Proceedings of the 17th International Conference on Head-Driven Phrase Structure Grammar

Université Paris Diderot, Paris 7, France

Stefan Müller (Editor)

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Contents

1 Editor's Note

The 17th International Conference on Head-Driven Phrase Structure Grammar (2010) was held at Université Paris Diderot, Paris 7.

The conference featured 2 invited talks and 19 papers, and 5 posters selected by the program committee (Doug Arnold, Emily M. Bender, Philippe Blache, Olivier Bonami (chair), Bob Borsley, Gosse Bouma, Rui Chaves, Ann Copestake, Berthold Crysmann, Kordula De Kuthy, Dan Flickinger, Daniele Godard, Anke Holler, Jean-Pierre Koenig, Valia Kordoni, Anna Kupsc, Bob Levine, Rob Malouf, Nurit Melnik, Philip Miller, Stefan Müller, Gerald Penn, Frank Richter, Ivan Sag, Manfred Sailer, Jesse Tseng, Frank Van Eynde, Gert Webelhuth, Shuichi Yatabe, Eun-Jung Yoo).

A workshop about *Morphology and Formal Grammar* was attached to the conference. It featured one invited talk and 10 papers and three posters, selected by the program committee of this workshop (Farrell Ackerman, Emily Bender, James Blevins, Olivier Bonami (chair), Dunstan Brown, Gilles Boyé, Berthold Crysmann, Bernard Fradin, Rob Malouf, Stefan Müller, Louisa Sadler, Pollet Samvelian, Andrew Spencer, Jesse Tseng, Gert Webelhuth).

In total there were 29 submissions to the conference and 24 submissions to the workshop. We want to thank the respective program committees for putting this nice program together.

Thanks go to Anne Abeillé (chair), Gabriela Bilbîie, Olivier Bonami, Marianne Desmets, Danièle Godard, Fabiola Henri, Frédéric Laurens, Philip Miller, François Mouret, Clément Plancq, Jana Strnadová, Delphine Tribout, Géraldine Walter, Grégoire Winterstein, who were in charge of local arrangements.

As in the past years the contributions to the conference proceedings are based on the five page abstract that was reviewed by the respective program committees, but there is no additional reviewing of the longer contribution to the proceedings. To ensure easy access and fast publication we have chosen an electronic format.

The proceedings include all the papers except those by Farrell Ackerman and Rob Malouf, Dan Flickinger, Jean-Pierre Koenig and Karin Michelson, Robert Levine, Jakob Maché, Nurit Melnik, and Gregory Stump.

Part I
Contributions to the Main Conference

Analysing Speech and Co-Speech Gesture in Constraint-based Grammars

Katya Alahverdzhieva
UNiversity of Edinburgh

Alex Lascarides
UNiversity of Edinburgh

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Alahverdzhieva, Katya, & Lascarides, Alex. 2010. Analysing Speech and Co-Speech Gesture in Constraint-based Grammars. In Müller, Stefan (Ed.), *Proceedings of the 17th International Conference on Head-Driven Phrase Structure Grammar, Université Paris Diderot, Paris 7, France*, 6–26. Stanford, CA: CSLI Publications.

Abstract

This paper addresses the form-meaning relation of multimodal communicative actions by means of a grammar that combines verbal input with hand gestures. Unlike speech, gesture signals are interpretable only through their semantic relation to the synchronous speech content. This relation serves to resolve the incomplete meaning that is revealed by gestural form alone. We demonstrate that by using standard linguistic methods, speech and gesture can be integrated in a constrained way into a single derivation tree which maps to a uniform meaning representation.

1 Introduction

Meaning in everyday communication is conveyed by a complex mixture of signals that includes the situated and dynamic context of language production and language perception. In face-to-face interaction, people rely on *utterance visible actions* (Kendon, 2004) to exchange information. For instance, in a multi-party conversation, a pronoun is often resolved by a pointing gesture towards the intended addressee; in living-space descriptions, people often create a virtual map so as to point to a designated location; when narrating stories people use hand movements to depict events or to provide visual characteristics of an object.

This project is concerned with embodied actions—also known as 'gesticulation', 'co-verbal gestures' or 'co-speech gestures'—that use the hand as a semantically intended medium for communication. The specific property of hand gestures is their *synchrony* with the co-occurring speech: a single thought is expressed synchronously in speech and in gesture, and is perceived as an integrated multimodal ensemble (McNeill, 2005). The synchronous nature of the multimodal signal is observed with the semantic relation between speech and gesture being one of redundancy (that is, the gestural signal "repeats" visually the spoken words) or a relation of complementarity (that is, the gesture adds propositional content to the final utterance). Whereas redundancy is not favoured in speech only, speech-gesture redundancy does not violate coherence (Lascarides and Stone, 2009), and it can facilitate learning and enhance expressiveness (Buisine and Martin, 2007).

In this project, we approach synchrony in multimodality by elevating formal language models to a description of multimodal input. In particular, we use well-established methods for composing a semantic representation of a signal from a representation of its form so as to provide a form-meaning mapping for multimodal communicative actions, consisting of spoken phrases and co-speech gestures. This will be achieved by developing a constraint-based multimodal grammar that takes verbal signals and hand gestures as input. The grammar captures generalisations about the well-formedness of the multimodal signal. Within the multimodal grammar one can elegantly capture the linguistic and visuo-spatial linkages at a conceptual level that trigger the synchronous production of speech and gesture: for instance, representing the interaction between a spoken signal and its synchronous gesture is a matter of constraining the choices of speech-gesture integration in the grammar.

Our focus of study are spontaneous and improvised co-speech gestures that communicate meaning:[1] *depicting (representative)* gestures depict, model the object of reference or enact a specific behaviour. The depiction can be literal (also known as iconic gestures), e.g., making a round shape with hands when talking about a cake, or metaphoric, e.g, moving the hand from the left to the right periphery to refer to the past and the future. *Pointing (deictic)* gestures can identify concrete coordinates in Euclidean space (Lascarides and Stone, 2009), point to an abstract object in the virtual space (McNeill, 2005), or even nominate as prominent a word or a phrase (Kendon, 2004). *Performative (pragmatic)* signals perform a speech act, e.g., the hand moves away across the body with palm facing down to express negation. Finally, in *interactive* gestures, the hand is used as an interaction regulator as when extending an open hand towards the addressee to offer them the floor (Bavelas et al., 1995). Other spontaneous communicative actions include *beats*. These are formless flicks of the hand that beats time along with the rhythm of the speech, and they often serve pragmatic functions such as commenting on one's own utterance or giving prominence to aspects of the speech (Cassell, 2000).

The gesture categories do not form a typology of distinct classes; rather, they are spread among mutually inclusive dimensions, and so a single gesture can exhibit traces of one or more dimensions (McNeill, 2005). Utterance (1) taken from a corpus collected and annotated by Loehr (2004) exemplifies such multidimensional gesture: the horizontal hand movement with palms facing down literally depicts some salient feature of the synchronous speech content, namely objects positioned at the bottom, and at the same time this gesture is a recurrent metaphor of a completion of a process.[2]

(1) <u>the BOTTOM</u> worked FINE
Hands are rested on the knees and elevate to the body centre with palms facing downwards. Right and left hand perform a horizontal movement to the right and left periphery, respectively.

2 Main Challenges

We shall now address the major challenges arising from the ambiguous form of gesture. Considered out of specific context, the form of a hand signal is massively ambiguous, potentially mapping to open-ended meanings. For instance, a rotating hand movement performed by the whole hand can resemble the circular motion of an object such as a mixer or a wheel; it can also be a visual representation of

[1]The classification that follows is largely based on Kendon (2004).

