the house?'

b. c-structure



c. f-structure

PRED	‘da’ <(↑SUB), (↑OBJ)>’	
SUB PRON-INT	PRED	‘Anɔ’ɔn’
	NTYPE	Pronoun
	PRON TYPE	Int, PERS 3, NUM 3, HUMAN +, CASE Neutral
OBJ	PRED	‘yir’
	NUM	sg
	DEF	+
TNS-ASP	MOOD	indicative
	ASPECT	PERF
	TENSE	PAST
CLAUSE TYPE	int	

d. i-structure

FOC	PRED-FN	dau la
	DTYPE	information focus
	DFORM	Ø, in-situ
BGD	[PRED-FN	di]
	[PRED-FN	diib]

Wh-words can be extraposed to the left-periphery, as is also common in several languages (Dayal 2016:3). Anytime a wh-word is moved to the left periphery, it is obligatorily followed by the focused particle *ka*.

(13) a. Dau la da’ bɔ?
man DEF buy.PERF what
‘What did the man buy?’

b. Bɔ ka dau la da’
what FOC man DEF buy.PERF
‘What did the man buy?’

c. Bɔ ka dau la mal (nɛ) yir la?
what FOC man DEF buy.PERF with house DEF
'What did the man buy?'

Anytime a verb with an inanimate object is questioned, the said object NP must often be introduced using the morpheme *nέ*[4], which is glossed as 'with', as demonstrated in (10c) above. Without, *nέ* 'with/to', *yir* 'house' will assume an animate connotation, which will render the utterance infelicitous. The animate object in (14b) does not require *nέ* to precede it.

(14) a. Dau la nwɛ buug la
man DEF beat.PERF goat house
'The man beat the goat.'

b. Bɔ ka dau la mal buug la
what FOC man DEF do goat DEF
'What did the man do to the goat?'

All grammatical categories can be moved to the left for discourse purposes. However, when a verb is moved, it gets nominalized, and a copy is left at the base position as in (15b) (Abubakari 2019).

(15) a. Atibil kua'a pito.
Atibil brew.PERF pito
'Atibil brewed pito (a local drink).'

b. <u>Kua'ab</u> kà Atibil <u>kua'a</u> pito.
brew.NOM FOC Atibil brew.PERF pito
'It is brewing that Atibil did of pito (as opposed to e.g. selling pito).'

It is important to add that wh-phrases that get extraposed to the left periphery are often non-subject constituents as in (13) and (14). Subject wh-phrases in Kusaal remain in-situ and do not attract the use of the subject focus marker *n* in the language. It is infelicitous to focus the wh-phrase in (16d) using the focused particle *n* (further discussion on this is found in § 5).

(16) a. Aduk di diib la
Aduk eat.PERF food DEF
'Aduk ate the food.'

b. Aduk n di diib la
Aduk FOC eat.PERF food DEF
'It is Aduk who ate the food.'

c. Anɔ'ɔ di diib la
who eat.PERF food DEF
'Who ate the food?'

[4] This is a homophone with the in-situ non-subject focus particle nέ. Depending on the context, it can also be interpreted as 'for' of 'at' among other interpretations.

d. *Anɔ'ɔ n di diib la
who FOC eat.PERF food DEF
Lit. 'Who ate the food?' (Who specifically out of the people ate the food)

As one can see in Table (2), below, no focus particle occurs with a question word in subject position. However, a non-subject question word can take the focus particle *nɛ* in-situ and when extraposed it takes the particle *ka*. The option to take these particles come with an extra meaning of contrast and exhaustivity; the absence of which also goes without the particles.

Table (2): Pattern of co-occurrence of question-phrases with subject, non-subject focus particles

Focus particles and subject, non-subject question phrases		
	In-situ focus particle	Ex-situ focus particle
Subject wh-phrase	Null (ungrammatical to us *n*)	Not applicable
Non-subject wh-phrase	*nɛ*	*ka*

The in-situ focus particle precedes the NP or question phrase it focuses. In focusing a VP or an entire IP that expresses surprise, *nɛ* occurs clause finally as in (17a), which could be uttered in a context where, for instance, a respected man surprisingly steals a fowl.

(17) a. Bɔ malɛ?
what happen
'What is it/what has happened?'

b. Dau la zu nɛ
man DEF steal.PERF FOC
'The man has stolen a fowl!

c. Dau la zu nɛ bɔɔ?
man DEF steal.PERF FOC what
'What did the man steal?'

d. Dau la zu *nɛ* *nua*
man DEF steal.PERF FOC fowl
'The man stole a fowl.'

4 Wh-questions and alternative questions as focus diagnostic tools in Kusaal

The notion of focus forms part of the general framework of information structure which differentiates between *common ground management* as against *common ground-content*. Common ground is seen as the knowledge or information that is shared by interlocutors in the communicative context. (Chafe 1976, Krifka 2008, Féry & Krifka 2008 cf Zimmermann and Onea 2011: 3; Stalnaker 1973, 1974, 2002; Abubakari 2024). A focus construction, therefore, has two components: background and focus. While background refers to the common ground knowledge, focus is the new information that is introduced in the communication context. The notion of focus is, therefore, a universal category of information structure which evokes alternatives out of which one is chosen (Rooth 1996, 1992; Zimmermann and Onea 2011; Abubakari 2018a, 2022).

(18) a. Ba di diib la ya?
3PL eat food DEF where
'Where did they eat the food?'

b. Ans: Ba di diib la daˈan la.
3PL eat food DEF market. LOC DEF
'They ate the food in the market.'

The response in (18b) is felicitous as a response to the question in (18a). The *daˈan la* 'the market' is new information which fills in the gap produced by the wh-part of the question. The focus constituent could have been any element in the following set of alternatives {market, hospital, school, home etc.} out of which one response is chosen.

4.1 Wh-question

The use of wh-questions has been argued to serve an incontestable approach for focus diagnostics. Zimmermann and Onea (2011) add that questions produce *bona fide* focused constituents in languages and establish the focus size of constituents (Zimmernann and Onea 2011; van der Wal 2016; Dik 1997, Rooth 1992, Lambrecht 1994, Beaver and Clark 2008, cf. Abubakari 2024 among others). Zimmermann and Onea (2011) further explain that in alternative semantics, the wh-part of the question, X, creates the open slot where several alternatives compete for the answer which will substitute X (i.e. Who ate the food? where who is X). This is captured as follows: "a focus constituent X expresses new-information if α introduces an element of A into the common ground, and if the alternatives to α have not been explicitly introduced in the preceding discourse." (Zimmermann and Onea 2011:1663). Using the minimal pair below, the constituent that introduces the question word *bɔ* 'what' introduces the focus constituent which is the new information in the discourse. The focus particle preceded the focused NP or question phrase which receives the contrastive interpretation.

(19) Q: Aduk dì (nɛ) bɔ?
Aduk eat FOC what
'Aduk ate what?'

a. [mui]F (Fragmented answer)
rice
'rice'

b. Aduk dì [mui]F (Non-exhaustive focus)
Aduk eat rice
'Aduk ate RICE.'

c. Aduk dì nɛ [mui]$_F$ (Exhaustive focus)
Aduk eat FOC rice
'Aduk ate RICE.'

Although the responses in (19a, b, c) have *mui* 'rice' as the new information, and can all be used as responses, (19c) will be the most felicitous response if the focus particle is used in the question in (19) because the question has the focus particle which requires the answer to be exhaustive by excluding all other alternatives. Thus, non-marked wh-questions in Kusaal, though inherently focused, lack semantic contrast and exhaustivity. Non-marked wh-questions are always in-situ in Kusaal.

4.2 Alternative questions

Alternative questions come in the form: Did the children eat rice or beans? (Rooth 1996; van der Wal 2016:9; Zimmermann and Onea 2011:1663; Abubakari 2024).The answer to this produces the type of focus called selective focus (Dik 1997), which is further elaborated in Zimmermann and Onea (2011:1663) as follows: 'A focus constituent X is used selectively if α introduces an element of A into the common ground, and α is chosen from a restricted subset of A the members of which have been explicitly mentioned in the preceding context'. The examples below serve as illustrations.

(20) a. Biig la gbisid nɛ bɛɛ o
child DEF sleep.IMPERF FOC or 3SG
kasid nɛ?
cry.IMPERF FOC
'Is the child sleeping or s/he is crying?'

Ans.: b. Biig la gbisid nɛ.
child DEF sleep.IMPERF FOC
'The child IS SLEEPING/ It is sleeping that the child is doing'.

Alternative questions naturally come with the focused particle *nɛ́,* which may be with each clause or occur at the end of the second clause (20a). The clauses are exhaustively marked and the response which chooses one alternative is equally marked for exhaustivity. The restricted response in alternative questions makes the response selective against a second alternative that was provided.

5 Exhaustive wh-questions and non- exhaustive wh-questions with their corresponding answer pairs in Kusaal

Wh-phrases in Kusaal can be grouped into two: exhaustive wh-phrases and non-exhaustive wh-phrases. The exhaustive status of a wh-phrase is directly linked to the overt morphological focus marking of the constituent in its associating gap. Unlike subject wh-phrases, non-subject wh-phrases can be morphologically marked for focused in-situ or ex-situ. All ex-situ wh-phrases are obligatorily focused and followed by the particle *kà*. As a consequence, answers to such questions must obligatorily be accompanied by the focused particle whilst it is often illogical and infelicitous to respond to non-exhaustive wh-question with the focus particle in a corresponding answer pair. The constructions with the *ka* particle are typical examples of cleft constructions which can be in the form of both it-cleft and wh-cleft. Clefts are associated with emphatic focus interpretations which further gives credence to the *ka* particle as a focus marker. Although studies also reveal that the particle *ka* may be 'weakly' exhaustive compared to *nɛ*, the interpretation of contrast and exhaustivity is present perhaps partly induced by the structural configuration of the dislocation and by the particle *ka* which is obligatory in this instance (Abubakari 2024).

Subject wh-questions, on the other hand, do not impose such restrictions on their answers. This can be linked to the fact that a subject wh-phrase cannot be followed by the focus particle. Answers to such questions can either be overtly marked for focus or not depending on the discourse context. The fronting of the wh-phrase to the left periphery is not entirely employed as a question strategy but rather as an information structure strategy (Aboh 2007). From the utterance in (21a) below, the following exhaustive questions can be derived where (21b) has a fronted Q-word followed by the focused particle *ka*, while (21c) has the Q-word in-situ preceded by the focus particle *nɛ.* The answers in (21d, e) are respective responses to (21b, c). They, (21d, e) also use the focus particles, after the fronted focused constituent in (21d) and before the focused constituent in (21e).

(21) a.

Ayipɔk	sa	dug	diib	tisi
Ayipɔk	PST	cook.PERF	food	give.PERF
biig	la.			
children	DEF			

'Ayipɔk prepared food and gave it to the children.'

b.

Bɔ	ka	Ayipɔk	sa	dug	tisi
what	FOC	Ayipɔk	PST	cook.PERF	give.PERF
biig	la?				
children	DEF				

'What did Ayipɔk cook and give to the children?'

c.

Ayipɔk	sa	dug	nɛ	bɔ	tisi
Ayipɔk	PST	cook.PERF	FOC	what	give.PERF
biig	la?				
children	DEF				

'What did Ayipɔk cook and give to the children?'

d. Ans.

Diib	ka	Ayipɔk	dug	tisi
food	FOC	Ayipɔk	cook.PERF	give.PERF
biig	la.			
children	DEF			

'It is food that Ayipɔk cooked and gave to the children.'

e.

Ayipɔk	sa	dug	nɛ	diib	tisi
Ayipɔk	PST	cook.PERF	FOC	food	give.PERF
biig	la.				
children	DEF				

'It is food that Ayipɔk cooked and gave to the children.'

The question in (22a) if non- exhaustive and the corresponding response in (22b) is also non- exhaustive. Although it is grammatically not wrong to use the exhaustive responses in (22c-d) to answer the question in (22a), it is semantically weird to do so.

(22) a. Ayipɔk sa dug bɔ tisi
Ayipɔk PST cook.PERF what give.PERF
biig la?
children DEF
'What did Ayipɔk cook and give to the children?'

b. Ayipɔk sa dug mui tisi
Ayipɔk PST cook.PERF rice give.PERF
biig la
children DEF
'Ayipɔk cooked rice and gave it to the children.'

c. Mui ka Ayipɔk sa dug diib
rice FOC Ayipɔk PST cook.PERF food
tisi?
give.PERF
'It is rice that Ayipɔk cook and gave to the child?'

d. Ayipɔk sa dug nɛ mui tisi
Ayipɔk PST cook.PERF FOC rice give.PERF
biig la
child DEF
'It is rice that Ayipɔk cook and gave to the child?'

The examples in (23) are further illustrations that employ a different Q-word. The questions in (23a-b) use the ex-situ focus particle *ka* and the in-situ non-subject focus particle, *nɛ*, respectively. The responses in (23c-d) follow the same structure.

(23) a. Bɔbʊŋ ka bʊʊg la ɔnb wʊsa?
what FOC goat DEF chew all
'What did the goat chew all of?'

b. Bʊʊg la sa ɔnb nɛ bɔbʊŋ wʊsa?
goat DEF PST chew FOC what all
'What did the goat chew all of?'

c. Ans. Vaad la ka bʊʊg la sa
leaves DEF FOC goat DEF PST
ɔnb wʊsa.
chew.PERF all
'It is the leaves that the goat chewed all of.'

d. Bʊʊg la sa ɔnb nɛ vaad
goat DEF PST chew.PERF FOC leaves
la wʊsa
DEF all
'It is the leaves that the goat chewed all of.'

The examples in (24a-b), however, are non-exhaustive in both the question-and-answer pair.

(24) a. Bʊʊg la sa ɔnb bɔbʊŋ
goat DEF PST chew.PERF what
wʊsa?
all
'What did the goat chew all of?'
b. Ans. Bʊʊg la sa ɔnb vaad la wʊsa.
goat DEF PST chew.PERF leaves DEF all
'The goat chewed all of the leaves.'

Subject wh-phrases in the questions in (25a) and (26a) do not occur with the in-situ subject focus particle *n* but answers to such questions may either express new information or exhaustive focus without or with a focus particle respectively as in (25d, e) and (26c, d). Abubakari and Issah (2020:602) and other scholars (Hiraiwa 2010, Erlewine 2012) assume the ban can also be a case of syntactic haplology, a phonological phenomenon which bans spell-out of sequential homophonous items, thus, the segment final /n/ in *anɔ'ɔn* 'who' bans the occurrence of the focus particle *n* from occurring immediately after it or anywhere else in the utterance.

(25) a. Anɔ'ɔn sa dug diib tisi
who PST cook.PERF food give.PERF
biig la?
children DEF
'Who cooked food and gave to the children?'

b. *Anɔ'ɔn n sa dug diib tisi
who FOC PST cook.PERF food give.PERF
biig la?
children DEF
Lit.: 'Who cooked food and gave to the children?'

c. *Anɔ'ɔn sa n dug diib tisi
who PST FOC cook.PERF food give.PERF
biig la?
children DEF
'Who cooked food and gave to the children?'

d. Ayipɔk sa dug diib tisi
Ayipɔk PST cook.PERF food give.PERF
biig la
children DEF
'Ayipɔk prepared food and gave it to the children.'

e. Ayipɔk ǹ sa dug diib tisi
Ayipɔk FOC PRT cook.PERF food give.PERF
biig la
children DEF
'It is Ayipɔk who prepared the food and gave it to the children.'

(26) a. Bɔbʊŋ sa ɔnb vaar la wʊsa?
what PST chew.PERF leaves DEF all
'What chewed all the leaves?'

b. *Bɔbʊŋ n sa ɔnb vaar la wʊsa?
what FOC PST chew.PERF leaves DEF all
Lit.: 'What chewed all the leaves?'

c. Bʊʊg la sa ɔnb vaad la wʊsa.
goat DEF PST chew.PERF leaves DEF all
'The goat chewed all the leaves.'

d. Bʊʊg la n sa ɔnb vaad la wʊsa.
goat DEF FOC PST chew.PERF. leaves DEF all
'It is the goat that chewed all the leaves.'

It is important to indicate that the subject focus particle must occur immediately after the focused subject constituent as in (25e) and (26d). No other constituent can occur between the two. Thus, one will ordinarily expect a Q-word which functions as a subject to equally have the subject focus particle occurring after it. However, this is ungrammatical as demonstrated in (25b) and (26b). It is also worthy of note that no word can occur between a Q-word as a subject and be followed by the focus particle as in (25c).

With reference to non-subject arguments in the examples above, a dichotomy can be established between exhaustive wh-questions and non-exhaustive wh-question. Exhaustive questions require the use of the focused particles in their respective answers whilst non- exhaustive wh-question requires their respective answers to be morphologically null with a corresponding non-exhaustive semantic implication. Subject wh-questions are open to answers expressing information focus or exhaustive focus. The fact that an exhaustive wh-question requires the target constituent in its corresponding answer pair to be equally exhaustive while a non- exhaustive wh-question requires its target constituent in the answer to be non- exhaustive indicates that the discourse status of a wh-question determines the discourse status of its target constituent in its corresponding answer pair. Similar observations are made in languages like Lele (Frajzyngier 2001:284/86, Amharic (Drubig & Schaffar 2001 among others) Gungbe (Aboh 2007:305) (all cf Aboh 2007:302-306).

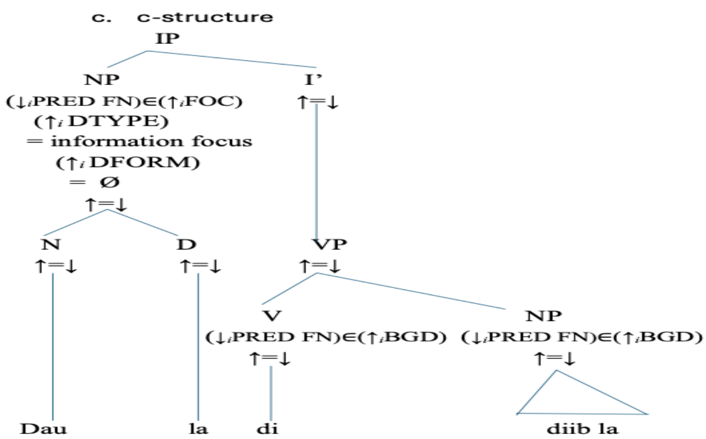
6 Information structure, interrogative constructions and the LFG Framework

Several studies have been conducted on the architectural representation of discourse information in the i-structure of LFG (King 1997; Mycock 2006; Mycock and Lowe 2013; Dalrymple and Nikolaeva 2011; Butt et al. 2016; Butt 2014; Butt and King 1996; Marfo and Bodomo 2004, among others). Additionally, studies on wh-phrases within the LFG framework have received significant attention with recent contributions including Butt and Biezma (2022), Butt et al. (2017), Butt et al (2016), and Mycock (2006). The current study adopts its architectural representations of the c-structure, the f-structure and the i-structure of interrogative constructions in Kusaal mainly from these previous studies (Mycock 2006; Butt et al. 2016 and Abubakari 2018a,b). With data from selected Mabia and Kwa languages, Abubakari (2018b) recognises previous attempts at capturing finer grained components of information structure such as background, given, focus and topic within the i-structure projection (Butt 2014; Butt et al. 2016). However, there remained some mismatches leading to ambiguity in the representation of discourse information in the i-structure when data from languages that have discourse particles for distinguishing subtypes of focus constructions: information focus/new information, contrastive focus, exhaustive focus, selective focus among others. To resolve this problem, Abubakari (2018a, b: 23) introduces an additional feature, DTYPE, with a value that specifies subtypes of focus and topic notions in the i-structure. DTYPE can have a value, for example, {exhaustive focus} or {information focus}. An additional feature called DFORM also shows values that may either be morphologically or phonologically realised on individual language basis. For example, the feature values [±New] and [±Prom] are suggested for some European languages whilst the morphological features: *n*, *nɛ* and *ka* are used for Kusaal. Due to space constraint, readers are encouraged to look at Abubakari (2018b) for a crosslinguistic detailed description of this proposal. It is used in differentiating the discourse interpretations of the utterances generated in the context below.

Context A: Apuasan wants to know the person who ate the food she left for her children. In response, Aduk gave the sentence in (27b) and Azumah corrects the wrong response that the man ate the food to categorically identify the 'the children as those who ate the food and not the man or any other person as in (28a). These two responses, (27b) and (28a) are captured in the c-structure and i-structure respectively for each sentence.

(27) a. Apuasan: Anɔˈɔn di diib la?
who eat food DEF
'Who ate the food?'

b. Aduk: Dau la di diib la.
man DEF eat food DEF
'The MAN ate the food.'



d. i-structure

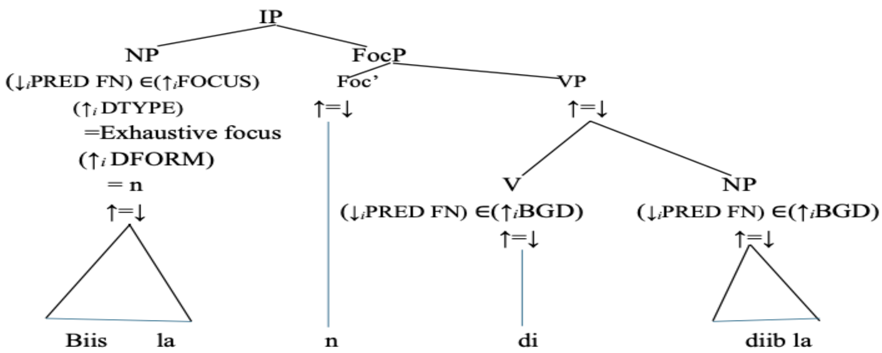
FOC { [PRED-FN dau
DTYPE information focus
DFORM Ø, in-situ] }

BGD { [PRED-FN di]
[PRED-FN diib] }

In the response in (27b), *dau la* 'the man', which is also captured in the c-structure in (27c) is new information focus. It is mapped to the i-structure via correspondence function *i*. The *i* subscript on the annotation shows that the information in the c-structure is projected to the i-structure. In the i-structure, (27d), as is also the case in subsequent i-structures, the values of focus and background are sets represented in the curly brackets which can have multiple instances (Butt et al. 2016). Each of these sets contains their respective PRED-FN (Predicate function) which identifies the roles of the elements as either focus or background. The DTYPE (discourse type: information focus, exhaustive focus) and the discourse form (*Ø, n, nɛ, ka*) are also provided via c-structure annotations.

(28) a. Azumah: Ayei, biis la n di diib la.
no children DEF FOC eat food DEF
'It is the children that ate the food.'

b. C-structure



c. I-structure

FOC { [PRED-FN biis
DTYPE exhaustive focus
DFORM n, +subject, + in-situ] }

BGD { [PRED-FN di
PRED-FN diib la] }

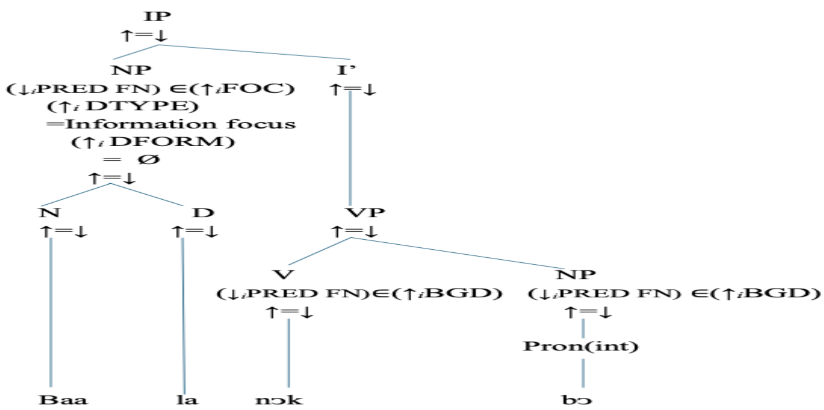
With this background, this study leverages on the proposal in Abubakari (2018a, b; Butt at al. (2016)) among others to argue for a clear distinction between exhaustive and non-exhaustive wh-questions in Kusaal. It intends to establish that the discourse information in these two types of constructions is different.

7 LFG representation of exhaustive wh-questions and non-exhaustive wh-questions

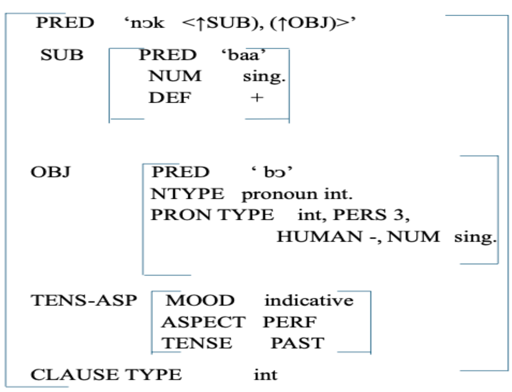
Having discussed the various realisations of wh-questions in discourse information packaging in Kusaal, this section shows the distinction between these two forms in the c-structure and i-structure architectures of LFG. It intends to illustrate that the c-structures of these two constructions are different and the same information when transferred into their i-structures are equally distinct. Example (29a) is marked for information focus, while (29b, c) are marked for exhaustive focus.

(29) a. Baa la nɔk bɔ?
dog DEF take what?
'The dog took what?'

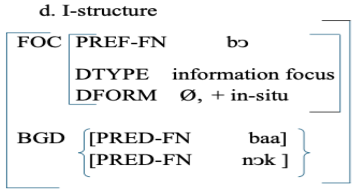
b. C-structure



c. F-structure

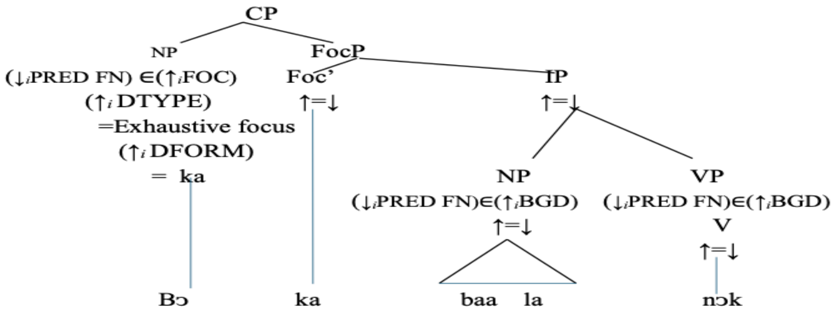


d. I-structure

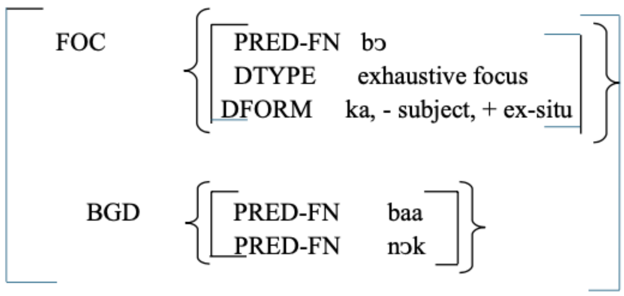


(30) a. Bɔ ka baa la nɔk?
what FOC dog DEF take
'WHAT did the dog take?' (X and nothing else)

b. c-structure

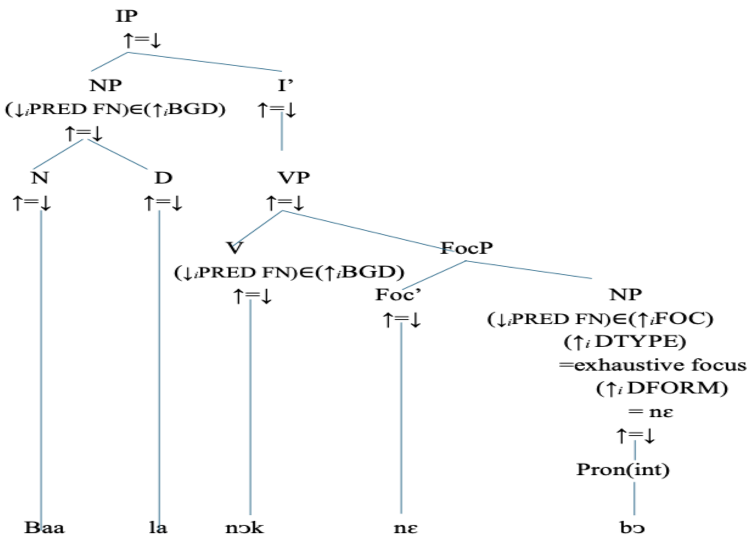


c. i-structure



(31) a. Baa la nɔk nɛ bɔ?
goat DEF take FOC what
'What did the dog take?' (X and nothing else)

b. c-structure



c. i-structure

FOC	PRED-FN	bɔ
	DTYPE	exhaustive focus
	DFORM	nɛ, -subject, + in-situ
BGD	{[PRED-FN	baa]
	[PRED-FN	nɔk]}

While the f-structures of all three sentences in (29a), (30a) and (31a), are the same and represented in (29c), their c-structures syntactically differ due to the presence or otherwise of the discourse particles. The discourse information in the c-structures in (29b) (30b) and (31b) correspond with the information in the i-structures in (29d), (30c) and (31c) via the correspondence function, *i*, respectively.

8 Conclusion

This study has examined the intricate relationship between interrogative constructions and discourse marking in Kusaal. It has elaborated on the complex system of morphosyntactic and semantic difference in encoding different types of focus in interrogative structures in the language.

The findings delineate two types of interrogative constructions in Kusaal: exhaustive wh-questions and non-exhaustive wh-questions. This dichotomy is observed morphologically. While the particles *ka* and *nɛ* are used in exhaustive wh-questions, they are absent in their non-exhaustive counterparts. Additionally, the study has discussed the asymmetry between subject and non-subject wh-questions revealing that while non-subjects maintain distinctions in both questions and their corresponding answer pairs, subject wh-questions do not.

LFG is used to demonstrate the formal representation of exhaustive wh-questions and non-exhaustive wh-questions in the c-structure, f-structure and i-structures. The introduction of DTYPE and DFORM values in the i-structure enhances the inclusion of finer grained details of the focus constituent.

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Unagreement and how morphology sees syntax

Alex Alsina

Pompeu Fabra University

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Abstract

The phenomenon of unagreement, found in Spanish, Catalan, and Greek, among other languages, poses four theoretical problems: 1) how to account for an apparent mismatch between trigger and target in an agreement relation; 2) how to account for the fact that not all languages have this phenomenon; 3) how to account for variation in the NPs that trigger unagreement within a given language and across languages; 4) how to account for the correlation between the presence or absence of unagreement and the type of *adnominal pronoun construction* (APC) allowed in the language. The analysis assumes a lexicalist unencapsulated view of the relationship between syntax and inflectional morphology, which implies that agreement is a strictly morphological phenomenon. The fundamental idea is that some determiners in some languages do not specify person information. This implies that a phrase headed by such a determiner is compatible with any person feature.

1 Introduction

The phenomenon of unagreement, found in Spanish, Catalan, Greek, among other languages, is illustrated by the Catalan examples in (1).[†] The same NP, in this case, *els artistes* 'the artists', can be the subject of a verb form showing agreement with a third person plural, as in (1a), a first person plural, as in (1b), or a second person plural, as in (1c), with the differences in meaning shown by the translations.[1] Examples in this paper are in Catalan unless otherwise noted.

(1)	a.	*Els*	*artistes*	*treballen*	*molt.*
		the.M.PL	artist.PL	work.3PL	much
		'Artists work a lot.'			
	b.	*Els*	*artistes*	*treballem*	*molt.*
		the.M.PL	artist.PL	work.1PL	much
		'We artists work a lot.'			
	c.	*Els*	*artistes*	*treballeu*	*molt.*
		the.M.PL	artist.PL	work.2PL	much
		'You artists work a lot.'			

The name *unagreement*, given by Hurtado (1985), suggests the idea that there is an agreement mismatch between the agreement trigger, an apparently third person NP, and the target, the verb, which can show first, second, or third person plural agreement.[2]

In section 2, we discuss three different views on agreement: the asymmetric syntactic view, the symmetric syntactic view, and the strictly morphological view. Section 3 outlines the four problems posed by unagreement: a) the fact that an apparently 3rd

[†]I gratefully acknowledge the comments made by two anonymous reviewers and the audience at the 29th International LFG Conference at the University of Ghana.

[1] In this paper, the term *NP* is used as a descriptive or theory-neutral term, equivalent to *nominal phrase*, whereas *DP* is the theoretical term used in theories that assume the hypothesis that the determiner is the head of its nominal phrase (Abney 1987).

[2] As suggested in section 3, it is plausible to analyze the NP *els artistes* in (1) not as the actual subject, but as a topic anaphorically controlling the null subject, with which it agrees in person and number. This still means that there is an apparent person/number mismatch between the null subject and the verb.

person NP can trigger 1st or 2nd person agreement; b) the fact that some languages have this phenomenon and some do not; c) the fact that, in languages with unagreement, some NPs allow it and some do not; and d) the fact that the presence or absence of unagreement in a language correlates with the type of adnominal pronoun construction (APC) found in the language. Section 4 presents an existing account within Distributed Morphology (DM) of the APC-unagreement correlation and shows some problems with it. Section 5 proposes an account of unagreement and the four problems noted earlier within a WYSIWYG LFG, i.e, without resorting to null categories. Section 6 concludes, with implications for agreement and the syntax-morphology interface.

2 Three views on agreement

Agreement is generally taken to be a syntactic phenomenon, one in which two different syntactic constituents, such as words, are in a dependency relation, as they both reflect, or carry, information about a single syntactic element. This syntactic dependency is sometimes viewed as an asymmetrical relation, in which one of the two syntactic constituents involved is the trigger and the other one is the target, in that the latter copies features of the former. (The term *controller*, or *controller of agreement*, is also very widespread along with *trigger*.) This is the view most commonly held in transformational frameworks, such as the Minimalist Program (MP). Agreement can also be seen as a symmetrical relation, in which the two syntactic constituents involved specify information about a given syntactic element. Neither constituent determines the form of the other directly, but they have to be mutually consistent as they jointly specify the features of the same element. This is the view that is prevalent in constraint-based approaches to syntax, such as Head-driven Phrase-Structure Grammar (HPSG) and LFG. (See Haug 2023 for discussion of the symmetrical and asymmetrical approaches to agreement.) But it is also possible to view agreement as a strictly morphological phenomenon: each of the two (or more) constituents involved in the agreement relation has the form that results from applying the set of rules of the inflectional morphology to it. A single feature structure (e.g., that of the subject of a clause) may have morphological effects on more than one syntactic constituent (e.g., the determiner of the NP that maps onto the subject and the verb of the clause), as a result of the morphological rules that apply to these constituents. In what follows I illustrate the three views in some more detail.

2.1 The asymmetrical syntactic approach

In an agreement relation, the features that are shared by two constituents involved in the relation are "meaningful" (to use Haug's 2023: 183 term) on only one of the constituents. This constituent is known as the trigger, whereas the other constituent involved is the target. In subject-verb agreement, where the features of person and number are shared between the subject NP and the verb, these features are only meaningful on the subject NP, which is therefore the trigger. The verb, which is the target in subject-verb agreement, can be said to copy the features of the trigger. A theory that adopts the view that there is a trigger and a target in an agreement relation can be said to treat agreement as an asymmetrical relation.

One of the defining features of transformational frameworks such as MP is the idea that grammatical functions (GFs) such as subject and object are represented as positions in the phrase structure. For example, in some versions of MP, the subject is the DP in Spec of TP. This implies that the features of the subject are the features of this DP. Thus, the asymmetric view of agreement is practically a consequence of this assumption about GFs. These features may be copied by some other constituent (such as T), which gives rise to a situation in which two different constituents (e.g., Spec of TP and T) have the same features, namely, agreement. In the illustration given in Sells (2023: 1950−1952), T assigns nominative Case to a DP that requires Case and copies the person and number features of this DP. After the verb attaches to T and merges with it and the morphological spell-out rules have taken place, we have a structure in which the verb agrees with a DP.

An analysis of unagreement within this approach implies that the agreement trigger, the subject NP in examples like (1), has three different representations depending on the person feature: one in which it is third person, one in which it is second person, and one in which it is first person. Since the verb is morphologically different in the three examples and since the verb is assumed to copy the features of the trigger, we have to assume that the trigger—the subject NP—is different in each example, despite the fact that it is phonologically identical in the three cases. In this respect, the asymmetrical syntactic approach leads to an unintuitive analysis of unagreement.

2.2 The symmetrical syntactic approach

The theoretical frameworks that separate the representation of GFs from the representation of overt constituents give rise to a symmetrical approach to agreement. This is the case of HPSG and LFG, among others: in them, each constituent involved in an agreement relation lexically specifies information about the same GF. As long as the information coming from the different constituents unifies, it is not necessary for all the relevant features to be present in the "trigger" constituent.

The French example (2), from Sells (2023: 1925−1926), is used to argue for the lack of directionality in the agreement relation.

(2) *Je suis heureuse*. (Fr)
I am happy.F.SG
'I am happy.' (spoken by a female)

It is clear that the subject in this sentence has grammatical gender feminine, but this information is not conveyed by the pronoun *je*, the only constituent that can be said to be a trigger, as it is unmarked for gender. It is likewise not conveyed by the verb *suis*, which specifies that its subject is first person singular, but is indifferent as to its gender. It is necessary to assume that the GF subject in (2) has the gender feature feminine because of the feminine form of the predicate adjective *heureuse*, which nevertheless is the target of the agreement relation. It would be very unmotivated to assume that *je* is lexically ambiguous having an entry with masculine gender and an entry with feminine gender, just in order to preserve an asymmetrical treatment of agreement.

The symmetrical approach to agreement lends itself to an intuitive analysis of unagreement. The NP in examples like (1) contributes information of the subject, because of its position, but carries no information about person, whereas the verb form specifies that its subject is third person, in (1a), first person, in (1b), or second person, in (1c). The information about the subject unifies because there is no inconsistency, but it is the "target", the verb, that specifies the person feature of the subject.

2.3 The morphological approach

The third approach to be considered here is one that assumes a non-encapsulated lexicon. The standard position in LFG is that the lexicon, which is the component in which word formation, or morphology, takes place, is encapsulated with respect to the syntax. In this view, words are inserted in the syntax fully formed and cannot use information from the syntactic context in which they appear for their morphological derivation. Alsina (2020, 2022, 2023b) argues against this view and in favor of a non-encapsulated view of the relation between morphology and syntax, namely, the position that word formation, particularly inflectional morphology, uses syntactic information in its rules. Morphological rules perform affixation operations (among other operations) on a word on the basis of the f-structure information that maps onto the c-structure position in which that word appears. For example, the inflectional endings that distinguish the three verb forms in (1) are the result of such rules. The *-m* in *treballem* in (1b) is found in verb forms whose subject is first person plural; the *-u* in *treballeu* in (1c) in verb forms whose subject is second person plural; and the *-n* in *treballen* in (1a) in verb forms whose subject is third person plural. The corresponding morphological rules are a block of rules (in the sense of Stump (2001), among others) that say: (a) if a verb form maps onto an f-structure whose subject has the features of first person and plural number, it has the suffix /m/; (b) if a verb form maps onto an f-structure whose subject has the features of second person and plural number, it has the suffix /w/; (c) if a verb form maps onto an f-structure whose subject has the feature of plural number, it has the suffix /n/. Given the Paninian principle by which a more general rule only applies if a more specific rule fails to apply, rule (c) only applies in those cases in which neither rule (a) or (b) can apply.[3]

The approach assumed here is that agreement is a strictly morphological phenomenon. The morphosyntactic features of the language (those that are reflected in the morphology) are present in the f-structure and referred to by the rules of the morphology licensing the appropriate word forms in the c-structure. In the case of subject-verb agreement, the f-structure features of the subject are reflected on the verb through the morphological rules that apply to verbs and, if there is an NP that maps onto the subject, the features of the subject are reflected on the word forms that make up the NP, such as

[3] If we assume that a morphological rule is a rule that affects or constrains the form of a word and that it can use any kind of linguistic information in its definition, such as syntactic, semantic, phonological, and other, then it is clear that the rules just mentioned are morphological rules. They are essentially identical to the morphological rules of encapsulated versions of LFG such as Dalrymple et al. (2019), only, in the latter versions, syntactic information is copied into the lexicon in the guise of m-features. By allowing morphological rules to make direct reference to syntactic information (both c- and f-structure information), as opposed to reference mediated by m-features, we achieve a simpler theory, as argued in Alsina (2020; 2022). There is no need to rename these rules morphosyntactic, as suggested by an anonymous reviewer. The present approach explicitly claims that inflectional morphology is dependent on syntactic information and that this should not be obscured by recasting this information as morphological. The ungrammaticality of sentences such as **We works a lot* is accounted for as instances of misapplication of morphological rules: a rule that should apply fails to apply or, conversely, a rule applies that should not apply.

the determiner, the noun, the adjective, etc. The morphological approach to agreement is much simpler than either of the two syntactic approaches outlined earlier because, whereas they all have to assume that there are morphological principles responsible for accounting for the different word forms, the morphological approach does not need to assume any syntactic principle to account for the use of the appropriate word forms in each syntactic environment. This is a further argument in favor of the non-encapsulated view of the relation between morphology and syntax.

3 The four problems of unagreement

The phenomenon investigated here affects both grammatical and anaphoric agreement (to use Bresnan and Mchombo's 1987 terms). Clear cases of anaphoric agreement are those in which a pronominal clitic agrees with a discourse topic, such as (3):

(3) a. *Als* *artistes*$_i$ *ens*$_i$ *agrada* *la* *feina*.
A.the.M.PL artist.PL 1.PL like.3SG the.F.SG work.F.SG
'We artists like work.'

b. *Als* *artistes*$_i$ *us*$_i$ *critiquen,* *però* *també* *us*$_i$ *ajuden*.
A.the.M.PL artist.PL 2PL criticize.3PL but also 2PL help.3PL
'You artists, they criticize you, but they also help you.'

Apparent subject-verb agreement in which the subject NP is preverbal, such as (1), might be taken to be an instance of grammatical agreement. However, there is considerable evidence that, in languages such as Catalan, the in situ position of the subject NP is postverbal and that the preverbal position is a topic position (Rosselló 1986, Bonet 1990, Solà 1992, Vallduví 1992, 2002, among others for Catalan, and Alexiadou and Anagnostopoulou 1998, and Barbosa 2001 for other languages). Under this interpretation, examples such as (1) would be instances of anaphoric agreement, in which a grammaticized topic anaphorically agrees with a pronominal subject that has no overt exponent except for the verb. Nevertheless, the unagreement construction can also involve postverbal subject NPs, which would be a clear case of grammatical agreement, as in (4):

(4) a. *En aquesta casa només treballem els artistes*.
in this F.SG house.SG only work.1PL the.M.PL artist.PL
'In this house only we artists work.'

b. *No canviarà res si no protesteu els estudiants*.
not change.FUT.3SG nothing if not protest.2PL the.M.PL student.PL
'Nothing will change unless you students protest.'

In the following paragraphs we discuss the four analytical problems posed by the phenomenon of unagreement.

3.1 A third person NP triggering first or second person agreement

The motivation for calling the phenomenon under investigation in this paper unagreement is that the NP that can trigger either first, second, or third person agreement in examples like (1) appears to be a third person expression. The components of the NP show no variation in form that can be attributed to the person feature. The relevant NP is *els artistes* in (1) whether the verb shows 3rd person, 2nd person, or 1st person agreement. In addition, if an NP that triggers unagreement is changed to the corresponding singular form, only 3rd person agreement is possible, as shown in (5) (compare (5a) with (1) and (5b) (3a)):

(5) a. *L' artista treballa /*treballo /*treballes molt.*
the.SG artist.SG work.3SG / work.1SG / work.2SG much
'The artist works a lot.'

b. *A l' artista$_i$ li$_i$ /*m'$_i$ /*t'$_i$ agrada la feina.*
A the.SG artist.SG 3SG / 1SG / 2SG like.3SG the.F.SG work.F.SG
'The artist likes work.'

Thus, the first question to address is: how come certain apparently 3rd person NPs can trigger 1st or 2nd person agreement, as well as 3rd person?[4]

3.2 Cross-linguistic variation: not all languages have unagreement

As noted in Höhn (2016) among others, some languages have unagreement, such as Spanish, Catalan, Galician, Greek, Bulgarian, to name a few, whereas others lack this phenomenon, including Italian, Portuguese, and Bosnian-Croatian-Montenegrin-Serbian. Italian, which belongs to the Romance family, like Spanish and Catalan, offers a clear contrast with the latter, as we see in (6):

(6) *Gli studenti lavorano /*lavoriamo /*lavorate molto.* (It)
the.M.PL student.PL work.3PL / work.1PL / work.2PL much
'(*We/*You) students work a lot.'

Whereas in (1) the plural definite NP allows agreement in 1st, 2nd, and 3rd person, the Italian counterpart only allows agreement in 3rd person. Thus, the second question we need to address is how to account for the existence of unagreement in some languages and its absence in other languages.

3.3 Variation in what NPs allow unagreement

Within a single language that exhibits some instances of unagreement, not all NPs can take part in this phenomenon. And the class of NPs that allow unagreement varies across languages. Whereas NPs introduced by the plural definite article allow unagreement in Catalan, as shown in (1), (3), and (4), as well as in Spanish, the corresponding singular form fails to allow first or second person agreement, while allowing third person agreement, as illustrated in (5). Other NPs that trigger unagreement in Catalan include those introduced by plural indefinite determiners and quantifiers such as *alguns/algunes* 'some', *uns quants/unes quantes* 'several', *quants/quants* 'how many', and cardinal numerals like *dos* 'two', *tres* 'three', etc. NPs that only allow third person agreement are those that are introduced by the singular counterparts of these determiners and quantifiers, by demonstratives (such as *aquests* 'these'), personal pronouns (such as *ells* 'they/them'), the indefinite pronoun *algú* 'some one', among others.

[4] An interesting question, which has to be left for further research, is why unagreement only occurs with plural verb forms in some languages, such as Catalan and Spanish. Greek, however, does seem to allow singular unagreement, as illustrated in (7).

The variation across languages can be illustrated comparing Greek with Catalan and Spanish. Greek reportedly allows unagreement with NPs introduced by the plural definite article (Höhn 2016: 546), just like Spanish and Catalan, but also allows it with NPs introduced by the singular definite article, in contrast with these other languages. In contrast with Catalan examples such as (5), where the singular definite article does not allow first or second person agreement, example (7) shows that Greek allows this type of agreement:

(7) *Ti travao i gynaika.* (Gr)
what suffer.1SG DET.NOM.SG woman
'What do I woman go through.' (Höhn 2016: 586)

The third problem is accounting for the variation in the NPs that allow or do not allow unagreement within a language and across languages.

3.4 Correlation with the type of adnominal pronoun construction

Höhn (2016) proposes that there is a correlation between the presence or absence of unagreement in a language and the type of *adnominal pronoun construction* (APC) allowed in the language. An APC is a nominal expression introduced by a personal pronoun such as *we* or *you* followed by an NP that modifies the pronoun. Cross-linguistically there are two types of APCs, referred to as *Type I* and *Type II*:

- Type I APC: the pronoun cannot be followed by the definite article; this type is found in Italian and Portuguese, among other languages, and illustrated in (8) for Italian;
- Type II APC: the pronoun must be followed by the definite article; this type is found in Catalan and Spanish, among other languages, and illustrated in (9) for Catalan.

(8) Type I APC: *noi (*gli) studenti* (It)
we ART.M.PL student.PL 'us students'

(9) Type II APC: *nosaltres *(els) estudiants* (Ca)
we ART.M.PL student.PL 'us students'

We can observe that the languages with Type I APC are those that lack unagreement, and that those with Type II APC are the ones that have unagreement. Höhn (2016: 560) claims that this correlation is not an accidental fact but that the two properties are causally connected and makes the following empirical claim:

(10) Null subject languages with definite articles
a. show unagreement if they have a definite article in APCs, and
b. do not show unagreement if they have no definite article in APCs.

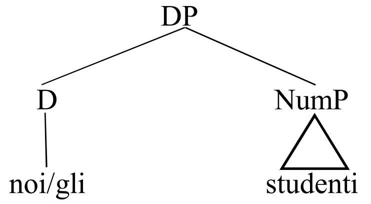
4 Höhn's (2016) account and a problem

Höhn (2016) proposes to account for the facts noted in the previous section by assuming that the presence or absence of unagreement in a language in essence depends on whether that language has one type of APC or the other. We will first outline his proposal and then present an empirical problem for it.

4.1 Höhn's (2016) theory

Languages split up according to the type of APC they have. In Type I definiteness and person are encoded on the same head (D), whereas in Type II person is encoded on a separate functional head higher than D. In Type I, elements of category D, which includes both pronouns and articles, appear in the one D position of the structure:[5]

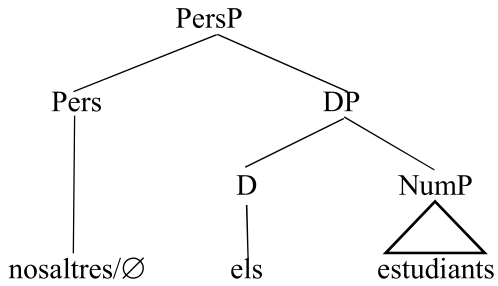
(11) Type I structure (for example, Italian):



The pronoun *noi* 'us' and the definite article *gli* 'the' are both D and compete for the single D position in the structure. Only one of the two can be used depending on the person feature of D. If D is 1st person plural, *noi* is used; if D is 3rd person plural definite, *gli* is used. When the DP is in subject position, verb agreement reflects the person feature of the subject DP.

In Type II languages, nominal expressions are not DPs, but PersP, a phrasal category headed by Pers, which hosts the person feature and takes a DP as its complement:

(12) Type II structure (for example, Catalan):



Pers is realized as a pronoun, which can be overt (e.g., *nosaltres*) or null (∅). The overt and the null versions are both pronouns and carry the same person features. It is overt if it has the feature [+dem(onstrative)] and is covert if it has the feature [−dem]. The possibility of unagreement crucially depends on the NP being a PersP headed by a null pronoun followed by an overt DP, as in Type II APC, which cannot arise in Type I APC. This captures the claim that, if the language has Type II APC, the pronoun precedes the article in an APC and it also has unagreement and, if the language has Type I APC, there is no article in an APC and it lacks unagreement. In a Type I language, a definite D is always overt, either as a pronoun or as an article.[6] The Italian spell-out rules assign

[5] The NumP in both types consists of a Num head and an NP; the Num head hosts number features and the NP may contain the noun (Höhn 2016: 563–564, 568).

[6] It is unclear why languages with type I APC cannot have a null definite pronoun heading the DP. In other words, why couldn't the phrase *studenti* have the structure [$_{DP}$ [$_{D}$ ∅] studenti]], in which the null determiner is the null counterpart of an overt pronoun? Why is it that type II languages can have both overt and null pronouns, whereas type I languages only have overt pronouns when the NumP contains phonologically overt material? Interestingly, when NumP is phonologically null, the pronoun in D position can be null, accounting for the possibility of null subjects. Clearly, the account depends on additional stipulations.

the phonological form *noi* to a first person plural definite D and the phonological form *i/gli* to a third person plural definite D. There is no null spell-out for a definite D. A null spell out of an indefinite D would give what looks like a bare noun, which would not trigger unagreement if indefinites are third person.

4.2 An empirical problem with Höhn's (2016) theory

A consequence of Höhn's (2016) theory is that what looks like a plain NP introduced by a determiner (whether the definite article, an indefinite such as *alguns* 'some' or a cardinal numeral such as *tres* 'three', among other possibilities) in a Type II APC language is really a PersP introduced by a null pronoun. This null pronoun may have any of the three person features. The NP *els estudiants* has the structure indicated in (12) using the null pronoun ∅ for the Pers node. It is therefore identical in structure to an NP with an overt pronoun such as *nosaltres els estudiants*. The only difference is in the phonology of the Pers node, which should have no effect on the syntax. A prediction that Höhn's theory makes is that there should be no difference between these two kinds of NPs that can be attributed to one being pronominal and the other not. What looks like a plain non-pronominal NP is, in fact, as pronominal as the NP with the overt pronoun. The two NPs in Höhn's theory are syntactically identical, except for the features [−dem]/[+dem].

Catalan shows that this is not right. Catalan strong pronouns (as opposed to clitics) can be used as reflexives; in other words, they can be coreferential with a more prominent GF in the same minimal nucleus, generally, the subject. In such cases, the pronoun is optionally modified by the adjective *mateix* 'same', in its different number and gender forms. The unambiguously reflexive *si* can be used for the third person, as an alternative to the strong pronoun *ell* in its various number and gender forms. Following are some examples of pronouns used as reflexives (ex. (13b) from IEC 2016: 687):

(13) a. *Com a artista la Paula s' inspira en ella (mateixa).*
as artist.SG the Paula REF inspireSG in PRO.3.F.SG same.F.SG
'As an artist Paula gets her inspiration from herself.'

b. *Sempre parles de tu (mateixa).*
always talk.2SG about PRO.2SG same.F.SG
'You always talk about yourself.'

If Höhn's (2016) theory were correct in claiming that an apparently non-pronominal NP such as *els artistes* 'the artists' is really pronominal, as it would be a PersP headed by a null pronoun, we would expect such an NP to behave like any other pronoun in the language and, thus, be able to function as a reflexive. The fact is that this is not the case: such NPs are disjoint in reference with a more prominent GF such as the subject in the same minimal nucleus. (14) offers minimal contrasts: when the pronoun is in complement position, it may corefer with the subject of its clause; when the complement is an apparently non-pronominal NP, it may not corefer with the subject of its clause.[7]

[7] One could stipulate that the null pronominals posited in apparently non-pronominal NPs lack the ability to function as reflexives, unlike all other pronouns in the language, but it would be a strictly ad hoc rescue mechanism.

(14) a. *Els artistes confiem només en nosaltres (mateixos).*
the.M.PL artist.PL rely.1PL only on PRO.1PL same.M.PL
'We artists rely only on ourselves.'

b. *(Nosaltres) confiem només en els artistes (mateixos).*
PRO.1PL rely.1PL only on the.M.PL artist.PL same.M.PL
'We rely only on the artists (themselves).'
*'We$_i$ rely only on us artists$_i$.'

Furthermore, it can be shown that a plain non-pronominal NP such as *les atletes* 'the (female) athletes' contrasts with an APC such as *vosaltres les atletes* 'you (female) athletes' even though they are both claimed to have the same structure. The former does not allow coreference with the subject of the minimal clause, as in (15b), whereas the latter does, as in (15c):

(15) a. *(Vosaltres) les atletes treballeu per vosaltres (mateixes).*
PRO.2PL the.F.PL athlete.PL work.2PL for PRO.2PL same.F.PL
'You athletes work for yourselves.'

b. *(Vosaltres) treballeu per les atletes.*
PRO.2PL work.2PL for the.F.PL athlete.PL
'You (pl.) work for the athletes.'
*'You$_i$ work for you athletes$_i$.'

c. *(Vosaltres) treballeu per vosaltres les atletes.*
PRO.2PL work.2PL for PRO.2PL the.F.PL athlete.PL
'You (pl.) work for yourselves athletes.'

This indicates that what looks like a non-pronominal NP is really non-pronominal, which means we cannot assume that an NP such as *els estudiants* 'the students' or *les artistes* 'the artists' has the structure in (12) with a null pronoun.

Thus, despite the success of Höhn's (2016) theory in accounting for the presence or absence of unagreement in different languages and for the correlation between the presence or absence of this phenomenon and the type of APC in the language, it cannot be right because it treats non-pronominal NPs as pronominal, which leads to incorrect predictions. We therefore need to propose a different analysis.

5 A WYSIWYG analysis of unagreement

5.1 Problem 1: an apparent agreement mismatch

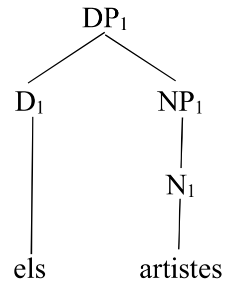
If we assume that the determiner is the category in the DP that can be associated with person information, two possibilities arise: some determiners are lexically associated with specific person information and some are not. The analysis proposed here crucially depends on the idea expressed in (16):

(16) Some determiners in some languages do not specify person information.

This implies that a DP headed by a determiner that does not specify person information is compatible with any person feature. A second idea of the present analysis is that inflectional morphology spells out the morphosyntactic features in the f-structure. The morphosyntactic features of a language are those that are reflected in the inflectional morphology, such as person and number, among other possibilities. These features are assigned in the f-structure by general rules.

The plural definite article *els/les* in Catalan does not lexically specify person information, although it does specify gender and number features. It follows that a DP headed by this determiner maps onto one of three alternative f-structure representations, each one with a different person feature PERS, assuming that PERS takes one of the three values 1/2/3. If the feature PERS is one of the morphosyntactic features of the language, it is assigned to GFs with any of its values. In this way, a DP headed by the determiner *els/les* may legitimately map onto a GF with any of the three person values. One of the three possible f-structures that correspond to the phrase *els artistes* is shown in (17), in which the feature PERS has the value 1.

(17) One of three possible f-structures for *els artistes*:



$$\left[\begin{array}{ll} \text{PRED} & \text{'artist'} \\ \text{DEF} & + \\ \text{IND} & \left[\begin{array}{ll} \text{PERS} & 1 \\ \text{NUM} & \text{PL} \\ \text{GEND} & \text{M} \end{array}\right] \end{array}\right]_1$$

Since neither of the two components of the DP—the determiner and the noun—impose any restriction on person, the DP can map onto an f-structure with any person value. The correspondence between c-structure and f-structure is shown by coindexation.

If the f-structure in (17) is the subject of a tensed clause, the inflection of the tensed verb, which reflects the person and number features of the subject, has to show that the subject is first person plural. As the same DP can map onto three different f-structures (with different values for the feature PERS), we account for the different agreement possibilities that we see in examples like (1).[8] This accounts for the first problem in section 3: why an apparently 3rd person DP can trigger 1st or 2nd person agreement.

5.2 Problem 2: languages without unagreement

For languages without unagreement, such as Italian, all we need to assume is that determiners are fully marked for person information, as expressed in the statement (18):

(18) In some languages (e.g., Italian) all determiners are fully specified for person information.

So, the plural definite article *i/gli* in Italian, as well as its feminine and singular counterparts, are lexically marked as [PERS 3]. Consequently, a DP headed by this determiner, such as *gli studenti*, is only a third person expression and its features have to be reflected in the inflected form of a verb or a pronoun agreeing with it. This accounts for the fact that (6), where that DP is the subject of a finite verb, is grammatical only if

[8] We need to assume that each of the three sentences in (1) has a GF SUBJ with a different value for PERS in order to account for the different verb morphology and the corresponding difference in meaning. Whether the intial DP maps onto that GF or is a topic that shares its index features with the subject, the DP is compatible with three different f-structure representations.

the verb shows third person morphology: the verb reflects the person and number features of its subject.

I am assuming, following Postal (1969) and others, that personal pronouns like *io* ‘I’ or *tu* ‘you’ are determiners. They are also specified for person information: first person for *io*, second person for *tu*.

5.3 Problem 3: variation across lexical units

The solution to the third problem is that languages with unagreement do not necessarily have all determiners lexically unmarked for person. In Spanish and Catalan, for example, while the plural definite article is lexically unmarked for person, its singular form is specified as third person, which accounts for the absence of unagreement (as the verb agrees in 3rd person) in cases like (5a), repeated as (19).

(19)

L’	*artista*	*treballa*	*/*treballo*	*/*treballes*	*molt*.
the.SG	artist.SG	work.3SG	/ work.1SG	/ work.2SG	much

‘The artist works a lot.’

Among determiners that allow unagreement, there is a tendency for unagreement to be restricted to the plural form of the determiner, while the singular form shows consistent agreement in the third person. This happens in Catalan (and in a similar way in Spanish) not only with the definite article, but also with the indefinite *algun/alguns* ‘some’, the interrogative *quin/quins* ‘which (one)’, etc. (Some plural determiners that allow unagreement, such as *quants/quantes* ‘how many’, *tants/tantes* ‘so many’, or *molts/moltes* ‘many’, are only used in the singular with uncountable or mass nouns, which makes them semantically incompatible with a first or second person singular reference.) However, some determiners only allow third person agreement, both in the singular and in the plural, as is the case with demonstratives.

Greek, in contrast with Catalan and Spanish, allows unagreement with NPs introduced by the definite article, both in the plural and in the singular. Example (7) illustrates the possibility of unagreement in Greek in the singular with a definite article.

In Catalan and Spanish, some indefinite determiners that can only be used in the singular allow a form of unagreement in which the DP headed by one of these determiners is in the singular whereas the agreeing element (verb or pronominal clitic) is either first or second person, but crucially in the plural. Some of the determiners that display this behavior are *ningú* ‘no one’, *cap* ‘no/none’, *cada* ‘each’, *cada u/cadascú* ‘each one’ in Catalan (the corresponding forms in Spanish being *nadie*, *ningún/ninguno*, *cada*, *cada uno*, respectively). (20) are examples of these person and number mismatches. (See similar examples in Spanish in Rivero (2008: 230).) (20a) (IEC 2016: 731) is an instance of unagreement involving clitic doubling of the direct object by means of the 2nd person clitic *us*; here the direct, or accusative, object is marked by the DOM preposition *a*.

(20) a.

Cap	*(de*	*nosaltres)*	*no*	*sabem*	*la*	*veritat.*
none.SG	(of	PRO.1PL)	not	know.1PL	the.F.SG	truth.SG

‘None of us knows the truth.’

b.

Us	*han*	*mencionat*	*personalment*	*a*	*cada un*	*(de vosaltres).*
2PL	have.3PL	mentioned	personally	A	each one	of PRO.2PL

‘They have mentioned each one of you personally.’

The claim that the determiners *cap* and *cada* are singular is based on the fact that, when they head a DP with an overt noun, the noun has to be singular: *cap estudiant* 'no student(SG)' vs **cap estudiants* 'no student(PL), *cada estudiant* 'each student(sg)' vs. **cada estudiants* 'each student(pl)'. In these cases, the unagreement phenomenon does not only involve an apparent person mismatch, but also a number mismatch.

Ackema and Neeleman (2013: 317) analyze unagreement in Spanish and propose the generalization that unagreement with singular DPs arises with quantifiers that lack a plural form: "quantificational unagreement is allowed with plural quantifiers, and with singular quantifiers as long as they do not have a plural counterpart." This generalization is only partially true. While it is correct, both for Spanish and for Catalan, that singular quantifiers that have a plural counterpart do not allow unagreement, it is not true that all singular quantifiers that lack a plural counterpart allow unagreement. A clear contrast is attested with *ningú* 'no one' and *algú* 'someone' (and their Spanish counterparts *nadie* and *alguien* respectively) both of which lack a plural counterpart: while the former allows quantificational unagreement, the latter does not. Examples with Spanish *nadie* and *alguien* are given in (21):

(21) a. *Nadie sabe /sabemos /sabéis la verdad.* (Sp)
no one.SG know.3SG/know.1PL/know.2PL the.F.SG truth.SG
'No one knows the truth.'

b. *Alguien sabe /*sabemos /*sabéis la verdad.* (Sp)
someone.SG know.3SG/know.1PL/know.2PL the.F.SG truth.SG
'Someone knows the truth.'

While *nadie* and *alguien* are pronominal quantifiers, which cannot cooccur with a noun, Ackema and Neeleman's (2013) generalization also fails to hold with some non-pronominal quantifiers that must cooccur with a noun: *todo/toda* 'any' and *cualquier* 'any' in Spanish (also the corresponding forms *tot/tota* and *qualsevol* in Catalan). The quantifier *todo/toda* may appear to have a plural form, namely, *todos/todas*. However, we have to distinguish the determiner *todo* from the predeterminer *todo*: the former has only a singular form, cannot cooccur with a determiner, has to be followed by a noun in the same DP, and is equivalent in meaning to 'any' or 'every'; the latter has both a singular and a plural form, must precede a determiner if it is followed by anything in the same nominal phrase, does not need to be followed by anything in the same nominal phrase, and is equivalent in meaning to 'all'. (22) illustrates the different behavior of the determiner *todo*, in (22a), and the predeterminer *todo*, in (22b,c).[9]

(22) a. *Todo (*el) *(estudiante) conoce la verdad.* (Sp)
every.SG the student.SG know.3SG the.F.SG truth.SG
'Every student knows the truth.'

b. *Todos *(los) estudiantes tienen derecho a la verdad.* (Sp)
all.PL the student.PL have.3PL right to the.F.SG truth.SG
'All students have a right to the truth.'

---

[9] Ackema and Neeleman (2013: 317) are not only unaware of the different behavior of determiner *todo* and predeterminer *todo* but give an ungrammatical example of the predeterminer without a following determiner as grammatical and give as grammatical a set of three ungrammatical examples of the predeterminer *todo* immediately followed by a modifier *de*-phrase.

c. *Toda (la harina) estaba estropeada.* (Sp)
all.F.SG the flour be.PAST.3SG damaged.F.SG
'All the flour/all of it had gone bad.'

This shows that determiner *todo* and predeterminer *todo* are two different words and, therefore, that determiner *todo* does not have a plural counterpart. If not having a plural form of the quantifier were a sufficient condition for the singular quantifier to trigger unagreement, we would expect determiner *todo* to allow unagreement. But it does not, as shown in Ackema and Neelema's (2013) example (52c), given here as (23):

(23) * *Todo niño creemos/creéis en los Reyes Magos.* (Sp)
every kid believe.1PL/believe.2PL in the Reyes Magos
'All of us/you kids believe in the Magi.'

Cualquier is another quantifier that does not have a plural form and yet does not allow unagreement.[10] To summarize, for a singular quantifier to allow unagreement, it is a necessary condition that it lack a plural form, but this is not a sufficient condition. So, there is some degree of arbitrariness in whether a singular quantifier allows unagreement or not. The generalization seems to be that a DP can show non-third person agreement with a verb or a pronoun if it can be interpreted as referring to a group of people that includes the speaker or the hearer. Crucially, the DP has to refer to a group. Thus, plural expressions satisfy this condition, as well as group denoting expressions, such as *gent* 'people', *colla* 'gang', or *jovent* 'youth', all of them grammatically singular. This condition is also satisfied by DPs headed by singular determiners such as *cap* 'none' or *cada un* 'each one' because they refer to a group.

The way to account for this phenomenon is to assume the split in agreement features into CONCORD and INDEX features (see Haug 2023 and references cited there). While person is only an INDEX feature, both gender and number are represented as features of both CONCORD and INDEX and have a potentially different value in both locations, although by default they have the same value. Thus, a word like *cap* 'none' (or Spanish *ningún/ninguno*) is restricted to having the feature [CONCORD [NUM SG]] and is lexically associated with the following biconditional information, which allows it to have the feature [INDEX [NUM PL]] provided person is either first or second:

(24) [INDEX [NUM PL]] $\leftrightarrow$ [INDEX PERS [1 $\vee$ 2]]

The proposal that some quantifiers, like *cap*, have the concord feature singular accounts for its lack of morphological plural marking and the fact that accompanying nouns and adjectives in the same DP are also morphologically singular. The idea that it is lexically unspecified as to person and that it can have the feature [INDEX [NUM PL]] when it is not third person accounts for the fact that an agreeing verb or pronoun can be in the first or second person in the plural, as seen in (20), and for the fact that third person agreement with a verb or pronoun is only possible in the singular, as in (25):

(25) *Cap (d' ells) no sap /*saben la veritat.*
none.SG (of PRO.3.PL) not know.3SG /*know.3PL the.F.SG truth.SG
'None of them knows the truth.'

[10] The dictionary of the Real Academia de la Lengua Española includes a plural form *cualesquier*. Nevertheless, it is very rare in corpus searches and it is reasonable to assume that it is absent from most speakers' repertoires.

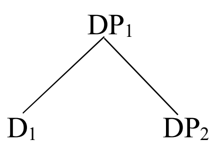
To summarize, while some plural determiners are unspecified for person, some singular determiners—a proper subset of those that do not have a plural form—are also unspecified for person, but show either third person singular agreement or non-third person plural agreement on verbs and pronouns. This phenomenon can be captured by assuming that number can have a different value as a feature of CONCORD and as a feature of INDEX for this subset of determiners.

5.4 Problem 4: the unagreement-APC correlation

The final problem we need to address is the correlation between the type of APC (adnominal pronoun construction) found in a given language and whether the language in question has unagreement or not. The claim is that a language has unagreement if its APC includes the definite article and does not have unagreement otherwise. The analysis cannot involve a null pronominal, as in Höhn's (2016) analysis, for two reasons. First, as shown in subsection 4.2, a non-pronominal NP in a language with unagreement does not behave like a pronominal NP; so, we cannot assume that non-pronominal NPs are headed by a null pronoun. Second, it goes against the spirit of LFG to resort to null categories: the separation of grammatical information into c-structure and f-structure allows us to dispense with the use of empty elements at c-structure in order to represent information that is expressed at f-structure. C-structure represents the arrangement of overt expressions in terms of grammatical categories, whereas potentially non-overt information is represented at f-structure.

Fortunately, an analysis is possible of the correlation under investigation without making use of empty categories. We can follow Höhn (2016) in assuming that the pronoun and the following nominal expression (the modifier) in an APC, as in *we linguists*, are in a closer dependency than an NP and an apposition (as in *we, the people*). This closeness is reflected in the requirement that the pronoun (categorially D) and the modifier share their agreement (INDEX, or IND) features, including person. This means that the person, number, and gender features of the pronoun are also those of the modifier. Thus, the c-structure and f-structure of an APC would be as in (26), where the correspondence between levels is shown by coindexation: in a pronominal DP with a modifier phrase, the IND features of the modifier (ADJ) are those of the pronoun. The tag notation, as in HPSG, is used to indicate sharing of structure: the boxed α as the value of the two occurrences of IND indicates that the same feature structure is the value of both uses of IND. The value of IND is a feature structure consisting of the features PERS, NUMB, and GEND. Thus, (26), as the cross-linguistic APC schema, captures the idea that these features of the pronominal DP are the same as those of the modifier DP.[11]

(26)



$$\begin{bmatrix} \text{PRED} & \text{`pro'} \\ \text{DEF} & + \\ \text{IND} & \boxed{\alpha} \\ \text{ADJ} & \begin{bmatrix} \text{DEF} & + \\ \text{IND} & \boxed{\alpha} \end{bmatrix}_2 \end{bmatrix}_1$$

[11] As noted by a reviewer, the structures in (26) make the claim that the pronoun is the head of the phrase, whereas, in the English ParGram grammar's analysis of *Us linguists* in *Us linguists like cake.*, the noun is the head (see https://clarino.uib.no/iness/xle-web). Comparatively evaluating the consequences of the two options is beyond the scope of this paper.

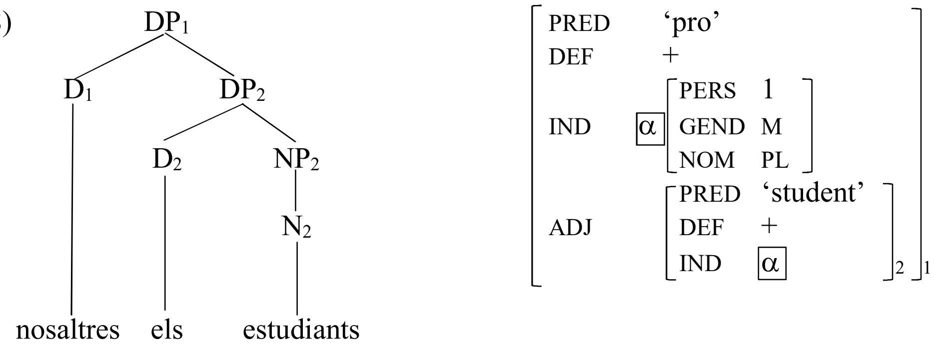
Thus, in a language with unagreement, such as Catalan or Spanish, where the plural definite article carries no person specification, this determiner can head the modifier DP in (26): its IND features can unify with the IND feature structure of a plural pronoun, whether it is first or second person. The APC *nosaltres els estudiants* ‘us students’ in Catalan satisfies all the requirements of (26): *nosaltres* is lexically specified as a first person plural definite pronoun, i.e., it has the f-structure information in (27):

(27) nosaltres: D_1

$$\begin{bmatrix} \text{PRED} & \text{‘pro’} \\ \text{DEF} & + \\ \text{IND} & \begin{bmatrix} \text{NUM} & \text{PL} \\ \text{PERS} & 1 \end{bmatrix} \end{bmatrix}_1$$

When this pronominal determiner occupies the head position in (26) and a DP such as *els estudiants* occupies the modifier position, the INDEX of both DPs has to be shared. Since there is no conflicting information associated with any of the lexical items involved, the c- and f-structure of the APC is well-formed:[12]

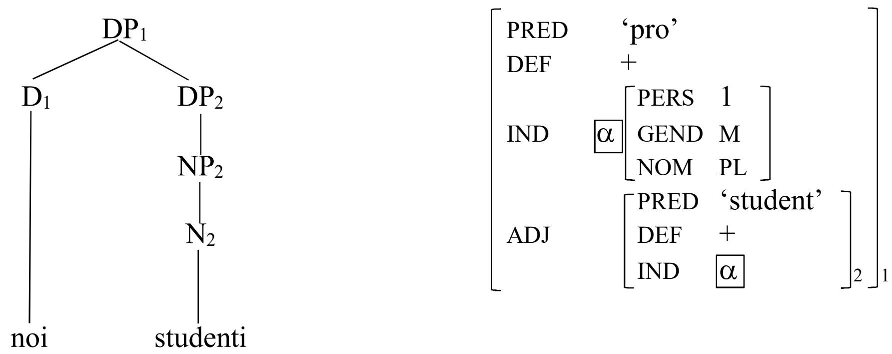
(28)



The structures satisfy the requirements on the APC, in particular, the sharing of agreement features between the pronoun and its modifier. The plural definite article in Catalan expresses gender and number and is compatible with any person feature.

In a language without unagreement, such as Italian, the plural definite article is marked as being third person and therefore cannot occur as the head of the modifier phrase in an APC with a first or second person pronoun: inconsistency would arise. Italian resorts to a headless DP for the modifier phrase in (26): without a D, the INDEX of the modifier has no person feature and can unify with the pronoun’s INDEX. The syntactic representation of the Italian phrase *noi studenti* ‘us students’ is shown in (29):

(29)



[12] The pronoun and the modifier have to agree in definiteness, as indicated in (26). The feature [DEF +] could be included in the set of features in (26) that have to be shared,

As can be seen comparing (28) and (29) the f-structures of the APCs in the two languages are the same. The c-structures differ in the presence or absence of the definite article heading the modifier phrase in the APC. The information conveyed by the definite article in (28) is provided by the schema in (26) and the sharing of agreement features of the pronoun and its modifier.

This means that the definite article makes a redundant contribution in a pair of structures such as (28), which raises the question why the definite article is required in the APCs of languages with unagreement like Spanish and Catalan. Recall from (9) that sequences like **nosaltres estudiants* are ill-formed as APCs. This can be explained assuming an Optimality Theory (OT) approach to syntax in which constraints on c-structure are ranked and can be violated if the violation of a constraint results in compliance with a higher-ranked constraint. One of the constraints involved is OB-HD (Obligatory Head), which requires all XPs to have a head (Kuhn 2023 and references cited there). All we need to assume is that this constraint ranks lower than the APC schema (26). In both types of languages (with and without unagreement), the same two c-structures are checked for compliance with the list of constraints: a c-structure with the definite article heading the modifier DP, as in (28), and a c-structure without a D heading that DP, as in (29). As noted, both c-structures can be paired with the same f-structure.

In a language where the plural definite article is specified to be third person, as in Italian, the presence of the article leads to a violation of the schema (26): even though the structure satisfies OB-HD, the violation of (26) makes the structure dispreferred over the alternative structure without the article, which satisfies (26) and violates the lower ranking OB-HD. This accounts for why **noi gli studenti* is ill-formed, as opposed to *noi studenti*, as seen in (8). In a language where the plural definite article is unspecified for person, such as Catalan and Spanish, the schema (26) is satisfied in both structures, with and without the definite article, but only the structure with the article satisfies OB-HD. Given that a violation of OB-HD would not be justified for compliance with a higher ranked constraint, the preferred structure is the one that also satisfies OB-HD, which explains the obligatory presence of the article in APCs in Catalan and Spanish, as seen in (9).

In this way we explain the fourth problem, the APC-unagreement correlation (languages with unagreement include the definite article in the APC; languages without unagreement do not), without resorting to null categories or assuming two types of APCs. We assume a single cross-linguistically valid schema for APC. Whether the language uses the plural definite article in the modifier phrase or not depends on (a) whether this article is specified for third person or is unspecified for person and (b) the proposal that, if possible, a DP includes its categorial head. Thus, the only parameter of variation within APCs is whether the language allows determiners that are not specified for person, the same parameter that accounts for whether the language has unagreement or not.

5.5 Formalization

For languages like Italian in which determiner lexemes are fully specified for person in their lexemic entry, we can assume the default correspondence principle (30), which states that a lexeme of category D has the index feature [PERS 3]:

(30) $[\text{LEXEME} \;\; \text{X}]_1 \,,\; \text{D}_1 \;\; \rightarrow \;\; [\text{IND} \;\; [\text{PERS} \;\; 3]]_1$

As a default, this correspondence principle can be overridden by lexemes that specify different person values, for example, pronouns that are first or second person such as *noi* 'we/us'.

(31) $[\text{LEXEME} \;\; \text{NOI}]_1 \qquad \text{D}_1 \qquad \begin{bmatrix} \text{IND} & \begin{bmatrix} \text{PERS} & 1 \\ \text{NUM} & \text{PL} \end{bmatrix} \end{bmatrix}_1$

This lexeme entry states a correspondence between morphological information, c-structure and f-structure information. As it is a more specific correspondence statement than (30), it takes precedence over the latter. Any determiner lexeme that is not specified for person is third person by default, as stated in (30). With this default, an NP with a determiner in Italian, such as *gli studenti* 'the students', maps onto a third person GF, accounting for the agreement and the APC facts.

For Catalan and Spanish, as examples of languages with unagreement, two generalizations can be made: lexemes that are demonstrative determiners are third person, as in (32); lexemes that are non-demonstrative determiners are either third person singular or plural, as in (33).

(32) $[\text{LEXEME} \;\; \text{X}]_1 \,,\; [\text{DEM} \;\; +]_1 \,,\; \text{D}_1 \;\; \rightarrow \;\; [\text{IND} \;\; [\text{PERS} \;\; 3]]_1$

(33) $\left\{ \begin{matrix} [\text{DEM} \;\; -]_1 \,,\; \text{D}_1 \\ [\text{LEXEME} \;\; \text{X}]_1 \,, \end{matrix} \right\} \;\; \rightarrow \;\; \begin{bmatrix} \text{IND} & \begin{bmatrix} \text{PERS} & 3 \\ \text{NUM} & \text{SG} \end{bmatrix} \vee \; [\text{NUM} \;\; \text{PL}] \end{bmatrix}_1$

Correspondence principle (33) ensures that the definite article, among others, if plural, is compatible with any person specification. This accounts for the fact that, in Catalan and Spanish, DPs headed by the singular definite article show third person agreement on the verb, while DPs headed by the plural definite article agree in first, second or third person with the verb.

6 Conclusions

The analysis of unagreement proposed here has as one of its main elements the idea that languages vary as to whether some of their determiners are unspecified for person information. An assumption made here is that, in the nominal (or DP) domain, the determiner is the expression of the person feature: it is the category that may spell out this morphosyntactic information. In some languages, all determiners are associated with a specific person feature. This is the case of Italian, where so-called strong pronouns, categorially determiners, like *noi* 'we'/'us', are lexically marked as having one of the three values of the person feature, and the remaining determiners, such as the definite article, are all third person. In other languages, some determiners are lexically unspecified as to their person feature. This is the case of Catalan and Spanish, where, along with many determiners that have a specific person value (including personal pronouns), determiners such as the plural definite article are compatible with any of the three person values. This lexical underspecification is visible in the ability of the DP headed by such a determiner to agree with a verb form that signals any of the three person values of the grammatical function corresponding to that DP. And it is also visible in the fact that such a DP can be the modifier of a first or second person pronoun in an APC.

In the verbal domain, the person information (as well as gender and number, and other, information) of some of the grammatical functions of the clause may be reflected through the inflectional morphology of the verb. In the Romance languages, which include Italian, Catalan, and Spanish, the person and number information of the subject is typically signalled by means of suffixal inflection on the finite verb. Objects and, in some of these languages, also obliques reflect some of their features such as person on verbal inflectional morphology of the type called clitics. (See Alsina (2023a: 1536–1544) for the claim that so-called clitics in Romance are part of the verbal inflection.)

An existing analysis of the unagreement phenomenon (Höhn 2016) resorts to null pronouns in order to account for the fact that an apparently non-pronominal NP may trigger first, second, or third person agreement. The idea is that such an NP is headed by a null pronoun, which can have any of the person values. According to this proposal, an apparently non-pronominal NP is just an APC with a null head. This explains the fact that such an NP can show agreement in any of the three person features and it accords well with the observation that the plural definite article has to appear in the modifier phrase of an APC in languages with unagreement, but cannot appear in this position in languages without unagreement.

This analysis has several drawbacks. The first and most important one is that an apparently non-pronominal NP in a language with unagreement is really non-pronominal. The proposal to treat it as a covertly pronominal NP fails to account for the fact that it does not behave like a pronominal NP, as seen in subsection 4.2. The second one is that it requires positing empty categories. Although this is not a problem for many frameworks, it does go against the spirit of LFG, in which having f-structure as a level of syntactic representation distinct from c-structure allows us to dispense with phonologically null words at c-structure. And the third drawback is that it requires assuming that there are two types of APCs cross-linguistically and that languages belong to one type or the other. If this were the only parameter of variation in Höhn's theory, we could say that it fares no worse than the present theory, whose parameter of variation consists in the classification of determiners into those that are marked for person and those that are unmarked. However, Höhn's theory also has to posit this source of cross-linguistic variation. For example, the definite article is analyzed differently in languages with and without unagreement: in Italian (without unagreement), it is the spell-out of the features of third person, together with other features, whereas, in Greek (with unagreement), it is the spell-out of a set of features that crucially does not include person (Höhn 2016: 579–580). Consequently, Höhn's theory is more complicated than the present one, which proposes a single structure for APCs cross-linguistically.

It should also be pointed out that Höhn's theory does not propose an account of why certain determiners in languages with unagreement allow unagreement in the plural, but not in the singular, as is the case of the definite article in Catalan and Spanish, unlike the present proposal (see subsection 5.5).

Within a lexicalist, non-encapsulated approach to morphology, the rules of inflectional morphology, are sensitive to the f-structure that corresponds to the c-structure position of a given word. Agreement such as subject-verb agreement arises because a single set of f-structure features constrains the form of two (or more) different words in the c-structure. It may give the impression that the form of an NP conditions the form of the verb. In fact, it is the features of a given GF that condition the form of both the words in the NP and the verb.

The GFs in an f-structure have their features assigned by general principles. These are the morphosyntactic features of a language. The morphological rules of the language spell out these features as morphs (or phonological operations) on the words that map onto the appropriate GFs. The rules of the verbal morphology may reflect the subject's features on the verb; the rules of the nominal morphology may reflect the features of a given GF on the N and D that map onto that GF. The subject's features may be thus reflected on both the N and D that map onto the subject and the verb that maps onto the f-structure that contains that subject. Agreement arises because a single set of features is phonologically reflected on two or more words in the c-structure.

So-called unagreement is simply agreement: it is accounted for by the same principles that account for ordinary instances of agreement. What makes it look like lack of agreement is the preconception that the features that are reflected on the verb should also be reflected on the agreeing NP. But this is not necessarily the case: the features of the subject that are reflected on the verb may be partially disjoint with the features of the subject that are reflected on the NP that maps onto the subject. In an unagreement type language, the verb reflects the person feature of the subject whereas the NP linked to the subject does not.

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Fusional morphology, metasyncretism, and secondary exponence: A morphemic, realizational approach to Latin declension

Ash Asudeh
University of Rochester

Bronwyn Bjorkman
Queen's University

Frances Dowle
University of Oxford

Neil Myler
Boston University

Daniel Siddiqi
Carleton University

Lisa Sullivan
Oklahoma State University

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Abstract

Using Latin as a case study, we show that Lexical-Realizational Functional Grammar (a union between a morpheme-based realizational morphology and the non-derivational, constraint-based syntactic framework of Lexical-Functional Grammar) is able to offer insights into two fundamentally important morphological phenomena. The first of these is metasyncretism, which is of particular interest because it is a (putative) paradigmatic effect, yet L$_\mathrm{R}$FG does not have paradigms as theoretical objects. Syncretism is captured via cascading macros (i.e., templates), such that a macro for one case value may also call another macro with a different case value, leading to case containment which models a feature hierarchy. We also use the same approach for gender and number. Metasyncretism is handled through a single vocabulary item mapping to a disjunction of two or more possible exponents. The second phenomenon of interest is secondary exponence (or morphological conditioning). This is handled through the addition of constraints to the (relevant) vocabulary items corresponding to their conditioning environments.

1 Introduction

Morpheme-based realizational models of morphology—those that are *lexical-realizational* according to Stump's (2001) classification—have often assumed interfaces with derivational models of syntax.[†] For example both the morphemic, realizational approaches of Distributed Morphology (Halle & Marantz 1993 et seq., among others) and Nanosyntax (Starke 2009, Caha 2009 et seq., among others) are paired with Minimalist syntax (Chomsky 1995). However, there is nothing about morpheme-based realization that is intrinsically derivational.

Lexical-Realizational Functional Grammar (L$_\mathrm{R}$FG; see Asudeh et al. 2023, Asudeh & Siddiqi 2023 and references therein) is a model of morphology that unites morpheme-based realization with the *non-derivational* constraint-based syntactic framework of Lexical-Functional Grammar (LFG; Kaplan & Bresnan 1982, Dalrymple et al. 2019, Dalrymple 2023, among others). In this paper, we show that this union offers insights into two phenomena that any theory of morphology must account for:

1. *Metasyncretism* (Williams 1994, among others)
   Metasyncretism is the phenomenon whereby the same syncretism patterns arise in different paradigms; for further discussion, see §2.1.

   (1) *do:n-i:s*   *do:n-i:s*
   gift-CLASS2.MASC.PL.DAT   gift-CLASS2.MASC.PL.ABL

   (2) *re:g-ibus*   *re:g-ibus*
   royal-CLASS3.MASC.PL.DAT   royal-CLASS3.MASC.PL.ABL

   We will demonstrate how L$_\mathrm{R}$FG handles metasyncretism through disjunctive exponence.

[†]We thank Nigel Vincent for initially pushing us along the Latin path. We also thank the audience and participants of LFG 2024 for excellent comments and feedback. We thank the members of the L$_\mathrm{R}$FG Lab for a thriving environment and for their comments and discussion. We also thank our reviewers, who improved the paper with their feedback. Any remaining errors are our own. For more on L$_\mathrm{R}$FG, visit our website: lrfg.online.

2. *Secondary exponence* (Noyer 1997, among others)
   Secondary exponence is the mechanism that captures the phenomenon of *morphological conditioning*, such that contextual allomorphy arises; for further discussion, see §2.2.

   For example, in all declensions, non-neuter ACCUSATIVE is expressed as a mora (realized as vowel lengthening), but only in the context of plural.[1]

   (3) *puell-am* girl.CLASS1.FEM.SG.ACC
   ci:v-em citizen.CLASS3.MASC.SG.ACC

   (4) *puell-**a:**s* girl.CLASS1.FEM.PL.ACC
   *ci:v-**e:**s* citizen.CLASS3.MASC.PL.ACC

   We will demonstrate how L_RFG handles secondary exponence through the addition of constraints to the (relevant) vocabulary items, which capture the vocabulary items' conditioning environments.

Our demonstration focuses on the analysis of the nominal declensions of Latin, a complex fusional system that expresses 5 cases (6 if vocative is counted), 3 genders (masculine, feminine, neuter), 2 numbers, and (a minimum of) 5 distinct declension classes. This is illustrated for two declension classes in Table 1, where a box with rounded corners indicates metasyncretism and a box with square corners indicates secondary exponence. We present the traditional affixes on the left, for comparison's sake. The right represents the decompositional analysis from Myler (2024) that we assume here. The theme vowels are excluded from the right for clarity.[2]

1.1 Why should L_RFG look at Latin?

First, Latin is standard fare for word-based/paradigm-based morphology (see, e.g., Matthews 1972, Stump 2001, Spencer 2013, Bonami & Stump 2016, Blevins 2018). Latin has long been an exemplar of paradigmatic morphology, even just in the descriptive/pre-theoretical sense. Here are some examples of properties of Latin morphology that seem to support the existence of theoretical objects called *paradigms*:

1. Highly fusional morphology
2. Multiple declension and conjugation classes
3. Intra-paradigmatic syncretism patterns
4. Cross-paradigmatic syncretism patterns

[1] As explained below, we analyze the *s* at the end of the forms in (4) as a plural marker, rather than being part of a fused case/number ending as in more traditional analyses.

[2] The fragment follows Oniga (2014: 81) in taking the first vowel of *-ibus* as being part of the case affix, as opposed to an allomorph of the theme vowel, although we acknowledge that this is potentially controversial. See Myler (2024: 10) for the strategies used to arrive at this presentation. Many important aspects of the surface forms, especially in the third declension (but only there), are accounted for by phonological rules. For the phonology we assume, see the supplemental materials associated with Myler (2024), available at https://tinyurl.com/5bw2tw9c.

	CLASS 2		CLASS 3	
	SG	PL	SG	PL
NOM	-us	-i:	-s	-e:s
ACC	-um	-o:s	-em	-e:s
GEN	-i:	-o:rum	-is	-um
DAT	-o:	-i:s	-i:	-ibus
ABL	-o:	-i:s	-e	-ibus

	CLASS 2		CLASS 3	
	SG	PL	SG	PL
NOM	-s	-i:	-s	-$\boxed{\mu}$-s
ACC	-m	-$\boxed{\mu}$-s	-m	-$\boxed{\mu}$-s
GEN	-i:	-rum	-is	-um
DAT	-μ	-$\boxed{\boxed{\text{i:}}}$-s	-i:	-$\boxed{\boxed{\text{ibu}}}$-s
ABL	-μ	-$\boxed{\boxed{\text{i:}}}$-s	-e	-$\boxed{\boxed{\text{ibu}}}$-s

Table 1: Latin cases in 2$^{\text{nd}}$ and 3$^{\text{rd}}$ declensions (masculine only)
Left-hand side: traditional (see, e.g., Allen & Greenough 1888)
Right-hand side: our revision, adapted from Myler (2024).

Since L$_\text{R}$FG does not have paradigms as theoretical objects, there is an onus on L$_\text{R}$FG to show that it can capture (putative) paradigmatic effects without such objects. This is why this paper looks at syncretism patterns, especially those that cross class paradigms (*metasyncretism*).

Second, Myler (2024) is an existing Latin declension fragment in Morphology as Syntax (MaS; Collins & Kayne 2023) and Myler (2023) compares this MaS fragment to a 'counter-fragment' in DM (both the MaS and DM fragments were devised by Myler himself). This allows us to compare our L$_\text{R}$FG fragment to Myler's explicit MaS fragment and his explicit, alternative DM fragment.[3]

1.2 What is L$_\text{R}$FG?

Lexical-Realizational Functional Grammar (L$_\text{R}$FG) is a theoretical framework that couples Lexical-Functional Grammar (LFG) with Distributed Morphology (DM). From DM, L$_\text{R}$FG inherits a morpheme-based, realizational approach to morphosyntax, one which distributes the putative functions of morphology across four domains: hierarchical syntactic structures, syntactic feature structures, phonological representations, and lexical and compositional semantics. L$_\text{R}$FG is thus a version of DM, but one that is "constraints all the way down" (Asudeh, Melchin & Siddiqi 2024), rather than a realizational framework with a derivational underbelly.

From LFG, L$_\text{R}$FG inherits a constraint-based syntax split into two modules, one capturing dominance and constituency (c-structure) and the other capturing features and syntactic relations (f-structure). L$_\text{R}$FG is thus also a version of LFG, but one that gives up Strong Lexicalism (Chomsky 1970, Lapointe 1980, Bresnan et al. 2016) and an isolated morphological module that feeds syntax.

L$_\text{R}$FG was first unveiled at the 2020 conference of the Canadian Linguistic Association (Melchin et al. 2020a) and has been developed further since (Melchin et al. 2020b,

[3]"Alternative" because L$_\text{R}$FG *is* a variety of DM, but a variety with a constraint-based, rather than derivational, syntax.

Everdell et al. 2021, Asudeh & Siddiqi 2022, Asudeh et al. 2023, Asudeh & Siddiqi 2023, Asudeh et al. 2024, Everdell & Melchin 2024, Siddiqi 2024). In Melchin et al. (2020a) and Melchin et al. (2020b), we sketched part of the morphology of a *polysynthetic* language, Ojibwe (Nishnaabemwin/Anishinaabemowin). Here we sketch part of the morphology of an inflectional-fusional language, Latin.

2 Phenomena: Metasyncretism and secondary exponence

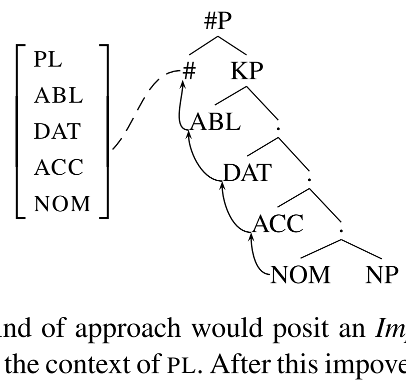
2.1 What is metasyncretism?

Metasyncretism is the phenomenon whereby the same syncretism patterns arise in different paradigms. In other words, while the pattern is consistent, the exponent of the pattern can vary across paradigms (Williams 1994, Bobaljik 2002, Harley 2008, Albright & Fuß 2012). This is the case with the DAT and ABL plurals shown in Table 1. Recall that metasyncretism is indicated by the rounded boxes in Table 1, ▢.

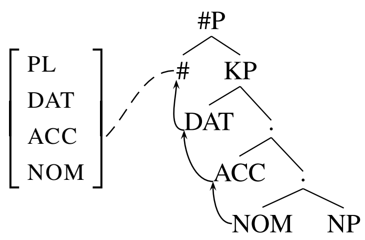
1. In class 2, DAT and ABL plural have the same exponent (*-i:*).
2. In class 3, DAT and ABL plural again have the same exponent (*-ibu*).
3. Thus, this is metasyncretism, because DAT and ABL plural are syncretic across paradigms, but the exponent is not identical.

Alternative contemporary DM analyses of metasyncretism account for the Latin type via a combination of containment among case features[4] (Caha 2009) and *Impoverishment* (Halle & Marantz 1994). For example, DAT/ABL metasyncretism in the plural would work as follows in (5) and (6) below. The first example, (5), is a syntactic representation of the ablative plural, which after head movement results in a complex head containing all the case features and plural. The second example, (6) shows the same for dative plural. The features in the square brackets are the targets for Vocabulary Insertion.

(5)



(6)



This kind of approach would posit an *Impoverishment Rule* which deletes the feature ABL in the context of PL. After this impoverishment rule applies, the targets for insertion in (5) and (6) are identical. Therefore, the same vocabulary item (VI) will be inserted in all instances of DAT PL and ABL PL, as in (5) and (6).

[4]For example, ABL case contains DAT, ACC, and NOM case, meaning ABL is simultaneously specified for all four cases, whereas ACC case contains only NOM, so ACC is encoded as only ACC and NOM. In traditional DM and Nanosyntax analyses, this is because case-marking is underlyingly a complex syntactic structure, with ABL selecting for DAT, DAT selecting for ACC, etc.

2.2 What is secondary exponence?

Secondary exponence is the mechanism that captures the phenomenon of *morphological conditioning*, such that contextual allomorphy arises. Secondary exponence in Latin is indicated by the thin, square-corner boxes in Table 1, □.

The standard DM proposal is that though each feature is only realized once, features can figure in the environment for other realizations. For example, -μ in the ACCUSATIVE PLURAL -μ-*s* in Table 1 is a realization of ACC as a mora (μ), but conditioned by the presence of PL. Contrast this with the realization of ACC in the singular, which is *m*. In DM, secondary exponence occurs when a feature is discharged by one vocabulary item but conditions the realization of other VIs (Noyer 1997). Rules (7a) and (7b) both expone the feature ACC, but (7b) only does so in the context of PL. Therefore, in the context of PL (and only in that context), (7b) is preferred to (7a). However, (7b) does not *discharge* the PL feature (indicated by round brackets). It only discharges the ACC feature (indicated by square brackets).

(7) a. [ACC] $\rightarrow$ *m*
b. [ACC](PL) $\rightarrow \mu$
c. [PL] $\rightarrow$ *s*

The PL feature is then expressed by (7c).

3 Analysis

We now turn to our analysis of metasyncretism and secondary exponence.

3.1 Metasyncretism

In L_RFG, metasyncretism of the Latin type arises from:

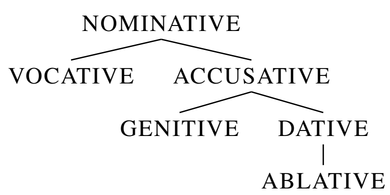
1. Case containment
2. Direct disjunction in the exponents of vocabulary items

Let us consider these in turn.

L_RFG captures case containment through the cascading of *macros* (a.k.a. *templates* in the LFG literature; see, e.g., Dalrymple et al. 2004 and Asudeh et al. 2013); we'll call this a *macro cascade*. This is the same method used for capturing person hierarchies in Ojibwe, as in Table 2. For example, HEARER entails PARTICIPANT, because the @HEARER macro calls the @PARTICIPANT macro.

Similarly, we can capture case containment in Latin through a macro cascade, as in Table 3. This captures the following case hierarchy:

(8)



Macro	*Description*	*Explanation*
INCLUSIVE(X)	(X PERS SPEAK) = + (X PERS HEAR) = + @PARTICIPANT(X)	1st person inclusive
SPEAKER(X)	(X PERS SPEAK) = + @PARTICIPANT(X)	1st person
HEARER(X)	(X PERS HEAR) = + @PARTICIPANT(X)	2nd person
PARTICIPANT(X)	(X PERS PART) = + @PROXIMATE(X)	1 and/or 2
PROXIMATE(X)	(X PERS PROX) = + @ANIMATE(X)	3 and above
ANIMATE(X)	(X PERS ANIM) = + @ENTITY(X)	3′ and above
ENTITY(X)	(X PERS ENTITY) = +	All persons (0 and above)

Table 2: Prominence hierarchy macros (based on Melchin et al. 2020a,b)

This, coupled with the absence of a relevant specifically ablative form, leads to *syncretism* between dative and ablative. For example, if there is no relevant VI for ablative, then the (relevant) dative VI will appear in both dative and ablative environments. We also use the same method for gender, as in Table 4. Note that 'neuter gender' is the exponent of the absence of gender features.[5]

Macro	*Description*	*Explanation*
NOM	(↑ NOMINATIVE) = +	Nominative case
ACC	(↑ ACCUSATIVE) = + @NOM	Accusative case
VOC	(↑ VOCATIVE) = + @NOM	Vocative case
GEN	(↑ GENITIVE) = + @ACC	Genitive case
DAT	(↑ DATIVE) = + @ACC	Dative case
ABL	(↑ ABLATIVE) = + @DAT	Ablative case

Table 3: Latin case containment

[5] We follow traditional underspecification accounts that use privative features, such as Kramer (2015), whereby singular is the lack of plural (or other more specific number features). The singular feature therefore does not appear—it is unmarked. This also becomes relevant for GENDER below, where MASC is the lack of FEM and NEUT is the lack of gender marking entirely. We acknowledge that, in the context of fusional languages, where both masculine and feminine appear to be equally marked, such a decomposition may be counter-intuitive.

Macro	*Description*	*Explanation*
MASC	(↑ GENDER) = +	Masculine gender
FEM	(↑ FEMININE) = + @MASC	Feminine gender
		Neuter gender

Table 4: Latin gender hierarchy

The second ingredient in the L$_{R}$FG account of Latin metasyncretism is direct disjunction in the exponents of vocabulary items. A disjunctive rule of exponence is one in which a single listed exponendum in the Vocabulary maps to more than one possible exponent (although only one can be selected on any given occasion). For example, the metasyncretism of *-i:* and *-ibu* is ensured because they are both exponents of the same exponendum, as demonstrated in (9).

(9)
$$\left\langle \begin{array}{l} [\text{K}],\ @\text{DAT} \\ \qquad (\uparrow \text{PLURAL}) \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & /\text{i:}/ \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}{=}1 \vee \text{X}{=}2 \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{CLASS} & \text{X} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \text{PHONREP} & /\text{ibu}/ \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}{=}3 \vee \text{X}{=}4 \vee \\ & \text{X}{=}5 \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{CLASS} & \text{X} \end{bmatrix} \end{bmatrix}$$

As shown in (9), *-i:* and *-ibu* must have the same distribution (modulo class), because they are exponents of a single VI. Moreover, the L$_{R}$FG analysis encodes the relationship between metasyncretism and simple syncretism directly. The application of the syncretism across multiple classes is expressed in the same rule that would otherwise express a simple syncretism. Note that in the Vocabulary fragment below (§5.4) there is no VI that expones ABLATIVE PLURAL. Note also that (9) contains all five classes. Therefore, The VI in (9) will be used in both dative and ablative plural in all five classes. However, in classes 1 and 2 it will have the form *-i:*, while in classes 3–5 it will have the form *-ibu*. Latin dative-ablative plural metasyncretism thus arises from a single VI being utilized in ten environments. Note also that (9) further demonstrates secondary exponence, since dative case is here conditioned by plural. We turn to secondary exponence next.

3.2 Secondary exponence

Recall that in standard DM, the issue in secondary exponence is that the licensing features 1) are not located in the target node and 2) are not discharged by insertion (the exponence function). This contrasts with the situation in L$_{R}$FG. The left-hand sides (exponenda) in vocabulary items contain two kinds of feature specifications (as in standard LFG):

1. *Defining equations* (annotated with plain =) define what features are in the f-structure by stating attributes and their values.

(10) $(\uparrow \text{FEATURE}) = +$ defines an f-structure $\begin{bmatrix}\text{FEATURE} & +\end{bmatrix}$

2. *Constraining equations* (annotated with $=_c$) state what attributes and/or values the f-structure that is defined by the defining equations must or must not contain.

   (a) $(\uparrow \text{FEATURE}) =_c +$ does *not* define an f-structure, but rather constrains the defined f-structure to contain this feature.

   Similarly, existential constraints and negated existential constraints operate on the defined f-structure and do not add information of their own:

   (b) $(\uparrow \text{FEATURE})$ constrains the f-structure to contain the feature FEATURE, but with any value.

   (c) $\neg(\uparrow \text{FEATURE})$ constrains the f-structure to *not* contain the feature FEATURE.

   Existential constraints are the *conditioning environment* of a vocabulary item. Negated existential constraints are the *restricted environment* of a vocabulary item.

For example, consider VI (37) from the fragment in §5.4 below. This morpheme *-m* is prohibited from appearing in f-structures that contain GENDER. The lack of GENDER is how NEUTER is defined. Therefore, NEUTER morphology is explicitly those vocabulary items which express f-structures that don't contain gender.

(37) $\left\langle \begin{array}{l}\text{[K], @NOM} \\ \langle\!\langle \neg(\uparrow \text{GENDER}) \rangle\!\rangle\end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix}\text{PHONREP} & /\text{m}/ \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}{=}2 \\ \text{HOST} & \begin{bmatrix}\text{IDENT} & + \\ \text{CLASS} & \text{X}\end{bmatrix}\end{bmatrix}$

Note that we have used an arbitrary double-angle notation $\langle\!\langle\ \rangle\!\rangle$ to highlight constraining equations (including existential and negative existentials). In other words, we use $\langle\!\langle\ \rangle\!\rangle$ to indicate a constraint on the (independently) defined f-structure. VI (37) is an example of *restricting* exponence using a negative existential constraint.

Now let's look at an example of *conditioning* exponence using a positive existential constraint. As we see in (36), again from §5.4 below, the morpheme *-s* is conditioned by f-structures that contain the GENDER feature.

(36) $\left\langle \begin{array}{l}\text{[K], @NOM} \\ \langle\!\langle (\uparrow \text{GENDER}) \rangle\!\rangle\end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix}\text{PHONREP} & /\text{s}/ \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}{=}2 \vee \text{X}{=}3 \vee \text{X}{=}4 \vee \text{X}{=}5 \\ \text{HOST} & \begin{bmatrix}\text{IDENT} & + \\ \text{CLASS} & \text{X}\end{bmatrix}\end{bmatrix}$

It will therefore only appear in MASCULINE or FEMININE environments. Note that this is functionally equivalent to DM's use of secondary exponence here, where *-s* would be a secondary exponent of the GENDER feature. However, because this is a constraint on a local f-structure, the phenomenon is captured entirely locally, whereas secondary exponence in standard DM is not inherently local. Additionally, There is no claim of *multiple exponence* here with respect to GENDER. Therefore, feature discharge is not an issue, because GENDER is not exponed twice but rather just conditions the allomorph.

4 Metasyncretism and secondary exponence in action

Let's look at Table 5, which shows the Latin declension paradigms for dative and ablative case; recall that paradigms are not objects in L_RFG theory—they are just useful ways to organize data.[6,7] In most declensions, there is a contrast between DATIVE and ABLATIVE in the singular that is always lost in the plural. The PLURAL-conditioned case marker does not span the PLURAL feature, which is realized independently as *-s*. The phenomena that need to be captured here are:

1. The consistent CASE metasyncretism conditioned by PLURAL
2. The secondary exponence of the PLURAL feature on the case marker

	Class 1		2		3		4		5	
	SG	PL	SG	PL	SG	PL	SG	PL	SG	PL
DAT	aqu-*a*-*j*	aqu-*i:*-*s*	do:n-*o*-*μ*	do:n-*i:*-*s*	re:g-*i:*	re:g-*ibu*-*s*	fru:ct-*u*-*i:*	fru:ct-*ibu*-*s*	r-*e:*-*i:*	r-*e:*-*ibu*-*s*
	aquae	*aqui:s*	*do:no:*	*do:ni:s*	*re:gi:*	*re:gibus*	*fru:ctui:*	*fru:ctibus*	*rei:*	*re:bus*
ABL	aqu-*a*-*μ*	aqu-*i:*-*s*	do:n-*o*-*μ*	do:n-*i:*-*s*	re:g-*e*	re:g-*ibu*-*s*	fru:ct-*u*-*μ*	fru:ct-*ibu*-*s*	r-*e:*-*μ*	r-*e:*-*ibu*-*s*
	aqua:	*aqui:s*	*do:no:*	*do:ni:s*	*re:ge*	*re:gibus*	*fru:ctu:*	*fru:ctibus*	*re:*	*re:bus*

Table 5: Latin DATIVE and ABLATIVE (Allen & Greenough 1888, Crowder 2024)[8]

Example (27), from §5.4 below, shows the regular plural marker that appears in all PLURAL environments except genitive plural. This analysis of the regular plural marker comes from Myler (2024).[9]

(27) $\langle\ [\#],\ @\mathrm{PL}\ \rangle \xrightarrow{\nu} \begin{bmatrix} \mathrm{PHONREP} & /\mathrm{s}/ \\ \mathrm{DEP} & \mathrm{LT} \\ \mathrm{HOST} & \begin{bmatrix} \mathrm{IDENT} & + \end{bmatrix} \end{bmatrix}$

Example (47), also in §5.4 below and initially presented in (9) above, is where our analysis of secondary exponence and metasyncretism is demonstrated.

[6]Case endings are shown in blue/underlined, number marking in red/double-underlined, and the noun stem and the theme vowel are given in plain black. When the theme vowel is not segmented separately, it has been deleted by the regular phonology. Note that this represents our Mylerian reanalysis; see discussion at Table 1 above.

[7]Astute readers may note that we omitted the possibility of the form *-ubus* as a possible allomorph in fourth declension nouns. In treating these forms as exceptional, we are following Oniga (2014: 82), who states, "An archaic or perhaps analogical ending *-ubus* for the dative and ablative plural is rarely attested. In Classical Latin, the *-ibus* form was generalized."

[8]We are aware that Crowder (2024) is a non-academic source, but it is accurate and easily accessible.

[9]Note that it is not the only vocabulary item that is realized as *s*: not all *s*'s are plural markers.

(47) $$\langle\ [\text{K}],\ @\textsc{dat}\ \langle\!\langle(\uparrow \textsc{plural})\rangle\!\rangle\ \rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & /\text{i:}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1 \vee \textsc{x}{=}2 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \textsc{phonrep} & /\text{ibu}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3 \vee \textsc{x}{=}4 \\ & \vee\ \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

With respect to secondary exponence, the VI is conditioned by the feature PLURAL, so it will appear in PLURAL environments, but does not expone PLURAL. With respect to metasyncretism, the right-hand side of the VI is disjunctive—giving one form in first and second declension and another form in the other declensions. This VI will appear in both DATIVE and ABLATIVE, because 1) DATIVE is a subset of ABLATIVE (the latter has one more feature) and 2) there is no competing ABL suffix in the fragment (the only VI specified with ABLATIVE is restricted from PLURAL environments; see (49) below).[10]

5 The Latin declension system: A fragment

This section contains the complete L_RFG analysis of Latin declension, which we present in the form of a fragment (a sub-grammar and vocabulary for a specific phenomenon). Since L_RFG fragments are by their nature a list of rules, macros, and vocabulary items, we present some exposition as we go.

5.1 Macros

There are three main kinds of macros in the fragment.[11] The first, which is featured across L_RFG analyses of all languages, is the *root individuation* macro, which individuates distinct $\sqrt{\ }$ categories by their PRED value.

(11) $\textsc{root}(\textsc{x}) := (\uparrow \textsc{pred}) = \text{`}\textsc{x}\text{'}$

The macro defines the PRED feature in the standard LFG way; as in LFG, we assume that the PRED value, demarcated by single quotes, is uniquely instantiated. This has the function of making sure that different 'stems' that have the same category in the c-structure ($\sqrt{\ }$) are still morphologically distinguishable from each other; see Siddiqi (2024) for discussion of root individuation in the context of L_RFG.

The second kind of macro concerns feature selection/association. We designate these with a ! and call them *bang macros*. We refer to them in speech as *number bang*, etc. Since singular is unmarked, there is only one number feature, PLURAL, in our fragment. Therefore, NUM! only calls the feature PLURAL; singular is just the absence of that feature.

(12) $\textsc{num}! := @\textsc{pl}$

[10] We have indicated restrictions with a negation: these preclude insertion in these environments. These are *not* negative features. We have only indicated preclusions when necessary for the fragment. In principle, there could be other (vacuous) preclusions present that we cannot detect in the analysis.

[11] By 'kinds' we do not mean to imply that there is a formal distinction, but rather that they serve different functions in the theory.

Latin has three genders: masculine, feminine, and neuter. Neuter is analyzed as the absence of a gender feature, much like singular modulo number. Therefore, GEND! calls a disjunction between two macros, MASC and FEM, where the latter contains the feature introduced by the former.

(13) GEND! := { @MASC | @FEM }

Latin has six cases, all of which are marked morphologically, so CASE! calls six case macros. These macros, like the ones for GENDER, are in a containment relationship, as described below.

(14) CASE! := { @NOM | @VOC | @ACC | @GEN | @DAT | @ABL }

In sum, bang macros give the possible c-structural exponenda[12] for the features in question by calling any of the specified range of particular macros. In any given c-structure, only one of the disjuncts appears. Thus, CASE!, for example, specifies the range of possible cases, only one of which is chosen on any given occasion. See examples (25) and (26) below. Note that this is distinct information from the category K, which is only responsible for the *distribution* of case (in c-structure) not the featural content/valuation of case in f-structure.

The third kind of macro is macros like PL, which just add a privative feature to the structure.

5.1.1 Feature containment

As mentioned in the previous section, feature macros in L_RFG often call other macros. This naturally gives rise to feature containment in terms of f-structural subsumption. Thus, macro cascades capture feature entailments which define hierarchies (of entailments); these are called *feature geometries* by Harley & Ritter (2002). This is particularly evident in the case of the gender and case macros below.

First, though, we consider the number macro, which defines a trivial/deficient hierarchy, since there is only one marked number feature in our analysis:

(15)

Number	**Hierarchy**
PL := $(\uparrow$ PLURAL$) = +$	PLURAL

In short, there is nothing 'below' PLURAL: it entails no further number features and singular is analyzed as the absence of plural.

Since GENDER has two features, it defines a non-deficient hierarchy:

(16)

Gender	**Hierarchy**
MASC := $(\uparrow$ GENDER$) = +$	GENDER | FEMININE
FEM := @MASC $(\uparrow$ FEMININE$) = +$	

[12]Recall that, in L_RFG the source of exponence includes both the c-structure category and the f-structural features associated with the category by c-structure rules. In other words, the terminal nodes in L_RFG for exponence are pairs of categorial/featural information. The terminal node is not the thing sitting under the pre-terminal category, as in standard LFG.

Notice that the MASC macro does not introduce a MASCULINE feature, but rather introduces a GENDER feature. Thus, masculine expresses the GENDER feature, which is also contained by feminine (Kramer 2015).[13]

The case hierarchy is considerably more complex than the gender hierarchy and has been determined by syncretism patterns.[14]

(17) **Case**

NOM := (↑ NOMINATIVE) = +

ACC := @NOM
(↑ ACCUSATIVE) = +

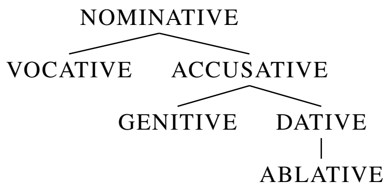
VOC := @NOM
(↑ VOCATIVE) = +

GEN := @ACC
(↑ GENITIVE) = +

DAT := @ACC
(↑ DATIVE) = +

ABL := @DAT
(↑ ABLATIVE) = +

Hierarchy



Note that we have added VOCATIVE mainly because it's straightforward to do so, but we follow the literature in not discussing it.

5.2 Lists

The second major part of our analysis is the LIST macro, which has not featured in previous L_RFG work. In the present paper, it merely captures which PRED FN values each declension class applies to—where the value of PRED FN is the general predicate function without uniqueness (Crouch et al. 2011)—because we assume that declension class is arbitrary and listed. For example, there is nothing about 'water' that puts it in the first declension; it is simply a fact that Latin learners must store. Of special note in the list below is that 'royal' appears in class 3, but also in M_1 and M_2, which is our way of encoding that the PRED FN royal appears in three different declensions with slightly different meanings (*rex* 'king', *regina* 'queen', *regnum* 'rule, authority. kingdom'). We use 'royal' to cover all these cases.[15]

[13]Of course, the GENDER feature could be called MASCULINE, but some might find it confusing in the feminine case, since the forms would be marked as MASCULINE *and* FEMININE.

[14]The analysis of case in terms of a feature breakdown is not new to f-structure; see Dalrymple et al. (2009).

[15]Note that the particular chosen indices are arbitrary up to identity. Since these only roughly correspond to declension class numbers, we have avoided using numerals to forestall confusion.

(18)
$$\text{LIST}(\text{X}) := \begin{array}{l} \text{X} = a \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_1 \\ \text{X} = b \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_2 \\ \text{X} = c \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_3 \\ \text{X} = d \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_{3m} \\ \text{X} = e \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_{3i} \\ \text{X} = f \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_4 \\ \text{X} = g \Rightarrow (\uparrow \text{PRED FN}) \in \text{C}_5 \\ \text{X} = v \Rightarrow (\uparrow \text{PRED FN}) \in \text{M}_1 \\ \text{X} = w \Rightarrow (\uparrow \text{PRED FN}) \in \text{M}_2 \\ \vdots \end{array} \quad \& \quad \begin{array}{l} \text{C}_1 = \{\ \text{water}, \dots\ \} \\ \text{C}_2 = \{\ \text{gift}, \dots\ \} \\ \text{C}_3 = \{\ \text{royal}, \dots\ \} \\ \\ \vdots \\ \\ \\ \text{M}_1 = \{\ \text{royal}, \dots\ \} \\ \text{M}_2 = \{\ \text{royal}, \dots\ \} \\ \vdots \end{array}$$

The LIST macro can in fact be used for controlling any kind of lexicalized information, including capturing exceptions to general patterns. Thus, we expect the LIST macro to feature prominently in L_RFG fragments. Note that in each case, a particular clause is triggered conditionally by an index passed through the phrase structure, which brings us to the next section.

5.3 Phrase structure

The third major ingredient of any L_RFG analysis is a set of annotated phrase structure rules for licensing c-structures, as in LFG.

5.3.1 Metarules

A *metarule* (Gazdar et al. 1985) is a compact specification of multiple phrase structure rules. The numerical annotation on arrows in metarules stands for the number of distinct instantiations of the x c-structure variable, i.e. 9 possible instantiations in rule (19) and 7 in rule (20). We also introduce a new notational convention on our rules (including metarules): annotations that are about the relationship between c-structure and f-structure, i.e. the ϕ-mapping, are written above the category, whereas annotations for exponence, i.e. c-structure exponenda, are written below the category.

(19)
$$\text{n}_x\text{P} \xrightarrow{9} \underset{@\text{ROOT}(\_\_)}{\overset{\uparrow = \downarrow}{\surd}} \qquad \underset{\substack{@\text{LIST}(x) \\ (\ @\text{GEND!}\ )}}{\overset{\uparrow = \downarrow}{\text{n}_{x \,\in\, \{a,b,c,d,e,f,g,v,w\}}}}$$

(20)
$$\theta\text{P} \xrightarrow{7} \overset{\uparrow = \downarrow}{\text{n}_x\text{P}} \qquad \overset{\uparrow = \downarrow}{\theta_{x \,\in\, \{a,b,c,d,e,f,g\}}}$$

The combination of (19) and (20) links rules to declension class, via the call to the LIST macro in (19) and the specification of theme vowel in (20). The nominalizer (n) in (20) is never independently exponed. Thus, the reason there are nine nominalizers in (19) but only seven in (20) is because the nominalizers corresponding to n_v and n_w *are* independently exponed, as captured in rules (23) and (24) below. The nominalizer n_v creates first declension nouns and n_w creates second declension nouns.

5.3.2 Rules

The specific rules for Latin declension are reasonably straightforward given the discussion above. The only things to note here are: 1) when number appears, it appears outside the case marker, as captured by (21), and 2) case always appears outside the theme vowel, as captured by (22).

(21) $$\#\text{P} \rightarrow \begin{array}{c} \uparrow = \downarrow \\ \text{KP} \end{array} \left(\begin{array}{c} \uparrow = \downarrow \\ \# \\ @\text{NUM}! \end{array} \right)$$

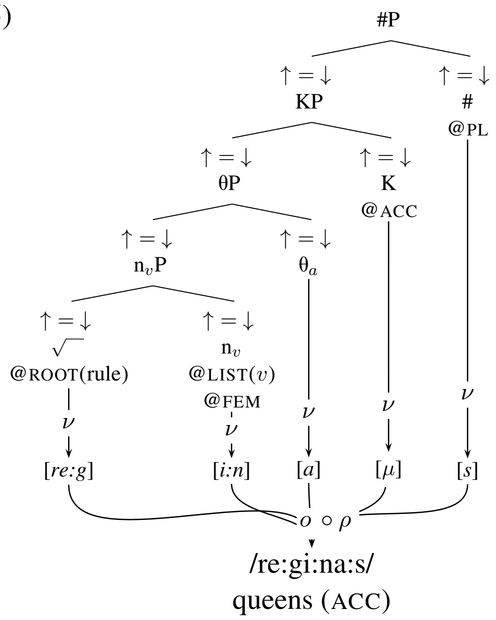
(22) $$\text{KP} \rightarrow \begin{array}{c} \uparrow = \downarrow \\ \theta\text{P} \end{array} \quad \begin{array}{c} \uparrow = \downarrow \\ \text{K} \\ @\text{CASE}! \end{array}$$

(23) $$\theta\text{P} \rightarrow \begin{array}{c} \uparrow = \downarrow \\ \text{n}_v\text{P} \end{array} \quad \begin{array}{c} \uparrow = \downarrow \\ \theta_a \end{array}$$

(24) $$\theta\text{P} \rightarrow \begin{array}{c} \uparrow = \downarrow \\ \text{n}_w\text{P} \end{array} \quad \begin{array}{c} \uparrow = \downarrow \\ \theta_b \end{array}$$

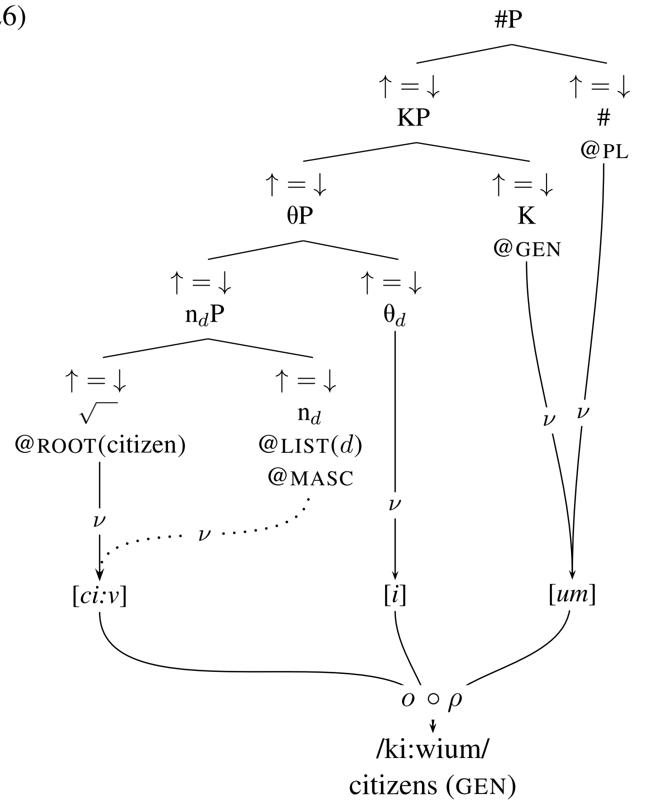
Examples (25) and (26) below show the c-structure and f-structure for two possible instantiations of the rules above. In the case of (25), these lead to the exponents [*re:g*], [*i:n*], [*a*], [μ], and [*s*]; in turn, these are mapped to the realization /re:gi:na:s/ ('queen.ACC-PL'), by the composition of the ρ correspondence function from v-structure to prosodic structure and the o correspondence function from prosody to the phonological string (Asudeh, Bögel & Siddiqi 2023: 39–41). Similarly, (26) leads to the exponents [*ci:v*], [*i*], and [*um*]. There is no exponent for n_d in (26) in the Vocabulary, so this node is *Pac-Man spanned* with the root (Asudeh, Bögel & Siddiqi 2023: 39), which is indicated by a dotted line. In the case of [*um*], this is a portmanteau form that *vocabulary spans* both case and number; see (46) below. These three exponents are mapped by $o \circ \rho$ to the realization /ki:wium/ ('citizen.GEN.PL').

(25)



$$\begin{bmatrix} \text{PRED} & \text{'royal'} \\ \text{GENDER} & + \\ \text{FEMININE} & + \\ \text{NOMINATIVE} & + \\ \text{ACCUSATIVE} & + \\ \text{PLURAL} & + \end{bmatrix}$$

(26)



PRED	'citizen'
GENDER	+
NOMINATIVE	+
ACCUSATIVE	+
GENITIVE	+
PLURAL	+

5.4 Vocabulary

This section contains the vocabulary items in the fragment's Vocabulary. These are listed by the role of the morpheme—whether it is part of number-marking, gender-marking, class-marking, or case-marking. A VI with a list of categories greater than 1, e.g. (46) below, is an instance of *vocabulary spanning*, whereby the VI spans two or more nodes in c-structure. For example, see c-structure (26) above, where K and # are exponed by the second option in the disjunction in (46), [*um*]. Recall that a disjunction on the right-hand side of a VI models metasyncretism. Recall also that the notation ⟪ ⟫ marks constraining equations (including existentials and negative existentials), which control secondary exponence; i.e., these constraints model morphological conditioning.

5.4.1 Number

(27) $\langle$ [#], @PL $\rangle \xrightarrow{\nu}$

PHONREP	/s/
DEP	LT
HOST	[IDENT +]

5.4.2 Nominalizers/gender

(28) $$\langle\ [\text{n}_v],\ @\text{FEM}\ \rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & \text{/i:n/} \\ \text{DEP} & \text{LT} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \end{bmatrix} \end{bmatrix}$$

(29) $$\langle\ [\text{n}_w],\ \varnothing\ \rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & \text{/n/} \\ \text{DEP} & \text{LT} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \end{bmatrix} \end{bmatrix}$$

5.4.3 Class

Note that θ_c is missing because it is zero-marked and therefore always spanned (Asudeh & Siddiqi 2023, Asudeh, Bögel & Siddiqi 2023: 39).

(30) $$\langle\ [\theta_a],\ \varnothing\ \rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & \text{/a/} \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}=1 \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{CLASS} & \text{X} \end{bmatrix} \end{bmatrix}$$

(31) $$\langle\ [\theta_b],\ \varnothing\ \rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & \text{/o/} \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}=2 \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{CLASS} & \text{X} \end{bmatrix} \end{bmatrix}$$

(32) $$\langle\ [\theta_d],\ \langle\!\langle(\uparrow \text{PL})\rangle\!\rangle\ \rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & \text{/i/} \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}=3 \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{CLASS} & \text{X} \end{bmatrix} \end{bmatrix}$$

(33) $$\langle\ [\theta_e],\ \varnothing\ \rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & \text{/i/} \\ \text{DEP} & \text{LT} \\ \text{CLASS} & \text{X}=3 \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{CLASS} & \text{X} \end{bmatrix} \end{bmatrix}$$

(34) $$\langle\ [\theta_f],\ \varnothing\ \rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & /\mathrm{u}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}4 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(35) $$\langle\ [\theta_g],\ \varnothing\ \rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & /\mathrm{e{:}}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

5.4.4 Case

(36) $$\left\langle\ \begin{array}{l} [\mathrm{K}],\ @\textsc{nom} \\ \langle\!\langle(\uparrow \textsc{gender})\rangle\!\rangle \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & /\mathrm{s}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}2\ \vee\ \textsc{x}{=}3\ \vee\ \textsc{x}{=}4\ \vee\ \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(37) $$\left\langle\ \begin{array}{l} [\mathrm{K}],\ @\textsc{nom} \\ \langle\!\langle\neg(\uparrow \textsc{gender})\rangle\!\rangle \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & /\mathrm{m}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}2 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(38) $$\left\langle\ \begin{array}{l} [\mathrm{K}],\ @\textsc{nom} \\ \langle\!\langle\neg(\uparrow \textsc{gender})\rangle\!\rangle \\ \langle\!\langle\neg(\uparrow \textsc{plural})\rangle\!\rangle \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & \mu \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}4 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(39) $$\left\langle\ \begin{array}{l} [\mathrm{K}],\ @\textsc{nom} \\ \langle\!\langle(\uparrow \textsc{plural})\rangle\!\rangle \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & \mu \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3\ \vee\ \textsc{x}{=}4\ \vee\ \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(40) $$\langle\ [\mathrm{K},\#],\ @\textsc{nom}\ @\textsc{pl}\ \langle\!\langle\neg(\uparrow\ \textsc{accusative})\rangle\!\rangle\ \rangle \xrightarrow{\nu} \left[\begin{array}{ll} \textsc{phonrep} & /\mathrm{j}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right] \vee \left[\begin{array}{ll} \textsc{phonrep} & /\mathrm{i{:}}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}2 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right]$$

(41) $$\langle\ [\mathrm{K},\#],\ @\textsc{nom}\ @\textsc{pl}\ \langle\!\langle\neg(\uparrow\ \textsc{gender})\rangle\!\rangle\ \rangle \xrightarrow{\nu} \left[\begin{array}{ll} \textsc{phonrep} & /\mathrm{a}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}2\ \vee\ \textsc{x}{=}3\ \vee\ \textsc{x}{=}4 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right]$$

(42) $$\langle\ [\mathrm{K}],\ @\textsc{acc}\ \langle\!\langle(\uparrow\ \textsc{gender})\rangle\!\rangle\ \rangle \xrightarrow{\nu} \left[\begin{array}{ll} \textsc{phonrep} & /\mathrm{m}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1\ \vee\ \textsc{x}{=}2\ \vee \\ & \textsc{x}{=}3\ \vee\ \textsc{x}{=}4\ \vee \\ & \textsc{x}{=}5 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right]$$

(43) $$\langle\ [\mathrm{K}],\ @\textsc{acc}\ \langle\!\langle(\uparrow\ \textsc{plural})\rangle\!\rangle\ \langle\!\langle(\uparrow\ \textsc{gender})\rangle\!\rangle\ \rangle \xrightarrow{\nu} \left[\begin{array}{ll} \textsc{phonrep} & \mu \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1\ \vee\ \textsc{x}{=}2 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right]$$

(44) $$\langle\ [\mathrm{K}],\ @\textsc{gen}\ \rangle \xrightarrow{\nu} \left[\begin{array}{ll} \textsc{phonrep} & /\mathrm{j}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right] \vee \left[\begin{array}{ll} \textsc{phonrep} & /\mathrm{i{:}}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}5 \\ \textsc{host} & \left[\begin{array}{ll} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{array}\right] \end{array}\right]$$

(45) $$\langle \text{[K], @}\textsc{gen} \rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & \text{/i:/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}2 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \textsc{phonrep} & \text{/is/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \textsc{phonrep} & \mu\cdot\text{/s/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}4 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(46) $$\left\langle \begin{array}{l} \text{[K,\#], @}\textsc{gen} \\ \quad\;\text{@}\textsc{pl} \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & \text{/rum/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1 \vee \textsc{x}{=}2 \vee \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \textsc{phonrep} & \text{/um/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3 \vee \textsc{x}{=}4 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

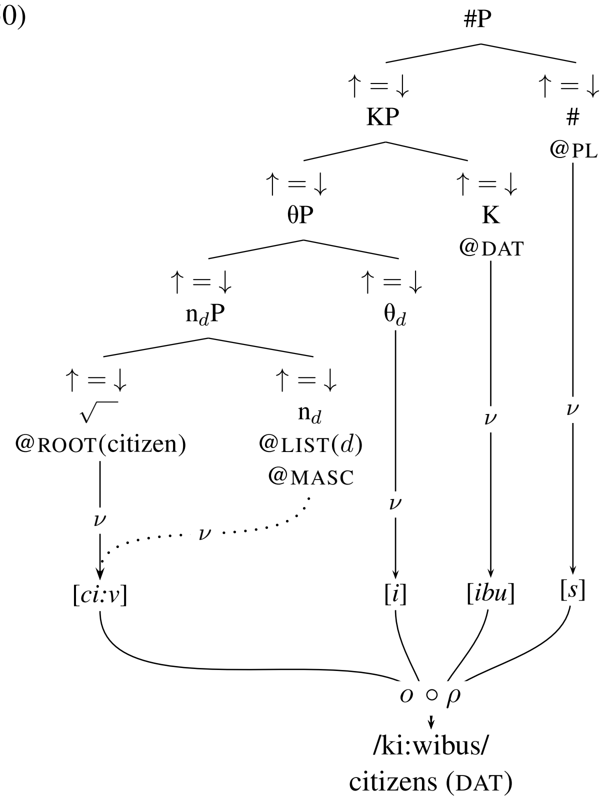
(47) $$\left\langle \begin{array}{l} \text{[K], @}\textsc{dat} \\ \quad\langle\!\langle(\uparrow \textsc{plural})\rangle\!\rangle \end{array} \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & \text{/i:/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1 \vee \textsc{x}{=}2 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \textsc{phonrep} & \text{/ibu/} \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3 \vee \textsc{x}{=}4 \\ & \vee\ \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$$

(48) $\langle\ [\mathrm{K}],\ @\textsc{dat}\ \rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & /\mathrm{i{:}}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3\ \vee\ \textsc{x}{=}4 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$

(49) $\left\langle\ [\mathrm{K}],\ \begin{matrix} @\textsc{abl} \\ \langle\!\langle \neg(\uparrow \textsc{plural}) \rangle\!\rangle \end{matrix}\ \right\rangle \xrightarrow{\nu} \begin{bmatrix} \textsc{phonrep} & \mu \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}1\ \vee\ \textsc{x}{=}4 \\ & \vee\ \textsc{x}{=}5 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix} \vee \begin{bmatrix} \textsc{phonrep} & /\mathrm{e}/ \\ \textsc{dep} & \textsc{lt} \\ \textsc{class} & \textsc{x}{=}3 \\ \textsc{host} & \begin{bmatrix} \textsc{ident} & + \\ \textsc{class} & \textsc{x} \end{bmatrix} \end{bmatrix}$

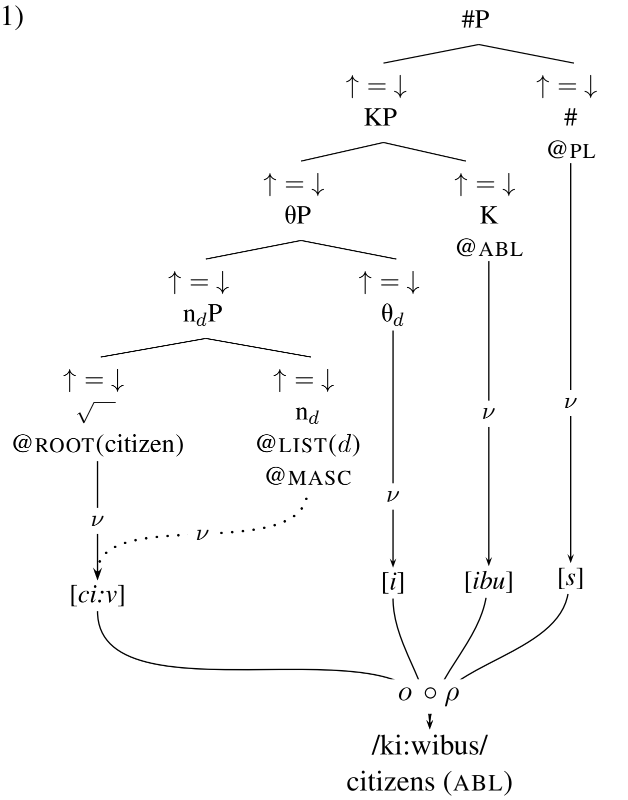
An example of these vocabulary items giving rise to syncretism occurs in the dative plural and ablative plural, as seen in (50) and (51) below.

(50)



$\begin{bmatrix} \textsc{pred} & \text{`citizen'} \\ \textsc{gender} & + \\ \textsc{nominative} & + \\ \textsc{accusative} & + \\ \textsc{dative} & + \\ \textsc{plural} & + \end{bmatrix}$

(51)



PRED	‘citizen’
GENDER	$+$
NOMINATIVE	$+$
ACCUSATIVE	$+$
DATIVE	$+$
ABLATIVE	$+$
PLURAL	$+$

Notice that the c-structure and f-structure for (50) and (51) are different: the c-structure for (51) calls the ABL macro and the f-structure for (51) has one additional feature, [ABLATIVE $+$]. However, both are realized by /ki:wibus/.[16] This is because *-ibu* is the best candidate for ablative plural and it is also the best candidate for dative plural. This happens since ablative case contains dative case—@ABL calls @DAT—and no ablative affix exists for the plural context. Thus, the less specified dative form appears.

6 Conclusion

L_RFG is an LFG-like theory that drills down into ‘words’ and offers a realizational morphology. Thus, L_RFG is a *morphemic*, realizational theory. One of the typical strengths of morphemic theories is a deeper analysis of polysynthesis, which seems an unlikely candidate for a paradigmatic approach. One of the typical weaknesses of morphemic theories is trouble with putative paradigmatic effects in fusional languages. Therefore it is incumbent on L_RFG to demonstrate that it can indeed provide analyses of fusional languages, of which Latin is a well-studied exemplar. We have delivered on this here.

[16] Note that the theme vowel deletes, which is why we get the realization /ki:wibus/ and not */ki:wi:bus/. The deletion of the theme vowel is due to a phonological rule in Latin that deletes short high vowels when they are preceded by a morpheme boundary and are followed by a morpheme boundary followed by /i/ (see Phonological Rule (27) in the supplemental materials accompanying Myler 2024).

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The story of *er*

Ash Asudeh
University of Rochester

Daniel Siddiqi
Carleton University

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Abstract

The English comparative *-er* is a particular challenge for contemporary morphological analysis. The comparative and superlative in English are in an ABB suppletion relationship, which strongly suggests a containment relationship. This in turn suggests that *-er* and *-est* are in competition with each other. This is a challenge for both morphemic and word-based models of morphology. Word-based models are particularly challenged by competition between morphological and periphrastic exponence. Morphemic models, like L_RFG (the model assumed here), have to deal with complex constraints on the affixal form. *More* and *-er* are in (mostly) complementary distribution, suggesting that they are allomorphs. The blocking of *-er* is not only triggered by phonology, but also by syntactic triggers and semantic triggers. Sometimes pure complementarity fails and both *more* and *-er* are licit (*I am even madder* and *I am even more mad*), but it does so in predictable ways (in contrast to true optionality). The net of all these properties is that the appearance of *-er* is the result of a complex competition involving two competitors (*more* and *-er*) and phonological, semantic, and syntactic conditions restricting their distributions.

1 Introduction

The English comparative *-er* is a particular challenge for contemporary morphological analysis (see, among others, Lindquist 2000, Mondorf 2003, Mondorf 2007, Hilpert 2008, Matushansky 2013, Dunbar & Wellwood 2016).[†] The comparative and superlative in English are in an ABB suppletion relationship (*good*^{A}, *better*^{B}, *best*^{B}; *bad*^{A}, *worse*^{B}, *worst*^{B}), which strongly suggests a containment relationship (Bobaljik 2012). This in turn suggests that *-er* and *-est* are in competition with each other; i.e., there is a common set of features that is a subset of the features they expone (e.g., COMP $+$, given Bobaljik 2012) and they expone a shared syntactic position.

Additionally, *more* and *-er* are in (mostly) complementary distribution, suggesting that they are allomorphs. This again suggests that they are in competition with each other. This particular competition is syntactically interesting because *more* is an independent, free form that appears to the left of the adjective, while *-er* is an affix that appears to the right of the adjective. In order for *more* and *-er* to compete with each other, according to realizational models of morphology including Distributed Morphology (DM) and therefore L_RFG, they must have a shared position of exponence. This suggests that, e.g., *more orange* and *redder* have identical c-structures.

The complementarity of *-er* and *more* seems to be such that monosyllabic stems get *-er* and trisyllabic-plus stems get *more* (*bigger* vs **enormouser*). We largely set disyllabic stems aside here, because there seems to be significant idiolectal variation between native speakers about the suitability of *-er* for such forms. For example, some speakers prefer *commoner* to *more common*, while this is reversed for other speakers; see also *little* and *stupid*. Since this competition is resolved based on the phonological nature

[†]We thank the members of the L_RFG Lab for their feedback on this material at various points. We also thank the audience at LFG 2024 for their questions and feedback. Lastly, we thank the two reviewers, who have both helped to improve the paper. Any remaining errors are our own. For more on L_RFG, visit our website: lrfg.online.

of the stem, we assume that this is caused by individual variation in the phonological restrictions of the affix and thus set it aside.

The blocking of *-er* is not only triggered by phonology, but also by syntactic triggers, as in (1), and semantic triggers, as in (2).

(1) The adornment is more pretty than practical.
$\neq$The adornment is prettier than practical.

(2) De'Aaron Fox was more clutch/*clutcher than any other player last year.

Finally, sometimes pure complementarity fails and both *more* and *-er* are licit

(3) I am even madder.

(4) I am even more mad.

Nevertheless, the variation is structurally and semantically predictable (in contrast to true optionality).

The net of all these properties is that the appearance of *-er* is the result of a complex competition involving two competitors (*more* and *-er*) and phonological, semantic, and syntactic conditions restricting their distributions.

2 Theoretical desiderata

The complex nature of this competition, which draws on mappings to multiple distinct representations, lends itself to a constraint-based, modular framework, such as LFG or L_RFG (for some recent work, and further references, see Asudeh & Siddiqi 2023, Asudeh, Bögel & Siddiqi 2023).

The overt competition of an affix and a free form (periphrasis) lends itself to a *lexical-realizational* (Stump 2001) approach, such as L_RFG. The designation *lexical* here means that morphological formatives are independent listed items and that these combine in complex forms. The designation *realizational* means that morphology *expresses* grammatical contrasts.

Given the complexity of the competitions, the English comparative represents the ideal morphological phenomenon to showcase all the different aspects of analysis in L_RFG and to provide the basis for a 'soup-to-nuts' demonstration of the framework, which is constraint-based, modular, and lexical-realizational. The English comparative thus also presents an opportunity for a a step-by-step primer on L_RFG analysis.

3 Morphological analysis

3.1 Determine allomorphy

Complementary distribution and blocking are the best ways to determine a suppletive allomorphy relationship (see Siddiqi 2024 for discussion). In the case of regular affixal morphology, we identify a systematic phonological alternation covarying with a systematic semantic/formal alternation. In the case of irregular allomorphy, we use the existence of that regular covariance to justify our assumption that a different phonological alternation is an irregular covariance with the same semantics (i.e., the irregular and the regular are in complementary distribution). We accept a proposed irregular covariance specifically when it blocks the regular covariance.

Following Bobaljik (2012), a standard approach to the distribution of comparatives and superlatives is some type of feature containment.[1] This is because G(rade) is the standard-bearer for the so-called **A/B/A* pattern. We assume that G is the syntactic category that hosts the features COMPARATIVE and SUPERLATIVE, i.e. G is the category of *-er/-est/more/most* and these project a Grade Phrase.[2] The typological claim here is as follows: if the comparative is suppletive for a given root, the superlative is never regular. The theoretical claim is that this pattern arises precisely because superlatives also express the featural content of comparatives (in addition to the feature that marks superlative). In the specific case of *-er* and *-est*, the *A/B/B* pattern occurs and *A/B/A* never occurs, as expected. There is thus arguably a subsumption relationship between the comparative and the superlative in English, such that the superlative properly contains the comparative information and therefore blocks it.

The blocking relationship between *more* and *-er* is perhaps more nuanced because it involves periphrasis (among others, Poser 1992, Embick & Noyer 2001, Kiparsky 2005, Ackerman et al. 2011), but in this case we can glean from the history of *-er* that, in contemporary English, *more* has changed from supporting *-er* to competing with it (Huddleston & Pullum 2002). We assume that *-er/-est* is morphophonologically restricted, while *more/most* is the elsewhere form.

We thus have four vocabulary items in English expressing the category G(rade): *-er*, *-est*, *more*, and *most*. As above, the superlatives outcompete the comparatives in superlative environments. The affixes outcompete the free forms in morphophonologically restricted environments. This complex competition is summarized in Table 1.

	Containment		
Morphophonologically unrestricted	*more*	$\sqsubset$	*most*
Morphophonologically restricted	*-er*	$\sqsubset$	*-est*

Table 1: English markers of comparative and superlative

3.2 Determine the vocabulary structure for each vocabulary item

The vocabulary items for *-er* (5a), *-est* (5b), *more* (5c), and *most* (5d) are listed below. The exponenda are in angled brackets (category, morphosyntactic features and interpretation). These map to the v(ocabulary)-structures (exponents; Asudeh, Bögel & Siddiqi 2023) in terms of descriptions of v-structures on the right hand side of the ν-mapping. However, it is more convenient and probably clearer to show the feature structure that satisfies the description than it is to show the description itself; we therefore continue to

[1]We remind the reader that, in L$_R$FG, more morphologically complex forms compete with less morphologically complex forms for exponence. For example, *feet* is competing with *foot* in the plural context. Bobaljik (2012) convincingly argues that the superlative is more complex than and includes the comparative. Therefore, all superlative forms are competing with comparative forms.

[2]We base Grade on Huddleston & Pullum (2002: 1580). We have not used the perhaps more familiar CmprP and SuprP, because we have no need for two syntactic positions. We could have used Degree (Phrase) or something else instead of Grade (Phrase).

use this representational convenience. For more discussion of this point and for further explication of v-structure features, see (Asudeh, Bögel & Siddiqi 2023):[3]

(5) a. $\langle$ [G], @CMPR $\rangle \xrightarrow{\nu}$
$\lambda\mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$

$$\begin{bmatrix} \text{PHONREP} & /\text{ə}\text{ɹ}/ \\ \text{PFRAME} & ((\ \ )_\sigma(\cdot)_\sigma)_{ft} \\ \text{PDOMAIN} & (\ \ )_\omega \\ \text{DEP} & \text{LT} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{PFRAME} & (\ \ )_\sigma((\ \ )_{\sigma=\mu}) \end{bmatrix} \end{bmatrix}$$

b. $\langle$ [G], @SUPR $\rangle \xrightarrow{\nu}$
$\lambda\mathcal{P}_{es}.[\mathbf{supr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$

$$\begin{bmatrix} \text{PHONREP} & /\text{əst}/ \\ \text{PFRAME} & ((\ \ )_\sigma(\cdot)_\sigma)_{ft} \\ \text{PDOMAIN} & (\ \ )_\omega \\ \text{DEP} & \text{LT} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{PFRAME} & (\ \ )_\sigma((\ \ )_{\sigma=\mu}) \end{bmatrix} \end{bmatrix}$$

c. $\langle$ [G], @CMPR $\rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & /\text{moɹ}/ \\ \text{PFRAME} & (\cdot)_\omega \end{bmatrix}$
$\lambda\mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$
$(\ \lambda P_{et}.[\mathbf{grade}_{\langle et,es\rangle}(P)]_{es}\ )$

d. $\langle$ [G], @SUPR $\rangle \xrightarrow{\nu} \begin{bmatrix} \text{PHONREP} & /\text{most}/ \\ \text{PFRAME} & (\cdot)_\omega \end{bmatrix}$
$\lambda\mathcal{P}_{es}.[\mathbf{supr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$
$(\ \lambda P_{et}.[\mathbf{grade}_{\langle et,es\rangle}(P)]_{es}\ )$

Note that we will return to further discussion of the **grade** function in §5 and §6.4. In the case of *more*, (5c), and *most*, (5d), since they are free forms, the v-structure is limited to its phonological and prosodic form. In the case of *-er*, (5a), and *-est*, (5b), which are instead affixes with phonological and prosodic restrictions, the v-structures encode these restrictions in their PFRAME and PDOMAIN features. They are suffixes, so they have left dependency (DEP(ENDENT) LT). There are phonological and syntactic restrictions on the nature of these affixes' hosts, so they have HOST features as well. In particular, [HOST [IDENT +]] specifies that the affix must be hosted by the c-structurally closest head that shares its v-structure. The other HOST feature, PFRAME, restricts the prosody of candidate hosts, such that the host must be no larger than a foot.[4]

[3] Note that $\cdot$ represents the ρ-mapping of the current v-structure.

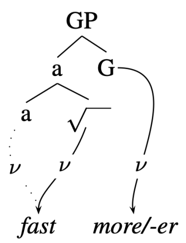
[4] In general, *-er* can be safely suffixed to monosyllabic hosts, but speakers vary somewhat as to which disyllabic hosts it can be suffixed to. We have taken a first step towards capturing this, by allowing an

4 Syntactic analysis

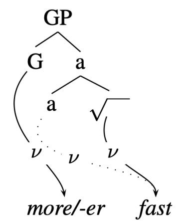
4.1 Determine shared c-structures

Because of the nature of lexical-realizational morphology, the c-structure is agnostic to the particular v-structures that it maps to. Therefore, when two vocabulary items (VIs) are shown to be in competition, they must share a position of exponence in the c-structure. There are two possible c-structures to consider because *more* surfaces on the left and *-er* surfaces on the right. We hypothesize—for simplicity and in the spirit of the standard LFG assumption that c-structure is surface-true barring prosodic effects—that one of the two candidates surfaces in its c-structural position, so we are considering only two underlying c-structures (6a,b).

(6) a.



b.



The VI for *more* (5c) does not have any phonological or syntactic constraints that would cause the order of its prosodic/phonological realization to differ from the order of its c-structure yield, so we would by default assume that (6b) is the shared c-structural representation. Furthermore, *-er* (5a) does have HOST and DEP properties that would trigger a mismatch, so we can reject (6a) as the shared representation. In short, for these reasons, when an affix and a free form are in competition, we by default assume that the free form's position is the underlying c-structural position. In the case of English, which is by hypothesis a head-initial language, general headedness properties would also lead us to assume that the functional/synthetic comparative head, which selects for an adjective, appears on the left.

4.2 Determine realized linear order

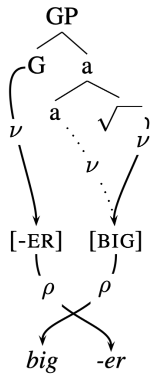
We now have to identify the mechanism by which *-er* occurs on the right while *more* occurs on the left. The DEP feature of *-er* (value LT) requires *-er*'s host to appear to the left of the affix. The [HOST [IDENT +]] feature requires that *-er*'s host is the adjective, which is the nearest head. This triggers prosodic inversion (Asudeh, Bögel & Siddiqi 2023).

The re-ordering of the affix and host is handled at p(rosodic)-structure, via the ρ correspondence function; see Asudeh et al. (2023) for a comparable example with *blacken* and further discussion. The $\mathrm{L_R}$FG c-structure is shown in (8), with additional ρ-mappings.

---

optional, second monomoraic syllable in the host. We have taken this step because there does seem to be agreement between speakers on these particular disyllabic roots, such as *happy* and *silly*.

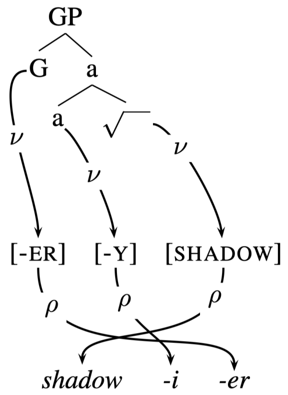
(7)



The dotted line in the c-structure (and the ones in those above) indicate *Pac-Man Spanning*, which is the mechanism that $\mathrm{L_R}$FG uses to map otherwise unexponed nodes to an exponent, thus dispensing with empty exponents (for some further discussion, see Asudeh et al. 2023).

Note that, in other cases, the adjectivizer does get realized, as in *shadow-y-er*:

(8)



See §6.3.1 below for further discussion of cases like the latter.

4.3 Determine f-structures in common

We assume here that *more* and *-er* have identical f-structures, because their competition is never resolved via f-structural featural content. The competition is resolved via phonological and semantic conditioning. Turning to *-er* and *-est*, these in contrast are in a straight-forward containment relationship. We know this because any suppletive form that applies to the comparative also applies to the superlative (e.g, *better* and *best*; see Bobaljik 2012). In $\mathrm{L_R}$FG, containment relationships are captured via *macros* (originally called "templates" by Dalrymple et al. 2004) which call other macros; see, e.g., the formalization of the Ojibwe person hierarchy in Melchin et al. (2020). In this case, @SUPR calls @CMPR, as in (9).

(9) a. SUPR := $(\uparrow$ SUPERLATIVE$) = +$
@CMPR

b. CMPR := $(\uparrow$ COMPARATIVE$) = +$

This results in f-structures like the following:

(10) a. $f\begin{bmatrix}\text{COMPARATIVE} & + \\ \text{SUPERLATIVE} & +\end{bmatrix}$ b. $g\begin{bmatrix}\text{COMPARATIVE} & +\end{bmatrix}$

Note that g properly subsumes f ($g \sqsubset f$); i.e. f-structure f contains the information that g does and more.

5 Semantic analysis

5.1 Determine compositional semantics

The semantic analysis of the comparative and superlatives is not our primary aim. However, we postulate that a distinction between the semantics of *-er* vs *more* (and *-est* vs *most*) accounts for *more/most*'s greater freedom of distribution.[5]

(11) De'Aaron Fox was more clutch/*clutcher than any other player last year.

(12) Kudrow's performance was more wooden/*woodener than Sorvino's.

Therefore, we need to present at least a sketch of a semantic analysis to show how the semantics can account for the distinction.

We adapt a basic, lexicalist degree semantics to a Glue Semantics context (Dalrymple 1999, Asudeh 2023). There has been much work on the semantics of comparatives, superlatives, and gradability. The standard reference for most modern approaches are Kennedy (1999, 2007) and Kennedy & McNally (2005), but see Burnett (2017) or Wellwood (2019) for recent monographs and further references therein. Here we build on Wellwood's (2019) characterization of a lexicalist approach.[6]

Wellwood (2019: 23) assumes the following types:

(13) **Semantic types**

a. e, v, s, t are the basic semantic types.

b. If δ, τ are semantic types, then $\langle \delta, \tau \rangle$ is a semantic type.
Notation: $\langle \delta, \tau \rangle \equiv \delta\tau$

c. Nothing else is a semantic type.

The types denote entities (e), events (v), degrees (s),[7] and truth values (t).

We also adopt Wellwood's notational conventions for variables:

(14) **Notational conventions**

a. $x, y, z, \ldots$ range over entities of type e (entities)

b. $e, e', e'', \ldots$ range over entities of type v (events)

c. $d, d', d'', \ldots$ range over entities of type s (degrees)

[5]Note that some speakers disprefer *woodener* due to the root *wooden* being disyllabic; see discussion above.

[6]Wellwood (2019) is in fact about developing an alternative to this approach, but this is the most familiar approach and her presentation is particularly clear. Again, the aim of this paper is not to argue for or against particular analyses of the phenomenon.

[7]This s is not to be confused with Montague's use of s as the non-basic/lexicalized intensional type s.

With these in hand, let us re-examine the meaning constructors for *-er* and *more* from (5a) and (5c) above, which are respectively repeated in (15a) and (15b). In this paper, we show only the meaning language side of the meaning constructors, but they are assumed to have a Glue/linear logic side of the usual kind as well.

(15) a. $\lambda \mathcal{P}_{es}.[\textbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$

b. $\lambda \mathcal{P}_{es}.[\textbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$
$(\ \lambda P_{et}.[\textbf{grade}_{\langle et,es\rangle}(P)]_{es}\ )$

The function **cmpr** is the following function from Wellwood's (2019: 26, (63)) approach:[8]

(16) $\textbf{cmpr}_{\langle es,\langle s,et\rangle\rangle} := \lambda g_{es} \lambda d_s \lambda x_e.g(x) > d$

The function **cmpr** takes three arguments: a gradable predicate (type es), a degree scale (type s), and an individual. The function applies the predicate of degrees to its entity argument and returns true if the entity's degree on the scale is greater than the degree taken as an argument.

The function **grade** maps from predicates of entities (type $\langle e, t\rangle$) to the denotation of a gradable adjective, which is type $\langle e, s\rangle$, i.e. a function that maps entities to degrees.[9]

(17) $\textbf{grade}_{\langle et,es\rangle} := \lambda P_{et} \lambda x_e.P(x) = \top | [\exists d_s.P_\delta(x)]_s$

The Glue proofs for two basic examples are shown in Figure 1; we continue to suppress the linear logic part of meaning constructors and show only the meaning language. Note that **intelligent** is already gradeable, so the **grade** function does not play a role here. We return to **grade** in §6.4.

6 Resolve competitions

6.1 Containment via f-structure features

The competition between *-er* (5a) and *-est* (5b) is located in the f-structures (and is thus codified in the exponenda, which are the left-hand side of the VIs). In (5a), *-er* is specified as exponing the contents of the template/macro @CMPR. In (5b), *-est* is specified as exponing the contents of the template @SUPR, which in turn calls the template @CMPR. Thus, superlative f-structures contain (are subsumed by) comparative f-structures.

(18) $\begin{bmatrix}\text{COMPARATIVE} & +\end{bmatrix}$

(19) $\begin{bmatrix}\text{COMPARATIVE} & + \\ \text{SUPERLATIVE} & +\end{bmatrix}$

[8] Wellwood (2019: 31, (84)) subsequently generalizes this function so that its type e arguments are of a type that is ambiguous between entities and events, such that all instances are either entities or events, but we do not need this extra refinement for our purposes.

[9] The δ notation on P_δ is meant to evoke degrees and is just meant to serve as a reminder that this is not a variable P of type et but is rather a variable P of type es, a predicate of degrees.

taller

$$\dfrac{\dfrac{\overset{\textit{tall}}{\lambda y_e.[\mathbf{tall}(y)]_s} \quad \overset{\textit{-er}}{\lambda \mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}}}{[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\lambda y_e.[\mathbf{tall}(y)]_s)]_{\langle s,et\rangle}} \multimap_{\mathcal{E}} \quad [(\lambda g_{es}\lambda d_s \lambda x_e.g(x) > d)_{\langle es,\langle s,et\rangle\rangle}(\lambda y_e.[\mathbf{tall}(y)])_s]_{\langle s,et\rangle}}{\dfrac{[\lambda d_s \lambda x_e.(\lambda y_e.[\mathbf{tall}(y)])_s(x) > d]_{\langle s,et\rangle}}{\lambda d_s.\mathbf{tall}(x) > d} \Rightarrow_\beta} \text{def}_{\mathbf{cmpr}}$$

more intelligent

$$\dfrac{\dfrac{\overset{\textit{intelligent}}{\lambda y_e.[\mathbf{intelligent}(y)]_s} \quad \overset{\textit{more}_1}{\lambda \mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}}}{[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\lambda y_e.[\mathbf{intelligent}(y)]_s)]_{\langle s,et\rangle}} \multimap_{\mathcal{E}} \quad [(\lambda g_{es}\lambda d_s \lambda x_e.g(x) > d)_{\langle es,\langle s,et\rangle\rangle}(\lambda y_e.[\mathbf{intelligent}(y)])_s]_{\langle s,et\rangle}}{\dfrac{[\lambda d_s \lambda x_e.(\lambda y_e.[\mathbf{intelligent}(y)])_s(x) > d]_{\langle s,et\rangle}}{\lambda d_s.\mathbf{intelligent}(x) > d} \Rightarrow_\beta} \text{def}_{\mathbf{cmpr}}$$

Figure 1: Proofs for *taller* & *more intelligent*

For f-structures containing the contents of @SUPR, $\textbf{MostInformative}_f$ selects *-est*, which has the most features (Asudeh & Siddiqi 2023).[10,11]

(20) $\textbf{MostInformative}_f(\alpha, \beta)$ returns whichever of α,β has the most specific f-structure in the set of f-structures returned by Φ applied to α/β's collected f-description.[12]

Intuition. Prefer portmanteau forms, whenever possible, on f-structural grounds. Choose the VI that defines an f-structure that contains the greater set of features.

Formalization. The proper subsumption relation on f-structures (Bresnan et al. 2016: chap. 5) is used to capture the intuition.

Given two VIs, α and β,

$$\textbf{MostInformative}_f(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \exists f.f \in \Phi(\pi_2(\pi_1(\alpha))) \wedge \forall g.g \in \Phi(\pi_2(\pi_1(\beta))) \rightarrow g \sqsubset f \\ \beta \textbf{ if } \exists f.f \in \Phi(\pi_2(\pi_1(\beta))) \wedge \forall g.g \in \Phi(\pi_2(\pi_1(\alpha))) \rightarrow g \sqsubset f \\ \perp \textbf{ otherwise} \end{cases}$$

Given an f-structure that contains SUPERLATIVE, as in (19), the competition proceeds as follows.

(21)
$$\textbf{MostInformative}_f\left(\begin{array}{l} \underline{\textit{-er}} \\ \langle [\text{G}], @\text{CMPR} \qquad \rangle \\ \qquad \lambda\mathcal{P}_{\langle s,et\rangle}.[\textbf{cmpr}(\mathcal{P})]_{\langle s,et\rangle} \end{array}, \begin{array}{l} \underline{\textit{-est}} \\ \langle [\text{G}], @\text{SUPR} \qquad \rangle \\ \qquad \lambda\mathcal{P}_{\langle s,et\rangle}.[\textbf{supr}(\mathcal{P})]_{\langle s,et\rangle} \end{array} \right)$$

$$= \textbf{MostInformative}_f\left(\begin{array}{l} \underline{\textit{-er}} \\ \begin{bmatrix} \text{COMPARATIVE} & + \end{bmatrix} \end{array}, \begin{array}{l} \underline{\textit{-est}} \\ \begin{bmatrix} \text{COMPARATIVE} & + \\ \text{SUPERLATIVE} & + \end{bmatrix} \end{array} \right)$$

$= \textit{-est}$

The f-structure competition between *more* and *most* is identical. Given an f-structure that contains COMPARATIVE, but not SUPERLATIVE, as in (18), there is no competition, because the conditions for *-est* are not satisfied and *-er* is the only viable candidate.

6.2 Suppletion in comparatives and superlatives

We now turn our attention to suppletive comparatives, such as *worse*. The simplex suppletive form blocks both complex regular forms: *worse/*badder/*more bad*. Exceptionally, irregulars fail to block regulars. In this case, the forms *badder* and *baddest* appear

[10] Recall that the right-hand side of a vocabulary item is itself a pair. Therefore, in a set-based representation, given a VI α, $\pi_1(\alpha)$ returns the left-hand side of the VI, while $\pi_2(\alpha)$ returns the right-hand side of the VI. The left-hand side is itself a pair; therefore $\pi_1(\pi_1(\alpha))$ returns the first member of the left-hand side pair, which is the list of categories, and $\pi_2(\pi_1(\alpha))$ returns the second member of the left-hand side pair, which is the information about f-structure, semantics, and information structure that constitutes the; we refer to this joint information as a *fugui* (Asudeh, Bögel & Siddiqi 2023). In short, $\pi_1(\pi_1(\alpha))$ returns the categories that the VI maps to its exponent v-structure, while $\pi_2(\pi_1(\alpha))$ returns the features, semantics and i-structural distinctions that determine its exponent.

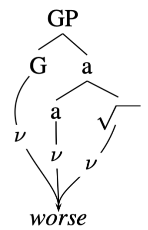
[11] We thank Adam Przepiórkowski and Sebastian Zawada for extensive discussion of this formalization, which supersedes prior versions we have proposed elsewhere.

[12] The function Φ is similar to the familiar ϕ from LFG, which LRFG also adopts. The difference is that ϕ maps c-structure nodes to the minimal f-structure that satisfies the mapping, whereas Φ maps f-descriptions to the minimal f-structures that satisfy them.

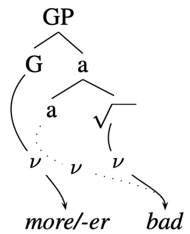
under restricted conditions in English,[13] but not with the same meaning as *worse*. *Worse* contributes a meaning constructor that is not present in the environments that give rise to the realization *badder* (also *worst/baddest*). See Asudeh & Siddiqi (2022) for details about regular forms appearing instead of irregulars, as in *divineness/divinity*.

Given the typical blocking behaviour of irregulars, we can conclude that the irregular is a vocabulary item that spans multiple c-structure terminals, (22a), and outcompetes two vocabulary items that express equivalent information, (22b).

(22) a.



b.



In this competition, **MostInformative**$_c$ chooses the portmanteau form over the complex form. Therefore, *worse* is preferred over *badder* and *more bad*.

(23) **MostInformative**$_c(\alpha, \beta)$ takes two sets of vocabulary items α,β and returns whichever set is smaller.

Intuition. Prefer portmanteau forms, whenever possible, on c-structural grounds. Choose the set of VIs that realizes the greater span of c-structure nodes.

Formalization. We define the functions in (24) to aid the presentation, where c is a c-structure, f is an f-structure, and v is a vocabulary item.

> Given a c-structure c and two sets of vocabulary items, α and β,
> **MostInformative**$_c(\alpha, \beta) =$
> $\alpha = \{x \mid x \text{ is a VI } \wedge \textbf{features}(x) \subseteq \textbf{targets}(c) \wedge \forall y \exists z.[y \in \textbf{categories}(x) \wedge z \in \textbf{labels}(c) \wedge \pi_2(z) = y]\}$
> $\beta = \{x \mid x \text{ is a VI } \wedge \textbf{features}(x) \subseteq \textbf{targets}(c) \wedge \forall y \exists z.[y \in \textbf{categories}(x) \wedge z \in \textbf{labels}(c) \wedge \pi_2(z) = y]\}$
> $$\begin{cases} \alpha \textbf{ if } |\alpha| < |\beta| \\ \beta \textbf{ if } |\beta| < |\alpha| \\ \bot \textbf{ otherwise} \end{cases}$$

(24)
- **features**$(v) := \Phi(\pi_2(\pi_1(v)))$
  the set of f-structures that VI v defines per the f-description in its left-hand side[14]
- **categories**$(v) := \pi_1(\pi_1(v))$
  the category list of VI v

[13] As in the famous Jim Croce song.

[14] We now want the second coordinate of the first coordinate of the VI represented as an input/output pair; see footnote 10.

- **targets**$(c) :=$
  $\{f \mid \phi(c) = f \wedge \pi_1(\textbf{labels}(c)) \subseteq \textbf{extendedProj}(f)\}$
  the set of f-structures that c-structure c defines, such that the nodes in the first-coordinate of the **labels** *of c are a subset of the* **extendedProj** *of f*
  - **labels**$(c) := \{\langle x, y\rangle \mid x \in \textbf{yield}(c) \wedge y = \lambda(x)\}$
    a set of pairs where the first member is a node in c-structure c and the second member is the node's label/category
    - **yield**$(c) := \{n \mid n \text{ is a terminal node in } c\}$
      the set of terminal nodes in c
  - **extendedProj**$(f) := \phi^{-1}(f)$
    the set of c-structure nodes that map to f-structure f; the extended projection of f in c-structure

We now explain the workings of the helper functions in (24) some more. The function **features** takes a VI as an argument and returns a set of f-structures. The f-structures that are returned are those defined by the second coordinate (π_2) of the first coordinate (π_1) of the vocabulary item. The first coordinate of the vocabulary item is its left-hand side and the second coordinate of that left-hand side includes any f-descriptions that are part of the VI's exponenda. The function Φ returns the set of f-structures defined by the f-description in the VI. Thus, **features**(v) returns a set of f-structures. The function **categories** takes a VI as an argument and returns its category list. Again, the first coordinate (π_1) of the VI is its left-hand side. The first coordinate (π_1) of the left-hand side is the VI's category list.

The function **targets** takes the given c-structure c as its argument. The function returns a set of f-structures. In other words, **targets**(c) returns the f-structures expressed by the terminal nodes in c. The f-structures that are returned must meet further conditions. In particular, each f-structure in the set must be such that the set of c-structure nodes that map to the f-structure (obtained from **extendedProj**) are a superset of the nodes in the c-structure c that is the argument to **targets**. These nodes are obtained by taking the first coordinate of the value of the **labels** function applied to c. The function **labels** returns a set of pairs, such that each pair consists of a node from the **yield** of c and its category, obtained through the standard LFG labelling function, λ (Kaplan 1989, 1995). The function **yield** returns the set of terminal nodes in c. Lastly, as alluded to before, the function **extendedProj** takes an f-structure as an argument and returns the set c-structure nodes that map to the f-structure in question; thus, this function captures all of the c-structure nodes that map to a given f-structure. In other words, it returns all of the nodes on any given $\uparrow = \downarrow$ path, such as a verbal spine or a nominal spine.

Thus, the arguments of **MostInformative**$_c$ are sets of vocabulary items. Each set is defined such that 1) its members' f-structures are subsets of the target f-structure for the given c-structure, 2) its members' category lists are such that for each category in the list there is an identical category in the set of categories that label the nodes of the given c-structure.

Turning back to our example, take α to be *worse* and β to be *badder*. In this case, α, β are expressing the same f-structural information and the same c-structural spans. α is a set containing a single vocabulary item (the one for *worse*) and β is a set containing two vocabulary items (the ones for *bad* and *-er*). Therefore, **MostInformative**$_c$ selects

α/*worse*, since $|\{[worse]\}| < |\{[bad], [\text{-}er]\}|$. The same reasoning explains why *worse* is preferred by **MostInformative**$_c$ to *more bad*. Note that this version of **MostInformative**$_c$ essentially captures the *Minimize Exponence* principle of Siddiqi (2006, 2009).

6.3 Periphrasis versus affixation

The phonological competition between *more* and *-er* is triggered by information in the v-structures, which are repeated in (25) and (26) respectively.

(25) $\begin{bmatrix} \text{PHONREP} & \text{/moɹ/} \\ \text{PFRAME} & (\cdot)_\omega \end{bmatrix}$

(26) $\begin{bmatrix} \text{PHONREP} & \text{/əɹ/} \\ \text{PFRAME} & ((\ )_\sigma(\cdot)_\sigma)_{ft} \\ \text{PDOMAIN} & (\ )_\omega \\ \text{DEP} & \text{LT} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{PFRAME} & (\ )_\sigma((\ )_{\sigma=\mu}) \end{bmatrix} \end{bmatrix}$

When two VIs have equivalent exponenda and are both phonologically licit, **MostSpecific** selects the VI with the most restricted distribution (Asudeh, Bögel & Siddiqi 2023).

(27) **MostSpecific**(α, β) returns whichever vocabulary item has the most restrictions on its phonological context.

Intuition. Prefer affixes whenever possible.

Formalization. The proper subsumption relation on feature structures (i.e., v-structures) is used to capture the intuition.

Given two exponents (v-structures), α and β,

$$\textbf{MostSpecific}(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \beta\backslash\text{PHONREP} \sqsubset \alpha\backslash\text{PHONREP} \\ \beta \textbf{ if } \alpha\backslash\text{PHONREP} \sqsubset \beta\backslash\text{PHONREP} \\ \bot \textbf{ otherwise} \end{cases}$$

As an affix, *-er* has a more restricted phonological environment than *more*, where the latter is the elsewhere case in this competition. Therefore, according to **MostSpecific**, *bigger* is preferred to *more big*, for example.

6.3.1 The prosodic domain of *er* and bracketing paradoxes

A classic puzzle in morphology concerns the comparative suffix *-er* and its appearance in, e.g., *unhappier*; see Pesetsky (1985) and Sproat (1988, 1992) and afterwards. The puzzle is that *unhappy* is trisyllabic, yet *-er* affixes to it (happily) despite its normal injunction against attaching to a domain greater than two syllables. Here we adopt what is a standard analysis of this puzzle (Sproat 1992), which is that *un-* is outside the prosodic domain of *-er* (i.e., PDOMAIN here). This sort of analysis shows that there is no bracketing paradox at all, but rather that there is a locality condition on the PDOMAIN of *-er*. In other words, the prosodic structure is [*un*[*happier*]].

We expand this discussion here to includes words like *shadowier*. With respect to forms like this, we hypothesize that the only VI within the PDOMAIN of *-er* is in fact the adjectivizer *-y*. Thus, *shadowier* is licit, because *shadow* is in fact outside the prosodic domain of *-er*. Some speakers reject *shadowier* in favour of *more shadowy*. This would be explained if, for these speakers, *shadow* in fact *does* occur in the domain of *-er*, resulting in an *-er* form that prosodically unsuitable. For these speakers, *shadowier* is not a possible prosodic word per *-er*'s requirements. In other words, for some speakers, the bracketing is the licit [*shadow*[*ier*]], whereas for others it is the illicit [[*shadowy*]*er*].

6.4 Semantic restrictions on competition

We return now to another question, which was initially raised in §5:

Q Why is **clutcher* ungrammatical but *more clutch* is not?

In particular, **MostSpecific** prefers *clutcher*, while **MostInformative**$_c$ and **MostInformative**$_f$ have no preference (they both *bork*, delivering $\perp$ as their output).[15] Foreshadowing a little, our answer is that **clutcher* simply fails semantically: there's nothing wrong with it morphosyntactically or morphophonologically.

Recall from §5 that we take a distinction between the semantics of *-er* vs *more* (and *-est* vs *most*) to account for *more/most*'s greater freedom of distribution:

(28) De'Aaron Fox was more clutch/*clutcher than any other player last year.

(29) Kudrow's performance was more wooden/*woodener than Sorvino's.

Gradable adjectives, like *tall* or *intelligent*, and non-gradable adjectives, like *clutch* or *wooden*, thus have different types:[16]

(30) a. $[\![\textit{tall}]\!] = \lambda x_e.[\textbf{tall}(x)]_s$

b. $[\![\textit{intelligent}]\!] = \lambda x_e.[\textbf{intelligent}(x)]_s$

(31) a. $[\![\textit{clutch}]\!] = \lambda x_e.[\textbf{clutch}(x)]_t$

b. $[\![\textit{wooden}]\!] = \lambda x_e.[\textbf{wooden}(x)]_t$

In other words, *tall/intelligent*, map their entity arguments to the entity's degree of tallness/intelligence, whereas *clutch/wooden* map their entity arguments to true/false, i.e. denote whether the entity *is* clutch/wooden.

Recall the vocabulary items from (5) above, focusing on the comparative ones to reduce clutter (the superlatives make the same point):

[15] It is up to the theory to determine how borking should be interpreted; for example, we could interpret as a tie, such that relative to the constraint in question, either VI can be chose.

[16] We assume a generally available, pragmatically motivated late existential closure of type $\langle es, et\rangle$ for these adjectives, such that, e.g., *tall* ends up meaning $\lambda x\exists d.\textbf{tall}(x) \geq d$. This same existential closure can be used in elliptical contexts such as *Alex is taller* or *Alex is tallest*, where no *than*-phrase is present.

(5) a. $\langle$ [G], @CMPR $\rangle \xrightarrow{\nu}$

$\lambda \mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$

$$\begin{bmatrix} \text{PHONREP} & /\text{ə}\text{ɹ}/ \\ \text{PFRAME} & ((\;)_\sigma(\cdot)_\sigma)_{ft} \\ \text{PDOMAIN} & (\;)_\omega \\ \text{DEP} & \text{LT} \\ \text{HOST} & \begin{bmatrix} \text{IDENT} & + \\ \text{PFRAME} & (\;)_\sigma((\;)_{\sigma=\mu}) \end{bmatrix} \end{bmatrix}$$

c. $\langle$ [G], @CMPR $\rangle \xrightarrow{\nu}$ $\begin{bmatrix} \text{PHONREP} & /\text{mo}\text{ɹ}/ \\ \text{PFRAME} & (\cdot)_\omega \end{bmatrix}$

$\lambda \mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}$

($\lambda P_{et}.[\mathbf{grade}_{\langle et,es\rangle}(P)]_{es}$)

The **grade** function, which only *more* and *most* can contribute, maps a predicate of entities to a function from entities to degrees.

(32) $\mathbf{grade}(\llbracket \textit{clutch} \rrbracket) = \lambda x_e.\mathbf{clutch}(x) = \top | [\exists d_s.\mathbf{clutch}_\delta(x)]_s$

In short, the optional **grade** meaning constructor in the VI for *more* (and *most*) allows composition with a non-gradable adjective, whereas *-er* (and *-est*) does not have this capacity. Figure 2 shows the computations.

In sum, the competition between, e.g., **clutcher* and *more clutch* as well as the putative optionality of *more red/redder* is a function of the gradability of the adjective, as resolved by the Glue Semantics. In particular, the base semantics of *more* and *-er* is the same, as indicated by the single, obligatory meaning constructor which occurs in each of their VIs in (5a) and (5c); but *more* also optionally contributes a meaning constructor that maps an ordinary property to a gradable property. Therefore, *more* is correctly predicted to be able to compose with non-gradables such as *clutch*, while *-er* is correctly predicted to not occur with such adjectives. Note that *more clutch* is not winning one of our competitions: *clutcher* is simply illicit semantically, while *more clutch* is not.[17]

6.5 Putative optionality

Lastly, let us turn to how overt comparative phrases interact with gradability.