[2]Throughout this work, small caps are used to indicate the pitch accented words and underlining is used to indicate the verbal segment temporally aligned with gesture; the gesture's transcription is given in italics after the verbal string.

the object being rotated by the hand; or each iteration can indicate distinct steps in an iterative process. Of course, many other propositions can be characterised by this hand movement. This is very roughly analogous to lexical sense ambiguity in language, where polysemous words can map to open-ended meanings if ones takes generative properties such as metaphor and nonce uses into account (Pustejovsky, 1995).

Further ambiguities concern the gestural category—representative or deictic—which affects the syntactic context. This ambiguity is useful as it allows us to differentiate between spatial and non-spatial content: deictic gestures provide spatial reference in the virtual situation and should thus receive spatial values, whereas representative gestures require qualitative values (Lascarides and Stone, 2009). A rough linguistic analogy is, for instance, the distinct categories of "duck"—a noun or a verb—leading to the syntactically ambiguous sentence "I saw her duck". The way this syntactic ambiguity is resolved depends on the context of use and resolving this ambiguity in form is logically co-dependent with resolving its interpretation in context: "I saw her duck, geese and chickens" would yield a syntactic and corresponding meaning representation distinct from that of "I saw her duck and hide in the hay".

Neither the form of the gesture nor the form of speech uniquely determine the linguistic phrase synchronous with gesture.[3] Following Lascarides and Stone (2009), we assume that computing the rhetorical connections between a gesture and its synchronous phrase, and resolving the meaning of the gesture to a specific value are logically co-dependent. With this in mind, consider the real example in (2) (Loehr, 2004).

(2) If I was TO REALLY TEACH someone how to be a professional musician ...
Hands are in the central space in front of speaker's body; palms face horizontally upwards. Along with "really", both hands perform a quick downward movement; possibly a conduit metaphor

Here the gesture stroke was performed while uttering the pre-head modifier, while annotators interpreted the gesture meaning as one where the open hands express the conduit metaphor (Lakoff and Johnson, 1980). The fact that annotators interpreted it in this way suggests that quantitative criteria alone—such as the timing of speech relative to gesture—are not sufficient to define adequate constraints on synchrony. This example also illustrates that in syntax, the gesture stroke interacts with the head daughter of the speech phrase, and in semantics, the content of the gesture is semantically related to that of the whole clause, in which way, the agent, patient and the idea transferred between them via teaching all serve to resolve the values of the participants in the conduit metaphor that is expressed by the gesture. However, this conduit interpretation is not available if the gesture temporally overlaps with only the subject daughter itself. Intuitively in this case, the

[3]In this paper, the term 'gesture' designates the expressive part of the whole movement, the kinetic peak of the excursion that carries the gesture's meaning—the so called *gesture stroke*.

gesture would simply denote the individual denoted by the subject, perhaps also placing him in a particular place that carries meaning. Finally, the gesture can receive a pragmatic interpretation that is paraphrasable as the parenthetical expression "I am informing you", which is possible by attaching the gesture to the S node. Despite the ambiguities in context, the result does not violate coherence—coherent multimodal actions tolerate certain unresolved ambiguities in interpretation, just as purely linguistic ones do.

Nonetheless, speech-gesture synchrony is not a free-for-all and our challenge is to identify the factors that make a multimodal act ill-formed. There is evidence in the literature that temporal alignment affects perception of speech and gesture integration, and the parameter that plays a role in perceiving a multimodal action as well-formed is prosody (Giorgolo and Verstraten, 2008).

To illustrate the effects of prosody on speech-gesture synchrony, consider the constructed example (3). Here it seems anomalous to perform the gesture on the unaccented "called" even though the gesture is intended as a depiction of something related to the act of calling. This ill-formedness would not arise if the gesture was placed along the whole utterance or a part of it which includes the prosodically prominent element "mother".

(3) * Your MOTHER <u>called</u> today.
The speaker puts his hand to the ear to imitate holding a receiver.

Ambiguity does not contradict our prediction that spontaneous gestures are a semantically intended communication source. In fact, they partially constrain the set of possible interpretations: this observation is valid not only for deictic and performative gestures whose recurrent form and orientation in the virtual space maps to a limited set of possible interpretations, but also for representative gestures whose imagistic resemblance with the object of reference is linked to an abstract meaning. By constructing a multimodal grammar we shall provide a methodology for the derivation of all possible interpretations in a specific context-of-use and for constraining speech-gesture ill-formedness.

We address the ambiguity of a disambiguated multimodal form by producing an underspecified logical formula which gives an abstract representation of what the signal means in any context of use. So, this abstract representation must support the full variety of specific interpretations of the gesture that occurs in different discourse contexts. How exactly it is going to resolve to a preferred value is a matter of discourse processing that is beyond the scope of our current goals. Multimodal ill-formedness is addressed by providing linguistic constraints of when speech and gesture can be synchronised. In this way, we address in a qualitative way the quantitative finding of Giorgolo and Verstraten (2008).

3 Form and Meaning of Gesture

Contrary to the decompositional analysis of lexical items or the semantic compositional approach to natural language, the meaning of a gesture cannot be determined decompositionally (McNeill, 2005).[4] A gesture obtains its meaning after conjoining the various gesture features—the shape of the hand, the orientation of the palm and fingers, the location of the hand and the direction of the movement—and linking them to the context of the accompanying speech. Recall that some ambiguity about the 'transfer' conduit (2) remains, and so formalising gesture content requires the framework to support ambiguity in coherent actions. The holistic aspect of gesture's form requires a description that is distinct from the tree descriptions of linguistic phrases. We benefit from previous unification-based models of gesture (Johnston, 1998), (Kopp et al., 2004) to formally regiment the contribution of each aspect of gesture in terms of Typed Feature Structures (TFSs). For instance, the form of the gesture in utterance (2) is representend in Figure 1. The representation is typed as *depicting_metaphoric* so as to distinguish the form features constrained by depiction from those constrained by spatial reference (Lascarides and Stone, 2009).

$$\begin{bmatrix} \textit{depicting\_metaphoric} & \\ \textsc{Hand-shape:} & \text{open-flat} \\ \textsc{Palm-orientation:} & \text{upwards} \\ \textsc{Finger-orientation:} & \text{forward} \\ \textsc{Hand-location:} & \text{centre-low} \\ \textsc{Hand-movement:} & \text{straight-down} \end{bmatrix}$$

Figure 1: TFS Representation of Gesture Form

Following previous research on semantics of gesture (Lascarides and Stone, 2009), we use the framework of Robust Minimal Recursion Semantics (RMRS) (Copestake, 2007) to provide a form-meaning mapping of embodied actions. RMRS is fully flexible in the type of semantic underspecification it supports: one can easily leave the predicate's arity and the type of the arguments underspecified until resolved by the discourse context, for instance. This is useful, because each form feature value can resolve to a wide range of fully specific predications in context, and these possibilities are not of unique arity. For instance, the downward movement in (2) can be interpreted as offering knowledge that is held by the open hand. In this case, the logical form contributed by the movement should be a three-place predicate denoting an event $teach(e, x, y)$. On the other hand, the movement in the same gesture that is performed in the different (constructed) speech context (4) depicts the uniformity of the shape of the keel of boat, from the port to the starboard, which by the hand shape is curved. Thus here the movement resolves to the one-place predicate $uniform(x)$ where x denotes the shape of the keel.

[4]There are attempts of hierarchical organisation of gesture ((Fricke, 2008), inter alia) similar to the hierarchically organised syntactic constituents but these are at the level of the entire hand excursion from a rest position to its retraction to a rest, also knows as a *gesture unit*.