(33) a. Max is more proud than happy.

b. *Max is prouder than happy.

(34) a. Max is more proud than he is happy.

b. Max is prouder than he is happy.

[17] A reviewer points out that there is still some work to be done here, since **MostSpecific** still prefers *clutcher* over *more clutch*. We leave the details of this for future work, but it seems that the system needs to be able to 'back off' to a candidate that expresses the right semantics, even if it is not the morphophonologically preferred candidate. This case seems to show that the **MostInformative** principles should take priority over **MostSpecific**. Concepts tend to find a way to be expressed.

clutcher

$$\dfrac{\overset{\textit{clutch}}{[\lambda y_e.[\mathbf{clutch}(y)]_t]_{et}} \quad \overset{\textit{-er}}{\lambda \mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}}}{} \not\vdash$$

more clutch

$$\dfrac{\overset{\textit{clutch}}{[\lambda z_e.[\mathbf{clutch}(z)]_t]_{et}} \quad \overset{\textit{more}_2}{\lambda P_{et}[\lambda y_e.[\mathbf{grade}_{\langle et,es\rangle}(P)(y)]_s]_{es}}}{[\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\lambda z_e.[\mathbf{clutch}(z)]_t)(y)]_{es}} \multimap_{\mathcal{E}}$$

$$\dfrac{[\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\lambda z_e.[\mathbf{clutch}(z)]_t)(y)]_{es}}{[\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y))]_{es}} \Rightarrow_\beta$$

$$\dfrac{[\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y))]_{es} \quad \overset{\textit{more}_1}{\lambda \mathcal{P}_{es}.[\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}(\mathcal{P})]_{\langle s,et\rangle}}}{\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}[\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y))]_{es})]_{\langle s,et\rangle}} \multimap_{\mathcal{E}}$$

$$\dfrac{\mathbf{cmpr}_{\langle es,\langle s,et\rangle\rangle}[\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y))]_{es})]_{\langle s,et\rangle} \quad [(\lambda g_{es}\lambda d_s\lambda x_e.g(x) > d)_{\langle es,\langle s,et\rangle\rangle}([\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y))]_{es})]_{\langle s,et\rangle}}{[\lambda d_s\lambda x_e.(\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y)))(x) > d]_{\langle s,et\rangle}} \text{def}_{\mathbf{cmpr}}$$

$$\dfrac{[\lambda d_s\lambda x_e.(\lambda y_e.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(y)))(x) > d]_{\langle s,et\rangle}}{[\lambda d_s.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(x)) > d]_{\langle s,et\rangle}} \Rightarrow_\beta$$

$$\dfrac{[\lambda d_s.\mathbf{grade}_{\langle et,es\rangle}(\mathbf{clutch}(x)) > d]_{\langle s,et\rangle}}{[[\lambda d_s.[\lambda P_{et}\lambda x_e.P(x) = \top|\exists d_s.P_\delta(x)]_{\langle et,es\rangle}(\mathbf{clutch}(x))]_{es} > d]_{\langle s,et\rangle}} \text{def}_{\mathbf{grade}}$$

$$\dfrac{[[\lambda d_s.[\lambda P_{et}\lambda x_e.P(x) = \top|\exists d_s.P_\delta(x)]_{\langle et,es\rangle}(\mathbf{clutch}(x))]_{es} > d]_{\langle s,et\rangle}}{\lambda d_s.[\lambda x_e.\mathbf{clutch}(x) = \top|\exists d_s.\mathbf{clutch}_\delta(x)] > d} \Rightarrow_\beta$$

Figure 2: Proofs for **clutcher* (unsuccessful) & *more clutch*

In (33), the comparative complement is a simple adjectival phrase, *happy*. In (33a), the analytical comparative morpheme *more* is permitted. In contrast, (33b) shows that the synthetic comparative is ungrammatical. Cases like (33) have been discussed in the literature as *metalinguistic comparatives*.[18] It has been known for some time that the synthetic comparative is disallowed under this interpretation (see, e.g., Bresnan 1973, Embick 2007).[19] In contrast, in (34), the comparative complement is a tensed clause, *he is happy*. First, we observe that, at least on the face of it, (33a) and (34a) can mean the same thing, since (34a) is ambiguous and one of its readings is shared with (33a). Second, we observe that (33a)/(34a) do not mean the same thing as (34b).

We take this as evidence that *Max is proud* is ambiguous.[20]

1. In the metalinguistic comparative reading, *proud* is non-gradable.

2. In the other reading, *proud* is gradable.

We now present the data again sorted accordingly.

(35) Ungradable

 a. Max is more *proud* than happy.
 b. Max is more *proud* than he is happy.

(36) Gradable

 a. *Max is prouder than happy.
 b. Max is prouder than he is happy.

The ungradable structure/reading (35) has two properties:

1. The synthetic comparative morpheme *-er* is illicit. The analytic comparative morpheme *more* is licit, which we expect in ungradable environments (see above).

2. Both the simple (adjectival) and complex (clausal) complements are licit.

The gradable structure/reading (36) has the opposing properties:

1. The synthetic comparative morpheme *-er* is licit.

2. But it is only licit if the comparative complement is complex (clausal), not simple (adjectival).

We now have an account of why the following examples from the introduction are both licit.

(3) I am even madder.

[18] We thank L$_R$FG Lab member, Danil Alekseev, for discussion of this point.

[19] We note these contributions in particular because Bresnan (1973) is the natural touchstone for LFG analyses and Embick (2007) for DM analyses, and these are L$_R$FG's ancestor frameworks. However, note that both these analyses provide purely syntactic accounts of the distribution, which we don't engage here. There is considerable further literature on this topic.

[20] We have noticed that the metalinguistic comparative reading is best supported by emphasizing the comparative adjective. This is unnecessary for the other reading.

(4) I am even more mad.

It is not the case that there is true optionality here, but rather that there are two different readings in play. We leave the exact nature of the semantic distinction for future work, but one analysis option is to postulate an inverse function to **grade** — call it **degrade** — that takes a gradable adjective and returns a related ungradable predicate of entities.

7 Conclusion

In summary, we have told the story of *-er*. At a big-picture level, the distribution of *-er* and its allomorphs provides an opportunity to see all the parts of L_RFG in action: the contents of the Vocabulary (mappings from exponenda to exponents); the principal parts of vocabulary items; how to determine the phonological properties in the v-structure (exponent) of a vocabulary item; how to determine a c-structural representation in L_RFG; how to resolve complex competitions using one or more of the **Most-Informative** constraints and **MostSpecific**; and how to use compositional semantics as another aspect of well-formedness. Thus, *-er* provided a great opportunity for a wide-ranging primer on L_RFG.

The overall analysis can be summarized as follows. The morpheme *-est* defeats *-er* in superlative environments, due to **MostInformative**$_f$; similarly, *most* defeats *more* in superlative environments, due to **MostInformative**$_f$. The synthetic form, *-er*, defeats the analytic form, *more*, in every environment where *-er* is permitted to surface, due to **MostSpecific**; similarly, *-est* defeats *most* in every environment where *-est* is permitted to surface, due to **MostSpecific**. Suppletive forms defeat regular forms, due to **MostInformative**$_c$. The analytic form *more* appears in some contexts where we might expect *-er* (for phonological reasons), because *-er* cannot attach to an ungradable root, due to the types in the compositional semantics and the fact that only the analytic forms can contribute the **grade** function. Thus, the phenomenon of 'metalinguistic comparatives' is not an instance of pure optionality, but rather rests on a systematic underlying ambiguity.

In sum, we have shown an L_RFG analysis of the English comparative (and superlative) as a demonstration of the theory, since it involves morphology, syntax, phonology/prosody, and semantics; L_RFG's architecture is designed to take all of this information into account.

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Language redundancy and acoustic salience: an account in LFG

Tina Bögel
University of Konstanz

Mila Freiseis
University of Konstanz

Romi Hill
Boston University

Daniel Wambach
University of Konstanz

Tianyi Zhao
University of Konstanz

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Abstract

This paper introduces a new way to integrate gradient language redundancy effects and their acoustic correlates in LFG. Based on data from a production experiment that showed how semantic priming and lexical frequency affect target word duration, the approach models the inverse relationship between language redundancy and acoustic redundancy, with p-structure as a pivotal point between grammar and signal. To this end, all redundancy measures are re-scaled to a common, meaningful scale, while their gradient nature is retained as part of the system. The result not only allows for gradient data to be integrated into the architecture of LFG, but also for the prediction of concrete acoustic measures, thus taking a large step towards the modelling of the phonology-phonetics interface and the generation of spoken language.

1 Introduction

Work in LFG and other frameworks has seen an increased necessity to capture measures of language redundancy in order to account for the preferences speakers have for a particular structure or form (e.g., Bögel 2021; Bresnan 2023).[†] To reflect the probabilities of specific syntactic structures in LFG, for instance, violable 'soft' OT(-inspired) constraints can be used to rank several possible structures according to, e.g., syntactic frequency (a.o., Frank et al. 1998) or prosodic input (Butt et al. 2017; Bögel 2020). Similarly, computational approaches have used corpora-based frequency measures to pre-process multiple parses (Cahill et al. 2007). Modelling spoken language, however, remains work in progress due to its often gradient nature, its variability and the lack of reliable and consistent acoustic cues.

One way to approach this problem is to capture speaker preference and the predictability of specific linguistic items by means of language redundancy measures elicited from different modules of grammar, and to relate these measures to specific acoustic realisations (cf. Turk 2010). This relationship between language redundancy and phonetic/phonological parameters has only recently received some attention in LFG. Bresnan (2023), for example, discussed form-reduced verb-pronoun sequences in English (*get them* vs. *get'em*) and proposed Lexical Sharing (Wescoat 2002) to account for the verb-clitic combinations, and Bögel (2021) discussed different pronominal forms in Swabian with respect to lexical i-structure constraints (see Section 4 for a detailed discussion).

In this paper, we propose a new model to account for reduction phenomena based on language redundancy which includes, but also goes beyond the categorical reduction phenomena discussed in Bögel (2021) and Bresnan (2023). Based on the data from a production experiment on semantic priming and lexical frequency, and their effects on durational measures (Freiseis et al. 2024), we show how gradient measures can be modelled in LFG.

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The paper is structured as follows: Section 2 outlines the relevant theoretical framework, namely the Smooth Signal Redundancy Hypothesis and the Prosodic Interface Hypothesis. Section 3 presents the production experiment on semantic priming which provided the data for this paper. Section 4 discusses previous LFG-related approaches to language reduction, before focusing on the problem of gradience, the inverse relationship between language redundancy and acoustic salience, and how this relationship can be modelled at p-structure by means of semantic priming and lexical frequency.

2 Language redundancy and acoustic salience: an inverse relationship

This paper follows the *Smooth Signal Redundancy Hypothesis* (henceforth SSRH; Aylett 2000; Aylett & Turk 2004, 2006; Turk 2010), which assumes signal redundancy, i.e., the recognition likelihood of different linguistic items (Turk 2010: 228), to be evenly (smoothly) spread throughout the utterance to ensure robust and efficient communication between interlocutors (cf. Lindblom 1990; Shannon 1948). Signal redundancy is determined by the inverse relationship between a) language redundancy, i.e., the recognition likelihood based on, e.g., lexical, syntactic, semantic or pragmatic factors, and b) acoustic redundancy, i.e., the recognition likelihood based on acoustic salience factors, e.g., duration or fundamental frequency (f_0). Linguistic items with high language redundancy values like frequent words, preferred syntactic structures, or contextually predictable items, would thus result in low acoustic redundancy measures, with shorter durations and smaller pitch/f_0 excursions. Conversely, if language redundancy is low (e.g., as it is with infrequent or unpredictable content words), acoustic salience is predicted to be high, with longer durations and larger pitch excursions (a.o., Bell et al. 2009, 2003; Aylett & Turk 2004, 2006; Bush 2001; Jurafsky et al. 2001; Pluymaekers et al. 2005a,b; Watson et al. 2008; Lam & Watson 2010).

It has further been proposed that this inverse relationship between language redundancy and acoustic salience is mediated via prosodic structure (see Figure 1).

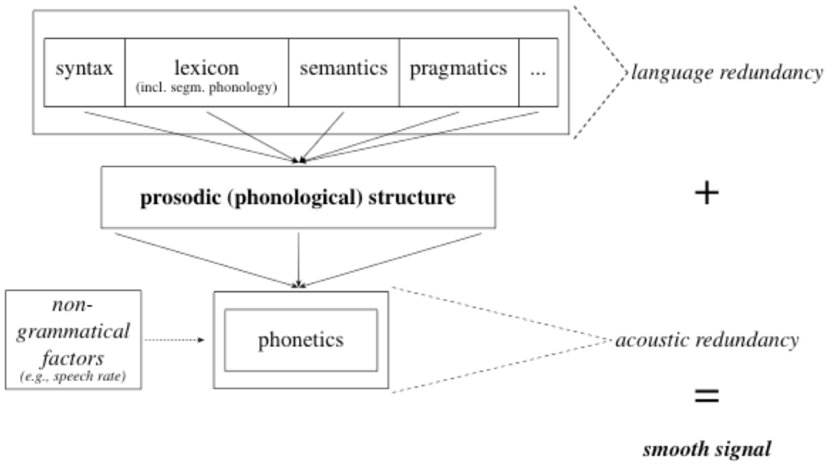

Figure 1: A representation of the SSRH and the PIH (modified from Turk & Shattuck-Hufnagel 2020: 191)

The *Prosodic Interface Hypothesis* (PIH) proposes that language redundancy effects are mostly realised at prosodically prominent sections of a given domain (e.g., word and phrasal stress; Aylett & Turk 2004, 2006), and at prosodic boundaries (Turk 2010), where the boundary-related intervals include the rhyme of the last syllable preceding the boundary and the first onset consonant after the boundary (Fougeron & Keating 1997; Turk & Shattuck-Hufnagel 2007; Dimitrova & Turk 2012). These two target areas in prosodic structure should furthermore be affected by different language redundancy factors in a similar way; i.e., language redundancy factors such as syntactic preferences, lexical frequencies, or bigram frequencies should all be realised by similar acoustic indicators that are associated with the stressed syllables and/or boundary-adjacent intervals, because these are the parts of words that are known to be affected by prosodic prominence and boundaries.

Previous research on the relationship between language redundancy and acoustic salience has been concerned with redundancy effects on the duration of words or morphemes (Fowler & Housum 1987; Pluymaekers et al. 2005a; Bell et al. 2009; Lam & Watson 2010; Kahn & Arnold 2012; Ibrahim et al. 2022b), segmental deletion/lenition/strengthening (Malisz et al. 2018; Brandt et al. 2021; Ibrahim et al. 2022a), also with respect to prosodic boundaries (Bögel & Turk 2019; Andreeva et al. 2020). Investigations above the word level have involved syntactic probabilities (Watson et al. 2006; Levy & Jaeger 2007; Tily et al. 2009), discourse mention, semantic relatedness, and focus (e.g., Lieberman 1963; Balota et al. 1989; Watson & Gibson 2004; Watson et al. 2008; Turnbull 2017).

Recent work by the authors and cooperation partners has been testing the assumptions made by the SSRH and the PIH regarding prosodic prominence and boundary structure in English and German as elicited by duration and f_0 values (Bögel & Turk 2019; Zhang et al. 2023; Zhao et al. 2024; Zhao Forthcoming). In this paper, we present data from an experiment on semantic priming and lexical frequency (Freiseis et al. 2024) and demonstrate how the relationship between language redundancy and acoustic salience (in form of durational measures) can be integrated into the modular structure of LFG.

3 Semantic priming experiment

Semantic priming describes the phenomenon that a word is processed more quickly if preceded by a word that is semantically related. For example, if a subject is presented with the prime *job interview*, they are likely to recognise the target word *applicant* faster than when the target word is preceded by a semantically unrelated word (e.g., *driver*). The semantic priming effect has been attested most notably in various lexical decision tasks, where it was demonstrated that participants have shorter reaction times for primed words than non-primed words (Balota et al. 1989; Foss 1982; Hoedemaker & Gordon 2017; Meyer & Schvaneveldt 1971).

Previous research also revealed an interactive effect between semantic priming and lexical frequency (Becker 1979; Yap et al. 2009; Scaltritti et al. 2013). Becker (1979), following Meyer & Schvaneveldt (1976), argues that semantic priming and increased lexical frequency have a similar activation effect on the target word. As both semantically primed target words and target words with a high lexical frequency are more likely to be recognised, the effect of semantic priming is larger for low frequency words than for high frequency words.

Following the SSRH, target words that are semantically primed are expected to be more redundant, and thus less acoustically salient than non-primed words, and vice versa. Since the SSRH assumes that language redundancy and acoustic salience are mediated by prosodic structure, semantic priming effects are predicted at the boundaries and on the stressed syllable of the target word. The following experiment focuses on the interaction of semantic priming and lexical frequency, and its effect/influence on duration at prosodic word boundaries.[1] A more detailed discussion can be found in Freiseis et al. (2024).

3.1 Methods

3.1.1 Materials

The materials included 22 sentence pairs in Standard German. In each pair, identical target words were presented in either a *priming context* (i.e., where the target word was primed) or a *non-priming context* (i.e., where the target word was not primed). Target words and their lexical frequencies were determined using WebCelex' database (Baayen et al. 2001), and lexical frequency measures for the chosen target words were additionally confirmed using hit numbers of the Google search engine. Table 1 illustrates the thresholds that were used for target words of low and high frequency.

frequency	**WebCelex**	**Google**
high	> 110	> 60 million
low	< 60	< 10 million

Table 1: Thresholds for target words with high or low lexical frequency

The two groups each included six target words which were used for the statistical analysis on the interaction between semantic priming and lexical frequency. The remaining 10 words between these thresholds were disregarded for the statistical analysis on the interaction, but were still included for the general analysis on semantic priming.

Following the predictions made by the SSRH and the PIH, the acoustic effects related to semantic priming and lexical frequency are expected to occur at the boundary-related intervals, i.e., at the interval including the rhyme of the previous word and the onset of the target word, and the interval including the rhyme of the target word and the onset of the following word (see Table 2). In order to guarantee segmentation reliability and comparability of the boundary-related intervals, only target words with plosive onsets were selected. The targets' final syllables were either *-en, -er, -in,* or *-or*. All target words consisted of three syllables and stress on the second syllable. To better distinguish potential priming effects on prosodic boundaries from effects on prosodic

[1]The materials used in this study were not suitable for testing effects on the stressed syllable. This would have required segment comparability of the stressed syllable in addition to the comparability of the boundary-related intervals, which makes it difficult to find suitable target words that also fit the frequency requirements. See Zhao et al. (2024) and Zhao (Forthcoming) for a study concerned with both the prominent syllable and prosodic boundaries.

prominence (i.e., the stressed syllable), lexical stress was avoided at the edges of target words.

Target words were common nouns referring to groups of people (e.g., *applicants, pilots*). 18 of the 22 target words appeared in their plural form, ensuring that each target had the same amount of syllables. The target words were preceded by the definite articles *die* (the.FEM/PL) or *der* (the.MASC) and followed by the reflexive pronoun *sich* ('herself/himself/themselves') and a verb. The contexts were designed with identical sentence structures and an approximately equal number of syllables. The priming/non-priming context occurred in the first part of the sentence, whereas the second part contained the target word.

Each context sentence pair was used twice with an alternating combination of target words and priming patterns. In the first context sentence, the first part of the sentence was the priming context for the first target word, and the non-priming context for the second target word. For the second context sentence, the order was reversed: The first part of the sentence was the priming context for the second target word, and the non-priming context for the first target word. Example (1) illustrates the material with the target words *Bewerber* 'applicants' and *Berliner* 'people.from.Berlin'. In the first sentence, the priming context in the first part of the sentence is *Vorstellungsgespräch* 'job interview', which primes *Bewerber*, but not *Berliner*. In the second sentence, the priming context is *Branderburger Tor* 'Brandenburg Gate'[2] which primes *Berliner*, but not *Bewerber*. This resulted in two versions for each context sentence in (1) and a total of four sentences for each target word pair.

(1)

Sentence 1: *Bewerber* in a priming context, *Berliner* in a non-priming context

Um	beim	Vorstellungsgespräch	zu	punkten,	mussten	die	Bewerber/Berliner	sich	behaupten
in.order	at.the	job interview	to	score.points	have.to	the	applicants/Berliner	themselves	assert

'In order to score points at the job interview, the applicants/people.from.Berlin had to assert themselves.'

Sentence 2: *Berliner* in a priming context, *Bewerber* in a non-priming context

Um	das	Brandenburger Tor	zu	sehen,	mussten	die	Bewerber/Berliner	sich	gedulden
in.order	the	Brandenburg Gate	to	see	have.to	the	applicants/Berliner	themselves	be.patient

'In order to see the Brandenburg Gate, the applicants/people.from.Berlin had to be patient.'

In order to confirm the priming relationship between context and target word, 18 native speakers of German were asked to check the semantic relatedness via a questionnaire. In the questionnaire, the 22 context sentence pairs were presented and participants were asked to select the intended target from three options (including the primed target, the non-primed target, and an unrelated third word). The intended primed target was chosen in 98.48% of the cases, confirming the semantic relatedness between primes and target words in the materials.

For the production experiment, two experimental lists were created from the 22 context pairs. Each target word only occurred once in each list, either in a priming or a non-priming context, while each context sentence occurred twice, once with a primed target and once with a non-primed target word. The priming context was always presented before the non-priming context, in order to prevent a weakening of the priming context for the primed target and to avoid the creation of a context for the non-primed

[2]The Brandenburg Gate is a famous landmark in Berlin.

target. Simultaneously, this design allowed for the weakening of the non-priming context, which - for this experiment - was a desirable effect to ensure that the participant perceived the context as a non-priming one.

3.1.2 Participants

21 German native speakers (mean age = 27, age range 18-30, 15 female and 6 male) participated in the experiment, the majority of whom were students or employees recruited at the University of Konstanz. Participants were randomly assigned to one of the two experimental lists.

3.1.3 Procedure

The recordings took place in a soundproof studio at the University of Konstanz with a condenser microphone (sampling rate 44.1 kHz, 16-Bit, stereo). For the experiment, participants were seated in front of a screen and asked to read out the sentences. After each sentence, the instructor clicked manually to display the next sentence. The procedure took approximately 30 minutes and participants received compensation after the recording.

3.1.4 Analysis

From the resulting 462 sentences, 32 sentences had incorrectly placed lexical stress or showed pronunciation errors and were thus excluded, leaving 430 sentences for the analysis. All sentences were first automatically annotated using MAUS (Kisler et al. 2017). The segmentation was then manually checked and adjusted in accordance with the standard annotation criteria in Turk et al. (2006) using Praat (Boersma & Weenink 2023). Durations of the following six intervals were annotated and extracted: 1) the rhyme of the last syllable of the preceding word (labelled as *R_prev*); 2) the onset of the target word (*O*); 3) the first boundary interval (*B1*) of the target, including the rhyme of the last syllable of the preceding word and the onset of the target; 4) the rhyme of the last syllable of the target (*R*); 5) the second boundary interval (*B2*) of the target word, including the rhyme of the last syllable of the target as well as the onset of the following word, which was the fricative /z/ for all sentences, and 6) the complete target word. Table 2 illustrates a simplified version of the annotation scheme.

(d)ie	*b*	*ewerb*	*er*	*s(ich)*
R_prev	O	–	R	–
B1		–	B2	

Table 2: Annotation scheme for the target word *Bewerber* 'applicant' (example (1))

3.2 Results

To assess the effect of semantic priming and lexical frequency on duration measures, linear mixed effects regression models (lmer; Baayen et al. 2008; Kuznetsova et al.

2017; R Core Team 2022) were used, with semantic priming and lexical frequency as fixed factors and participants and items as crossed random factors.[3]

3.2.1 Semantic priming without lexical frequency

A general effect of semantic priming on duration could be established: Primed targets were significantly shorter than non-primed targets in terms of durations of the whole target words (beginning of onset to end of rhyme) ($p < 0.001$). Significant priming effects were also found at the following intervals: 1) Primed targets had a shorter onset (*O*) than their non-primed counterparts ($p < 0.05$), 2) the rhyme of the last target syllable (*R*) was shorter in the primed condition ($p < 0.05$), and 3) the second boundary interval of the targets (*B2*) was shorter in the primed condition as well ($p < 0.05$). In constrast, the first boundary interval *B1* as a whole and the rhyme of the last syllable of the previous word (*R_prev*) did not exhibit any significant priming effect.

3.2.2 Semantic priming effects for frequent and infrequent items

In a second step, the interaction between lexical frequency and semantic priming was calculated. To this end, respective subsets for both frequency and priming conditions were made to take a closer look at the interaction (cf. Section 3.1.1/Table 1). We first started with the semantic priming effects and analysed how the two priming conditions affected frequent and infrequent words, respectively.

For the frequent items, no significant priming effects were found for word-initial intervals. In contrast, for *B2*, primed targets were significantly shorter than non-primed targets ($p < 0.001$). For *R*, the effects approached statistical significance ($p = 0.057$). In contrast, infrequent items were significantly shorter at the beginning of the word (*R_prev, O, B1*) when primed ($p < 0.001$), but not at the end of the word (*R, B2*).

3.2.3 Lexical frequency effects for the primed and the non-primed condition

In order to gain another perspective on the interaction between lexical frequency and semantic priming, a second set of *lmer* models focused on the effects of lexical frequency on primed and non-primed target words.

The onset interval of primed targets yielded a significantly shorter duration for infrequent items than for frequent ones ($p < 0.05$). However, regardless of the priming condition, longer duration was associated with lower lexical frequency towards the end of the targets. Contrary to the results of the target-initial onset, infrequent targets had longer *B2* in both priming ($p < 0.01$) and non-priming condition ($p < 0.05$). The same results were further attested in the sub-interval *R* (primed: $p < 0.01$; non-primed: $p < 0.01$). Figure 2 illustrates the reversed effects of lexical frequency on the onset and the rhyme for the subset of primed target words exclusively.

[3] The following section is a condensed version of Freiseis et al. (2024). The reader is referred to this paper for more details.

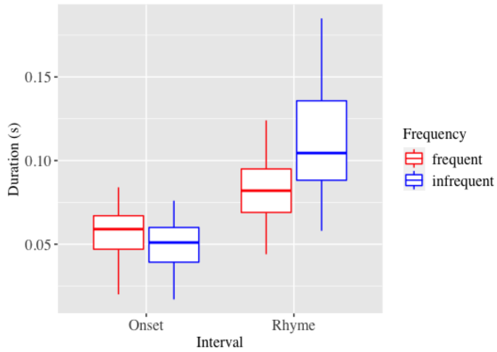

Figure 2: Onset and rhyme duration for the primed data indicating opposite effects of lexical frequency in the word-initial onset and word-final rhyme

3.3 Discussion

The results establish an effect of semantic priming on word duration. The results are also consistent with previous research on the interaction of lexical frequency and semantic priming: The effects of semantic priming seem to be stronger with infrequent items (see also Becker 1979; Yap et al. 2009). However, the results also indicated opposite effects of lexical frequency on the different areas of primed targets (Figure 2), which is not consistent with previous research.

We leave this unexpected observation on the interaction of lexical frequency and primed data for further research (see Freiseis et al. (2024) for some hypotheses). In the remainder of the paper, we will instead focus on the overall priming effects, which were in accordance with the proposals made by the SSRH and the PIH: Semantic priming resulted in shorter durations at the boundary-related intervals of the target words, while non-primed target words featured longer durations. The following sections show, how this gradient relationship between language redundancy factors and acoustic salience can be modelled in LFG.

4 Language redundancy, acoustic salience, and LFG

The results from Section 3 show that language redundancy effects on acoustic salience follow a predictable pattern: As described by the SSRH, there is an inverse relationship between language redundancy and acoustic salience. For our purposes, we can predict that if a lexical item is primed and/or frequent, then duration measures at the boundary-related intervals will be shorter. Vice versa, if a lexical item is non-primed and/or infrequent then its durational measures will be longer. This ensures robust communication between interlocutors, enhancing understanding where needed, and preserving energy where possible.

An open question for LFG (and other frameworks) is how to integrate the regular gradient measures of language redundancy in order to account for speaker preferences and output form. Some previous LFG-related work used violable ‘soft’ OT(-inspired) constraints (Frank et al. 1998) which rank several possibilities to indicate syntactic preferences, also with reference to prosodic indicators (a.o., Butt et al. 2017; Bögel 2020).

However, while LFG-OT constraints are useful to capture the choice between valid syntactic structures, they nevertheless express categorical choices and are thus not suitable to convey real gradience as it is given in the present data and in the relationship between language redundancy and acoustic salience

Recent work by Bresnan (2023) analysed different forms of object pronouns following verbs, i.e., the difference between *get them* and *get'em*. Based on Pierrehumbert's hybrid exemplar-based model of the mental lexicon (Pierrehumbert 2001), Bresnan follows the concept of 'memory traces' of language use. Memory traces include the phonetic forms and their probability distributions learned from the user's experience. Bresnan groups these different forms into two categories, the full form *them* and the clitic *'em*. As some of the verb-clitic combinations exhibit special meanings (e.g., *go get'em* vs. *get/grab them*) and the clitic usually forms a prosodic word with its host, Bresnan proposes Lexical Sharing (Wescoat 2002) as a solution to explain the close relationship between verb and clitic in terms of language redundancy. Under this approach, reduction phenomena and/or phonological cliticisation are explained by assuming that the clitic and its host form one lexical entry projecting to two syntactic nodes, as illustrated in Figure 3.

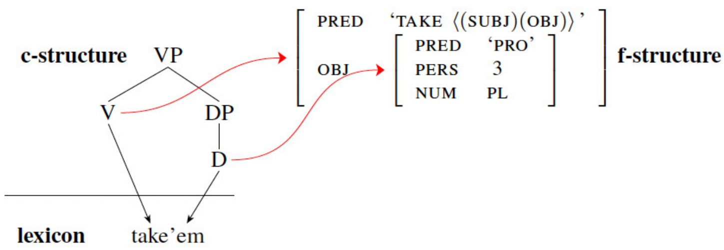

Figure 3: Lexical Sharing as a solution for phonological reduction phenomena (Bresnan 2023: p.69, Figure 3)

The non-compositional meaning of some of the verb-clitic instances indeed points towards lexicalisation. However, this does not imply that all instances of the clitic should be subject to Lexical Sharing, in a similar way that, for example, *bucket* in the idiomatic expression *kick the bucket* does not automatically share a lexical entry with all other items it can occur with. With regard to the argument of prosodic wordhood, it has been established that prosodic words can be smaller or larger than 'lexical' words, and that this mismatch occurs quite frequently with complex morphological structures or function words (a.o., Booij 1984; Nespor & Vogel 1986; Inkelas & Zec 1990; Wheeldon 2000). Consequently, two words forming one prosodic word do not automatically imply Lexical Sharing. In fact, a consequence of Bresnan's approach would be that almost every function word shares its lexical entry with the previous or the following word; a possibility that would lead to infinite additional lexical entries which is not sustainable in terms of efficiency.

An alternative approach to the distinction between pronominal full forms and clitics was discussed in Bögel (2021), where the pronoun retains a separate lexical entry and the prosodic reduction of the clitic form was linked to a) prosodic phrasing constraints, and b) information structural constraints in form of focus and givenness. Under this approach, the two forms reflect (redundancy) information from different modules of the grammar; their final form is determined as part of p-structure. Figure 4 shows the two possible Swabian 1st nominative singular pronoun forms: full form [i] and reduced form [ə].[4] While [i] is a full prosodic word, [ə] can only occur as an enclitic (=σ) similar to the object pronouns discussed in Bresnan (2023). Both forms are associated to the same s-form; their p-forms are distinguished based on whether the pronoun is marked for focus in i-structure, and on prosodic constraints internal to p-structure (e.g., the enclitic cannot occur in the first position of an intonational phrase).

s-form		**p-form**		
PRON	(↑ PRED) = ‘ich’	[i]	SEGMENTS	/i/
	(↑ PERS) = 1		METR. FRAME	$({}^{\prime}\sigma)_\omega$
	(↑ CASE) = nom	- - - - - - - - - - - - -	- - - - - - - - - -	- - - - - -
	(↑ PRON) = pers	[ə]	SEGMENTS	/ə/
	(↑ NUM) = sg		METR. FRAME	=σ
	...		$\neg(\uparrow_i$ FOCUS)	

Figure 4: Lexical entries for the Swabian 1NomSg pronoun [i] and its reduced form [ə], modified from (Bögel 2021: 19)

This approach incorporates the well documented relationship between form reduction and language redundancy constraints expressed by the SSRH and the PIH discussed in Section 2: Prosodic structure regulates the inverse relationship between language redundancy and acoustic salience. If language redundancy is low (i.e., the pronoun is in focus), acoustic salience is high (i.e., the full form is applied) and if language redundancy is high (i.e., the pronoun in its unmarked context) acoustic salience is low and the reduced form is applied.

However, neither of these approaches, Bögel (2021) and Bresnan (2023), can account for gradient data. Pronouns are not considered to be gradient, but they usually are assumed to encompass more than the two forms discussed above. For the pronoun *them*, for example, this would include *them, ’em, ’m,* and ϕ, where the phonological realisation has been tied to language redundancy, namely a ‘givenness’ scale (a.o., Baumann 2006). This categorical scale of four forms already poses a problem for Lexical Sharing, but could be integrated into the approach illustrated in Figure 4. Problematic for both are the numerous cases where surface forms are reduced on gradient scales and thus do not allow for a natural categorical classification. This paper tackles this problem and introduces a new proposal to integrate gradient data into LFG, following the assumptions made by the SSRH and the PIH on the inverse relationship between language redundancy and acoustic salience, with prosodic structure as the pivotal point between them.

4.1 Gradient data is expressed by gradient scales

The experiment discussed in Section 3 is concerned with two different language redundancy factors: semantic priming and lexical frequency. For the statistical analysis, the

[4]See Section 4.3. for a brief overview on the multidimensional lexicon as proposed in Bögel (2015).

two factors were treated as categorical: primed and non-primed, and high and low frequency. However, this classification ignores the fact that both groups are also gradient within the respective categories. Furthermore, the SSRH does not predict one duration for all elements in one category, but a successive gradation in relation to the corresponding language redundancy measures.

In order to obtain representative scales for the lexical frequencies and the semantic priming measures of the experimental target words, we extended the methods that were used to create the materials (see Section 3.1.1). For the raw lexical frequencies of our target words, we used the German Wikipedia dataset of *Projekt Deutscher Wortschatz* (PDW; Goldhahn et al. 2012).[5] In order to sum lexical frequencies across inflected forms, we tokenized the lemmatized dataset with SpaCy (Montani et al. 2023). For stop word removal, we use a modified version of a stop word list for German (Savand et al. 2024).[6]

Within the 5 million Wikipedia sentences, there was a great variability between the raw word frequencies. For example, *benehmen* 'to behave' occurs only 55 times, while *sehen* 'to see' has a frequency count of 52205. Such differences will only increase with larger corpora, with many infrequent words having low numbers and only a few frequent words with high numbers (following Zipf's law; Zipf 1936, 1949); a problem that requires a solution before the data can be used in our model.

To measure semantic priming we used co-occurrence counts and positive pointwise mutual information (PPMI) (Fano 1961; Church & Hanks 1990), which is high for words that are closely related to each other and low for unrelated tokens, taking the general frequency of a word and its likelihood to co-occur with other words into account as well. The formula is provided in the equation in (2), where the PPMI measures the association between two words x and y. The probability of the words co-occurring is divided by the probability of each word occurring independently. The denominator thus takes into account the lexical frequencies of the individual words. Closely related words are those that co-occur more often than predicted under independence.

(2) $$PPMI(x,y) = max(log2\frac{P(x,y)}{P(x)P(y)}, 0).$$

Word frequencies and co-occurrence counts are required for the denominator and numerator respectively. Both of these calculations were extracted from the German Wikipedia dataset of the PDW with the same pre-processing techniques described above for lexical frequencies. The co-occurrences were calculated at the sentence level. To do so, a data frame was created which stored all the words in the corpus, their respective co-occurring tokens and the number of co-occurrences for each of these pairs. Based on the frequency counts and this data frame, we calculated the PPMI score between any two words. Similar to the Zipf distribution for lexical frequencies, the PPMI score distribution is also skewed. Most words do not co-occur with each other, resulting in 0.0

[5] Lexical frequencies do not necessarily represent a specific participant's familiarity with different words, but they provide a good approximation for a majority of the population.

[6] This particular list was chosen and extended because the ones offered by common libraries like SpaCy or NLTK (Bird et al. 2009) are too extensive for our cause, and would exclude words that we deem important for the calculations.

PPMI scores for the majority of word pairs.

As mentioned above, we only focus on onset closure durations (O-values) of the word-initial plosives from the experiment described in Section 3 for demonstration purposes, but the method can easily be extended to all other target areas. For the onset duration scale we extracted all onset measures from the experimental production data, excluding any outliers beyond the interquartile range.

For the research question discussed in this paper we thus have three gradient scales that express different measures of language redundancy and acoustic salience:

- lexical frequencies: 0 to millions of occurrences
- semantic priming: 0 to millions of co-occurrences
- onset closure duration: 0.02 to 0.102 seconds

With other language redundancy factors, different target areas, or further acoustic cues (e.g., f_0 in Hertz instead of duration in seconds), there are potentially many more scales expressing the gradient nature of the data, with many of them being non-linear. There are thus two problems that need to be solved with regard to gradient data: 1) How can we relate the different scales of - in our case - semantic priming in form of PPMI scores, lexical frequencies, and onset closure durations? And 2) how can we meaningfully integrate these measures into a formal model of grammar?

4.2 Normalising and modelling the inverse relation

In order to curtail the non-linear scales and to map these different measures onto a single scale, we applied logarithmic normalisation to the raw occurrence counts, duration values, and PPMI scores. The log-transformation represents all measures on a scale between 0 and 1, while still capturing the gradient nature of the data, even if the original data is heavily skewed (lexical frequencies and PPMI scores). In order to make all scales comparable, we apply the log-transformation also to the duration values, even though they are normally distributed. Example (3) shows the corresponding formula.

(3) $$\text{log normalisation} = \frac{\ln(\text{value}) - \ln(\text{minimum})}{\ln(\text{maximum}) - \ln(\text{minimum})}$$

For the language redundancy factors of lexical frequency and semantic priming, this subsequently means that values close to 1 represent a high language redundancy value. Values close to 0 on the other hand indicate a low redundancy. For duration values, scores close to 0 represent short durations, i.e., low acoustic salience, and numbers close to 1 represent longer durations and thus high acoustic salience. The interpretation of the scales is thus reversed: High scores on the language redundancy scale represent frequent items, while high scores on the acoustic redundancy scale represent infrequent items.

In order to model the inverse relationship between language redundancy and acoustic salience, and to predict the acoustic redundancy score during language production, we subtract the log-normalised language redundancy value from 1 (the maximum log-value an item can have) and receive the log-normalised acoustic redundancy value. This log-value can then be mapped back against the concrete acoustic values from the experiment, in our case onset closure duration.

(4) 1– language redundancy (log) = acoustic redundancy (log)
$\rightarrow$ onset closure duration (prediction in s)

To give a concrete example: The word *Berliner* has a raw lexical frequency value of 9610 occurrences which is normalised to the corresponding log-value of 0.827. Subtracted from 1, the returned inverse acoustic redundancy value will be 0.173.

(5) 1 – 0.827 = 0.173

In a second step, the acoustic redundancy log-value is mapped against concrete onset measures. As mentioned above, the onset closure durations collected as part of the experiment were log-normalised as well. The log-value from example (5) corresponds to the concrete value of 0.027 seconds in the onset closure duration data.

(6) 0.173 log-value $\approx$ 0.027 onset closure duration in seconds

The onset closure duration is rather short in this example, reflecting the high lexical frequency of the word *Berliner*. Of course, it is unlikely that the predicted exact value of 0.027 seconds is produced by a speaker uttering the word *Berliner*. There are many factors influencing spoken language, with lexical frequency just being one of them. However, we can predict that based on lexical frequency, the duration of onset closure duration will be *approximately* 0.027 seconds.

To summarize, our approach allows us to transform the different raw value scales of lexical frequency, semantic priming, and onset closure duration to a log-transformed scale between 0 and 1. For language redundancy values, items with the value of 1 are highly frequent/predictable and items with the value of 0 are infrequent/non-predictable (with values in between trending towards one end of the scale). For duration measures, the scales are reversed, in that a value of 1 represents a long onset closure duration, and a value of 0 a short duration. The normalised scales then allow us to model the inverse relationship between language redundancy and acoustic redundancy as illustrated in Table 3.

word	raw freq.	language red.		acoustic red.	onset clos.dur
Berliner	9610	0.827	1 – 0.827	0.173	0.027

Table 3: Modelling the inverse relationship between language redundancy and acoustic redundancy by means of normalised log-scales for the word *Berliner*

This approach allows us to effectively calculate realistic acoustic values based on language redundancy values. The next sections discuss how these values can be modelled in LFG with p-structure providing the pivotal point between language redundancy and acoustic redundancy as predicted by the PIH.

4.3 Recap: The prosody-syntax interface (Bögel 2015)

The new proposal introduced in this paper is based on the syntax-prosody interface model developed in Bögel (2015), which assumes two levels of information exchange between c-structure and p-structure: 1) The transfer of vocabulary which exchanges phonological and morphosyntactic information of lexical elements via the multidimensional lexicon, and 2) the transfer of structure (♮) which exchanges information on syntactic and prosodic constituency, and on intonation. The model distinguishes between comprehension (i.e., parsing; from form to meaning) and production (i.e., generation; from meaning to form), slightly altering communication at the interface in each case.[7] During comprehension, information from the speech signal feeds into p-structure; during production, information from p-structure forms the basis for the speech signal/the utterance. Figure 5 illustrates.

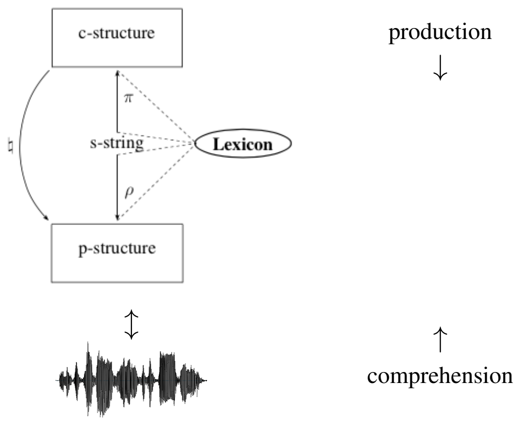

Figure 5: The prosody-syntax interface as proposed in Bögel (2015)

The multidimensional lexicon associates morphosyntactic (s-form) and phonological information (p-form) on lexical elements and projects them to their respective structures (c-structure or p-structure). Figure 6 shows the (simplified) lexical entries for the noun *Bewerber* 'applicant' and the determiner *die* 'the'.

concept	**s-form**			**p-form**	
APPLICANT	N	(↑ PRED)	= 'Bewerber'	SEGMENTS	/b ə v ɛ ʁ b ɐ/
		(↑ NUM)	= {sg | pl}	METRICAL FRM	$(\sigma{}'\sigma\sigma)_\omega$
DETERMINER	D	(↑ PRED)	= 'die'	SEGMENTS	/d i/
		(↑ NUM)	= {sg | pl}	METRICAL FRM	σ

Figure 6: (Simplified) lexical entries for *die* and *Bewerber*

Next to the (semantic) concept and the morpho-syntactic s-form, each lexical entry also contains information on its phonological representation in p-form. This includes the segments and the metrical frame, which contains the number of syllables, information on lexical stress, and whether the entry itself is a prosodic word (*Bewerber*) or not (*die*).

[7] See Bögel (2020) for a detailed example, and Bögel (2023) for a discussion.

Each lexical dimension can only be accessed by the related module, i.e., p-structure can only access information from the p-form, and c-structure can only access information from the s-form. At the same time, the lexicon also has a translation function: Once a dimension is triggered, the related dimensions can be accessed as well. During comprehension, the input from the speech signal is matched against the lexicon's p-form until a match is made and the s-form becomes available for processing. During production, information on a particular s-form is passed from the grammar to the lexicon, and the associated p-form becomes available to p-structure.

The model proposed in this paper is discussed from the perspective of production, i.e., how semantic priming and lexical frequency effects are realised as part of the acoustic signal. P-structure is represented by the p-diagram, a syllablewise representation of the speech signal over time. During production, the p-diagram consists of two levels, the *lexical* level with information from the lexicon's p-form, and the *interpretation* level, which, e.g., contains information on c-structure constituents translated into prosodic constituents. The p-diagram in Figure 7 contains the string ... *mussten die Bewerber* ... from example (1).

PHRASING	$(_{\iota}(\sigma$	$\sigma)_{\omega}$	σ	$_{\omega}(\sigma$	σ	$\sigma)_{\omega}$	...	*interpretation*
TOBI	–	–	–	L	+H*	–	...	↓
LEX.STRESS	x	–	–	–	x	–	...	*lexical*
SEGMENTS	/mʊs/	/tən/	/di/	/bə/	/vɛʁ/	/bɐ/	...	↓
VECTORINDEX	$\mathbf{S_1}$	$\mathbf{S_2}$	$\mathbf{S_3}$	$\mathbf{S_4}$	$\mathbf{S_5}$	$\mathbf{S_6}$	...	

Figure 7: A (simplified) p-diagram during production for the string ... *mussten die Bewerber* ... (example (1))

For each word, the p-diagram stores the syllables, the segments, lexical stress, and prosodic frame as defined in the lexicon. In addition, further information on high and low tones and on larger prosodic units (here the start of an intonational phrase ($_{\iota}$)) are added based on the lexical information and information from the grammar.[8] This initial p-diagram includes the basic phonological information, which is then further adjusted according to language specific prosodic rules and principles. However, so far – and in contrast to the model in comprehension – the production model does not yet include an interface to phonetics (i.e., the actual speech signal), and it does not provide a means to express language redundancy and its inverse relationship with acoustic salience.

4.4 Modelling language redundancy in LFG: a new proposal

Section 4.2 showed how different factors of language redundancy and acoustic redundancy can be normalised on one scale, and how their inverse relationship can be expressed. This section demonstrates how redundancy measures can be integrated into LFG and how p-structure can be used as a pivot between grammar and signal, using the proposal of Bögel (2015) as discussed in Section 4.3.

[8]Further information is left out in order to simplify the discussion.

In order to integrate lexical frequencies, the multidimensional lexicon is extended to include a *redundancy* section as illustrated in Figure 8 for the words *Berliner, Bewerber* and *Vorstellungsgespräch* from example (1).[9]

s-form		p-form		redundancy
N	(↑ PRED) = 'people.from.Berlin'	P-FORM	[bɛʁli:nɐ]	lex.freq: 0.827
	(↑ NUM) = pl	METR. FRAME	(σ'σσ)$_\omega$	
s-form		**p-form**		**redundancy**
N	(↑ PRED) = 'applicants'	P-FORM	[bəvɛʁbɐ]	lex.freq: 0.579
	(↑ NUM) = pl	METR. FRAME	(σ'σσ)$_\omega$	
s-form		**p-form**		**redundancy**
N	(↑ PRED) = 'job interview'	P-FORM	[fo:ɐʃtɛlʊŋsgəʃpʁɛ:ç]	lex.freq: 0.18
	(↑ NUM) = sg	METR. FRAME	('σσσσ'σ)$_\omega$	

Figure 8: Lexical entries for the words *Berliner, Bewerber* and *Vorstellungsgespräch*, including log-transformed lexical frequency values

These values become available to p-structure during the transfer of vocabulary. To this end, the p-structure is extended to include a *redundancy level* which stores the lexical frequency value for all the syllables associated with that lexical entry. This input to p-structure is further processed to calculate the corresponding measure of acoustic salience. Figure 9 demonstrates this process for the word *Bewerber* 'applicant'.

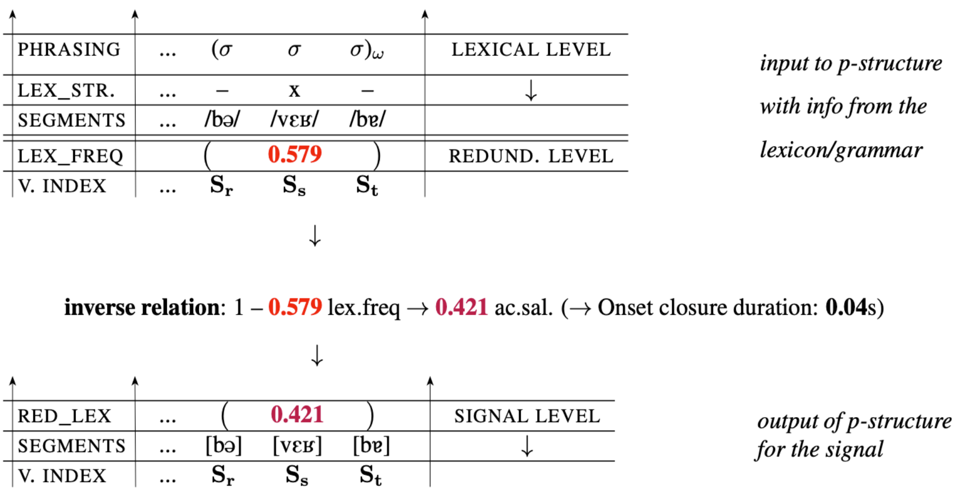

Figure 9: Prosodic structure as the pivotal point between language redundancy and acoustic redundancy for *Bewerber* 'applicant'

Once the log-value of the acoustic salience is established, it can be mapped to a concrete acoustic value as part of the p-structure-phonetics interface. This can be the concrete onset closure duration (which in this case would be 0.04 s), but it could also be mapped against any other acoustic value associated with the target word (overall and further partial duration values, f_0 values, etc.). The acoustic salience measure thus forms an

[9]The redundancy section in this example only contains the lexical frequency measures. Further measures could, e.g., be syllable bigrams which have also been shown to have an effect on acoustic salience.

abstract representation for a number of phonetic realisations while at the same time allowing for their gradient nature to be captured as well.

Semantic priming is different from lexical frequency as it does not express the activation of an isolated word, but the relationship between two different words. This network between words is also part of the mental lexicon, but not part of a single lexical entry's redundancy level. Figure 10 shows the semantic priming measures (i.e., the log-normalised PPMI values from the corpus) between single lexical entries in blue. The numbers indicate a strong priming relationship between 'applicant' and 'job interview' (0.963) and no priming relationship between 'job interview' and 'Berliner' (0). In p-structure, semantic priming measures are added to the new redundancy level.[10] As it is the case with lexical frequency, semantic priming measures can be inversely correlated with the log-value for acoustic redundancy (0.037 in Figure 10).

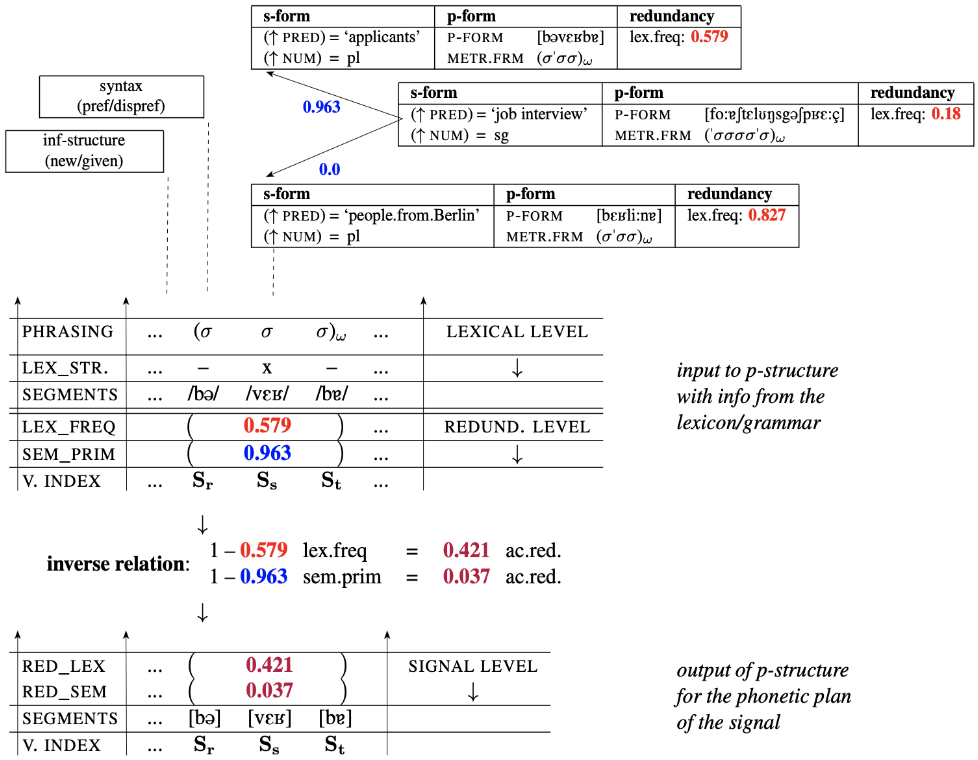

Figure 10: Calculated measures of semantic priming, lexical frequency, and acoustic redundancy for the word *Bewerber* at the prosody-syntax interface Bögel (2015)

The remaining question is how these two acoustic redundancy measures determined by semantic priming (0.421) and lexical frequency (0.037) can be united. Is the mean between the two values an appropriate representation? Or does one value 'override' the other value? Initial results as discussed in Section 3.2 show that the relationship is rather complex, so we will leave this question for further research.

[10]Further values to add to the redundancy level could be, for example, syntactic preferences or information from i-structure on focused or given structures.

5 Conclusion

This paper introduced a new approach to integrate gradient language redundancy effects into a formal model of grammar. Following the Smooth Signal Redundancy Hypothesis and the Prosodic Interface Hypothesis, the approach assumes that language redundancy and acoustic redundancy form an inverse relationship mediated by prosodic structure. If language redundancy is high, acoustic redundancy is low, and vice versa, with the effects mainly being realised at the prosodic boundaries and on the stressed syllable.

The concept was demonstrated by means of an experiment on semantic priming and lexical frequency and their inverse relationship with durational values at the prosodic word boundaries as an acoustic redundancy measure. To model this relationship, these three types of gradient redundancy measures were log-normalised to a common scale between 0 and 1. The normalisation allowed for an abstract representation of the different redundancy values, while at the same time preserving the gradient nature of the data. The common scale furthermore made it possible to model the inverse relationship between language redundancy and acoustic redundancy measures. These gradient representations were then integrated into LFG, with p-structure as the pivotal point between language redundancy and acoustic salience.

The formal integration of gradient redundancy measures in a way presupposes the assumption that these measures are part of the (rule-based) grammar, which opens up an interesting discussion on the exact definition of a speaker's language competence vs. performance. While this discussion is beyond the scope of this paper, the paper showed that the relationship between language redundancy and acoustic salience can be captured by regular inverse correlation patterns. The integration of gradient data also avoids the commonly found classification of such values into different categories based on random thresholds (e.g., 'frequent' and 'infrequent', or 'given' and 'new'). Instead, the proposal is able to preserve the original nature of the data on the one hand, and the fundamental rule-based structure of LFG on the other hand, by adding redundancy values to already existing structures and by providing a predictive algorithm to calculate specific redundancy values.

In addition, the paper also takes an important step towards the interface between phonology and phonetics by means of abstract acoustic redundancy values. These values can be further transformed into concrete acoustic measures, thus providing a means to support the generation of spoken language based on deep linguistic information as it is traditionally found in LFG.

Appendix

The following section lists the stimuli used in the experiment described in Section 3. The sentence pairs are grouped with identical target words in a priming (first sentence) and a non-priming (second sentence) context. All target words are highlighted in blue.

1. Um die Nachbarn zu erfreuen, mussten die Bewohner sich benehmen.
   Um die Botschaft zu verkünden, mussten die Bewohner sich bemühen.

2. Um die Botschaft zu verkünden, mussten die Propheten sich bemühen.
   Um die Nachbarn zu erfreuen, mussten die Propheten sich benehmen.

3. Um das Brandenburger Tor zu sehen, mussten die Berliner sich gedulden.
   Um beim Vorstellungsgespräch zu punkten, mussten die Berliner sich behaupten.
4. Um beim Vorstellungsgespräch zu punkten, mussten die Bewerber sich behaupten.
   Um das Brandenburger Tor zu sehen, mussten die Bewerber sich gedulden.
5. Um das Eigentum zu behalten, mussten die Besitzer sich beweisen.
   Um den Eiffelturm zu besuchen, mussten die Besitzer sich gedulden.
6. Um den Eiffelturm zu besuchen, mussten die Pariser sich gedulden.
   Um das Eigentum zu behalten, mussten die Pariser sich beweisen.
7. Um das Geld zu klauen, mussten die Banditen sich verbünden.
   Um das Haar zu föhnen, mussten die Banditen sich beeilen.
8. Um das Haar zu föhnen, mussten die Blondinen sich beeilen.
   Um das Geld zu klauen, mussten die Blondinen sich verbünden.
9. Um die Römer zu besiegen, mussten die Germanen sich verbünden.
   Um den Bruder zu verärgern, mussten die Germanen sich bemühen.
10. Um den Bruder zu verärgern, mussten die Geschwister sich bemühen.
    Um die Römer zu besiegen, mussten die Geschwister sich verbünden.
11. Um die Ehe zu retten, musste die Gemahlin sich bemühen.
    Um den Gegner zu schlagen, musste die Gemahlin sich beweisen.
12. Um den Gegner zu schlagen, musste der Gewinner sich beweisen.
    Um die Ehe zu retten, musste der Gewinner sich bemühen.
13. Um das Königreich zu walten, musste die Prinzessin sich benehmen.
    Um die Vorlesung zu halten, musste die Prinzessin sich beweisen.
14. Um die Vorlesung zu halten, musste der Professor sich beweisen.
    Um das Königreich zu walten, musste der Professor sich benehmen.
15. Um das Frachtschiff zu kapern, mussten die Piraten sich verbünden.
    Um das Flugzeug zu landen, mussten die Piraten sich beeilen.
16. Um das Flugzeug zu landen, mussten die Piloten sich beeilen.
    Um das Frachtschiff zu kapern, mussten die Piloten sich verbünden.
17. Um die Sehenswürdigkeit zu betrachten, mussten die Touristen sich gedulden.
    Um an der Universität zu lehren, mussten die Touristen sich beweisen.
18. Um an der Universität zu lehren, mussten die Dozenten sich beweisen.
    Um die Sehenswürdigkeit zu betrachten, mussten die Dozenten sich gedulden.
19. Um das Volk zu unterdrücken, mussten die Tyrannen sich verbünden.
    Um den Chef zu beeindrucken, mussten die Tyrannen sich behaupten.
20. Um den Chef zu beeindrucken, mussten die Kollegen sich behaupten.
    Um das Volk zu unterdrücken, mussten die Kollegen sich verbünden.

21. Um den Gefährten zu helfen, mussten die Kumpanen sich vertrauen.
    Um den Eintritt zu bezahlen, mussten die Kumpanen sich gedulden.

22. Um den Eintritt zu bezahlen, mussten die Besucher sich gedulden.
    Um den Gefährten zu helfen, mussten die Besucher sich vertrauen.

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Iranian perception predicates revisited: Evidence from Hazaragi

Miriam Butt
University of Konstanz

Saira Bano
University of Konstanz

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Abstract

Taking the recent work by Asudeh & Rad (2023) on Persian predicates of perception as a point of departure, we investigate predicates of perception in the under-researched Iranian language Hazaragi. We show that the proposed existing classification for Persian predicates of perception is not adequate in light of data from Hazaragi and propose an alternative analysis for predicates of perception formed via N-V combinations. This analysis sees most of the N-V combinations as metaphorical and idiomatic uses, but some as instances of N-V complex predications, which we analyze via the event-based linking approach we have previously formulated for Urdu/Hindi N-V predicates of perception (Butt et al. 2023).

1 Introduction

Asudeh & Rad (2023) present a glue semantics analysis of Persian verbs of perception based on Viberg's original typologically motivated classification (Viberg 1984, 2001).[†] We take this paper as our point of departure and propose an alternative approach. We do this on the basis of data from the related but under-researched Iranian language Hazaragi. Overall this paper together with Asudeh & Rad (2023) must be seen as part of a larger discussion currently taking place within LFG as to the status and interpretation of predicate-argument relations in LFG. In the original formulation of LFG, predicate-argument relations were seen as part and parcel of a predicate's subcategorization frame (Butt & King 2006 [1983]). In light of work in the 1980s and 1990s on causatives, applicatives and other argument alternating phenomena primarily in Bantu and Romance, LFG's *Mapping Theory* was developed (see Butt 2006 for an overview) and continually updated in different ways (see Findlay et al. 2023 for the most recent overview), so that currently several different proposals exist for the relationship between semantic roles and grammatical relations.

A new twist was brought into research on the relation between a predicate's event participants and the corresponding f-structural subcategorization frame by the continual development of a formal syntax-semantics interface within LFG, namely glue semantics (Dalrymple et al. 1993; Dalrymple 1999; Asudeh 2023) and the fact that event-based formal semantics generally makes reference to a predicate's event participants in the meaning representations, for example as practiced in Davidsonian semantics (e.g., Davidson 1967; Parsons 1990, 1995). The question then arises—if there is a formal treatment of predicate event participants as part of the clausal semantic analysis, then why postulate a separate argument structure? The answer to this question by the line of research represented by, a.o., Asudeh & Giorgolo (2012), Asudeh et al. (2014), Findlay (2016) and Findlay (2020) is that there is in fact no need for a separate argument structure representation that potentially duplicates information also available independently in a semantic representation.

However, the reason that argument structure approaches focusing on the lexical semantics (rather than the clausal semantics) of predicates have been undertaken at

[†]We are very grateful to Ash Asudeh for the lively and interesting discussions of this topic at Accra as part of LFG'24 and to both him and Siavash Rafiee Rad for raising the topic of Iranian psych predicates in the first place at LFG'23 in Rochester. We would also like to thank our reviewers for extremely valuable feedback. The work in this project was supported by funding from Project-ID 251654672 — TRR 161, Project D02 "Visual Analytics for Linguistic Representations".

least since Ostler (1979) is motivated by the observation that there seems to be a subset of a combination of semantic and morphological information that is relevant for the determination of a predicate's overall syntactic subcategorization frame. It is this subset of information that Mapping Theories such as that formulated in LFG seek to capture (see also Alsina 2001). A case in point has been the study of complex predicates, where one or more predicational elements are combined to form a single syntactic predication (Mohanan 1994; Butt 1995; Alsina 1996; Alsina et al. 1997; Butt 2010; **?**) and it is only this combined set of arguments coming from within lexical semantics that then enters the clausal semantic calculations.

In this context, Asudeh & Rad (2023) present an analysis of Persian N-V verbs of perception that follows the newer glue semantic approach to predicate-arguments and eschews a separate representational level for a(rgument)-structure. They combine this with an approach that maps between macro roles in the sense of Van Valin & Polla (1997), more fine grained thematic roles and their realization as grammatical functions. Asudeh & Rad (2023) thus also formulate a new theory of mapping.[1]

In recent work, we investigated Indo-Aryan psych predicates and N-V combinations (Butt et al. 2023), but from the perspective of an alternative extension to LFG's Mapping Theory in terms of an Event-Based Linking Theory (Schätzle 2018; Beck & Butt 2024). We therefore see this paper as contributing to the ongoing discussion about the integration of predicate-argument information into the architecture of LFG.

The paper is structured as follows. In section 2 we first present Viberg's crosslinguistic classification scheme for verbs of perception that Asudeh & Rad (2023) base themselves on. In section 3 we provide a brief recap of what we have already established about verbs of perception with respect to Urdu/Hindi and the attendant analysis of the N-V predicates of perception as complex predicates within our Event-Based Linking Theory. We compare our analysis with that of Asudeh & Rad (2023) for Persian in section 4 and then move on to an alternative analysis in section 6 based on our findings in section 5 for the related Iranian language Hazaragi, of which co-author Bano is a native speaker. Section 7 concludes.

2 Viberg on verbs of perception

Viberg conducted a series of studies on the crosslinguistic properties of verbs of perception. Most relevant for this paper are the comparative, typologically oriented studies in Viberg (1984, 2001). Viberg proposes to classify verbs of perception crosslinguistically in terms of the five basic senses: 1) sight, 2) hearing, 3) touch, 4) taste, 5) smell. His analysis further shows that verbs of perception seem to fall into theree basic categories crosslinguistically and that these categories can be described in terms of the types of events that are involved. As shown in (1), he distinguishes between Activities, Experiences, and Copulatives. Activities involve an agentive activity, experiences consist of an Experiencer perceiving a Stimulus and copulatives involve only a Stimulus that is emitted, with the appearance of Experiencer in the clause being optional.

[1]Note that Asudeh & Rad's particular theory of mapping is new, but that much of the work around folding a-structure into a more general semantics account has also (necessarily) involved formulating alternatives to LFG's classic Mapping Theory.

(1) a. **Activity**, e.g., *Ali listened to the birds.* (Agent-Theme)
b. **Experience**, e.g., *Ali heard the birds.* (Experiencer-Stimulus)
c. **Copulative**, e.g., *The birds sounded happy (to Ali).* (Stimulus-(Experiencer))

Taking the five sensory categories together with the three types of events identified by Viberg, this results in 15 possible cells that languages can potentially lexicalize with dedicated verbs of perception. Viberg finds that languages have very different lexicalization patterns. Generally, not all the cells are filled with dedicated lexical items such as *listen* or *hear* in (1) for English. For example, *hear* might be expressed by a periphrastic construction such as 'sound came' or be expressed by various different phrasings altogether. Viberg also finds polysemy between verbs of perception so that a single lexical item is used to express both 'hear' and 'see', for example, and thus fills multiple cells. Overall Viberg proposes a cognition-based hierarchy between the different perception types in order to make sense of the crosslinguistic lexicalization and polysemy patterns.

Evans & Wilkins (2000) conducted a follow-up study with a focus mainly on Australian languages to examine whether Viberg's generalization holds over this set of languages. On the whole, they found that Viberg's approach and insights hold, though they propose some refinements. Most recently, Norcliffe & Majid (2024) conducted a large scale typological study that also aimed at investigating Viberg's results and insights in more detail and with a larger sample of languages. Their findings are not only broadly in line with Viberg, they also confirm patterns which Viberg had only identified tentatively and find that sight appears to work somewhat differently from the other senses, also often giving rise to raising verbs like 'seem'. While the empirical findings are broadly in line with Viberg, Norcliffe & Majid (2024) propose a different explanation of the crosslinguistic patterns. Rather than invoking a cognition-based hierarchy, they propose that communicative constraints and conceptual similarity give rise to the observed crosslinguistic patterns.

While the crosslinguistic data, issues and proposed explanations are fascinating in their own right, delving more deeply into them would lead us too far afield in the context of this paper, which is to study Indo-Iranian verbs of perception more closely in terms of their argument structure properties. In this context, we would also like to note that while Norcliffe & Majid (2024) look at 100 languages, they do not include a single Iranian or Asian language in their sample.

We thus return to Viberg (1984), who explicitly discusses Persian and Hindi and provides the following table for Hindi (Viberg 1984: 133).[2] As can be seen, polysemy is posited for Hindi between 'look at/see' and 'hear/listen' so that the language is analyzed as not distinguishing these verbs in terms of whether the perception is agentive. Several cells are left completely unfilled, indicating that the language does not have a dedicated lexical item to express this type of perception. Furthermore, as can be seen in Table 1, some cells are filled by N-V combinations, e.g., *xʊʃbu*'smell' + *a* 'come'.[3]

Viberg's compilation of these patterns is extremely valuable. However, given his macro perspective of identifying typological patterns, it is unsurprising that some details of the empirical observations are incomplete or incorrect.

[2] Table adjusted in terms of transcription and glossing.

[3] Note that *sũg*ʰ is the verb for 'to smell' and is agentive in that it takes an ergative subject. In contrast, *xʊʃbu* is a noun that combines with the motion verb 'come' to take a dative subject.

<table>
<tr><th></th><th>Activity</th><th>Experience</th><th>Copulative</th></tr>
<tr><td>sight</td><td colspan="2">dek^{h}
‘look at/see’</td><td></td></tr>
<tr><td>hearing</td><td colspan="2">sʊn
‘hear/listen’</td><td></td></tr>
<tr><td>touch</td><td>tʃu
‘touch’</td><td>cʊb^{h}
‘prick/pinch’</td><td>lɑg
‘seem’</td></tr>
<tr><td>taste</td><td>cɑk^{h}
‘taste’</td><td>dative SUBJ
+ lɑg ‘seem’</td><td></td></tr>
<tr><td>smell</td><td>sũg^{h}
‘smell’</td><td>dative SUBJ
+ xʊʃbu a
‘smell come’</td><td></td></tr>
</table>

Table 1: Viberg’s table for Hindi predicates of perception

While we have not done an exhaustive study of Urdu/Hindi verbs of perception, there are some immediate observations that can be made with respect to Viberg’s Hindi table. For one, more cells could be filled with more lexical items. For example, there is a well-known causative alternation in Hindi between *dek*^{h} ‘see’ and *dɪk*^{h} ‘appear to’. The latter would be a candidate to fill the sight/Experience cell. Furthermore, this same cell could also hold the N-V combination in (2), which is a very common way of expressing non-agentive ‘see’ in Urdu/Hindi.

(2) ɑli=ko kabutɛr nɑzɑr ɑ-ya (Urdu/Hindi)
Ali.M=Dat pigeon.M.Sg.Nom sight.F.Sg come-Perf.M.Sg
‘Ali saw a pigeon (lit. sight of a pigeon came to Ali).’

Viberg (1984: 133) does note that in general South Asian languages appear to use the dative to signal experiencer semantics (as in the cells taste/Experience and smell/-Experience in Table 1, for example. This observation is in line with our own work (Ahmed & Butt 2011; Butt & Deo 2013; Beck & Butt 2024), as well as other work (e.g., Verma & Mohanan 1990; Mohanan 1994; Montaut 2003; Ahmed 2006).

In the next section we take a closer look at the Urdu/Hindi patterns, focusing on the N-V combinations. We show how one can account for these via an approach which posits a separate representation for a-structure and combines this with mapping principles to explain the regular relationship between a predicate’s semantic event partcipants and the predicate’s syntactic subcategorization frame through our Event-Based Linking.

3 Urdu/Hindi predicates of perception

3.1 Case alternations and semantics

Urdu/Hindi shows regular alternations in the case marking system that correspond to generalizable semantic differences (Butt & Ahmed 2011). A case in point is a very regular alternation between datives and ergatives whereby ergative subjects denote Actors/Initiators in the broad sense and datives in contrast signal non-agentivity, as in

(3-b), for example, where the dative corresponds to experiencer semantics and stands in contrast to (3-a).

(3) a. nadya=**ne** kahani **yad** **k-i**
Nadya.F.Sg=Erg story.F.Sg.Nom memory do-Perf.F.Sg (Urdu/Hindi)
'Nadya remembered a/the story (actively).'
(lit.: Nadya did memory of the story.)

b. nadya=**ko** kahani **yad** **a-yi** (Urdu/Hindi)
Nadya.F.Sg=Dat story.F.Sg.Nom memory come-Perf.F.Sg
'Nadya remembered a/the story (it came to her mind).'
(lit.: Memory of the story came to Nadya.)

Both examples in (3) involve N-V combinations, which in these cases have been shown to be complex predicates (Mohanan 1994). This means that the noun and the verb combine their a-structures (information about event participants) to form a predication that is equivalent to that of a single verb and which results in a monoclausal f-structure (only one SUBJ, no embedded COMP or XCOMP; see e.g., Mohanan 1994; Alsina 1996; Butt 1995, 2010).

Note that (3-a) contains the agentive light verb *kar* 'do' whereas (3-b) makes use of the motion verb *a* 'come'. It can be shown that most of the modern experiencer predicates with dative subjects find their origin in spatial expressions so that 'Memory of a story comes to Nadya' changes to mean 'Nadya remembered the story' (see Beck & Butt 2024; Butt & Ahmed 2011; Montaut 2003, 2009, 2016 and references therein). The ergative is licensed by the light verb 'do' in (3-a), while the dative is licensed by the non-agentive light verb 'come' in (3-b).

Examples such as (3) illustrate that the morphosyntax of languages like Urdu/Hindi wears the clausal semantics on its proverbial sleeve. In what follows, we propose to take this observation seriously and expect the morphosyntax together with the lexical items used in N-V combinations to provide us with the building blocks of a compositional analysis. Before proceeding on to the presentation and analysis of Hazaragi verbs of perception and what we can conclude from that with respect to Persian, the next sections illustrates our overall approach to complex predication and mapping between a-structure and f-structure by way of an apparent exception to the pattern in (3).

3.2 An apparent exception

As part of his overall discussion of Hindi, Viberg (1984: 134) notes that there are uses of the otherwise agentive verb *de* 'give' with an experiencer dative subject to form an experiencer predicate; see (4) (note that the glossing in (4) is Viberg's). This example is extremely interesting as it would seem to constitute an exception to the otherwise very robust pattern of dative = non-agentive verb, ergative = agentive verb.

(4) mʊj^{h}e vo dɪk^{h}ai diya (Urdu/Hindi)
me-to he be=visible gave
'I saw him.' (Viberg 1984: 134)

We investigated examples like (4) in Butt et al. (2023) in some detail and found that: 1) there is no other instance in the language where the agentive verb *de* 'give' occurs with a dative subject; 2) the combination with *de* 'give' occurs only with exactly two predicates of perception: *dɪkʰai* 'seeing' and *sʊnai* 'hearing'. These two forms turned out to be interesting in and of themselves and we determined they are morphologically complex, consisting of: a) the verb stem; b) the causative morpheme *-a*; c) a nominalizing morpheme *-i*. The full/proper gloss of (4) is then as in (5).

(5) mʊjʰe vo dɪkʰ-a-i di-ya (Urdu/Hindi)
I.Dat Pron.3.Sg.Nom see-Caus-Nomlz.F.Sg give-Perf.M.Sg
'I saw him.' (lit. He gave sighting to me.)

Somehow this combination of morphology then ends up meaning 'seeing' and 'hearing' and together with 'give' ends up meaning 'see' and 'hear'.

3.3 Complex predication

We found that we could explain the seeming exception offered up by (5) if we analyzed it as a complex predicate made up of three different parts that are then nominalized. Our approach was couched within the Event-Based Linking Approach first suggested by Schätzle (2018) and then worked out further in Beck & Butt (2024) in combination with Butt's overall theory of complex predication (Butt 2014).

3.3.1 Theoretical background

Given space constraints, we provide only a brief sketch of our approach in this section; see Schätzle (2018), Butt (2014) and Beck & Butt (2024) for details. Overall we work with the ideas in Kibort's (2007; 2008; 2014) version of LFG's Mapping Theory; see also Findlay et al. (2023: 741–748) for an overview. Kibort posits four abstract argument types as an independent tier of representation ('argument slots') at a-structure, eschewing thematic role labels (cf. also Grimshaw 1990). These are represented with an x, a notation we adopt. Our overall linking schema is as shown in (6).

(6) General Linking Schema

		init	proc	res	rh	
Predicate	<	x	x	x	x	>
		FIGURE	GROUND			
Grammatical Functions		SUBJ	OBJ	OBJ_θ	OBL	

We extend and expand on Kibort's ideas by integrating an event-based approach to linking. We do this by adopting Ramchand's (2008) tripartite organization of subevental structure. Ramchand decomposes an event into three major subevents: i) a causing or initiating subevent (*init*), which results in ii) a process subevent (*proc*), which results in iii) a result state (*res*). In addition, *rhemes* (*rh*) are descriptions of a predicate that are in a static relationship with one of the three subevents of a predicate, like the classic static spatial Figure/Ground relationship (Talmy 1975; Svenonius 2010). *Rhemes* roughly correspond to LFG's OBLs. We analyze the abstract argument slots posited by

Kibort as being licensed by the subevents *init, proc, res* and *rh*, with a maximum of four arguments per monoclausal predication, as proposed by Findlay (2016: 317f.).

A mapping or linking algorithm determines which of the argument slots are linked to which of the grammatical functions. For this algorithm we again combine Kibort's formulation with further proposals in the literature, namely the use of Proto-Role information (Dowty 1991) as operationalized for LFG by Zaenen (1993). We combine this with notions of prominence in terms of Figure vs. Ground (based on the original proposals by Talmy 1975). In brief, the event participant with the most Proto-Agent properties is linked to the SUBJ , while the event participant with the most Proto-Patient properties is linked to the OBJ. Typical Proto-Agent properties include being licensed by an *init* event, being realized as a Figure and being sentient. Typical Proto-Patient properties include being licensed by a *proc* or res subevent and being realized as a Ground. The rhemes are considered to be inert with respect to Proto-Role properties and tend to be linked to OBL.

We further combine this linking algorithm with Butt's theory of complex predication. This also has several parts. For one, complex predicates are taken to be formed when two or more predicational elements enter into a relationship of co-predication. Each predicational element adds arguments (or information about an argument) to a monoclausal predication. That is, we can tell that an N+V, V+V or A+V or V+Inflection combination is a complex predicate if each part can be shown to contribute to the overall predication in terms of the number and type of arguments that are involved. Following Alsina (1996), the argument combination is triggered by one of the elements being an instance of an *incomplete predication*, that is a *light verb*, which must combine with another event predication in order to be able to deploy its a-structure. Following the XLE notation (Crouch et al. 2011) for variables, we notate such incomplete predication with a %, e.g., *%proc*.

When two or more a-structures are combined, certain arguments are coindexed/-identified with other arguments. We follow the formalization in Butt (2014), whereby the highest (as determined by the subevental structure) embedded argument is identified with the lowest matrix argument. Exactly how all these pieces of the formalism work together is illustrated in the next section.

3.3.2 Analysis of the apparent exception

In this section, we work with (7) as the running example to be analyzed. Recall that the noun *dɪk*^{h}*ai* 'seeing' consists of several pieces of morphology, which each affect the overall a-structure of the predication. These are: 1) the verb of perception *dɪk*^{h} 'appear'; 2) the causative morpheme *-a*; 3) a nominalizing affix *-i*. This complex word additionally combines with the verb *de* 'give', which in this case is acting as a light verb that triggers complex predication.

(7)	muj^h-e	jahaz	dɪk^h-a-i	di-ya	(Urdu/Hindi)
	Pron.1.Sg-Dat	plane.M.Sg.Nom	see-Caus-Nomlz.F.Sg	give-Perf-M.Sg	
	'I saw a plane.'				

Let us begin with the light verb. It is based on the ditransitive agentive verb 'give'. Under Ramchand's subevental approach to predicate-argument structure, it would therefore be analyzed as containing an *init* subevent (licensing the Agent/Actor of the event), a *proc* subevent (representing the event in progress and generally licensing the Undergoer/Patient of the event) and a *res* subevent, which represents the end result of the event and generally licenses the Goal or endpoint of the event. In its light verb use, the *proc* part of the event is taken to be filled by another predicate, that is, what is 'given' to somebody is not a thing, but an event. In our example in (7) it would be the 'seeing' event that is given to the speaker. The overall subevental analysis of the light verb version of 'give' is thus as shown in (8).

(8) GIVE $<$ init %proc res $>$

Next we look at the verb of perception *dık*^{h} 'appear to'. In Viberg's classification scheme it would fill the Experience/sight cell. That is, we have an Experiencer responding to a Stimulus that can be perceived by sight. In Ramchand's system, Experiencers are analyzed as holders of a state of experience. This translates into the verb consisting of two subevents: 1) a holder of a state; 2) a rheme. The Experiencer (holder of a state) is licensed by the *init* subevent. The stimulus is inert and licensed by the *rheme*. We thus propose the subevental analysis in (9) for *dık*^{h} 'appear to'.

(9) APPEAR TO $<$ init rh $>$

The causative morpheme *-a* involves a causer (initiator in Ramchand's system) that causes an event. This event is again represented as *proc* and as a variable to be substituted into: %proc, as shown in (10).

(10) CAUSE $<$ init %proc $>$

We now have all the pieces of the complex predication in place except for the nominalizing suffix *-i*. In line with LFG's classic Mapping Theory (and approaches to nominalization in general), we take this nominalization to suppress the highest argument of the a-structure it combines with.

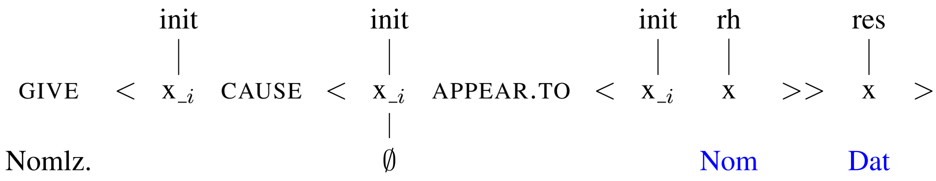
The complete analysis of how the complex predication is arrived at in Butt et al. (2023) is shown in (11). We begin with the verb of perception 'appear to', which is causativized. The causativization is represented by substituting in the subevental structure of 'appear to' into the *%proc* event variable of the causative. This complex combination in turn is substituted in to the *%proc* subevent of the light verb 'give'.

(11)

```
GIVE  <  init  %proc  res  >
                 |
               CAUSE  <  init   %proc   >
                                  |
                            APPEAR TO  <  init  rh  >
```

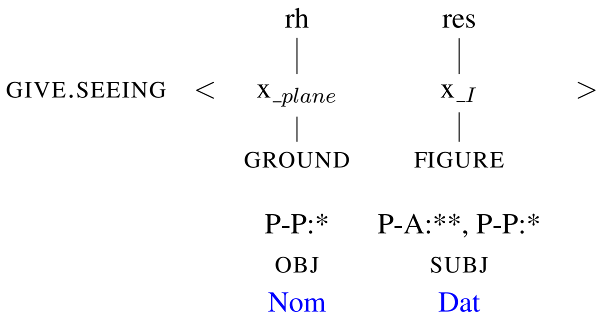
Overall this results in the complex argument structure in (12), in which the effects of argument identification due to complex predicate formation (cf. Butt 2014) are applied: 1) the highest argument of 'appear to' is identified with the lowest available argument of the causative; 2) the highest argument of the causative is identified with the lowest available argument of ‘give’. We thus end up with three arguments in the complex predication: 1) the argument licensed by the *init* subevents; 2) the Stimulus argument licensed by the *rheme*; 3) the Goal or endpoint of the event as licensed by *res*.

(12)

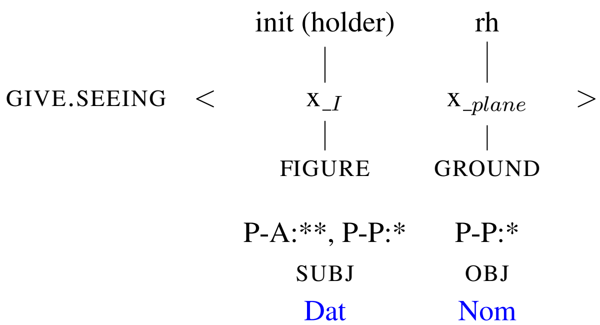


When this complex predication is nominalized, the nominalization prevents the coindexed *init* arguments from being expressed in the syntax, as also shown in (12). So the complex predication works out to only express two arguments in the syntax: a *rheme* (the stimulus) and a *res*. The linking to grammatical functions of the configuration in (12) is shown in (13). The number of Proto-Role properties are indicated via ‘*’. The argument licensed by the rheme receives one Proto-Patient (P-P) property on account of it being a GROUND, the argument licensed by the result subevent receives a P-P property because it is a result, but two Proto-Agent (P-A) properties because it is a sentient argument and functions as the FIGURE in our example. It is thus this argument that is linked to SUBJ, while the rheme (the Stimulus) is linked to OBJ.

(13)



(14)



There is independent evidence that configurations as in (13) with sentient goals were reanalyzed as part of language change and were reinterpreted over time as representing an experiencer configuration in which there is a holder of a state, as in (14), rather than a spatial predicate in which something “arrives” at a destination as in (13) (e.g., see Schätzle 2018; Beck & Butt 2024). The dative case marking is due to the original goal (result) semantics (cf. Butt & King 1991, 2003; Butt & Ahmed 2011), but is retained, giving rise to dative subjects in the language and exceptionally associating a dative subject with the otherwise agentive verb *de* ‘give’.

With respect to our running example, we further suggest that the originally complex predications of *dɪkʰai* and *sunai* have been lexicalized to form the nouns ‘seeing’ and ‘hearing’, respectively. This accounts for the fact that this construction is not productive today in that we can find these expressions of perception only with *dɪkʰai* and *sunai* in modern Urdu/Hindi.

Having illustrated how complex predicates of perception can be accounted for systematically via our Event-Based Linking Approach in combination with Butt’s theory of complex predication, even with respect to seemingly exceptional instances of verbs of perception, we now turn to examining Iranian from this perspective.

4 Persian Verbs of Perception

Asudeh & Rad (2023) base their investigation of Persian verbs of perception on the original classification by Viberg and present the data in Figure 1 as an overview of the types of verbs of perception available in Persian. As can be seen, they adopt a slightly different terminology from Viberg, labeling Activity verbs as Actor verbs and replacing ‘Copulative’ with the more perspicuous term ‘Percept’. Their assumptions as to the underlying event participants of these predicates are also indicated in the table (ACTOR,STIMULUS; EXPERIENCER,STIMULUS; STIMULUS,EXPERIENCER)

Actor ⟨ACTOR,STIMULUS⟩		**Experiencer** ⟨EXPERIENCER,STIMULUS⟩	**Percept** ⟨STIMULUS,EXPERIENCER⟩	
negāh kard-an look do-INF X look at Y		did-an see-INF X see Y	be češm āmad-an/resid-an to eye come-INF/arrive-INF Y was seen by X	
guš kard-an ear do-INF X listen to Y		šenid-an hear-INF X hear Y	sedā dād-an sound give-INF Y emitted a sound to X	be guš āmad-an/resid-an to ear come-INF/arrive-INF Y was heard by X
lams kard-an touch do-INF X touch Y (possibly inadvertently)	dast zad-an hand hit-INF X feel Y (necessarily intentionally)	ehsās kard-an sense do-INF X feel Y	hes dād-an sense give-INF Y emitted a feel to X	
maze kard-an taste do-INF X taste Y		(maze) hes kard-an (taste) sense do-INF X taste Y	maze dād-an taste give-INF Y emitted a taste to X	
bu kard-an smell do-INF X smell Y		(bu) hes kard-an (smell) sense do-INF X smell Y	bu dād-an smell give-INF Y emitted a smell to X	

Figure 1: Table classifying Persian verbs of perception from Asudeh & Rad (2023: 49)

We found this classification interesting as it includes several N-V combinations with agentive verbs that are classified as experiencer verbs. For example, ‘sense+do’ is classified as an experiencer/stimulus type and ‘sound/sense/taste/smell+give’ are classified as stimulus/experiencer types. The ‘sound+give’ construction in particular is very reminiscent of the Urdu/Hindi ‘hearing/seeing give’ construction discussed above. This construction was identified as being exceptional to an otherwise very regular pattern in Urdu/Hindi, whereby agentive verbs do not show up with dative subjects.

Unlike Urdu/Hindi, Persian does not allow for non-nominative subjects. This means that agentive and experiencer subjects are not distinguished morphologically. However, as experiencer semantics clash with agentive semantics (experiencers are non-agentive by definition), we decided to take a closer look.