(4) The boat's keel is curved
same gesture as in (2)

Form-meaning mapping from a gesture stroke to its highly underspecified semantic representation consists in reading the gesture's predications directly off the feature structure as shown in Figure 2.

$$
\begin{array}{l}
l_0 : a_0 : [\mathcal{G}](h) \\
l_1 : a_1 : hand\_shape\_open\_flat(i_1), \\
l_2 : a_2 : palm\_orientation\_upwards(i_2), \\
l_3 : a_3 : finger\_orientation\_forward(i_3), \\
l_4 : a_4 : hand\_location\_centre\_low(i_4), \\
l_5 : a_5 : hand\_movement\_straight\_down(i_5) \\
h =_q l_i \;\; where \;\; 1 \leq i \leq 5
\end{array}
$$

Figure 2: RMRS Representation of Gesture Meaning

Each predication is associated with a (not necessarily unique) label ($l_0 \ldots l_5$), a unique anchor ($a_0 \ldots a_5$) and an index variable ($i_1 \ldots i_5$) that underspecifies its main argument. The label is used to determine the scopal position of its predicate in the logical form (so Figure 2 exhibits semantic scope ambiguities among the resolved predications). The anchor for each predication is used as a locus for adding arguments to the predication—for instance, $ARG(a, x)$ means that $hand\_shape\_open\_flat$ resolves in context to a predicate that takes (at least) two arguments and the second is x. The predication $hand\_shape\_open\_flat(i_1)$ underspecifies the referent i_1 depicted through the hand shape of the hand (i_1 can resolve to an individual variable x or to an event variable e). An RMRS predicate is resolved to a specific predicate (or a combination thereof) on the semantics/pragmatics interface. The range of possible specific predicates that a given predication can resolve to is limited by iconicity (Lascarides and Stone, 2009). Further, Lascarides and Stone (2009) motivate the introduction of an operator $[\mathcal{G}]$ that limits the scope of the predicates within the gesture modality. This captures constraints on co-reference between speech and gesture, and across different gestures.

The gesture's interpretation in context is logically co-dependent on how it is coherently related to its synchronous speech. Lascarides and Stone (2009) argue that there is an inventory of semantic relations between the gesture and the linguistic phrase: for instance, the gesture can *depict*, *elaborate*, *explain*, but not *contrast with* the information introduced by speech. In the grammar, we shall therefore introduce in semantics an underspecified semantic relation $vis\_rel(s, g)$ between the content denoted by a speech s daughter and the content denoted by a depicting gesture g daughter when they are combined via a grammar construction rule that reflects that s is the linguistic phrase that g is synchronous with. How this relation resolves is a matter of commonsense-reasoning. This is similar to the treatment of free adjuncts in language: the covert relationship between the content of the main clause and the proposition of the free adjunct must be determined in pragmatics.

4 Speech-Gesture Synchrony

4.1 What is Synchrony?

There is a very broad consensus within the gesture community that speech and co-speech communicative actions function in *synchrony* to convey an integrated message (McNeill, 2005), (Kendon, 2004). However, the conditions on synchrony are controversial: is synchrony defined solely in terms of temporal alignment (McNeill, 2005), (Engle, 2000) or are there other prevailing conditions (Oviatt et al., 1997)? Further confusion arises as to what the criteria are when considering the temporal extension of the gesture: is it the gesture stroke that is temporally aligned with the spoken signal, the gesture phrase from its beginning to its semantic peak, or the entire gesture excursion from a rest to a rest. We therefore start by working out our own definition as follows:

Definition 1 (Synchrony) *The choice of which linguistic phrase a gesture stroke is synchronous with is guided by: i. the final interpretation of the gesture in specific context-of-use; ii. the speech phrase whose content is semantically related to that of the gesture given the value of (i); and iii. the syntactic structure that, with standard semantic composition rules, would yield an underspecified logical formula supporting (ii) and hence also (i).*

Whereas synchrony has already been defined in terms of (i) and (ii), the last factor is our contribution: we exploit standard methods for constructing form and meaning in formal grammars to constrain the choices of integrating speech and gesture into a single derivation tree, and thus to derive logical forms from syntax. An overall challenge is to constrain synchrony in a way that rules out ill-formed multimodal input, and nevertheless enables the derivation of highly underspecified logical formulae for well-formed input that will support pragmatic inference and resolve to preferred values in specific contexts. Note that this definition abandons simultaneity as a condition on synchrony. As attested in (2) and (3), this dovetails with the fact that our own perceptual system can make the judgement of which signals are synchronised and which are not.

The constraints on integrating speech and co-speech gesture into a single tree are guided by prosody (the literature offers enough evidence for the prosody-gesture interaction (Kendon, 1972), (McClave, 1991), (Loehr, 2004), (Giorgolo and Verstraten, 2008) inter alia), syntax (recall (2) and its subsequent discussion), and also the temporal performance of gesture relative to speech.

While there is a clear interaction between gesture and prosody, and between gesture and syntax-semantics of speech, we remain agnostic as to whether gesture, its dimension(s), content and composing phases interact with the distribution of information into theme and rheme. Cassell (2000) hypothesises that the type of *relation* between gesture and speech plays a central role in combining with either thematic or rhematic utterances. This information might be needed by a discourse processor but we are not convinced that information structure should constrain the choices of attachment for linguistic phrases and gesture within the grammar. So, in the absence of convincing empirical evidence that speech-gesture synchrony is informed by the type of the tone and correspondingly, by the thematic and rhematic functions of an utterance, we shall limit ourselves to prosody, syntax-semantics and timing as central factors for combining speech with gesture within the grammar to produce a unified meaning representation.

4.2 Empirical Investigation

To spell out constraints on speech-gesture integration, we conducted empirical investigation on a 165-second collection of four recorded meetings annotated for gesture and intonation (Loehr, 2004). Our experiments were intended to shed light on the following questions: Does the temporal performance of gesture relative to speech constrain the choices of integrating gesture into the parse tree? Do gestures occur with a particular syntactic constituent, if any at all? Is the gesture stroke performed while uttering a prosodically prominent syllable?

Gesture and Syntax To check for the interaction between communicative gestures and syntax, we assigned syntactic labels to the gesture strokes. This analysis was preceded by a preprocessing step which involved insertion of sentence boundaries, replacement of shortened forms with the corresponding long ones (e.g., "I've" $>$ "I have"), and also replacement of the filled and unfilled pauses with dummy words to handle incomplete grammatical slots.

The syntactic annotation was strictly driven by the temporal performance of gesture relative to speech, and in particular, by the type of the overlap relation between gesture and speech. In general, we observed three (not necessarily exclusive) temporal relations of a gesture (G) overlapping the relevant spoken word(s) (S): (1) inclusion where $S\ during\ G$; (2) precedence where $start(G) \prec start(S)$ and/ or $end(G) \prec end(S)$, i.e., the stroke starts or ends at some midpoint of the spoken word, and (3) sequence where $start(G) \succ start(S)$ and/or $end(G) \succ end(S)$, i.e., the stroke starts or ends at some midpoint of the spoken word. In case of inclusion, we have assigned the corresponding part-of-speech or syntactic labels of the included word(s). In case of precedence/sequence, there is generally a choice as to whether to include those midpoint words: provided that these word(s) were part of a syntactic constituent, they were included in the labelling, and otherwise they were ignored. Of course, if the inclusion (exclusion) of the midpoint words lead to distinct syntactic labels, all of the possibilities have been captured. And if the words overlapping the gesture did not form a syntactic constituent, this has been labelled as a "Non-constituent". Moreover, whenever the gesture starts at the midpoint of $word_1$ and finishes at midpoint of $word_2$, the gesture has been annotated in terms of the label of $word_1$, $word_2$ and their common syntactic label (if available). The results of the syntactic categories assigned to gesture strokes (G) are summarised in Table 1. Since every gesture potentially maps to more than one syntactic category, the total number of labels exceeds 100%.