4.1 The glue semantics plus macro role analysis

Asudeh & Rad (2023) assume that the N-V constructions are complex predicates and provide a compositional glue semantics analysis. However, while they use the formal means of the Restriction Operator (Kaplan & Wedekind 1993) to effect predicate composition at the level of f-structure, their analysis does not assume that each part of the predication contributes arguments (or some extra information about the event participants) to the overall predication. Rather, as can be seen in Figures 2 and 3 for the verbs ‘do’ and ‘give’, respectively, all of the information about the event participants of the overall predication is encoded on the verb.

kardan

$(\uparrow \text{PRED}) = \text{‘do’}$

$$\begin{array}{l}
\lambda\mathcal{R}\lambda y\lambda x\lambda v.\mathcal{R}(y)(x)(v) \wedge \text{UNDERGOER}(v) = y \wedge \text{ACTOR}(v) = x : \\
[(\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \multimap \\
[(\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \\
\left(\left\{\begin{array}{l}
\begin{array}{l|}
\lambda Q\lambda y\lambda x\lambda v.(\mathbf{do}(Q))(v) \wedge \text{PATIENT}(v) = y \wedge \text{AGENT}(v) = x : \\
(\uparrow_\sigma \text{PVP}) \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma
\end{array} \\
\lambda Q\lambda y\lambda x\lambda v.(\mathbf{do}(Q))(v) \wedge \text{STIMULUS}(v) = y \wedge \text{EXPERIENCER}(v) = x : \\
(\uparrow_\sigma \text{PVP}) \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma
\end{array}\right\}\right)
\end{array}$$

Figure 2: Glue semantics analysis of Persian ‘do’ (Asudeh & Rad 2023: 50)

dādan

$(\uparrow \text{PRED}) = \text{‘give’}$

$$\begin{array}{l}
\lambda\mathbb{R}\lambda z\lambda y\lambda x.\mathbb{R}(z)(y)(x)(v) \wedge \text{LOC}(v) = z \wedge \text{UND}(v) = y \wedge \text{ACT}(v) = x : \\
[(\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \multimap \\
[(\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \\
\left(\left\{\begin{array}{l}
\begin{array}{l|}
\lambda z\lambda y\lambda x\lambda v.\mathbf{give}(v) \wedge \text{GOAL}(v) = z \wedge \text{TH}(v) = y \wedge \text{AG}(v) = x : \\
(\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma
\end{array} \\
\lambda z\lambda y\lambda x\lambda v.\mathbf{P}_{\neg v}(v) \wedge \text{EXP}(v) = z \wedge \text{STIM}(v) = y \wedge \text{SOURCE}(v) = x : \\
(\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma
\end{array}\right\}\right)
\end{array}$$

Figure 3: Glue semantics analysis of Persian ‘give’ (Asudeh & Rad 2023: 51)

The lexical entries in Figures 2 and 3 integrate glue semantics with a mapping approach that works with the macro role approach pioneered by Van Valin & Polla (1997). This is very similar to Dowty's Proto-Roles, which were invoked above in our analysis. The basic predication of the verb 'do' in Figure 2 is thus in terms of an Actor and an Undergoer: these are the macro role event participants licensed by the verb. Asudeh & Rad (2023) propose that these macro roles can be specified further in terms of their semantics via a set of general purpose entailment relations between thematic roles and macro roles that govern which macro role could potentially be realized as which particular thematic role and which grammatical functions these thematic roles could then be related to. These are shown in (15) (Asudeh & Rad 2023: 50).

(15)
a. AGENT, EXPERIENCER, SOURCE $\subseteq$ ACTOR &
AGENT $\cap$ EXPERIENCER $\cap$ SOURCE = $\emptyset$ — SUBJ roles
b. THEME, STIMULUS $\subseteq$ UNDERGOER &
THEME $\cap$ STIMULUS = $\emptyset$ — OBJ roles
c. GOAL, EXPERIENCER, SOURCE $\subseteq$ LOCATION &
GOAL $\cap$ EXPERIENCER $\cap$ SOURCE = $\emptyset$ — OBL roles

The set of entailments is essentially a list of disjunctions specifying which thematic role can correspond to a macro role. Note that Experiencers and Sources can be associated with both Actors and Locations.

The effect of the macro role specification is shown in the lower half of the lexical entries in Figures 2 and 3. This is the part enclosed in round brackets and it also provides for the possibility of combining with a so-called preverbal element (PVP, the noun in our case). As can be seen for 'do' in Figure 2, when combined with a noun, this verb can either predicate as an agentive verb or it can predicate as an experiencer verb.

The same is true for the verb 'give' in Figure 3. It has a standard ditransitive reading involving an Agent, Theme and a Goal and an additional experiencer reading with an Experienecer, a Stimulus and a Source (the **P** in the lexical entry stands for a Perceptual Predicate). The experiencer reading is intended to account for examples as in (16).

(16) max bu-ye xub mi-dād (Persian)
Max smell-Ezafe good Dur-give.Past.3Sg
'Max smelled good.' (Asudeh & Rad 2023: 60)

Unlike in Butt's approach to complex predication, where light and main verb versions are taken to predicate differently in terms of their predicational abilities, in Asudeh & Rad's approach the light and main verb versions are treated identically in terms of their predicational power. The light verb combines with a further element (the N or preverbal element in Persian), but it does not receive any information relevant for the determination of the overall number and type of arguments from the noun. The noun is not assumed to provide any argument specifications of its own, very much unlike the analysis we saw for the Urdu/Hindi 'seeing/hearing'+give constructions above.

Overall, it appears that the experiencer semantics of the verbs 'do' and 'give' for verbs of perception in Persian are arrived at via lexical stipulation rather than falling out from more general crosslinguistic or compositional principles. We also note a possible dissonance between the classification given in Figure 1 and the actual semantics associated with the predicate of perception. Consider, for example, (16), which is classified as being of the type smell/Copulative by Viberg (1984) and therefore also by Asudeh & Rad (2023) (smell/percept in their terminology). According to Viberg, items in this category denote: 1) states; 2) non-agentive actions. But both ‘give’ and ‘do’ are agentive verbs, resulting in a seeming contradiction of lexical vs. clausal semantics. One might also postulate that while the English translation in (16) denotes a state, the Persian N-V construction might actually not do so. We therefore decided to investigate this possibility with respect to the closely related language Hazaragi.

5 Evidence from Hazaragi

Hazaragi is an under-researched Iranian language which is mainly spoken in Hazarajat in central Afghanistan (Dulling 1973) and in Quetta (Pakistan), but also world-wide in the Hazara diaspora. Hazaragi is strucuturally very close to Dari, one of the national languages of Afghanistan (Kieffer 2003), as well as to Persian.

5.1 Tests for the classification scheme

Viberg (2001) proposes several tests to differentiate between the three perception types. One test concerns aspect. The Activities/Actor category should consist of events which contain a non-resultative (unbounded) process. In contrast, the Experience category is taken to encompass states or inchoatives and Copulative/Percept are only states.

Another test pertains to the degree of agentivity exhibited by the Actor of the event. The Activities/Actor category should contain activities that are controlled and possibly intentional, whereas the Experience and the Copulative/Percept categories involve perceptions (experiences) which cannot be controlled because they happen involuntarily. Sample tests for the degree of agentivity include, for example, pairs of examples like in (17). If somebody is ordered to do something, they must do so actively, so an experiencer predicate is not good in these contexts.

(17) a. I ordered/persuaded Peter to listen. (Activities/Actor)
b. I ordered/persuaded Peter to #hear. (Experience)

In the next section, we apply tests to perception predicates in Hazaragi to determine how they should be classified.

5.2 Hazaragi classification and comparison with Persian

Asudeh & Rad (2023) focus on five examples. We focus on the same five examples for the sake of analytical comparison and always first present the Persian and then the Hazaragi equivalent. We apply tests to the Hazaragi equivalent to see how the data should be categorized and compare it to the table for Persian constructed by Viberg/Asudeh & Rad. The tests we use to determine agentive/controlled actions are: 1) embedding under *X ordered/persuaded Y to …*; 2) compatiblity with adverbs like *deliberately*. With respect to aspectual properties, we check whether a predicate is compatible with the progressive *darau*. If it is, we can identify it as an unbounded event with a process component and can conclude that this is an instance of the Activities/Actor type.

We demonstrate that *darau* acts as a progressive with respect to (18) and (19), which involve different ways of expressing 'believe'. In English this is clearly a stative verb. In Hazaragi, we have two different N-V combinations: one with the agentive activity verb 'do' (19) and one with the stative 'have' (18). As can be seen, *darau* is not compatible with the stative version of 'believe', but does work when the verb is an agentive activity verb.

(18) a. ma yaqeen dar-om (Hazaragi)
I belief have-1Sg
'I believe.'

b. *ma darau yaqeen dar-om (Hazaragi)
I Prog belief have-1Sg
'I am believing.'

(19) a. ma i qisa=ra yaqeen mu-n-um (Hazaragi)
I this story=OM belief Impf-do.Pres-1Sg
'I believe this story.'

b. ma i qisa=ra darau yaqeen mu-n-um (Hazaragi)
I this story=OM Prog belief Impf-do.Pres-1Sg
'I am believing this story (at the moment, but am doubtful).'

Overall we have found that *darau* consistently acts as a progressive in Hazaragi.

5.2.1 Copulative/Percept and 'give'

We begin applying our tests to (19), repeated here as (20). This example is classified as a stative Copulative/Percept and is analyzed as having an a Stimulus object ('smell') and an unexpressed Experiencer.

(20) max bu-ye xub mi-dād (Persian)
Max smell-Ezafe good Dur-give.Past.3Sg
'Max smelled good.' (Asudeh & Rad 2023: 60)

(21) max bu=yi xub mi-dad (Hazaragi)
Max smell=Ezafe good Impf-give.Past.3.Sg
'Max smelled good.'

The examples in (22-a) and (22-b) test for control/agentivity, while (22-c) tests for stativity by checking whether the verb is compatible with the progressive.

(22) a. ali max=ra guf-t ki bu=yi xub bi-di (Hazaragi)
Ali Max=OM say-Past.3.Sg that smell=Ezafe good Imp-give.Pres.2.Sg
'Ali told Max to smell good.'

b. ??max az qast bu=yi xub mi-dad (Hazaragi)
Max knowingly smell-Ezafe good Impf-give.Past.3.Sg
'Max smelled good deliberately.'

c. max darau bu-yi xub mi-dad (Hazaragi)
Max Prog smell-Ezafe good Impf-give.Past.3.Sg
'Max was smelling good.'

The tests yield the result that the subject Max can indeed be ascribed control over the action and that it is an unbounded activity. In contrast to what was posited for Persian, the very similar Hazaragi thus yields a classification of Activities/Actor whereby we have an Agent-Theme (Agent=Max, Theme=smell) constellation in an ongoing activity.

5.2.2 Experiencer and 'do'

Viberg and Asudeh & Rad classify (23) as an Experience verb of perception. This means we expect an Experiencer-Stimulus configuration with Max as the experiencer and 'food' as the stimulus. In addition, it should be stative or inchoative.

(23) max bu-ye ghazā hes kar-d (Persian)
Max smell-Ezafe food sense do-Past.3.Sg
'Max smelled food.' (Asudeh & Rad 2023: 60)

(24) max naan bu-yi kad (Hazaragi)
Max food smell-Indef do.Past.3.Sg
'Max smelled food. (lit. Max did food smelling.)'

Again, the examples in (25-a) and (25-b) test for control/agentivity while (25-c) tests for stativity (incompatibility with the progressive).

(25) a. max az qast naan=ra buyi kad (Hazaragi)
Max knowingly food=OM smell do.Past.3sg
'Max smelled food on purpose.'
b. ali max=ra naan=ra bu-yi kad-o=ra guf-t (Hazaragi)
Ali Max=OM food=OM smell-Indef do-Inf=OM say-Past.3.Sg
'Ali told Max to smell the food.'
c. max naan=ra darau bu-yi mu-kad (Hazaragi)
Max food=OM Prog smell Impf-do.Past.3.Sg
'Max was smelling the food.'

Again the Hazaragi data works differently from what was posited for Persian. The application of the tests instead point to an Agent-Theme configuration (Agent=Max, Theme=food) and an ongoing activity.

5.2.3 Activities/Actor and 'hit'

Viberg and Asudeh & Rad classify (26) as an Activities/Actor type. This means that we expect an Agent-Theme configuration (Agent=Max, Theme=clothes) and that the event be an activity with a process component.

(26) max lebās-rā dast zɑd (Persian)
Max clothes-OM hand hit.Past.3Sg
'Max felt the clothes.'

(27) max kala=ra dist zad (Hazaragi)
Max clothes=OM hand hit.Past.3.Sg
'Max felt the clothes.'

Again, (28-a) and (28-b) test for control/agentivity while (28-c) tests for stativity (incompatibility with progressive). As can be seen from (28), the tests indeed yield an Agent-Theme configuration and an ongoing activity.

(28) a. ali max=ra guft ki kala=ra dist bi-zan (Hazaragi)
Ali Max=OM say.Past.3.Sg that clothes=OM hand Imp-hit.Pres.2.Sg
'Ali told Max to feel/touch the clothes.'

b. max az qast kala=ra dist zad (Hazaragi)
Max knowingly clothes=OM hand hit.Past.3.Sg
'Max deliberately felt/touched the clothes.'

c. Max darau kala=ra dist mi-zad (Hazaragi)
Max Prog clothes=OM hand Impf-hit.Past.3.Sg
'Max was feeling/touching the clothes.'

Given that *zad* 'hit' is an agentive verb, these results are also fully in line with its default semantics.

5.2.4 Copulative/Percept and 'come'

Viberg and Asudeh & Rad classify (29) as a Copulative/Percept type. This leads us to expect a Stimulus-Experiencer configuration (Experiencer=owner of the eye, Stimulus=light) and a stative predication.

(29) nur-i az dur be češm āma-d (Persian)
light-Indef from afar to eye come.Past-3Sg
'A light was seen from afar.' (Asudeh & Rad 2023: 61)

In this case the Hazaragi uses a slightly different expression, employing the verb 'fall' instead of 'come' and (31) is given as the better way of expressing (29). Note that in (31) 'light' is actually functioning as the subject and 'Ali' as the object (*Ali* carries the object marker *ra*), unlike what is suggested by the English translation.

(30) roʃn-i az dur mane cim mo-prid (Hazaragi)
light-Indef from far inside eye Impf-fall.Past.3.Sg
'Light was seen from afar.' (lit. Light fell into the eye from afar.)

(31) ali=ra roshn-i malum dad (Hazaragi)
Ali=OM light-Indef knowledge give.Past.3.Sg
'Ali saw a light.'

In order to remain close to the Persian for the sake of comparison, we apply our tests to the version with 'fall' in (30). In this case we see that control/agentivity cannot be attributed to the subject ('light'). In terms of aspect, it behaves as an ongoing activity. The result of the tests is in line with the basic semantics of 'fall', which has a process component, but is non-agentive.

(32) a. *ali guft ki roʃn-i az dur da cim mo-prid (Hazaragi)
Ali say.Past.3.Sg that light-Indef from far inside eye Impf-fall.Past.3.Sg
'Ali told the light to be seen from afar.'

b. *roʃn-i qastan az dur mane cim par-id (Hazaragi)
light-Indef deliberately from far inside eye fall-Past.3.Sg
'Light fell into the eye deliberately from afar.'

c. roʃn-i az dur darau mane cim mo-prid (Hazaragi)
light-Indef from far Prog inside eye Impf-fall.Past.3.Sg
'Light was being seen from afar.'

5.2.5 Copulative/Percept and 'arrive'

Viberg and Asudeh & Rad classify (33) as a Copulative/Percept. This means we expect a Stimulus-Experiencer configuration (Stimulus=sound, Experiencer unexpressed) and a stative predication. As shown in (34), in this case Hazaragi can use both 'arrive/reach' and 'fall'.

(33) sedā-ye ajib-i az ānjā be guš resid (Persian)
sound-Ezafe strange-Indef from there to ear arrive.Past.3Sg
'A strange sound was heard from there.' (Asudeh & Rad 2023: 61)

(34) awaz=i ajib az unzunji mane goʃ res-id/par-id (Hazaragi)
sound=Ezafe strange from there inside ear reach-Past.3.Sg/fall-Past.3.Sg
'A strange sound arrived from there.'

We apply our tests to both possibilities and find that they do not differ in terms of their behavior. As in the last section with 'come', we find that there is no evidence for agentivity and that the predication can be interpreted as an ongoing activity.

(35) a. *ali guft ki awaz=i ajib az unzunji mane goʃ
Ali say.Past.3.Sg that sound=Ezafe strange from there inside ear
res-id/par-id (Hazaragi)
reach-Past.3.Sg/fall-Past.3.Sg
'Ali told a strange sound to arrive from there.'

b. *awaz=i ajib qastan az unzunji mane goʃ
sound=Ezafe strange deliberately from there inside ear
res-id/par-id (Hazaragi)
reach-Past.3.Sg/fall-Past.3.Sg
'A strange sound deliberately arrived from there.'

c. awaz=i ajib darau az unzunji mane goʃ
sound=Ezafe strange Prog from there inside ear
me-rsid/mo-prid (Hazaragi)
Impf-reach.Past.3.Sg/Impf-fall.Past.3.Sg
'A strange sound was arriving from there.'

5.2.6 Interim summary

Our investigation has shown that the Hazaragi predicates of perception do not quite conform to the classifications that one would expect given what has been posited for the closely related language Persian. Instead, what we find is that all of the predicates of perception that involve agentive verbs ('give', 'do', 'hit') behave like agentive activity predicates and that the predicates of perception formed with verbs of motion ('come', ‘reach/arrive’, ‘fall’) behave like non-agentive verbs. This is entirely in line with the behavior one would expect of these verbs of motion and agentive verbs independently.

We also found no difference with respect to stativity among the different N-V predicates of perception. Again, this is what one would expect given the underlying semantics of the verbs of motion and the agentive verbs: all of these denote events that involve a process and therefore none of them denote states.

The empirical evidence for Hazaragi thus does not support adopting the classification given for Persian predicates of perception (the same battery of tests remains to be run for Persian). In the next section we therefore propose an alternative analysis.

6 Analysis

Recall that Asudeh & Rad (2023) propose a complex predicate analysis for the N-V predicates of perception. This involves invoking the formal mechanism of the Restriction Operator to allow for the composition of two predicates as part of the c-structure rules which serve to put the predicates together. The effect is that a single PRED with a single subcategorization frame is projected to the f-structure. However, while the N and V elements of the Persian predicates of perception can be composed like this, it is not clear to us why this is necessary. This is because in complex predication the tricky part tends to be that information about the predicate-argument structure is coming from two (or more) places at once and must be combined somehow.

In contrast, in Asudeh & Rad’s analysis, the verbs (‘do’, ‘give’, ‘come’, ‘fall’) are doing all of the heavy lifting in the sense that all of the information as to the number and types of arguments of the supposed complex predication is coming from them. The nouns contribute their own PRED, but beyond that the nouns otherwise contribute no information about the type and number of arguments to the overall predication. This is very different from what we saw with respect to the Urdu/Hindi ‘seeing/hearing+give’ above. But if the N-V constructions are not complex predicates, then what are they? A closer look shows that most of the Hazaragi predicates of perception are not actually complex predicates, but instances of metaphorical and idiomatic usages.

6.1 Predicates of perception via metaphors

Consider (36), for example. If one examines the overall predication one finds that the subcategorization frame and the number and type of event participants are exactly that of the main verb ‘fall’: there is some X which falls to some location. We have exactly two arguments in (36): the light (subject) and the place where it falls (the location, namely the inside of an eye). There are no additional arguments or specifications. So this is not a complex predication, but a metaphorical use of ‘fall’.

(36) roʃn-i az dur mane cim par-id (Hazaragi)
light-Indef from far inside eye fall-Past.3.Sg
‘Light was seen from afar.’ (lit. Light fell into the eye from afar.)

The same is true for (37) and (38). In (37) we have the verbs ‘reach/fall’ and the number and type of arguments exactly match what the main verb versions would have, namely that there is an X which falls towards or reaches some location: a sound (X) falls/reaches the ear (location).

(37) awaz=i ajib az unzunji mane goʃ res-id/par-id (Hazaragi)
sound=Ezafe strange from there inside ear reach-Past.3.Sg/fall-Past.3.Sg
'A strange sound arrived from there.'
(lit. A strange sound arrived into the ears from there.)

(38) max bu=yi xub mi-dad (Hazaragi)
Max smell=Ezafe good Impf-give.Past.3.Sg
'Max smelled good.'

Example (38) involves an agentive verb, unlike the previous two examples. Similarly to the previous examples, however, we find that there are no extra arguments in the clause that cannot be attributed to 'give' and there are also no further oddities in the argument realization that would point towards complex predicate formation. The only special feature exhibited by (38) is the absence of the goal, as we have Max who functions as the agent and who is giving off a smell to an unspecified goal, which in this case must be interpreted as the world in general.

6.2 Predicates of perception via complex predicates

In contrast, we find that the predications with 'do' fit the complex predicate schema. Consider (39), for example.

(39) max naan bu-yi kad (Hazaragi)
Max food smell-Indef do.Past.3.Sg
'Max smelled food. (Lit. Max did food smelling.)'

Here we have three possible arguments: 'Max', 'food' and 'smell'. However, the verb 'do' does not license more than two arguments: an Agent and a Theme (or the event/thing to be done). We thus have an extra argument that needs to be accounted for. This can be done elegantly via a complex predicate analysis. Under this analysis we have a light verb 'do', which takes the noun 'smell' as an argument. The noun 'smell' in turn contributes an argument to the overall predication, namely the thing that is smelled: the food (cf. Mohanan 1994). Our Event-Based Linking analysis is shown in (40).

(40)

DO $<$ init_i %proc $>$
|
SMELL $<$ init_i rh $>$

In this analysis the combination of an agentive verb with an experiencer predicate (the noun) yields a configuration which can only be interpreted as an experiencer predicate. In addition, since the two *init* arguments of 'do' and 'smell' are identified with one another, we end up with a subject which has properties of both an agent and an experiencer, accounting for the data in section 5.

We thus arrive at exactly the right kind of an analysis without lexical stipulation, but by putting together the pieces of the predication in a systematic manner and letting each piece contribute what it “wears on its sleeve” anyway, so to speak.

6.3 Predicates of perception with ‘hit’

In this last section we turn to the examples with ‘hit’ as in (41). These turn out to be more difficult to analyze. As we saw above, a complex predicate analysis would assume two parts of the predicate. One would be the verb ‘hit’, which like ‘do’ is agentive and involves an Agent and a Patient. So, as with ‘do’, we would posit an *init* and a *proc* subevent. However, ‘hand’ is not an eventive noun (cf. Grimshaw 1990) and it is difficult to understand what its event participants could be.

(41) Max kala-ra dist zad (Hazaragi)
Max clothes=OM hand hit.Past.3.Sg
‘Max felt/touched the clothes.’

(42)

HIT < init_i %proc >
|
HAND < ??? >

In the reading of the physical hand, there are no arguments it can contribute. In the reading of ‘handing’ somebody something, it could have three arguments (an agent (X) who hands a goal (Y) something (Z)). But this also does not fit (41) since we do not see any extra goal arguments in the clause.

We here tentatively conclude that it is likely that (41) is an instance of an idiomatic use of N-V combinations, as has been established for the use of ‘hit’ in combination with nouns for Swahili, for example (Olejarnik 2009).

7 Conclusion

We were inspired to embark on the investigations in this paper by the work presented by Asudeh & Rad (2023) on Persian verbs of perception. In our examination of the classification and analysis of N-V verbs of perception, we focused on the under-researched language Hazaragi and found that the existing classifications by Viberg and Asudeh & Rad cannot be applied to Hazaragi. We suspect that the same conclusion can also be reached with respect to the Persian examples from Viberg and Asudeh & Rad, but this remains to be established.

We also took issue with the complex predicate analysis proposed by Asudeh & Rad. For Hazaragi, we showed that the N-V combinations with ‘do’ are the only ones that can directly and elegantly be explained as complex predicates. The other N-V combinations are better analyzed as metaphorical and idiomatic usages.

For the N+‘do’ complex predicates, we proposed an analysis in terms of the Event-Based Linking developed in Schätzle (2018) and Beck & Butt (2024) and the theory of complex predication from Butt (1995, 2014) to propose a compositional analysis. Under this analysis the experiencer semantics of the predicates of perception are located in the experiencer predicate (e.g., ‘smell’), rather than as part of the agentive light verb (contra Asudeh & Rad 2023).

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Alternative questions in Urdu: from the speech signal to semantics

Miriam Butt
University of Konstanz

Tina Bögel
University of Konstanz

Mark-Matthias Zymla
University of Konstanz

Benazir Mumtaz
University of Konstanz

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Abstract

This paper extends LFG's abilities to include information coming directly from the speech signal (Bögel 2015, 2022; Butt & Biezma 2022). We do this by developing an analysis and concomitant computational implementation for alternative vs. polar questions in Urdu. The implementation allows for a seamless integration of data from the speech signal into a semantic analysis of questions. We build on, but also go beyond, Butt & Biezma (2022), who included a semantic and pragmatic analysis, but did not demonstrate how exactly this could be arrived at on the basis of their c- and f-structural analyses. As far as we are aware, LFG is to date the only theoretical linguistic approach that is able to connect syntactic, semantic and pragmatic representations holistically with information coming directly from the speech signal.

1 Introduction

This paper extends LFG's abilities to include information coming directly from the speech signal (Bögel 2015, 2022; Butt & Biezma 2022). We do this by developing an analysis and concomitant computational implementation for alternative vs. polar questions in Urdu. The implementation allows for a seamless integration of data from the speech signal into a semantic analysis of questions and builds on an understanding of the complex interplay between prosody, morphosyntax, and semantics/pragmatics via LFG's projection architecture.[†] To showcase the effects of prosody on interpretation, we focus on ambiguous structures that can either be interpreted as alternative questions (AltQ) or as polar questions (PolQ). By means of a case study we show how these questions can be distinguished based on prosodic cues and how they can be theoretically modelled and computationally implemented in LFG's modular architecture. In doing so, we present a holistic integration of information from the speech signal into a semantic analysis, thus going all the way from *form* to *meaning*.

We crucially build on previous work by Bögel (2015), which extends the analytical abilities of LFG to include information coming directly from the speech signal in a modular manner. This model of the prosody-syntax interface has been successfully used to analyze a number of different phenomena, including pronominal placement, case disambiguation and question interpretation (e.g., Bögel et al. 2018; Bögel 2020; Butt & Biezma 2022). Building on these theoretical insights, we have been able to implement our approach to the prosody-syntax interface computationally. In recent work, for example, we demonstrated the system's ability to operate at the prosody-syntax interface in order to utilize prosodic cues for the disambiguation of syntactically ambiguous structures in German (Bögel & Zhao 2024). Similarly, Butt & Biezma (2022) integrated prosodic information via Bögel's prosody-syntax interface to disambiguate between a string/utterance that could either be interpreted as a *wh*-question or as a PolQ containing *kya* 'what' as a marker of uncertainty (see Biezma et al. 2024 for a full analysis). Butt & Biezma (2022) include a semantic and pragmatic analysis of the question types, but

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do not demonstrate how exactly this semantic and pragmatic analysis is arrived at on the basis of the prosodically disambiguated c- and f-structural analyses.

In this paper we extend the architecture and implementation to include the dimension of meaning, working with the Glue Semantics Workbench (Meßmer & Zymla 2018) and a co-descriptive approach (though description by analysis is a viable alternative). We focus on the prosodic disambiguation and syntactic and semantic analysis of AltQs and PolQs as a sample phenomenon. We show how our implementation allows for the automatic processing of the speech signal to extract grammatically relevant information that can then be accessed by other modules of grammar (not just the syntax). To the best of our knowledge, we are the only theoretical framework that can provide a formal model and concomitant computational implementation of the integration of prosody with morphosyntax and semantics/pragmatics.

The paper is structured as follows. Section 2 describes the basic data, section 3 introduces Bögel's architecture for the prosody-syntax interface in LFG and shows which prosodic information can be leveraged to disambiguate between AltQ and PolQ (and declarative) interpretations for those strings/utterances in Urdu that are structurally ambiguous. Section 4 then provides semantic analyses for the AltQs and the PolQ versions, working with the Glue Semantics Workbench. Section 5 concludes.

2 Background: Urdu questions

Urdu/Hindi[1] has basic SOV word order and shows a general LH intonational pattern on phrases (Harnsberger 1994; Patil et al. 2008; Puri 2013; Féry 2010; Urooj et al. 2019), as appears to be typical for South Asian languages. The difference between PolQs and declaratives is signaled via intonation: Declaratives as in (1-a) are signaled via a low final intonational phrase boundary tone L%, while PolQs as in (1-b) have a high boundary tone H%. Figure 1 shows the pitch contours and their difference in the final intonational phrase boundary tone for the examples in (1).

(1) a. ʃahina=ne norina=ko $\text{mara}_{\text{L-}\mathbf{L\%}}$
Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
'Shahina hit Norina.' (Declarative)

b. ʃahina=ne norina=ko $\text{mara}_{\text{L/H-}\mathbf{H\%}}$
Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
'Did Shahina hit Norina?' (Polar Question)

The most robust indication of focus in Urdu/Hindi seems to be a larger pitch excursion of the basic LH contour (Patil et al. 2008; Féry 2010; Jabeen & Braun 2018). Unsurprisingly then, constituent question words carry LH contours in which the H tone corresponds to the highest f_0 peak in the utterance. In (2), this is the constituent question word *kɪs=ko* 'whom'. Constituent questions are unlike PolQs and like declaratives in that they end on a low boundary tone.

[1]Urdu and Hindi are structurally almost identical, with Urdu being the national language of Pakistan and Hindi one of the official languages of India. Differences are mainly located in the lexicon. We use Urdu/Hindi when the discussion pertains to generalizations established for both languages and only Urdu when so far we have information only for Urdu.

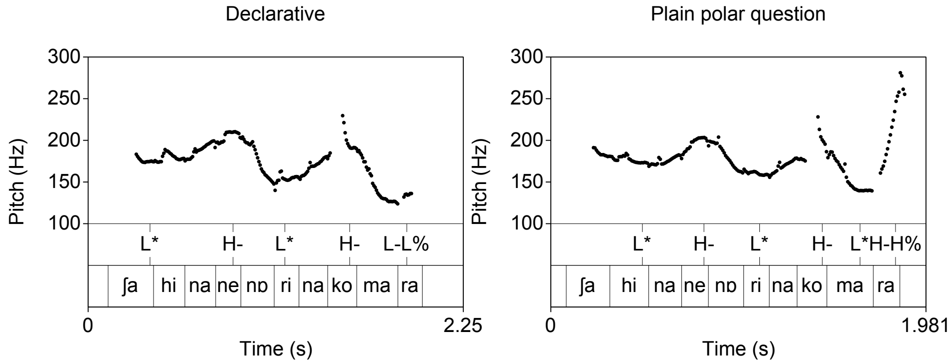


Figure 1: F_0 contour of a string identical declarative and polar question

(2) ʃahina=ne kɪs=ko mara$_{\text{L-}\mathbf{L\%}}$
Shahina.F=Erg who=Acc hit-Perf.M.Sg
'Who did Shahina hit?' (Constituent Question)

This is crosslinguistically unremarkable and we leave aside further discussion of Urdu constituent questions as they are not the focus of this paper (interested readers are directed to Mahajan 1990, 1997; Dayal 2017; Bhatt & Dayal 2007; Manetta 2010, 2012; Butt 2014; Butt et al. 2016; Gribanova & Manetta 2016, a.o.).

2.1 Interaction between PolQs and AltQs

Polar questions can be optionally expressed with *kya* 'what', as in (3). The precise semantic and pragmatic import of this "polar *kya*" has been the subject of debate, with the most recent work by Biezma et al. (2024) concluding that it expresses that the speaker has no preconceived idea of the answer (yes or no) and thus in effect functions as a marker of uncertainty (see Biezma et al. 2024 for details). Bhatt & Dayal (2020) propose a different analysis of polar *kya* in terms of the precise pragmatics and syntax-semantics/pragmatics interface, but both Biezma et al. and Bhatt & Dayal agree that polar *kya* is a focus sensitive operator whose job is to provide more precise information about the underlying question.

(3) (**kya**) ʃahina=ne norina=ko mara?
what Shahina.F=Erg Norina.F=Acc hit-Perf.M.Sg
'Did Shahina hit Norina?'

Of interest to this paper is that polar *kya* can also optionally occur in questions containing alternatives, as illustrated in (4) (Han & Romero 2004; Bhatt & Dayal 2020).

(4) (kya) tʃan̪d̪ra=ne kofi p-i ya tʃae?
what Chandra.F=Erg coffee.F.Nom drink-Perf.F.Sg or tea.F.Nom
'Did Chandra drink tea or coffee?'

Bhatt & Dayal (2020) show that there is an interesting interaction between AltQs and polar *kya* in that when polar *kya* appears initially, as in (5), where the disjunction is between two NPs, both PolQ and AltQ readings are available. However, if the polar *kya* appears in clause final position, the AltQ reading is not available, as shown in (6).

(5) **kya** tʃand̪ra=ne kofi ya tʃae p-i?
what Chandra.F=Erg coffee.F.Nom or tea.F.Nom drink-Perf.F.Sg
'Did Chandra drink tea or coffee?'
Alternative Question reading: 'Did Chandra drink tea or did she drink coffee?'
Polar Question reading: 'Is it the case that Chandra drank either tea or coffee?'

(6) tʃand̪ra=ne kofi ya tʃae p-i **kya**?
Chandra.F=Erg coffee.F.Nom or tea.F.Nom drink-Perf.F.Sg what
'Did Chandra drink tea or coffee?'
*Alternative Question reading: 'Did Chandra drink tea or did she drink coffee?'
Polar Question reading: 'Is it the case that Chandra drank either tea or coffee?'

There is no ready syntactic explanation for the patterns in (5) and (6). Bhatt & Dayal (2020) therefore speculated that this interaction might be due to a prosody-syntax interaction by which clause-final polar *kya* becomes difficult to pronounce. Biezma et al. (2024) instead propose a different explanation, which involves the scope of polar *kya*. Biezma et al. show that when polar *kya* is clause initial it is ambiguous between targeting either the verb (as the default focus of the clause) or just the item immediately to its right (if that item is marked prosodically as being in focus). In either case, both a PolQ and an AltQ interpretation are possible. On the other hand, if polar *kya* is in clause final position, then its scope is over the whole clause and, under these circumstances, an AltQ reading becomes impossible. The disjunction is not accessible for questioning since the alternative answers are only calculated at the clause level. Thus the only two available options to be questioned are: 1) Did Chandra drink tea or coffee; 2) Did Chandra not drink tea or coffee? This results in only a yes-no (polar) question, not a question targeting the alternatives of tea vs. coffee.

At the time of the writing and research conducted by both Bhatt & Dayal and Biezma et al. there was next to no information available on the prosody of Urdu/Hindi AltQs. In parallel, we therefore set out to gather information as to the prosody of Urdu AltQs via a series of experiments. We used both ambiguous PolQ vs. AltQ structures as in (5) and unambiguous AltQ vs. PolQ structures to gather data. We used the opposition to PolQs to have a benchmark to compare against, since the prosody of PolQs was comparatively better understood. These experiments and their results are detailed in Mumtaz & Butt (2024a,b). Overall, the results showed that string-identical AltQs vs. PolQs as in (5) could indeed be disambiguated via prosodic cues. In the next subsection we briefly present the results relevant for this paper.

2.2 Experimental evidence: Prosody of PolQs vs. AltQs

The discussion in this section is based on Mumtaz & Butt (2024a,b). In order to accumulate data on the prosody of AltQs, we conducted a series of production and perception experiments that contrasted AltQs with PolQs. We worked with both ambiguous and unambiguous strings, providing contexts for the ambiguous strings that prompted speakers to produce either AltQs or PolQs. The experiments were conducted in Lahore at the Center for Language Engineering (CLE) at the University of Engineering and Technology (UET). All participants were born and raised in Lahore, Pakistan, were fluent in Urdu and Punjabi, and knew some English.

2.2.1 Materials

For the experiments that are relevant for this paper, we worked with string-identical examples that are potentially ambiguous between AltQs and PolQs, as in (7).[2]

(7) t̪ʊm muli ja gobʰi kʰao-gi?
you radish.F.Nom or cauliflower.F.Nom eat-Fut.F.Sg
AltQ: 'Will you eat radish or$_{\text{ALT}}$ (will you eat) cauliflower?'
PolQ: 'Will you eat either radish or cauliflower (yes or no)?'

All examples were presented alongside disambiguating contexts as in (8).

(8) **AltQ Context**: *You are planning to cook dinner. There are only two vegetables in the house, radish and cauliflower, and you can only cook one vegetable. Ask your sister what she will eat.*

PolQ Context: *You get up to cook dinner. There are some vegetables available in the house. But you don't know whether your sister will eat those vegetables or not. Ask her:*

Following this approach, we constructed a total of seven sentence pairs with the same structure to minimize acoustic variation; see Table 1. Each target sentence began with the pronoun [t̪ʊm] 'you' and only contained bisyllabic CVCV nouns with stress on the first syllable and ending in [i]. The verb always ended with the future morpheme *gi*. The stimuli were presented in written form together with the context and participants were asked to produce the corresponding utterance in consideration of the context.

AltQ	Translation
t̪ʊm məri ja bali dʒao-gi?	Will you go Murree or Bali?
t̪ʊm pani ja kofi pɪjo-gi?	Will you drink water or coffee?
t̪ʊm muli ja gobʰi kʰao-gi?	Will you eat radish or cauliflower?
t̪ʊm lari ja gaɽi beʧo-gi?	Will you sell a lorry or a car?
t̪ʊm gʰori ja kʰot̪i mãgo-gi?	Will you ask for a mare or a donkey?
t̪ʊm roʈi ja boʈi kʰao-gi?	Will you eat bread or meat?
t̪ʊm bali ja ʧuɽi d̪ekʰo-gi?	Will you see an earring or a bangle?

Table 1: Stimuli for prosodic experiments

[2]Note that we have an inconsistency in our transcriptions. In the previous sections we transcribed the sound [j] as 'y', in keeping with the existing literature on Urdu/Hindi, which has traditionally used an orthography based transcription. For the experimental work, we used the IPA transcriptions since we were analyzing the speech signals. This inconsistency mostly pertains to the items *ya/ja* 'or' and *kya/kja* 'what' in this paper.

2.2.2 Results

We here present a summary of the results from the production experiments, focusing on the properties of AltQs vs. PolQs. For one, we found that the first noun and the following conjunction [jɑ] 'or' have a wider range in f_0 for AltQs compared to PolQs. For the verb we found a wider range of f_0 in PolQs, but the absence of an accent on V in AltQs. These differences are illustrated in in Figure 2, where the f_0 contours of string identical AltQs vs. PolQs are compared (*Qtype* stands for Question Type and *F-marker* for future marker in the legend).

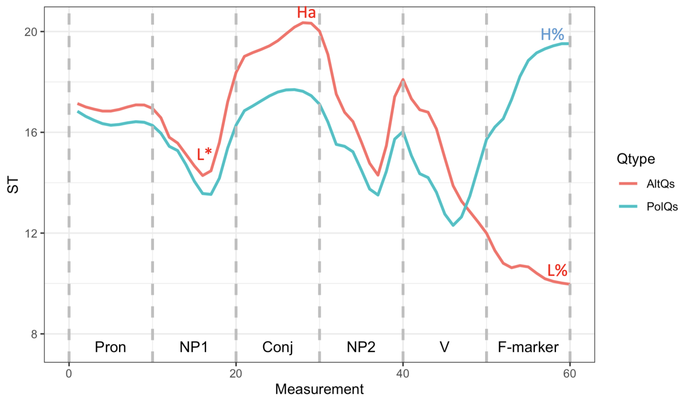


Figure 2: F_0 contour of string identical AltQs vs. PolQs

The statistical analysis also showed that AltQs predominantly have an L% boundary tone, while PolQs predominantly have an H% boundary tone (contra Jabeen 2022, but consistent with Urooj et al. 2019 and Harnsberger 1994); see Table 2.

Tones	PolQs	AltQs
L%	1	135
H%	209	39
HL%	12	50

Table 2: Distribution of boundary tones in AltQs vs. PolQs

A possible semantic analysis of AltQs is as disjunctions of PolQs (cf. Bhatt & Dayal 2020). Our results establish that from a prosodic perspective, AltQs can definitely not be treated as disjunctions of PolQs (i.e., [(PolQ_H%) OR (PolQ_H%)]). We also zeroed in on several prosodic cues that distinguish AltQs from PolQs. While both types of questions follow the general L*H pattern on prosodic phrases found in Urdu (Harnsberger 1994; Urooj et al. 2019), there are differences in terms of the pitch excursion. Recall that the highest pitch excursion in a sentence tends to signal focus. The wider range of f_0 on the verb in PolQs is consistent with the verb being the default focus in PolQs (will the eating event take place?). In contrast, the larger f_0 range on the first noun plus the conjunction [jɑ] 'or' in AltQs suggests a focus on N1+Conj in AltQs. This is consistent with focus placement on one of the proferred alternatives (e.g., radish vs. cauliflower).

Having established that string identical PolQs and AltQs can be differentiated via prosodic cues, we move on to showing how this prosodic information can be used by the syntactic component for disambiguation and how the disambiguated analysis can then be passed onto a semantic component. Thus, we show how one can go from the speech signal to the semantic analysis via the (morpho)syntax and the lexicon.

3 Prosody and disambiguation

3.1 The prosody-syntax interface

We use the approach proposed in Bögel (2015) for our analysis. This approach assumes a two-way exchange of information at the prosody-syntax interface: a) The transfer of vocabulary, which exchanges phonological and morphosyntactic information of lexical elements via the multidimensional lexicon, and b) The transfer of structure, where information on syntactic and prosodic phrasing, and on intonation, is exchanged. The model assumes a general distinction between comprehension (from form to meaning) and production (from meaning to form). Figure 3 illustrates the architecture that is assumed; see Bögel (2023) for a recent detailed discussion.

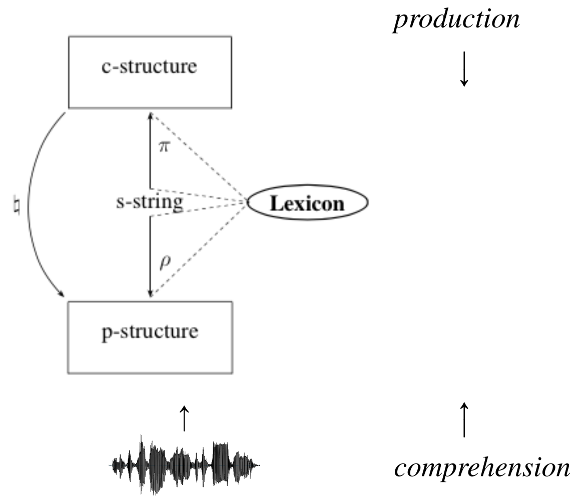


Figure 3: The prosody-syntax interface as proposed in Bögel (2015)

During comprehension, information from the speech signal feeds into p-structure which is represented by the p-diagram, a syllabic representation of the speech signal over time.[3] Figure 4 illustrates how each input syllable is associated with a vector, which records and stores the values associated with different phonetic attributes that are part of the speech signal, for example the duration of the syllable or its mean fundamental frequency (f_0). The lower part of the vector records the raw values from the speech signal. Symbolic information for phonological analyses is determined algorithmically on the basis of these raw values, for example, the occurrence of high and low tones and their individual shapes (see Bögel & Zhao 2024 for details on the tones used below) and prosodic phrasing. In Figure 4, for example, we can see that the highest f_0 value is on the [jɑ] 'or', which can thus be interpreted to have a distinct high tone. A high tone

[3]For the purposes of this paper we assume this syllabic segmentation and do not go into further details as to the algorithms or technology needed for automatic syllabification.

is also found on the final syllable of the second NP. Following the NP, the fundamental frequency values fall towards the end of the utterance, so the final boundary tone is low.

PROS.PHRASE	σ	(σ	σ	σ)	(σ	σ)	(σ	σ	σ)
TONES	–	–	L2	+H4	L2	+H4	–	–	L%
DURATION	0.123	0.212	0.143	0.138	0.194	0.133	0.190	0.079	0.173
FUND. FREQ.	320	266	247	419	240	301	204	194	191
SEGMENTS	[t̪ʊm]	[mu]	[li]	[jɑ]	[go]	[bʰi]	[kʰɑ]	[o]	[gi]
VECTORINDEX	$\mathbf{S_1}$	$\mathbf{S_2}$	$\mathbf{S_3}$	$\mathbf{S_4}$	$\mathbf{S_5}$	$\mathbf{S_6}$	$\mathbf{S_7}$	$\mathbf{S_8}$	$\mathbf{S_9}$

Figure 4: The p-diagram for the AltQ version of (7)

We can see from the prosodic analysis contained in the vectors of the p-diagram in Figure 4 that the utterance carries the prosodic characteristics of an AltQ: a strong high tone (H4) on the conjunction [jɑ] and a clear fall towards the end (L%).

3.2 Prosodic disambiguation

The information contained in the p-diagram thus contains exactly the right information needed to disambiguate examples like (7), repeated below as (9).

(9) t̪ʊm muli jɑ gobʰi kʰɑo-gi
you radish.F.Nom or cauliflower.F.Nom eat-Fut.F.Sg
AltQ: 'Will you eat radish or$_{\text{ALT}}$ (will you eat) cauliflower?'
PolQ: 'Will you eat either radish or cauliflower (yes or no)?'
Declarative: 'You will eat radish or cauliflower.'

In fact the string in (9) has three readings as it could also be a simple declarative. These three readings correspond to three different f-structures, whereby the crucial difference lies in the features CLAUSE-TYPE and QUESTION-TYPE; see (10).

(10) a. Alternative question:
[CLAUSE-TYPE interrogative, QUESTION-TYPE alternative]
b. Polar question:
[CLAUSE-TYPE interrogative, QUESTION-TYPE polar]
c. Declarative:
[CLAUSE-TYPE declarative]

The full c- and f-structural analysis for the AltQ analysis is given in Figures 5 and 6. These analyses have been produced by an Urdu grammar fragment that has been implemented via the grammar development platform XLE (Crouch et al. 2017). The fragment follows the analyses and design decisions made by the ParGram project in general (Butt et al. 1999) and the Urdu ParGram grammar in particular (e.g., Butt & King 2007; Sulger et al. 2013). This includes positing an exocentric S category to model the fact that all major constituents can scramble in Urdu. There is furthermore no evidence for a VP constituent (cf. Butt 1995); the verbal complex instead follows a relatively templatic structure.[4] The transcription in the structures is according to the convention established within the Urdu ParGram grammar (Malik et al. 2010).

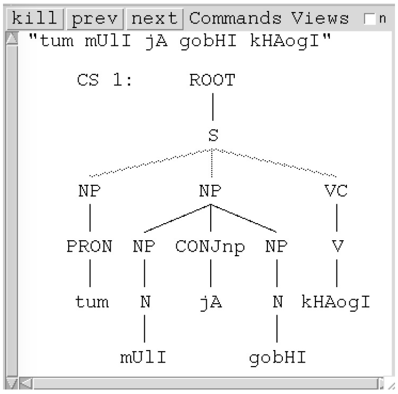


Figure 5: C-structure analysis of AltQ version for (9)

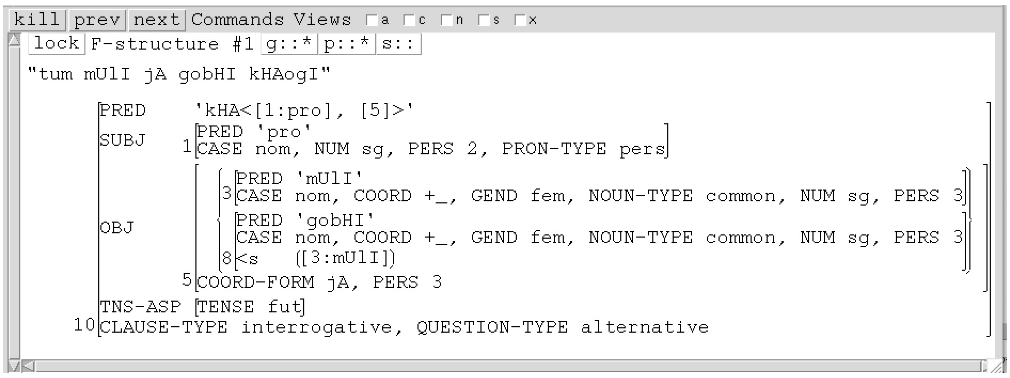


Figure 6: F-structure analysis of AltQ version for (9)

The f-structure in Figure 6 is quite standard, showing a coordinated object whose coordinator is [jɑ] (COORD-FORM). The underscore (_) after a feature's value indicates that this is an instantiated feature that cannot be unified with; see Crouch et al. (2017). The <s feature records the linear precedence of the two NPs in the coordination, indicating on the f-structure for *gobHI* 'cauliflower' that it was preceded by *mUlI* 'radish'. The details of the analysis are not of central relevance here; the main question is how we can leverage the prosodic features and have them interact with the syntactic analysis in order to effect the necessary disambiguation.

Figure 7 shows the p-diagram for the polar question interpreation of (9), which features a strong accent (H4) on [jɑ] and a strong rising final boundary tone (H%).[5]

[4]For sample analyses by the Urdu ParGram grammar, see the ParGram treebank on INESS at http://clarino.uib.no/iness/landing-page?collection=ParGram.

[5]We have left out the first syllable *tʊm* 'you' in Figures 7 and 8 for reasons of space as it is irrelevant for the disambiguation.

PROS.PHRASE	(σ	σ	σ)	(σ	σ)	(σ	σ	σ)
TONES	–	L2	+H4	L2	+H4	–	–	H%
DURATION	0.153	0.119	0.102	0.161	0.128	0.200	0.098	0.261
FUND. FREQ.	263	255	370	252	332	242	212	352
SEGMENTS	[mu]	[li]	[jɑ]	[go]	[b^{h}i]	[k^{h}ɑ]	[o]	[gi]
VECTORINDEX	$\mathbf{S_2}$	$\mathbf{S_3}$	$\mathbf{S_4}$	$\mathbf{S_5}$	$\mathbf{S_6}$	$\mathbf{S_7}$	$\mathbf{S_8}$	$\mathbf{S_9}$

Figure 7: The p-diagram for the PolQ version of (9)

Figure 8 shows the declarative interpretation of (9), with a weak accent (H1) on [jɑ] and a falling final boundary tone (L%).

PROS.PHRASE	(σ	σ	σ)	(σ	σ)	(σ	σ	σ)
TONES	L1	–	H1	–	H1	–	–	L%
DURATION	0.225	0.118	0.142	0.148	0.108	0.250	0.140	0.164
FUND. FREQ.	228	217	231	196	200	178	162	152
SEGMENTS	[mu]	[li]	[jɑ]	[go]	[b^{h}i]	[k^{h}ɑ]	[o]	[gi]
VECTORINDEX	$\mathbf{S_2}$	$\mathbf{S_3}$	$\mathbf{S_4}$	$\mathbf{S_5}$	$\mathbf{S_6}$	$\mathbf{S_7}$	$\mathbf{S_8}$	$\mathbf{S_9}$

Figure 8: The p-diagram for the declarative version of (9)

These differences in prosody, which are captured by the p-diagrams above and are summarised in Table 3, can be used for the disambiguation. The next section shows how we go about this exactly.

type	*coord-tone*	*boundary tone*		*clause-type*	*question-type*
alternative	H4	L%	→	interrogative	alternative
polar	H4	H%	→	interrogative	polar
declarative	H1/2	L%	→	declarative	–

Table 3: Pitch accents and boundary tones of the different semantic interpretations

3.3 Computational implementation

The computational implementation is based on that of Bögel & Zhao (2024) for German and has been adjusted to accomodate specific characteristics of Urdu. It is an extension of the system built for Butt & Biezma (2022), which aimed to disambiguate between Urdu polar *kya* and the corresponding constituent question word *kya* 'what'.

The input to the system consists of a speech signal, annotated with syllables in Praat (Boersma & Weenink 2021), as shown in Figure 9. Our system extracts all the information from this speech signal automatically via Praat (for example, calculating f$_0$-values and duration). Based on these calculations, pitch accents, boundary tones, and prosodic constituents are determined automatically and recorded in the p-diagram.

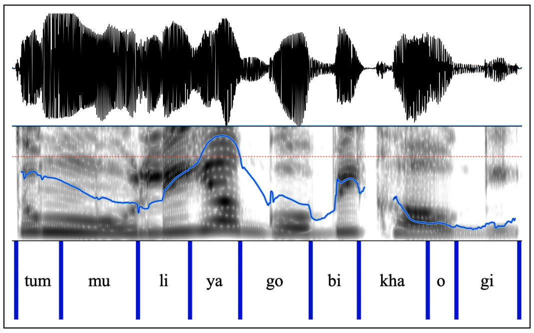


Figure 9: Input to the system: a speech signal annotated with syllables

Within the prosody-syntax interface, the transfer of vocabulary is activated in order to determine which lexical items are involved. This is done by matching the syllables against the multi-dimensional lexicon defined as part of the grammar. An example is provided in the middle of Figure 11, where the lexicon includes the usual functional information (PRED, etc.), but also phonological information as to the phonological segments involved: stress and the metrical frame of the item, for example. The matching is done greedily so that longer matches are preferred to shorter ones. Concretely, the input syllables are matched against a lexicon that is implemented using powerful finite-state methods (xfst; Beesley & Karttunen 2003). The lexicon transforms the prosodic-syllabic string into the syntactic string, thus modelling the transfer of vocabulary. This syntactic string serves as the input to an Urdu grammar, which parses the string of words and provides c- and f-structural analyses.

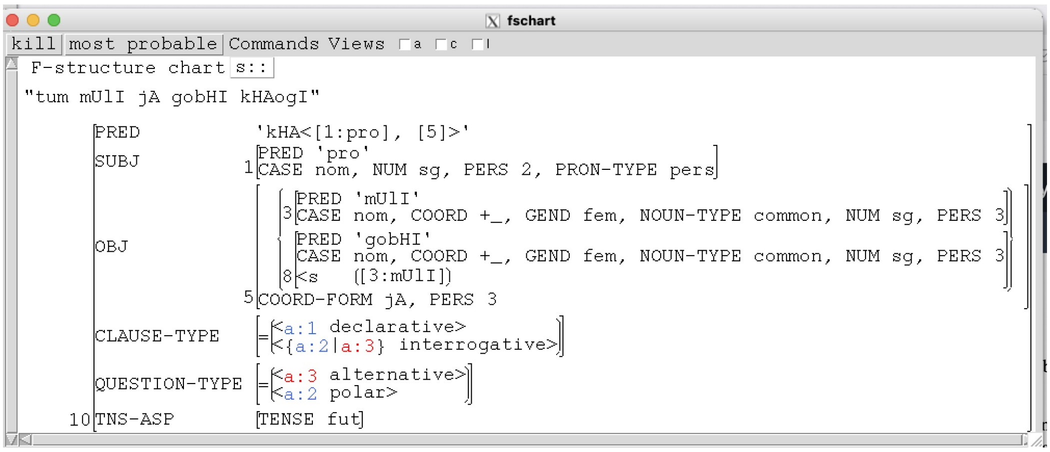


Figure 10: Fschart for the example in (9), showing three different parsing possibilities in a packed representation

The syntactic analysis results in three different possibilities for our sample input in Figure 9: 1) an AltQ; 2) a PolQ; 3) a declarative. These three possibilities are displayed together via the packed representation afforded by XLE in the fschart, as shown in Figure 10. The goal of the system now is to disambiguate the possibilities in this fschart. In order to do this, the system checks back with p-structure and the information in the p-diagram in order to identify high and low tones at crucial positions, i.e., with the coordination [jɑ] and on the final position of the clause as specified in Table 3.

Figure 11 illustrates the analysis of the AltQ in (9) at the prosody-syntax interface from the comprehension (parsing) direction.[6] The analysis in Figure 11 shows some of the raw signal information (mean f_0 values and segments) and the calculation of high and low tones and accent phrases (ap) based on the signal information in the p-diagram. This information is matched against LFG's multi-dimensional lexicon, for which we provide the examples for *mUlI* 'radish' and *gobHI* 'cauliflower'.

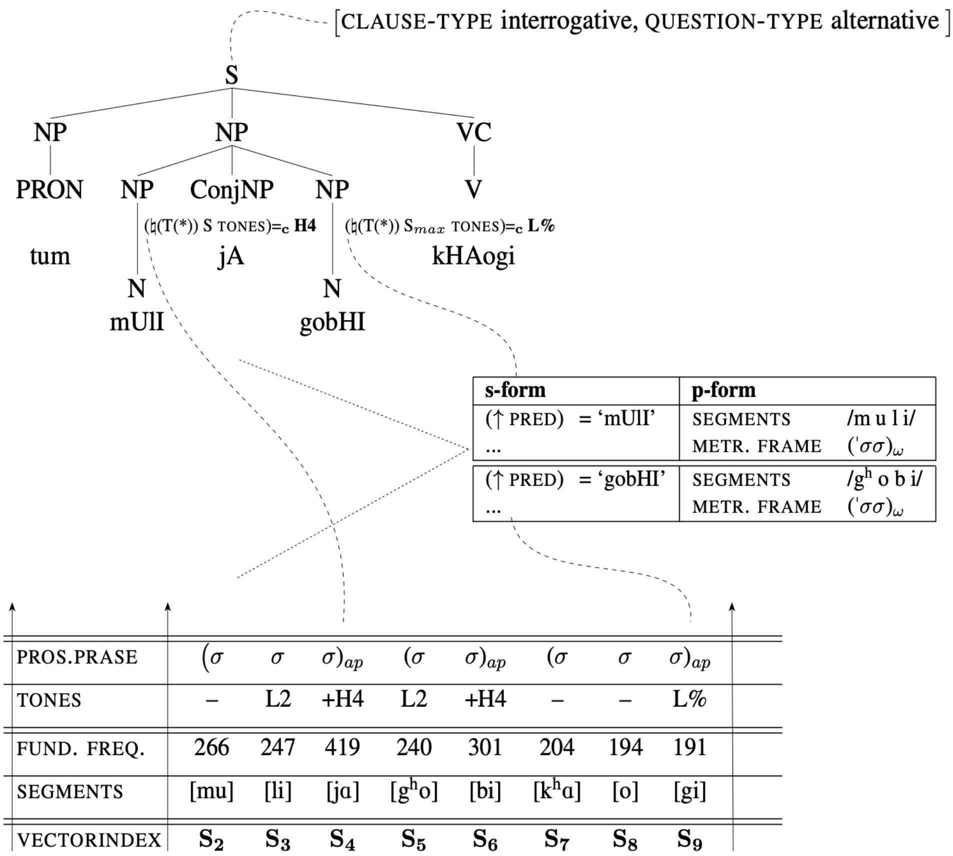


Figure 11: An AltQ at the prosody-syntax interface during comprehension

The figure also includes parts of the constraints responsible for the prosodic disambiguation of an AltQ. For example, as shown in (11), the constraints associated with the conjunction [jɑ] state that the corresponding syllable (S) in the p-diagram has to have an H4 tone as the value of the attribute TONES. If this is the case, then CLAUSE-TYPE is interrogative, but the QUESTION-TYPE can be alternative or polar.

[6]Again, we have left out the pronoun from the p-diagram for reasons of space.

(11) Constraints associated with the conjunction *ja* 'or':

a. $(\natural(T(*))$ S TONES$) =_c$ H4
(↑ CLAUSE-TYPE) = interrogative

b. { (↑ QUESTION-TYPE) = alternative | (↑ QUESTION-TYPE) = polar }

The decision as to whether the question is a PolQ or an AltQ is made based on the information about the final boundary tone. This set of constraints is shown in (12). The first part of the disjunction states that of all the syllables corresponding to this terminal node, if the syllable with the maximum index (S_{max}) has an L% tone, then CLAUSE-TYPE can be either interrogative (with QUESTION-TYPE alternative) or declarative. In contrast, the second part of the disjunction states that if the final boundary tone is H%, then the CLAUSE-TYPE must be interrogative and the QUESTION-TYPE polar.

(12) Constraints associated with the clause final position:

{ $(\natural(T(*))$ S_{max} TONES$) =_c$ L%
  { (↑ CLAUSE-TYPE) = interrogative
    (↑ QUESTION-TYPE) = alternative
  | (↑ CLAUSE-TYPE) = declarative }
| $(\natural(T(*))$ S_{max} TONES$) =_c$ H%
  (↑ CLAUSE-TYPE) = interrogative
  (↑ QUESTION-TYPE) = polar}

Taken together, (11) and (12) thus disambiguate the syntactic structures based on the information from the p-diagram. Computationally, this is achieved by selecting the corresponding option in the fschart. Once the syntactic analysis has been determined, the system is ready to tackle the semantic and pragmatic analysis.

4 A resource-sensitive semantics for questions

The meaning of questions is determined by both semantic and pragmatic factors. In this paper, we focus mainly on the compositional process of assembling the meaning of questions. Our approach uses LFG's Glue Semantics (Dalrymple 1999), which we extend to be able to deal with alternative semantics. The fundamental property that is attributed to questions is that they partition the Common Ground (Stalnaker 2002) into alternatives corresponding to the answers to a question (Groenendijk & Stokhof 1984). This is fairly intuitive for constituent questions, as shown in (13), where the alternatives are represented as a set of semantic representations. This approach to questions essentially follows Hamblin (1973) and forms the basis for much of the formal semantic literature on questions.

(13) Who ate the radish?
$\{\lambda w_s.eat(jordan, radish, w), \lambda w_s.eat(alex, radish, w), ...\}$

AltQs can be presented as sets of alternatives in a similarly intuitive manner, as shown in (14), since it is generally assumed that AltQs spell out the corresponding possible answers (however, see Meertens 2021 for some special cases). In contrast, PolQs present somewhat more of a challenge as answers to basic PolQs in principle correspond simply to *yes* and *no*, but this correspondence is not necessarily straightforward. The classic analysis due to Hamblin (1973) suggests that for some PolQ $Q(p)$, the denotation in alternative semantics is $\{p, \neg p\}$. However, it has been shown that such a semantics does not capture certain nuances of PolQs, e.g., Van Rooy & Safarova (2003). In our work, we follow Biezma & Rawlins (2012) concerning the semantics for PolQs. Biezma & Rawlins analyze the semantics of a PolQ in terms of a singleton-set corresponding to the/a true answer of the question. This is illustrated in (14-b), which states that there exists some proposition *p* which corresponds to the true answer of the PolQ.

(14) Will you eat radish or cabbage?

a. $\{\lambda w_s.eat(you, radish, w), \lambda w_s.eat(you, cabbage, w)\}$ AltQ

b. $\{\lambda w_s.\exists p[p \in \{\lambda w_s.eat(you, radish, w), \lambda w_s.eat(you, cabbage, w)\} \wedge p(w) = 1]\}$ PolQ

Comparing the semantics of the AltQ and PolQ in (14), it becomes clear that they have a common core: the alternative set $\{\lambda w_s.eat(you, radish, w), \lambda w_s.eat(you, cabbage, w)\}$. This alternative set is not, in fact, introduced by virtue of the expressions being questions (as is the case for constituent questions), but rather by the disjunction (cf. Alonso-Ovalle 2006, who suggests that disjunction is better modeled in terms of alternatives rather than as a Boolean connective).

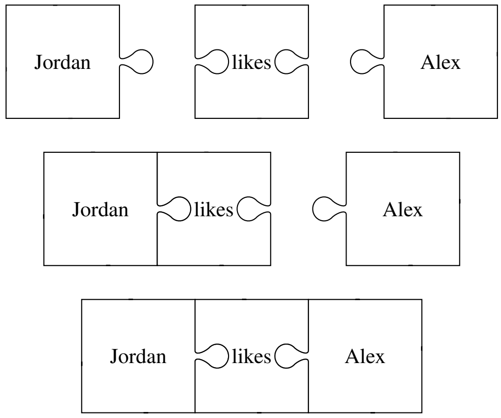
If we adopt the approach to questions sketched in this section, we need to introduce two interacting components to Glue Semantics as a consequence: a semantics of alternatives and a semantics of questions. We show how this is done in the next section.

4.1 Glue Semantics and alternatives

Essentially Glue Semantics can be understood as a puzzle where the grammar provides the individual pieces (see Asudeh 2022, 2023 for some recent compact introductions). For any semantic derivation, all and only the available pieces provided by the grammar need to be used. This is achieved by dividing semantic representations into two components: a representation of meaning (here, λ-First-Order Logic) and assembly instructions (formalized in linear logic). Roughly, the meaning representation corresponds to what is on a puzzle piece and the assembly instructions correspond to the shape of the puzzle piece. This is exemplified in Figure 12, which is accompanied by a (possible) corresponding formal representation, a proof tree. As shown in the figure, linear implication ($\multimap$) is used to indicate that a piece has notches that need to be filled. Atomic premises such as '$g : Jordan$' can fill these notches.[7]

To deal with alternatives, we need to extend our meaning language correspondingly. Concretely, this means that we not only allow simple λ-terms, but also sets of λ-terms. These sets must be restricted to elements of the same type. Thus, (15-a) and (15-b) are valid meaning representations, but (15-c) is not.

[7] Glue semantics also allows for higher-order linear logic terms (Lev 2007), e.g., $(e \multimap t) \multimap t$. These are trickier (i.e., more unwieldy) to represent as puzzle pieces. They are not required for the examples discussed in this paper.



$$\dfrac{\dfrac{Jordan : g \qquad \lambda x.\lambda y.like(x,y) : g \multimap h \multimap f}{\lambda y.like(jordan,y) : h \multimap f} \qquad Alex : h}{like(jordan, alex) : f}$$

Figure 12: Two proof-diagrams for *Jordan likes Alex*

(15) a. $\{jordan, sam\}$
b. $\{\lambda x.\lambda y.visit(x,y), \lambda x.\lambda y.hug(x,y)\}$
c. $\{\lambda x.\lambda y.visit(x,y), \lambda x.\lambda y.hug(x,y), jordan\}$

Through this move, the combinatory instructions can be kept simple, while the heavy lifting in terms of semantics is carried by the meaning side. This allows us to work with the usual computational tools for Glue Semantics (see section 4.3).

For the meaning side, we assume that λ-terms can be coerced into singleton sets at no cost. With this assumption in place, we only have to define function application (the process by which we compositionally combine meanings) for sets. Figure 13 specifies a rule for pointwise function application in the spirit of Hamblin (1973).[8,9] Function application with sets thus boils down to forming the Cartesian set of functors and arguments combining the elements via function application. Thus, intuitively, each element of the functor set is applied to each element of the argument set.

$$\dfrac{\alpha : A \multimap_{\times} B \qquad \beta : A}{\{\alpha_i(\beta_j) \mid \alpha_i \in \alpha, \beta_j \in \beta\} : B} \multimap_{\times}\text{-E}$$

Figure 13: Implication elimination with alternatives

[8] We assume that pointwise function application is the default when sets are involved. Regular function application is required only in special cases (see section 4.2). Thus, the glue fragment presented here remains fully type logical, as there are no ambiguities as to which application rule to choose.

[9] A corresponding rule for λ-abstraction or implication introduction is not required for present purposes. There are two possibilities for dealing with sets of alternatives: introducing a separate λ-binder for each element in the meaning set or having a global λ-binder scoping over the set. Here, the choice is irrelevant (i.e., equivalent), but probing deeper into the semantics of alternatives, e.g., for modeling focus, might force us to make a choice. We leave this for future work.

Set formation can be induced by various semantic devices. Relevant for us is the disjunction *or*, which, intuitively, creates alternatives from its disjuncts. In our puzzle analogy, *or* allows us to create pieces corresponding to multiple elements while maintaining the same combinatory properties, as illustrated in Figure 14. As shown there, we combine two consumable resources to produce a new consumable resource of the same semantic type e. Example (16) presents the corresponding formal notation, where the set operation $\cup$ coerces simple λ-terms into singleton sets. Example (16) roughly corresponds to the semantics of *or* following Alonso-Ovalle (2006).[10]

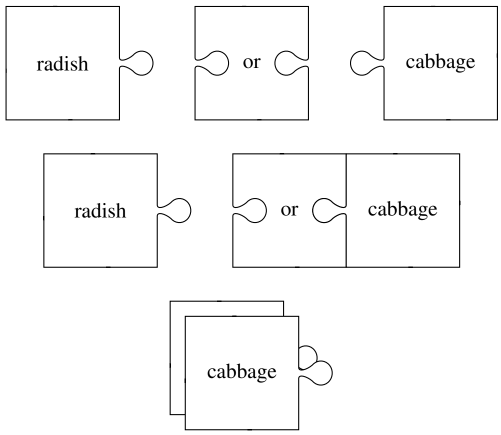


Figure 14: Creating alternatives

(16) a. $\lambda x_e.\lambda y_e.x \cup y : r_e \multimap c_e \multimap o_e$
b. $\{\textit{radish}, \textit{cabbage}\} : o_e$

This semantic machinery allows us to capture the basic facts of alternative semantics and allows us to formalize the semantics of disjunctive PolQs and AltQs.

4.2 From alternatives to questions

Recall that the semantics of questions have the sets of their answers as denotations. Thus, for AltQs, the question form does not contribute any additional semantic content. Rather, it has a pragmatic effect. Biezma & Rawlins (2012) model this in terms of presuppositions targeting the question under discussion (QUD; Roberts 2012), following Alonso-Ovalle (2006) in treating the alternative set introduced by *or* as underspecified. In this paper, we focus on the semantics since a computationally viable formalization for the pragmatics remains to be developed in future work (but see Zymla et al. 2015 for some initial work). We have therefore also set the system up in such a way that it can be extended easily in the future to account for pragmatic factors.

[10]Alternative sets need to be closed off corresponding to the meaning of the disjunctive element. Thus, both *or* and and denote sets of alternatives, but *or* requires only one of the alternatives to be true, whereas *and*, following standard assumptions about conjunction meaning, requires all elements in its alternative set to be true. This is achieved by closing off the alternative sets later in the derivation. We formalize this idea for questions below.

With respect to the semantics, we posit a semantically vacuous closure operator for AltQs, see (17). This provides us with an anchor for the relevant presuppositions in the derivation. Informally, Biezma & Rawlins (2012) suggest that AltQs have two requirements: the possible answers must be either salient alternatives or neutral in the context, and there is more than one such alternative.

(17) $[\![\, Q(\alpha) \,]\!] = [\![\, \alpha \,]\!]$

Thus, the AltQ operator takes a set of propositions and returns the same set with the appropriate pragmatic properties, here simply specified as *Q*. This can be combined with the underspecified semantics for alternatives presented in (18). As the meaning constructors there and the corresponding derivation in Figure 15 show, we can derive the meaning $\{\lambda w_s.eat(you, radish, w), \lambda w_s.eat(you, cabbage, w)\}$ for the disjunctive proposition set: first we combine *or* with *radish* and *cabbage*. Our semantics for *or* form a set of alternatives from its disjuncts. Given this alternative set, $\{radish, cabbage\}$, we can derive the semantics of a disjunctive proposition (i.e., *you eat radish or cabbage*) represented as a set of alternatives. This is the result at the bottom of Figure 15.

(18) a. Will you eat [radish or cabbage]$_o$?
  or $\lambda x.\lambda y.x \cup y : r_e \multimap c_e \multimap o_e$
  eat $\lambda x.\lambda y.\lambda w.eat(x, y) : u_e \multimap o_e \multimap w_s \multimap f_t$
 b. **cabbage** $cabbage : c_e$
  radish $radish : r_e$
  you $you : u_e$

$$\dfrac{\dfrac{\dfrac{\dfrac{radish : r_e \quad \begin{matrix}\lambda x.\lambda y.x \cup y :\\ r_e \multimap c_e \multimap o_e\end{matrix}}{\begin{matrix}\lambda y.\{radish\} \cup y :\\ c_e \multimap o_e\end{matrix}} \quad cabbage : c_e}{\{radish\} \cup \{cabbage\} : o_e}}{\{radish, cabbage\} : o_e}\cup \quad \dfrac{\begin{matrix}\lambda x.\lambda y.\lambda w.eat(x, y, w) :\\ u_e \multimap o_e \multimap w_s \multimap f_t\end{matrix} \quad you : u_e}{\begin{matrix}\lambda y.\lambda w.eat(you, y, w) :\\ o_e \multimap w_s \multimap f_t\end{matrix}}}{\begin{matrix}\{\lambda w.eat(you, radish, w), \lambda w.eat(you, cabbage, w)\} :\\ w_s \multimap f_t\end{matrix}}\multimap_{\times}\text{-E}$$

Figure 15: Underspecified disjunctive question

As discussed above, the difference between PolQs and AltQs lies in how we close off the alternatives (of which there are two in our running example). For AltQs, we simply apply the identity function (ignoring pragmatic constraints, as they do not affect the compositional process). However, to properly close off the derivation, we give it a special type. As shown in (19), we close off the derivation with a compound type for propositions *st* following a proposal made in Asudeh (2005).[11] Thus, as we expect, questions are denoted by sets of propositions.

[11]This is done mainly for stylistic reasons, i.e., so that our computations have an atomic result type. Generally speaking, f_{st} is equivalent to $f_s \multimap f_t$. This becomes relevant when embedding questions, e.g., *Do you know whether you want radish or cabbage?*

(19) **AltQ** $\lambda p_{st}.Q(p) : (w_s \multimap f_t) \multimap f_{st}$

The semantics of PolQs then only differs in the applied closure operator, which is given in (20). This operator has a special property as it takes a set as an argument. This means it does not apply in a pointwise fashion to the input set. We mark this with a special type in the meaning language we call α.

(20) **PolQ** $\lambda q_{\alpha}.\{\lambda w_s.\exists p[p \in q \wedge p(w) = 1]\} : (w_s \multimap f_t) \multimap f_{st}$

A functor asking for an argument of type α essentially asks that its argument is a set and that it is treated as a regular argument. This is shown in action in Figure 16. The type α is underspecified on the meaning side; however, due to the Curry-Howard isomorphism, its type is fixed by the linear logic side, thus avoiding unwanted combinations.

$$\frac{\begin{array}{c}\lambda q_{\alpha}.\{\lambda w_s.\exists p[p \in q \wedge p(w) = 1]\} : \\ (w_s \multimap f_t) \multimap f_{st}\end{array} \qquad \begin{array}{c}\{\lambda w_s.eat(you, radish, w), \lambda w_s.eat(you, cabbage, w)\} : \\ w_s \multimap f_t\end{array}}{\begin{array}{c}\{\lambda w_s.\exists p[p \in \{\lambda w_s.eat(you, radish, w), \lambda w_s.eat(you, cabbage, w)\} \wedge p(w) = 1]\} : \\ f_{st}\end{array}}$$

Figure 16: Applying the PolQ operator

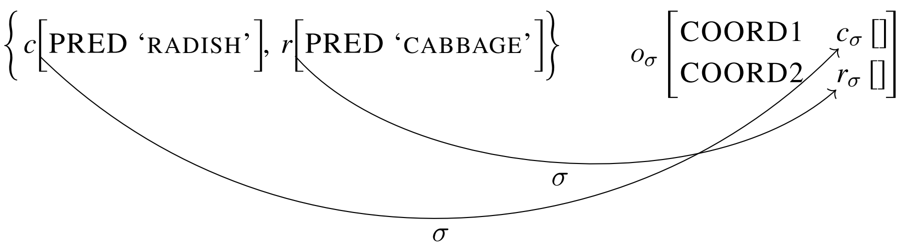
With this, we now have a Glue Semantics approach to AltQs and PolQs in place and can use the Glue Semantics Workbench to implement it computationallly.

4.3 Computational implementation

The semantics are implemented in XLE+Glue (Dalrymple et al. 2020) which interfaces XLE with the Glue Semantics Workbench (GSWB; Meßmer & Zymla 2018). For the purposes of this paper, the GSWB has been updated to include an ability to calculate alternatives, including the special type α.

In addition, we assume a semantic analysis that proceeds via a co-descriptive approach (though description by analysis is also a viable alternative), so we need to adjust the Urdu grammar fragment to include semantic information. It turns out that we need to include semantic information in just two places: 1) the NP coordination rule; 2) where the clause-type of the utterance is determined. For the NP coordination, we simply take over the ParGram approach to coordination (Crouch et al. 2017) and store each conjunct's s-structure index as a conjunct in the s-structure. These references are used to specify the meaning constructor for disjunction. The element o_σ is also the glue index corresponding to the semantics of the conjoined NP and the grammatical function it instantiates. The following example summarizes this:

(21) $\lambda x_e.\lambda y_e.x \cup y : r_\sigma \multimap c_\sigma \multimap o_\sigma$



Meaning constructors:

```
{
cabbage : 5_e
(/q_a.{(/w_s.Ep_<s,t>(in(p,q)&eq(p(w),1)))}) : ((12_s -o 12_t) -o 12_t)
[/x_e.[/y_e.[/w_s.eat(x,y,w)]]] : (10_e -o (3_e -o (12_s -o 12_t)))
you : 10_e
radish : 4_e
(/x_e.(/y_e.{x,y})) : (4_e -o (5_e -o 3_e))
}
{
cabbage : 5_e
[/q_<s,t>.q] : ((12_s -o 12_t) -o 12_t)
[/x_e.[/y_e.[/w_s.eat(x,y,w)]]] : (10_e -o (3_e -o (12_s -o 12_t)))
you : 10_e
radish : 4_e
(/x_e.(/y_e.{x,y})) : (4_e -o (5_e -o 3_e))
}
```

Figure 17: GSWB-representation of meaning constructor sets for underspecified questions

These alternatives percolate through the derivation all the way up to the clausal level. Since questions and declaratives are string-identical in Urdu, the question operators are introduced at the S node at c-structure rather than by concrete lexical items. We therefore also add the question-specific semantic information at this level. Additionally, the disjunctions are dependent on certain features, e.g., AltQs are only available if there is an alternative-inducing operator, i.e., disjunction. This is tested for at the level of f-structure by checking for the existence of the COORD-FORM feature somewhere in the f-structure.[12]

Given these two additions, an XLE+Glue grammar produces the correct meaning constructors for PolQs vs. AltQs for a corresponding string, as shown in Figure 17. Based on these individual meaning pieces, we can derive the correct results shown in (22). Which meaning is to be associated with the string is dependent on the prosodic disambiguation described in section 3. Concretely, the question closure operators are sensitive to the CLAUSE-TYPE feature, as was illustrated in (12). In our current implementation they are attached at the clause level (the S-node) in the c-structure rules in the same disjunct. There are different attachment possibilities, but approaches for ambiguity management, e.g., Findlay & Haug (2022), may profit from attaching question operators high in the tree. We leave an extended exploration of this possibility for future work.

(22) **Resulting solutions:**

a. PolQ:
$\{\lambda w_s.\exists p[p \in \{\lambda z_s.eat(you, radish, z), \lambda z_s.eat(you, cabbage, z)\} \wedge p(w) = 1]\}$

b. AltQ: $\{[\lambda w_s.eat(you, radish, w)], [\lambda w_s.eat(you, cabbage, w)]\}$

[12] These constraints can certainly be refined, but work well for our purposes so far.

5 Conclusion

In this paper we have focused on showing how the projection architecture of LFG allows for an elegant and holistic integration of prosodic information with morphosyntax and semantics. We demonstrated this with respect to Urdu AltQs vs. PolQs, which are string identical, but which can crucially be disambiguated via prosodic cues. We established the prosodic cues involved via a series of experiments described in detail in Mumtaz & Butt (2024a,b). We extracted the identified cues automatically from a speech signal and showed how the prosodic information can be passed to the syntax via the prosody-syntax interface first defined by Bögel (2015). We then showed how Glue Semantics and the GSWB can be extended to provide a semantics for alternatives and how this can be integrated directly into a core LFG grammar. To the best of our knowledge, LFG is the only framework to date whose architecture and concomitant computational implementation allows for a seamless asscociation of a speech signal with a semantic analysis via a morphosyntactic analysis.

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Mutation in Welsh: Syntactic mutation without empty categories

Frances Dowle
University of Oxford

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Abstract

The XP Trigger Hypothesis is a widely accepted account of syntactic mutation in Welsh which states that mutation, a regular alternation in form of the initial segment of a word, occurs if a word is positioned after the right edge of an XP (with some additional framework-specific structural constraints). The XP Trigger Hypothesis poses a problem for Lexical-Functional Grammar (LFG) because it presupposes the existence of empty categories. Null subjects and *wh*-traces both 'count' as XPs for the purposes of the XP Trigger Hypothesis, and therefore must be represented in the tree structure. Such empty categories are generally not represented as XPs in the tree in LFG, being represented only at f-structure. In my analysis, I show that it is possible to account for the data of the XP Trigger Hypothesis without presupposing the existence of empty categories, instead using phrase-structural rules and f-structural relationships between words to predict mutation.

1 Introduction

Welsh is a language with initial mutations, regular alternations in word-initial phonemes according to a word's environment.[†] A mutation 'target' is a word whose initial segment undergoes such an alternation. The type of alternation is determined by the mutation 'trigger' which may be a preceding word that is lexically-specified to have this effect, or the target's syntactic environment. This paper considers the latter type of triggers, and how these might be captured in Lexical-Functional Grammar (LFG). Crucially, the analysis presented here shows that it is possible to account for the data without positing empty phrases or words in the tree structure, thus showing that the Welsh data is not evidence that these types of linguistic objects must exist.

In this paper, I set out some background on mutations in Welsh and provide some examples of typical mutation triggers. Then, I discuss the core data that relates to the issue of syntactic mutation in Welsh, and how the 'XP Trigger Hypothesis' aims to account for such data. I show that the XP Trigger Hypothesis has important implications for LFG, because it presupposes the presence of empty phrases in the tree, and additionally posits further null elements to account for certain exceptions. The use of empty categories is controversial in LFG: Falk (2007) considers them to be a "last resort" within the framework. Hence, the remainder of the paper is dedicated to setting out an alternative account of syntactic mutation. The analysis extends previous work on Welsh mutations within the LFG framework (Mittendorf & Sadler 2006) by reducing the amount of redundancy in the lexicon and establishing a general rule for syntactic mutation, at the same time showing that empty categories are not required in an account of syntactic mutation in Welsh. The new analysis proposes two mechanisms via which syntactic mutation is triggered; this more fine-grained approach avoids over-predicting mutation and eliminates the need to provide special mechanisms for dealing with certain exceptions.

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2 Mutations in Welsh

2.1 Types of mutation

There are three principal types of mutation in Welsh: soft, nasal and aspirate; in this paper we are primarily concerned with the first, which is also the most common. Unmutated forms are referred to as radical forms. Different lexical and syntactic triggers cause different types of mutation. The type of mutation determines the alternations that the initial phoneme of the target word undergoes. Table 1 lists the changes according to mutation type (standard Welsh orthography on the left, IPA transcription on the right).[1] Blank cells indicate that a letter is not affected by a particular mutation type. Some segments are never mutated (such as /s/) and, consequently, are not included in the table. Words beginning with segments that do not undergo (a particular) mutation can still occur in (those particular) mutation environments; they simply exhibit no change when they do so.

Radical		Soft		Nasal		Aspirate	
p	[p]	b	[b]	m	[m̥ʰ]	ph	[f]
t	[t]	d	[d]	nh	[n̥ʰ]	th	[θ]
c	[k]	g	[g]	ngh	[ŋ̊ʰ]	ch	[χ]
b	[b]	f	[v]	m	[m]		
d	[d]	dd	[ð]	n	[n]		
g	[g]	∅	–	ng	[ŋ]		
m	[m]	f	[v]				
rh	[r̥ʰ]	r	[r]				
ll	[ɬ]	l	[l]				

Table 1: Changes to (radical) initial segments in the principal mutation environments of Welsh (Borsley et al. 2007: 20)

I augment standard Welsh orthography using superscript capital letters (R = radical, S = soft, N = nasal, A = aspirate) to label the word forms as necessary. Radical forms are labeled only where they are unexpected or otherwise pertinent. Vacuous application of a mutation (e.g., to a word beginning with an immutable segment) is indicated by a strike through of the superscript letter; such forms are identical to radical forms, but the marking indicates a mutation would be expected were a different initial segment to occur in that position.[2] Where a particular word can be identified as a trigger, the trigger word is underlined.

2.2 Typical mutation triggers

The prototypical mutation trigger is a word which is lexically-specified to trigger mutation on any immediately following word. These types of mutation triggers provide

[1] The entry for *g* under soft mutation indicates that the segment is deleted under soft mutation.

[2] The following glossing abbreviations are also used in this article, in addition to those found in the Leipzig Glossing Rules: impf = imperfective; imprs = impersonal, s = singular, p=plural, foc.int = focus interrogative particle, prt = particle. Clitic boundaries are marked = as in the Leipzig rules, but clitics are separated from their host for greater clarity.

important context to how syntactic mutations are accounted for under the XP Trigger Hypothesis, as they demonstrate the significance of linear adjacency in accounting for at least some mutations.

Although the origins of mutation in Welsh are phonological (Hannahs 2014: 121–126 and Ball & Müller 1992: 53–77, among others), examples (1)–(4) demonstrate that neither being a trigger nor the type of mutation triggered is predictable from the synchronic phonology; and (1)–(3) and (5) show that it is also not predictable from the category of the trigger word.

(1) eu $^{\mathbf{R}}$cath nhw
/i kaθ n̥ʰuː/
3P cat 3P
'their cat'

(2) ei $^{\mathbf{A}}$chath hi
/i χaθ hiː/
3S.F cat 3S.F
'her cat'

(3) ei $^{\mathbf{S}}$gath e
/i ɡaθ ɛː/
3S.M cat 3S.M
'his cat'

(4) i $^{\mathbf{S}}$gath
/i ɡaθ/
to cat
'to a cat'

(5) fy $^{\mathbf{N}}$nghath i
/və ŋ̊ʰaθ iː/
1s cat 1s
'my cat'

There are sometimes generalizations to be made above the level of the individual word. For example, all feminine singular nouns trigger mutation on following words, as exemplified in (6) and (7) by the phrases containing the feminine noun *agwedd* 'aspect' (from Mittendorf & Sadler 2006: 346). Note the strict adjacency requirement demonstrated by (7), which is considered typical of mutation. The soft mutation triggered by the feminine singular noun *agwedd* affects *dra* but not *phwysig*, which has undergone the aspirate mutation lexically triggered by *dra*.

(6) agwedd $^{\mathbf{S}}$bwysig
aspect.S.F important
'an important aspect'

(7) agwedd $^{\mathbf{S}}$dra $^{\mathbf{A}}$phwysig
aspect.S.F extremely important
'an extremely important aspect'

Example (7) establishes the importance of linear-adjacency relationships in accounting for at least some types of mutation, which the XP Trigger Hypothesis (discussed below) aims to maintain even for instances of syntactic mutation.

Finally, it is useful to note that, contrary to the representation in Table 1, whether a target word is susceptible to mutation is not purely determined by phonology. There are some words which never undergo mutation such as *gêm* 'game' or *dy*, the 2s agreement clitic (Borsley et al. 2007: 25). For this reason (among some others) mutation in Modern Welsh is treated in this paper as a morphological rather than phonological phenomenon (for further discussion on this matter, the reader is directed to Breit 2019).

2.3 Syntactic mutation

2.3.1 Mutation of verbal objects

Some mutations are not triggered by a particular lexical item, or type of lexical item, but are triggered by something more abstract. There is debate about how such abstract triggers should be captured. The variable mutation behaviour of verbal objects has been particularly central to these discussions: objects soft-mutate if the lexical verb is finite, but do not undergo any mutation (they are in their radical form) if the lexical verb is non-finite, as in sentences where an auxiliary verb conveys tense/aspect/mood:

(8) Pryn-odd dyn [S]feic.
buy-PST man bike
'A man bought a bike.'

(9) Roedd dyn wedi prynu [R]beic.
be.IMPF man PERF buy.NF bike
'A man had bought a bike.'

An account of syntactic mutation in Welsh must predict the mutation of the direct object *feic* in (8), at the same time as ensuring that mutation is not incorrectly predicted on *beic* in (9). One particularly compelling solution to this problem is the 'XP Trigger Hypothesis' (Tallerman 1987; Borsley 1999; Tallerman 2006, among others).[3] The XP Trigger Hypothesis is a generalization which proposes that syntactic phrases *of all types* (hence, ***X***P) trigger a soft mutation at their right edge, affecting whichever word follows.

Under the XP Trigger Hypothesis, the reason for the variable mutation behaviour of *feic/beic* in (8) and (9) has to do with word order and constituency. In both cases, the NP *dyn* triggers a soft mutation at its right edge, but it is only in the former that the direct object *feic* is situated immediately after the right edge of the NP. In (9), *wedi* is positioned here, and vacuously absorbs the mutation because it begins with an immutable segment, /w/:

(8′) Pryn-odd [dyn $_{NP}$] [S]feic.
buy-PST man bike.
'A man bought a bike.'

(9′) Roedd [dyn $_{NP}$] [S]wedi prynu beic.
be.IMPF man PERF buy.NF bike
'A man had bought a bike.'

The XP Trigger Hypothesis is compelling because it uses the same mechanism to also account for some other instances of mutation in Welsh: (10) below shows that the object of an impersonal verb does not usually mutate; (11) shows that it nevertheless does when an adverb phrase precedes it. Under the XP Trigger Hypothesis, the explanation is that the right-phrase-boundary of the adverb phrase is responsible for the mutation of *feic* in (11).

(10) Pryn-wyd [R]beic.
buy-PST.IMPRS bike
'A bike was bought.'

(11) Pryn-wyd [hefyd $_{ADVP}$] [S]feic.
buy-PST.IMPRS also bike
'A bike was also bought.'

Hence, the XP Trigger Hypothesis is able to account for a wider range of data, not simply that presented in (8) and (9).

2.3.2 Constraining the XP Trigger Hypothesis

There are some additional constraints which form part of the XP Trigger Hypothesis. These are formulated differently depending on the framework within which the hypothesis is implemented; for example:

[3]For an extensive overview of the XP Trigger Hypothesis and competing accounts of syntactic mutation, including Case-linked accounts, consult Borsley et al. (2007) and Breit (2019). For a phonological approach see Hannahs (1996). Space precludes discussion of alternatives here.

A. Principles & Parameters (Borsley & Tallerman 1996; Borsley 1999)

A constituent bears soft mutation at its left edge if it is immediately preceded by a c-commanding phrase, provided the c-commanding phrase has lexical content or Case (thus including null subjects or *wh*-traces, but not PRO or NP-trace).

B. Head-Driven Phrase Structure Grammar (Borsley 1999)

A complement (which in this context includes subjects) bears soft mutation at its left edge if it is immediately preceded by a phrasal sister, including phrasal sisters that are null subjects or *wh*-traces (thus providing evidence that these empty categories, but not PRO or NP-trace, exist). CPs are excluded from this.

C-command/complement relationship requirements account for the lack of mutation in the following positions indicated by the superscript R (for radical, i.e. unmutated).

(12) [Yn sydyn $_{\textbf{ADVP}}$], $^{\mathbf{R}}$dechreu-odd y môr $^{\text{S}}$ferwi.
PRED sudden, start-PST the sea boil.NF
'Suddenly, the sea started to boil.' (Borsley et al. 2007: 230)

(13) [mor $^{\text{S}}$wyntog $_{\textbf{AP}}$] $^{\mathbf{R}}$dydd
so windy day
'as windy a day'[4]

(14) [mwyaf gwyntog $_{\textbf{AP}}$] $^{\mathbf{R}}$dydd
most windy day
'the windiest day'[5]

(15) bwrdd [mawr $_{\textbf{AP}}$] $^{\mathbf{R}}$[crwn $_{\textbf{AP}}$] $^{\mathbf{R}}$brenin
table big round king
'a king's big round table'

(12) shows an adverb phrase failing to trigger mutation on the next word; (13) and (14) the failure of a prenominal adjective phrase to trigger mutation, and (15) the failure of post-nominal adjectives to trigger mutations on each other or the possessor of the noun phrase; in each case the assumption is that the XP in question fails to trigger mutation on the following word because it does not c-command, or is not a sister of, the next word.

There is also the matter that conjuncts do not mutate each other. Note how only the first conjunct undergoes soft-mutation in (16). (The aspirate mutation on *chaws* arises because *a* is a lexically-specified aspirate mutation trigger.)

(16) Bwyt-ais i [$^{\text{S}}$fara $_{\textbf{NP}}$] [$^{\mathbf{R}}$menyn $_{\text{NP}}$] $^{\text{S}}$a [$^{\text{A}}$chaws $_{\text{NP}}$].
eat-PST.1s 1s bread butter and cheese
'I ate bread, butter and cheese.'

The lack of mutation on *menyn* cannot be restricted via the requirement for a c-command relationship proposed by Borsley & Tallerman (1996), who instead account for the data in (16) by proposing an empty element (a null conjunct particle), positioned

[4] *Mor*, an intensifying adverb, is a lexically-specified soft-mutation trigger; this explains the soft mutation of *wyntog* in (13).

[5] This and the preceding example are cited in Borsley (1999) and attributed to an unpublished paper by Maggie Tallerman. Although most APs follow the head noun, equative, comparative and superlative APs may precede it.

directly after *fara*, which absorbs the soft mutation that the NP *fara* would otherwise trigger on *menyn*, in much the same way that *wedi* does in (9′). As Borsley (1999) points out, this null particle must be restricted to non-initial and non-final conjuncts, and there are no other known examples of such a particle in other languages to corroborate it. In contrast, the complement restriction in Borsley (1999: 294) accounts for the non-mutation of non-initial, non-final conjuncts in a less stipulative way, because whilst "a conjunct may be part of a complement, it is not itself a complement". Only the left edge of the whole complement will undergo mutation, and thus conjuncts positioned later will be unaffected.

As apparent from the formulation of the XP Trigger Hypothesis above, some proposed empty/null phrases act as XPs under the hypothesis, whilst others do not. On the basis that the mutation facts are invariable irrespective of whether subject pronouns are overt (17, 18) or null (19, 20), the latter pair of sentences receive the analyses outlined in (19′) and (20′) respectively.

(17) Pryn-och [chi$_{\mathbf{NP}}$] $^{\mathbf{S}}$feic.
buy-PST.2P 2P bike
'You bought a bike.'

(18) Pryn-a [di$_{\mathbf{NP}}$] $^{\mathbf{S}}$feic.
buy-IMP.2S 2S bike
'Buy (you) a bike.'

(19) Pryn-och $^{\mathbf{S}}$feic.
buy-PST.2P bike
'You bought a bike.'

(20) Pryn-a $^{\mathbf{S}}$feic.
buy-IMP.2S bike
'Buy a bike.'

(19′) Pryn-och [*pro* $_{\mathbf{NP}}$] $^{\mathbf{S}}$feic.

(20′) Pryn-a [*pro* $_{\mathbf{NP}}$] $^{\mathbf{S}}$feic.

Similarly, the presence of soft mutation after the 'extraction site' of subject long-distance dependencies is taken as evidence that '*wh*-traces' or copies are also XPs in the string:[6]

(21) Pwy $^{\mathbf{S}}$bryn-odd [t_{wh} $_{\mathbf{NP}}$] $^{\mathbf{S}}$feic?
Who buy-PST bike
'Who bought a bike?'

(22) Y dyn [$_{\text{CP}}$ $^{\mathbf{S}}$bryn-odd [t_{wh} $_{\mathbf{NP}}$] $^{\mathbf{S}}$feic]...
the man buy-PST bike
'The man who bought a bike...'

The status of other empty phrase types posited by Principles & Parameters analyses is different. Big PRO and NP-traces fail to either trigger (23, 24) or block (25, 26) mutation:

(23) Mae [Ed $_{\text{NP}}$] yn disgwyl [[PRO $_{\mathbf{NP}}$] $^{\mathbf{R}}$prynu beic].
be.PRS Ed PROG expect.NF buy.NF bike
'Ed expects to buy a bike.'

(24) Mae [Ed $_{\text{NP}}$] yn dechrau [[∅ $_{\mathbf{NP}}$] $^{\mathbf{R}}$beicio].
be.PRS Ed PROG start.NF cycle.NF
'Ed starts to cycle.'

[6] I set aside discussion of the mutation on *bryn-odd* in these examples, which depends on the grammatical function of the fronted phrase, and is not automatic.

(25) Disgwyliodd [Ed $_{\text{NP}}$] [[PRO $_{\text{NP}}$] $^{\text{S}}$brynu beic].
expect.PST Ed buy.NF bike
'Ed expected to buy a bike.'

(26) Dechreuodd [Ed $_{\text{NP}}$] [[∅ $_{\text{NP}}$] $^{\text{S}}$feicio].
start.PST Ed cycle.NF
'Ed started to cycle.'

The data in (23) and (24) is the reason for the Case restriction in Borsley & Tallerman's (1996) formulation of the XP Trigger Hypothesis, although this does not explain why the phrases fail to block mutation in (25) and (26). Borsley (1999) uses this data to argue that, unlike *pro* and *wh*-traces, big PRO and NP-trace do not exist, which is in keeping with independently-reached conclusions in HPSG.[7]

2.3.3 Some exceptions

There are some further data points that seem to constitute exceptions to the XP Trigger Hypothesis: the lack of mutation at the beginning of embedded interrogative CPs, such as that in (27), and the lack of mutation on the lexical verb in a negative imperative sentence, such as (28).

(27) Hol-a [di $_{\text{NP}}$] $^{\text{R}}$mab i bwy yw =r llanc.
ask-IMP.2s 2s son to who is =the lad
'Ask whose son the lad is.'

(28) Paid [ti $_{\text{NP}}$] $^{\text{R}}$meiddio chwerthin.
NEG.IMP.2s 2s dare.NF laugh.NF
'Don't you dare laugh.' (Very informal)

The data in (27) is accounted for via the Case requirement in version A of the XP Trigger Hypothesis, and via a specific stipulation that CPs are impervious to mutation in version B. However, not all possible CPs are impervious to mutation, which presents further complications. Tallerman (2006: 1771, fn. 19) provides the following example:

(29) Gwn i [$_{\text{CP}}$ fod Mair yn mynd yfory].
know.1s 1s be.NF Mair PROG go.NF tomorrow
'I know that Mair is going tomorrow.'

In spoken Welsh there is variability as to whether even interrogative embedded CPs are actually impervious to mutation or not (Tallerman 2006: 1769–1771).

It is also possible to develop an approach which uses empty categories to block the mutation predicted by the NP-edges in (27). An empty element could be posited before *mab*, which absorbs the predicted soft-mutation, and triggers no mutation of its own, much like *wedi* in (9′). An overt element which behaves in exactly this way, specifically the interrogative focus particle *ai*, can appear here in formal registers, lending support to this approach.

[7] These empty categories have also been proposed elsewhere in HPSG, and so are not included solely to account for mutation facts. However, this treatment of *pro* and *wh-trace* is controversial within the framework (Müller et al. 2021: 1470).

(27′)	Hol-a	[di $_{NP}$]	^{S}**ai**	mab	i	bwy	yw	=r	llanc.
	ask-IMP.2s	2s	INT.FOC	son	to	who	is	=the	lad

‘Ask whose son the lad is.’ (Very formal)

This approach can be extended to (28) as well. *Â* is a preposition-like element or particle which typically accompanies *paid*, the negative imperative auxiliary, and appears after the subject NP, as in (28′). *Â* vacuously absorbs the predicted soft mutation, and triggers aspirate mutation of its own, just like *dra* in (7). The overt expression of the article has become optional in some colloquial varieties, generally without affecting the mutation behaviour of the following verb, giving us (28). In some instances, aspirate mutation has also now been lost, but, crucially, soft mutation does not arise.

(28′)	Paid	[ti $_{NP}$]	$^{S-}$**<u>â</u>**	$^{A-}$meiddio	chwerthin.
	NEG.IMP.2s	2s	PRT	dare.NF	laugh.NF

‘Don’t you dare laugh.’

2.3.4 Implications of the XP Trigger Hypothesis for LFG

The XP Trigger Hypothesis, and in particular its reliance on empty phrases, poses challenges for LFG because of the proliferation of empty categories it entails. Empty categories in LFG have either been entirely eschewed (e.g. Dalrymple et al. 2019) or have been perceived as a “last resort” (Falk 2007) within the framework, meaning that, at most, they should only be incorporated into an analysis when all alternatives have been exhausted. The crux of the problem is that the XP Trigger Hypothesis is a c-structural generalisation, but null pronouns and ‘*wh*-traces’ or ‘copies’ are represented at f-structure only (Toivonen 2023: 566–572, Kaplan 2023: 428–436, among others). Furthermore, additional empty categories are employed on a case-by-case basis (albeit fewer of them in the HPSG version) for dealing with apparent exceptions to the XP Trigger Hypothesis. These are also undesirable from an LFG perspective. The Welsh data on phrasal mutation raises the question as to whether LFG must accept empty phrases and words in its c-structures, in at least some instances; in this paper, I show that this “last resort” is not required for Welsh mutation.

3 An LFG approach to syntactic mutation

3.1 Existing analyses of Welsh mutation in LFG

The existing account of mutation in LFG, from Mittendorf & Sadler (2006), is one that has been developed in the Xerox Linguistic Environment (XLE; Crouch et al. 2017) as part of the ParGram project (Butt et al. 2002). It currently captures simple linear-lexical mutation triggers (such as the mutation triggered by *i* in (4)), the behaviour of adverbs and adjectives modifying singular feminine nouns, as in (6, 7), as well as mutation at the beginning of negative clauses, which I do not discuss here. It does not account for all of the data presented for discussion in this paper, and provides no overall generalisation for syntactic mutations equivalent to the XP Trigger Hypothesis.

The analysis assumes that words can be decomposed into a linear string of features, somewhat contrary to mainstream LFG assumptions but possible within XLE/ParGram, which uses finite-state-transducers in the morphology (Kaplan et al. 2004: 11–20, Bögel et al. 2019: 417–438). Mittendorf & Sadler (2006) model mutation as a constraint on this string of features. Both the initial and final positions of a word's decomposition string are occupied by values for a mutation, and a concatenated string of words in a sentence must pass a grammaticality test such that adjacent mutation values match. A word like *i* 'to' in (4) carries a final SOFT morpheme. The form *gath* carries an initial SOFT morpheme. The phrase *i gath* is correctly predicted to be grammatical since the adjacent mutation morphemes match:

(30) A simplified representation of *i gath* (4) according to Mittendorf & Sadler (2006):
. . . [+RAD *to* **+SOFT**] [**+SOFT** *cat* +F +SG +RAD] . . .

Final and initial morphemes are both 'radical' by default, with the consequence that one word does not mutate the other unless specified to do so. To prevent words from being blocked from occurring after a trigger that only vacuously applies to them, all words are listed with every possible initial mutation morpheme, even if there is no corresponding change in surface form. To some degree, this is undesirable, as it means there is significant redundancy in the lexicon.

As well as entering the structure at the end of a particular lexical item, mutation triggering morphemes can also enter into the structure via phrase-structure rules (PSRs). For example, a +SOFT morpheme is introduced in the 'post-subject' position by a PSR, so that soft mutation occurs here. This removes the need for a *wh*-trace or null pronoun in the c-structure, but the approach is not a general one. Each type of syntactic mutation, whether there is an overt phrase or not, would have to be individually coded in annotated c-structure rules. It is not easy to see how the approach could be generalized without over-generating mutation and requiring yet further phonologically null morphemes to enter into the phrase structure to block this.

This paper therefore moves the LFG analysis of mutation forward, considering not only how mutation can be accounted for without breaking down words into a linear string of morphemes (thus showing that such assumptions are not essential) and without redundancy and over-generation in the lexicon, but also by offering a generalization with the predictive power of the XP Trigger Hypothesis.

3.2 A new approach to Welsh mutation in LFG

The generally linear and lexical behaviour of mutation can be captured by positing mutation as a feature of the units of the s(yntactic)-string. Following Mycock & Lowe (2013), Lowe (2016), and others, the s-string in LFG is a linearly-ordered string of attribute-value matrices (AVMs), each one corresponding to a syntactic word. Words are not decomposed into a linearly-ordered string of morphemes in this approach; instead, features are associated with whole words. I propose that one feature (in Welsh) of these AVMs is the feature 'MUT', which in turn has several possible values, including S, N, A and R, of which it can bear only one at any one time. It is desirable to avoid representing mutation, a very restricted phenomenon cross-linguistically, at f-structure, as this is a level of representation which is cross-linguistically stable.[8]

[8]With thanks to Miriam Butt for first bringing this consideration to my attention.

A lexical mutation trigger, such as *i* in sentence (4), contains a specification in its entry that defines the mutation value of whatever string element comes next as *soft*: (≻MUT) = s. The symbol ≻ designates the result of the application of the *N* function, as defined in Asudeh (2009), to the current s-string unit, meaning that it picks out the next string-element.

In fact, this is not sufficient, because possessor phrases (including any adjuncts in them) are immune to soft mutation. Consider that *merch* and *gwir* are unmutated despite immediately following a feminine noun, which ordinarily would trigger soft mutation on a following word—cf. (6, 7).

(31)	cath	**R**merch	(32)	gweithred	**R**gwir ffrind
	cat.F.S	girl.F.S		act.F.S	true friend.M.S
	'a girl's cat'			'an act of a true friend'	

In light of this, I propose the following soft-mutation triggering template, which is called on all lexical triggers of soft mutation:

(33) $$@\text{S-TRIGGER} := \; \succ \neq (((\text{ADJ} \in)^{*} \wedge) \; \text{POSS} \; (\text{ADJ} \in)^{*}) \Rightarrow (\succ \; \text{MUT}) = \text{S}$$

Following Asudeh (2009), ≻ designates the f-structure of the next s-string unit i.e., $\varphi(\pi(N(\bullet)))$ or $\varphi(\pi(\succ))$. I also introduce ∧ to refer to the f-structure of the *current* string unit, i.e. $\varphi(\pi(\bullet)))$. This replaces the common practice of extending the use of ↑ to abbreviate $\varphi(\pi(\bullet))$ alongside its existing use as an abbreviation for $\varphi(\hat{*})$ (Dalrymple et al. 2019: 411). Thus, the template in (33) states that, if the next string unit's f-structure is not the possessor, nor an adjunct (possibly itself within an adjunct) inside the possessor, of the current s-string unit—or a '(grand)parent' f-structure of the current unit's, if the current unit is itself (an adjunct embedded in) an adjunct—then the next string unit must have an s value for its MUT feature. This template captures the fact that possessors and their adjuncts are always immune to soft mutation by their possessum or its adjuncts. The template provides structure to the lexicon by collecting information that repeatedly occurs together into a 'bundle' that can be used across multiple lexical entries. I now extend this approach from lexical triggers to the syntactic triggers at issue in this paper.

3.3 The XP Trigger Hypothesis re-imagined

Rather than considering the c-structural relationships between phrases to be the predictive factor for syntactic soft mutation in Welsh, I instead propose that the mutations predicted by the XP Trigger Hypothesis arise in one of two ways: via a lexically-supplied template, or via phrase-structure rules (PSRs).[9] What is lost in not providing a single generalisation is gained through not having to propose multiple exceptions. It also avoids the need to posit empty elements in the c-structure, and makes concrete the way the mutations are introduced into the structure. Consider the following mini-fragment of Welsh grammar, for which lexical entries are included, alongside relevant examples,

[9]Both lexical and phrase-structural mechanisms are used to trigger mutations in Mittendorf & Sadler, but only the latter are used for syntactic mutations.

in the next section. As is standard in LFG, all nodes on the right-hand side of each rule are optional (Belyaev 2023: 69–71).[10]

(34) Mutation-triggering template, called on all words:

$$
\begin{array}{lll}
@\text{ALL} := & (((\text{GF}\ (\in))^{+} \curlywedge)\ (\text{GF}\ (\in))^{+}) = \succ & \textit{if the f-str. I'm in contains the next word's,} \\
& \wedge\ (\curlywedge\ (\text{GF}\ (\in))^{*}) \neq \succ & \textit{\& my f-str. doesn't contain the next word's,} \\
& \wedge\ (\succ\ (\text{GF}\ (\in))^{*}) \neq \curlywedge & \textit{\& the f-str. of the next word doesn't contain mine,} \\
& \wedge\ (\in \curlywedge) \neq (\in \succ) & \textit{\& my f-str. and the next word's aren't in the same set,} \\
& \Rightarrow @\text{S-TRIGGER} & \textit{then @S-TRIGGER is called}
\end{array}
$$

(35)
$$
\text{CP} \rightarrow \underset{(\uparrow \text{DIS}) = \downarrow}{\text{XP}} \quad \underset{\uparrow=\downarrow}{\text{C}'}
$$

(36)
$$
\text{C}' \rightarrow \underset{\uparrow=\downarrow}{\text{C}} \quad \underset{\uparrow=\downarrow}{\text{IP}}
$$

(37)
$$
\text{IP} \rightarrow \underset{\uparrow=\downarrow}{\text{I}} \quad \underset{\uparrow=\downarrow}{\text{S}}
$$

(38)
$$
\text{S} \rightarrow \left\{ \begin{array}{c} \text{NP} \\ (\uparrow \text{SUBJ}) = \downarrow \ \middle|\ \begin{array}{c}(\uparrow \text{OBJ}) = \downarrow\} \\ \neg(\uparrow \text{SUBJ})\end{array} \end{array} \right\}
\left(\left\{ \begin{array}{c} \text{XP} \\ (\not\!\!/\!\!/\ \text{MUT}) = \text{S} \end{array} \middle| \begin{array}{c} \text{CP} \\ (\uparrow \text{COMP}) = \downarrow \\ (\uparrow \text{TYPE}) =_c \text{Q} \end{array} \middle| \begin{array}{c} \text{VP} \\ \uparrow=\downarrow \\ (\not\!\!/\!\!/\ \text{MUT}) = \text{A} \\ (\uparrow \text{MOOD}) =_c \text{IMP} \\ (\uparrow \text{POL}) =_c \text{NEG} \end{array} \right\} \right)
\begin{array}{c} \text{AdvP} \\ \downarrow = (\text{ADJ} \in \uparrow) \end{array}
$$

(39)
$$
\text{XP} := \left\{ \begin{array}{c} \text{VP} \\ \uparrow=\downarrow \\ \neg \left(\begin{array}{c} (\uparrow \text{MOOD}) = \text{IMP} \\ \wedge\ (\uparrow \text{POL}) = \text{NEG} \end{array} \right) \end{array} \middle| \begin{array}{c} \text{AdjP} \\ (\uparrow \text{PREDLINK}) = \downarrow \end{array} \middle| \begin{array}{c} \text{PP} \\ (\uparrow \text{OBL}_\theta) = \downarrow \end{array} \middle| \begin{array}{c} \text{CP} \\ (\uparrow \text{COMP}) = \downarrow \\ (\uparrow \text{TYPE}) \neq \text{Q} \end{array} \right\}
$$

(40)
$$
\text{VP} \rightarrow \begin{array}{c} \text{V}^0 \\ \uparrow=\downarrow \end{array} \left\{ \begin{array}{c} \text{CP} \\ \uparrow \text{COMP} = \downarrow) \end{array} \middle| \begin{array}{c} \text{VP} \\ (\uparrow \text{XCOMP}) = \downarrow \\ \vee\ (\uparrow \text{COMP}) = \downarrow \end{array} \middle| \begin{array}{c} \text{NP} \\ (\uparrow \text{OBJ}) = \downarrow \\ (\uparrow \text{SUBJ}) \end{array} \middle| \begin{array}{c} \{\text{NP} \mid \text{PP}\} \\ (\uparrow \text{OBL}_\theta) = \downarrow \end{array} \right\}
$$

(41)
$$
\text{V}^0 \rightarrow \underset{\uparrow=\downarrow}{\widehat{\text{Neg}}} \quad \underset{\uparrow=\downarrow}{\widehat{\text{Asp}}} \quad \underset{\uparrow=\downarrow}{\text{V}^0}
$$

The template in (34) states that, if a particular set of f-structural relationships hold between one word and the next (essentially that they belong to different phrases), then the latter will undergo soft mutation, via the calling of the @S-TRIGGER template. Specifically, the first line expresses the set of possible paths that can be taken to connect the f-structure of the current string-element to the f-structure of the following string-element. (∈) is included in brackets because it is not always needed (the f-structures of the string-elements in question may not belong to sets) but it can be: a single string-element does not typically correspond to sets of adjuncts or sets of conjuncts but rather a single member of such a set, and in these cases (∈) is required to navigate through the structure correctly. The subsequent two lines of the template express that neither f-structure can be contained by the other, and the penultimate line that neither f-structure can belong to the same set as the other. If this relationship holds, the @S-TRIGGER template is called.

The rule in (38) makes use of the notation $\not\!\!/\!\!/$, defined by Mycock & Lowe (2013) to identify the string element associated with the left-most node underneath the current

[10]The annotation (↑ OBJ) = ↓ on the NP in (38) and (40) is accompanied by a constraint (either ¬(↑ SUBJ) or (↑ SUBJ)) to indicate that the position of the object is conditioned by the presence or absence of a subject in the f-structure. This means that the objects of impersonal verbs appear outside of VP (one of the possible instantiations of XP). For further discussion and an example, see (46) below. In the trees themselves, these annotations have been simplified so that only the relevant disjunct is shown. For information on non-projecting categories such as those found in (41), see Toivonen (2003).

node. Hence, in this rule, the annotation (⫽ MUT) = s specifies that the left-most string element that falls under 'XP' (defined in (39)) must have the mutation value 's' i.e., that it must be soft-mutated. This rule is necessary because words in this position mutate regardless of their f-structural relationship with a preceding subject, and regardless of whether the subject is actually present at all.[11]

In the next section, I provide some examples of these rules in action, showing how the template in (34) and the PSR in (38) together predict all the mutations of the XP Trigger Hypothesis, at the same time avoiding redundancy, and without the use of empty categories.

3.4 LFG syntactic mutation in action

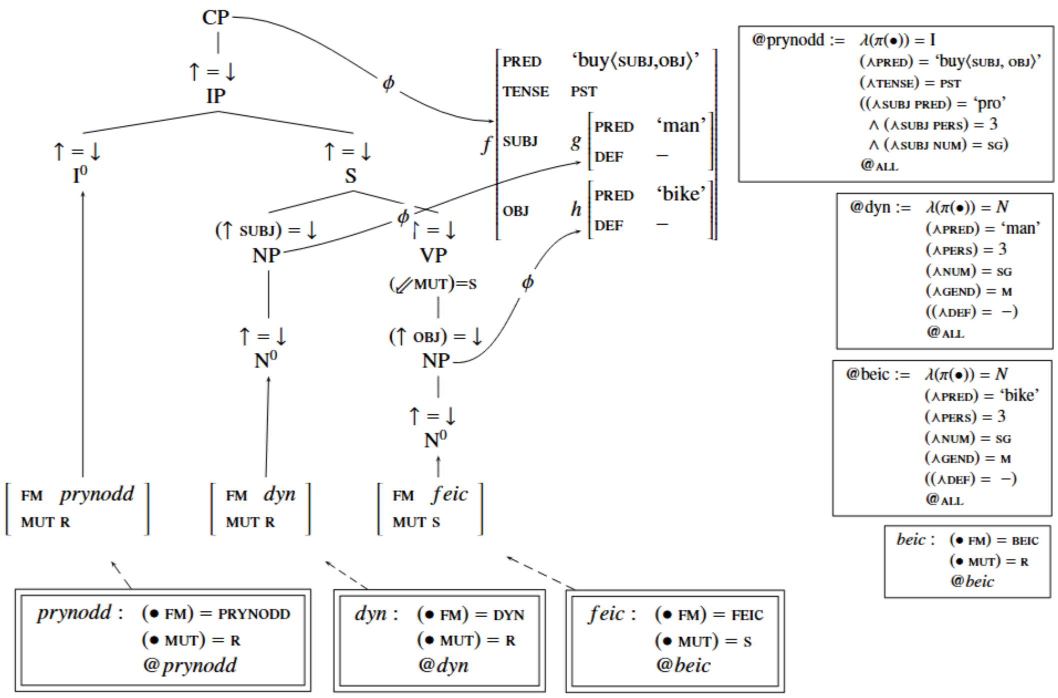
Recall the sentences (8) and (9), which were used to demonstrate the variable mutation behaviour of verbal objects.

(8) Pryn-odd dyn [S]feic
buy-PST man bike
'A man bought a bike.'

(9) Roedd dyn [S]wedi prynu [R]beic.
be.IMPF man PERF buy.NF bike
'A man had bought a bike.'

The f-structure, c-structure, string and some relevant lexical entries and templates for (8) are provided in (42). Mutated forms of the same word share a lexical template containing all the information which is constant across mutation forms. The lexical entry for unmutated *beic* is included for comparison.

(42) *analysis of (8)*

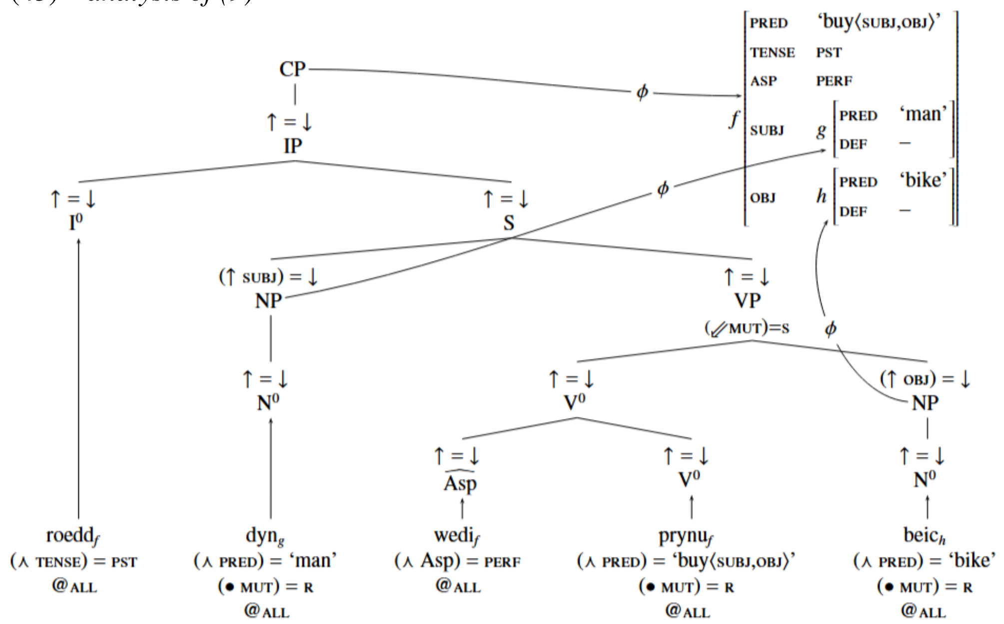


[11]This kind of PSR specification can also be used to capture soft-mutation at the beginning of negative clauses, and the optional soft-mutation of adverb phrases regardless of their relative position to other phrases, phenomena which there is not space to discuss further here.

In this analysis, unmutated *beic* cannot appear in the object position of sentence (8) because occupants of this position are limited to words that bear the value [MUT S]. In (8), this constraint arises twice (see (44)): once because of the annotation on the XP in (38), which here is instantiated as VP; and once because of the template @ALL, defined in (34), called on the word *dyn*. The @ALL template on this word has its requirements to call soft mutation met: as shown in (42), *dyn* projects to g, *feic* to h, and ((SUBJ g) OBJ) = h is in the set of possible paths generated by $((\text{GF}\ (\in))^{+}\ \wedge)\ (\text{GF}(\in))^{+} = \succ$. Within LFG, it is not an issue that two places in the grammar separately state the mutation value for *feic*; the values unify in the attribute-value matrix, because none of the specifications contradict one another.

(43) shows that the change in word order in (9), resulting from the periphrastic expression of tense, means that the string-element in the left-most position of XP (which is again instantiated as VP) is now *wedi*.[12] *Wedi* can appear with any mutation value in its AVM, and so is compatible with the (⫽ MUT) = S specification. *Beic* does not undergo mutation because it is not in the left-most-in-XP position, and *prynu* triggers no mutation on it because the requirements for the @ALL template to trigger mutation are not met: the path between *prynu*'s f and *beic*'s h is not in the possibilities specified by @ALL, and, furthermore, the constraint that one f-structure not contain the other fails too because f contains h.

(43) *analysis of (9)*

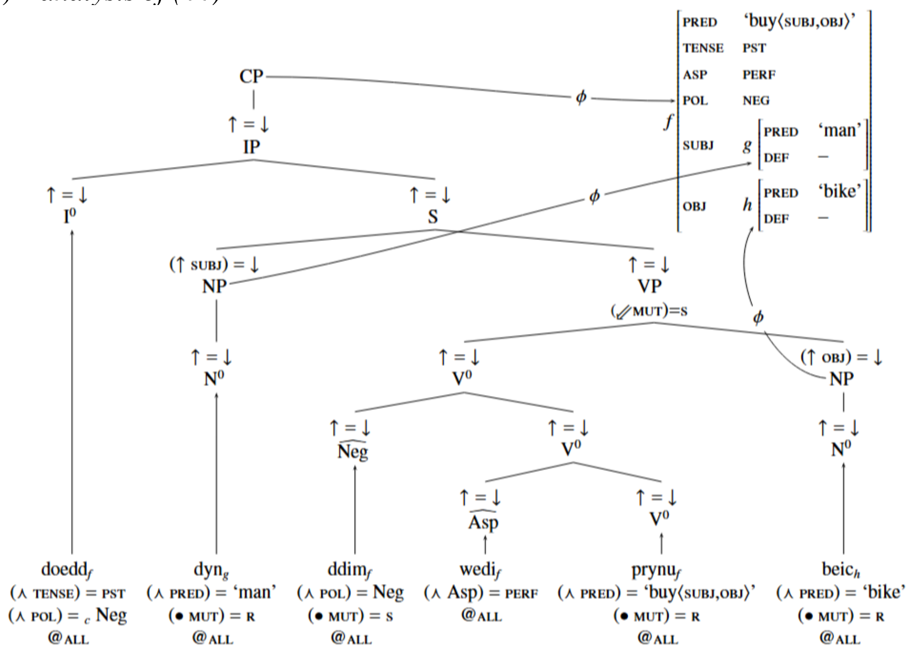


Other elements that appear at the left-edge of the VP, such as the negation marker *ddim* overtly show the predicted soft mutation:

(44) Doedd dyn ˢddim wedi prynu beic
NEG.be.IMPF man NEG PERF buy.NF bike
'A man had not bought a bike.'

[12]In this and all subsequent examples, I simplify the representations, setting aside the distinction between an s-string element (which is an AVM containing at least a form and mutation value) and a lexical entry which corresponds to it. I also include only particularly pertinent parts of lexical entries.

(45) *analysis of (44)*



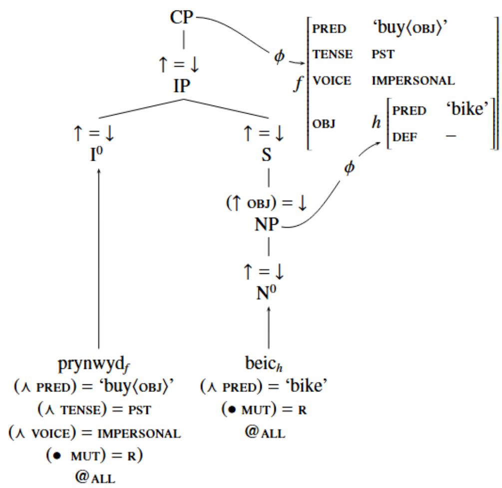
For the pair of impersonal sentences considered, the analysis successfully predicts the lack of mutation in (10) and the triggering of mutation in (11′):

(10) Pryn-wyd beic.
buy-PST.IMPRS bike
‘A bike was bought.’

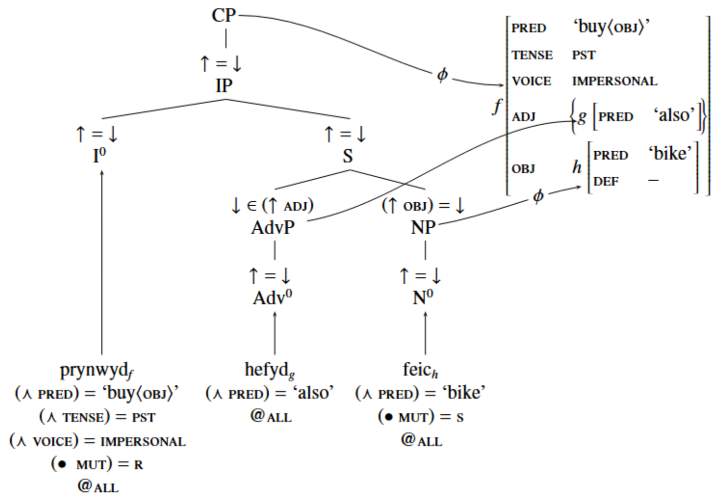
(11′) Pryn-wyd hefyd ^{S}feic.
buy-PST.IMPRS also bike
‘A bike was also bought.’

I assume that impersonal verbs only select for an object, which is a fairly standard assumption in Welsh syntax based on the agreement behaviour of the argument (Borsley et al. 2007: 232). This object appears before XP (here, VP), and is therefore not subject to the (⫽ MUT) = s constraint: this is captured by the annotation on the NPs in the PSRs (38) and (40), which state that the OBJ appears before XP (VP) if there is no subject at f-structure, but inside XP (VP) otherwise. Hence the PSR (38) does not trigger mutation in either of these impersonal sentences.

(46) *analysis of (10)*



(47) *analysis of (11′)*



The differences arise from the interactions of word order and the @ALL template. In (10), *prynwyd* precedes *beic*. Since the f-structure of *prynwyd* (f) contains that of *beic* (h), the @ALL template on *prynwyd* does not trigger mutation on *beic*. However, in (11), *hefyd* precedes *feic*, and the soft-mutation trigger template *is* called by the @ALL template on *hefyd*, because *hefyd*'s f-structure is related to *feic*'s by the path ((ADJ ∈ f) SUBJ) = h. This illustrates the inclusion of optional ∈ in the path between f-structures specified in @ALL.

The behaviour of the adjunct in (11′), can be contrasted with that in (12′). The lack of mutation after the adjunct in (12′) is because the adjunct precedes the main predicate of the sentence, not an argument. The main predicate cannot be mutated by an adjunct in the sentence, because its f-structure contains that of the adjunct, and so the requirements in the @ALL template for calling the @S-TRIGGER template are not met. There is no need to posit a null blocking element or use Case to restrict the XP Trigger Hypothesis.

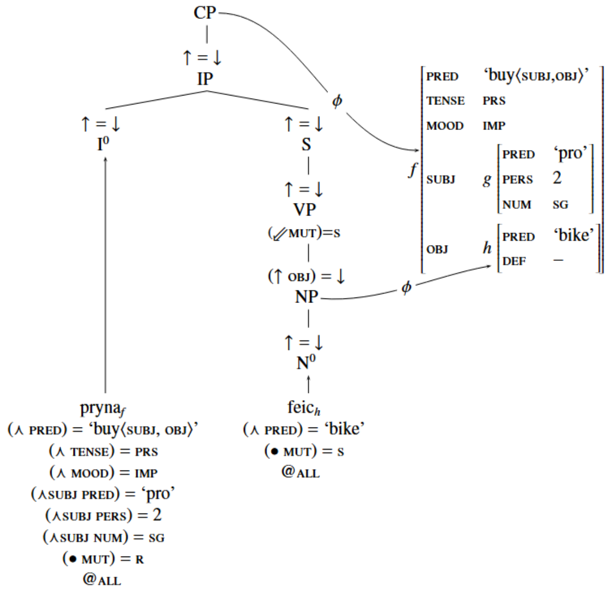
(12′) Yn sydyn, ᴿdechreu-odd y môr ˢferwi.
PRED sudden, start-PST the sea boil.NF
'Suddenly, the sea started to boil.' (Borsley et al. 2007: 230)

3.4.1 Mutation after empty subjects

In sentences where the subject is not overtly realised, the need for the PSR to also introduce mutation becomes apparent. For instance, in sentence (20), the (⫽ MUT) = S constraint in the PSR is the only thing that triggers the soft mutation of *feic*, due to the lack of any subject in the string.

(20) Pryn-a ˢfeic.
buy-IMP.2S bike
'Buy a bike.'

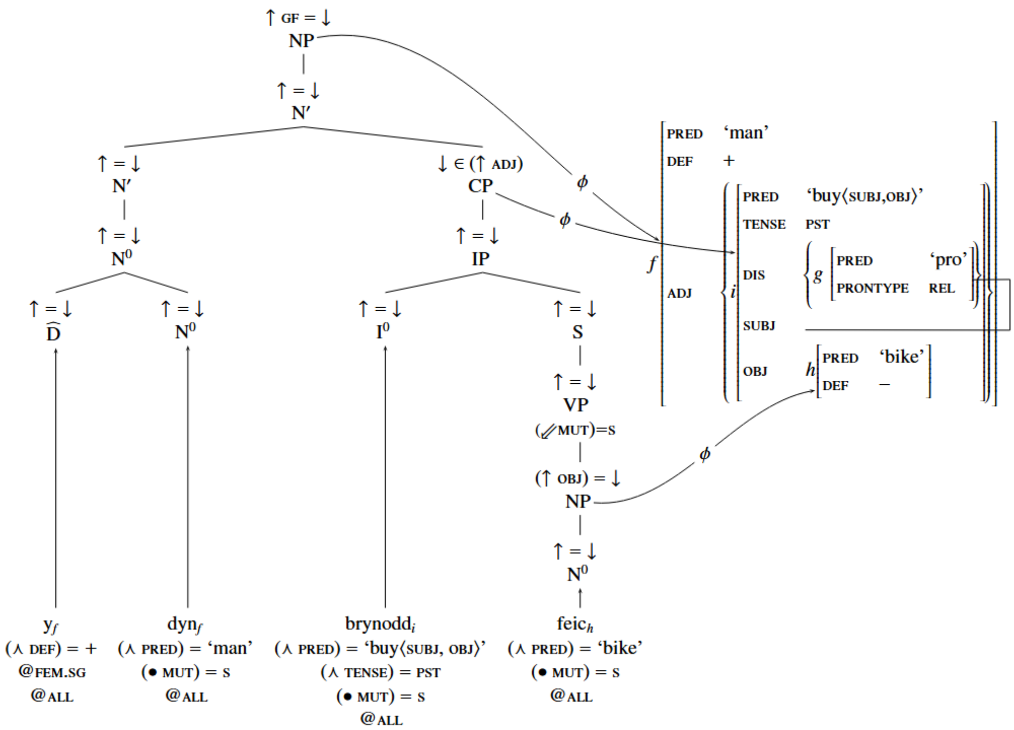
(48) *analysis of (20)*



The PSR also triggers the mutation in sentence (22):

(22) Y ^{S}dyn [^{S}brynodd ^{S}feic]...
the man buy-PST bike
'The man who bought a bike...'

(49) *Analysis of (22)*



As with the above null subject example, the mutation on *feic*, is triggered by the left-edge constraint on the VP in (38), and not by *brynodd*, since the f-structure of *brynodd (f)* contains that of *beic (g)*.

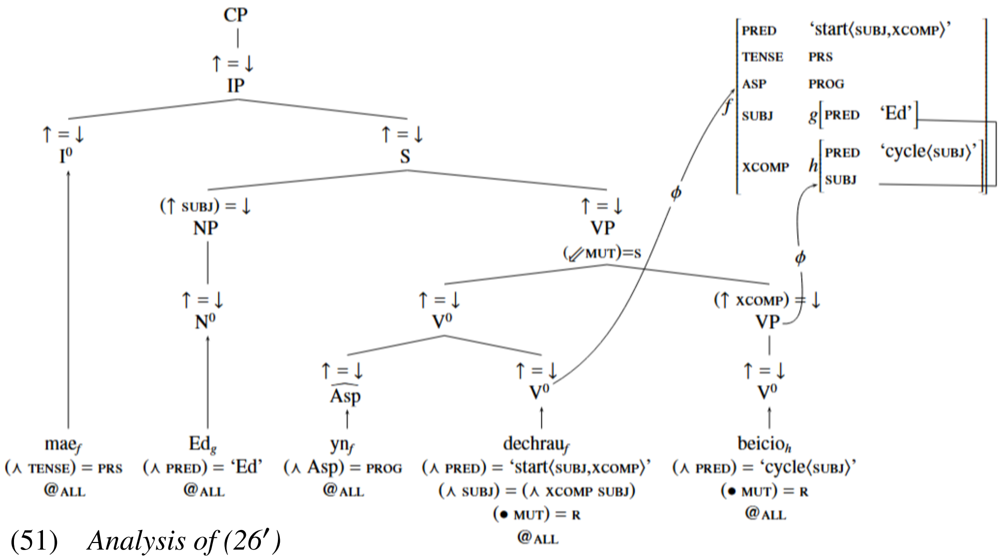
3.4.2 PRO and NP-trace

Recall that LFG does not posit the existence of either PRO or NP-trace. In sentences like (23) and (24), the reason for the lack of mutation is that a VP embedded in another VP does not bear the (⫽ MUT) = S annotation; this is captured by rule (40). In contrast, the verb *feicio* in (26) is subject to this annotation because it falls at the left-edge of the highest VP, which is embedded in S and thus governed by rule (38). It also mutates because the path from *Ed*'s f-structure to *feicio*'s f-structure in (26′) is ((SUBJ ∧) XCOMP) = ≻, meaning @ALL calls @S-TRIGGER. There is no such path in (24′).

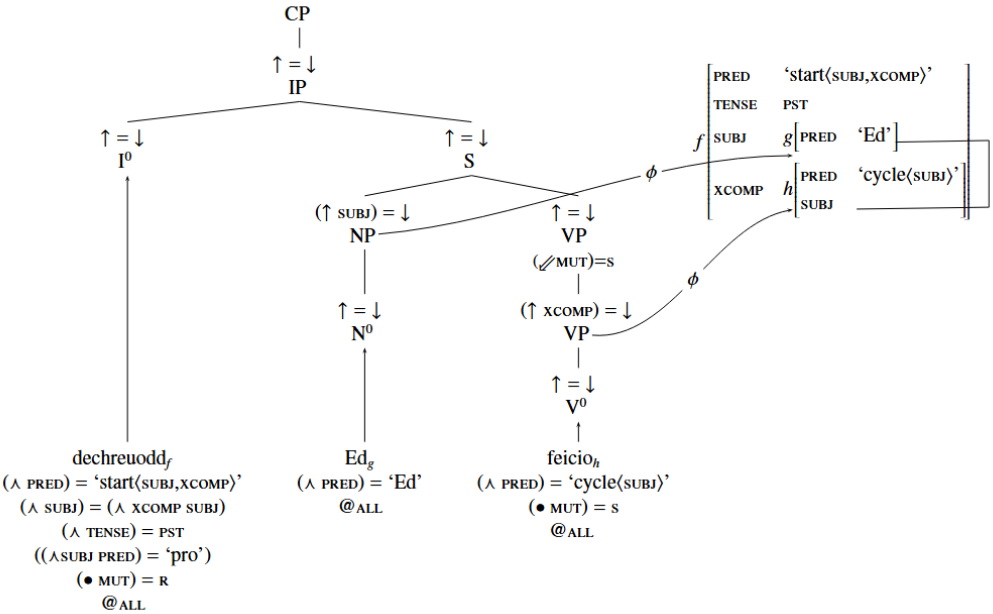
(24′) Mae Ed yn dechrau beicio.
be.PRS Ed PROG start.NF cycle.NF
'Ed starts to cycle.'

(26′) Dechreuodd Ed ^S^feicio.
start.PST Ed cycle.NF
'Ed started to cycle.'

(50) *Analysis of (24′)*



(51) *Analysis of (26′)*



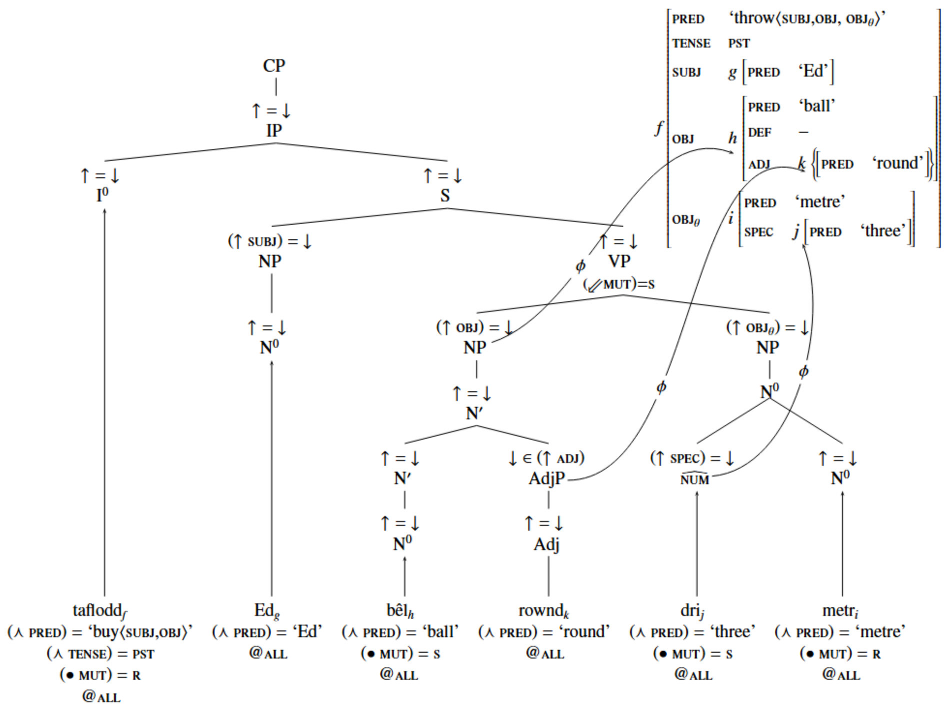
The LFG analysis proposed here thus does not rely on the presence of empty phrases that are required in other theories, because the PSRs and the @ALL template successfully account for the data. The insight of this analysis is that only one of two possible requirements must be met for soft mutation to be triggered: a particular (f-)structural relationship with a preceding word or a particular position in the sentence.

3.4.3 Multi-argument verbs

The @ALL template is also useful in dealing with multi-argument verbs, the mutation facts for which the existing LFG analysis does not cover. Consider the following example:

(52) Taflodd Ed ^{S}bêl rownd ^{S}dri metr.
throw-PST Ed ball round three metre
'Ed threw the round ball three metres.'

(53) *Analysis of (52)*



As is by now familiar, the object's mutation is triggered by the @ALL on the subject, and by the PSR for the VP (XP). The mutation on *dri* is triggered by the @ALL called on *rownd*.

3.4.4 Adjuncts and coordination

This LFG analysis does not face a problem with the lack of mutation by one conjunct or adjunct to another in its set, because of the requirement that the @S-TRIGGER template only be called when the next word's f-structure does not belong to the same set as the current word's f-structure:

(16′) Bwytais i ^{S}fara, $^{\mathbf{R}}$menyn, a ^{A}chaws.
eat-PST.1s 1s bread butter and cheese
'I ate bread, butter and cheese.'

(15′) bwrdd mawr $^{\mathbf{R}}$crwn ^{R}brenin
table big round king
'a king's big round table'

Recall that the lack of mutation on the possessor is part of the @S-TRIGGER template, and is therefore part of a more general rule.

3.4.5 Interrogative CPs

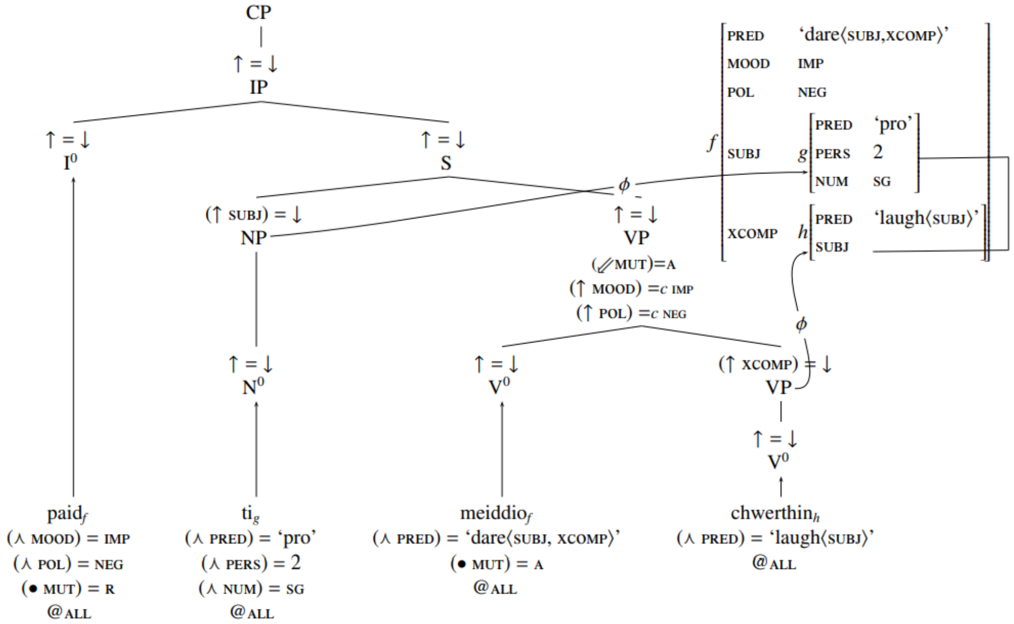
Interrogative CPs are considered separately to non-interrogative CPs in the PSRs above; unlike non-interrogative CPs, they are not one of the possible instantiations of XP. This gives us the mutation facts in (27) without the need to propose an empty blocking element. At some point an association between interrogative CPs and lack of mutation was established, and new generations of (native) learners list such CPs separately to XP in (38) because it is not subject to the soft mutation requirement.

Tallerman (2006) reports that some speakers soft-mutate interrogative CPs. This suggests that not all speakers now distinguish two types of CPs as shown in this fragment. For some speakers, all CPs are subject to the XP generalization, and thus they have acquired a simpler S rule (38) and definition of XP (39).

3.4.6 Negative imperatives

The explanation for the aspirate mutation on verbs after the subject in negative imperatives is very similar. The VP in a negative imperative is not part of XP, and so not subject to the (⫽ MUT) = S constraint; instead it has its own (⫽ MUT) = A constraint. The @ALL template provides no competing soft-mutation requirement, because *meiddio* is treated as the main predicate, with *paid* simply contributing mood and polarity information. This has the result that the f-structure to which *meiddio* projects contains that of the preceding word, the subject *ti*, preventing @ALL calling @S-TRIGGER and thus avoiding a clashing value. Hence, although the word order of the negative imperative is superficially similar to a control context like (26) (finite verb – subject – lexical verb) the mutation facts are different, because it is only in the control sentence that the lexical verb is positioned inside XP (and thus has mutation imposed on it by the PSR in (38)), and only in this sentence that it is subject to the @S-TRIGGER template via @ALL, because there is no raising structure for an auxiliary like *paid*, compared to a control verb. In the negative imperative, the PSR imposes aspirate mutation instead.

(54) *Analysis of (28)*



4 Conclusions and future directions

This analysis captures the mutation facts of Welsh using well-established formal tools within the LFG framework, such as PSRs and templates. The latter formally abbreviate information that is repeated across lexical entries. Significantly for the LFG framework, this account shows that empty phrases are not necessary to account for mutations in Welsh; instead PSRs such as that in (38) trigger relevant mutations. Furthermore, by listing certain categories which sit outside XP in the S rule in (38), it is possible to avoid positing sometimes otherwise-unmotivated empty categories in the structure to absorb a predicted mutation.

In terms of future research, a question arises as to whether the f-structural relationship required by the @ALL template, or perhaps sub-parts of it like the 'lack of containment' relationship, i.e. $(f\ (\text{GF}\ (\in))^{*}) \neq g \wedge (g\ (\text{GF}\ (\in))^{*}) \neq f$, or the 'not in same set' relationship, i.e. $(\in f) \neq (\in g)$, have more general applications or not. Lack of containment, in one direction, i.e., $(f\ \text{GF})^{*} \neq g$, is specified in the f-command relation (and true in the second direction, i.e., $(g\ \text{GF})^{*} \neq f$, but redundant) (Dalrymple et al. 2019: 238–240), but is here extended to deal with members of sets. The 'not in same set' relation, or its complement, 'same-set membership', may be useful because it distinguishes the relationship between adjuncts and conjuncts in a set from that between say, a subject and object, or object and oblique. The full relationship specified in @ALL has some parallels to XP boundaries without repeating them directly (recall the lack of boundary between the subject and main predicate in (54), for example). Although not essential, it would certainly lend further weight to the analysis presented here if it could be shown that the relationship specified in @ALL, which is not unlike f-command in some respects, is applicable in other analyses. I leave this matter to future research.

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The syntax-prosody interface in LFG: Revisiting Korean question focus

Stephen M. Jones
University of Groningen

Yoolim Kim
Wellesley College

Cong Zhang
Newcastle University

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Abstract

This paper sets out two challenges to LFG analyses of the syntax-prosody interface—one general, one specific—arising from experimental evidence that shows considerable hearer variation in the interpretation of specific prosodic patterns in Korean that are canonically associated with the scope of question focus. We assume that this arises from a lexical preference for the question word reading of content pro-forms that are ambiguous between question words and indefinite pronouns, which has an effect on how pitch contours are perceived. A revised formal treatment of the phenomenon, building on Jones (2016) is presented, which robustly handles the variation in hearer perception and links to ongoing work to model hearers' decision-making process.

1 Introduction

Prosody is widely held to play a crucial role in disambiguating different readings of identical strings in Korean, including differentiating between statements and questions, and distinguishing content from polar questions.[†] However, new evidence (Jones et al. under review) suggests that the canonical account of Korean prosodic disambiguation does not always hold. An experiment that started by trying to more precisely specify the amount of F0 variation required for a hearer to register focus, turned out to open up a wider question regarding the assumptions on ambiguity. In this paper we propose an analysis that revises the definition of the prosodic characteristics of question focus given in Jones (2016), and which is amenable to variation in hearer comprehension.

In the following sections, we give a brief overview of the phenomenon, of various accounts of the prosodic characteristics used to disambiguate, and of LFG accounts that incorporate prosody into analyses. We then present experimental evidence before detailing the revised account.

2 Background

Written sentences in the Korean polite speech style, marked by the sentence-final particle *-yo*, are ambiguous between declarative, imperative, interrogative and propositive moods. Canonically, this ambiguity disappears in the spoken language (see e.g. Jun & Oh 1996). Specific utterance-final tunes distinguish between declarative and interrogative mood: Jun (2005) describes declarative mood as being marked by a HL% tune[1], whereas interrogative mood is marked with an LH% tune. Within interrogative mood, there is consensus that content and polar questions are distinguished prosodically, but the exact nature of these differences is still the subject of investigation and debate.

When combined with content pro-forms (CPFs)—words that are ambiguous between content question words (wh-words) and indefinite pro-forms—the resulting sentence has statement, content question, and polar question readings (1).

[†]We thank Jacolien van Rij for her assistance and advice in building the statistical models. We also thank two anonymous reviewers and the editors, especially Jamie Findlay, for their comments and suggestions, which have substantially improved the analysis.

[1]In the description of tones, H and L stand for high and low tones respectively. % indicates the boundary of an utterance, so HL% is an utterance-final HL tone sequence, or tune.

(1) *hakchangsicel ttay nwukwu-lul mollay sarangh-aysse-yo*
school.days during who/someone-OBJ secretly love-PST-POL

a. "You secretly loved someone when you were at school."[2] (statement)
b. "Who did you secretly love when you were at school?" (content question)
c. "Did you secretly love someone when you were at school?" (polar question)

2.1 Korean prosody

Jun (2005) gives an account of Korean prosody in which prosodic phrases are marked by characteristic tone patterns at their left and right edges, with phrase-final lengthening. Jun's model includes syllables, prosodic words, accentual phrases (AccP) and intonational phrases (IntP). For this analysis, the AccP and IntP are most important: Jun claims that prosodic words are unmarked, with no evidence for lexical stress. Within prosodic structure, AccPs are nested inside IntPs in line with Selkirk's (1984) Strict Layer Hypothesis. However, the boundaries of prosodic constituents are not constrained by syntactic constituent boundaries: a syntactic phrase with many syllables may be split between AccPs, and these AccPs may also cover parts of adjacent syntactic phrases.

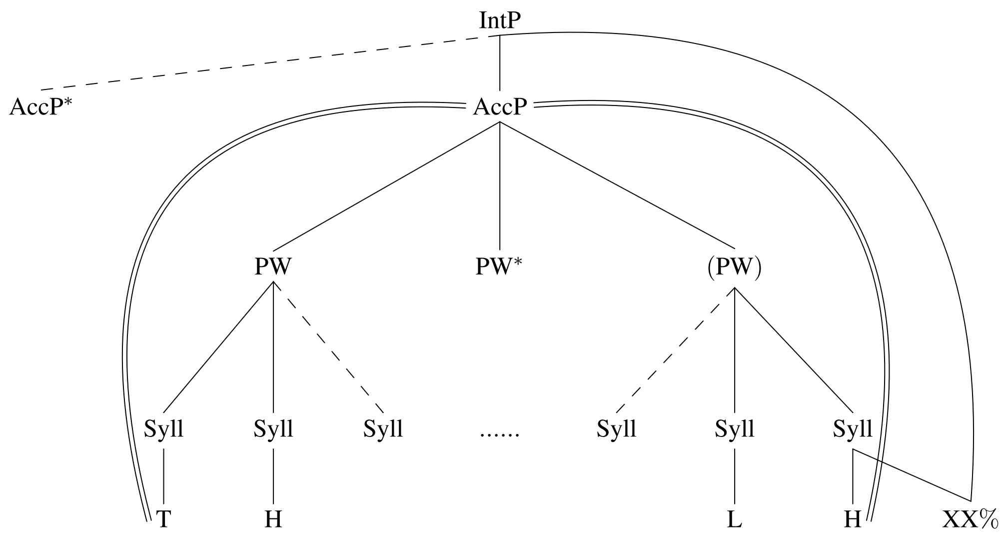

Figure 1: General intonation structure of Korean, including prosodic hierarchy, proposed by Jun (2005: 205). T represents either an H or L tone, phonologically conditioned by the onset of the first syllable. An IntP-final boundary tune, represented here as XX%, replaces the final H of the last AccP in an IntP

2.2 Accounting for the phenomenon

Accounts of the phenomenon rest on two assumptions: a difference in scope of focus between the two question types, and a characteristic prosodic pattern that is associated

[2]Glossing abbreviations follow the Leipzig Glossing Rules apart from POL, which indicates the informal polite speech style. In all three translations, the subject of the utterance is unspecified and pragmatically determined; we have given 'you' as an example.

with the presence of focus. Following Dalrymple & Nikolaeva (2011) we assume that polar questions have broad focus: the whole of the proposition expressed by the question is at issue. Content questions show narrow focus: the CPF constrains the set of felicitous answers and so bears the question focus.

The various accounts of the disambiguation rest on a combination of prosodic characteristics including AccP boundaries (marked by characteristic tone patterns but not necessarily breaks), F0 values associated with focus, post-focus pitch compression, and the presence or absence of L tones within AccPs. The earliest account is that of Jun & Oh (1996), who propose that differences in the placement of AccP boundaries in relation to the CPF and the verb are the primary determiner, albeit with some observed differences in the nature of the final tone/tune (varying between H% or LH%).

Jones (2016) carried out a speech production experiment and observed raised F0 pitch spreading left from the right edge of the constituent holding question focus: within the CPF for content questions and at the verb for polar questions. Based on this, he proposed a prosodic feature EXPANDED PITCH RANGE.

In contrast to these approaches, Yun (2019) identified dephrasing after the CPF as the primary disambiguator. In experimental manipulations this was found to be more influential than the size of the F0 pitch peak at the CPF. Further experiments (Yun & Lee 2022) resulted in a more fine-grained view, identifying a larger number of contributory factors. A raised F0 pitch peak at the CPF was sufficient, but not necessary, for a question to be interpreted as a content question. For content questions, changing the final tone from LH% to H% increased the likelihood of the question being perceived as polar. And for polar questions, changing the final tone from H% to LH% and removing the L tone after the CPF increased the chance of being perceived as a content question.

2.3 LFG and prosody

LFG is capable of including prosodic structure within its modular framework. There are two current approaches: in this paper we are using the approach proposed by Dalrymple & Mycock (2011) and elaborated by Mycock & Lowe (2013). Details of the other approach (Bögel 2015, 2022) and a more detailed discussion of the history of LFG accounts of the syntax-prosody interface can be found in Bögel (2023).

In the approach first set out by Dalrymple & Mycock (2011) and subsequently elaborated by Mycock & Lowe (2013) and Dalrymple et al. (2019: 406 ff.), prosody and syntax are connected by a mutually constraining relationship between p-string elements (which have a functional relationship with the terminal nodes of p-structure) and s-string elements (which have a functional relationship with the terminal nodes of c-structure). All p- and s-string elements are assumed to have features L and R. Where the associated terminal nodes in p- or c-structure sit at the left or right edge of a constituent at any level of their containing structures, that information is captured in the sets that are the values of features L and R respectively.

Edge sets can also hold information about the prosodic or syntactic expression of information-structural features such as focus. Where a syntactic constituent corresponds to the scope of focus, the node representing that constituent holds a feature representing the exponence of syntactic focus. Language-specific cascade rules determine how the exponent feature is passed down the c-structure tree into the terminal nodes, such that it appears in an edge set of the left or right edge of the constituent. The mutual constraints between prosody and syntax are governed by the principle of Interface Harmony. This states that an utterance is well-formed if and only if the prosodic and syntactic exponents of an information structural attribute are contained in the the corresponding p-structure and s-string edge sets respectively.

In this model, prosodic exponence of focus is captured by rules that render acoustic information as abstract prosodic features. These prosodic features are linked with features representing the prosodic exponence of information-structure attributes such as focus. Again, language-specific rules determine which of the p-structure edge sets a prosodic exponent sits in.

2.4 LFG and Korean prosody

To date, the only attempt to provide an LFG account of the syntax-prosody interface in Korean is Jones (2016). His account followed Dalrymple & Mycock (2011) and Mycock & Lowe (2013) and assumed Jun's (2005) description of Korean prosodic structure. Based on a speech production experiment, he proposed the prosodic feature EXPANDED PITCH RANGE which was minimally present at the right edge of an AccP holding question focus, and which could spread left through the AccP. Variations in the point of onset of EXPANDED PITCH RANGE were seen as due to individual speaker variation, and because the critical edge set was the right edge of the AccP, the variation did not have a material effect on the account.

Jones's (2016) account is unsatisfactory because the nature of the proposed prosodic feature EXPANDED PITCH RANGE is not precisely specified. He presents evidence that shows regular pitch differences within the AccP hosting question focus, but does not address the the question of precisely what size of pitch range is needed for EXPANDED PITCH RANGE to be taken as present, compared with F0 variation in AccPs that do not exhibit the prosodic feature.

3 Experimental evidence

In an attempt to sharpen the definition of EXPANDED PITCH RANGE, the authors carried out a large scale ($n = 124$) online speech perception study. The experiment followed the gating paradigm, using stimuli where size of the natural F0 range had been artificially reduced in the regions of interest.

3.1 Method

The experimental task was to identify whether experimental stimuli were statements, content questions or polar questions, or whether it was not possible to tell. Twenty-one natural stimulus sets were generated from three-way ambiguous strings (statement/content question/polar question). These sets were then recorded in each of the variants with natural prosody by a native speaker of Seoul Korean. The natural stimuli for content and polar questions were then manipulated in Praat (Boersma 2001) using scripts derived from models provided by Lennes (2017) to vary the F0 contour in the region of interest, where Jones (2016) predicted that the prosodic feature EXPANDED PITCH RANGE would be found.

For content questions, the region of interest was the AccP containing the CPF: the difference between minimum and maximum F0 in this AccP was measured, and compared with the difference between the minimum and maximum F0 in the corresponding AccP in the statement. Natural pitch range expansion was then calculated as the difference between these two values. The F0 contour of the question stimulus was smoothed, and the pitch peak manipulated to produce variants with the F0 peak in the region of interest at 25%, 50% and 75% of the natural pitch range expansion.

For polar questions, the region of interest was the final AccP which contains the verb including the utterance-final LH% tune. Here, two pitch ranges were measured: the difference between maximum and minimum F0 during the verb stem, and the difference between maximum and minimum F0 during the the utterance-final tune. The F0 values for the content question were taken as the baseline (0% natural focus prosody), with the difference between the polar question and the content question taken as the natural pitch range expansion. Again, the pitch contours of the polar question stimuli were smoothed, and the pitch maximum was manipulated to create variants with F0 peaks at 25%, 50% and 75% of the natural pitch range expansion. Thus the three stimuli in a natural stimulus set resulted in a manipulated stimulus set of 11 stimuli (5 $\times$ content question, 5 $\times$ polar question, 1 $\times$ statement) for each of the 21 strings. The manipulated stimuli were then tested for acceptability with native speakers, with the mean acceptability score being 4.54 on a scale of 1 (low)–5 (high).

Once the manipulated stimulus sets had been created, all stimuli were segmented into incrementally-longer fragments following the schema in Figure 2. Thus for each stimulus within a stimulus set, there was a test item set of five audio files. The boundaries between segments mostly coincided with word boundaries apart from the boundary between segments 4 and 5, which was the boundary between the verb and the sentence-final particle *-yo*. This was done because the final particle carries the utterance-final tune (HL% for statements and LH% for questions), and we were interested to know whether participants distinguished questions from statements before hearing the categorical prosodic information.

	Segments				
	1	2	3	4	5
a.	*hakchangsicel ttay*				
b.	*hakchangsicel ttay*	*nwukwulul*			
c.	*hakchangsicel ttay*	*nwukwulul*	*mollay*		
d.	*hakchangsicel ttay*	*nwukwulul*	*mollay*	*saranghaysse-*	
e.	*hakchangsicel ttay*	*nwukwulul*	*mollay*	*saranghaysse-*	*yo*
	schooldays during	who/someone	secretly	loved	POL

Figure 2: Rows a.–e. show the iterated, incrementally lengthened presentation of a stimulus. After each presentation, participants were asked to identify the utterance—if they could—as a statement, a content question, or a polar question. The region of interest, where canonical prosodic expression of the scope of focus is found, is in segment 2 for content questions and in segments 4–5 for polar questions

The experiment was hosted on a JATOS server (Lange et al. 2015) and written using jsPsych (de Leeuw et al. 2023). Participants used their own computer equipment for the experiment. Participants were native speakers of Korean recruited using the participant recruitment service Prolific,[3] and were remunerated for their time at the rate of GBP 12 per hour. Test item sets were presented iteratively, with incrementally long fragments. After each fragment was presented, participants were asked to make a judgement on the type of stimulus. A Latin Square design was used so that each participant was exposed to only one item from each manipulated stimulus set, with the 11 variants counterbalanced across participants. Full details of the preparation of the stimuli and the experimental procedure are given in Jones et al. (under review).

Following Jones (2016), we predicted that for stimuli with 100% natural pitch range expansion, content questions would be disambiguated at segment 2 when expanded pitch range was heard at the CPF, and that polar questions would be disambiguated at segment 4, when expanded pitch range was heard at the verb. We also predicted a gradient effect of the reduction in natural pitch expansion, with accuracy decreasing and disambiguation taking place later in the utterance as the proportion of natural pitch expansion decreased.

3.2 Results

The results were analysed using R 4.3.2 (R Core Team 2023) and the packages *lme4* (Bates et al. 2015), *mgcv* (Wood 2017), and *itsadug* (van Rij et al. 2022). Generalised additive models (Hastie & Tibshirani 1990) were constructed separately for content and polar question data, with fixed effects of segment and of the proportion of natural pitch range expansion present, and random effects of participant, item and order of presentation. For each type of question, pairs of models were constructed with and without an interaction between segment and the proportion of natural prosody present. For content questions, the model without an interaction was preferred, whereas for polar questions the model with an interaction was preferred. Further details of the statistical analysis are available in Jones et al. (under review) and the study results suggest that other factors are in play.

Figure 3 shows that statements were successfully disambiguated from questions, and that this took place at the final particle *-yo*, which was marked by the utterance-final tune. This provides further evidence in support of Jun's (2005) widely-accepted description of the HL% and LH% utterance-final tunes as being the defining prosodic characteristic of statements and questions respectively. The relationship between correct disambiguation and distance through the utterance is non-linear: there is a small though not-significant reduction in accuracy at the second segment, which is the CPF.

Summary plots of the preferred statistical models for content and polar questions are shown at Figures 4 and 5 respectively. The findings are not in line with the predictions and so do not support the hypothesis derived from Jones (2016) about the nature of EXPANDED PITCH RANGE.

Figure 4 shows that content question stimuli were ultimately disambiguated successfully. However, this was only at the final segment. There was no successful disambiguation at the CPF, and although the level of successful disambiguation rose as

[3] https://prolific.com

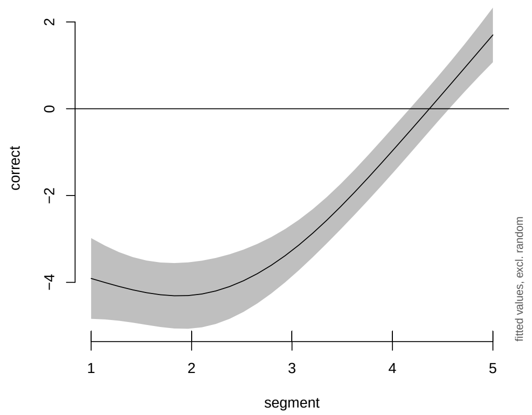

Figure 3: Disambiguation of statement stimuli. X-axis = region of stimulus: 1 = opening constituent; 2 = CPF; 3 = adverbial; 4 = verb; 5 = final particle *-yo*. Y-axis = log odds of successful disambiguation: 0 = chance

participants heard more of the stimuli, it was only at segment 4 that these reached chance level. Throughout the presentation, there was no significant difference in the levels of disambiguation, regardless of the proportion of natural pitch range expansion that was present. Even with 0% of natural focus prosody, with the CPF having the same pitch range as that of a natural polar question, the stimuli were interpreted as content questions.

Figure 5 shows the corresponding results for polar question stimuli. Here, a gradient effect of prosody was seen, with an interaction between the proportion of natural pitch range expansion and segment. For stimuli with full natural pitch range expansion, the chance of successful disambiguation increased more rapidly than for stimuli with 0% of the natural pitch range expansion. However, even where 100% of the natural pitch range expansion was present, correct disambiguation only occurred at chance levels at the final particle *-yo*: thus the speaker's intent to communicate a polar question was inconsistently perceived by participants. For the variants with a lower proportion of natural pitch range expansion, stimuli were always significantly likely to be incorrectly disambiguated.

Figure 6 shows the final response given by participants to polar question stimuli. For levels of natural pitch range expansion below 75%, participants significantly misidentified the stimuli as content questions. For 75% and 100% of natural pitch range expansion, there was no significant difference between the correct identification and misidentification as a content question. In other words, even without the pitch range expansion at the CPF, which is canonically associated with content questions, and in the absence of natural pitch range expansion at the verb, which is canonically associated with polar questions, participants showed a preference to interpret a polar question as a content question. Where pitch range expansion was present at the verb, this was not enough for participants to significantly prefer the canonical interpretation as a polar question.

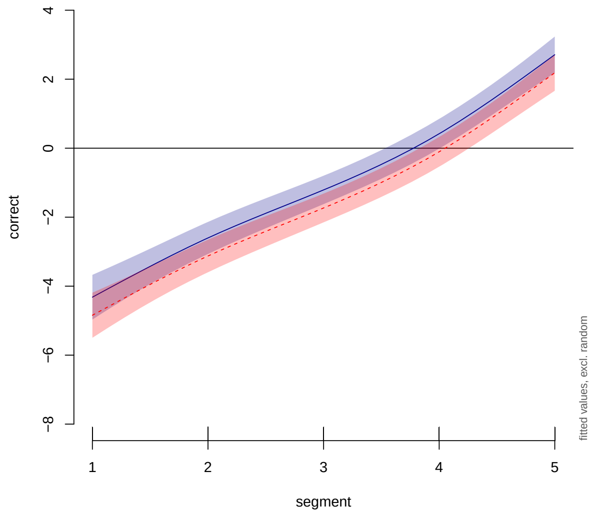

Figure 4: Disambiguation of content question stimuli. X-axis = region of stimulus: 1 = opening constituent; 2 = CPF; 3 = adverbial; 4 = verb; 5 = final particle *-yo*. Y-axis = log odds of successful disambiguation: 0 = chance. Solid blue = 100% and dashed red = 0% of natural pitch range expansion respectively

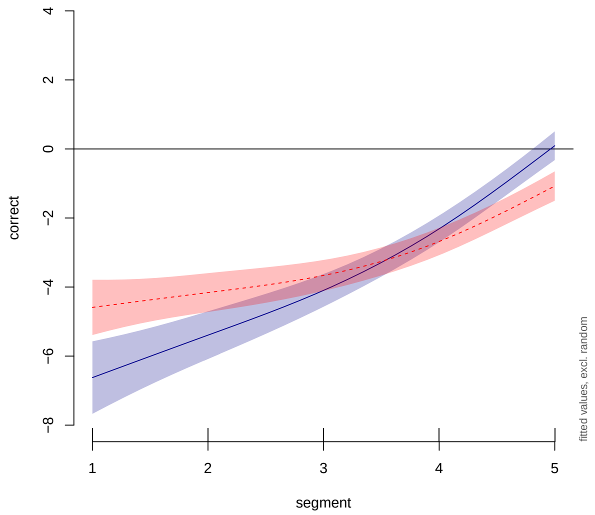

Figure 5: Disambiguation of polar question stimuli. X-axis = region of stimulus: 1 = opening constituent; 2 = CPF; 3 = adverbial; 4 = verb; 5 = final particle *-yo*. Y-axis = log odds of successful disambiguation: 0 = chance. Solid blue = 100% and dashed red = 0% of natural pitch range expansion respectively

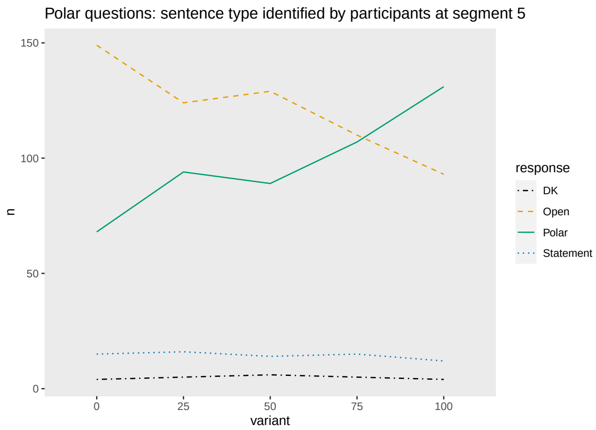

Figure 6: How participants identified polar questions once the full utterance had been heard. X-axis = percentage of natural pitch range expansion. Y-axis = number of responses. Green/solid = correctly identified as a polar question. Yellow/dashed = incorrectly identified as a content question. Blue/dotted = incorrectly identified as a statement. Black/dot-dash = don't know

In a small proportion of trials, less than 10%, participants identified the stimuli as statements: we assume that they did not hear the final LH% tune. For space reasons, detailed analysis of this is excluded from this paper. Fewer than 1% of trials were not assigned to any of the categories

3.3 Interim discussion

Our results show great variation, and while in line with the broad direction of Yun & Lee (2022), they deviate from the canonical view of the relation between prosody and meaning in Korean. Why might this be? There are of course individual differences between experimental participants, but the presence of the observed effects despite the large number of participants suggests that there is something more happening than just a noisy system. Our experiment was large-scale, which may enable patterns to be seen that were not detectable in smaller samples. We also accessed participants online rather than in a controlled laboratory environment: while this can build in variation, it may also more closely reflect the conditions under which language is used day-to-day.

One possible explanation is that there is a lexical bias towards the question-word reading for the relevant CPFs. This is difficult to determine from corpus studies because of the ambiguity between readings, but there is some supporting evidence. For example, the dic.daum.net online dictionary lists the question-word meaning before the indefinite pro-form for all of the words used in our experiment.[4] If this is the case, then it may trigger an early preference among hearers, which may be imperfectly cancelled by the presence of raised levels of F0 at the verb for those polar question stimuli with 100% natural prosody, and which cannot be cancelled for the manipulated stimuli with lower levels of prosody at the verb. This bias may also be present for only some hearers, rather than universally.

[4]Checked 2024-01-24.

4 Challenges to existing LFG work

These results show an ambiguity that all accounts must address, in that the same measurable input (text plus F0 contour) can be interpreted categorically differently by different hearers. In the case of our data, an F0 peak above declination[5] at the CPF is sufficient for interpretation as a content question, but not necessary. Conversely, an F0 peak above declination at the verb is necessary, but not sufficient, for a polar question reading.

Specifically, our results challenge the account proposed by Jones (2016). His specification assumed a definition of a prosodic feature EXPANDED PITCH RANGE that minimally was present at the right edge of the focused constituent and could optionally spread left through the constituent, but which did not appear to the right of the focused constituent. However, for content questions with natural prosody, the right edge of an AccP is not always aligned with the right edge of the focused syntactic constituent. Early attempts to manipulate stimuli such that F0 expansion ended at the right edge of the syntactic constituent were rejected as unnatural by hearers. Acceptable F0 manipulations created a contour with an F0 peak within the AccP with smooth slopes to the AccP boundaries at either side. The presence of a syllable-linked F0 peak is in line with Yun & Lee (2022) and formally has similarities with Mycock & Lowe's (2013) approach to focus linked to English nuclear pitch accent, despite there being scant evidence for a nuclear pitch accent in Korean outside focused contexts.

Jones's account also assumed that the prosodic contribution to the analysis was similar whether EXPANDED PITCH RANGE was associated with the CPF or the verb. The differential conditions for content and polar questions with respect to the relationship between prosodic expression and hearers' interpretation of the string suggest a differential analysis. If CPFs do indeed have a lexical bias towards a content question reading, as discussed in Section 3.3, a satisfactory account will incorporate this.

5 An LFG account

Modelling participants' responses is a conundrum: an optional question-word reading for the CPF must be available, but this must be constrained to prevent overgeneration. The proposed account still assumes the prosodic feature EXPANDED PITCH RANGE proposed by Jones (2016) but this is now defined as being expressed at the F0 maximum of an AccP, rather than minimally at its right edge. There are three new elements: a revised c-structure rule for question focus that makes an explicit link between the presence of a syntactic exponent of question focus and the discourse function FOCUS at i-structure; a revised p-structure rule for the EXPANDED PITCH RANGE feature that associates it with the non-initial H tone in the relevant AccP; and a lexical specification with two alternative entries for indefinite CPFs, the choice of which is constrained at f-structure.[6]

[5]Declination is the tendency for the height of F0 peaks to reduce over the course of an utterance in the absence of other prosodic marking (Ladd 2008).

[6]This proposal using f-structure features is one possible solution: an analysis using p-string elements may provide a more elegant solution and is the subject of further research.

5.1 C-structure rules

Phrase structure rules (2)–(4) are adapted from Cho & Sells (1995) who assume no maximal phrasal projections. In Cho & Sells' rules, the combinatorial possibilities of words are constrained by a feature TYPE, whose value is determined by the particles that attach to the root. Words of any category with TYPE: V-SIS can attach as the left sister of a verb, and words of any category with TYPE: N-SIS can attach as the left sister of a noun. Thus the verb *mekta* 'eat', whose root is *mek*, can host the past tense complementiser *un* with TYPE:N-SIS to modify a noun, e.g. *mek-un sakwa* 'an apple that was eaten', or the tenseless complementiser *e* with TYPE:V-SIS to modify a verb, e.g. *mek-e bota* 'to try to eat'.

Cho & Sells' rules assume only one level of projection in Korean phrases and because they see no evidence for a specifier in Korean syntax, they denote the maximal projection as X′. They take V′ to be the root node of c-structure, but for the purposes of this analysis, which includes cascade rules, we are assuming a root node S. In the full analysis, the type constraints have been omitted for clarity.

(2)
$$\text{S} \rightarrow \begin{array}{c} \text{X}' \\ \text{TYPE: V-SIS} \\ (\uparrow \text{GF}) = \downarrow \end{array} \quad \begin{array}{c} \text{V}' \\ \text{TYPE: NO} \\ \uparrow = \downarrow \end{array}$$

(3)
$$\begin{array}{c} \text{N}' \\ \text{TYPE: Y-SIS} \\ \uparrow = \downarrow \end{array} \rightarrow \begin{array}{c} \text{X}' \\ \text{TYPE: N-SIS} \\ (\uparrow \text{GF}) = \downarrow \end{array} \left\{ \begin{array}{c} \text{N}' \\ \text{TYPE: Y-SIS} \\ \uparrow = \downarrow \end{array} \middle| \begin{array}{c} \text{N} \\ \text{TYPE: Y-SIS} \\ \uparrow = \downarrow \end{array} \right\}$$

(4)
$$\begin{array}{c} \text{V}' \\ \text{TYPE: Y-SIS} \\ \uparrow = \downarrow \end{array} \rightarrow \begin{array}{c} \text{X}' \\ \text{TYPE: V-SIS} \\ (\uparrow \text{GF}) = \downarrow \end{array} \left\{ \begin{array}{c} \text{V}' \\ \text{TYPE: Y-SIS} \\ \uparrow = \downarrow \end{array} \middle| \begin{array}{c} \text{V} \\ \text{TYPE: Y-SIS} \\ \uparrow = \downarrow \end{array} \right\}$$

5.2 P-structure rules

The p-structure rules (5)–(8) are repeated from Jones (2016) and originally derived from Jun (2005). The rule for prosodic words has been omitted because in Jun's account they play no role in marking phrase boundaries.

(5) Timing tier: p-structure
   a. IntP → AccP^{+}
   b. AccP → Syll^{+}

(6) Timing tier: final syllable lengthening
   Syll → Syll: / ___#

(7) Intonation tier: edge tones
   a. IntP → ___%##
   b. AccP → #TH___LH#

(8) Intonation tier: assimilation of IntP final tones
   H → Ø/ ___%##

5.3 Question semantics

The c-structure and p-structure rules for question semantics are as follows. For the purposes of this paper, we assume that an umbrella abstract notion of ‘question semantics’ can represent both content and polar question semantics: developing a full glue account that builds on the contributions from Mycock (2006) for content questions and Dalrymple et al. (2019: 422) for polar questions is left for future work. Rule (9) amends rule (16) from Jones (2016), stating that, if present, the syntactic exponent of question semantics **Sem_Qsem** appears within the value of R in the rightmost s-string element of the utterance; the feature CLTYPE with value INT is added to f-structure, indicating an interrogative clause; and the i-structure $\uparrow_{\sigma\iota}$ must have a value for its FOCUS attribute. An S constituent where this holds will include the abbreviated meaning constructor **Qsem** in its s-structure. Rule (10) ensures that the prosodic exponent of question semantics is within the value of the R feature of the rightmost AccP in an IntP, where that IntP has the boundary tune LH%.