Syntactic Category of G	**Percent**	**Syntactic Category of G**	**Percent**
S	6.38%	RB	7.45%
VP	10.64%	TO	2.13%
V *(present and past verb forms, base forms, modal verbs, present and past participles)*	27.66%	JJ *(positive and comparative adjectives)*	5.32%
NP	20.21%	DT	13.83%
NN *(singular and plural)*	9.57%	UH	1.06%
PRP *(personal and possessive)*	20.21%	C *(coordinating or subordinating conjunction)*	6.38%
IN	5.31%	Pause	8.51%
PP	1.06%	Non-constituent	6.38 %

Table 1: Gesture-Syntax Correlation

Discussion On the sole basis of the temporal performance of gesture relative to speech, the mapping of a gesture to a syntactic phrase is one-to-many without any restrictions on the syntactic category. Further, when a gesture overlaps a verbal head (a single verb form, a verb phrase, or an entire sentence), the ambiguous form of the hand signal often does not fully constrain the attachment of gesture to a particular tree node. This attachment ambiguity is observed with gestures spanning a verb only, a verb phrase, or an entire sentence, thereby allowing for more mappings beyond the strict temporal performance. To illustrate this, consider utterance (5) where the gesture stroke overlaps an entire sentence.

(5) So he MIXes MUD . . .
Speaker's left hand is rested on the knee in ASL-B, palm extended and facing up as if holding something. Right hand performs consecutively four rotation movements over the left palm.

Here there is ambiguity as to whether the contextually specific interpretation of the circular hand movement addresses the content of the verb arguments "mud" and "he". Specifically, there is not sufficient information coming from form whether this gesture is a literal depiction of a mixing action, or the hand signal elaborates on the speech by showing the manner of executing the mixing action over the object, or even that the hand signal enacts the event of mixing mud from the speaker's viewpoint, and the hand is thus an extension of the actor's body performing the mixing. Note that these ambiguities would also arise if the gesture was performed while uttering "mixes" only or even "he mixes".

To address these multiple possibilities, in the grammar we shall define rules where the synchronous phrase can be derived by attaching gesture to the verb head daughter and extending it over the arguments to the head, thereby allowing for a gesture to attach to the head only, and also to a (syntactic and/or prosodic) constituent. In this way, we shall address two important issues: firstly, synchrony cannot be defined solely in terms of temporal alignment, i.e., the incomplete meaning of gesture as derived from form does not constrain the synchronous phrase;

secondly, the inclusion of the arguments is grounded in the *synthetic* nature of gesture versus the *analytic* nature of the spoken words, for instance, the information about an event, the object of the event and the agent can be provided by a singular gesture performance and several linearly ordered lexical items (McNeill, 2005). A single utterance can thus receive more than one correct parse analysis where each one contributes a distinct relation between the speech daughter and the gesture daughter.

We predict that the same principle of exploring synchronicity beyond the strict temporal alignment can be applied to gestures overlapping a word sequence that does not form a syntactic constituent, and also to gestures overlapping a prepositional, adjectival or a noun head. Utterance (6) (McNeill, 2005) demonstrates that gestures can be extended over the preposition head arguments.

(6) and he goes up THROUGH the drainpipe
Right hand is extended forward, palm facing up, fingers are bent in an upward direction. The hand shape resembles a cup.

The stroke temporally overlapping with the preposition denotes some salient feature of upward direction and "interiority" (McNeill, 2005). One possible synchronous phrase is the gesture signal combined with the co-temporal verb particle and preposition (McNeill, 2005). From this perspective, the gesture *complements* the denotation of the temporally aligned elements by narrowing down to a specific content. Our prediction for the non-unique gesture attachment possibilities would also favour an attachment to a larger phrase containing the object, "the drainpipe". We anticipate that both synchronous analyses are legitimate and should be obtainable by the grammar so as to provide the necessary underspecified relations resolvable by contextual knowledge.

Similarly, we predict that in case of gestures overlapping non-head daughters such as determiners or modifiers, the synchronous phrase is obtained by linking the gesture to the non-head daughter, but also to a larger phrase resulting from the unification of the non-head daughter with its head. In this way, the information coming from the head can also serve to resolve the contextually specific interpretation (recall (2)).

As for gestures overlapping nouns and noun phrases, we predict that the type of relation between gesture and speech could possibly determine the preferred attachment. In example (1), for instance, the interpretation where the hand movement represents literally the bottom cupboards can be obtained by attaching the gesture to the overlapping noun phrase. At the same time, the gesture can resolve to the metaphor of completing some process only by an S attachment. We therefore intend to explore the type of relation $R(s, g)$ between the s speech daughter and the g daughter so as to provide all plausible contextually specific interpretations.

Since there is not enough evidence about the semantic interaction between a gesture and the rest of the syntactic labels, interjections, and conjunctions, we shall leave them for future research. Finally, gestures happening along an unfilled or a filled pause are not envisaged by the grammar performance.

Gesture and Prosody In his doctoral dissertation, Loehr (2004) sought evidence for simultaneity in the performance of the pitch accent and the gesture apex, i.e., the most prominent part of gesture which unlike the stroke and the post-stroke hold does not span some interval. Conversely, we need prosody inasmuch as it is a possible constraint on gesture form, particularly on the contentful part of gesture (see example (3)).

To test for correlations between the pitch-accented element and the gesture stroke, we checked automatically the number of strokes temporally overlapping a pitch accent. The statistical analysis was performed after removing the gestures overlapping non-communicative hand movements[5] and (filled or unfilled) speech pauses. The results are summarised in Table 2.

Temporal Overlap	**Percent**
Gesture stroke and pitch accent	78.41%
Gesture stroke and pitch accent $< 250msec$	97.73%

Table 2: Gesture-Prosody Correlation

Discussion The statistical analysis showed that 78.41% of the gesture strokes were overlapped by a pitch accent. Then we relaxed the overlap by plus/minus 250 msec which is the average duration of a word in the corpus. Under this condition, the gesture stroke-pitch overlap raised to 97.73% (there were two events performed with a positive or negative delay of 250–320 msec). Essentially, none of the words performed within these extra miliseconds crossed a constituency boundary: for instance the pitch was on the pre-head modifier or on the complement of the argument temporally aligned with the gesture stroke. Within the grammar, we shall therefore provide rules for attaching gesture to a phrase larger than the single prosodically prominent lexical item temporally aligned with the gesture stroke. This also motivates our prediction that gestures can be synchronised with a constituent larger than the element temporally aligning the gesture stroke. In this way, we address by means of qualitative criteria the findings of Giorgolo and Verstraten (2008) and the descriptive studies detailing the synthetic nature of gesture (McNeill, 2005). A possible way to think of this extension beyond the temporal alignment is that syntactically, gestures are roughly analogous to lexical items and semantically, they are analogous to utterances. By attaching gesture 'higher' than the temporally co-occurring item, we allow for establishing a speech-gesture relation after having exploited the semantics of a larger spoken phrase and the semantics of the gesture.

The empirical study also demonstrated that while prosody can make a multimodal utterance ill-formed, in syntax there is generally several choices for attaching gesture to a speech constituent. It is thus essential to find the right balance between prosodic well-formedness and the possible syntactic attachments.