(9)
$$\text{S} \rightarrow \quad \text{X}' \qquad \begin{pmatrix} \text{V}' \\ \textbf{Sem\_Qsem} \in (\searrow \text{R}) \\ (\uparrow \text{CLTYPE}) = \text{INT} \\ (\uparrow_{\sigma\iota} \text{ FOCUS}) \end{pmatrix}$$

(10)
$$\text{IntP} \rightarrow \quad \text{AccP*} \qquad \begin{array}{c} \text{AccP} \\ (\% = \text{TONE LH}) \Rightarrow \\ \textit{Sem\_QSem} \in (\searrow \text{R}) \end{array}$$

5.4 Question focus

Syntactic and prosodic rules for question focus, again following Jones (2016) and Mycock & Lowe (2013), are shown below. Rule (11) states that focus is present within a c-structure constituent where **DF_Focus**, the syntactic exponent of focus, is present within the value of the R attribute of its rightmost s-string element. It introduces the f-structure checking feature FOCUS-PROSODY with value +, which is used to constrain the choice of lexical entry for the CPF, discussed further in Section 5.5.

Rule (12) ensures that the s-structure information cascades along the right edge of the constituent headed by the maximal projection of the terminal node associated with the s-string element.

(11)
$$\Sigma \rightarrow \quad \Sigma^* \qquad \begin{pmatrix} \Sigma \\ (\uparrow \text{FOCUS-PROSODY}) = + \\ (\uparrow_{\sigma} \text{ DF}) = \text{FOCUS} \\ \textbf{DF\_Focus} \in (\searrow \text{R}) \end{pmatrix} \qquad \Sigma^*$$

(12)
$$\Sigma \rightarrow \quad \begin{array}{c} \Sigma^* \\ \left\{ (\uparrow_{\sigma} \text{ DF}) \neq \text{FOCUS} \;\middle|\; \begin{array}{c} (\uparrow_{\sigma} \text{ DF}) =_c \text{FOCUS} \\ (\uparrow_{\sigma} \text{ DF}) = \text{FOCUS} \end{array} \right\} \end{array}$$

Rule (13) revises rule (19) from Jones (2016). It specifies that expanded pitch range on the H pitch peak of the AccP is associated with the prosodic exponent of focus. The metavariable $\wr$ in ($\wr$ R) indicates that the prosodic exponent is associated with feature R of the syllable that it relates to, not to the edge of the containing AccP. Following Jones (2016), Interface Harmony in Korean can be satisfied by any of the p-string elements corresponding to an s-string element: the relevant p-string element does not need to be at the edge of a p-structure constituent.

(13)

$$\text{AccP} \rightarrow \text{Syll*} \quad \underset{\substack{[(\textsc{tone} = \text{H}) \wedge \\ (\textsc{pitch} = \textsc{exp})] \Rightarrow \\ DF\_Focus \in (\wr\ \textsc{r})}}{\text{Syll}} \quad \text{Syll*}$$

5.5 A lexical bias towards content question readings

The lexical bias of CPFs towards content question readings is modelled by the two alternative lexical specifications in (14), one with a baseline reading which assumes that focus is assigned prosodically, and one which assigns question focus to the CPF in the absence of prosodic support.

The baseline specification (14a) is always available. In the version that assigns question focus to the CPF, (14b), there are three additional constraints. In the f-description, the constraint $((\textsc{obj}\ \uparrow)\ \textsc{cltype}) =_c \textsc{int}$ prevents the question word reading from appearing in non-question utterances. In the p-form, the constraint $DF\_Focus \in (\wr\ \textsc{r})$ adds the feature of prosodic exponence, *DF_Focus*, into the right edge set of the AccP containing the CPF. This allows the exponent feature to appear in the p-form even if the prosodic feature as specified in rule (13) is not present, in turn allowing the constraint in (11) to be satisfied.

(14) a. Baseline lexical entry with ambiguous reading:

s-form	$(\bullet\ \textsc{fm}) =$	nwukwulul
c-structure category	$\lambda(\pi(\bullet)) =$	N [TYPE:V-SIS]
f-description	$(\uparrow \textsc{pred}) =$	'PRO'
	$(\textsc{obj}\ \uparrow)$	
p-form	/nuguɾɯl/	

b. Lexical entry with obligatory focus

s-form	$(\bullet\ \textsc{fm}) =$	nwukwulul
c-structure category	$\lambda(\pi(\bullet)) =$	N [TYPE:V-SIS]
f-description	$(\uparrow \textsc{pred}) =$	'PRO'
	$(\textsc{obj}\ \uparrow)$	
	$((\textsc{obj}\ \uparrow)\ \textsc{cltype}) =_c \textsc{int}$	
	$((\textsc{obj}\ \uparrow)\ \textsc{focus-prosody}) \neq +$	
p-form	/nuguɾɯl/	
	$DF\_Focus \in (\wr\ \textsc{r})$	

5.6 The analysis

The three cases—content question correctly identified, polar question correctly identified and polar question misidentified as a content question—can then be analysed using the proposal from Jones (2016), as amended in (9)–(14). All examples use sentence (1), repeated here.

(1′) *hakchangsicel ttay nwukwu-lul mollay sarangh-aysse-yo*
school.days during who/someone-OBJ secretly love-PST-POL

a. "You secretly loved someone when you were at school." (statement)
b. "Who did you secretly love when you were at school?" (content question)
c. "Did you secretly love someone when you were at school?" (polar question)

For clarity, in Figures 7–9, c- and p-structures for *hakchangsicel ttey* 'at school' have been simplified, adjuncts have been omitted from f-structure, and the mapping from s-structure to i-structure is not shown.

5.6.1 Content question

If EXPANDED PITCH RANGE is perceived to be present at the CPF, rule (13) applies to the AccP containing the CPF. This sets the value of f-structure feature FOCUS-PROSODY to be + and so prevents the use of lexical entry (14b). The question is interpreted as a content question because the feature **DF_Focus**, the syntactic exponent of focus, appears in the right edge set of the CPF constituent, satisfying the principle of Interface Harmony. Figure 7 shows the full analysis of sentence (1) with perceived pitch expansion at the CPF, resulting in reading (1b).

5.6.2 Polar question

If EXPANDED PITCH RANGE is perceived to be present at the verb, rule (13) applies to the final AccP of the utterance, again setting the value of f-structure feature FOCUS-PROSODY to be + and preventing the use of lexical entry (14b). In this case, the question is interpreted as polar, with the feature **DF_Focus** in the right edge set of the verb. Again, the principle of Interface Harmony is satisfied. Figure 8 shows the full analysis of sentence (1) with perceived pitch expansion at the verb, resulting in reading (1c).

5.6.3 Polar question misidentifed

We assume that misidentification of polar questions occurs because EXPANDED PITCH RANGE is not perceived at the verb. In this case, where there is still a final LH% tune, the utterance is interpreted as a content question. Rule (9) requires the discourse function FOCUS to be present at i-structure, without specifying which element should be in focus. However, rule (13) does not apply: without Interface Harmony the optional focus constraints in rules (11)–(12) cannot be applied. The c-structure rules do not provide a value for $(\uparrow_{\sigma\iota}$ FOCUS$)$ (mediated via s-structure) and the f-structure feature FOCUS-PROSODY is unspecified. In order to satisfy the requirement for focus from rule (9), lexical entry (14b) must be used, which in turn assigns question focus to the CPF using Interface Harmony. Figure 9 shows the full analysis of sentence (1) with no perceived pitch expansion, resulting in reading (1b) rather than the speaker's intention (1c).

6 Discussion

The rules above can generate a well-formed analysis whether or not EXPANDED PITCH RANGE is perceived at either the CPF or the verb. However, they do not explain why the variation in perception occurs. This paper does not seek to explore the wider issue of divergent speaker and hearer analyses: in our view it is sufficient to ensure that there are reasonable formal assumptions about the nature of the speaker and hearer experience that support a well-formed account. However the question remains why a substantial proportion of hearers perceived a content question even though the natural prosody associated with the production of a polar question was in the signal. The difference between our results and the canonical view merits further discussion and potentially further experimental exploration.

In the interim discussion, Section 3.3, the possibility was mentioned of an "early prediction, imperfect cancellation" strategy, linked to a lexical preference for the question-word reading of the CPF. If that is the case, then the gating paradigm, with its repetition of the earlier stimuli, may have reinforced the prediction. It seems that most participants understood the instructions as being only to give a judgement when they were certain what the type of utterance was, leading to a delay in identification. Most participants answered "don't know" until segment 4 had been heard. However, from segment 2, when the CPF was heard, through to segment 4, the verb, the second most frequent answer, for all proportions of natural prosodic range, was to identify the stimulus as a content question—see Jones et al. (under review) for more details. This provides tentative support for the idea of an imperfectly-cancelled prediction.

The algorithm used to manipulate the stimuli may also have introduced a confound. In a pilot attempt where the pitch was manipulated at many intermediate points, the manipulated stimuli were unintelligible and so we were advised to take a simpler approach. However, it is possible that the F0 contours, although tested for acceptability with native speakers, were oversimplified and that F0 contours are needed with more intermediate scaling points.

Further experimentation using refined stimuli could help to build an explanation, with two modes of stimulus presentation—the gating paradigm and entire utterances—and revised instructions asking participants to say as early as possible which type of utterance they think is the most likely, depending on what they have heard. If it appears that participants change their opinion during the course of the utterance (other than from "don't know" to one of the sentence types) the phenomenon would be amenable to incremental cognitive modelling.

7 Conclusion

We entered this project with the aim of sharpening our understanding of the relationship between F0 contours and meaning in otherwise ambiguous Korean sentences. Our data suggest not only that this relationship is different to and more complex than previous accounts would have it, but also that the canonical assumption of the central role of prosody in disambiguation is mediated by lexical factors. This merits further investigation. Our proposed analysis uses LFG's established techniques for dealing with ambiguity and allows perceptual differences between hearers to be included in a unified account.

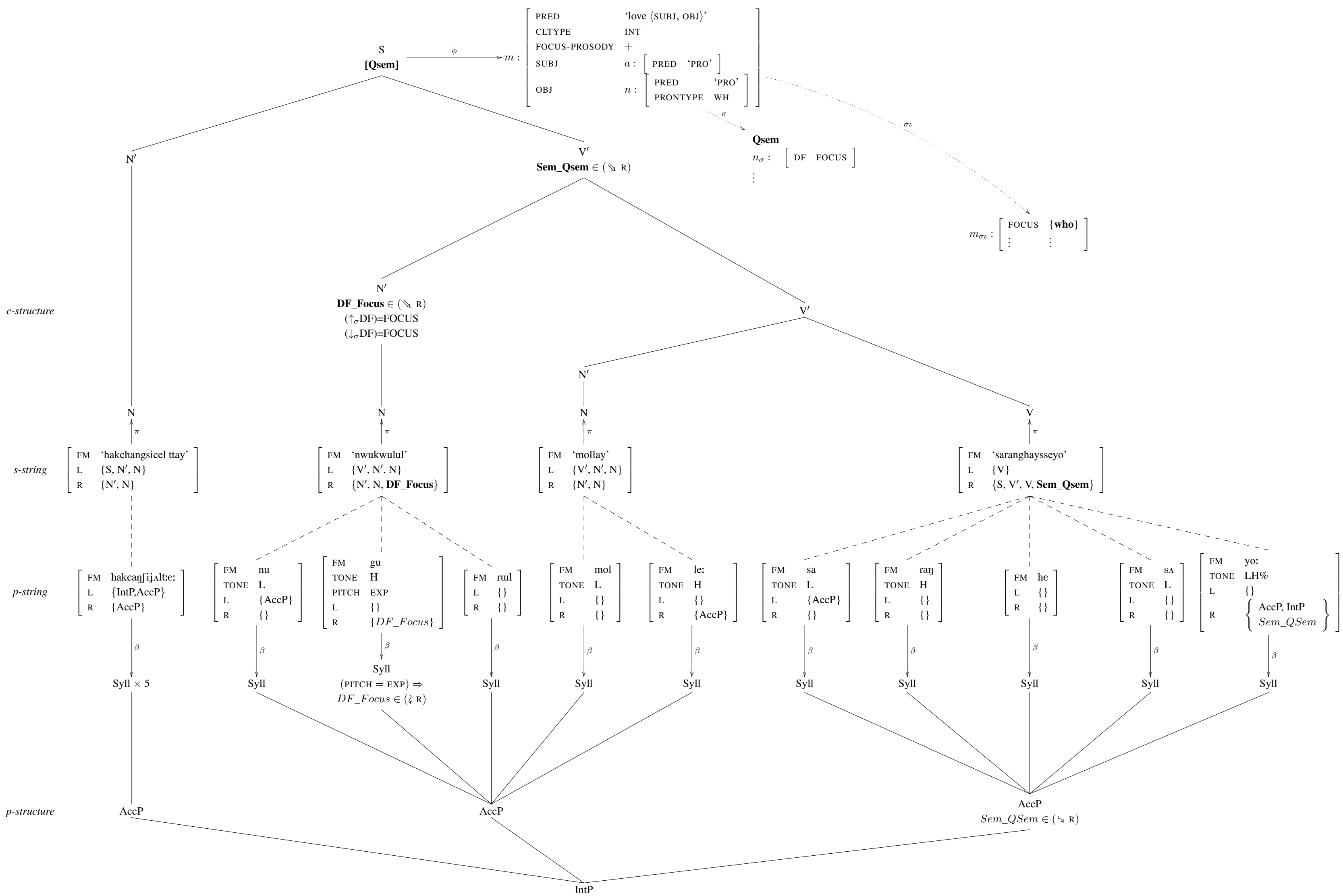

Figure 7: Content question: 'Who did you secretly love at school?'
Prosodic feature EXPANDED PITCH RANGE is perceived at syllable [gu] during the CPF *nwukwulul* 'who/someone', placing the prosodic exponent *DF_Focus* in the value of its R feature by rule (13). Interface Harmony requires the syntactic exponent **DF_Focus** in the value of the R feature of the s-string element 'nwukwulul'. Note that the right edges of N 'nwukwulu' and AccP [nuguruɯl molleː] do not align

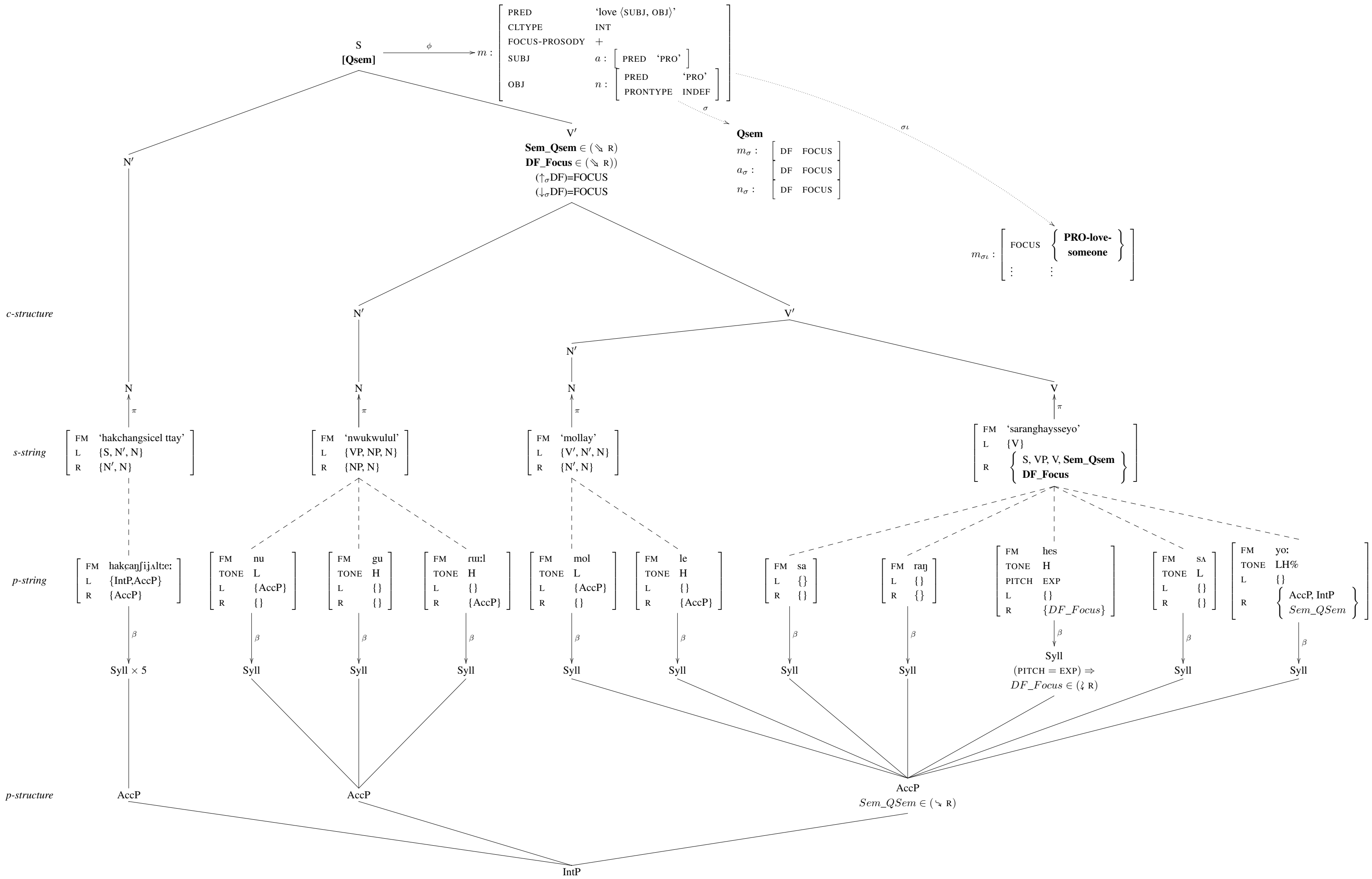

Figure 8: Polar question: 'Was there someone that you secretly loved at school?'
Prosodic feature EXPANDED PITCH RANGE is perceived at syllable [hes] during the verb *saranghaysseyo* 'who/someone', placing the prosodic exponent *DF_Focus* in the value of its R feature by rule (13). Interface Harmony requires the syntactic exponent **DF_Focus** in the value of the R feature of the s-string element 'saranghaysseyo'

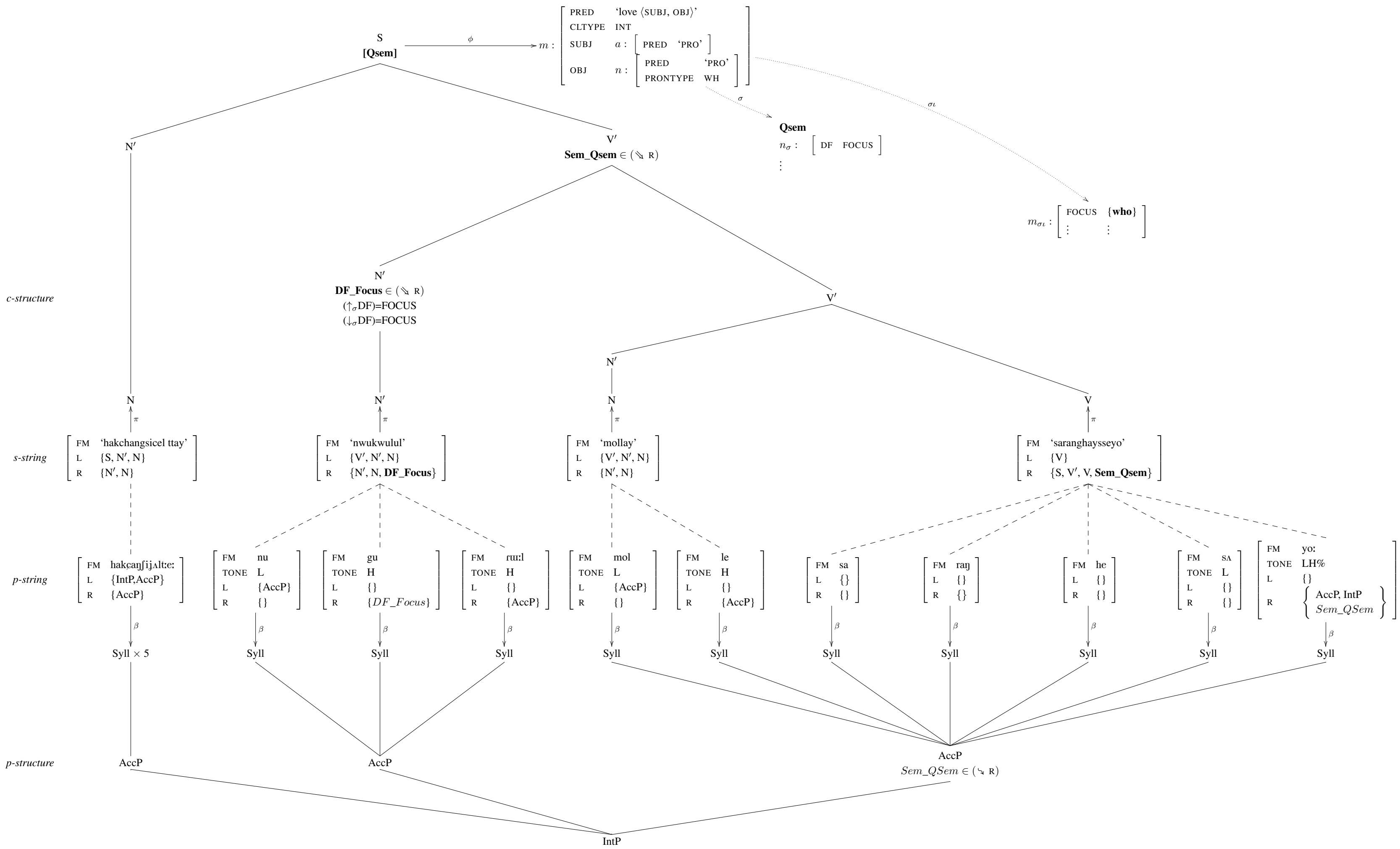

Figure 9: Polar question 'Was there someone that you secretly loved at school?' where EXPANDED PITCH RANGE during the verb is not perceived by the hearer so the question is incorrectly identified as a content question

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Coordination of unlikes in Turkish

Berke Şenşekerci
University of Warsaw

Adam Przepiórkowski
Institute of Computer Science,
Polish Academy of Sciences
University of Warsaw
Massachusetts Institute of
Technology

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Abstract

One widely accepted view posits that the grammaticality of a coordinate structure depends on its conjuncts having the same grammatical properties, such as case and syntactic category. Although this assumption has been repeatedly challenged, the debate still centers on limited data mainly from Polish and English. In this study, we further challenge the assumption that conjuncts must be alike with various corpus examples and judgments of native speakers. We analyze our findings within the framework of Lexical-Functional Grammar, following the approach proposed by Przepiórkowski & Patejuk (2021), and validate the analysis with an XLE implementation. Our results add to the growing body of research questioning the assumption that conjuncts must be alike.

1 Introduction

It is generally assumed that conjuncts must share the same syntactic category (Chomsky 1957: 35–36; Williams 1981: §2; Bruening & Al Khalaf 2020). However, this assumption is challenged by data that appears to contradict it, as shown in (1a–b).

(1) a. Pat is [[$_{\text{NP}}$ a Republican] and [$_{\text{ADJP}}$ proud of it]].
(Sag et al. 1985: 117, ex. (2b))

b. We walked [[$_{\text{ADVP}}$ slowly] and [$_{\text{PP}}$ with great care]].
(Sag et al. 1985: 140, ex. (57))

In an attempt to reconcile this assumption with conflicting evidence, two types of accounts have been proposed, both seeking to demonstrate that the categorical mismatch between the conjuncts is only superficial.

The first account suggests that examples like those in (1) involve coordination of same supercategories. In a recent development of this account, Bruening & Al Khalaf (2020) introduce the supercategories PRED(icate) for predicative phrases and MOD(ifier) for modifier phrases. Their analysis interprets the coordination of mismatching predicative arguments in (1a) as the coordination of the same supercategory PRED, as shown in (2a). Similarly, the coordination of unlike verbal modifiers in (1b) is understood to be the coordination of the same supercategory, MOD, as shown in (2b).

(2) a. Pat is [$_{\text{PRED:\{NP, ADJP\}}}$ [$_{\text{PRED:NP}}$ a Republican] and [$_{\text{PRED:ADJP}}$ proud of it]].

b. We walked [$_{\text{MOD:\{ADVP, PP\}}}$ [$_{\text{MOD:ADVP}}$ slowly] and [$_{\text{MOD:PP}}$ with great care]].

As Patejuk & Przepiórkowski (2023) point out, Bruening & Al Khalaf's supercategory analysis fails to account for corpus evidence that extends to various argument positions. Two such examples are found in (3), where the unlike conjuncts are the coordinated arguments of the verbs *believe* (see, (3a)) and *hope* (see (3b)).

(3) a. Xenocrates . . . believed [[$_{\text{CP}}$ that stars are fiery Olympian Gods] and [$_{\text{PP}}$ in the existence of sublunary daimons and elemental spirits]].
(Patejuk & Przepiórkowski 2023: 344, ex. (82))

b. We hope [[$_{\text{PP}}$ for another good year], and [$_{\text{CP}}$ that we continue to grow]].
(Patejuk & Przepiórkowski 2023: 346, ex. (95))

According to the second account (e.g., Beavers & Sag 2004; cf. Bruening & Al Khalaf 2020), ellipsis – specifically, some form of *conjunction reduction* – creates an illusion of a categorical mismatch between the conjuncts. For example, the apparent coordination of an NP and an AdjP in (1a), *a Republican and proud of it*, is actually a coordination of two VPs, with the repeated verb in the second conjunct, *is*, omitted, as shown in (4).

(4) Pat [$_{VP}$[$_{VP}$ is a Republican] and [$_{VP}$ ~~is~~ proud of it]].
(cf. Beavers & Sag 2004: 54, ex. (12a))

However, there are numerous examples that cannot be explained through such elliptical processes (see, e.g., Peterson 2004: 648–649; Levine 2011; Abeillé & Chaves 2021: 755–756; Patejuk & Przepiórkowski 2023: 330–336). For instance, in correlative structures involving conjuncts with different categories, as in (5a), it is unclear what the supposed underlying parallel coordination would be. Moreover, the fact that unlike coordination can be pseudo-clefted (see (5b)) suggests that it is a constituent, contrary to the predictions of the ellipsis account.

(5) a. This boycott would show [not only [$_{NP}$ unity] but [$_{CP}$ that there is a price to pay for killing us]].
(Patejuk & Przepiórkowski 2023: 335, ex. (41))

b. [Not only [$_{NP}$ our great unity in the face of oppression] but also [$_{CP}$ that there is a price to pay]] is what this boycott would show.
(Patejuk & Przepiórkowski 2023: 335, ex. (42))

Most recent work on coordination (e.g., Bruening 2023; Neeleman et al. 2023) acknowledges that unlike categories can be coordinated. However, other research, such as Fortuny (2024), remains skeptical of this conclusion. Consequently, the issue is still a topic of ongoing debate and controversy.

Another less-explored controversy surrounds the possibility of coordinating different grammatical cases, as exemplified by the Polish example in (6), where *wina*, an NP in genitive, is coordinated with *całą świnię*, an NP in accusative.

(6) Dajcie [wina i całą świnię]!
give wine.GEN and whole.ACC pig.ACC
'Serve (some) wine and a whole pig!'
(Przepiórkowski 1999: 175, ex. (5.269))

Weisser (2020) proposes a cross-linguistic generalization called the "Symmetry of Case in Conjunction," which asserts that the grammatical cases of conjuncts always match at a fundamental level, with apparent mismatches attributed to ellipsis and other surface-level morphological processes.

Challenging Weisser's generalization, Przepiórkowski (2022) provides multiple examples of order-independent case mismatches similar to the one in (6), with case morphologically realized on multiple words within each conjunct. Hence, there is also a lack of agreement regarding the possibility of coordinating NPs with mismatching cases.

Research on coordination of unlikes has been hindered by two empirical limitations. First, existing work has predominantly focused on Indo-European languages, with most of the discussion limited to English and Polish. Second, while recent work is to some extent based on data extracted from corpora, there appears to be no prior research on the coordination of unlikes supported by acceptability judgment experiments (but see Bruening 2023 and Przepiórkowski & Patejuk 2024 for recent related work).

The present work contributes to rectifying these two shortcomings. First, it explores Turkish, a non-Indo-European language. Second, it reports the results of both a corpus study and an acceptability judgment experiment, the details of which are outlined in §2 and §3, respectively. The results of our empirical findings corroborate the LFG analysis of the coordination of unlikes proposed in Przepiórkowski & Patejuk (2021) and Przepiórkowski (2022). Accordingly, the LFG formalization of Turkish coordination facts closely follows the approach developed in these works, as detailed in §4.

2 Corpus study

The corpus investigation relied on a large (3.3 billion words) morphosyntactically annotated Turkish corpus, Turkish Web 2012 (trTenTen12; Baisa & Suchomel 2012). A variety of CQL (Corpus Query Language) queries were formulated in SketchEngine (http://www.sketchengine.eu; Kilgarriff et al. 2014) to qualitatively identify instances of coordination involving unlike categories and cases. During the verification process, examples containing annotation errors or those resolved to like coordination due to suspended affixation were identified and rejected.[1]

2.1 Coordination of unlike categories

Table 1 provides an overview of the unlike category coordination configurations investigated in the corpus. We imposed a set of limitations on search patterns to minimize the number of false positives. For instance, NP & PP configuration tends to produce examples where the NP serves as the complement of the postpositional head that follows the second conjunct (i.e., [[NP & NP] P]). Similarly, AdjP & NP and AdvP & NP configurations typically produce false positives due to nominalizing suffixes that extend their scope over the entire coordination (see Akkuş 2016; Şenşekerci 2022), transforming the initial AdjP or AdvP conjuncts into NPs derived from adjectival or adverbial roots, respectively.

Out of a sample of 1687 results[2] from 227,177 hits, 137 were identified as true positives (TPs). Hence, 18,000–19,000 such TPs among all hits can be expected. The examples we confirmed[3] were mostly coordinations of predicates and adjuncts, similar to (1a)–(1b), but also coordinations of arguments, as in (7)–(8).

[1]Suspended affixation is a morphosyntactic phenomenon where an affix, or a series of affixes, found in the outermost conjunct takes phrasal scope over the entire coordination. In Turkish, this particular conjunct is the rightmost one, and the case suffixes are implicated in this process if the preceding conjunct(s) lacks case marking. This may lead to the false impression that conjuncts with different cases are coordinated.

[2]The imbalance in sample numbers across configurations is due to most queries generating an excessive number of duplicate or poorly annotated sentences. This necessitated a flexible adjustment of sampling rates for different queries.

[3]Unless otherwise stated, all Turkish examples presented in this paper are drawn from the Turkish Web 2012 corpus. For clarity, most examples have been simplified. Readers interested in the original examples can locate them in the Turkish Web 2012 by querying *only* the coordination parts of the examples.

Configuration	Hits	Sampled	TPs
PP & NP	173,774	527	33
PP & AdvP	1,523	240	20
PP & AdjP	25,272	240	29
NP & AdjP	26,318	390	29
NP & AdvP	290	290	26
Total:	227,177	1687	137

Table 1: General results of unlike category investigation in the corpus

(7) Bu program [[$_{NP}$ her hafta] ve [$_{ADVP}$ saat-ler-ce]] sür-ecek.
this program every week and hour-PL-ADVZ last-FUT
'This program will run every week and for hours.'

(8) Kolektör-ler sıklıkla [[$_{PP}$ antik enstrüman-lar hakkında] veya [$_{NP}$ ticari bilgi]] konuş-ur-lar.
collector-PL frequently antique instrument-PL about or commercial information talk-AOR-3PL
'Collectors frequently talk about antique instruments or commercial information.'

The verbal stem *sür-* in the sense of 'last/continue' combines with a temporal argument, whether it is an NP or an AdvP – or a coordination of such categories, as in (7). Similarly, the direct object of *konuş-* 'talk, speak' may be an NP or a PP headed by *hakkında* 'about';[4] (8) shows that this object may be realized by a coordination of such NPs and PPs. Such examples are analogous to attested English examples used in Patejuk & Przepiórkowski (2023) to argue against Bruening & Al Khalaf's (2020) attempt at explaining away coordination of unlikes, and they provide further evidence that coordinating unlike categories is possible across different languages.

2.2 Coordination of unlike cases

The investigation also extended to the coordination of unlike cases. Currently, the literature lacks consensus on the number of cases in Turkish due to the dubious morphosyntactic status of the bound morpheme *-(y)lA*, which is either classified as the cliticized form of the postposition *ile* 'with' (Lewis 1967; Kornfilt 1997), or an instrumental/comitative case marker (Göksel & Kerslake 2010; van Schaaik 2020). Our work aligns with more recent descriptive grammars of Turkish by Göksel & Kerslake (2010) and van Schaaik (2020) and acknowledges an instrumental/comitative case realized by *-(y)lA*.[5]

[4] *Konuş-* may also combine with another postposition, namely, *üzerine* 'upon/over', which will be considered in §4. However, we did not observe any instances of unlike category coordination with this postposition.

[5] As there is no empirical work confirming or refuting the existence of an instrumental/comitative case, it is possible that all NPs labeled as instrumental/comitative in this study could instead be classified as PPs projected by *ile*. In such a scenario, examples of unlike case coordination involving instrumental NPs would be reinterpreted as instances of unlike category coordination.

Ultimately, we recognize 6 grammatical cases in Turkish: accusative, genitive, dative, ablative, locative, and instrumental/comitative. As it makes sense to claim that unmarked nominals lack case altogether instead of bearing a specific (nominative) case (e.g., de Hoop & Malchukov 2008), they are not taken into account here.

We searched for patterns such as "NP-¬ABL & NP-ABL", where "NP-¬ABL" stands for an NP with a case suffix other than ablative. The outcomes of these searches are detailed in Table 2.

Configuration	Hits	Sampled	TPs	Breakdown of TPs
NP-¬INS & NP-INS	9,524	140	30	26 × LOC & INS, 4 × ABL & INS
NP-¬ABL & NP-ABL	8,437	140	5	3 × LOC & ABL, 2 × INS & ABL
NP-¬LOC & NP-LOC	15,709	140	15	13 × INS & LOC, 2 × ABL & LOC
Total:	33,670	420	50	

Table 2: General results of unlike case coordination investigation in the corpus

Similar searches focusing on the other three overtly marked cases – accusative, genitive, and dative – only returned false positives, as is expected, given that true positives would involve coordination of different grammatical functions (e.g., an accusative direct object with a locative adjunct), which we hypothesize to be not allowed in Turkish.[6]

Among the results, including the ones in (9)–(11), 50 relevant examples were found in a 420-hit sample from the population of 33,670 hits. This suggests the presence of around 4,000 similar unlike case coordinations among all hits, indicating the availability of unlike case coordination.

(9) [Doğru yer-de ve doğru antrenör-le] çalış-ıyor-uz.
right place-LOC and right trainer-INS work-PRES.PROG-1PL
'(We) work in the right place and with the right trainer.'

(10) Proje-ye [doğru zaman-da ve doğru fiyat-tan] gir-di-m.
project-DAT right time-LOC and right price-ABL enter-PST-1SG
'I joined the project at the right time and at the right price.'

(11) Pamuk-lu çarşaf-lar-ı [yumuşak deterjan-la ve soğuk su-da] yıka-yın.
cotton-ADJZ sheet-PL-ACC soft detergent-INS and cold water-LOC wash-2P.IMP
'Wash the cotton sheets with mild detergent and in cold water.'

3 Acceptability judgment experiment

In order to validate the corpus findings, we conducted an acceptability judgment experiment with Turkish native speakers ($n = 48$) who assessed sentences on a 7-point Likert

[6]However, among the results of "NP-¬ABL & NP-ABL" there also was the following example of coordination of dative and ablative, which is marginal, but not entirely unacceptable according to our native speaker informants (n = 6).

(i) Öğretmen-im-le [aynı yön-e ve aynı yer-den] bak-mı-yor-uz.
teacher-POSS.1SG-with same direction-DAT and same place-ABL look-NEG-PRES.PROG-1PL
'My teacher and I do not look in the same direction and from the same place.'

scale ranging from –3 (completely unnatural) to 3 (completely natural).[7]

The recruitment primarily took place in Bursa Uludağ University in Turkey and the sample consisted mainly of undergraduate and graduate students (Mean age = 30.25 years). Most of the participants ($n = 40$) reported that they have acquired Turkish in a strictly monolingual environment. Notably, a significant number of them ($n = 18$) acquired Turkish in regions outside the recruitment region (Marmara Region).

The experimental hypothesis was that different categories and different cases may be coordinated in Turkish, as long as they express the same grammatical function. The experiment followed the repeated measures factorial design, and was broken down into two blocks, one for unlike categories, the other for unlike cases.

The category block adhered to a standard 2×2 factorial design with the two factors being category (same or different: LCAT vs. UCAT) and grammatical function (same or different: LF vs. UF). A similar design was intended for the case block, considering same or different cases (LCASE vs. UCASE) and grammatical functions (LF vs. UF) – however, here only three configurations were viable, excluding LCASE-UF, since in Turkish there is a rather consistent mapping between grammatical cases and grammatical functions (e.g., accusative NPs are always direct objects, so no examples of the coordination of accusative NPs bearing different functions could be constructed).

The study employed the token-set methodology (Cowart 1997), with 12 token sets for each block, i.e., with $12 \times 4 + 12 \times 3 = 84$ target sentences. The materials were divided into 4 surveys (following the Latin square procedure), each featuring 21 target sentences and supplemented with 22 uncontroversially grammatical or ungrammatical fillers. Each survey also included 3 practice sentences for participants to familiarize themselves with the survey platform.[8] Consequently, for each survey, there were 46 distinct sentences to be assessed, including the practice sentences.

3.1 Category block

In the 12 token sets in the category block, the crucial UCAT-LF tokens with coordinations of unlike categories involved different categories of adjuncts (9 examples, with different categories taken from: AdvP, NP, and PP), predicates (1 example of "NP & AP" coordination), and arguments (2 examples of "PP & NP" coordinations), including (12) below.

(12) Bu isyan-lar [[$_{PP}$ yıl-lar boyunca] ve [$_{NP}$ her gün]] sür-dü.
this rebellion-PL year-PL throughout and every day continue-PST
'These revolts lasted for years and every day.'

As can be seen in Figure 1, such tokens were judged relatively high on the average (Mdn = 2.5, M = 1.88, SD = 1.53), although somewhat lower than examples featuring fully parallel LCAT-LF coordinations (Mdn = 3.0, M = 2.45, SD = 1.10). However, this difference did not reach statistical significance ($p = .11$; LCAT-LF vs. UCAT-LF).[9] By

[7] We would like to express our gratitude to Katarzyna Kuś, Erkan Şenşekerci, and Szymon Talaga for providing assistance in the implementation of the experiment.

[8] The experiment was implemented and distributed through LimeSurvey (https://www.limesurvey.org/).

[9] All inferential statistics were conducted using linear mixed-effects models, fitted and analyzed in R (version 4.1.2; R Core Team 2021) with *lme4* (Bates et al. 2015) and *emmeans* (Lenth 2024) packages.

contrast, coordinations of unlike grammatical functions – both LCAT-UF and UCAT-UF – were judged dramatically lower (in both cases, Mdn $= -1.0$, M ≈ -0.8, SD ≈ 1.9, $p < .001$ with respect to UCAT-LF). In conclusion, the data suggests that Turkish permits the coordination of unlike categories but not unlike functions, under the assumption of binary grammaticality.

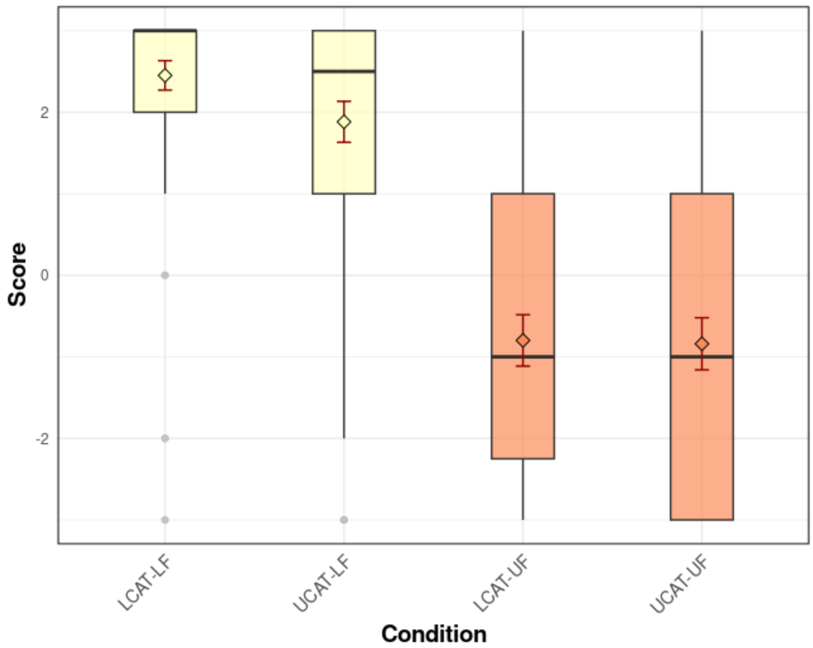

Figure 1: Raw scores of the category block stimuli by sentence type (x-axis), with 95% confidence intervals

3.2 Case block

Similarly, the 12 crucial sentences with unlike cases but the same adjunct grammatical function (see UCASE-LF in Figure 2) were analogous to those found in the corpus, i.e., they each involved two of the three cases typical for NP adjuncts: ablative, instrumental, and locative. For example, there were 4 sentences with coordinations of the type "NP-LOC & NP-ABL", including (13) below.

(13) Dünya-da-ki gelişme-ler-i [küçük yurt oda-m-da
world-LOC-ADJZ development-PL-ACC small dormitory room-1SG.POSS-LOC
ve internet-ten] takip ed-iyor-um.
and internet-ABL follow do-PRES.PROG-1SG
'I follow the developments in the world in my small dormitory room and over the internet.'

As is standard practice, participants and items were treated as random effects with random intercepts and slopes, while the experimental conditions were treated as fixed effects.

As can be seen in Figure 2, such UCASE-LF coordinations are judged (statistically significantly) lower than LCASE-LF coordinations with fully parallel conjuncts (LCASE-LF: Mdn = 3.0, M = 2.32, SD = 1.38; UCASE-LF: Mdn = 2.0, M = 1.58, SD = 1.71, $p < .001$ with respect to LCASE-LF). Nonetheless, the average acceptability becomes negative only in the case of coordinations with different grammatical functions (UCASE-UF; Mdn = −1.0, M = −0.37, SD = 2.04, $p < .001$ with respect to UCASE-LF). Therefore, assuming binary grammaticality, unlike case coordination must be considered grammatical in Turkish, in contrast to unlike function coordination.

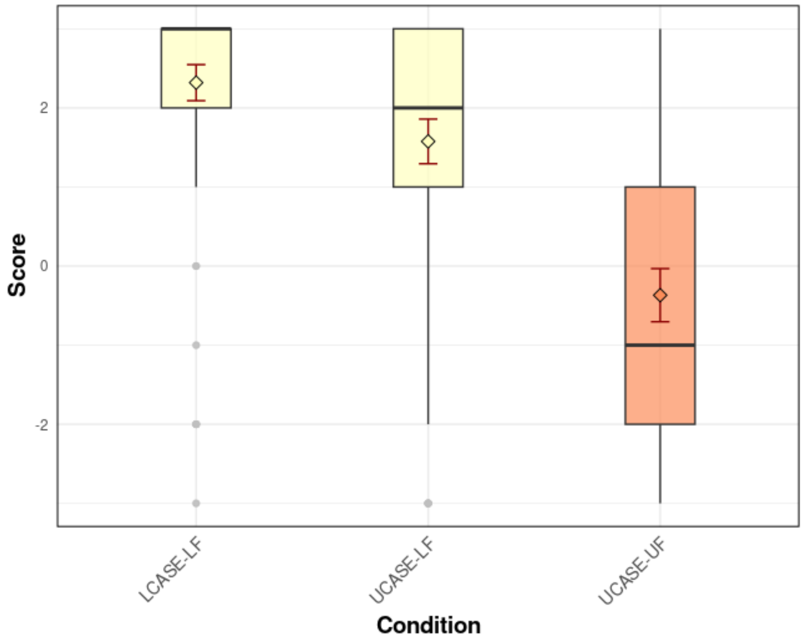

Figure 2: Raw scores of the case block stimuli by sentence type (x-axis), with 95% confidence intervals

In summary, the experimental findings reveal that Turkish allows for the coordination of unlike categories and cases but not unlike functions. We attribute the small difference between LCAT-LF and UCAT-LF in the category block and LCASE-LF and UCASE-LF in the case block to frequency factors on acceptability[10] (Bresnan 2007; Francis 2021) and/or unlike coordination being more difficult to process (Frazier et al. 2000).[11]

4 Formalization

4.1 Evaluating possible solutions

There are two recent LFG analyses of coordination of unlikes: Dalrymple (2017) (henceforth, D) and Przepiórkowski & Patejuk (2021) and Przepiórkowski (2022) (henceforth, P&P).

[10]We observed that fully parallel coordination is far more common in various Turkish corpora.

[11]Şenşekerci (2024) proposes a gradient analysis of the experimental results described in this section.

On D's analysis, syntactic category labels are replaced with feature matrices. For instance, nominal nodes conventionally denoted as N and NP are represented as [N +, V −, P −, ADJ −, ADV,−]. In coordinate structures, the feature matrix of the mother node that dominates the conjuncts aggregates the categorical information from each conjunct. For instance, a coordination of an NP and a PP, as in (8) or (12), yields [N +, V −, P +, ADJ −, ADV,−] as the ultimate category of the coordination.

Categorical restrictions imposed by predicates on their arguments are encoded through feature matrices coupled with the CAT predicate (Kaplan & Maxwell 1996) to specify the prohibited categories, allowing for the co-occurrence of permissible ones. To illustrate this, consider again the Turkish verb *konuş-* 'talk, speak'. The object of *konuş-* can either be an NP or a PP, as shown in the attested examples in (14) and (15), respectively. As illustrated in the previous section, NP & PP coordination (irregardless of order) is also possible in the object of position of *konuş-* (see (8)).

(14) Obama Kuzey Kore hakkında konuş-tu.
Obama North Korea about talk-PST.3SG
'Obama talked about North Korea.'

(15) Zengin ile Türk yemek kültür-ü-nü konuş-tu-k.
Zengin with Turkish food culture-3P-ACC talk-PST-1PL
'With Zengin, we talked about the Turkish food culture.'

Consequently, we would encode these restrictions by including the CAT predicate constraint from (16) in the lexical entry of *konuş-*. Notably, the feature matrix of the coordination between an NP and a PP, [N +, V −, P +, ADJ −, ADV −], would be compatible with this CAT predicate constraint since the prohibited categories are negatively valued.

(16) CAT((↑ OBJ), %C)
(%C V) = −
(%C ADJ) = −
(%C ADV) = −

P&P point out that it is not clear how to extend D's analysis to address more complex selectional restrictions targeting specific morphosyntactic and lexical properties. Consider the verb *believe*, which can combine either with a PP or a CP. However, as shown in (17), the PP must be projected by *in* (and not, for instance, *on*), while the CP must be projected by *that* (and not, for example, *until*).

(17) We all believe [[$_{PP}$ in/*on positive energy] and [$_{CP}$ that/*until what you give comes back]].
(Przepiórkowski & Patejuk 2021: 210, ex. (11))

The same issue arises in Turkish. (8) (repeated below as (18)) and (19) feature a PP & NP coordination that is the object of the verb *konuş-* 'talk/speak'. However, not just any NP or a PP is permitted in this position. The object NP must either be unmarked (indicating non-specificity), as in (18), or carry the accusative case marker (indicating specificity), as in (19).

(18) Kolektör-ler sıklıkla [[PP antik enstrüman-lar hakkında] veya [NP ticari
collector-PL frequently antique instrument-PL about or commercial
bilgi]] konuş-ur-lar.
information talk-AOR-3PL
'Collectors frequently talk about antique instruments or commercial information.'

(19) Kendi-si ile [[PP Sofya baş müftü yardımcısı Necati Ali hakkında] ve [NP
self-3P with Sofia chief mufti deputy Necati Ali about and
yap-tık-ları hizmet-ler-i]] konuş-tu-k.
do-PTCP-3PL.POSS service-PL-ACC talk-PST-1PL
'With him/her, we talked about Necati Ali, the deputy chief mufti of Sofia, and the services they provide.'

Additionally, the head of the PP must either be the postposition *hakkında* 'about', as in (18) and (19), or *üzerine* 'upon/over', as in (20). Hence, specifying the selectional restrictions of *konuş-* as [V −, ADJ −, ADV −] is insufficient.

(20) Sayın vali ile Ortadoğu-da-ki son gelişme-ler üzerine konuş-tu-k.
honorable governor with Middle East-LOC-ADJZ last development-PL over talk-PST-1PL
'With the honorable governor, we talked about the latest developments in the Middle East.'

A possible solution to D's account involves the introduction of complex categories, where the relevant morphosyntactic properties, such as case and the form of the postposition, are integrated into the category labels. This solution would entail representing the category of *hakkında* not as a simple P but as a complex category P[*hakkında*]. Similarly, the grammatical case of an NP would need to be encoded using complex categories. Since practically all Turkish grammatical cases are involved in unlike coordination, this would require 7 distinct nominal categories (including the non-marked form) in the form of NP[x], where x stands for a Turkish case.

Nonetheless, as highlighted by P&P, this solution is not without its shortcomings. First, it is in conflict with LFG's parallel correspondence architecture, where universal and abstract grammatical features, such as CASE, are represented in f-structure. The introduction of numerous complex c-structure categories that incorporate such information leads to significant redundancy with respect to information already present in f-structure. Second, even if complex categories were adopted, they would not guarantee comprehensive coverage. P&P substantiate this argument with Polish examples that illustrate how the case assignment for a nominal can vary based on the presence of negation, further complicating the complex category and CAT predicate analysis.

To address these limitations, P&P propose moving syntactic category information from c-structure (or l-structure; Lowe & Lovestrand 2020) to f-structure whereby syntactic categories are encoded as values of a distributive CAT attribute in f-structure. This allows for such complex selectional restrictions to be uniformly formulated as constraints on f-structure. Accordingly, the selectional restrictions of *konuş-* 'talk/speak' could be formalized as in (21), utilizing P&P's approach.

(21) $(\uparrow \text{OBJ}) = \%\text{C} \;\wedge$
$[\,[(\%\text{C CAT}) =_c \text{N} \wedge (\%\text{C CASE}) \in_c \{\text{NOM, ACC}\}] \;\vee$
$[(\%\text{C CAT}) =_c \text{P} \wedge [(\%\text{C PFORM}) =_c \text{HAKKINDA} \vee$
$(\%\text{C PFORM}) =_c \text{ÜZERINE}\,]]\,]$

According to this constraint, the f-structure associated with the OBJ(ect) of the predicate, which is assigned the local name %C, must either 1) have the N(ominal) CAT(egory) and either bear the NOM(inative) or the ACC(usative) case, or 2) have the P(ostpositional) CAT(egory) and be projected by either *hakkında* or *üzerine*.

Unfortunately, in case of coordination, this statement is assessed only once for the whole coordination object in vanilla LFG, rather than for each conjunct (each set member) separately – i.e., all conjuncts are forced to uniformly conform to one possibility, such as all conjuncts being PPs headed by *üzerine* or NPs in accusative.

To indicate that a constraint is to be evaluated for each conjunct (i.e., each set member), Przepiórkowski (2022) proposes the notation "%X: ϕ(X)" as an extension to the standard LFG framework. According to this notation, when the value of the local name %X is a set, the property ϕ has to separately hold for each set member.

Therefore, the statement in (21) should be revised with this notation as in (22) (preliminary version, further modified in (23)).

(22) $(\uparrow \text{OBJ}) = \%\text{C} \;\wedge$
$\%\text{C}\text{: } [\,[(\%\text{C CAT}) =_c \text{N} \wedge (\%\text{C CASE}) \in_c \{\text{NOM, ACC}\}] \;\vee$
$[(\%\text{C CAT}) =_c \text{P} \wedge [(\%\text{C PFORM}) =_c \text{HAKKINDA} \vee$
$(\%\text{C PFORM}) =_c \text{ÜZERINE}\,]]\,]$

4.2 Unlike arguments

The proposed constraint remains problematic as it allows for the coordination of nominative and accusative objects. Kalin & Weisser (2019) note that, in contrast to some other languages, such a coordination is ill-formed in Turkish and we confirm this observation through informal judgments from native speakers (and by failing to find such examples in corpora).

The choice of nominative or accusative in Turkish direct objects is relatively complex: it depends mainly on specificity (von Heusinger & Kornfilt 2005), but also on animacy (Krause & von Heusinger 2019) and affectedness (Kizilkaya et al. 2022). In line with much of the literature on such Differential Object Marking (DOM), we assume that – while the marking of the "strength" of the object depends to a large extent on semantic and discourse properties of particular NPs – what is marked as "strong" is the whole object, rather than individual NPs within it.

We propose to formalize this with the distributive binary feature DOM, with strong objects specified as DOM $+$, and weak as DOM $-$. When the object position is occupied by a coordinate structure, this feature distributes uniformly to all conjuncts, resulting in identical values for DOM.

Revised specifications of the selectional restrictions of *konuş-* are shown in (23). Given that either all conjuncts are DOM $+$, or all are DOM $-$, all nominal conjuncts must have the same CASE value, accusative or nominative, respectively.

(23) $(\uparrow \text{OBJ}) = \%\text{C} \quad \wedge$

$\%\text{C}: [\,[(\%\text{C CAT}) =_c \text{N} \wedge [[(\%\text{C CASE}) =_c \text{NOM} \wedge (\%\text{C DOM}) =_c -] \vee$
$[(\%\text{C CASE}) =_c \text{ACC} \wedge (\%\text{C DOM}) =_c +\,]]]$
$\vee \;\; [(\%\text{C CAT}) =_c \text{P} \wedge [(\%\text{C PFORM}) =_c \text{HAKKINDA} \vee$
$(\%\text{C PFORM}) =_c \text{ÜZERINE}]]\,]$

Crucially, this specification alone cannot ensure that all coordinated objects are either DOM $+$ or DOM $-$. This generalization must be encoded independently in the grammar. We propose to incorporate this generalization into the lexical entries of all Turkish predicates that take objects using the parametrized template TRANSITIVE, as demonstrated in (24).[12]

(24) $\text{TRANSITIVE(\_P)} \;\; \equiv \;\; (\uparrow \text{PRED}) = \text{`\_P}\langle\text{SUBJ, OBJ}\rangle\text{'}$
$(\uparrow \text{CAT}) = \text{V}$
$[\,(\uparrow \text{OBJ DOM}) = + \;\; \vee \;\; (\uparrow \text{OBJ DOM}) = -\,]$

This template guarantees that all coordinated objects are marked as either $+$ or $-$ due to DOM being a distributive attribute.[13] Ultimately, the lexical entry for the verb in (18), *konuşurlar* '(they) talk', would look as follows:

(25) *konuşurlar* X $@\text{TRANSITIVE(TALK)}$
$(\uparrow \text{SUBJ NUM}) = \text{PL}$
$(\uparrow \text{SUBJ PERS}) = 3$
$(\uparrow \text{TENSE}) = \text{AOR}$

$(\uparrow \text{OBJ}) = \%\text{C} \quad \wedge$
$\%\text{C}: [\,[(\%\text{C CAT}) =_c \text{N} \wedge$
$[[(\%\text{C CASE}) =_c \text{NOM} \wedge (\%\text{C DOM}) =_c -] \vee$
$[(\%\text{C CASE}) =_c \text{ACC} \wedge (\%\text{C DOM}) =_c +\,]]]$
$\vee \;\; [(\%\text{C CAT}) =_c \text{P} \wedge$
$[(\%\text{C PFORM}) =_c \text{HAKKINDA} \vee$
$(\%\text{C PFORM}) =_c \text{ÜZERINE}]]\,]$

Coordination of unlike arguments was also observed with the verbal stem *sür-* 'last/continue', which selects a temporal argument that can take the form of an AdvP, NP, PP, or a coordination of these categories, as exemplified in (26).

(26) Bu [[$_{\text{NP}}$ her gün] ve [$_{\text{ADVP}}$ yıl-lar-ca]] sür-dü.
this every day and year-PL-ADVZ last-PST
'This continued every day and for years.'

However, not all NPs or PPs can be the oblique argument of *sür-*. The relevant restriction appears to be that the NP must be in the nominative case – as changing the

[12]Since syntactic category labels are no longer represented on c-structure nodes in P&P's approach, the template also includes the f-description for the syntactic category, $(\uparrow \text{CAT}) = \text{V}$.

[13]As one reviewer noted, this template requires the DOM attribute to appear in PP objects as well. While this does not affect the empirical predictions of our analysis, it raises a broader question about whether PP objects need to be marked for "strength." Addressing this question, however, falls outside the scope of our paper. Therefore, we retain the current analysis and leave this issue for future research.

case of the nominal conjunct in (26) results in ungrammaticality – and the PP must be projected by either *boyunca* ‘throughout/during’, (see (27)), or *kadar* ‘until’ (see (28)).

(27) Organizasyon ilk- etap-ta üç yıl boyunca sür-ecek.
organization first stage-LOC three year throughout last-FUT
‘The organization will initially last for three years.’

(28) Kıbrıs ada-sı-nda bu Arap iktidarı 10. yüzyıl-a kadar sür-dü.
Cyprus island-3P-LOC this Arab rule 10th century-DAT until last-PST
‘This Arab rule on the island of Cyprus lasted until the tenth century.’

While no examples of unlike category coordination incorporating such PPs (i.e., [[PP & AdvP] *sür*-] or [[PP & NP] *sür*-]) could be found in the corpus, such environments, as illustrated in the constructed examples in (29) and (30), are still acceptable.

(29) Köy-de-ki düğün [[$_{\text{ADVP}}$ saat-ler-ce] ve [$_{\text{PP}}$ sabah-a kadar]]
village-LOC-ADJZ wedding hour-PL-ADVZ and morning-DAT until
sür-ecek.
last-FUT
‘The wedding in the village will last for hours and until the morning.’

(30) Toprak-lar-ımız-da-ki savaş [[$_{\text{PP}}$ mevsim-ler boyunca] ve [$_{\text{NP}}$ her gün]]
land-PL-1PL.POSS-LOC-ADJZ war season-PL throughout and every day
sür-dü.
last-PST
‘The war in our lands continued through the seasons and day after day.’

Accordingly, (31) captures the morphosyntactic constraints that *sür*- imposes on its oblique argument.

(31) $(\uparrow \text{OBL}) = \%\text{C} \;\wedge$
$\%\text{C}$: $[\,[(\%\text{C CAT}) =_c \text{N} \wedge (\%\text{C CASE}) =_c \text{NOM}] \;\vee$
$(\%\text{C CAT}) =_c \text{Adv} \;\vee$
$[(\%\text{C CAT}) =_c \text{P} \wedge [(\%\text{C PFORM}) =_c \text{BOYUNCA} \vee$
$(\%\text{C PFORM}) =_c \text{KADAR}]]\,]$

4.3 Unlike predicates

Turkish predicative arguments can be PPs, NPs, and AdjPs. As expected, there appears to be no prohibition against coordinating predicative arguments that have different syntactic categories, as evinced by the attested examples in (32a–c).

(32) a. [[$_{\text{NP}}$ Çok büyük bir proje] ve [$_{\text{ADJP}}$ çok masraf-lı]] ol-acak.
very big INDF.DET project and very cost-ADJZ be-FUT
‘This will be a very big project and very costly.’

b. Konuşma-lar-ınız [[$_{\text{PP}}$ hedef-e yönelik] ve [$_{\text{ADJP}}$ net]] ol-malı.
speech-PL-2PL.POSS goal-DAT towards and plain be-NECESS
‘Your speeches should be to the point and plain.’

c. Bu iş [[PP sevgi ile] ve [NP gönül-den]] ol-malı.
This job love with and soul-ABL be-NECESS
'This work should be done with passion and from the heart.'

In (32a), an NP, *çok büyük bir proje*, is coordinated with an AdjP, *çok masraflı*. (32b) involves a coordination of a PP, which is projected by *yönelik*, and an AdjP, while (32c) features a coordination of a PP and an NP.

Moreover, PP predicates can project with virtually any Turkish postposition. Some verified examples of these postpositional heads include *yönelik* 'towards', *ile* 'with', *kadar* 'until', *birlikte* 'together', *karşı* 'against', *göre* 'according to', *için* 'for', *gibi* 'like', *dolayı* 'due to'. Therefore, we can infer that the verb *ol-* 'be/become' leaves the PFORM attribute of its PREDLINK argument underspecified. Likewise, there appears to be no morphosyntactic constraint on predicative AdjPs.

By comparison, NPs are subject to restrictions: only the NPs that are in nominative, locative, ablative or instrumental cases can be predicates. This is because the remaining grammatical cases – i.e., accusative, dative, and genitive – rather consistently denote non-predicative functions in Turkish. The accusative case marks direct objects, while dative is used for oblique arguments and genitive for subjects of embedded clauses (van Schaaik 2020). The absence of corpus examples featuring accusative, dative and genitive nominals as predicates further reinforces this constraint.[14]

Thus, we formalize the relevant morphosyntactic constraints on predicative arguments as follows:

(33) $(\uparrow \text{PREDLINK}) = \%\text{C} \ \wedge$
$\%\text{C}: [\ [(\%\text{C CAT}) =_c \text{N} \wedge (\%\text{C CASE}) \in_c \{\text{NOM, LOC, ABL, INS}\}] \ \vee$
$(\%\text{C CAT}) =_c \text{P} \vee$
$(\%\text{C CAT}) =_c \text{Adj}\ ]$

4.4 Unlike adjuncts

Nominal modifiers can be any PP or AdjP with more specific morphosyntactic properties left underspecified. We formally model this observation with the c-structure rule in (34) that restricts the permissible categories in the nominal modifier position to PP and AdjP.

[14]Apparent counterexamples can be found in corpora, such as the one below:

(ii) Çocuk Ahmet'in ol-acak.
child Ahmet-GEN be-FUT
'(The) child will be Ahmet's.'

At first glance, a genitive NP, *Ahmet'in* "Ahmet's", appears to be the predicative argument of the verb *-ol* "be/become". However, *Ahmet'in* is not a genuine genitive NP, but a nominative NP where the possessed element (in this case, *çocuk* "the child") has been omitted, as illustrated below with the omitted element highlighted in italics:

(iii) Çocuk Ahmet'in *çocuğ-u* ol-acak.
child Ahmet-GEN child-3SG be-FUT
'(The) child will be Ahmet's child.'

(34) $X' \longrightarrow \underset{(\downarrow \text{CAT}) \in_c \{\text{P, Adj}\}}{\underset{\downarrow \in (\uparrow \text{ADJ})}{\text{XP}}} \quad \underset{(\downarrow \text{CAT}) =_c \text{N}}{\underset{\uparrow = \downarrow}{X'}}$

The vanilla LFG counterpart of this c-structure rule would be as in (35). Notably, this rule has to invoke the CAT predicate, as the disjunctive specification on the label alone, {PP | AdjP}, would not be sufficient to permit unlike coordination between these categories (see Przepiórkowski & Patejuk 2021 for details).

(35) $N' \longrightarrow \underset{\text{CAT}(\downarrow, \{\text{PP, AdjP}\})}{\underset{\downarrow \in (\uparrow \text{ADJ})}{\{\text{PP} \mid \text{AdjP}\}}} \quad \underset{\uparrow = \downarrow}{N'}$

Verbal items can be modified by any PP, any AdvP or an NP in the locative, ablative, or instrumental case. This observation is formalized with the c-structure rule in (36), which not only specifies the permissible categories for verbal modifiers but also imposes restrictions on the grammatical case when a nominal item fills the modifier position.

(36) $X' \longrightarrow \begin{array}{c} \text{XP} \\ \downarrow \in (\uparrow \text{ADJ}) \\ (\downarrow \text{CAT}) =_c \text{P} \vee \\ (\downarrow \text{CAT}) =_c \text{Adv} \vee \\ [(\downarrow \text{CAT}) =_c \text{N} \wedge (\downarrow \text{CASE}) \in_c \{\text{LOC, ABL, INS}\}] \end{array} \quad \begin{array}{c} X' \\ \uparrow = \downarrow \\ (\downarrow \text{CAT}) =_c \text{V} \\ \\ \\ \end{array}$

4.5 Implementation

We implemented the proposed formalization in XLE (Crouch et al. 2017) and verified it through 53 corpus-based sentences that included various configurations of unlike coordination, both well-formed ($n = 31$) and ill-formed ($n = 22$).

As discussed earlier, the solution proposed by Przepiórkowski (2022) extends the definition of distributivity to complex statements. Alas, the notation for representing distributive statements, "%X: ϕ(X)", is not supported in the current version of XLE.

The desired outcome (i.e., a complex statement that is evaluated separately for each set member) can be achieved in vanilla LFG – and consequently in XLE – by formulating such statements as off-path constraints (Przepiórkowski & Patejuk 2012). For example, the off-path equivalent of (33) (repeated here as (37)) would be (38), which is evaluated for each PRED containing f-structure that is the value of the PREDLINK attribute.

(37) $(\uparrow \text{PREDLINK}) = \%\text{C} \;\; \wedge$
$\%\text{C}\text{: } [\, [(\%\text{C CAT}) =_c \text{N} \wedge (\%\text{C CASE}) \in_c \{\text{NOM, LOC, ABL, INS}\}] \;\; \vee$
$(\%\text{C CAT}) =_c \text{P} \vee$
$(\%\text{C CAT}) =_c \text{Adj} \;]$

(38) $(\uparrow \text{PREDLINK} \quad \underset{[\,[(\leftarrow \text{CAT}) =_c \text{N} \;\wedge\; (\leftarrow \text{CASE}) \in_c \{\text{NOM, LOC, ABL, INS}\}] \;\vee\; (\leftarrow \text{CAT}) =_c \text{P} \;\vee\; (\leftarrow \text{CAT}) =_c \text{Adj} \;]}{\text{PRED}} \quad)$

As a result, our implementation involved converting the constraints formulated in this paper into their corresponding off-path versions.

5 Conclusion

The present work introduced novel corpus and acceptability judgment data to the ongoing debate on coordination of unlikes. The Turkish data presented here reinforces the claim that there is no universal requirement for conjuncts to be identical in terms of their syntactic categories and cases. The overarching generalization for Turkish appears to be this: if a specific syntactic function can be fulfilled by elements with differing syntactic categories or nominals bearing distinct cases, then we can assume that the coordination of such unlike elements is also acceptable.

To formalize this generalization in LFG, a formal mechanism is required whereby a given morphosyntactic constraint is evaluated individually for each conjunct, rather than for all conjuncts at the same time. For this reason, we formalized the empirical facts using the formal mechanisms proposed in Przepiórkowski & Patejuk (2021) and Przepiórkowski (2022), which allow relevant selectional restrictions to be not only uniformly formulated as f-structure constraints but also independently assessed for each conjunct. We further implemented the proposed formalization in XLE and validated with a test suite.

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An OT-LFG account of the syntax of the Determiner Phrase in Kafire

Songfolo Lacina Silué

Inalco (Institut national des
langues et civilisations
orientales)
Lacito (Langues et civilisations
à tradition orale)

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Abstract

This study addresses the syntax of the determiner phrase in Kafire in an OT-LFG perspective. This syntax is characterized by the interaction of various constraints that determine the correct output. There is a constraint that requires most nouns in Kafire to be part of a determiner phrase whose determiner has to be lexically realized. There is also another constraint that prevents a set of nouns of gender 1 to have such a lexically realized determiner, but which forces them to fill both an N and D nodes. Yet, this does not apply when the noun and the expected lexically realized determiner are not adjacent, in which case the lexical form of the determiner appears under the D node. The study captures and formalizes these facts with an OT-LFG formalism. It is the first study to pay much attention to this phenomenon in Senufo languages, especially in Kafire.

Introduction

The grammar of a language contains some constraints that are expected to be satisfied, otherwise there is ungrammaticality. However, in some circumstances, constraints can be overridden. For instance, French has a constraint that obligatorily contracts a sequence of a preposition followed by a definite article (Rowlett 2007: 56) as in (1) and (2).

(1) a. ***à le** garçon → **au** garçon 'to the boy'
b. ***à les** garçons → **aux** garçons 'to the boys'
c. ***à les** filles → **aux** filles 'to the girls'

(2) a. ***de le** garçon → **du** garçon 'of the boy'
b. ***de les** garçons → **des** garçons 'of the boys'
c. ***de les** filles → **des** filles 'of the girls'

But this constraint cannot be satisfied when the two are separated by another category, especially a quantifier as in (3).

(3) a. à **tout** le personnel → *au **tout** personnel 'to all the personnel'
b. de **tout** le personnel → *du **tout** personnel 'of all the personnel'

Since this constraint is satisfied except for the mentioned context, it means that this context also works as a constraint that must be satisfied by violating it. Thus, it outranks it in terms of the hierarchy of importance in the language. It is interesting to note that the interaction between the constraints involved in this phenomenon can be used to fully capture and predict the correct form of the prepositional phrase in French, but also in other languages, making typological generalizations possible based on such an interaction in languages (Wescoat 2007). Apart from the prepositional phrase, other types of structures can involve an interaction between constraints in the choice of the right structure.

This study addresses the case of the determiner phrase in Kafire, an underdescribed Senufo language. It is shown that the determiner phrase of this language can be analysed as being governed by some constraints that are ranked according to their importance and which interact to select the appropriate grammatical structure. The analysis is couched in an OT-LFG theoretical approach, an approach that considers that there exists several potential grammatical structures for a given input in a grammar, but the one that gets chosen is the one that respects the best the hierarchy of constraints in the grammar.

1 Background information

1.1 The Kafire language

Kafire is a Senufo language belonging to the Central Senari group. Senufo is part of Niger-Congo languages, but has a variable classification within this phylum. It is sometimes considered as a language family on its own (Williamson & Blench 2000, Hammarström et al. 2024), or as being a Gur language close to Central Gur (Miehe, Reineke & von Roncador 2012, Miehe 2020). Note that Gur is also known as Mabia (Bodomo 1993, 2020).

Kafire is spoken in northern Côte d'Ivoire in the department of Korhogo. Its speakers (i.e., Kafibele) are settled in an area called 'Kafigue', i.e., the area including Sirasso, Nafoun, Kanoroba (see the map below). It is an area of 54705 people.

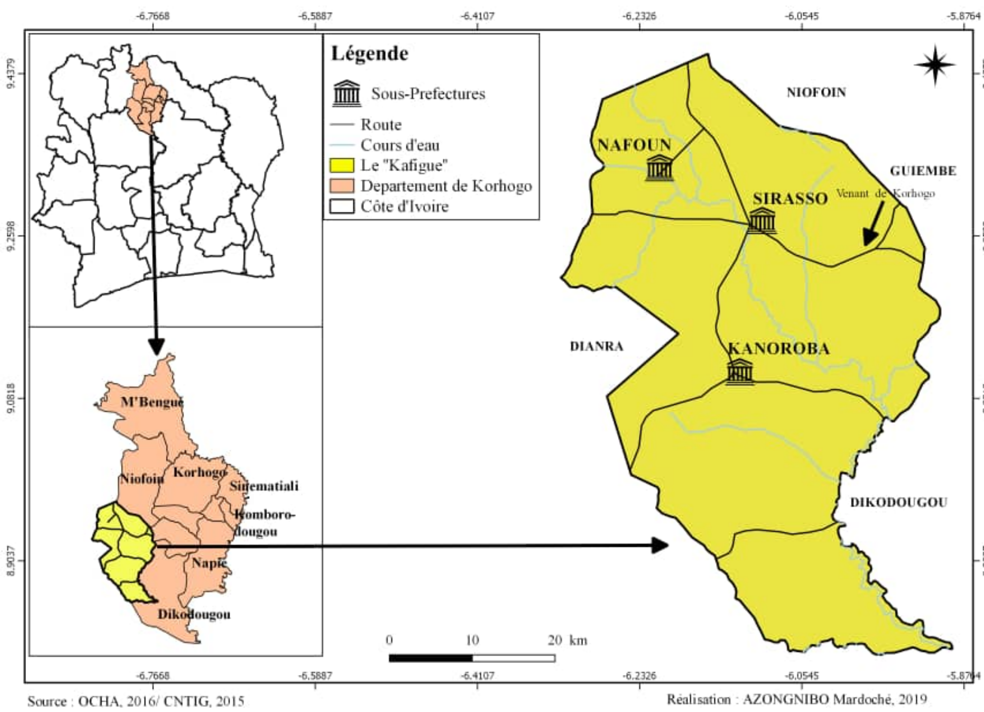


Figure 1: Kafigue : the area of settlement of the Kafibele

1.2 The OT-LFG theoretic approach

The OT-LFG theoretic approach combines OT (Optimality Theory) and LFG (Lexical Functional Grammar) tools for analyses (Bresnan 2001).

OT posits that for a given input in a language, there exist numerous potential grammatical structures, but the chosen one results from conflict resolution among universal constraints, ranked according to their importance in that language (Prince & Smolensky 1993/2002). To explain the choice of the right structure, OT considers that there are three components at work, namely **GEN**erator, **CON**straints and **EVAL**uator. For a given input, GEN produces the candidates, i.e., the potential grammatical structures. EVAL assesses their compliance with ranked constraints CON. The chosen structure, i.e., the optimal structure is the one that minimally violates the highest-ranked constraints.

The formalization of the analyses in OT is provided in a **tableau** as in (4). It shows the work of **CON**, **GEN** and **EVAL**. Candidate 2 is chosen over Candidate 1 even if it incurs two constraints. This is because the constraint 1 Candidate 1 violates is higher ranked that the two other constraints in this given language, namely constraint 2 and constraint 3.

(4)

Input	**CONSTRAINT 1**	**CONSTRAINT 2**	**CONSTRAINT 3**
1. candidate 1	*!		
2. ☞candidate 2		*	*

When LFG is combined with OT, the input of the tableau will be an f-structure and the candidates will be c-structures or a pair of f-structures and c-structures.

1.3 Genders and the determiner phrase in Kafire

As in any Senufo language, nouns in Kafire belong to different classes. Following some of my predecessors, I refer to those classes as genders (Carlson 1994, Baron 2016).

There are five genders in Kafire. As it is typical to gender systems (Aksenov 1984: 17–18, Corbett 1991: 8), genders in Kafire have a semantic origin, though in the synchrony nouns that belong to the same gender are not homogeneous. For instance, nouns that belong to gender 1 are typically human beings, but they can include animals, artefacts and borrowings. The humanness values of gender 1 is more obvious when an entity is personified in narratives. In this case, it has to belong to gender 1. Another way of determining the original and typical semantic values associated with a gender is by changing the definiteness markers that appear with a noun of that gender. In (5), we can see that switching the definiteness marker of gender 2 (the gender typically associated with bigness) to that of gender 3 (the gender typically associated with smallness) results in treating the tree as small.

(5) a. cí=**gē** 'a tree (conceptually considered as big)'
b. cí=**lē** 'a tree (a small one)'

In (6), I present the typical semantic values associated with different genders in Kafire.

(6)

Gender 1	humanness; personification (in narratives)
Gender 2	bigness; augmentative values
Gender 3	smallness; diminutive values
Gender 4	Mass terms ; terms for unbounded quantities of objects
Gender 5	liquids ; abstract qualities

These genders are distinguished grammatically by the way different markers associated with the noun agree with the noun (Nikitina & Silué 2023). These markers either appear in the phrase involving the noun or is adjoined to it. This applies to mainly the indefinite and the definite determiners.[1] I assume that these determiners are the head of that phrase, thus it is a determiner phrase. This analysis is based on a number of facts. The determiner is in principle obligatorily present and appears at the end of the phrase, a position usually occupied by heads in Kafire. It is the morphosyntactic locus of the phrase in the sense that it formally encodes all the grammatical information relevant for the whole phrase, namely number, gender and definiteness. Finally, there is a pronominal *wō* (corresponding roughly to the English 'one' as in *the one*) that can target the noun and its adjunct, leaving the determiner outside. This implies that the determiner is part of another structure where it is the head, i.e., the determiner phrase. Based on that, I assume that the minimal structure containing the noun is the determiner phrase, not a noun phrase. In the following tables, I present the different determiners of Kafire.

(7) a.

Gender	Indefinite singular	Indefinite plural
Gender 1	wV	bele / bVlV
Gender 2	gV	jV
Gender 3	lV	gele / gVlV
Gender 4	rV	
Gender 5	mV	

b.

Gender	Definite singular	Definite plural
Gender 1	wì	bèle^{H}
Gender 2	gì	jì
Gender 3	lì	gèle^{H}
Gender 3	rì	
Gender 5	mì	

As we can observe in those tables, the monosyllabic indefinite determiner and definite determiner have respectively an indefinite vowel V, i.e., a vowel whose nature is not defined in advance and the vowel [i] (which is usually omitted). The vowel of the monosyllabic indefinite determiner is precisely the copy of the last vowel of the noun, i.e., there is a total vowel harmony (Silué & Ballo 2018). For the disyllabic indefinite and definite determiners, the plural determiners of genders 1 and 3, the vowel is [e]. Yet, for the indefinite plural determiners of genders 1 and 3, there also exists some free variants whose vowels are also indefinite V.

Note that a minimal determiner phrase in Kafire consists of a determiner, i.e., an

[1]Note that in the literature on Senufo languages, these determiners are treated as suffixes. But we argue for an alternative analysis which consists of treating them as clitics (Nikitina & Silué 2023).

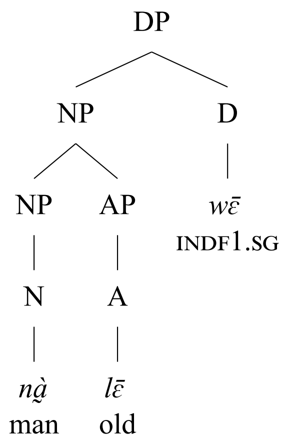
indefinite or definite determiner that is the head, and its complement that is a noun forming itself a noun phrase. This structure can be extended by various other categories, especially an adjectival phrase that modifies the noun phrase, the complement of the determiner. This can be formulated with the simplified following rules:

(8) a. DP → NP D
b. NP → NP AP
c. NP → N
d. AP → A

These rules can be illustrated with the example (9). Its c-structure is presented in (10).

(9) nà̰ lɛ̄=wɛ̄
man old=INDF1.SG
'an old man'

(10)



2 The puzzle in the determiner phrase in Kafire

Apart from exceptional cases that we will account for in the rest of this study, any noun in Kafire has to occur in the discourse with a determiner in order to be fully referential. The lexical form of the determiner has to be obligatorily realized. In other words, a noun in Kafire has to be part of a determiner phrase whose determiner has to have a lexical form, whether the noun is modified by other categories or not, especially by an adjective. This can be illustrated with the following examples that contain nouns of different genders where the determiner is the indefinite singular one. This determiner cannot be left out.

(11) a. nà̰*(=**wà̰**)
man=INDF**1**.SG
'**a** man'

b. nà̰ lɛ̄*(=**wɛ̄**)
man old=INDF**1**.SG
'**an** old man'

(12) a. cí*(=**gé**)
tree=INDF**2**.SG
'**a** tree'

b. cí lɛ̄*(=**ʔɛ̄**)
tree old=INDF**2**.SG
'**an** old tree'

(13) a. númɔ̰́*(=**nɔ̰̀**)
ant=INDF**3**.SG
‘**an** ant’

b. númɔ̰́ lɛ̄*(=**wɛ̄**)
ant old=INDF**3**.SG
‘**an** old ant’

(14) a. tā*(=**rā**)
land=INDF**4**
‘**a** land’

b. tā lɛ̄*(=**rɛ̄**)
land old=INDF**4**
‘**an** old land’

(15) a. sṵ̀*(=**mɔ̰́**)
oil=INDF**5**
‘**some** oil’

b. sṵ̀ lɛ̄*(=**mɛ̰̄**)
oild old=INDF**5**
‘**some** old oil’

The same holds for nouns that occur in noun phrases with definite reference. In the examples below, we can see the same constructions as those of the previous examples, but with the determiner appearing as the definite singular determiner.

(16) a. nǎ̰*(=**w**)
man=DEF**1**.SG
‘**the** man’

b. nà̰ lɛ̄*(=**w**)
man old=DEF**1**.SG
‘**the** old man’

(17) a. cí*(=**g**)
tree=DEF**2**.SG
the tree

b. cí lɛ̄*(=**g**)
tree old=DEF**2**.SG
the old tree

(18) a. númɔ̰́*(=**n**)
ant=DEF**3**.SG
‘**the** ant’

b. númɔ̰́ lɛ̄*(=**n**)
ant old=DEF**3**.SG
‘**the** old ant’

(19) a. tā*(=**r**)
land=DEF**4**
‘**the** land’

b. tā lɛ̄*(=**r**)
land old=DEF**4**
‘**the** old land’

(20) a. sṵ̌*(=**m**)
oil=DEF**5**
‘**the** oil’

b. sṵ̀ lɛ̄*(=**m**)
oild old=DEF**5**
‘**the** old oil’

However, there exists a set of nouns of gender 1 that behave differently with regards to the obligatory presence of the determiner. Those nouns cannot appear with an indefinite singular determiner, but are still interpreted as being in the indefinite singular. This is possible for nouns like *fjā* 'a fish', *pɔ̄* 'a dog', *gbòjó* 'a pig', *sètúgù* 'a cat', *pìcá* 'a young girl' and all borrowings. We can see in (21) and (22) two nouns of this set that cannot occur in the discourse with the indefinite singular determiner. This determiner as we know is expected to be of the form WV with V being the copy of the last vowel of the noun or the preceding category.

(21) a. fjā
fish.INDF**1**.SG
'**a** fish'

b. *fjā=**wā**
fish=INDF**1**.SG
Target : '**a** pig'

(22) a. nɛ̀ʔɛ̀só
bicycle.INDF**1**.SG
'**a** bicycle'

b. *nɛ̀ʔɛ̀sò=**wó**
bicycle=INDF**1**.SG
Target : '**a** bicycle'

This also happens with all de-verbal agentive nouns and nouns derived by the suffixation of the male sex suffix. De-verbal agentive nouns take a suffix that has two variants according to the context. When the unmodified noun is expected to occur in a context with the indefinite singular reading, the suffix is *-fɔlɔ* while it is *-fɛ* when it is modified or expected to occur in a context with the definite reading. The same holds with the derived male denoting noun. When the unmodified noun is expected to occur in a context with the indefinite singular, it takes *-pɔlɔ* whereas it takes *-pɛ* when it is modified or occurs in a context with a definite reading. The examples in (23) and (24) illustrate the cases where de-verbal agentive nouns and derived male denoting nouns appear in the indefinite singular (for the appearance of the second variants of their suffixes, see (26) and (28)). They cannot occur with the lexical form of the indefinite singular determiner.

(23) a. túgú-fɔ́lɔ́
dig-AGT.INDF**1**.SG
'**a** digger'

b. *túgú-fɔ́lɔ́=**wɔ́**
dig-AGT=INDF**1**.SG
Target : '**a** digger'

(24) a. bà-pɔ́lɔ́
sheep-MALE.INDF**1**.SG
'**a** ram'

b. *bà-pɔ́lɔ́=**wɔ́**
sheep-MALE=INDF**1**.SG
Target : '**a** ram'

We can observe that with these examples, it is impossible for the noun to appear with a lexical form of the indefinite singular determiner which in this case is expected to be of the form WV with V being the copy of the last vowel of the noun. But without it, it is still interpreted as being in the indefinite singular. Nevertheless, this only happens when these nouns are unmodified and are expected to be adjacent with the determiner in the determiner phrase, otherwise the determiner has to have a lexical form as usual. For instance, in (25), (26), (27) and (28), we can see that when the same noun as those of the examples (21), (22), (23) and (24) are modified by an adjective, the determiner has to have a lexical form.

(25) a. *fjā lɛ̄
fish.INDF**1**.SG old
Target : ‘**an** old fish’

b. fjā lɛ̄=**wɛ̄**
fish old=INDF**1**.SG
‘**an** old fish’

(26) a. *túgú-fɛ̄ lɛ̄
dig-AGT old.INDF**1**.SG
‘**an** old digger’

b. túgú-fɛ̄ lɛ̄=**wɛ̄**
dig-AGT old=INDF**1**.SG
‘**an** old digger’

(27) a. *nɛ̀ʔɛ̀sò lɛ̄
bicycle.INDF**1**.SG old
Target : ‘**an** old bicylce’

b. nɛ̀ʔɛ̀sò lɛ̄=**wɛ̄**
bicycle old=INDF**1**.SG
‘**an** old bicycle’

(28) a. *bà-pɛ̄ lɛ̄
sheep-MALE old.INDF**1**.SG
‘**an** old ram’

b. bà-pɛ̄ lɛ̄=**wɛ̄**
sheep-MALE old=INDF**1**.SG
‘**an** old ram’

3 Analysis

3.1 Possible analyses

To capture and formalize the fact that in the Kafire determiner phrase, the determiner is in principle obligatory, but the indefinite singular one cannot occur for some nouns when they stand alone, yet it occurs when they are modified by an adjective, a solution of having two different lexical entries for these nouns can be proposed. In this case, there will be a lexical entry that directly encodes the information of the indefinite singular determiner as in (29) and which is involved in a c-structure rule where the D node is not present as in (30). This absence of the D node is ensured by the principle of the economy of expression (Bresnan et al. 2016: 90). According to that principle, all nodes are optional unless required by other principles. Since the noun encodes the relevant information, the determiner is not required to be present to encode that same information. Based on that, the c-structure tree involving the lexical entry in (29) is presented in (31).

(29) *fjā* N (↑ PRED) = ‘FISH’
(↑ DEF) = -

(30) DP → NP

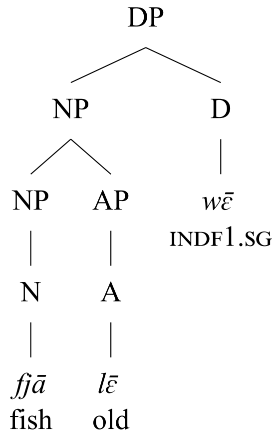
(31)
DP
|
NP
|
N
|
fjā
fish.INDF1.SG

The second lexical entry will not encode the information of the indefinite singular determiner and will be involved in a c-structure rule where the D node and an adjectival phrase are present. This can be respectively presented in (32) and (33). The c-structure tree involving this lexical entry is presented (34).

(32) *fjā* N (↑ PRED) = 'FISH'

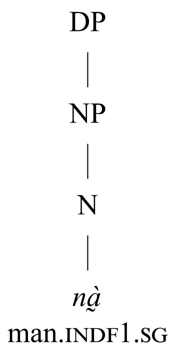
(33) DP → NP D

(34)

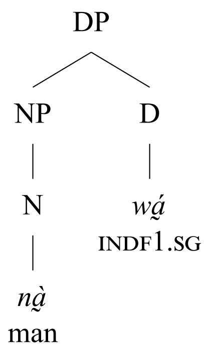


Even if such an analysis can be proposed, it encounters a difficulty. Firstly, it does not explain the inconsistency of the economy of expression. For instance, nothing explains why the noun of gender 1 referring to 'man' cannot encode the information of the indefinite singular determiner as in (35). In this case, the lexical form of the determiner has to be present as in (36).

(35) *Ill-formed!*

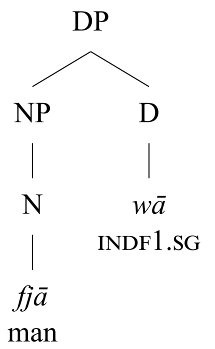


(36) *Well-formed!*

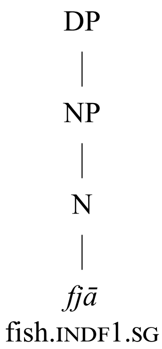


It does not also explain the reverse situation. The noun referring to 'fish' has to encode the information of the indefinite determiner as in (37), but cannot occur with the lexical form of the determiner as in (38).

(37) *Ill-formed!*



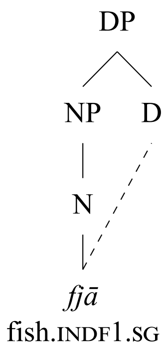
(38) *Well-formed!*



A brief analysis we provided in Nikitina & Silué (2023) was that there is a set of nouns of gender 1 that allow a lexical sharing mechanism (Wescoat 2002, 2005, 2007). Thus, for that set of nouns of gender 1, the form of the indefinite singular determiner is fused in the noun in the cases where it encodes its information, allowing the noun to project two nodes, i.e., the N and the D nodes. This explains why the lexical form of the determiner cannot appear with such nouns since they already fill the D node. Thus, it can be said that the noun in that case has a lexical entry as in (39), with a c-structure tree as in (40).

(39) *fjā* N (↑ PRED) = 'FISH'
(↑ DEF) = -
D

(40)



The other nouns that occur with the lexical form of the determiner do so because they do not project two nodes, but only the N node as seen in the lexical entry in (32). However, that brief analysis did not explain when lexical sharing is required or not. For example, it does not explain why the lexical form of the determiner has to occur in (41-a) and (41-b) where respectively the determiner is definite and the noun is modified by an adjective.

(41) a. fjā*(=**w**)
fish=DEF**1**.SG
'**the** fish'

b. fjā lɛ̄*(=**wɛ̄**)
fish old=INDF**1**.SG
'**an** old fish'

Based on the previous facts, to make predictions on when the lexical sharing mechanism can and cannot apply in the determiner phrase in Kafire, an OT-LFG analysis using constraints can be proposed. Particularly, an analysis combining lexical sharing analysis with OT. This is formulated in the following subsection.

3.2 The OT-LFG analysis

In the cases where the lexical form of the determiner has to occur in the determiner phrase in Kafire, it can be said that a certain constraint is at work. I assume that this constraint is an instance of the following constraint.

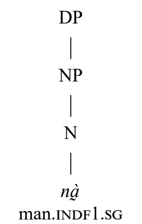
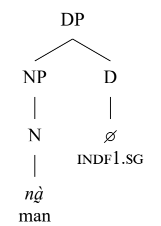
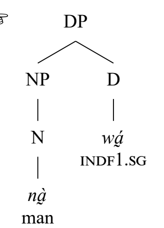
(42) **OB-HD**: every projected category (X′, X″) has a lexically filled (extended) head (Bresnan 2001: 352, Sells 2005: 64 and also Grimshaw 1997 for the first use).

Since the **OB-HD** constraint favours the lexical expression of the head (the exceptional cases will be explained) under another phrase structure node instead of having its information expressed by only the noun, it appears that a structure that respects it violates a constraint that prevents the use of much phrase structure nodes. I assume that that other constraint is the constraint of the economy of expression as formulated below.

(43) ***PROJ**: Avoid projections (Wescoat 2007: 18, see also Bresnan 2001: 351).

Note that the constraint of the economy of expression also prohibits the use of empty categories (see also Bresnan 2001: footnote 30 for the effect of this constraint in avoiding empty nodes) in such a way that such a use is governed by the 'last resort' principle (Bresnan et al. 2016: 91–92). Thus, it would prohibit the use of a phonologically and semantically empty determiner especially as there are non phonologically empty determiners counterparts in the same contexts.

In summary, the structures involving the lexical form of the determiner are governed by the requirement of the constraint OB-HD to have a headed DP, instead of respecting the constraint *PROJ that requires the minimal use of phrase structures. This means that we have the following hierarchy of constraints: OB-HD(FP) ≫*PROJ. This hierarchy can be illustrated with a determiner phrase for the expression of the idea of 'a man'. The choice of the optimal structure for this idea is shown in the following tableau.

Input: [PRED 'MAN', DEF -, GENDER 1, NUM SG]	OB-HD(FP)	*PROJ
a. 	*!	
b. 		*!
c. ☞ 		*

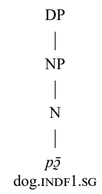
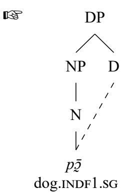
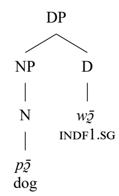
In this tableau, three candidates are competing to be the optimal output to express the idea of ‘a man’. Candidate a is not headed, so it is ruled out by OB-HD(FP), the highest ranked constraint. Candidate b respects OB-HD(FP) by having a D node, but still violates the constraint *PROJ that prohibits empty nodes. This rules it out. As for candidate c, even if it violates *PROJ, it does not violate OB-HD(FP) which outranks the former in the hierarchy of constraints. It is therefore the optimal candidate.

As already discussed, there are many nouns of gender 1 that appear without a lexical form of the indefinite singular determiner, but are interpreted as being in the indefinite singular. There is also evidence that the D node is present in the determiner phrase hosting these nouns since no lexical form can fill that slot, as if it is already filled. In reality, the noun itself can be considered as filling two slots, that of the N node and that of the D node. This is thus the manifestation of lexical sharing, particularly an instance of the Poser blocking constraint as defined by Wescoat (2007: 15). This is defined as follows:

(44) **PBLK** : assign a violation sign to any sequence of N and D nodes where the leaves are two independent morphologically complete words, instead of only one word as a leaf.

A structure that satisfies this constraint also satisfies OB-HD(FP) in the sense that the D node is lexically filled. Nevertheless, that structure will not satisfy *PROJ since the noun does not encode the information of the indefinite singular determiner without being obliged to project another node. This violation cannot be fatal though because it is the least important one. All this gives the following ranking: OB-HD(FP) ≫BPBLK ≫*PROJ.

Based on that, to express the idea of ‘a dog’ where ‘dog’ belongs to the set of nouns that project both the N and D nodes, we could have the following tableau.

Input: [PRED ‘DOG’, DEF -, GENDER 1, NUM SG]	OB-HD(FP)	PBLK	*PROJ
a. 	*!		
b. ☞ 			*
c. 		*!	

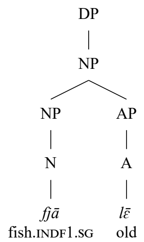
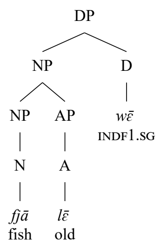
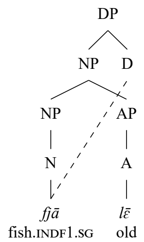
In this tableau, candidate a is ruled out because the c-structure of the determiner phrase is not headed. As made clear in the tableau, this is the highest constraint in terms of hierarchy in the language. Its violation rules out the candidate that is involved in such a violation. As for candidate c, it contains a noun that should respect the lexical sharing constraint requiring such a noun to project an N and D nodes, but it does not respect that. Since the lexical sharing constraint is the second most important constraint in the hierarchy, it rules this candidate out. Finally, regarding candidate b, it respects both the constraint OB-HD(FP) that requires the determiner phrase to have lexically filled D node and the lexical sharing constraint PBLK in projecting both an N and D nodes. It is therefore the chosen candidate, even if it violates the constraint of the economy of expression *PROJ by having a D node for the expression of the information of the determiner. This constraint is the lowest one, thus this structure is the optimal one.

Moreover, for this class of nouns or any other noun, when the noun and the expected determiner are not adjacent in the determiner phrase, the constraint PBLK does not apply. Thus, the determiner has a lexical form as usual. In reality, it can be said that the poser blocking constraint does not apply because of an adjacency constraint. For the poser blocking constraint to be satisfied, the N and D nodes should be adjacent. Once they are not adjacent, the homomorphic lexical integrity theorem as defined by Wescoat (2007: 8) prevents the noun to project two nodes. This constraint is formulated below.

(45) **HLIT** (homomorphic lexical integrity theorem): only sequences of adjacent terminals may share a lexical exponent.

The fact that this constraint blocks the effect of the poser blocking constraint, it outranks the poser blocking constraint in the hierarchy. This gives the following hierarchy: OB-HD(FP) ≫HLIT ≫BPBLK ≫*PROJ.

The following tableau illustrates the interaction between those constraints in the choice of the structure expressing the idea of ‘an old fish’.

Input: [PRED 'FISH', DEF -, GENDER 1, NUM SG, ADJ {[PRED OLD]}]	OB-HD(FP)	HLIT	PBLK	*PROJ
a. 	*!			
b. ☞ 				*
c. 		*!		

In this tableau, candidate a is ruled out because it does not have a lexically filled head, violating the constraint OB-HD(FP), which requires a lexically filled head. Candidate c is ruled out by HLIT because the noun projects both N and D nodes, even though they are not adjacent. As for candidate b, it is the chosen one because it not only respects the constraint HLIT, which prevents lexical sharing in this case, but also satisfies all other constraints, except for the lowest-ranking one, *PROJ. Therefore, its violation of this lowest-ranking constraint does not exclude it.

Finally, for the set of nouns that can project both the N and D nodes, it was shown earlier that they cannot project both when the information of the determiner to encode is the definite one. To account for such cases, there are two possible solutions. One approach is to consider that there is no other lexical entry available for those nouns that will project both N and D nodes with the definite singular information. Another solution is that the information of the definite still incorporates the lexical entry that projects both N and D nodes and containing the indefinite singular information. In this case, due to a clash of information between the definite and indefinite values (because of the violation of the uniqueness principle), the lexical entry that is supposed to project both N and D nodes is not used. Instead, the entry that does not project these nodes is used. Either solution could work, and there is no need for a specific formalization in this case.

4 Discussion

To my knowledge, Kafire is the only Senufo language for which the current phenomenon has been fully analysed. Many studies on Senufo languages simply mention that some nouns of gender 1 do not have a lexical form of the indefinite singular determiner. But they do not explore the fact they can still take a lexical form of the indefinite singular determiner phrase under some conditions. Moreover, many studies propose that when the determiner does not have a lexical form, there a is zero morpheme (Traoré 2015, Coulibaly 2020). But in Kafire, we cannot talk about a zero morpheme since there is evidence that the information of the determiner is fused in the noun and fills two slots in the c-structure. When this fusion is not possible because the noun and the expected determiner are not adjacent, the lexical form of the determiner has to be under the D node. Apart from Kafire (and other Senufo languages), there also exists some languages in which we have situations that may involve the same types of constraints, though the phenomenon of those languages may not be exactly the same as in Kafire. Börjars (1998: 7–8) (see also Börjars & Donohue 2000) analysed some predicative constructions of some Germanic languages, especially Swedish where the indefinite determiner of some role or function referring nouns only appears under some conditions. When the noun is alone and expected to be adjacent to the indefinite determiner, the indefinite determiner does not appear. However, the lexical form of the indefinite determiner appears when there is a pre-nominal adjective that intervenes between the noun and the expected indefinite determiner. The existence of such situations, which seem to involve the same constraints as those described in Kafire, paves the way for undertaking typological studies to fully understand and classify them. The current study is thus interesting for such an enterprise.

Conclusion

This paper explored the syntax of the determiner phrase of Kafire in an OT-LFG perspective. It was shown that there exists different constraints that interact to select the appropriate structure of the determiner phrase in Kafire. One constraint that forces most nouns to have a lexical form of the determiner. However, there is a set of nouns that belong to gender 1 whose indefinite singular determiner cannot have a lexical form, but whose information has to be part of the noun. The noun projects both the N and the D nodes in such cases. Yet, this constraint applies only when the noun and the determiner are expected to be adjacent. Otherwise, when there is another category separating them, especially an adjective, the form of the determiner has to be realized on its own under the D node. It was mentioned that such types of nouns exist in many Senufo languages. But their behaviour has not been fully explored. The determiner of those nouns, which is considered in those studies as suffixes, is seen as a zero morpheme. Nevertheless, such an analysis does not apply to Kafire where there is no evidence for a zero morpheme. Finally, it was shown that many languages like Germanic languages have a phenomenon that seems to involve the same types of constraints as those described in Kafire. This makes the current study interesting for undertaking typological studies on phenomena involving those constraints.

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In defense of a COMP-less approach to Hungarian finite clauses

Péter Szűcs

University of Debrecen

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Abstract

In this paper, I defend Szűcs's (2018) approach to Hungarian finite complement clauses. I argue that the grammatical function COMP is not necessary, and the criticism voiced by Laczkó (2021) can be satisfactorily addressed by considering general principles regarding coordination and the argument-structure of certain verbal and nominal predicates. Laczkó (2021) presents some evidence that seem to support COMP, but I rather propose treating them as (thematic) ADJUNCTs and in the case of simple event nouns, as instances of POSS. Supporting data chiefly cited from Hungarian but theoretical and cross-linguistic considerations are also added. I also discuss some related issues, such as some unresolved issues with regards to adverbials, and the nature of demonstrative pronouns involved in clausal complements. I conclude with some meta-theoretical remarks advocating a generally restrictive view of LFG's inventory of grammatical functions.

1 Introduction

In their seminal paper, Dalrymple & Lødrup (2000) argue that finite complement clauses, in addition to being analyzed as having the traditional COMP grammatical function, may alternatively be treated as objects in "mixed-languages". In this view, the *that*-clause in (1a), subcategorized by the verb *hope,* functions as a COMP, while the one in (1b), subcategorized by *believe*, is an OBJ.†

(1) a. *I hope [that the Earth is round].* (subordinate clause is COMP)

b. *I believe [that the Earth is round].* (subordinate clause is OBJ)

The fact that the complement clause in (1a) cannot be replaced with a nominal or pronominal element while the one in (2b) can, provides empirical support for this position, as such elements are uncontroversially OBJs. The *that*-clause of *believe* can also be coordinated with such an element, suggesting that they are functionally parallel, as attested by examples (3) and (4).

(2) a. **I hope {the claim / it / that}.* b. *I believe {the claim / it / that}.*

(3) *I believe the claim and that accepting it would benefit everyone.*

(4) *Pat remembered [the appointment] and [that it was important to be on time].* (Sag et al. 1985:165)

At the same time, there has been a "reductionist"/ "restrictive" line of research as well, starting with Alsina et al. (1996). Researchers in this paradigm argue that the COMP function should not be supplemented but *be replaced* by other grammatical functions. In other words, all clauses should be seen as instances OBJs, OBL_θs or OBJ_θs. For example, Alsina et al. (2005) argue that complement clauses in Catalan can instantiate the OBL_θ function: the canonical PP-based realization in (5a) alternates with the CP in (5b), demonstrating the same point for OBL_θ that (1b) and (2b) proves for OBJ. Note the

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PP alternative for (1a) and (2a) as well, in (6). Alsina et al. (2005) support this view with arguments based on data related to subcategorization alternatives, cliticization, and passivization, and they offer an account where LFG is complemented by Optimality Theory-based considerations.

(5) a. *M'heu de convèncer de les seves possibilitats.*
me have.2PL to convince of the 3SG.POSS possibilities
'You have to convince me of his possibilities.'

b. *M'heu de convèncer que torni a casa.*
me have.2PL to *convince* that return.1SG to home
'You have to convince me to return home.'

(6) *I hope for it.*

The "COMP-debate" is still ongoing in LFG. Forst (2006), Patejuk & Przepiórkowski (2014, 2016), and Szűcs (2018) argue that facts from German, Polish and Hungarian (respectively) support the restrictive perspective, while Belyaev et al. (2017) and Laczkó (2021) argue, based on Moksha Mordvin and Hungarian (respectively), that for certain complements, an OBJ/OBL$_\theta$/OBJ$_\theta$-based analysis is inadequate – therefore, COMP must be retained in LFG's inventory of grammatical functions.[1]

As seen from the papers mentioned in the previous paragraph, Hungarian features prominently in this discussion. This paper aims to contribute to the dialogue from a restrictive perspective. In particular, I argue that the position on finite complement clauses advocated by Szűcs (2018) can be defended against the criticism raised by Laczkó (2021). In other words, the analysis of Hungarian *that*-clauses does not require the COMP grammatical function.

Before delving into the main points of the paper, I offer two preliminary comments. First, I acknowledge that my conclusions do not mean that the COMP grammatical function is universally to be discarded, but the arguments I present may be applicable to other data that pose challenges for the reductionist view, thus contributing meaningfully to the discussion. Additionally, while the primary focus will be on Hungarian, we will keep the cross-linguistic picture in mind, both from theoretical and empirical perspectives. While I would prefer LFG to be a theory without the COMP function (I will also make some meta-theoretical points on this in my conclusion), I recognize that the debate is still going to be open after this paper. In fact, in section 5, I will even make some concessions about certain complement clauses (not the ones presented in Laczkó 2021), the proper analysis of which remain not very straightforward under a COMP-less approach.

Second, while the COMP-debate may (and should) be extended to the open function XCOMP, I am going to stay within the realm of finite complementation. Szűcs (2018) presents some points about the elimination of XCOMP in Hungarian, see also Falk (2005) for a broader view from the perspective of Lexical Mapping Theory. This part of the debate also involves theorizing about the nature of open functions and the mechanism of functional and anaphoric control, which would fall outside the scope of the present article.

The structure of the paper is as follows. In section 2, I outline the basic picture regarding Hungarian finite complement clauses. First, we approach this from the

[1] Bodomo & Lee (2001) may also be mentioned, who argue that the analysis of Cantonese necessitates COMP too. However, they only consider OBJ as an alternative to COMP.

COMP-less proposal of Szűcs (2018), followed by a presentation of Laczkó's (2021) criticism. In sections 3 and 4, I defend the COMP-less approach by showing that the points made by Laczkó (2021) can be refuted. Section 3 focuses on complements of verbs and section 4 addresses complements of nouns (e.g. *the fact that…*). The nominal domain is generally not explored by the literature on COMP[2], so the perspectives presented there are novel for the discussion. In both section 3 and 4 I will show that the seemingly problematic data can be handled with reference to general principles, ADJUNCTs and the POSS function (the latter in the case of nouns). Section 5 discusses some additional perspectives related to the topic of this paper. One such issue is the question of clauses associated with adverbial elements. This part is motivated by the Moksha Mordvin data presented by Belyaev et al. (2017), which also has parallels in Hungarian. I will remain undecided about the proper analysis there. A recurring theme throughout the paper will be the presence of demonstrative pronouns in various clausal constructions, which I will also discuss. Section 6 concludes the paper.

2 Finite complement clauses in Hungarian

2.1 Szűcs (2018)

According to Szűcs (2018: 328), Hungarian complement clauses may function as a SUBJ (7), OBJ (8) or OBL_{θ} (9) argument of the relevant predicates. These grammatical functions may be realized either by a lexical noun (7b, 8b, 9b), a demonstrative pronoun plus finite clause complex (7c, 8c, 9c), or a finite clause by itself (7d, 8d, 9d). An infinitival clause is also an option, as in (7e), (8e) and (9e), but as I noted in the introduction, these are not considered further here. The relevant parts of the examples in (7)-(9) are set in boldface.[3]

(7) a. *derogál* '<(**SUBJ**)(OBL_{θ})> feels derogatory to somebody'

b. ***A vereség*** *derogál Kati-nak.*
the defeat feels.derogatory Kate-DAT
'The defeat feels derogatory to Kate.'

c. ***Az*** *derogál Kati-nak,* ***hogy vereség-et szenvedett****.*
that feels.derogatory Kate-DAT that(c) defeat-ACC suffered.
'It feels derogatory to Kate that she was defeated.'

d. *Derogál Kati-nak,* ***hogy vereség-et szenvedett****.*
feels.derogatory Kate.DAT that(c) defeat-ACC suffered.
'That she was defeated felt derogatory to Kate.'

e. *Derogál Kati-nak* ***vereség-et szenved-ni****.*
feels.derogatory Kate-DAT defeat-ACC suffer-INF
'To be defeated feels derogatory to Kate.'

2 Note however that Lødrup (2012) argues (with some reluctance) that some NPs can be COMPs. This is different from the present issue, which is about the functional status of CP-complements of nouns, not the possible part-of-speech categories of COMPs.

3 The gloss "that(c)" stands for "complementizer *that*". This is to avoid confusion with the demonstrative in such sentences (or the grammatical function COMP). Nominative case and present tense have no morphological exponent and are therefore not indicated in the gloss.

(8) a. *akar* ‘<(SUBJ)(**OBJ**)> want’

b. *Kati* ***étel-t*** *akar.*
Kate food-ACC wants.INDEF
‘Kate wants food.’

c. *Kati* ***az-t*** *akarja,* ***hogy*** ***együnk****.*
Kate that-ACC wants.DEF that(c) eat.1PL.SBJV
‘Kate wants (it) that we eat.’

d. *Kati* *akarja,* ***hogy*** ***együnk****.*
Kate wants.DEF that(c) eat.1PL.SBJV
‘Kate wants that we eat.’

e. *Kati* ***en-ni*** *akar.*
Kate eat-INF wants.INDEF
‘Kate wants to eat.’

(9) a. *fél* ‘<(SUBJ)(**OBL**$_{\theta}$)> fear’

b. *Kati* *fél* ***a*** ***kutyák-tól****.*
Kate fears the dogs-ABL
‘Kate fears dogs.’

c. *Kati* ***at-tól*** *fél,* ***hogy*** ***a*** ***kutya*** ***megharapja****.*
Kate that-ABL fears that(c) the dog bites.DEF
‘Kate fears that the dog may bite her.’

d. *Kati* *fél,* ***hogy*** ***a*** ***kutya*** ***megharapja****.*
Kate fears that(c) the dog bites.DEF
‘Kate fears that the dog may bite her

e. *Kati* *fél* ***kutyá-t*** ***tarta-ni****.*
Kate fears dog-ACC keep-INF
‘Kate fears keeping a dog.’

Szűcs (2018) further supports this view with coordination-data paralleling earlier examples. One illustration is shown in (10).

(10) *Kati fél a kutyák-tól és hogy azok megharapják.*
Kate fears the dogs-ABL and that(c) those bite.3PL
‘Kate fears dogs and that they might bite her.’

2.2 Criticism by Laczkó (2021)

Laczkó (2021) challenges the picture outlined in Section 2.1 from three perspectives:

(11) Criticism by Laczkó (2021)
i. Challenging the validity of the coordination-data of the sort presented in (10).
ii. Arguing that a certain class of Hungarian verbs subcategorize exclusively for finite clauses – with no possible alternative realizations, he deems the COMP function as the appropriate analytical solution.
iii. Involving the nominal domain in the discussion, which in his view necessitates the COMP.

2.2.1 The verbal domain

Regarding (11i), Laczkó (2021) claims that examples like (10) are problematic, as the two conjuncts are not completely independent due to the anaphoric relationship between the oblique-marked nominal in the first clause and the demonstrative subject of the second clause (*kutyák* 'dogs' – *azok* 'those'). In his view, the absence of such a dependency would result in significantly degraded grammaticality, as shown in (12a). Swapping the conjuncts would worsen the situation further, as seen in (12b).

(12) a. *??Kati fél a macskák-tól és hogy a kutyák megharapják.*
Kate fears the cats-ABL and that(c) the dogs bite.3PL.DEF
'Kate fears cats and that dogs may bite her.'

b. *???Kati fél hogy {azok / a kutyák} megharapják és a macskák-tól.*
Kate fears that(c) those the dogs bite.3PL.DEF and the cats-ABL
'Kate fears that {those / the dogs} may bite her and cats.'

For (11ii), Laczkó (2021) points out that there are certain verbs that do not exhibit the alternation shown in (7)-(9). In (12a) *jelez* 'signal' occurs transitively like *akar* 'want' in (8), indicated by the definite conjugation in these examples.[4] Notably, this verb can also appear intransitively, as in (13b), shown by the conjugation (13a) and (13b) according to Laczkó (2021) are semantically equivalent but functionally different, (13b) involving a COMP-clause. *Int* 'wave' in (14) exclusively occurs in the intransitive frame, motivating the same analysis for him.

(13) a. *Kati jelez-te (az-t), hogy induljunk.*
Kate signalled.3SG.DEF that-ACC that(c) leave.SBJV.1PL

b. *Kati jelz-ett, hogy induljunk.*
Kate signalled.3SG.INDEF that(c) leave.SBJV.1PL
Both: 'Kate signalled that we should leave.'

(14) *Kati int-ett(*-e), hogy induljunk.*
Kate wave-PAST.3SG.INDEF(*DEF) that(c) leave.SBJV.1PL
'Kate waved (her hand) that we should leave.'

In section 3, I will argue that while the first issue raises a valid concern, the delicacy of coordination data does not undermine Szűcs's (2018) basic argument. Furthermore, the seemingly problematic intransitive examples in (13)-(14) require the ADJUNCT function in their analysis, not the COMP.

2.2.2 The nominal domain

As stated in (11iii), Laczkó (2021) extends the discussion to the nominal domain. He argues, referencing Dalrymple & Lødrup (2000), that since nouns are intransitive

[4] Finite clauses (as opposed to infinitival ones) count as definite. Alternatively, the definite conjugation is triggered by a pro-dropped demonstrative (as argued by Laczkó 2022). We will briefly return to the issue of demonstratives in section 5.

categories, the *that*-clause associates of nouns like *jelzés* 'signal/sign', *gondolat* 'thought', or *kérdés* 'question' must be COMPs.

(15) *Kati jelz-és-e, hogy induljunk*
Kate signal-DEV-POSS.3SG that(c) leave.SBJV.1PL
'Kate's signal that we should leave'

(16) *a gondolat, hogy indulunk*
the thought that(c) leave.1PL
'the thought that we leave'

(17) *a kérdés, hogy ki induljon*
the question that(c) who leave.SBJV.3SG
'the question of who should leave'

For these, I will argue – following the well-established tradition in the literature – that CP-associates of such simple event nouns are not arguments but adjuncts. Nevertheless, there exists the group of nouns that does take CP arguments – these are certain relational nouns. Crucially, the CPs here are not COMPs either, but should be analyzed as having the POSS grammatical function.

3 Addressing the problematic issues in the verbal domain

Both Szűcs (2018) and Laczkó (2021) acknowledge that coordination is a complex issue and nuance is expected. However, the fact that some examples are degraded should not lead us to abandon the diagnostic as an argument or discard the hypothesis. This is akin to the well-known problem with constituency tests: sometimes they fail to yield the expected results for independent reasons, but this alone is not enough to deny their general value or to reject the idea that a given string of elements form a constituent – the failure to extract from a DP and stranding the definite article does not mean that *big dogs* is not an NP constituent in **big dogs, I like the*. My point is that once we accept that some coordinations with respect to the relevant data are acceptable, this acceptance may serve a valid basis for determining the grammatical-functional status of the data at hand. Of course, explaining the complicating factors is a necessary addition to the account. I do not claim to have all the answers here but I can point to some factors.

In fact, Dalrymple & Lødrup (2000) already acknowledged that arguments from coordination are vulnerable because of "a number of poorly-understood grammatical and extragrammatical factors influence the acceptability of coordination". Nevertheless, they "do not believe that the unacceptability of example (18) (ex. 8 in the original publication) constitutes clear evidence against our analysis". I concur with this view. They further illustrate the point with (19a) and (19b), which are syntactically very similar but differ in acceptability. (19c), with reversed conjuncts, is even more degraded.

(18) **He proposed [a 20% reduction for the elderly] and [that the office be moved to the suburbs].*

(19) a. *Pat is a Republican and proud of it.* b. *??Pat is a Republican and stupid.*

c. *???Pat is proud of it and a Republican.*

Note how (19a) involves an anaphoric dependency (*be a republican – it*), unlike (19b). This is reminiscent of what we saw with (12a). My earlier example in (3) (*I believe the claim and that accepting it would benefit everyone*) demonstrates the same phenomenon. Note also the conceptual link in Sag et al.'s (1985) example in (4) (*appointment – be on time*). Clearly, having some sort of a semantic/conceptual coherence between the conjuncts is a positive force, especially if c-structural coherence (i.e. categorial identity) is lacking. An anaphoric dependency is one way to provide this coherence. That the anaphoric dependency has a preference to be in a particular order as in (19a) versus (19c) is not at all surprising: it is simply infelicitous in discourse organization to introduce a pronoun when its reference is unknown to the conversational partner.[5]

Thus, unlike Laczkó (2021), I do not believe that the relevant examples in (12) (and accordingly, in (18) and (19)) are ungrammatical; they are simply infelicitous for pragmatic or processing reasons. However, this is an issue independent of their f-structural status. Such distinctions are particularly important in a framework like LFG, where the separation of analytical levels and the use of a parallel architecture is a key feature.

It is well-known in the pertinent literature that, beyond c- or f-structural considerations, various other factors influence the acceptability of coordinate structures. For instance, Schachter (1977) notes the degraded status of the following examples, suggesting that "semantic function" (in the broad sense) plays a role in regulating acceptability in coordination, even when the syntactic statuses of the conjuncts are identical. The aforementioned pragmatic or processing considerations may well fall into the same category.[6]

(20) a. **What are you doing and shut the door.*

b. **John ate with his mother and with good appetite.*

c. **John probably and unwillingly went to bed.*

Apart from the general considerations about coherence mentioned earlier, one could also consider the following with regards to the problematic examples in (12). The fact that the issue shows gradiency already suggests that we are dealing with acceptability in the broad sense, and not grammaticality in the narrow sense. Furthermore, it is not surprising that in coordinations, the clausal element tends to appear as the second conjunct, given well-known syntactic and stylistic constraints on clause positioning. For example, Stowell (1981) notes that *that*-clauses extrapose to the right, as in (21), where the adjunct intervenes between the main predicate and its clausal argument. Note the contrast with (22) – such sentences are routinely used to illustrate the argument-adjunct distinction and to show the closer syntactic and semantic connection of arguments to predicates (compared to adjuncts). Clauses show a behavior that is clearly distinct from nominal arguments.

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[5] Note: *I like John$_i$ and invited him$_i$* vs. *#I like him$_i$ and invited John$_i$.*

[6] Perhaps instead of the stars that Schacter (1977) rates these sentences with, one should rather use ?s or #s, but that is an issue orthogonal to the point made.

(21) *Mary said (quietly) that she wanted to drive (*quietly).* (Stowell 1981: 161)

(22) a. *Mary ate the cookie quietly.* b. **Mary ate quietly the cookie.*

Even when the intervening element is not an adjunct but a pronoun that can be analyzed as argumental, the associated clause still needs to be right-peripheral. This happens in the following example, which Alsina & Yang (2019: 19) explains by invoking a linear precedence rule "a clausal phrase must follow a sister GF", to model the extraposition.

(23) a. *I resent it that you didn't call me.* b. **I resent that you didn't call me it.*

This is certainly a factor that makes (12b) more marked than (12a), which are repeated here in (24) for convenience.

(24) a.

??Kati	*fél*	*a*	*macskák-tól*	*és*	*hogy*	*a*	*kutyák*	*megharapják.*
Kate	fears	the	cats-ABL	and	that(c)	the	dogs	bite.3PL.DEF

'Kate fears cats and that dogs may bite her.'

b.

???Kati	*fél*	*hogy*	*{azok /*	*a*	*kutyák}*	*megharapják*	*és*	*a*	*macskák-tól.*
Kate	fears	that(c)	those	the	dogs	bite.3PL.DEF	and	the	cats-ABL

'Kate fears that {those / the dogs} may bite her and cats.'

References to principles like "end-weight" are abundant in both theoretical and descriptive literature. Alsina and Yang (2019) note, and I concur, that "we are in line with Huddleston and Pullum (2002: 1403) in considering that, 'the effect of extraposition is to place a heavy constituent at the end' ". Clauses are naturally heavy constituents and accordingly, it is natural for them to gravitate towards the second position in a coordinated structure.

This leads to the expectation that increasing the weight of the nominal should, at least partially, mitigate the effect seen in (24b). This expectation is correct: in my judgement, adding a relative clause to the nominal does make (25) more acceptable.

(25)

?Kati	*fél*	*hogy*	*megharapják*	*a*	*kutyák*	*és*	*[az*	*olyan*	*macskák-tól*	*is,*	*akik*	*túlságosan*	*vadnak*	*néznek*
Kate	fears	that(c)	bite.3PL.DEF	the	dogs	and	the	such	cats-ABL	also	REL	too	wild	look.3PL

ki].	
out	

'Kate fears that dogs may bite her and also such cats that look too wild.'

My overall conclusion about coordination is that while Laczkó (2021) raises valid questions and the picture is admittedly more complex than what Szűcs (2018) presented, the general stance that the sentences in question (9c and 9d) contain an OBL_{θ} can still be maintained.

Laczkó's (2021) other line of argumentation concerns clauses that do not alternate with nominal (proper noun as in 9b / pronoun as in 9c) constituents. The relevant examples are repeated here.

(26) a. *Kati jelez-te (az-t), hogy induljunk.*
Kate signalled.3SG.DEF that-ACC that(c) leave.SBJV.1PL

b. *Kati jelz-ett, hogy induljunk.*
Kate signalled.3SG.INDEF that(c) leave.SBJV.1PL
Both: 'Kate signalled that we should leave.'

(27) *Kati int-ett(*-e), hogy induljunk.*
Kate wave-PAST.3SG.INDEF(*DEF) that(c) leave.SBJV.1PL
'Kate waved (her hand) that we should leave.'

The underlying assumption behind Laczkó's (2021) reasoning is that the subordinate clause in (26) has the same argument-status as the one in (26a) and the one in (27) as well (as noted in section 2.2.1, *int* is intransitive, hence the impossibility of the definiteness-morpheme *e* in 27). However, there are reasons to believe that this assumption is false: (26b) contains an ADJUNCT-CP, as so does (27). They are in contrast with the CP in (26a), which functions as an OBJ argument, as attested by the definite conjugation.

First, the subordinate clauses in (26b) and (27a) are optional[7], both syntactically and semantically: a propositional dependent may be added but it is by no means an absolute necessity.

(28) *Kati {jelzett/ intett}, (hogy induljunk).*
Kate signalled.3SG.INDEF waved.3SG.INDEF that(c) leave.SBJV.1PL
'Kate signalled/waved (that we should leave.)'

Second, it is well-known that complementizer-drop in Hungarian (as well as in English) is only possible in case of argumental-clauses (see e.g. Kenesei 1992 and Synder 1992). This is demonstrated in (29), where we find the expected pattern: the complementizer after the definite verb can be dropped, while after the indefinite one in (29b), it may not. More precisely, the drop results in a pronounced intonational break before the subordinate clause, indicating its appositive status, elaborating on the communicative purpose of the signalling.

(29) a. *Az új tulajdonos már jelez-te, a házat*
the new owner already signalled.PAST.3SG.DEF the house.ACC
átépíti.
rebuild.3SG.DEF
'The new owner has already signalled that he will rebuild the house.' (from the Hungarian National Corpus)

b. **Az új tulajdonos már jelzett, a házat*
the new owner already signalled.PAST.3SG.INDEF the house.ACC
átépíti.
rebuild.3SG.DEF
'The new owner has already signalled, he will rebuild the house.'

[7] Technically, the object in (26a) is also optional, but the conjugation would still entail its presence, thus *Kati jelezte* would simply be an instance of object pro-drop. I thank one of my reviewers for calling attention to this detail.

The same point can be corroborated by extraction. In (30), we can see that the unbounded wh-dependency is only possible if the verb is the transitive version of *signal*, which takes the clause as an OBJ, whereas for the other two, the CP is an ADJUNCT and therefore an island.

(30)

Hova$_i$	*{jelezte /*	**jelz-ett /*	**int-ett}*	*Kati,*
where	signalled.3SG.DEF	signalled.3SG.INDEF	waved.3SG.INDEF	Kate
hogy	*induljunk*	t_i*?*		
that(c)	leave.SBJV.1PL			

'Where did Kate signal/wave that we should leave?'

At the center of Laczkó's (2021) argumentation is the claim that the transitive and intransitive versions of *signal* are semantically equivalent and thus should receive the same analysis in terms of their composition with the subordinate clause. As opposed to this, my claim is that the two instances are related but conceptually separate lexical items. While I so far have glossed both of them as 'signal', in actuality, *jelez*.TRANS is more precisely translated as 'indicate', while *jelez*.INTRANS would be something like 'give signals'. More concretely, *jelez*.TRANS is not specified with respect to agentivity/humanness, *jelez*.INTRANS is (positively). From this perspective, it is not surprising that the more neutral, transitive version is more frequent in the Hungarian National Corpus. Some typical examples are provided below, also illustrating the infelicity of the intransitive version with a nonhuman subject.

(31) a.

Alex	*hunyorogva*	*{jelzett/ jelezte}*	*hogy*	*valami*	very
Alex	squinting	indicated.3SG(INDEF/DEF)	that(c)	something	*nagyon*
fontosat	*lát.*				
important.ACC	sees				

'Squinting, Alex gave signals/ indicated that he saw something very important.'

b.

Halk	*koccanás*	*{#jelzett/ jelezte},*	*hogy*	*a*	*kerékpárját*	*az*
soft	clink	indicated.3SG(INDEF/DEF)	that(c)	the	bike.ACC	the
egyik	*bádogasztalhoz*	*támasztotta.*				
one	tin.table.ALL	leaned.3SG				

'A soft clink indicated that he had leaned his bicycle against one of the tin tables.'

Although I claim that the two lexical entries at hand are distinct, it should also be admitted that they are related in a conceptual sense. In my view, Kenesei (1992) is right in stating that these intransitive predicates have an associated proposition in their "conceptual frame". This could be described in more recent terms as them being thematic adjuncts (Rákosi 2006). Such a thematic adjunct can then be "argumentalized", making it a "derived argument", in the sense of Needham & Toivonen (2011). According to them, such a process takes place for instance when adjunct *for*-beneficiaries become indirect object arguments in cases such as:

(32) a. *John baked cookies for Mary.* b. *John baked Mary cookies.*

In fact, this is the standard approach to a wide range of verbs in Hungarian, including manner of speaking verbs.[8]

(33) a. *{ordít/ kiabál/ suttog}, hogy ...*
shouts.INDEF yells.INDEF whispers.INDEF that(c)

b. *{azt ordítja/ kiabálja/ suttogja}, hogy…*
that.ACC shouts.DEF yells.DEF whispers.DEF that(c)
'shouts/ yells/ whispers that…

In sum, rather than viewing such predicates as equally subcategorizing for a propositional argument in some very broad communicative sense (as Laczkó 2021 argues), I believe it is semantically and syntactically motivated to make a distinction. By doing so, we eliminate the need to invoke the COMP function for the intransitive, seemingly problematic instances. The CPs in question are thematic ADJUNCTS, which may be reanalyzed as OBJ or OBL_{θ} (see footnote 7) arguments.

4 Addressing the problematic issues in the nominal domain

Laczkó (2021) expands the discussion of COMPs to the nominal domain. The relevant examples are repeated here for convenience, including simple event nouns (SENs).[9]

(34) *Kati jelz-és-e, hogy induljunk*
Kate signal-DEV-POSS.3SG that(c) leave.SBJV.1PL
'Kate's signal that we should leave.'

(35) *a gondolat, hogy indulunk*
the thought that(c) leave.1PL
'the thought that we leave'

(36) *a kérdés, hogy ki induljon*
the question that(c) who leave.SBJV.3SG
'the question of who should leave'

If one accepts the conclusion in section 3 that *jelez* 'signal' may occur with a thematic adjunct clause, this position easily extends to the nominal version in (34), as well as to (35) and (36), making COMP unnecessary for these cases. In fact, this is the standard position in the literature, both cross-linguistically and specifically for Hungarian.

[8] Kenesei (1992: 615) notes a contrast in the same vein, with the verb *bíztat*. According to him, this verb may occur with a CP alone with the meaning 'tell somebody to do something', or with a subative-marked demonstrative + associated clause dependent, with the meaning 'urge/encourage'. Thus, in this case, we have the thematic adjunct turned into an OBL_{θ}.
Admittedly, this "argumentalization"-process needs further elaboration in future research. See Synder (1992) and Grimshaw (2015) for the syntax and semantics of manner of speaking verbs.
[9] I leave a discussion of complex event nouns from this perspective for further research. A paper on the topic by Laczkó, Szűcs & Rákosi (2020) does not reference the COMP function.

Regarding Hungarian, Kenesei (1992: 634) states that such nouns involve a proposition not as an argument but a "complement" in their "conceptual frame", akin analysis in the previous section. For English, it was argued as early as Stowell (1981) that such nouns (including nouns like *claim*, *belief*, *question*, *fact*, etc.) do not take CP-arguments. That is, in contrast with the classic PP-argument in (37), the CPs in (38) are not arguments, but appositive thematic adjuncts.[10]

(37) *the destruction [of the city]*

(38) a. *the claim/belief/fact [that all people are equal]*

b. *I'm a firm believer [that all people should have equal rights].*[11]

Bondarenko (2021) makes a parallel claim for Russian:

(39) *Mnenie čto belki vpadajut v spjačku ošibočno.*
opinion that(c) squirrels fall in hibernation mistaken
'The opinion that squirrels hibernate is mistaken.'

Bondarenko (2021) supports this position with evidence from optionality, binding-theoretic considerations, and case. For us, this last point is most relevant as it leads to another type of Hungarian nouns, which have not been discussed in the COMP-literature. She claims that nouns that do occur with clausal arguments also involve a genitive-marked demonstrative.

(40) *aspekty *(togo) čto načalas' èpoxa Èllinizma*
aspects that.GEN that(c) began period Hellenism
'aspects of (the fact) that the Hellenistic time began'

Such nouns (*aspekty* and the ones discussed below) should be regarded as relational (RNs) as their conceptual structure necessarily involve an entity to which they are related: *aspect/benefit/*etc. *#(of something)*. They display a similar behavior in Hungarian. While they can take a CP argument, I argue that the CP is not a COMP but a POSS, as suggested by the case marking. Kenesei (1992: 627) includes the Hungarian equivalents of nouns like *benefit*, *sense*, *consequence*, etc. in his discussion of the issue, see e.g. (41).

(41) *An-nak a haszn-a, hogy a vírus-t felfedezték, óriási.*
that-DAT the benefit-POSS.3SG that(c) the virus-acc discovered.3PL enormous
'The benefit (of it/that) that they discovered the virus is enormous.'

[10] The "conceptual frame" / "*thematic* adjunct" qualifications are important since obviously not all nouns may be supplemented with a CP-adjunct (*the thought/*brain that we leave*).

[11] See Tyler (2023) for a detailed argumentation for the adjunct-status of complements of *er*-nominalizations in English.

For discussing this issue, the following piece of background about Hungarian possessors is necessary. Hungarian has two kinds of possessors: nominative and dative (Szabolcsi 1994, Laczkó 2004).

(42)	*János*	*kalap-ja.*	b.	*János-nak*	*a*	*kalap-ja.*
	John.NOM	hat-POSS.3SG		John-DAT	the	hat-POSS.3SG
	Both: 'John's hat.'					

In my view, (41) corresponds to (42b). That is, RNs of this type subcategorize for a POSS, which may manifest as a simple nominal (e.g. *a cselekedet haszna/következménye* 'the action's benefit/consequence') or as a clause as well. Two auxiliary assumptions are needed. First, CPs cannot function as possessors directly, likely because they cannot receive appropriate case marking. This is why a demonstrative is used as a proxy in possessive constructions. Second, nominative demonstratives cannot function as possessors, a fact not unique to Hungarian, compare **that's hat* vs. *the hat of that*.

(43)	a.	**az*	*kalap-ja*	b.	*an-nak a kalapja*
		that	hat-POSS.3SG		that-DAT the hat-POSS.3SG
		Both: 'that's hat'			

The combination of these factors results in a situation where the clause, together with the dative-marked demonstrative pronoun, functions as the POSS argument of the given predicate. The proposed f-structure is shown below in (44). (The nominal+clause complex serves as the SUBJ of *enormous*, this is not represented, to save space.)

(44) *the benefit (of it/that) that they discovered the virus (is enormous)*

$$\begin{bmatrix} \text{PRED} & \text{`}\textit{benefit} \text{ <(POSS)>'} \\ \text{POSS} & \begin{bmatrix} \text{PRED} & \text{`}\textit{discover} \text{ <(SUBJ)(OBJ>'} \\ \text{SUBJ} & \text{`}\textit{they}\text{'} \\ \text{OBJ} & \text{`}\textit{the virus}\text{'} \\ \text{SPEC} & \begin{bmatrix} \text{`}\textit{that}\text{'} & \\ \text{DEIXIS} & \text{distal} \\ \text{DEF} & + \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

That SENs and RNs are different can be seen by the fact that the latter, but not the former, instantiates a genuine possessive relationship, which can be paraphrased using the Hungarian construction for 'X had a benefit' (Kenesei 1992: 628).

(45)	*An-nak,*	*hogy*	*Kati*	*megérkezett,*	*volt*	*{haszn-a /*
	that-DAT	that(c)	Kate	arrived.3SG	had.3SG	benefit-POSS.3SG
	**gondolat-a}.*					
	thought-POSS.3SG					
	'That Kate arrived had some benefit/*thought.'					

Furthermore, RNs *must* occur in the possessive frame with the dative demonstrative, as the possessor is a basic argument for them. While a possessor may also be added to SENs (so the dative proform is licit in 46b) but compared to RNs, this is only an additional element for them. Accordingly, SENs (but not RNs) can also occur with a nominative, non-possessor demonstrative.

(46) a. *az a {gondolat / *haszon}, hogy…*
that the thought benefit that(c)
'the (that) thought that…'

b. *annak a {gondolat-a / haszn-a}, hogy…*
that-DAT the thought-POSS.3SG benefit-POSS.3SG that(c)
'the thought/benefit of it that…'

In sum, nouns either occur with ADJUNCT clauses (simple event nouns: *belief*, *thought*, etc.) or POSS clauses (relational nouns: *benefit*, *consequence*, etc.). COMPs are not needed in the analyses, making this grammatical function superfluous for Hungarian.

5 Additional considerations

5.1 Clauses with adverbial associates – an unresolved issue

Belyaev et al. (2017), in their defense of COMP, invoke Moksha Mordvin data such as (47), where the adverbial proform *aftə* 'so' references a clause. Since their assumption is that OBJ and OBL_θ-clauses are referenced by appropriately case-marked nominal proforms, *aftə*-related clauses then must bear a different grammatical function, namely, COMP. (This point is further reinforced by replacement with a contentful noun and coordination.)

(47) *Nu mon t'aftə af dumand-an.*
well I thus NEG think-1SG
'Well, I don't think so (thus).'

While as I noted in the introduction, my goal is a more modest one of arguing for a COMP-less approach in Hungarian and not generally, the data is still relevant as some Hungarian clauses can be associated with a comparable adverbial manner demonstrative proform, *úgy* 'so.DIST'. In most instances there is an alternation with the nominal form (47a), but there are cases where the adverbial is the only option (e.g. 48b).[12]

[12] A reviewer noted that the notion "adverbial", not being a technical term of LFG, should be elaborated upon. I use it in a descriptive, traditional way, to refer to modifiers of verbs. For Moksha Mordvin, I simply Belyaev et al.'s (2017: 94) label. For Hungarian, the adverbial nature of *úgy* 'so.DIST' can be easily seen from the fact that in its standard pronoun use, it can replace a manner adverb, as shown in (i). For a relatively recent overview of propositional anaphors, including English *so*, see van Elswyk (2018).

(i) *{Szépen/úgy} csináltam.*
quickly so.DIST did.1SG
'I did it quickly/in that way.'

(48) a. *Kati {az-t / úgy} gondolja, hogy együnk.*
Kate that-ACC so.DIST thinks.DEF that(c) eat.3PL.SBJV
'Kate thinks that we should eat.'

b. *Kati {*az-t / úgy} emlékszik, hogy ettünk.*
Kate that-ACC so.DIST remembers that(c) ate.3PL
'Kate remembers (it/so) that we ate.'

We may treat the pronoun+clause complex as a single argument of the main predicate. Alternatively, only *úgy* 'so.DIST' is the argument of the main predicate and the clause is associated in some other fashion (Szűcs 2022 vs. Laczkó 2022, see also the next section). In either case, the question of the grammatical function remains.

While I cannot provide a definitive account to the issue of adverb-related clauses and do not exclude the possibility of a COMP-based analysis, I would like to highlight some relevant factors.

It is likely an important fact that that Hungarian *emlékszik* 'remember' can occur with a subative marked nominal (*emlékszik valami-re* 'remember something-SUB'), which may support an analysis involving OBL$_\theta$. However, this cannot be generalized: for instance, the verb *vél* 'deem' exclusively occurs with the adverbial manner demonstrative. Additionally, it is unclear whether the nominal and adverbial proforms for *gondol* 'think' should be treated as surface alternations of an OBJ or there is a deeper grammatical distinction to be uncovered.

Another possibility worth investigating as a relevant grammatical function is OBJ$_\theta$. Belyaev et al. (2017) also entertain this option but ultimately reject it, citing a lack of independent evidence, such as morphological contrasts between different kinds of OBJs. While this is a valid point, I do not believe it is conclusive. Admittedly, more investigation is needed, and the burden of proof lies with the proponents of the OBJ$_\theta$-analysis.

Belyaev et al. (2017) also note that the adverbial proform is associated with certain semantic effects, suggesting that there may be more to this issue than grammatical function alone. In particular, both the Moksha Mordvin and the Hungarian adverbial proforms are linked to (non)-factivity. This is illustrated in (48), where the predicate alternates between occurring with the nominal and the adverbial proform, with the former triggering a factive interpretation and the latter a non-factive interpretation.

(49) *{Azt/ úgy} tudom, hogy Kati okos.* (Hungarian)
that.ACC so.DIST know.1SG that(c) Kate smart
With that.ACC: 'I know the fact that Kate is smart.'
With so.DIST: 'According to my knowledge, Kate is smart.'

It must be acknowledged that the issue of adverbial elements has broader implications beyond the COMP-debate. The general question concerns the status of arguments with an adverbial nature. What grammatical function should be assigned to the entailed manner meaning component of a predicate like *behave*? Notice that even in the absence of an explicit adverb, the predicate still strictly entails that the behavior happened in some contextually appropriate manner.

(50) *They should behave #(appropriately / nicely / badly / etc.).*

This is a non-trivial question that necessitates further investigation. OBL$_\theta$ seems much more intuitively appropriate here than any other option (including COMP). If this is correct, then perhaps the variability inherent of the OBL$_\theta$ function might be exploited in the domain of the clausal arguments discussed in this section as well.

5.2 On demonstratives as clausal associates

In the constructions examined, demonstrative pronouns played a prominent role, so I would like to offer some insights regarding their syntactic and semantic status. This discussion is partially based on Szűcs (2022), viewed from the perspective of the present paper, with some additional considerations.

The Moksha Mordvin *t'aftə* 'thus' in (47) is clearly an argumental demonstrative pronoun, serving whatever grammatical function is most appropriate for the propositional argument of the predicate *dumand* 'think'. The same is true for the Hungarian equivalent below where the manner demonstrative has both distal and proximal forms. Both are usable, the choice depending on discourse deictic considerations (speaker's attitude, information structure, etc.)

(51) (responding to an earlier statement)
Én nem {úgy/ így} gondolom.
I not so.DIST so.PROX think.1SG
'I don't think so.'

Example (48a) is different, as there is a formal association between the pronoun and the clause and in some sense, as they jointly serve as the propositional argument. (7c), (8c) and (9c) illustrate the same phenomenon as (48a). The distinct status of these pronouns is supported by special licensing conditions – related to the semantic nature of the main predicate and the information structure of the sentence – as well as the marked status of the proximal form (see Szűcs 2022 for details).

Szűcs (2022) endorses a "unification" analysis based on insights by Berman et al. (1998), in which the proform contributes a PRED attribute and the clause is a restriction over that attribute, as they jointly serve as the appropriate grammatical function. Szűcs (2024) is also an analysis in this spirit in a Minimalist framework, the pronoun being a secondary predicate in the specifier of the CP. As an alternative, Laczkó (2022) proposes that the pronoun is the argument of the main predicate by itself, and it is also a predicate that licenses the clause. Essentially, both analyses recognize the special status of the clausal associate demonstrative, and they converge on its predicative nature. The key difference between the two lies in whether the relationship between the main predicate and the complement clause is direct (Szűcs) or indirect (Laczkó).

Finally, we also observed demonstrative pronouns with the nominals like *gondolat* 'thought' and *haszon* 'benefit' in section 4 (examples 41, 45, 46). Here, I see no reason to assume that these should receive an analysis distinct from run-of-the-mill demonstrative determiners in Hungarian. There are no special licensing conditions or deictic restrictions that would motivate such a special treatment. Thus, in terms of the syntactic and semantic status of demonstratives, (52a) and (52b) are analogous. The same applies to *benefit*-type relational nouns. This analysis is reflected by representing its contribution to the f-structure SPEC in (44).[13]

(52)	a.	*{az /*	*ez}*	*a*	*kutya*	b.	*{az /*	*ez}*	*a*	*gondolat, hogy…*
		that	this	the	dog		that	this	the	thought that
		'that/this dog'					'the thought that…'			

6 Conclusion

In this paper, I defended Szűcs's (2018) COMP-less approach to finite complement clauses in Hungarian. While Laczkó (2021) raises some valid concerns with respect to coordination, subcategorization and nominals which seem to support the invocation of COMP, I argued that the concerns are not conclusive, and a closer scrutiny actually favors analyses without COMP. The problematic data can be addressed through general considerations (about coordination), reference to thematic adjuncts (CPs occurring with verbs like intransitive *jelez* 'signal' and simple event nouns like *gondolat* 'thought'), and the POSS function (for relational nouns). Overall, my conclusion is that all relevant facts in Hungarian can be captured with a COMP-less analysis and thus using this grammatical function offers no analytical advantage.

Admittedly, the COMP-debate cannot be considered as closed. A narrower question concerns the functional status of adverbial arguments (both clauses and genuine adverbs), for which COMP might be a potential solution. While this issue primarily arose in the context of Moksha Mordvin and Hungarian, the cross-linguistic diversity of complement clauses suggests that similar questions may arise in other languages.

The related broader question is a meta-theoretical one: what constitutes sufficient grounds for postulating a given grammatical function? Historically, LFG began with COMP in its inventory, so the burden of proof seems to rest on those who, in the words of Alsina et al. (2005), seek to "get rid of it". However, one could argue that historical precedent alone should not dictate what constitutes a null hypothesis. After all, Bresnan (1982) did not introduce COMP after a comprehensive evaluation of the theoretical and empirical landscape. Unlike SUBJ and OBJ, this grammatical function did not have precursors in the traditional literature – rather, it was an intuitive and useful analytical tool that was incorporated into the LFG-framework. Hence, COMP's existence is not a logical, theoretical necessity and it is easy to imagine an alternative history where it was not introduced.

Now one can ask this question: in this alternative timeline, would facts like the ones we saw in Moksha Mordvin and Hungarian in section 5.1 be enough for inventing a new grammatical function like COMP? And, for that matter, why stop at COMP and not add more grammatical functions? I believe the danger of the slippery slope is real: as I said, I suspect the range of the cross-linguistic data would allow for some arguments in that direction. For instance, Bodomo & Lee (2001: 422) states that "a introduction of a degree of mixedness" is necessary and Falk (2005) adds XOBL_θ and XOBJ_θ. Given

[13] Obviously, (52a) and (52b) differ in that the SENs and RNs license a propositional dependent (as thematic adjunct or as a POSS argument, respectively), while simple nouns like *dog* do not. Also, it is a presently irrelevant syntactic detail that English does not permit the co-occurrence of a demonstrative determiner and a definite article while Hungarian does. This might be not very common cross-linguistically but is not unheard of either. For examples, see Dékány (2021: 93-94).

LFG’s generally conservative stance on adding new categories (see e.g. Börjars et al. 1999) it is perhaps unsurprising that these proposals never gained much traction, and researchers would rather opt for problematic data to be handled with the help of a more restrictive GF-inventory. That said, others may interpret the situation differently and argue that the complexity added by the auxiliary considerations do shed favorable light on adding a separate grammatical function.

At any rate, I hope to have shown that a COMP-less view like Szűcs’s (2018) for Hungarian is a viable one. What this means for a *COMP*lete view of the theory remains to be seen.

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Demonstrative TO in Polish – an L$_R$FG analysis

Sebastian Zawada
Institute of Computer Science,
Polish Academy of Sciences

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Miriam Butt, Jamie Y. Findlay and Ida Toivonen (Editors)

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Abstract

This paper offers an L_{R}FG analysis of the Polish demonstrative word *to*, which may occur in two syntactic environments: (i) in typical nominal positions and (ii) in the unique copular structure TO + BYĆ 'to be' + NP, in which the right-hand NP appears in the nominative case and triggers agreement with the copula. In (i), *to* may only refer to antecedents lacking number and gender (e.g., clauses), whereas in (ii) it may refer to any antecedent. *To* is analysed as one underspecified vocabulary item exponing two structures: a noun lacking number and gender in (i) and a demonstrative identifier in (ii). The difference in their anaphoric possibilities follows from blocking: *to* is blocked in (i) by personal pronouns whenever the antecedent has number and gender, due to an anaphoric agreement mechanism and the specification of vocabulary items.

1 Introduction

In typical nominal positions, Polish personal pronouns and the demonstrative pronoun *to* used anaphorically are in a complementary distribution, as shown in (1a)–(1b) and (2a)–(2b).† Whenever the antecedent is a nominal phrase bearing number and gender (*nowy komputer* 'a new computer.SG.M' in (1)), a corresponding personal pronoun must be used (*on* 'PERS.SG.M'). Otherwise, for example, in the case of the clausal antecedent in (2), the demonstrative word *to* is used.[1] As will be shown below, *to* in (2a)–(2b) is a noun, and hence this use of *to* is dubbed here TO_{N}.

(1) Kupiłem [nowy komputer]$_i$.
'I bought a new computer.'

a. Jest {on$_i$ / #to$_i$} świetnym narzędziem do nauki.
is.3SG PERS.SG.M / this excellent.INS tool.INS to study
'It is an excellent tool for studying.'

b. {Miał on$_i$ / #Miało to$_i$} świetne parametry.
had.3SG.M PERS.SG.M / had.3SG.N this excellent specifications.ACC
'It had excellent specifications.'

(2) [Polska przegrała kolejny mecz]$_i$.
'Poland lost another match.'

a. Było {to$_i$ / #ono$_i$} prawdziwym skandalem. (TO_{N})
was.3SG.N this / PERS.SG.N real.INS scandal.INS
'It was a real scandal.'

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[1]The class of Polish third-person personal pronouns consists of three singular forms (*on*.SG.M/*ona*.SG.F/*ono*.SG.N) and two plurals: masculine virile (*oni*.PL.MV) and other than masculine virile (*one*.PL.NMV). Personal pronouns are further glossed as PERS. The other morphosyntactic abbreviations follow the Leipzig Glossing Rules (https://www.eva.mpg.de/lingua/resources/glossing-rules.php). To avoid clutter, only morphosyntactic information relevant to the phenomenon under investigation is presented. Since personal pronouns in all examples in this paper are in the nominative case, this information is not included in the glosses.

b. Zaskoczyło mnie {to$_i$ / #ono$_i$}. (TO$_{\text{N}}$)
surprised.3SG.N I.ACC this / PERS.SG.N
'It surprised me.'

Sentences (1a) and (2a) are typical Polish copular clauses with instrumental predicates, whereas (1b) and (2b) contain standard non-copular verbs. The anaphoric items in all these sentences can be replaced by lexical nouns. The word order in the sentences above (as well as in (1c) and (2c) below) is driven by information structure and is quite flexible: in principle, in each of these sentences the pronoun can be placed initially, but this would be slightly less natural and could suggest a contrastive interpretation. Note that Polish verbs express gender in the past tense, but not in the present, and hence *Jest* in (1a) is simply glossed as 'is.3SG'.

Intriguingly, *to* must be used regardless of the syntactic status of the antecedent in the unique copular structure consisting of *to*, the copula BYĆ 'to be', and the nominal predicate in the nominative case agreeing with the copula, see (1c) and (2c). This use of *to* is dubbed here TO$_{\text{D}}$ (in §2.1.2, I argue that its syntactic category is demonstrative identifier).[2]

(1) Kupiłem [nowy komputer]$_i$.
'I bought a new computer.'

c. Był {to$_i$ / #on$_i$} świetny zakup. (TO$_{\text{D}}$)
was.3SG.M this / PERS.SG.M excellent purchase.SG.M.NOM
'It was a great purchase.'

(2) [Polska przegrała kolejny mecz]$_i$.
'Poland lost another match.'

c. Był {to$_i$ / #ono$_i$} prawdziwy skandal. (TO$_{\text{D}}$)
was.3SG.M this / PERS.SG.N real scandal.SG.M.NOM
'It was a real scandal.'

At this point, it is worth adding that Polish personal pronouns indeed require the presence of some *syntactic* features on their antecedents. Their semantic status does not play a role: they can be inanimate concrete objects (the new computer in (1)), humans (see (3)), and even abstract objects, such as an event expressed by a gerund form (see (4)).[3] What is relevant is that they bear agreement features (henceforth: AF) corresponding to the pronoun's features.[4]

(3) Ale najbardziej bałam się o dziecko$_i$: ono$_i$ musiało
but most feared.3SG.F REFL about child PERS.SG.N had.3SG.N
urodzić się zdrowe!
born.INF REFL healthy
'But what I feared most was for the baby: it had to be born healthy.' (NCP)

[2]Note that the labels TO$_{\text{N}}$ and TO$_{\text{D}}$, which hint at the categorial status discussed later, are only intended to help the reader navigate the data and do not have any theoretical value. Labels such as ITEM1 and ITEM2 could be used instead.

[3]The sentences marked 'NCP' come from the National Corpus of Polish (Przepiórkowski et al. 2012).

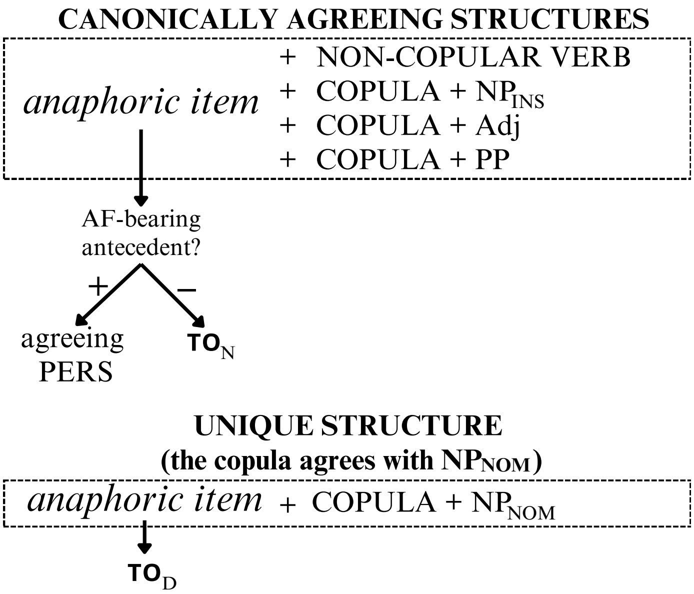
[4]To jointly refer to NUMBer and GENDer, I use the term *agreement features* (AF) instead of *ϕ-features* – commonly used in the Minimalist and formal semantic literature – to avoid possible confusion with the ϕ-function, mapping c-structure to f-structure. Antecedents will often be described as AF-*less* and AF-*bearing*, meaning *agreement-featureless* and *agreement-features-bearing*, respectively.

(4) Gdy zaczęło się kupowanie$_i$, miało ono$_i$ gwałtowny
when started.3SG.N REFL buying.SG.N.NOM had.SG.N PERS.SG.N violent
charakter.
character
‘When the buying started, it had a violent nature.’ (NCP)

The aim of this paper is to provide an analysis of the observed phenomenon, which is recapitulated in a concise generalisation in (5), and for convenience schematically presented in Figure 1. More specifically, the paper answers the following questions: Why does only TO_N have restricted anaphoric possibilities? What is the relationship between TO_N and TO_D?

(5) When used anaphorically, *to* in the copular structure with the nominative nominal predicate (TO_D) may have an antecedent of any type, whereas *to* in any other structure (TO_N) can only have an antecedent lacking number and gender.

Figure 1: Anaphoric items used in Polish syntactic constructions



The proposed analysis adopts the Lexical-Realizational Functional Grammar framework (L_RFG; Melchin et al. 2020; Asudeh et al. 2023, Asudeh & Siddiqi 2023: §5.3; among others). I argue that the realisational character of this approach and a competition mechanism that it employs allow for a parsimonious and insightful explanation of the observed phenomenon. *To* is analysed as an underspecified vocabulary item exponing two structures: an AF-less noun (which gives rise to TO_N) and a demonstrative identifier (TO_D). The AF-less noun TO_N can only be inserted when personal pronouns cannot be exponed because their licensing conditions are not satisfied. This situation arises when the structure they are supposed to expone lacks AF. The presence of AF in the anaphoric nominal structure is, in turn, determined by the form of antecedent.[5]

[5]It should be noted that the paper focuses exclusively on the nominative case of the relevant forms. The complexities of Polish personal pronouns in other cases go far beyond the scope of this paper. Suffice it to say that all non-nominative forms of personal pronouns are suppletive and can have up to four forms:

When the antecedent lacks AF, the nominal structure also lacks them and is exponed by the elsewhere form *to*. The demonstrative identifier (TO$_{\text{D}}$) can only be realised as *to* because the conditions licensing the personal pronoun stem are in this case never satisfied.

In §2, I present more data and show that TO$_{\text{N}}$ is a noun, but it does not bear gender or number, whereas TO$_{\text{D}}$ is a demonstrative identifier (Diessel 1999). In §3, I introduce the basics of the L$_{\text{R}}$FG framework and present the analysis briefly sketched in the previous paragraph. §4 discusses some limitations of the proposed analysis and concludes the paper.

2 Analysis

2.1 Categorial status

2.1.1 TO$_{\text{N}}$ is a noun, TO$_{\text{D}}$ is not

The item called here TO$_{\text{N}}$ is a noun, whereas TO$_{\text{D}}$ is not: the former passes all diagnostic tests for nounhood presented below, whereas the latter does not pass any of them.

The first test is modifiability by adjectives. As shown in (6a) and (6b), only TO$_{\text{N}}$ can be modified by the adjective SAM 'alone'.[6]

(6) [Polska przegrała kolejny mecz]$_i$.
'Poland lost another match'

a. (Samo) to$_i$ było skandalem. (TO$_{\text{N}}$)
alone this was.SG.N scandal.SG.M.INS
'This alone was a scandal.'

b. (*Samo) to$_i$ był skandal. (TO$_{\text{D}}$)
alone this was.SG.M scandal.SG.M.NOM
Intended: 'This alone was a scandal.'

Another feature that differentiates TO$_{\text{N}}$ from TO$_{\text{D}}$ and indicates the nominal character of the former is the coordination of *to* with another NP. This is possible in the case of TO$_{\text{N}}$, but not in the case of TO$_{\text{D}}$, see (7a)–(7b).[7]

(7) [Polska przegrała kolejny mecz]$_i$.
'Poland lost another match'

a. To$_i$ i pomeczowa bójka było skandalem. (TO$_{\text{N}}$)
this and post-match brawl.SG.F.NOM was.3SG.N scandal.SG.M.INS
'This and the post-match brawl were a scandal.'

b. To$_i$ (*i pomeczowa bójka) był skandal. (TO$_{\text{D}}$)
this and post-match brawl.SG.F.NOM was.3SG.M scandal.SG.M.NOM
Intended: 'This and the post-match brawl were a scandal.'

long (accented), short (unaccented), a special form occurring after prepositions, and a clitic form attached to prepositions. For instance, consider the genitive singular masculine pronoun in these four versions, respectively: *jego* / *go* / *niego* / *-ń*.

[6] Due to the pronominal semantics, other adjectives do not easily combine with *to*.

[7] The unexpected singular neuter form of the copula in (7a) is briefly discussed in §2.2.1.

Two other empirical facts suggest that TO$_{N}$ is a noun. Polish nouns inflect for case and, obviously, serve as arguments of verbs and prepositions. *To* also inflects for case (e.g., *tego*.GEN or *temu*.DAT) and can be found in the position of a nominal argument of a verb or preposition (e.g., *Nie lubię tego* 'I don't like this.GEN'). Importantly, it will never have an antecedent bearing AF in such situations. This can be treated as further evidence for the nounhood of TO$_{N}$.

Given that TO$_{D}$ can only be found in one particular construction (*To*+BYĆ+NP$_{NOM}$), it is not possible to directly check if it inflects for case or serves as an argument of a preposition or a verb (other than the copula BYĆ agreeing with the predicate). However, the aforementioned fact that *to* inflected for case or placed in an argument position never refers to an AF-bearing antecedent – and thus always behaves like TO$_{N}$ – may be treated as indirect evidence against the nominal status of TO$_{D}$.

In conclusion, TO$_{N}$ is a noun, whereas TO$_{D}$ is not, with the arguments summarised in Table 1.

Table 1: Summary of the diagnostic tests for nounhood

	TO$_{N}$	TO$_{D}$
combines with adjectives	+	–
coordinates with NPs	+	–
inflects for case	+	(–)
serves as a dependent of V/P	+	(–)

2.1.2 TO$_{D}$ is a demonstrative identifier

While it is straightforward to demonstrate that TO$_{D}$ is not a noun, determining its true categorical status is much more challenging. In the Polish tradition, TO$_{D}$ has been analysed either as a noun (for example by Wiśniewski 1987) or as a quasi-verb – a predicative item formed by the complex unit TO BYĆ (see Bogusławski 1988, 2002). Here I argue that TO$_{D}$ is neither of them, but belongs to the class of demonstrative identifiers (Diessel 1999).[8]

[8] The analysis treating TO$_{D}$ as a quasi-verb assumes that the form *to* in sentences such as (1c) and (2c) is an integral part of the *verbal* unit TO BYĆ, which takes the nominative NP as its sole argument. While there is no space to provide a full critique of this kind of analysis here, it suffices to note that all Polish verbs (and quasi-verbs, such as TRZEBA 'necessary') attach the negative marker to the left. However, in sentences with TO$_{D}$, the negative marker always directly precedes the copula, indicating that this is the only verbal element in this sentence, see (i)–(ii). Employing the attachment of the negation marker as a test for determining verbal character is adopted from Bondaruk (2013: 218).

(i) a. (Nie) trzeba (*nie) było biegać. (quasi-verb)
NEG necessary.QV NEG was.3SG.N run.INF
'It wasn't necessary to run.'
b. (Nie) było (*nie) trzeba biegać. (quasi-verb)
NEG was.3SG.N NEG necessary.QV run.INF

(ii) a. (*Nie) to (nie) był skandal. (TO$_{D}$)
NEG this NEG was.3SG.M scandal.SG.M.NOM
'It wasn't a scandal.'
b. (Nie) był (*nie) to skandal. (TO$_{D}$)
NEG was.3SG.M NEG this scandal.SG.M.NOM

Also, it is worth noting that adopting the quasi-verb approach would require some reformulation of the final analysis presented in §3, but the main insight would remain intact.

TO$_{\text{D}}$ does not inflect and cannot trigger agreement, and yet it is a strictly referential item that can be used anaphorically and deictically. In his monograph on demonstratives, Diessel (1999: §4:3) calls such peculiar items occurring exactly (and uniquely) in copular clauses demonstrative *identifiers* (in opposition to demonstrative *pronouns*, *determiners* and *adverbs*). The author argues that they can be identified in many typologically unrelated languages based on phonological and morphological clues.[9] In some languages – such as Supyire, Karanga and Western Bade (Diessel 1999: 80–83) – the stem of the demonstrative in a copular or non-verbal clause is different from the stem of demonstratives used in other contexts.

In other languages, including some Indo-European languages such as French, German, Modern Hebrew, Dutch (den Dikken 2024), and Serbo-Croatian (Browne 1999), the demonstrative identifier can be distinguished based on morphological and syntactic evidence. Namely, it does not agree nor inflect, see the German example in (8).[10]

(8) a. Das ist meine Schwester. (German)
DEM.NOM/ACC.SG.N is my sister.SG.F
'This is my sister.' (Diessel 1999: 88)

b. Das sind meine Freunde. (German)
DEM.NOM/ACC.SG.N are my friend.PL
'These are my friends.' (Diessel 1999: 88)

The item dubbed here TO$_{\text{D}}$ perfectly matches the morphological and syntactic criteria for demonstrative identifier, and is therefore classified as belonging to this category.

Of course, postulating a single-element grammatical category may raise some concerns. Diessel's arguments (having a phonologically distinct stem and/or failing to agree and inflect) do not form conclusive evidence for a distinct category on their own. It seems, however, that we have no alternative – TO$_{\text{D}}$ does not conform to any category usually assumed to exist in Polish. I consider this fact, combined with Diessel's morphological and syntactic arguments and the frequency of the cross-linguistic pattern, to be sufficient justification for classifying TO$_{\text{D}}$ as a demonstrative identifier. In the c-structure, I will refer to it with the label Dem.

Determining that TO$_{\text{D}}$ is not a noun, but must be analysed as a distinct category (such as Dem adopted in this paper), will turn out sufficient to account for the generalisation presented in (5). This allows us to remain agnostic about the c- and f-structural representation of sentences containing TO$_{\text{D}}$, such as (1c) and (2c), repeated below as (9) and (10). The only thing relevant for the analysis at hand is that the c-structure rules responsible for building these sentences employ Dem.

(9) Był to świetny zakup. (TO$_{\text{D}}$)
was.3SG.M this excellent purchase.SG.M.NOM
'It was a great purchase.'

(10) Był to prawdziwy skandal. (TO$_{\text{D}}$)
was.3SG.M this real scandal.SG.M.NOM
'It was a real scandal.'

[9] Diessel's *morphological* evidence for demonstrative identifiers is in fact *morphological and syntactic*: it relies not only on inflection but also on agreement facts.

[10] The morphosyntactic glosses in (8) are drawn from Diessel (1999); however, the demonstrative identifier *das* should probably be analysed as caseless and lacking AF, only homonymous to the NOM/ACC.SG.N demonstrative.

Here, we can only point out why it is not straightforward how to analyse such sentences in LFG, leaving a comprehensive analysis for future research. Note that the nominative predicate agrees with the copula, and hence – at least according to what is typically assumed for Polish – it should be analysed as SUBJ. In consequence, *to* must be assigned a different grammatical function, but any that is usually postulated in LFG cannot be adequately motivated for such a strange item: serving as the subject of predication, having pronominal, referential semantics, and being syntactically inert.[11] At this point, it can only be concluded that a thorough analysis of sentences such as (9)–(10) can provide valuable insights into the research on copular clauses in LFG (see Dalrymple et al. 2019: §5.4.5 for an overview).

2.2 TO_N does not have agreement features

Consider (11), a modified version of (2b). In the subject position, TO_N triggers what seems to be 3rd person singular neuter agreement.

(11) To mnie zaskoczyło. (TO_N)
this I.ACC surprised.3SG.N
'It surprised me.'

At first glance, this may be treated as evidence that TO_N itself is a singular neuter noun. Note, however, that third person singular neuter is also the *default* agreement in Polish (Dziwirek 1990), triggered when the subject is not a nominative NP equipped with AF. The default agreement is observed, for instance, when the subject is an infinitival phrase or an accusative numeral phrase, as illustrated in (12) and (13), respectively.[12]

(12) Strzelać było zakazane.
shoot.INF was.3SG.N forbidden
'Shooting (*lit*. to shoot) was forbidden.' (NCP)

(13) Pięć osób przyszło.
five.ACC person.PL.F.GEN came.3SG.N
'Five people came.' (NCP)

I argue that (11) is also an instance of default agreement triggered exactly for the same reason as in (12)–(13), namely, the absence of an AF-bearing nominative NP in the subject position. *To* in the subject position in (11) is a nominative NP, but lacks AF.

In §2.2.1 and §2.2.2, I present two arguments for AF-less status of TO_N, based on coordination facts and on observations related to situations in which TO_N itself is the antecedent of an anaphoric item.[13]

[11] This suggests exploring alternative approaches, such as the reductionist approach proposed in Patejuk & Przepiórkowski (2016), which eliminates specific grammatical functions from the f-structure if they cannot be justified by established syntactic tests.

[12] Arguments supporting the analysis assuming the accusative case on Polish numeral subjects can be found, for instance, in Przepiórkowski (1999: §5.3.1.1).

[13] The idea that the demonstrative word *to* in such sentences is AF-less – rather than possessing true singular neuter features – has been proposed in Bartošová (2017) for the Czech demonstrative *to*. However, it was not supported by arguments of the sort presented here.

2.2.1 Coordination

Polish coordinated NPs trigger either plural agreement or, with some restrictions, closest conjunct agreement, see (14). In contrast, coordinated AF-less items always trigger third-person singular neuter (default) agreement, see (15) (such coordinations are slightly degraded because a more natural option – with gerunds instead of infinitives – is available).

(14) Okno i krzesło {było / były} w tym pokoju
window.SG.N and chair.SG.N was.SG.N / were.PL in this room
najładniejsze.
beautiful.SUP
'The window and the chair were the most beautiful in this room.'

(15) [Skoczyć na bungee]$_{\text{InfP}}$ i [wejść na Kilimandżaro]$_{\text{InfP}}$ {?sprawiło
jump.INF on bungee and climb.INF on Kilimanjaro made.3SG.N
/ *sprawiły} mu najwięcej problemów.
/ made.PL he.DAT most troubles
'Bungee jumping (*lit.* to bungee-jump) and climbing (*lit.* to climb) Kilimanjaro posed the greatest challenges for him.'

Crucially, the coordination of two instances of TO$_{\text{N}}$ cannot trigger plural agreement. Therefore, it aligns with the AF-less infinitival phrases in (15), and not with the singular neuter nouns shown in (14). Note that coordinating two anaphoric uses of *to* is problematic, as it seems impossible to determine which *to* refers to what. However, TO$_{\text{N}}$ can also be used deictically and as a correlate heading a complementiser phrase. Instances of these uses of *to* can be easily coordinated, but they never trigger plural agreement, see (16)–(17).

(16) To$_{\rightarrow}$ i to$_{\rightarrow}$ mnie {zaskoczyło / *zaskoczyły}.
this and this I.ACC surprised.3SG.N / surprised.3PL
'This and this surprised me.' ('$\rightarrow$' = pointing gesture)

(17) [To, że Polska przegrała], i [to, że kibice się pobili],
this COMP Poland lost and this COMP fans REFL brawled
{było / *były} skandalem.
was.SG.N / were.PL scandal.SG.M.INS
'[That Poland lost]$_{\text{nominalised}}$ and [that fans got into a brawl]$_{\text{nominalised}}$ was a scandal.'

Interestingly, the default agreement is also most natural in cases where *to* is coordinated with a lexical noun that serves as the closest conjunct, see (18), which is a modified version of (7a).

(18) [Polska przegrała kolejny mecz]$_i$. To$_i$ i pomeczowa bójka
Poland lost another match this and post-match brawl.SG.F.NOM
{było / ?była / ??były} skandalem.
was.SG.N / was.SG.F / were.PL scandal.SG.M.INS
'Poland lost another match. This and the post-match brawl was a scandal.'

Even though the closest conjunct is feminine, the singular neuter form of the verb is the most acceptable. I argue that this is because TO$_N$, being AF-less, disrupts the standard agreement mechanism of coordinated phrases and imposes default agreement. Other possibilities (closest conjunct and plural agreement) are not fully excluded, suggesting that the grammar exhibits some flexibility in this respect, possibly because such coordinations are not very common.

2.2.2 Reference to TO$_N$

As previously mentioned, Polish personal pronouns must agree with their antecedents, cf. (1). Note that the singular neuter pronoun *ono* cannot refer to an instance of TO$_N$, as shown in (19).

(19) A: To$_i$ mnie zaskoczyło. (TO$_N$)
this I.ACC surprised.3SG.N
'It surprised me.'

B: Mnie też {to$_i$ / #ono$_i$} zaskoczyło. (TO$_N$)
I.ACC also this / PERS.SG.N surprised.3SG.N
'It surprised me as well.'

If we accept the claim that TO$_N$ is AF-less, the phenomenon illustrated in (19) is immediately explained: the pronoun *ono* 'PERS.SG.N' expects its antecedent to have singular number and neuter gender. The word *to* in the sentence uttered by A lacks these features, and thus *ono* cannot take it as an antecedent.

Also, this observation justifies the exact formulation of the main generalisation presented in (5). We say that TO$_N$ must refer to AF-*less* items, although examples (1)–(2) may suggest another interpretation: that TO$_N$ must refer to *non-nominal* items. However, this would undergenerate: TO$_N$ can take as an antecedent another instance of TO$_N$, which is a noun but lacks AF.

Let us also present evidence that the two tests employed here are indeed sensitive to the AF-bearing vs. AF-less status of some phrase. As already shown in (4), repeated below as (20), Polish gerunds are referred to with the use of the personal pronoun *ono* 'PERS.SG.N'. Therefore, Polish gerunds pass one of the two tests for having true singular neuter features.

(20) Gdy zaczęło się kupowanie$_i$, miało ono$_i$
when started.3SG.N REFL buying.SG.N.NOM had.SG.N PERS.SG.N
gwałtowny charakter.
violent character
'When the buying started, it was of (*lit.* had) a violent nature.' (NCP)

This provides a welcome opportunity to validate the tests themselves. Namely, we expect the other test (agreement triggered by coordinated phrases) to yield the result consistent with (20). In other words, we expect coordinated gerunds to be able to trigger plural agreement. If they fail to do so, the tests turn out to be ineffective, as they give conflicting results.

However, coordinated gerunds can indeed trigger plural agreement, as demonstrated in (21)–(22), and thereby they confirm the reliability of the tests.

(21) Osądzanie i szufladkowanie powodują, że
judging.SG.N.NOM and pigeonholing.SG.N.NOM cause.3PL COMP
rozmówca musi koncentrować się na obronie poczucia własnej wartości.
interviewee must focus.INF REFL on defence feeling own value
'Judging and pigeonholing cause the interviewee to focus on defending their self-esteem.' (NCP)

(22) Nagradzanie i karanie są ściśle powiązane
rewarding.SG.N.NOM and punishing.SG.N.NOM are.PL strictly linked
z procesem motywowania pracowników.
with process motivating employees
'Rewarding and punishing are closely linked to the process of motivating employees.' (NCP)

The facts established in this section will serve as a basis for the formal analysis presented in §3. The key points are: (i) TO_N is a noun, but it lacks AF, and (ii) TO_D is not a noun, but it belongs to the class of demonstrative identifiers (Dem) postulated by Diessel (1999).

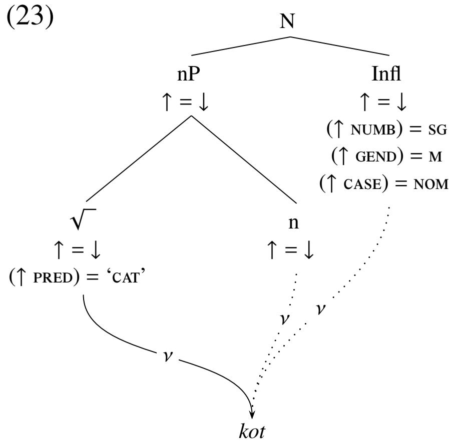
3 L_RFG formalisation

3.1 Introduction to L_RFG

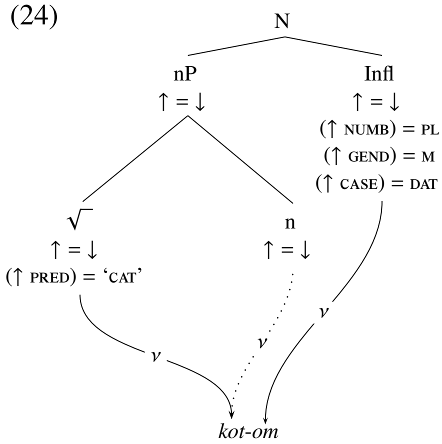
The analysis presented here adopts Lexical-Realizational Functional Grammar (see Melchin et al. 2020; Asudeh et al. 2023, Asudeh & Siddiqi 2023: §5.3, a.o.), which combines LFG with Distributed Morphology (DM; Halle & Marantz 1993), a realisational and morpheme-based approach to word formation.

In L_RFG, the c-structure terminal nodes are populated not by words coming from the lexicon, but by c-structure labels (categories) equipped with f-descriptions, which are in turn mapped to v(ocabulary)-structures via a separate function (ν). See the examples involving two Polish forms – *kot* 'cat.SG.M.NOM' and *kotom* 'cat.PL.M.DAT' – in (23)–(24), which are further discussed below.

(23)



(24)



As shown in the trees above, I assume that the Polish nominal spine consists of a root providing the PRED value ($\sqrt{\ }$), a morpheme responsible for the category (the nominaliser n), and a nominal suffix (Infl) expressing gender, number and case.[14]

Instead of a lexicon, L_RFG postulates a list of vocabulary items (VIs), that is, a list of mappings from an exponendum (the tuple on the left-hand side of $\xrightarrow{\nu}$ in (25)) to an exponent (the v-structure on the right-hand side of $\xrightarrow{\nu}$ in (25)). The v-structure is further mapped onto the prosodic structure and finally the phonological string. For the purposes of this paper, I present simplified versions of v-structures, containing only the phonological representation, as in (23)–(24).

(25) The structure of a vocabulary item (Asudeh et al. 2023: 23)

$$\left\langle \underset{\textit{distribution}}{[C_1, ..., C_n]} \;,\; \underset{\textit{function/meaning}}{F \cup G \cup I} \right\rangle \xrightarrow{\nu} \left[\quad \right]_{\textit{v-structure}}$$

The first member of the exponendum is a list of syntactic categories (the labels of c-structure terminal nodes). A vocabulary item can contain more than one category C, as it can *span* multiple adjacent c-structure nodes.[15] The second member (F ∪ G ∪ I) is the union of three possibly empty sets: a set of f-descriptions (F), a set of descriptions of s-structures and Glue meaning constructors (G), and a set of descriptions of i-structures (I).

Consider the Vocabulary Items used in the trees presented above: (26), exponing the stem *kot* 'cat', and (27), exponing the plural dative suffix. Given that the suffix *-om* marks the plural dative in all Polish inflecting nouns, regardless of their gender, the VI in (27) is not specified for this feature.

(26) $$\left\langle [\sqrt{\ }],\ \begin{array}{l}(\uparrow \text{PRED}) = \text{`CAT'} \\ \textbf{cat} : (\uparrow_\sigma \text{VAR}) \multimap (\uparrow_\sigma \text{RESTR})\end{array} \right\rangle \xrightarrow{\nu} \textit{kot}$$

[14] This is a departure from what is typically assumed in Distributed Morphology, where gender, number and case are usually represented on separate nodes (see Norris 2022 for an overview). However, as noted by Belyaev (2024), there are no good arguments for such a large structure in Russian, where gender, number and case are marked with a single fusional suffix. This also holds true for Polish. Note that the gist of the analysis presented here does not hinge on the size of the nominal spine and can be easily reformulated to adhere to typical DM standards.

[15] On spanning, see for example Haugen & Siddiqi (2016) and references therein.

(27) $\langle$ [Infl], $(\uparrow \text{NUMB}) = \text{PL}$ $\rangle \xrightarrow{\nu}$ *-om*
$(\uparrow \text{CASE}) = \text{DAT}$

We have not postulated vocabulary items for the nodes n and the nominative version of Infl (specified as in (23)). The mapping of these nodes in (23)–(24) represent instances of the so-called Pac-Man spanning (expressed by dotted line): if a terminal node would be left unexponed due to the absence of an appropriate vocabulary item, it is mapped to a neighbouring exponent.[16]

The mapping from c-structure to v-structure must maximally satisfy the set of **MostInformative** functions, which are an L$_\text{R}$FG implementation of the Subset Principle postulated in Distributed Morphology. We will concentrate on **MostInformative**$_f$, as it will serve as the primary tool in our analysis. A VI to be inserted must contain a subset (possibly a perfect match) of the features located at the relevant part of the c-structure. The **MostInformative**$_f$ chooses the VI that is best specified in this respect. It takes two VIs as input and returns the VI which defines an f-structure containing the greater set of features, as shown in (28).[17] The function π_1 returns the VI's exponendum, π_2 extracts the second coordinate out of it (the 'F ∪ G ∪ I' part), and Φ ('big phi') maps f-descriptions to the minimal f-structures that satisfy them. The notation $g \sqsubset f$ indicates that the f-structure g properly subsumes the f-structure f (see Bresnan et al. 2016: Ch. 5).