[5]In the gesture community, non-communicative hand gestures are usually referred to as *adaptors*. These are practically grounded, meaningless bodily movements such as nervous ticks or movements satisfying bodily needs such as rubbing the eyes or scratching one's nose.

5 An HPSG-based Account

We choose the framework of HPSG to spell out the theoretical principles of the multimodal grammar. This extends Johnston's (1998) HPSG analysis of gesture to cover a wider variety of gestures and to regiment their *domain-independent* constraints on form and meaning. Our motivation to use HPSG stems from its mechanisms to induce structural prosody in parallel with the derivation of syntactic structures (Klein, 2000). In so doing, we show that isomorphism between prosodic and surface syntactic structures is not necessary for encoding well-formedness constraints. Moreover, the semantic component in HPSG is based on Minimal Recursion Semantics (MRS) (Copestake et al., 2005) which is entirely compatible with RMRS, the framework we need for representing the highly underspecified content of gesture given its form (see § 3). Finally, the grammar can be easily augmented with tone/information structure constraints (Haji-Abdolhosseini, 2003) once we establish whether there is evidence for a direct interaction between on one hand, the tonal type and hence the information type, and on the other hand, the gesture performance.

As detailed in § 1, gestures are multidimensional. We regiment this formally in a multiple inheritance type hierarchy (Pollard and Sag, 1994), as shown in Figure 3. In this way, a gesture consisting of, say, deictic and depicting dimensions can inherit information from the type *concrete* and the type *literal*.

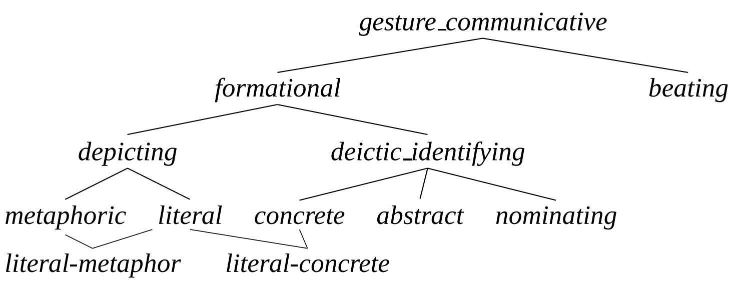

Figure 3: A Fragment of the Gesture Type Hierarchy

The type hierarchy of gestures is based on whether the form of the hand signal contributes some aspect of its meaning or not. In the former case, we distinguish *formational* actions, and in the latter, we talk about *beating*. The formational type subsumes *literal* depiction to account for form features which literally depict the object of reference, and *metaphoric* depiction where the form features are used as a metaphoric representation of the object of reference. Descriptive studies on deixis suggest that the form of the hand is dependent on its context and intended meaning. For instance, if the speaker designates an individual, the pointing is typically performed with an extended index finger, and if the speaker points to a class of objects, to an object exemplar, the pointing hand is typically open up (Kendon, 2004). This motivates us to represent deictic gestures as a subtype of *formational*. The deictic subtypes account for the distinct relations between the pointing signal and the referent: the hand can identify a *concrete* referent at the spatio-temporal coordinates; it can point to an *abstract* representation of the referent; it can also *nominate* certain words or phrases as more prominent. Formless beat-like movements are typed as *beating*. This type hierarchy is intended as an illustration of gestural organisation rather than an exhaustive hierarchy of the possible gestural dimensions.

The mapping from hand movement to types on this hierarchy is one to many, thereby providing a representation of ambiguity about whether a communicative gesture is deictic, depicting, or a mixture thereof, and the ambiguity is resolvable only through its relation to speech. For this reason while investigating depicting and deictic gestures, we will analyse them in terms of this multidimensional perspective.

Synchronising linguistic and gestural input in the derivation tree involves unifying a feature structure typed as *gesture_communicative* (or any of its subtypes) and a feature structure typed as *spoken_sign* (or any of its subtypes). Upon unification, the multimodal signal is of type *depict(ing)_sign* which subsumes *depict_word*, *depict_phrase* and *depict_mtr*(τ). The multimodal type hierarchy can be further extended with subtypes highlighting the type of the gesture signal.

While ambiguity in the type of gesture is regimented by mapping a gesture signal to more than one type in Figure 3, ambiguity in multimodal synchrony is reflected in the grammar by distinct rules constraining the permissible attachments. In this paper, we shall provide rules for integrating speech and representational co-speech gesture. The theoretical framework will be illustrated in terms of utterance (5) from Loehr's (2004) corpus.

5.1 Integration of Depicting Gesture and Prosodic Word

Our theoretical analysis begins with the straightforward case of attaching gesture to a single word.

Definition 2 (Situated Prosodic Word Constraint) *Gesture can attach to any syntactic head in the spoken utterance if 1. there is an overlap between the temporal performance of the gesture stroke and the head; 2. the head is a prosodically prominent word.*

The representation of Definition 2 in a constraint-based framework is illustrated in Figure 4. We shall now describe each aspect of this feature structure in turn.

This constraint accounts for a sign of type *depict_word* derived via unification of a single prosodic word of type *spoken_word* and a gesture of type *depicting*. As illustrated by example (3), the well-formedness constraints are guided by the relative temporal performance of both modalities: there must be a temporal overlap between the performance of the gesture phrase and the prosodic word. Otherwise, the multimodal signal is ill-formed. The temporal overlap entails the relations of inclusion, precedence and/or sequence, as detailed in § 4.2.

$$
\begin{bmatrix}
\textit{depict\_word} & \\
\text{TIME} & \text{overlap}\left\langle \boxed{10}, \boxed{7} \right\rangle \\
\text{PHON} & \boxed{3} \\
\text{SYNSEM} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \boxed{12} \\ \text{VAL} & \boxed{5} \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{HOOK} \mid \text{INDEX} & \boxed{4} \\ \text{RELS} & \left\{ \begin{bmatrix} \textit{vis\_rel} & \\ \text{S-HNDL} & \boxed{1} \\ \text{G-HNDL} & \boxed{2} \\ \text{M-ARG} & \boxed{4} \end{bmatrix}, \begin{bmatrix} \text{LBL} & \boxed{1} \end{bmatrix}, \begin{bmatrix} [\mathcal{G}] & \\ \text{LBL} & \boxed{2} \\ \text{ARG1} & \boxed{6} \end{bmatrix}, \begin{bmatrix} \textit{depicting\_eps} & \\ \text{LBL} & \boxed{13} \end{bmatrix} \right\} \\ \text{HCONS} & \begin{bmatrix} \text{HARG} & \boxed{6} \\ \text{LARG} & \boxed{13} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\
\text{S-DTR} & \begin{bmatrix} \textit{spoken\_word} & \\ \text{TIME} & \boxed{7} \\ \text{PHON} & \boxed{3}\ \textit{p-word} \\ \text{SYNSEM} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \boxed{12}\ \text{P-o-S} \in \left\{\text{verb, noun, adj, prep}\right\} \\ \text{VAL} & \boxed{5} \begin{bmatrix} \text{F} \in \left\{\text{SUBJ, COMPS, SPR}\right\} \end{bmatrix} \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{HOOK} \mid \text{LTOP} & \boxed{1} \\ \text{RELS} \mid \text{LBL} & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\
\text{G-DTR} & \begin{bmatrix} \textit{depicting} & \\ \text{TIME} & \boxed{10} \\ \text{SYNSEM} & \begin{bmatrix} \text{CONT} & \begin{bmatrix} \text{HOOK} \mid \text{LTOP} & \boxed{2} \\ \text{RELS} & \left\{ \begin{bmatrix} [\mathcal{G}] & \\ \text{LBL} & \boxed{2} \\ \text{ARG1} & \boxed{6} \end{bmatrix}, \begin{bmatrix} \textit{depicting\_eps} & \\ \text{LBL} & \boxed{13} \end{bmatrix} \right\} \\ \text{HCONS} & \begin{bmatrix} \text{HARG} & \boxed{6} \\ \text{LARG} & \boxed{13} \end{bmatrix} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\
\text{C-CONT} & \begin{bmatrix} \textit{vis\_rel} & \\ \text{S-HNDL} & \boxed{1} \\ \text{G-HNDL} & \boxed{2} \\ \text{M-ARG} & \boxed{4} \end{bmatrix}
\end{bmatrix}
$$

Figure 4: Situated Prosodic Word Constraint

For the gesture daughter, we record its temporal performance and its semantic contribution. The semantic components are encoded as follows: the local top is obtained via co-indexation with the label of the main predicate which is the operator $[\mathcal{G}]$. For the sake of readability, we gloss the set of elementary predications contributed by a depicting gesture as *depicting_eps*. These include every aspect of gesture meaning such as $l_1 : a_1 : hand\_shape\_open\_flat(i_1), l_2 : a_2 : palm\_orientation\_upwards(i_2)$, etc. It is vitally important to constrain these predications so that they appear within the scope of the $[\mathcal{G}]$ modality (see Lascarides and Stone (2009) for motivation): this is expressed by equating ARG1 of the operator with the label of the elementary predications within the HCONS condition.

For the speech daughter, it is equally important to record its timing, syntax-semantics information and also its prosody. The synchronicity between a depicting gesture and a lexical item necessitates the latter to be prosodically marked: we allow for the combination of a prosodically prominent word of type *p-word* and a gesture but we restrict the combination of an unstressed word "leaner" (Zwicky, 1982) of type *lnr* and a gesture. The head is not constrained to any particular category. In so doing, the gesture can be related to a verb ("MIXES mud"), a noun ("KING of Scotland"), a preposition ("THROUGH the drainpipe") or an adjective ("CLOSE to the station") as long as it is prosodically prominent. The VAL feature of the head indicates its potential to combine with other arguments. The underspecified semantic component of the speech daughter is defined in the familiar fashion in terms of its hook and relations features. The rule schema remains as unspecific as possible with respect to its EPs.

This rule contributes its own underspecified vis_rel (visualising relation) between the topmost label of the speech-daughter and the topmost label of the gesture daughter. This is specified by identifying S-HNDL of the relation with the local top label of the speech content (l_1) and G-HNDL of the relation with the local top label of the gesture content (l_2). Any relations contributed by the rule itself are specified within the C-CONT feature. The resolution of this relation is a matter of discourse which is not envisaged by this project. Based on Lascarides and Stone (2009), vis_rel is used to refer to the set of possible rhetorical relations between gesture and speech (e.g., *Narration*, *Depiction* or *Overlay*, but not *Contrast*).

We finally introduce an M-ARG (multimodal argument) attribute which serves as a pointer to the integrated multimodal signal and so it can be taken as an argument by any external predicate. This analysis is analogous to the treatment of conjunction in ERG where a $conjunction\_relation$ introduces an index which serves as a pointer to the conjoined entity.

The derivation of the mother node follows the algebra of Copestake, Lascarides and Flickinger (2001). It is strictly compositional: we unify the TIME, PHON and SYNSEM values of the daughters. The head feature is percolated up to the mother node and also the PHON value of the unified multimodal signal is identified with the PHON value of the speech daughter. The semantic representation involves appending the RELS and HCONS lists of S-DTR to the RELS and HCONS lists of G-DTR.

Applied to utterance (5), this constraint enables the gesture to attach to the verb "mixes": the verb is prosodically marked and the extension of its temporal performance overlaps the extension of the temporal performance of speech. In this case, vis_rel can resolve in context to a literal depiction of some mixing event. Alternatively, the gesture can also be combined with the NP "mud" which is prosodically prominent, it is a head of itself and its temporal performance overlaps the temporal performance of the gesture stroke. In this case, the verb "mix" would take two arguments: ARG1 will be identified with ARG0 of "he", and ARG2 will be identified with M-ARG of the depicting word "mud" + depicting gesture. Note that the derivation is still constrained: nothing licenses attaching the gesture to "he". Likewise, this constraint prohibits the gesture in (3) to attach to "called" or to "mother": the former is not prosodically marked and the latter does not temporally overlap with the gestural performance.

In the next section, we shall focus on attaching gesture to a phrase larger than a single prosodic word.

5.2 Integration of Depicting Gesture and Spoken Phrase

Definition 3 (Situated Head-Argument Constraint) *Gesture can attach to the head daughter in the spoken utterance upon fully or partially saturating the head with the (externally and/or internally) selected arguments if: 1. the phrase is a prosodic constituent, 2. there is an overlap between the temporal performance of the constituent and the gesture stroke.*

We use partial of full saturation to remain neutral about the number of satisfied arguments. This is driven by the ambiguous form of the hand signal which corresponds to multiple attachment solutions. The formal rendition of this constraint is shown in Figure 5. The temporal condition, the semantic contribution of the rule, the semantics of gesture, and also the derivation of the mother node is consistent with the Situated Prosodic Word Constraint. We therefore forego any details about them.

Following the empirical analysis in § 4.2, this rule formalises synchrony beyond the strict temporal alignment of the signals. In so doing, the semantics of the head is provided with its “minimal specification” (Pustejovsky, 1995) which is necessary for resolving the incomplete meaning of gesture to one or more contextually-specific interpretations.

$$\left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{depict_phrase}} \\
\text{TIME} & \text{overlap}\left\langle \boxed{10}, \boxed{7} \right\rangle \\
\text{PHON} & \boxed{3} \\
\text{SYNSEM} & \text{synsem} \\
\text{S-DTR} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{spoken_phrase}} \\
\text{TIME} & \boxed{7} \\
\text{PHON} & \boxed{3} \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{mtr}(\tau)} \\ \text{DOM} & \text{ne-list} \bigcirc \boxed{11} \\ \text{DTE} & \boxed{11} \end{array}\right] \\
\text{SYNSEM} & \left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \text{HEAD} & \boxed{12}\ \text{pos} \\ \text{VAL} & \boxed{14} \left\{ \left[\begin{array}{ll} \text{SUBJ} & <> \\ \text{COMPS} & <> \end{array}\right] \vee \left[\begin{array}{ll} \text{SUBJ} & < synsem > \\ \text{COMPS} & <> \end{array}\right] \right\} \end{array}\right] \end{array}\right]
\end{array}\right] \\
\text{G-DTR} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{depicting}} \\ \text{TIME} & \boxed{10} \\ \text{SYNSEM} & \text{synsem} \end{array}\right]
\end{array}\right]$$

Figure 5: Situated Head-Argument Constraint

Prosody constrains the combination of both modalities: the PHON value of the speech daughter is restricted to type *mtr(τ)*—i.e., a metrical tree of any depth

(Klein, 2000). The domain union relation ($\bigcirc$) serves to interpolate the prosodically prominent element, the so called Designated Terminal Element (DTE), into the non-empty list of domain objects. In case of broad focus, the DTE element is in right-most position. We make use of the disjunction operation in the SYNSEM | CAT | VAL list to remain as neutral as possible about the number of saturated arguments when the synchronisation of the gesture can take place. This constraint allows one to attach a gesture to a headed phrase whose complement requirements have been fullfilled or to a headed phrase whose both subject and complement requirements have been fullfilled.

It is important to underline the distinct status of vis_rel in the Situated Prosodic Word Constraint and in the Situated Head-Argument Constraint: whereas the former remains as vague as possible about the speech-gesture relation, the combination of the head with its arguments in the latter contributes to its minimal specification and hence the choices of resolving this relation are more constrained.