(28) Given two VIs, α and β,

$$\textbf{MostInformative}_f(\alpha, \beta) = \begin{cases} \alpha \textbf{ if } \exists f. f \in \Phi(\pi_2(\pi_1(\alpha))) \wedge \forall g. g \in \Phi(\pi_2(\pi_1(\beta))) \rightarrow g \sqsubset f \\ \beta \textbf{ if } \exists f. f \in \Phi(\pi_2(\pi_1(\beta))) \wedge \forall g. g \in \Phi(\pi_2(\pi_1(\alpha))) \rightarrow g \sqsubset f \\ \perp \textbf{ otherwise} \end{cases}$$

Having provided this brief introduction, we can now turn our attention to the analysis of Polish pronouns.

3.2 Analysis

A straightforward, "naive" analysis of the presented phenomena could posit two lexical entries – one for TO$_\text{N}$ and one for TO$_\text{D}$. The former would include a restriction forcing TO$_\text{N}$ to refer solely to AF-less antecedents. Such a solution, however, would be nothing more than a description of the empirical data in formal terms. It postulates mere homonymy of TO$_\text{N}$ and TO$_\text{D}$, neglecting their formal and semantic affinity, and just stipulates the difference in their anaphoric possibilities (AF-less vs. any antecedent), without providing any insights about where it comes from.

The L$_\text{R}$FG framework allows for a more insightful analysis, in which a single vocabulary item related to the form *to* expones both TO$_\text{N}$ and TO$_\text{D}$. Crucially, in the proposed analysis, the aforementioned difference (AF-less vs. any antecedent) follows from an independent mechanism of competition between vocabulary items (**MostInformative**$_f$).

[16]Note that (23)–(27) present just a toy example ignoring inflectional classes, affected by factors such as morphophonology of nominal stems. For a full-fledged analysis of part of a declension system in L$_\text{R}$FG, see Asudeh et al. (2024), devoted to Latin.

[17]The formalisation of **MostInformative**$_f$ presented here differs from the one assumed in previous L$_\text{R}$FG works. I would like to thank Adam Przepiórkowski for suggesting it and Ash Asudeh for discussion.

The first ingredient of the analysis are the relevant vocabulary items. The demonstrative stem *to* is the least specified form, as it only expones the pronominal root providing the PRED value, see (29).[18,19]

(29) $\langle[\sqrt{\ }],\ \ \begin{array}{c}(\uparrow \text{PRED}) = \text{`}\textit{pro}\text{'}\\ x_i : \uparrow_\sigma\end{array}\ \rangle \xrightarrow{\nu} \textit{to}$

The personal pronoun stem (*on*) can only be used in the presence of AF (regardless of their value), manifesting the phenomenon known as secondary exponence (see Noyer 1997; Asudeh et al. 2024). It means that (30) requires that GEND and NUMB be present in the f-structure to which the relevant portion of c-structure ([$\sqrt{\ }$, n]) is mapped. However, these features and their values cannot be directly defined on $\sqrt{\ }$ or n (in fact, they are specified on Infl, as in (23)–(24)). This is modelled by the existential constraints (↑ GEND) and (↑ NUMB).

(30) $\langle[\sqrt{\ }, \text{n}],\ \ \begin{array}{c}(\uparrow \text{PRED}) = \text{`}\textit{pro}\text{'}\\ (\uparrow \text{NUMB})\\ (\uparrow \text{GEND})\\ x_i : \uparrow_\sigma\end{array}\ \rangle \xrightarrow{\nu} \textit{on}$

Note that the f-descriptions in the VIs are sufficient for *on* to outcompete *to* (via **MostInformative**$_f$), whenever the former is applicable. At first glance, this makes the distinction between the two spans ([$\sqrt{\ }$, n] vs. [$\sqrt{\ }$]) redundant. However, this difference is intended to capture the fact that *on* occurs exclusively in the pronoun, whereas *to* appears in various other forms, whose detailed analysis is beyond the scope of this paper. Crucially, it is present in the demonstrative adjective (see *to dziecko* 'this child.SG.N'), which seemingly does have AF, as a result of adjective-noun concord. Without the difference in spans, the analysis would incorrectly predict that the stem *on* should also occur in the adjective.[20]

Let us now consider the suffixes. The singular feminine suffix that can be found in *on-a* 'PERS.SG.N' is presented in (31), and the singular neuter suffix occurring in *on-o* 'PERS.SG.N' is shown in (32). The singular masculine nominative (*on*) lacks an overt suffix, and as a result such a specification of Infl will be mapped to the stem through Pac-Man spanning (as in (23)).

[18]The semantics of anaphoric items is presented here simply as a variable (x_i). A more comprehensive semantic account, including deictic uses, should take into consideration an alternative approach that treats the pronominal root as an operator forming a definite description with a hidden argument (see Ahn 2022 and references therein).

[19]In Distributed Morphology, pronouns are often argued to lack roots (see, for instance, Moskal 2015), which is also generally adopted in L$_\text{R}$FG. However, if we conceptualise roots just as category-neutral nodes providing the PRED value, it makes sense to have them in pronouns. This also seems to be the most straightforward way (i) to have one VI exponing two items of different categories (the form *to* exponing just the root common for TO$_\text{N}$ and TO$_\text{D}$, and possibly for other demonstrative items mentioned in fn. 20), and (ii) to enable the competition between *on* and *to*: they must have something in common, which is here the same root providing the pronominal PRED value.

[20]Other forms presumably containing the stem *to* include the manner adverb *tak* 'this way', and the locative adverbs *tu* 'here' and *tam* 'there'. It is not clear whether *-o* is part of the stem *to* and is subsequently deleted due to morphophonological constraints, or whether the stem itself should be analysed as *t-*. For simplicity, the current analysis assumes the former, though it should not be considered a definitive solution.

(31) $\langle$[Infl], $\begin{matrix}(\uparrow \text{NUMB}) = \text{SG} \\ (\uparrow \text{GEND}) = \text{F} \\ (\uparrow \text{CASE}) = \text{NOM}\end{matrix}$ $\rangle \xrightarrow{\nu}$ *-a*

(32) $\langle$[Infl], $\begin{matrix}(\uparrow \text{NUMB}) = \text{SG} \\ (\uparrow \text{GEND}) = \text{N} \\ (\uparrow \text{CASE}) = \text{NOM}\end{matrix}$ $\rangle \xrightarrow{\nu}$ *-o*

The second ingredient of the analysis are the c-structure rules. Let us first present the rule forming the demonstrative identifier.

(33) Dem $\rightarrow$ $\begin{matrix}\sqrt{\ } \\ \uparrow = \downarrow \\ (\uparrow \text{PRED}) = \text{‘}\textit{pro}\text{’}\end{matrix}$ $\begin{matrix}\text{dem} \\ \uparrow = \downarrow\end{matrix}$ (demonstrative identifier)

Rule (33) simply posits the categoriser dem, which gives the demonstrative identifier its category and is restricted to combining with the pronominal root only.

The rules that form nouns are more complex. The lowest part of a noun (nP) consists of an acategorial root ($\sqrt{\ }$) and the nominaliser (n). The template used in (34) is a metarule saying that any PRED value possible in a language can satisfy it. Its definition is given in (35) (Asudeh et al. 2024).[21]

(34) nP $\rightarrow$ $\begin{matrix}\sqrt{\ } \\ \uparrow = \downarrow \\ @\text{ROOT}(\_)\end{matrix}$ $\begin{matrix}\text{n} \\ \uparrow = \downarrow\end{matrix}$ (nP for both lexical nouns and pronouns)

(35) ROOT(X) := (↑ PRED) = ‘X’

While both lexical nouns and pronouns share the rule presented in (34), they differ at the higher level of noun formation, related to their inflection. The rule forming lexical nouns, previously used in (23) and (24), is shown in (36). It states that nP combines with a node carrying gender, number and case. The templates ending in “!” are special types of templates called *bang macros* (Asudeh et al. 2024), which simply enumerate possible values of a given attribute. The definitions of the bang macros used here are given in (37), with only part of the definition of @CASE! shown to minimise clutter.

(36) N $\rightarrow$ $\begin{matrix}\text{nP} \\ \uparrow = \downarrow\end{matrix}$ $\begin{matrix}\text{Infl} \\ \uparrow = \downarrow \\ @\text{NUMBER!} \\ @\text{GENDER!} \\ @\text{CASE!}\end{matrix}$ (N for lexical nouns)

(37)
NUMBER!	:=	(↑ NUMB) = SG | (↑ NUMB) = PL
GENDER!	:=	(↑ GEND) = M | (↑ GEND) = F | (↑ GEND) = N
CASE!	:=	(↑ CASE) = NOM | (↑ CASE) = GEN | (↑ CASE) = DAT | ...

[21]Note that the system must be restricted to prevent generating non-existent nouns. This problem is approached in Asudeh et al. (2024) by postulating that nominalisers, specific for particular inflection classes, restrict which PRED values license them. Similarly, the v-structures of the suffixes must specify their hosts. However, since this paper focuses on the distribution of Polish anaphoric items, and not on Polish declension, these issues are not addressed here.

As demonstrated in the introductory section of this paper, TO_N is in a complementary distribution with personal pronouns, which must agree with their antecedents. Given that they are all nouns, they are built by the same rule given in (38). To capture the pronoun's dependency on its antecedent, the rule for pronouns replaces @GENDER! and @NUMBER! with the restriction @ANT-AGR, which ensures that either the pronoun and the antecedent match in gender and number or both lack these features. Such an agreement mechanism is present exclusively in pronouns, and hence the @ANT-AGR-bearing Infl is equipped with the constraining equation which requires the presence of the *pro* PRED value in the f-structure it is mapped to.

(38) N → nP Infl (N for pronouns)

(38)	N →	nP	Infl	(N for pronouns)
		$\uparrow = \downarrow$	$\uparrow = \downarrow$	
			$(\uparrow \text{PRED FN}) =_c \textit{pro}$	
			@ANT-AGR	
			@CASE!	

Formally, @ANT-AGR is a template comprising a few equations, as shown in (39).

(39) @ANT-AGR :=
(i) $(\text{GF}^{+} \uparrow)\ \text{GF} = \%\text{ANT}$
(ii) $\mathcal{R}((\uparrow_\sigma \text{INDEX})) = ((\%\text{ANT})_\sigma\ \text{INDEX})$
(iii) $(\%\text{ANT NUMB}) \implies (\%\text{ANT NUMB}) = (\uparrow \text{NUMB})$
(iv) $(\%\text{ANT GEND}) \implies (\%\text{ANT GEND}) = (\uparrow \text{GEND})$

Line (i) in @ANT-AGR establishes a pathway to an argument and assigns it the local name ANT(ecedent). In line (ii), this argument is declared to be an antecedent of the pronoun by the function $\mathcal{R}$ taken from PCDRT (Haug 2014; Dalrymple et al. 2018).[22] Lines (iii)–(iv) indicate that if the antecedent bears number and gender, the pronoun will have the same values of these features. The equations in (iii)–(iv) employ implications as defined in Bresnan et al. (2016: 60–61). If the left-hand side of the implication sign is satisfied, then the right-hand side (the consequent) will hold as a defining equation. Otherwise, the consequent is not treated as a defining equation. Consequently, if the antecedent lacks AF, the pronoun will lack them as well, given that they are not defined anywhere else in the nominal structure.

As a result, a pronoun having an AF-less antecedent will also be AF-less, while a pronoun referring to an AF-bearing antecedent will match its agreement features. The next section demonstrates how this analysis works in practice.

3.3 Analysis at work

Recall the generalisation presented in (5) and repeated below:

(5) When used anaphorically, *to* in the copular structure with the nominative nominal predicate (TO_D) may have an antecedent of any type, whereas *to* in any other

[22]Note that (i) and (ii) require the antecedent to be present in the same f-structure as the pronoun. Therefore, @ANT-AGR is unable to capture intersentential anaphora. For the purposes of this paper, I assume that @ANT-AGR operates across f-structures, although formalising such a mechanism poses a significant challenge for LFG, where access to previous f-structures is denied. This issue is briefly discussed in §4.

structure (TO$_{\text{N}}$) can only have an antecedent lacking number and gender.

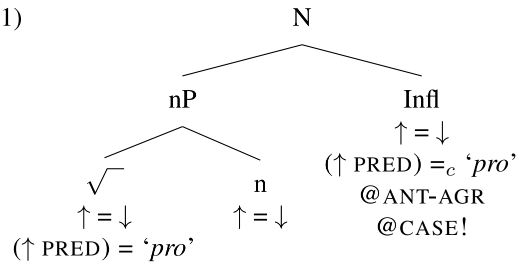
Consider examples (1b)–(1c), partly illustrating this phenomenon, which are repeated below as (40a)–(40b).[23]

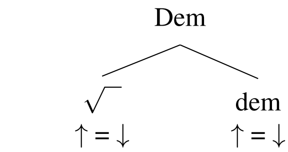
(40) Kupiłem [nowy komputer]$_i$.
'I bought a new computer.'

a. {Miał on$_i$ / #Miało to$_i$} świetne parametry.
had.3SG.M PERS.SG.M / had.3SG.N this excellent specifications.ACC
'It had excellent specifications.'

b. Był {to$_i$ / #on$_i$} świetny zakup. (TO$_{\text{D}}$)
was.3SG.M this / PERS.SG.M excellent purchase.SG.M.NOM
'It was a great purchase.'

The anaphoric item in (40a) is a noun, and hence it is built by rules (34) and (38) presented in §3.2, see (41). The demonstrative identifier in (40b) is formed by rule (33), and its structure is presented in (42).

(41)


(42)


The vocabulary items than can potentially expone these structures are given in (43) and (44).

(43) $\langle [\sqrt{\ }],\ \begin{matrix}(\uparrow \text{PRED}) = \text{`}pro\text{'} \\ x_i : \uparrow_\sigma\end{matrix} \rangle \xrightarrow{\nu} to$

(44) $\langle [\sqrt{\ }, \text{n}],\ \begin{matrix}(\uparrow \text{PRED}) = \text{`}pro\text{'} \\ (\uparrow \text{NUMB}) \\ (\uparrow \text{GEND}) \\ x_i : \uparrow_\sigma\end{matrix} \rangle \xrightarrow{\nu} on$

Let us first focus on the nominal version, that is, (41). Consider the @ANT-AGR restriction again:

(45) @ANT-AGR :=
(i) (GF$^+$ ↑) GF = %ANT
(ii) $\mathcal{R}$((↑$_\sigma$ INDEX)) = ((%ANT)$_\sigma$ INDEX)
(iii) (%ANT NUMB) ⟹ (%ANT NUMB) = (↑ NUMB)
(iv) (%ANT GEND) ⟹ (%ANT GEND) = (↑ GEND)

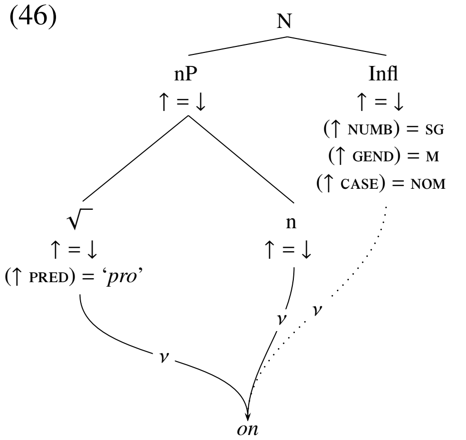
The antecedent (*nowy komputer* 'new computer.SG.M') has NUMBer and GENDer, and

[23] Example (1a) is omitted here, as it will behave exactly like (1b). Analogously, (2a) will be omitted in the later part of this section.

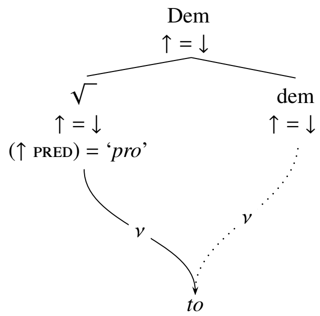
hence lines (iii) and (iv) force the pronoun to have matching values of these features. This, in turn, makes the VI for *on* available. Because it is better specified than the VI for *to*, the latter will be blocked by **MostInformative**$_f$, see (40a). In contrast, the demonstrative identifier in (40b) cannot be exponed by *on* – it lacks gender and number, and also does not contain the n node (see (42)); therefore, it is realised by *to*. Note that the structure in (42) is indifferent to the AF of the antecedent.

The structures discussed above together with ν-mappings are presented in (46) and (47). In the case of (46), I present only those parts of the f-description attached to Infl which are relevant for exponence, that is, number and gender (in their unpacked form – originally they are contained in the @ANT-AGR macro).

(46)



(47)



Now, consider examples (2b) and (2c), repeated below as (48a) and (48b).

(48) [Polska przegrała kolejny mecz]$_i$.
'Poland lost another match.'

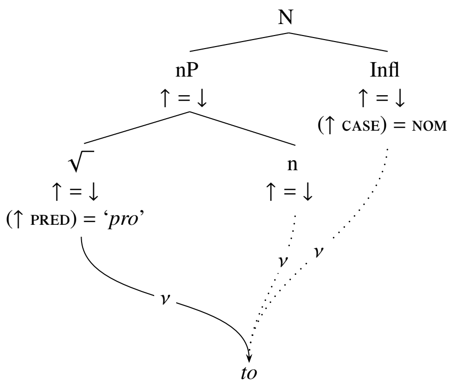
a. Zaskoczyło mnie {to$_i$ / #ono$_i$}. (TO$_{\text{N}}$)
surprised.3SG.N I.ACC this / PERS.SG.N
'It surprised me.'

b. Był {to$_i$ / #ono$_i$} prawdziwy skandal. (TO$_{\text{D}}$)
was.3SG.M this / PERS.SG.N real scandal.SG.M.NOM
'It was a real scandal.'

The antecedent lacks AF, and *to* is present in both types of structures: as a noun (TO$_{\text{N}}$), and as a demonstrative identifier (TO$_{\text{D}}$). Again, two c-structures are available, (41) and (42). In the nominal structure, @ANT-AGR checks if the antecedent has AF. It does not, so the pronoun cannot have them either: the implications in lines (iii) and (iv) are not satisfied. In consequence, the nominal structure is AF-less, as number and gender are not specified anywhere else.

The VI for the personal pronoun stem (see (44)) requires AF in the structure, so it cannot be used. Instead, *to* is used in (48a), the only anaphoric item able to expone the resulting structure, which is presented in (49). Analogously to (46), I only include the equations which are directly relevant to exponence. The Infl node in (49) does not contain number and gender, since lines (iii) and (iv) in @ANT-AGR have not been satisfied.

(49)



The demonstrative identifier in (48b) is exponed by *to* as usual, see (47).

To summarize, this subsection has demonstrated how the proposed analysis predicts the difference in anaphoric possibilities between the two uses of *to*. The nominal use (TO_N) can only refer to antecedents lacking number and gender, because otherwise it is blocked by personal pronouns. In contrast, the item present in the copular clause with a nominative nominal predicate is a demonstrative identifier. It can never meet the conditions required for personal pronouns to be exponed, and hence is always realised as *to* (TO_D).

4 Open problems and conclusion

Let us begin this summary by discussing the limitations of the proposed analysis and point to potential directions for future research. At least three issues require further investigation to achieve a comprehensive analysis of the Polish pronominal system.

The first issue, as noted in fn. 22, is intersentential anaphora. Polish personal pronouns bear the same *syntactic* features as their antecedents. This property seems to be encoded in their lexical entries (similarly to the practice of encoding the fact that English *he* requires a *male* antecedent, see Heim & Kratzer 1998: 244–245, Dalrymple et al. 2019: 533). This has been implemented here using a set of constraints comprising a template called @ANT-AGR. However, within the current LFG architecture, it seems impossible to enforce this constraint intersententially, across f-structures. Let us only hint at a possible solution here, which is to shift anaphoric agreement to the module explicitly designed to track information throughout the discourse, that is, to the discourse structures from the Discourse Representation Theory (e.g., PCDRT, as already integrated with LFG in Dalrymple et al. 2018, Dalrymple et al. 2019: Ch: 14–15). It would assume that lexical items such as nouns and pronouns introduce predicates to the discourse structure carrying information such as *expressed by a masculine noun*. A formalisation of such an approach and an exploration of its consequences are left for future research.

The other two limitations follow from the empirical focus of this paper, which resulted in leaving other intriguing issues related to the presented data unexplored. The aim of this work was to analyse the distribution of *to* in two types of sentences. Consequently, the syntactic structure of these sentences – particularly the peculiar copular clause with TO_D, where the predicate occurs in the nominative case and triggers agreement – has not been analysed. The numerous issues related to the c- and f-structural representation of such sentences, as well as their semantic composition, undoubtedly require a separate study.

The final issue, noted in fn. 5, is that the intricate system of Polish personal pronouns in non-nominative cases has been neglected. This opens up an interesting direction for exploration, particularly in the context of the morphemic and realisational framework of L_RFG.

Notwithstanding these limitations, this paper offers a novel perspective on an intriguing phenomenon concerning Polish pronouns, aiming to explain the distribution of the word *to* and personal pronouns used anaphorically. A key observation that led to this research was the fact that *to*, when used in typical nominal positions, can only refer to AF-less antecedents (TO_N), whereas *to* in the unique copular structure, containing a nominal predicate in the nominative case, can have an antecedent of any type (TO_D). The closer examination of the data allowed for a principled explanation of this phenomenon: the difference follows from the mechanism of anaphoric agreement, the specification of the relevant vocabulary items, and the rules of exponence postulated in L_RFG.

More precisely, the personal pronoun stem (*on*) can only be exponed in the presence of AF. These features, in turn, can (and must) be present on the pronoun when the antecedent possesses AF. If the antecedent is AF-less, the anaphoric pronoun also is and cannot be realised by *on*. *To* is inserted then, forming the AF-less pronoun TO_N. Being underspecified for grammatical category, it also expones the demonstrative identifier (TO_D), present in the aforementioned copular structure with the nominative predicate.

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Ambiguity management in computational Glue semantics

Mark-Matthias Zymla
University of Konstanz

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Abstract

This paper presents extensions to XLE+Glue and the Glue semantics workbench. Concretely, it builds on Findlay & Haug's (2022) idea of multistage proving. By combining their insights with techniques first described in Lev (2007), this paper provides a more flexible implementation of multistage proving. Furthermore, it presents an extension of XLE+Glue that allows users to integrate multistage proving into computational LFG grammars. Finally, the paper discusses some insights from working on ambiguity management and semantic grammar writing suggesting that full syntactic or semantic autonomy is a challenge for computational models of LFG.

1 Introduction

The goals of this paper are two-fold.[†] Firstly, it presents a technical contribution in the shape of a new implementation of Findlay & Haug's (2022) multistage proving. This implementation tackles multiple aspects of their proposal and arguably improves on them. Secondly, it discusses the role of semantics in the projection architecture more generally. Concretely, the ideals of syntactic and semantic autonomy are put under scrutiny from the perspective of computational LFG.

Glue semantics suffers from abundant spurious and unwanted ambiguities.[1] Multistage proving is a proposal that aims to solve both of these problems to an extent (Findlay & Haug 2022). The general idea is to add additional structure to Glue proofs. Intuitively, Glue proofs are made (partially) associative (Gotham 2021). This is handled via a new projection: the proof structure, a tree-like structure partitioning Glue meaning constructors (MCs). While the idea is formally well laid out, the proposed computational implementation is somewhat rudimentary. Derivations are handled in a cascading bottom-up manner; i.e., one derivation is split up into a set of derivations. In this paper, I argue that this potentially affects Glue semantics' ability to capture long-distance dependencies. I present a computationally more adequate implementation of multistage proving that better reflects its formal ideas. Additionally, this paper presents a concrete implementation of multistage proving for the Xerox Linguistics Environment (XLE; Crouch et al. 2017), making it available for computational LFG research.

An exploration of the ideas underlying multistage proving unveils more fundamental questions about the flexibility of Glue semantics. Concretely, the question is whether Glue semantics requires us to build additional structure to properly constrain ambiguities or whether it is sufficient to transduce structure from other modules of the grammar into the semantics.[2] According to Findlay & Haug (2022), both structure building and

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[1]I use the term *unwanted* ambiguities for cases where unattested readings arise to contrast them with spurious ambiguities that are semantically equivalent.

[2]This discussion is partially due to Ron Kaplan, p.c. It also builds on various other insights related to syntactic and semantic autonomy due to, among others, Asudeh (2004) and Gotham (2021).

transduction are necessary to block unwanted ambiguities, but as it stands, their proposal is more of a tool rather than a theory with any explanatory power.

Ultimately, the simple matter of fact is that a set of binary branching trees can easily represent a semantics built around function application. The goal of ambiguity management is, then, either to arrange the terminal nodes of such trees in the right order or to filter out trees in the case that multiple are possible. The question is to what extent such trees are built in the semantics, how much is projected onto the semantics by other structures, and what other factors may add additional structure to the semantics. Although it is difficult to definitively answer these questions, this paper aims to provide some new insights or at least perspectives on these issues. Thus, it covers both computational and theoretical aspects of ambiguity management in Glue semantics.

In the next section, the main challenge is introduced: spurious and unwanted ambiguities. Then, I proceed to introduce graph-based proving for Glue semantics due to Lev (2007) in Section 3. This provides the necessary background for Section 4, which introduces a graph-based approach to multistage proving. Furthermore, Section 4.4 makes a proposal for integrating the proof structure in the XLE, thus making it available for computational LFG research. In Section 5, a more broad perspective is taken exploring the syntax/semantics interface and the question of whether syntactic and semantic structures are two sides of the same coin. Finally, Section 6 concludes.

2 Compositional ambiguities in Glue semantics

Glue semantics, despite the name, is a theory of the syntax/semantics interface rather than semantics itself (Asudeh 2022).[3] This is reflected in the fact that the idea of Glue semantics is to be compatible with different syntactic and semantic representations. This is achieved by splitting up semantic representations into meaning representations, reflecting the semantics, and instructions for compositional assembly serving as an interface to the syntax. Thus, compositionality is governed by two aspects: type logic and relations to the syntax. Linear logic is a logic that allows us to capture both at the same time (Kokkonidis 2006). The relation to type logic emerges due to Montague's (1970) seminal work on formal semantics, later streamlined by Heim & Kratzer (1998). However, other than the previously cited work, Glue semantics is not based on transformations (e.g., quantifier raising) of syntactic trees.[4]

As with any other formal system for assigning linguistic representations to language, Glue semantics struggles with two types of ambiguities: unwanted ambiguities and spurious ambiguities. This can be illustrated very straightforwardly by virtue of multiple adjectival modification of nouns. Given the naive assumption that all adjectives follow the same template (that of intersective adjectives), we expect two representations for the adjectival noun phrases in (1) and (2). In the case of intersective adjectives, (1), this leads to spurious ambiguity as the two readings are equivalent. In the case of (2), we get a completely unwanted interpretation we want to rule out.

[3] Glue semantics (Dalrymple et al. 1993; Dalrymple 1999) has recently received a number of concise introductions: Asudeh (2022, 2023). Thus, we omit a re-iteration of the basics.

[4] As we will discuss later, a semantics built on function application can ultimately be represented as a binary branching tree. Glue semantics generates such trees from more syntax-independent constraints.

(1) a trustworthy Scottish chairman

a. $\lambda Q.\exists x[\text{trustworthy}(x) \wedge \text{scottish}(x) \wedge \text{chairman}(x) \wedge Q(x)] \equiv$
b. $\lambda Q.\exists x[\text{scottish}(x) \wedge \text{trustworthy}(x) \wedge \text{chairman}(x) \wedge Q(x)]$

(2) a trustworthy former chairman

a. $\lambda Q.\exists x[\text{trustworthy}(x) \wedge \text{former}(\text{chairman}(x)) \wedge Q(x)]$
b. ~~$\lambda Q.\exists x[\text{former}(\text{trustworthy}(x) \wedge \text{chairman}(x)) \wedge Q(x)]$~~

The spurious ambiguity seems innocent at first but has massive implications as sentences and analyses become more complex. That we predict unattested readings makes the situation worse. The main issue here is that it is difficult in Glue semantics to distinguish unwanted from spurious ambiguities. The reason for this is fairly simple: Ambiguities arise from the assembly instructions, i.e., linear logic, but whether an ambiguity is, in fact, wanted, unwanted, or spurious is generally determined by the meaning side. Consider the following examples. Example (3) shows a simple analysis of intersective adjectives. The intersective meaning is accounted for by conjunction on the meaning side. Since conjunction is commutative, both derivations are correct. Thus leading to spurious ambiguity. However, the meaning side and linear logic side share this property, suggesting that they are in unison.

(3) a trustworthy Scottish chairman

a. $\lambda P.\lambda x.\text{trustworthy}(x) \wedge P(x) : (g_e \multimap g_t) \multimap g_e \multimap g_t$
b. $\lambda P.\lambda x.\text{scottish}(x) \wedge P(x) : (g_e \multimap g_t) \multimap g_e \multimap g_t$
c. $\lambda x.\text{chairman}(x) : g_e \multimap g_t$

Derivation 1:

$$\dfrac{\text{trustworthy} : (g_e \multimap g_t) \multimap g_e \multimap g_t \qquad \dfrac{\text{scottish} : (g_e \multimap g_t) \multimap g_e \multimap g_t \quad \text{chairman} : g_e \multimap g_t}{\text{scottish}(\text{chairman}) : g_e \multimap g_t}}{\text{trustworthy}(\text{scottish}(\text{chairman})) : g_e \multimap g_t}$$

Derivation 2:

$$\dfrac{\text{scottish} : (g_e \multimap g_t) \multimap g_e \multimap g_t \qquad \dfrac{\text{trustworthy} : (g_e \multimap g_t) \multimap g_e \multimap g_t \quad \text{chairman} : g_e \multimap g_t}{\text{trustworthy}(\text{chairman}) : g_e \multimap g_t}}{\text{scottish}(\text{trustworthy}(\text{chairman})) : g_e \multimap g_t}$$

This is not always the case. We have seen in example (2) that not all adjectives work commutatively. Nonetheless, as example (4) suggests, the assembly instructions remain the same across all kinds of adjectives: they are modifiers, meaning constructors that take some input, modify it, and return it without changing its type.[5] For us, it indicates a mismatch between the meaning side and the linear logic side of meaning constructors. Glue semantics does not capture some of the finer nuances that constrain adjective ordering.[6]

[5]In actuality, some finer details change, but the main point – that adjectives are modifiers – remains the same (see Dalrymple 2001).

[6]Andrews (2018) also discusses and criticizes this treatment of adjectival modifiers. More generally, e.g, Findlay (2021) points out that the link between semantics and the rest of the projection architecture via linear logic is relatively weak, at least in the form it is currently popularly practiced.

(4) a former Scottish chairman

a. $\lambda P.\lambda x.\text{trustworthy}(x) \wedge P(x) : (g_e \multimap g_t) \multimap g_e \multimap g_t$
b. $\lambda P.\lambda x.\text{former}(P(x)) : (g_e \multimap g_t) \multimap g_e \multimap g_t$
c. $\lambda x.\text{chairman}(x) : g_e \multimap g_t$

There are a couple of ways to go from here: Early works, e.g., Gupta & Lamping (1998) suggest leaving ambiguities of this nature underspecified, whereas Lev (2007) presents various heuristics for ambiguity management and weeding out unwanted interpretations in a computational context. More recently, Findlay & Haug (2022) suggested the introduction of additional structure to the projection architecture to deal with both unwanted and spurious ambiguities that arose from the need for calculating Glue derivations in a more computationally efficient manner.[7] Ambiguity management has also received a fair share of attention in the theoretical literature. For example, Gotham (2019, 2021) modifies the assembly language to avoid unwanted ambiguities with the goal of preserving semantic autonomy (this topic is briefly discussed in Section 5).[8]

This section has shown that the issues of spurious ambiguities and unwanted ambiguities arise from the same source. However, spurious ambiguities are mainly discussed in a computational context, whereas in theoretical work they are often swept under the rug. Thus, computational approaches, which are in pursuit of efficient systems for dealing with ambiguities, often provide a more holistic perspective. As this is the central topic of this paper, the next section introduces the more technical aspects of linear logic derivations, particularly Lev's (2007) graph-based prover, re-implemented in the Glue Semantics Workbench (Meßmer & Zymla 2018).

3 Graph-based proving

The Glue Semantics Workbench (GSWB) uses two provers based on Hepple (1996) and Lev (2007). The prover based on Hepple's work is a chart-based prover with improvements suggested by Lev (2007). The second prover is a graph-based prover based on additional work by Lev. This paper expands on the graph-based prover and focuses on the management of compositional ambiguities.

The graph-based prover can be seen as an instance of factorizing out ambiguities (Maxwell & Kaplan 1993). Intuitively, this means that derivations are partitioned into ambiguous and non-ambiguous parts such that non-ambiguous parts have to be computed only once and can participate in possibly multiple derivations resulting from ambiguity. Before delving deeper into how this is achieved, we have to discuss some core properties of graph-based proving. Firstly, we turn to the compilation process.

3.1 Compilation of premises

First proposed by Hepple (1996) for his chart prover, the compilation process has the goal of reducing all higher-order linear logic formulas into first-order formulas. A formula is higher-order if any linear implication within it has a complex antecedent. A

[7]Findlay and Haug, p.c.

[8]Ambiguity management is also sometimes mentioned more as a by-product of certain analyses, e.g., Andrews (2018); Cook & Payne (2006); Crouch & Van Genabith (1999).

common example of this is the type for quantifiers $(e \multimap t) \multimap t$. The corresponding compilation process is illustrated in (5-a). As shown there, the complex antecedent $e \multimap t$ is split up, creating a new premise $[e]^i$. This new premise corresponds to traditionally used assumptions and is marked similarly with brackets. We also highlight its origin with an index i. This index ensures that the remainder of the initial formula, here $t_i \multimap t$, combines with an element that made use of the new resource. This is shown in (5-b) where we want to combine the quantifier with a first-order formula, $e \multimap t$. First, the first-order formula consumes the compiled-out assumption $[e]^i$. The resulting t^i now carries the index of the assumption. The assumption is discharged by combining it with the assumption's original host, $t_i \multimap t$. This derivation corresponds to a simple sentence like *a dog barked*, as illustrated.

(5) a. $(e \multimap t) \multimap t \rightarrow_{comp} [e]^i, t_i \multimap t$

b.
$$\dfrac{\dfrac{\dfrac{X : [e]^i \qquad \lambda x.\text{bark}(x) : e \multimap t}{\text{bark}(X) : t^i}}{\lambda x.\text{bark}(x) : t^i} \qquad \lambda Q.\exists x[\text{dog}(x) \wedge Q(x)] : t_i \multimap t}{\exists x[\text{dog}(x) \wedge \text{bark}(x)] : t}$$

The process of compilation plays a role in accounting for long-distance dependencies in Glue derivations as there can be an arbitrary distance between the use of the assumption and its re-connection with its host.

A consequence of the compilation process is that it becomes clear that quantifiers share properties with modifiers, i.e., they can be reduced to premises of type $X \multimap X$.[9, 10] As already stated by Gupta & Lamping (1998), only modifiers cause compositional ambiguity. This means that dealing with wanted scopal ambiguities and unwanted or spurious ambiguities both rely on how modifiers are handled. The factoring-out mentioned above aims at disentangling skeletons from modifiers.[11] By factoring out modifiers from a derivation, we can constrain the need for ambiguity management to subparts of the proof. This idea was proposed by Lev (2007) for Glue semantics.

3.2 The category graph

Concretely, a so-called category graph is used.[12] A category graph for some sentence is formed by inspecting all categories that are used in its Glue derivation. Categories correspond to the set of unique linear logic formulas appearing in the premise set. They form (a part of) the vertices of the graph. During a computational derivation, the input premises are first compiled and indexed; then categories are extracted.[13] Consider example (6). From the compiled premise set, we can determine the categories in (7).

[9] The compiled out assumption ensures that quantifiers cannot arbitrarily modify any element of type t, but only those that carry the appropriate assumption. Nonetheless, their modifier status is the cause of scopal ambiguity.

[10] Impure modifiers are possible, e.g., $a \multimap b \multimap a$. They have the same properties as pure modifiers.

[11] Opposed to modifiers, skeletons are Glue premises that follow a fixed order of combination, i.e., their input must be different from their output.

[12] A more detailed explanation is given in Lev (2007). However, we state the key points here to provide a concise overview of graph-based Glue derivations.

[13] The indices are important to assure resource sensitivity and will be explained in more detail later.

Each category is unique, but it can be instantiated multiple times in MCs. For example, the category $f \multimap f$ occurs twice in the input premise set (assumption indices are not part of a category's properties). The subformula $h \multimap f$ occurs as part of the verb's meaning constructor, but is also a category in its own right. Similarly, the category f is instantiated multiple times as part of the quantifiers as well as the verb.

(6)
$$\begin{array}{l} \lambda Q.\forall x[\text{person}(x) \rightarrow Q(x)] : (g_e \multimap f_t) \multimap f_t \\ \lambda x.\lambda y.\text{see}(x,y) : g_e \multimap h_e \multimap f_t \\ \lambda Q.\exists y[\text{person}(y) \wedge Q(y)] : (h_e \multimap f_t) \multimap f_t \end{array} \longrightarrow_{\text{compile}} \begin{array}{l} [0]\lambda Q.\forall x[\text{person}(x) \rightarrow Q(x)] : f_{t,[3]} \multimap f_t \\ [3]X : g_e^3 \\ [1]\lambda x.\lambda y.\text{see}(x,y) : g_e \multimap h_e \multimap f_t \\ [2]\lambda Q.\exists y[\text{person}(y) \wedge Q(y)] : f_{t,[4]} \multimap f_t \\ [4]Y : h_e^4 \end{array}$$

(7) Relevant categories:

a.
$$\begin{array}{lll} g_e & f_t \multimap f_t & g_e \multimap h_e \multimap f_t \\ h_e & h_e \multimap f_t & \\ f_t & & \end{array}$$

The category graph is a directed graph built by combining categories according to the combination rules of linear logic. For example, h_e is combined with $h_e \multimap f_t$ via a combination node (the additional vertex in the graph), which points to the category f_t, indicating the obvious result of combining the two categories. This allows us to build the graph in Figure 1, on the left. There, the orange nodes correspond to the original premises before compilation.[14] Rectangular blue nodes correspond to the relevant categories used in the derivation while circular blue nodes correspond to combination steps. The yellow node corresponds to the goal category of the proof. Green nodes with multiple elements play a special role. They correspond to cycles, as with the bottommost node in Figure 1 on the left. Such cycles correspond to an embedded graph, thus, the green node on the left corresponds to the cyclic graph on the right. As indicated by the dashed lines, the inputs from the main graph on the left feed into the cyclic graph. This is due to the fact that these nodes play a role in the calculations within the embedded graph. The difference between the two graphs is to be made clear shortly.

This layout is achieved by applying a strong connectivity algorithm that condenses cycles in a graph. The result is a graph containing strongly connected components (SSCs; Tarjan 1972), sub-graphs in which there is a path between any two vertices. All modifiers are contained within strongly connected component. Thus, this allows us to treat skeleton premises and modifier premises independently. We simply need to combine skeleton premises according to the main graph and then deal with the ambiguity through the SSC with added input nodes, as shown in Figure 1 on the right.

3.3 Semantic derivation

The combination process is guided through so-called *histories*. They store information on indices and on the meaning side and keep track of combination steps via pointers to their parents. All initial categories (those whose category exactly matches an input premise) are associated with initial histories. Initial histories do not have parents, as illustrated in (8) by not having the feature p. Importantly, the category $f \multimap f$ has two histories corresponding to the two different original premises associated with it.

[14]Their outgoing edges indicate the compilation process.

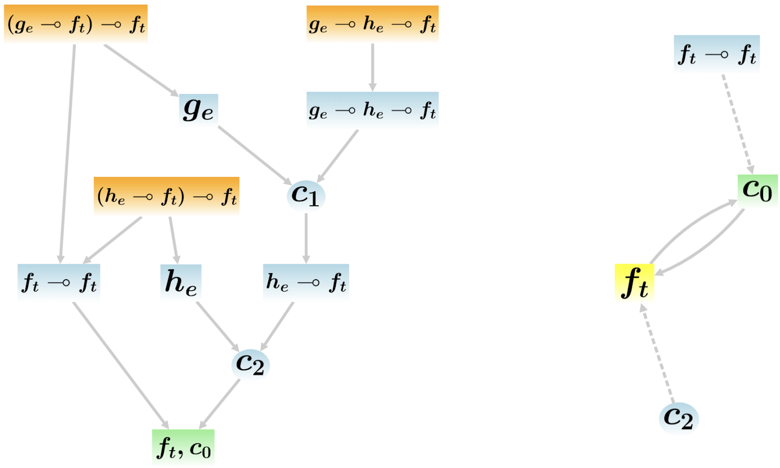

Figure 1: Linear logic derivation graph with strongly connected component in green

(8) a. History for category $g_e \multimap h_e \multimap f_t$:

$$g_e \multimap h_e \multimap f_t \quad \rightarrow \quad \{\ h_1 : [1]\ \lambda x.\lambda y.\text{see}(x, y) : g_e \multimap h_e \multimap f_t\ \}$$

b. Histories for category $f_t \multimap f_t$:

$$f_t \multimap f_t \quad \rightarrow \quad \left\{ \begin{array}{l} h_1 : [0]\ \lambda Q.\forall x[\text{person}(x) \rightarrow Q(x)] : f_{t,[3]} \multimap f_t \\ h_2 : [2]\ \lambda Q.\exists y[\text{person}(y) \wedge Q(y)] : f_{t,[4]} \multimap f_t \end{array} \right\}$$

The combination of two histories is illustrated in (9). There, the history for the category $h_e \multimap f_t$ is built up by combining the histories of the categories g_e and $g_e \multimap h_e \multimap f_t$. Accordingly, the *parents*-array marked with *p* provides pointers to parent histories corresponding to functor f and argument a.

For finding a successful derivation, the semantics are ignored when combining histories. Rather, they built up a tree structure consisting of function application steps. Thus, the process of finding a successful derivation is prioritized before actually building the corresponding semantics since this can be done by inspecting only the linear logic side (Lev 2007; see also Dalrymple et al. 1999a).

(9) History for category $h_e \multimap f_t$:

$$h_e \multimap f_t \quad \rightarrow \quad \left\{ \begin{array}{l} h_3 : [1,3]\ f(a) : h_e \multimap f_t, \\ p \left[\begin{array}{l} f : h_1 : [1]\ \lambda x.\lambda y.\,\text{see}(x, y) : g_e \multimap h_e \multimap f_t \\ a : h_2 : [3]\ X : g_e \end{array} \right] \end{array} \right\}$$

The full semantics of a derivation can then be calculated by tracing back function application steps from the history or histories corresponding to the goal category (yellow in Figure 1). This is illustrated in Figure 2.

Why are there two solutions? This is where the indexation of the compiled premises comes into play. Recall that the process for handling ambiguous elements is distinct from that of combining skeletons which can be simply read off the category graph. To deal with the ambiguity in example (6) we need to employ a variation of the chart prover. For this, we make the additional assumption that whenever two premises are combined,

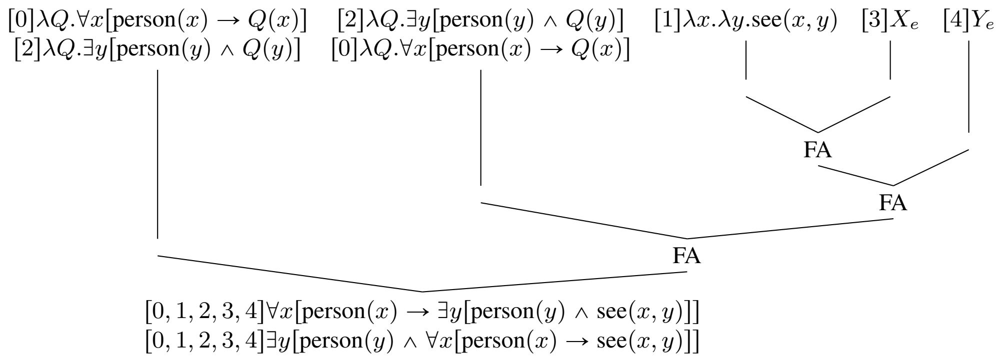

Figure 2: Resulting semantic derivation

then their index sets are combined. Furthermore, only premise sets with disjoint index sets may be combined. Example (9) illustrates this. There, the history h_3 with index set $[1, 3]$ results from the combination of the histories h_1 with index set $[1]$ and h_3 with index set $[3]$. For our running example, by combining the verb with its arguments we get the history in (10) (here with semantics for ease of exposition). These steps are the same regardless of the semantic ambiguity. We only have to compute them once!

(10) a. History for category f_t:
$$f_t \quad \rightarrow \quad \{\ h_1 : [1, 3, 4]\ \text{see}(X, Y) : f_t\ \}$$

This illustrates what I have stated in the previous section: the category graph disentangles skeleton and modifier premises. Example (10) is the result of the skeleton derivations of (6). For the computation of the cyclic subgraph, we use the chart prover. It works by naively trying to combine each element with each other element in the derivation until no new combinations emerge, and storing intermediate solutions on a chart. This makes it a reasonable tool for calculating proofs with multiple solutions.[15]

The factoring out of the skeleton computations results in a reduction of computations necessary for the chart prover because we can feed in results of the skeleton derivation. This is done by following the dashed lines from c_2 into the subgraph in Figure 1. This means, for the current example, we now only have to check six possible combinations (halving the number of combinations necessary with a pure chart prover).

Of these, only two succeed. The results are again naively combined with the premise set, and again, only two combinations succeed due to the disjoint index set constraint. The corresponding procedure is schematized in (11). The left column shows the input. The center column shows the intermediate results of trying to combine all initial elements on top. By attempting to combine those again with the elements below the line, we arrive at the two solutions in the right column.

[15]It is described in Hepple (1996) and Lev (2007: ch. 5), as well as Meßmer & Zymla (2018). Thus, we will not explain it in detail here. However, there is a full chart derivation of (6) in the appendix.

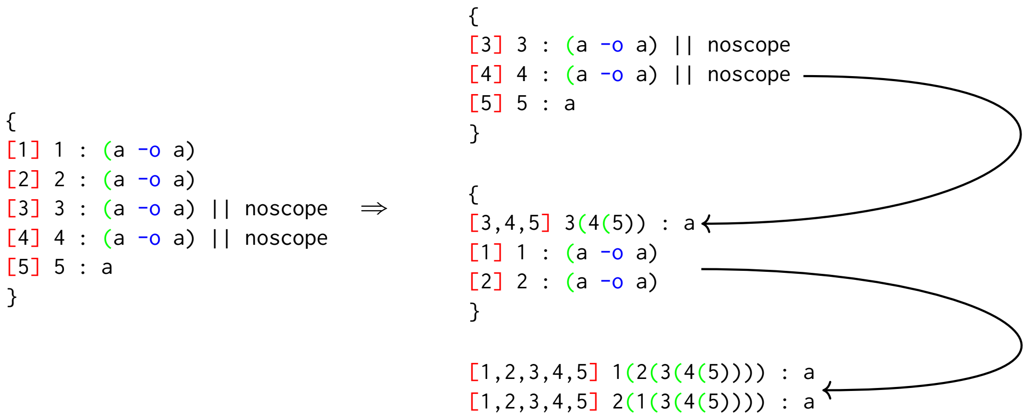

Figure 3: Partioning meaning constructors with the noscope flag

(11)
$$\begin{array}{l}[0] : (f_{t,3} \multimap f_t)\\ [2] : (f_{t,4} \multimap f_t)\\ [1,3,4] : f^{3,4}\end{array} \longrightarrow_{prove} \dfrac{\begin{array}{l}[1,2,3,4] : f_t\\ [0,1,3,4] : f_t\end{array}}{\begin{array}{l}[0] : (f_{t,3} \multimap f_t)\\ [2] : (f_{t,4} \multimap f_t)\\ [1,3,4] : f^{3,4}\end{array}} \longrightarrow_{prove} \begin{array}{l}[0,1,2,3,4] : f_t\\ [0,1,2,3,4] : f_t\end{array}$$

3.4 Partioning premise sets

The important caveat of the chart prover is that it is naive. In the graph-based prover, premises are sorted by the category graph, which can be built quadratically. Conversely, the chart prover is unstructured. In the worst case, its derivations are factorial. As such, even when the ambiguity is factored out, it can become overwhelming computationally.

In Section 2, we established that it is sometimes difficult in Glue to distinguish spurious ambiguities from unwanted ambiguities. However, the simplest way to deal with this is to mark MCs that would introduce spurious ambiguities as such. This simple way to deal with ambiguities is proposed by Lev (2007) in the shape of the noscope flag. The noscope flag essentially partitions the input set of the chart prover into scoping and non-scoping modifiers. Furthermore, as the name implies, noscope flags indicate that the order of application does not matter. For example, one has to find only one solution for a set containing only non-scoping modifiers (in addition to any potential arguments). The process is illustrated in Figure 3. First, the non-scoping modifiers are applied to any suitable input resources in arbitrary order.[16] The result is passed onto a second stage of chart-proving, including the result of the non-scoping derivation and the remaining scope-sensitive modifiers. Thus, two solutions are found instead of 24.

[16]This means that everything marked with noscope has more narrow scope than scoping elements. Across multiple premises marked with noscope, the scope is determined by the order in which premises are processed during the chart derivation (i.e., randomly). There are various ways of doing this efficiently but they are not important here (see, e.g., Lev 2007: 197ff.). In general, it is fairly straightforward to find a solution given the true commutativity of noscope-marked modifiers.

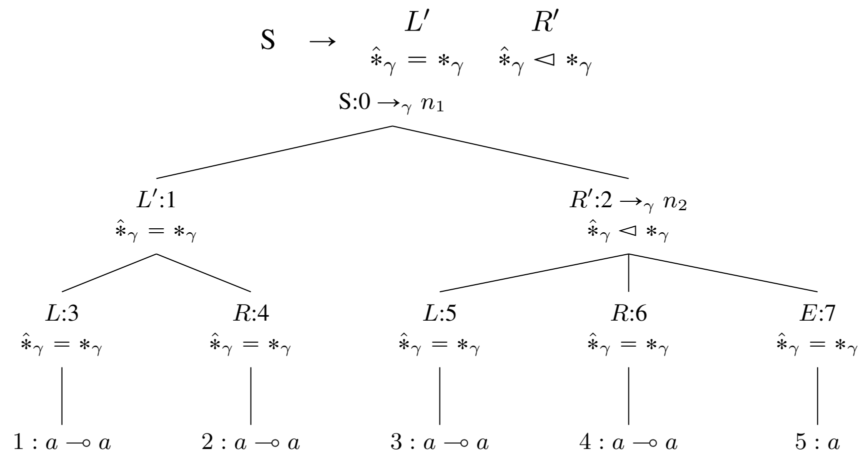

Figure 4: Example phrase structure rule and corresponding c-structure

4 A faithful implementation of multistage proving

In a sense, the idea of partitioning meaning constructors into groups has been expanded upon by Findlay & Haug (2022). While this idea is conceptually straightforward, they, furthermore, integrate it into the projection architecture of LFG in a formally sophisticated manner. In this section, we first briefly discuss their proposal, both theoretically and technically, then formulate some criticisms for their computational implementation, and finally propose a novel implementation that circumvents at least the technical problems but also may push the exploration of theoretical questions by providing an explicit implementation in the Xerox Linguistics Environment (XLE; Crouch et al. 2017).

4.1 The proof structure

Findlay & Haug (2022) propose a new projection in LFG's modular architecture, the proof structure. The proof structure is formally a tree and specified via equality and dominance constraints. This is illustrated in Figure 4. There, * identifies c-structure indices. The subscript γ maps c-structure nodes onto their proof structure counterparts. Thus, proof constraints describe relations between proof structure nodes. In Figure 4, the proof structure essentially partitions the c-structure into L' and R'. Thus, we partition our meaning constructors according to a certain c-structure configuration.[17] Let us call the resulting structure g(lue)-structure (as p(roof)-structure clashes with p(honological)-structure).

The g-structure for the example in Figure 4 is given in Figure 5.[18] There, each proof node is associated with a set of meaning constructors t_i, percolated up via the pre-terminal nodes, where i is an index co-identifying the relevant proof structure node.

[17] As a reviewer of the abstract pointed out, generally speaking, the proof structure is more flexible as it can potentially apply to indices from any projection and even introduce new nodes. We will discuss this point later.

[18] In Figure 4, the annotation indicates that only two nodes play a role in building the proof structure, namely n_1 and n_2 marked with the γ-correspondence $\rightarrow_\gamma$.

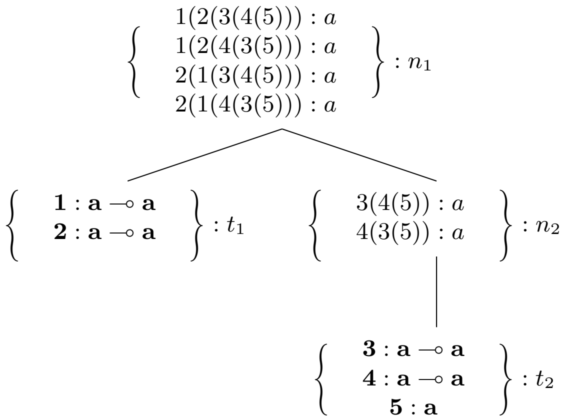

Figure 5: G-structure with added solutions

Thus, in this case, we get the given tree. By convention, the left-most daughter carries the associated meaning constructors. Consequently, our meaning constructors are partitioned into two stages. Each stage still introduces an ambiguity in our example, but once again, we have reduced 24 possible solutions to four, which could, in fact, be desired.

4.2 Original implementation and criticism

Findlay & Haug (2022) propose to implement this by virtue of a cascade of chart provers. Concretely, they traverse the tree bottom-up. For each node t_i, they calculate all possible combinations and pass up the relevant intermediate results to the next stage. Thus, in Figure 5, all the results stored in n_2 would be combined into a premise set with the elements in t_1 to calculate the solutions in n_1.

This approach has a major weakness: The intermediate goals of different stages need to be explicitly stated. This is necessary to avoid passing up information that has already been used up in the derivation. Thus, somewhere in the architecture, intermediate solutions must be specified before they are concretely derived. This seems ad hoc. That this is inelegant and not always trivial can be illustrated by examining one of their examples regarding scope freezing, e.g., example (12) (their (9) and Figure 3). There, it is assumed that it is impossible for the universal quantifier in the direct object NP to outscope the existential quantifier in the indirect object NP.

(12) Hilary gave a student every grade.

a. $\exists < \forall$
b. ~~$\forall < \exists$~~

This means that, similar to our previous example, we have two stages, as shown in Figure 6. The embedded node t_2 combines the verb with the quantifier scoping over the direct object. Thus, Findlay & Haug (2022) predict the intermediate and correct solution in example (13-a) for n_2 in Figure 6, as the sequent in (13-b) is valid. To work with intermediate goals computationally, they add a Goal premise with the intermediate type as antecedent. This is exemplified in (13-c) which can be then added to t_2 in

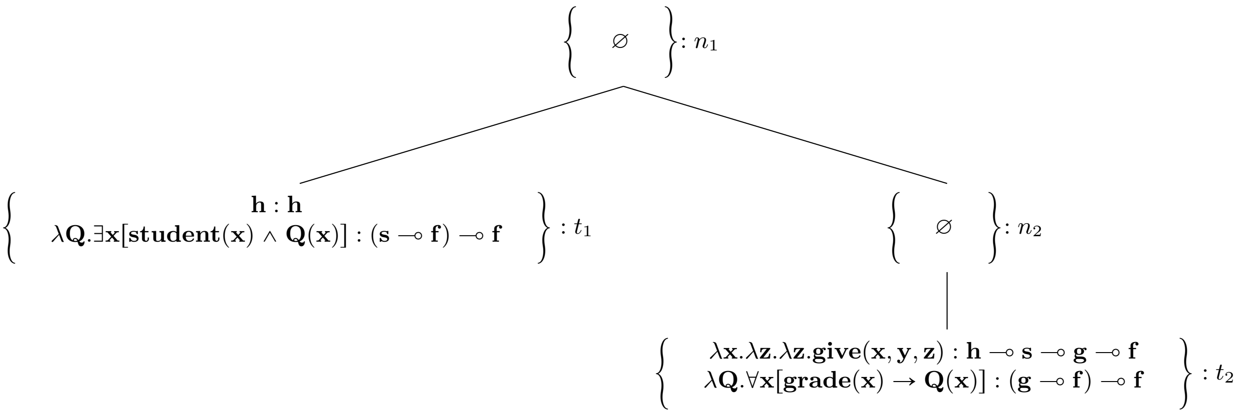

Figure 6: Computationally failing proof structure for (12)

Figure 6. The result is a set of premises that has an atomic goal G. The meaning side of G is a dummy predicate GOAL which can be stripped off the intermediate meaning representation easily.

(13) a. $\lambda x.\lambda y.\forall z[\text{grade}(z) \rightarrow \text{give}(x, y, z)]] : h \multimap s \multimap f$
b. $h \multimap s \multimap g \multimap f, (g \multimap f) \multimap f \vdash h \multimap s \multimap f$
c. $\lambda P.\text{GOAL}(P) : (h \multimap s \multimap f) \multimap G$

This approach essentially duplicates resources that are missing from t_2 by hard-coding them within the proof tree. One could argue that the information can be reconstructed from within stage n_2. However, if not hard-coded, the goal needs to be derived from the left-hand side of the sequent in (13-b), introducing additional computations and, possibly, multiple results requiring us to deal with further spurious ambiguities.[19]

Thus, overall the cascading chart prover approach to multistage proving does not faithfully implement the formal elegance of the multistage proving idea.[20] In the next section, I present an alternative method to multistage proving, which does away with the need for knowing intermediate goals beforehand, while maintaining the general idea of cascading proof steps. This is achieved by integrating multistage proving within the graph-based proving paradigm introduced in Section 3. Furthermore, I integrate this method into XLE+Glue, thus providing an explicit implementation for LFG grammars.

[19]For example, the following sequent is also valid:

(i) $h \multimap s \multimap g \multimap f, (g \multimap f) \multimap f \vdash s \multimap h \multimap f$

Thus, making the goal category of n_2 in Figure 6 ambiguous. Findlay & Haug (2022) acknowledge problems along these lines. The present proposal provides a possible solution.

[20]It is possible that this approach is expected to work in tandem with the propsal made in Findlay (2021). There, intermediate results are purposefully stored in the semantic structure. However, the computational complications discussed here still need to be considered when evaluating the implementation.

```
{
//2: Scope freezing; 1 solution
h : h_e
a-student : ((s_e -o f_t) -o f_t)
    {
    every-grade : ((g_e -o f_t) -o f_t)
    give: (h_e -o (s_e -o (g_e -o f_t)))
    }
}
```

Figure 7: Bracketed meaning constructors for example (12)

4.3 Graph-based multistage proving

In the proposal made in this paper and following Findlay & Haug's (2022) idea, multistage premise sets are represented as bracketed premise sets. Thus, Glue semantics is made partially non-associative (see also Gotham 2021). According to Moot & Retoré (2012: 111ff.), this is a desirable result: "What we would like is to have some sort of controlled access to the structural rules of associativity and commutativity."[21] An example of this is given in Figure 7.

The intuitive idea behind graph-based multistage proving is to apply the cascading chart-proving mechanism only within the cycles that may occur during graph-based proving. Let us unwrap this idea. First, we label each set of brackets according to coordinates in the proof tree and store relations between them in a separate graph structure. This is the proof structure in the original proposal, now encoded via bracketing. As explained in Section 3, graph-based proving factors out modifiers and applies chart-based proving to them. Here, we use the proof tree to partition the chart. The important difference to Findlay & Haug (2022) is that our chart is reduced. All skeleton combinations are already processed.[22] The input to the chart-prover is determined by the nodes within the strongly connected component and the nodes leading into the sub-graph representing the cycle. The graph corresponding to the MCs in Figure 7 is shown in Figure 8. Recall that the graph is based on the compiled premises shown in (14).

(14)
$$\begin{array}{l} [0] : \mathrm{h} : h_e \\ [1] : \lambda Q.\exists x[\mathrm{student}(x) \wedge Q(x)] : ((s_e \multimap f_t) \multimap f_t) \\ [2] : \lambda Q.\forall x[\mathrm{grade}(x) \rightarrow Q(x)] : ((g_e \multimap f_t) \multimap f_t) \\ [3] : \lambda x.\lambda y.\lambda z.\mathrm{give}(x,y,z) : h \multimap s \multimap g \multimap f \end{array} \xrightarrow{\text{compile}} \begin{array}{l} [0] : \mathrm{h} : h_e \\ [1] : (f_{t,4} \multimap f_t) \\ [2] : (f_{t,5} \multimap f_t) \\ [3] : h \multimap s \multimap g \multimap f \\ [4] : s_e \\ [5] : g_e \end{array}$$

The proof corresponding to the cycle in Figure 8 is schematized in (15). Only two input nodes are relevant as indicated by the dashed lines in the cycle representation. The algorithm collects the corresponding histories for chart-proving. Then, the premise set is partitioned according to the proof tree. The tree is traversed bottom-up from left to

[21] We will discuss commutativity briefly in Section 5.

[22] This is not always the case. Some complex cycles can contain skeleton premises which need to be taken into account. However, as the chart-proving method is a very general method for calculating Glue proofs, this is not a problem.

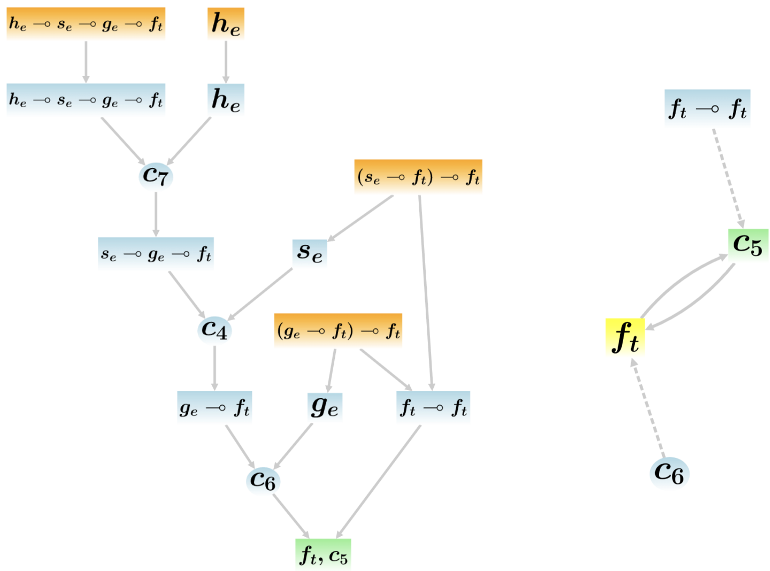

Figure 8: Derivation graph for example (14)

right.[23] As example (15) indicates, only the results of the derivation are passed on to the next stage. This is achieved by making sure that only elements are passed on where all modifiers in the input set have been applied.[24]

(15)
$$\begin{array}{l}[1] : (f_{t,4} \multimap f_t)\\ [2] : (f_{t,5} \multimap f_t)\\ [0,3,4,5] : f^{4,5}\end{array} \longrightarrow_{partition} \left\{ \begin{array}{c}[2] : (f_{t,5} \multimap f_t)\\ [0,3,4,5] : f^{4,5}\\ \downarrow_{prove}\\ [1] : (f_{t,4} \multimap f_t)\\ [0,2,3,4,5] : f^{4}\end{array} \right\} \longrightarrow_{prove} [0,1,2,3,4,5] : f^{4,5}$$

In summary, the method presented here does not require us to know intermediate goals due to the fact that fixed elements in the derivation are factored out and only modifiers are applied in a certain order based on the proof tree. Thus, by combining the intuitive idea of partitioning meaning constructors with a graph-based prover, we can omit certain stipulations made by Findlay & Haug (2022).

4.4 XLE+Glue with proof structure

This also makes it easier to interface multistage proving with the XLE. Concretely, we use XLE+Glue, developed by Dalrymple et al. (2020), as a basis. We extend the system with a component that extracts proof trees from XLE analyses and translates them into bracketed meaning constructor sets. We make the following basic assumptions:

[23]Sister nodes could potentially be parallelized for additional performance gains.

[24]In Section B of the appendix, a more complex example is shown that illustrates that other resources potentially need to be available at multiple stages.

```
EQUAL-GLUE(DOWN UP) =
      UP = %up
      DOWN = %down
      %down $ (t::%up ELEMENTS).

DOMINATES-GLUE(DOWN UP N) =
      @(CONCAT DAUGHTER N %daughter)
      UP = %up
      DOWN = %down
      %down $ (t::%up %daughter
              ELEMENTS).
```

$$n_1\left[\begin{array}{ll}\text{DAUGHTER1} & n_2\left[\begin{array}{ll}\text{ELEMENTS} & t_2\left\{\begin{array}{l}h \multimap s \multimap g \multimap f\\ (f_{t,5} \multimap f_t)\\ g_e\end{array}\right\}\end{array}\right]\\ \text{ELEMENTS} & t_1\left\{\begin{array}{l}(f_{t,4} \multimap f_t)\\ s_e\\ h_e\end{array}\right\}\end{array}\right]$$

Figure 9: Proof structure templates and sample AVM-representation for example (12)

i) The proof structure is a single rooted tree.

ii) Meaning constructors are associated with c-structure indices.

The proposal is illustrated in Figure 9. There, two templates are specified to build up the proof tree in the `t::` projection: the *equation*-template and the *dominance*-template. Both take two arguments, namely indices governed by the proof structure. The local names `%up` and `%down` are used to properly instantiate all relevant nodes with projection information, which is sometimes omitted when a node is not required for deriving the f-structure.[25] In the *dominance*-template, the additional parameter `N` is used to differentiate between sister nodes in the proof tree.[26] Consequently, the proof structure is an attribute/value matrix built from these templates. Importantly, to avoid clutter in the grammar, each node with no proof structure specification is treated as having the annotation $\hat{*}_\gamma = *_\gamma$, i.e., equality with its mother node. This is taken care of when traversing the c-structure to extract the multistage premise set.

Figure 10 illustrates a sample use of the proof structure templates to avoid unwanted ambiguities in example (14). As described in Findlay & Haug (2022), the secondary object (here OBJ2) is put in an embedded position with the verb, whereas the SUBJ and primary object remain in the dominating proof tree node. By using the same index, the embedded elements are stored as part of the same proof tree node.[27]

Bracketed premise sets are extracted by traversing XLE's c-structure output. This process relies on the fact that the c-structure is hierarchical for resolving implicit equations between mother and daughter nodes. Thus, the proof structure is also strictly a tree in this implementation. As a result, the procedure is fairly straightforward.

[25]This seems to be an idiosyncrasy of XLE rather than necessarily intended behavior. Thus, the use of local names can be seen as an implementation trick.

[26]In the current implementation, sister nodes need to be enumerated manually.

[27]Another technical trick employed here is the fact that the proof node is associated with the f-structure index of the VP rather than the c-structure index. This is due to the fact that multiple-branching trees are treated as covert binary trees in XLE. Thus, using `t::M*` to refer to the c-structure mother node instead of `t::^` would make the system a bit more complicated. However, this also illustrates how the proof structure can interact not only with c- but also with f-structure in this implementation.

```
S --> NP: (^ SUBJ)=!
          (! CASE)=nom
          @(EQUAL-GLUE * t::^);
      VP: (^ TNS-ASP TENSE).
```

```
VP --> (AUX)
       V: ^=!
          @(DOMINATES-GLUE * t::^ 1);
       (NP: (^ OBJ)=!
            (! CASE)=acc
            @(EQUAL-GLUE * t::^))
       (NP: (^ OBJ2) = !
            @(DOMINATES-GLUE * t::^ 1))
                 "secondary object"
         ...
```

Figure 10: Sample use of proof structure templates

4.5 Exploring multistage proving

The GSWB (Meßmer & Zymla 2018) has grown into a more comprehensive ecosystem including various aspects of computational Glue semantics that I have subsumed under the banner of XLE+Glue (coined by Dalrymple et al. 2020). The current work can be explored at https://github.com/Mmaz1988/xleplusglue/tree/lfg2024_multistage_proving. This repository combines the GSWB,[28] LiGER,[29] and the original XLE+Glue[30] into one large framework for exploring various aspects of computational Glue semantics. Furthermore, it provides a web interface for using the tools without the need for extensive technical knowledge. However, an XLE license and the XLE source code, as well as Docker,[31] are required. The repository contains a toy grammar for exploring multistage proving and a test file for the GSWB, including tests of varying complexity for the multistage proving algorithm. These tests go far beyond the simple examples discussed in this paper.

5 Some general considerations on ambiguity management

Multistage proving is, among other things, a tool for making semantic parsing more efficient. Ambiguities arise in all phases of parsing a linguistic expression. The computational complexity tends to rise as one moves from form to meaning: morphology is encoded in terms of regular languages, which can be solved in $O(n)$, c-structures are polynomial ($(O(n^3))$), and f-structures are exponential (all in the worst case). For semantics, the simple chart parser fares even worse in the worst case, being at least factorial ($(O(n!))$). Consequently, it is sometimes useful to push labor toward the more computationally efficient parts of parsing. One such instance is, for example, the presence of complex categories, which effectively push functional disjuncts into the domain of phrase structure rules. Similarly, Glue semantics can be made to involve more or less information from other projections. I discuss f-structure and c-structure in particular.

[28]https://github.com/Mmaz1988/GlueSemWorkbench_v2
[29]https://github.com/Mmaz1988/liger
[30]https://github.com/Mmaz1988/xle-glueworkbench-interface
[31]https://www.docker.com/

$$\dfrac{\dfrac{\lambda x.\lambda y.\text{visit}(y,x) : g \multimap (h \multimap f) \qquad a : g}{\lambda y.\text{visit}(y,a) : h \multimap f} \qquad j : h}{\text{visit}(j,a) : f}$$

Figure 11: Traditional derivation for *Jordan visits Alex*

5.1 Imposing hierarchical structures

Linear logic is quite capable of encoding hierarchical information. This can be seen in Figure 11 based on the meaning constructors in example (16-a). They mirror the constituency hierarchy between the SUBJ and OBJ-GF in a configurational language, specifically English. Nothing in Glue semantics hinges on this possibility of mirroring the c-structure though. However, even this could still be seen as capturing the fact that there is a hierarchical relationship between SUBJ and OBJ that needs to surface somewhere in the syntax/semantics interface. If this hierarchy is already expressed at the level of syntax, why not transduce it to the semantics from there?

(16) Jordan visits Alex.

a. **John** $j : g$
Alex $a : h$
visits $\lambda x.\lambda y.\text{visit}(y,x) : g \multimap (h \multimap f)$

Arguably, this hierarchy is not always enforced in syntax. This has been famously shown in Austin & Bresnan (1996) for Australian Aboriginal languages and has also been explored computationally, for example, in Urdu (Butt & King 2007). The languages in question are modeled with an exocentric category S that dominates a flat c-structure (see also Kroeger 1993). In this case, the semantics would not simply recapitulate hierarchical information from the syntax but rather integrate the hierarchical information directly into the semantics. This is at odds with the idea of a framework that is often sold on the basis of getting away without structure building (in contrast to, e.g., the logical form (LF) approach to semantics; Heim & Kratzer 1998). However, ultimately, it seems to be a question of implicit vs. explicit hierarchical ordering. In other words, hierarchical structures always emerge. We can either make them explicit, or they will occur implicitly during the derivation process.

To understand this, let us compare the hierarchical approach above to a flatter approach: since the rising popularity of event semantics (Davidson 1967; Parsons 1990), Glue semantics has developed in a direction that eliminates meaningful hierarchical structure from Glue proofs by treating (some) arguments as modifiers. This development perhaps began around the time of Asudeh & Giorgolo (2012), where only optional arguments are treated as modifiers. It also follows a more general trend in formal semantics away from the traditional saturation-based semantics (i.e., the approach outlined above) towards a restriction-based semantics (Chung & Ladusaw 2003).

Just recently, radically modifier-oriented approaches to Glue semantics have found their way into computational LFG. Two recent works highlight this.[32] One of them is on

[32] Lev (2007) also already uses event semantics, but there core arguments of verbs are still hard-coded

$$\frac{\dfrac{\lambda P.\lambda x.P \wedge \text{ag}(e) = x : f \multimap g \multimap f \qquad \dfrac{\dfrac{\lambda P.\lambda x.P \wedge \text{th}(e) = x : f \multimap h \multimap f \qquad \text{visit}(e) : f}{\lambda x.\text{visit}(e) \wedge \text{th}(e) = x : h \multimap f} \qquad a : h}{\text{visit}(e) \wedge \text{th}(e) = a : f}}{\lambda x.\text{visit}(e) \wedge \text{th}(e) = a \wedge \text{ag}(e) = x : g \multimap f} \qquad j : g}{\text{visit}(e) \wedge \text{th}(e) = a \wedge \text{ag}(e) = j : f}$$

$$\frac{\dfrac{\lambda P.\lambda x.P \wedge \text{th}(e) = x : f \multimap h \multimap f \qquad \dfrac{\dfrac{\lambda P.\lambda x.P \wedge \text{ag}(e) = x : f \multimap g \multimap f \qquad \text{visit}(e) : f}{\lambda x.\text{visit}(e) \wedge \text{ag}(e) = x : g \multimap f} \qquad j : g}{\text{visit}(e) \wedge \text{ag}(e) = j : f}}{\lambda x.\text{visit}(e) \wedge \text{ag}(e) = j \wedge \text{th}(e) = x : h \multimap f} \qquad a : h}{\text{visit}(e) \wedge \text{ag}(e) = j \wedge \text{th}(e) = a : f}$$

Figure 12: Simplified event semantics derivations for *Jordan visits Alex*

coordination (Przepiórkowski & Patejuk 2023), implementing a Champollion (2015)-style semantics. The other is actually Findlay & Haug (2022), discussed in this paper, which implements a version of Asudeh et al.'s (2014) restriction-based event semantics.

Example (17) presents a simplified set of meaning constructors for such a restriction-based semantics.[33] As shown there, the meaning of the verb is assembled from its core meaning, i.e., the eventuality it describes, and its arguments, the entities participating in the eventuality which are treated as modifiers (one of the fundamental properties of Parsons's 1990 neo-Davidsonian event semantics). As a result, each argument introduces additional spurious ambiguities (see Figure 12).

(17) **John** $j : g$
Alex $a : h$
visits $\text{visit}(e) : f$
$\lambda P.\lambda x.P \wedge \text{ag}(e) = x : f \multimap g \multimap f$
$\lambda P.\lambda x.P \wedge \text{th}(e) = x : f \multimap h \multimap f$

Computationally, we can use something like the `noscope` flag mentioned in Section 3.4 to avoid spurious ambiguity. However, what this does is simply force an arbitrary hierarchy for applying modifiers. After all, we privilege one hierarchical ordering over the other when we choose a proof tree from the two possibilities in Figure 12.[34] In Glue semantics, linear logic is simply a vehicle for constraining the lambda calculus and, thus, function application forests.

Consequently, a hierarchy will emerge in either case. The only question is whether enforcing explicitly the hierarchy makes predictions that are not borne out. In many cases, the main difference seems to be descriptive parsimony (cf. Asudeh et al. 2014).

in the meaning constructors of the verb.

[33]We leave e as a free variable to keep the types concise. Of course, in actuality, they would be lambda abstracted over and bound by an existential closure mechanism.

[34]Computationally speaking, linear logic has the benefit that it is not actually necessary to enumerate the two possible solutions (i.e., this means they would be constructed and then filtered), but rather, only one solution can be calculated without ever expecting another one. Critically, this only works in commutative contexts, i.e., non-scoping contexts.

However, the relationship between descriptive parsimony and computational efficiency is not always clear. What is clear, though, is that computational implementations profit from explicit structure building to weed out spurious ambiguities.

As the above discussion suggests, the important question could be where the structure is built. Tools like parameterized rules suggest that disambiguating early can increase performance. Similarly, Zymla (2024) argues that, from a computational perspective, it is easier to leave completeness and coherence in f-structure, as unnecessary computations are avoided in the semantics by filtering out possible but unwanted analyses early. Overall, the idea should be to build structure early where possible. This is exactly what multistage proving allows us to do. Thus, the fact that it has arisen as part of the development towards a modifier-based event semantics is not all that surprising. An alternative view is that multistage proving is another instance of factoring out calculations (as is the graph prover for the chart prover). This view highlights an alternative strategy for efficient ambiguity management: distribute complex facts across multiple simple projections. This, of course, is in the spirit of LFG (Kaplan 1995).

5.2 Extensions of linear logic

The proposal made in this paper presupposes the *implicational fragment* of linear logic. There are at least two typical extensions that have been explored in the literature: the implicational fragment with quantification over variables of type t and *multiplicative linear logic*. The first was and is famously used to model the flexibility of quantifiers, and the second has been used in various guises to generate compound objects. Do these extensions complicate the current view on ambiguity management?

(18) $\forall X_t.(e_e \multimap X_t) \multimap X_t \quad \Leftrightarrow \quad (e_e \multimap \%scope_t) \multimap \%scope_t$,
where often $\%scope = (GF{+} \uparrow)$

(19) a. $\lambda x.\lambda y.\text{visit}(x, y) : g \multimap h \multimap f \quad \Leftrightarrow \quad \lambda\langle x \times y\rangle.\text{visit}(x, y) : g \otimes h \multimap f$
b. $\lambda z.z \times z : (\uparrow \text{ ANTECEDENT}) \multimap ((\uparrow \text{ ANTECEDENT}) \otimes \uparrow)$

The first extension is the de facto standard in Glue semantics theory and is illustrated in (18). There, two versions of the familiar quantifier type $(e \multimap t) \multimap t$ are shown. The quantifier on the left freely scopes over any constants of type t. In comparison, the quantifier on the right only scopes over constants that lie on an inside-out functional uncertainty (IOFU) path (i.e., only constants that dominate the quantifier). Ultimately, the two approaches are likely equivalent in terms of resulting analyses for quantifier types. Eliminating quantification over linear logic variables from the used Glue fragment is, in fact, an instance of resolving ambiguities early that is particularly popular in computational Glue (for reasons of efficiency, as discussed in the previous section). However, it is sometimes dispreferred theoretically as it obfuscates semantic autonomy (Gotham 2021; but see, e.g., Andrews 2010 for arguments in favor of the IOFU-approach).

The second extension is the inclusion of multiplicative conjunction. From a computational perspective, the addition of multiplicative conjunction $\otimes$ can be reduced to linear implication in cases like (19-a) (Hepple 1998). However, it also has the interesting aspect of allowing us to duplicate meanings, e.g., to copy antecedents of pronouns

(Dalrymple et al. 1999b).[35] Lev (2007: ch. 8.2) shows that such cases can be covered by the implicational fragment of linear logic, given careful consideration. Furthermore, Lev (2007) argues that such approaches are difficult to maintain as it is not possible to rule out spurious ambiguities in corresponding Glue derivations. He concludes that pronoun resolution should be left to a pragmatic module rather than solved during semantic composition (see also Kokkonidis 2006; Dalrymple et al. 2018). Given the view defended in Zymla (2024), I am inclined to take a similar stance.

Overall, the extensions discussed here introduce additional complications from a computational perspective without much payoff. It also seems like they can be ultimately reduced to clever uses of simple function application. Thus, we can maintain the position that function application is what lies at the heart of formal semantics.

6 Conclusion

The main goal of this paper is to provide a more nuanced approach to ambiguity management in computational Glue semantics under examination of the recent multistage proving proposal by Findlay & Haug (2022). To this end, the paper presents a more faithful implementation that simplifies the computational machinery by eliminating some adhoc requirements, particularly pre-specified goals. This is achieved by integrating the original idea into Lev's (2007) graph-based prover. This also allows us to use some other tools of the graph-based prover, e.g., the `noscope` flag that essentially eliminates commutatively equivalent analyses, considerably increasing efficiency. Thus, we can relax or constrain Glue semantics derivations across two dimensions of combinatory logic (Moot & Retoré 2012). However, the exact configuration based on meaningful semantic generalizations needs to be baked into the formal tools outlined by Findlay & Haug (2022) and explored in the present paper.

Concretely, as Gotham (2021) explains by virtue of quantifiers, different semantic properties, e.g., semantic monotonicity, may affect scope interactions (see also Lev 2007: 194ff.). Thus, the simple mechanisms of equality and dominance used for building proof structures may need to be made sensitive to an intricate set of constraints in the vein of Gotham (2019, 2021). Next to these concerns, phenomena like the exceptional scopal properties of indefinites (Farkas 1981; Brasoveanu & Farkas 2011) may also require more intricate mechanisms for constraining scope. Thus, there is room for further research regarding the proof structure and multistage proving.

This paper aims to steer research in this direction by providing a computational implementation of proof structure and multistage proving in XLE+Glue. Through this, hopefully, computational Glue and theoretic innovation will stay in touch, harboring LFG's strength of a close relationship between theoretical and computational research.

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A Proof procedures

Complex chart-based prover example

$$\lambda Q.\forall x[person(x) \rightarrow Q(x)] : (g_e \multimap X_t) \multimap X_t$$
$$\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$$
$$\lambda Q.\exists y[person(y) \wedge Q(y)] : (h_e \multimap Y_t) \multimap Y_t$$

$\longrightarrow_{compile}$

Agenda	**Chart**
$[0]\lambda Q.\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$	
$[3]X : g_e^3$	
$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$	
$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$	
$[4]Y : h_e^4$	

...

Agenda	**Chart**
$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$	$[3]X : g_e^3$
$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$	$[0]\lambda Q.\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$
$[4]Y : h_e^4$	

Agenda	**Chart**
$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$	$[3]X : g_e^3$
$[4]Y : h_e^4$	$[0]\lambda Q.\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$
$[1, 3]\lambda y.see(X, y) : (h_e \multimap f_t)^3$	$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$

...

Agenda	**Chart**
$[1, 3]\lambda y.see(X, y) : (h_e \multimap f_t)^3$	$[3]X : g_e^3$
	$[0]\lambda Q.\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$
	$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$
	$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$
	$[4]Y : h_e^4$

Agenda	**Chart**
$[1, 3, 4]see(X, Y) : f_t^{3,4}$	$[3]X : g_e^3$
	$[0]\lambda Q.\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$
	$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$
	$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$
	$[4]Y : h_e^4$
	$[1, 3]\lambda y.see(X, y) : (h_e \multimap f_t)^3$

Agenda	**Chart**
$[0, 1, 3, 4]\forall x[person(x) \rightarrow see(x, Y)] : f_t^4$	$[3]X : g_e^3$
$[1, 2, 3, 4]\exists y[person(y) \wedge see(X, y)] : f_t^3$	$[0]\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$
	$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$
	$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$
	$[4]Y : h_e^4$
	$[1, 3]\lambda y.see(X, y) : (h_e \multimap f_t)^3$
	$[1, 3, 4]see(X, Y) : f_t^{3,4}$

Agenda	**Chart**
$[0, 1, 2, 3, 4]\exists y[person(y) \wedge \forall x[person(x) \rightarrow see(x, y)]] : f_t$	$[3]X : g_e^3$
$[0, 1, 2, 3, 4]\forall x[person(x) \rightarrow \exists y[person(y) \wedge see(x, y)]] : f_t$	$[0]\forall x[person(x) \rightarrow Q(x)] : X_{t,[3]} \multimap X_t$
	$[1]\lambda x.\lambda y.see(x, y) : g_e \multimap h_e \multimap f_t$
	$[2]\lambda Q.\exists y[person(y) \wedge Q(y)] : Y_{t,[4]} \multimap Y_t$
	$[4]Y : h_e^4$
	$[1, 3]\lambda y.see(X, y) : (h_e \multimap f_t)^3$
	$[1, 3, 4]see(X, Y) : f_t^{3,4}$
	$[0, 1, 3, 4]\forall x[person(x) \rightarrow see(x, Y)] : f_t^4$
	$[2, 1, 3, 4]\exists y[person(y) \wedge see(X, y)] : f_t^3$

...

$\square$

B Non-atomic modifier example – multiple adjectives

(20) A big black dog appeared.

```
{
//10: adjective test; 1 solution
appear : (7_e -o 11_t)
a : ((9_e -o 8_t) -o ((7_e -o 11_t) -o 11_t))
    {
    big : ((9_e -o 8_t) -o (9_e -o 8_t))
        {
        black : ((9_e -o 8_t) -o (9_e -o 8_t))
        dog : (9_e -o 8_t)
        }
    }
}
```

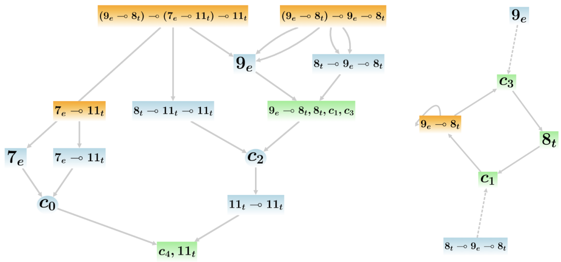

Figure 13: Meaning constructors and derivation graph for example (20)

(21)

$$\begin{array}{l}
[0] : \lambda x.dog(x) : 9_e \multimap 8_t \\
[1] : \lambda P.\lambda Q.\exists x[P(x) \wedge Q(x)] : (9_e \multimap 8_t) \multimap (7_e \multimap 11_t) \multimap 11_t \\
[2] : \lambda P.\lambda x.[black(x) \wedge P(x)] : (9_e \multimap 8_t) \multimap 9_e \multimap 8_t \\
[3] : \lambda P.\lambda x.[big(x) \wedge P(x)] : (9_e \multimap 8_t) \multimap 9_e \multimap 8_t \\
[4] : \lambda x.appear(x) : 7_e \multimap 11_t
\end{array}
\longrightarrow_{compile}
\begin{array}{l}
[0] : 9_e \multimap 8_t \\
[1] : 8_t \multimap 11_t \multimap 11_t \\
[2] : 8_t \multimap 9_e \multimap 8_t \\
[3] : 8_t \multimap 9_e \multimap 8_t \\
[4] : 7_e \multimap 11_t \\
[5] : 9_e \\
[6] : 7_e \\
[7] : 9_e \\
[8] : 9_e
\end{array}$$

(22)

$$\begin{array}{l}
[2] : 8_{t,7} \multimap 9_e \multimap 8_t \\
[3] : 8_{t,8} \multimap 9_e \multimap 8_t \\
[0,5] : 8^5 \\
[0,7] : 8^7 \\
[0,8] : 8^8 \\
[5] : 9_e \\
[7] : 9_e \\
[8] : 9_e
\end{array}
\longrightarrow_{partition}
\left\{
\begin{array}{l}
[2] : 8_{t,7} \multimap 9_e \multimap 8_t \\
[0,5] : 8^5 \\
[0,7] : 8^7 \\
[0,8] : 8^8 \\
[5] : 9_e \\
[7] : 9_e \\
[8] : 9_e \\
\qquad \downarrow_{prove} \\
\color{blue}{[3] : 8_{t,8} \multimap 9_e \multimap 8_t} \\
[0,2,5,7] : 8_t \\
\color{blue}{[0,2,7,8] : 8_t} \\
\color{blue}{[5] : 9_e} \\
[7] : 9_e \\
[8] : 9_e \\
[0,5] : 8^5 \\
[0,7] : 8^7 \\
[0,8] : 8^8
\end{array}
\right\}
\longrightarrow_{prove}
\color{blue}{[0,2,3,5,7,8] : 8}$$

•Due to the disjoint index-set constraint and the need to discharge assumptions, only the blue elements may be combined into a single solution.