This constraint allows the G-DTR in (5) to attach to the VP "mixes mud" or to the S "he mixes mud": the temporal condition is complied; the prosodic word temporally overlapping gesture is an unsaturated syntactic head that needs to be saturated with the selected arguments: them being either "mud" only or both "mud" and "he". The inclusion of arguments into the synchronous phrase ultimately affects the gesture interpretation in context, as discussed in § 4.2.

The prosodic structure induced in parallel with the syntactic tree does not disrupt the traditional notion of syntactic constituency. Nevertheless, the syntactic structure is not necessarily isomorphic to the prosodic structure. Definition 3 constrains synchrony to a phrase where the head and the other elements are in a head-argument relation. From the perspective of an HPSG-based analysis, this involves specifying a rule so that a gesture phrase can be accommodated into a prosodic constituent that is distinct from the syntactic constituent. We therefore extend our analysis, and provide a further constraint, called Situated Prosodic Phrase Constraint (Figure 6), where the attachment is informed only by prosody, ignoring any SYNSEM values. Our motivation for this relaxation stems from the tight alignment between the speech rhythm and gesture performance: we have already observed that prosody can make embodied actions ill-formed. This constraint intergrates a gesture of type *depicting* to a metrical tree *mtr*(τ) of any depth. Similarly as before, synchrony requires temporal overlap between the gestural and the spoken modalities. The rest of the features remain the same.

The synchronisation is constrained: we unify the feature structure of both modalities making sure that the mother node inherits the semantic contribution of G-DTR. Since we have no access yet to the SYNSEM value of speech, we can only record the semantic component of gesture and add an underspecified relation vis_rel between both modalities. This relation outscopes the local top of the gesture content and the local top of the linguistic content whatever its SYNSEM is going to be.

Applying the situated prosodic phrase constraint to our working example in (5) enables the combination of the gesture and the phrase "he mixes": both modali-

$$
\left[\begin{array}{ll}
\textit{depict\_mtr}(\tau) & \\
\text{TIME} & \text{overlap}\left\langle \boxed{10}, \boxed{7}\right\rangle \\
\text{PHON} & \boxed{3} \\
\text{SYNSEM} & \left[\begin{array}{ll} \text{CONT} & \left[\begin{array}{ll} \text{HOOK} \mid \text{INDEX} & \boxed{4} \\ \text{RELS} & \left\{ \left[\begin{array}{ll} \textit{vis\_rel} & \\ \text{S-HNDL} & \boxed{1} \\ \text{G-HNDL} & \boxed{2} \\ \text{M-ARG} & \boxed{4}\end{array}\right], \left[\begin{array}{ll}[\mathcal{G}] & \\ \text{LBL} & \boxed{2} \\ \text{ARG1} & \boxed{6}\end{array}\right], \left[\begin{array}{l}\textit{depicting\_eps} \\ \text{LBL}\ \boxed{13}\end{array}\right]\right\} \\ \text{HCONS} & \left[\begin{array}{ll}\text{HARG} & \boxed{6} \\ \text{LARG} & \boxed{13}\end{array}\right]\end{array}\right]\end{array}\right] \\
\text{S-DTR} & \left[\begin{array}{ll} \textit{spoken\_word} & \\ \text{TIME} & \boxed{7} \\ \text{PHON} & \boxed{3}\left[\begin{array}{ll} \textit{mtr}(\tau) & \\ \text{DOM} & \text{ne-list} \bigcirc \boxed{11} \\ \text{DTE} & \boxed{11}\end{array}\right]\end{array}\right] \\
\text{G-DTR} & \left[\begin{array}{ll} \textit{depicting} & \\ \text{TIME} & \boxed{10} \\ \text{SYNSEM} & \left[\begin{array}{ll} \text{CONT} & \left[\begin{array}{ll} \text{HOOK} \mid \text{LTOP} & \boxed{2} \\ \text{RELS} & \left\{ \left[\begin{array}{ll}[\mathcal{G}] & \\ \text{LBL} & \boxed{2} \\ \text{ARG1} & \boxed{6}\end{array}\right], \left[\begin{array}{l}\textit{depicting\_eps} \\ \text{LBL}\ \boxed{13}\end{array}\right]\right\} \\ \text{HCONS} & \left[\begin{array}{ll}\text{HARG} & \boxed{6} \\ \text{LARG} & \boxed{13}\end{array}\right]\end{array}\right]\end{array}\right]\end{array}\right] \\
\text{C-CONT} & \left[\begin{array}{ll} \textit{vis\_rel} & \\ \text{S-HNDL} & \boxed{1} \\ \text{G-HNDL} & \boxed{2} \\ \text{M-ARG} & \boxed{4}\end{array}\right]
\end{array}\right]
$$

Figure 6: Situated Prosodic Phrase Constraint

ties overlap in time, and also the prosodic phrase is a metrical tree whose DTE is the prosodic word "mixes". Informally speaking, this synchronisation of modalities contributes some underspecified relation between the content of gesture and the content of speech. Whereas the gesture content is known (due to the compositional analysis), the speech content is going to be further specified once accessing the SYNSEM of the syntactic phrase. Upon that, the semantics of the depicting phrase will be able to incorporate the relevant elementary predications coming from the speech daughter: in this case, they will be roughly equivalent to: $l_1 : pron(x_4)$; $l_2 : pronoun\_q(x_4)$ $l_2 : RESTR(h_6)$ $l_2 : BODY(h_7)$; $l_3 : mix(e_1)$ $l_3 : ARG1(x_4)$ $l_3 : ARG2(x_9)$ and $h_6 =_q l_1$.

This rule is needed because it balances between syntactic constituency and prosodic constituency. Nonetheless, its specification would not be necessary in other formalisms that have isomorphic prosodic, syntactic and semantic structures (Steedman, 2000).

6 Conclusions

In this paper, we demonstrated that current methods for semantic composition can be extended to multimodal language so as to produce an integrated meaning representation based on the form of the spoken signal, the form of the co-speech gesture, and their relative timing. We also saw that the ambiguous gesture form provides one-to-many form-meaning mappings without violating coherence in the final interpretation.

The integration of speech and gesture into a single derivation tree is informed by linguistic criteria (prosody and syntax) and non-linguistic criteria (temporal relation between speech and gesture), and it produces a highly underspecified logical form that will be resolved to preferred values in specific context. Our generic rules—the Situated Prosodic Word Constraint and the Situated Head-Argument Constraint—provided the methodology for producing an integrated tree where on one hand, syntax permits multiple attachments which subsequently produce underspecified relations, and on the other, prosody constrains the well-formedness of the embodied act. Moreover, the Situated Prosodic Phrase Constraint illustrates that gestures can be elegantly integrated into a prosodic constituent, and so this rule demonstrates that isomorphism between prosodic and syntactic structure is not necessary for the derivation of the multimodal signal.

In future, we intend to extend those rules with analysis of deictic gestures where sequentiality of the performance of spoken and the gestural signal is common. We also hope to implement the theoretical findings into a computational multimodal grammar for English (Bender et al., 2002).

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Does Chain Hybridization in Irish Support Movement-Based Approaches to Long-Distance Dependencies?

Anke Assmann
Universität Leipzig

Fabian Heck
Universität Leipzig

Johannes Hein
Universität Leipzig

Stefan Keine
Universität Leipzig

Gereon Müller
Universität Leipzig

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Stefan Müller (Editor)

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Abstract

Huybregts (2009) makes the claim that hybrid Ā-chains in Irish favor derivational theories of syntax over representational ones such as HPSG. In this paper, we subject this assertion to closer scrutiny. Based on a new technical proposal, we will reach the conclusion that, in principle, both derivational and representational accounts can accomodate hybrid dependencies. Thus, no argument against either approach can be made on the basis of the Irish data, disconfirming Huybregts's (2009) claim.

1 Introduction

Modern Irish is one of the world's languages exhibiting morphological reflexes of unbounded dependencies. The form of complementizers is conditioned by whether they are within the range of a non-local dependency or not.[1] In addition to marking the presence vs. absence of a dependency, the complementizers in Modern Irish track the type of the dependency involved. Complementizers occurring within the range of a dislocation are distinct from those falling in the domain of a resumption dependency. This paper focuses on the interaction of these complementizer patterns and their theoretical ramifications. As already observed by McCloskey (1979), a single non-local dependency spanning several clauses may lead to different forms of the respective complementizers. Thus, one complementizer may occur in one form (say, the dislocation-dependent one), while the next higher one shows up in another form (the resumption-based one), although they are in the domain of just one dependency, spanning both clauses. We will refer to such dependencies as *hybrid* (McCloskey 1979 uses the term "mixed"), as they seem to consist of chaining together of two smaller dependencies of distinct types.

In a recent comparison of derivational and declarative approaches to syntax, Huybregts (2009) makes the claim that the hybrid dependencies found in Irish are unproblematic for derivational approaches to syntax such as the Minimalist Program (Chomsky, 1995, *et seq.*) but are not readily accommodated in representational frameworks like HPSG. If this argument is correct, the Irish data provide evidence against declarative frameworks.

The purpose of this paper is to subject Huybregts's (2009) claim to closer scrutiny. We will demonstrate it to be incorrect. The paper is structured as follows: Section 2 lays out the empirical facts that the discussion is based on. Section 3 illustrates the derivational approach to the Irish complementizer system proposed by

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[1]We will assume here without discussion that the reflex is situated at the complementizer. For a discussion of alternatives, see Lahne (2009) and references cited there. Lahne (2009) also provides an in-depth analysis of the morphological aspects of the alternation.

McCloskey (2002). Our own analysis couched within HPSG is developed in section 4. Section 5 provides the conclusion.

2 Irish Ā-chains

Complementizers in Modern Irish appear in one of the three guises in (1), depending on their environment. If crossed by a dislocation dependency, the form of the complementizer is *aL*. Complementizers in the range of a resumption dependency appear as *aN*. Finally, complementizers not affected by any nonlocal dependency take the form *go*. The distribution of the three types in the domain of uniform chains is schematized in (2), where 't' designates a trace, and 'pro' an empty resumptive pronoun. Examples are provided in (3).[2,3]

(1) *Three types of complementizers*
a. aL (A-bar, dislocation)
b. aN (A-bar, resumption)
c. go (declarative)

(2) *Uniform chains*
a. [$_{CP}$ aL ... [$_{CP}$ aL ... t]]
b. [$_{CP}$ aN ... [$_{CP}$ aN ... pro]]
c. [$_{CP}$ go ... [$_{CP}$ go ...]]

(3) a. an tainm *a* hinndeadh dúinn *a* bhí _ ar an áit
the name *aL* was.told to.us *aL* was on the place
'the name that we were told was on the place'
b. an bhean *a* raibh mé ag súil *a* bhfaighinn uaithi é
the woman *aN* was I hope prog *aN* get.COND from.her it
'the woman that I was hoping that I would get it from her'
c. Dúirt mé [$_{CP}$ *gu*-r shíl mé [$_{CP}$ *go* meadh sé ann]]
said I *go*-PAST thought I *go* would.be he there
'I said that I thought that he would be there.'

[2] 'L' and 'N' are common abbreviations for a complex cluster of phonological properties (McCloskey, 1979). As for the gloss, the preposition *uaithi* 'from.her' in (3b) agrees with the empty resumptive pronoun.

[3] While (3) gives examples for relative clause formation, the dislocation and resumption strategies are also attested in constituent questions, clefts, and so on. (ia,b) give examples for dislocation and resumption in *wh*-movement contexts, respectively:

(i) a. Céacu ceann a dhíol tú?
which one aL sold you
'Which one did you sell?'
b. Céacu ceann a bhfuil dúil agat ann?
which one aN is liking at.you in.it
'Which one do you like?'

Relative pronouns in Irish are always phonologically empty. We accept the widely held position that there are covert resumptive pronouns in Irish (McCloskey and Hale, 1984; McCloskey, 2002; Vaillette, 2002).[4] Our goal is not to develop a reanalysis of the Irish data but to investigate whether under the interpretation of the data presupposed by Huybregts (2009) an argument against HPSG can be constructed.

Importantly, the different markings of the complementizer may interact. If there is a single dependency of either type which involves more than one clause, then not only the uniform complementizer marking in (2) is possible, but mixing of different complementizers is attested as well (McCloskey, 2002). This gives rise to *hybrid* dependencies, as illustrated in (4). Examples are provided in (5).

(4) *Hybrid chains*

a. [$_{\text{CP}}$ aN … [$_{\text{CP}}$ aL … t]] (Pattern 1)
b. [$_{\text{CP}}$ aL … [$_{\text{CP}}$ aN … pro]] (Pattern 2)
c. [$_{\text{CP}}$ aN … [$_{\text{CP}}$ go … pro]]

(5) a. rud *a* raibh coinne aige *a* choimhlíonfadh _ an aimsir
thing *aN* was expectation at.him *aL* fulfill.COND the time
'something that he expected time would confirm'

b. aon duine *a* cheap sé *a* raibh ruainne tobac aige
any person *aL* thought he *aN* was scrap tobacco at.him
'anyone that he thought had a scrap of tobacco'

c. achan rud *a* rabh dóchas aca *go* dtiocfadh sé
every thing *aN* was hope at.them *go* come.COND it
'everything that they hoped (that it) would come'

In (5) a single non-local dependency emerges as the result of two local dependencies of different types. Thus, in, e.g., (5a) the lower clause contains a dislocation dependency (as evidenced by the complementizer *aL*), whereas the higher clause involves a resumption dependencies (marked by *aN*). The crucial observation is that both combine to yield a single dependency crossing both clauses.

Focussing on the patterns 1 and 2 in (4a,b), Huybregts (2009) claims that the Irish hybrid dependencies cannot be accounted for in representational frameworks of syntax and hence constitute evidence against them. We will demonstrate this claim to be incorrect by devising an HPSG analysis of the patterns 1 and 2 of (4). An LFG account of the same data has been independently proposed by Asudeh (2004, ch. 6).[5]

[4] To give just one example, dislocation and resumption dependencies differ in that only the latter may cross strong islands. This can be seen by looking at the form of the complementizers. Dependencies marked by *aL* may not cross island boundaries, while *aN*-marked ones may. The form of the complementizer can thus be taken as a diagnostic of the nature of the dependency involved, even though the bottom of the two dependency types may be indistinguishable.

[5] We are indebted to Peter Sells for making us aware of Asudeh's account.

3 A Minimalist analysis of hybrid chains

Before turning to the HPSG account, let us consider a derivational approach to hybrid dependencies. Huybregts (2009) explicitly refers to the proposal of McCloskey (2002) as a benchmark for theoretical accounts of the data laid out in the previous section. To assess his claim that representational theories are less adequate than derivational ones when it comes to hybrid dependencies, we will model our HPSG analysis after McCloskey's (2002) to ease comparison. Some familiarity with the derivational approach suggested by McCloskey (2002) will thus help to evaluate Huybregts's (2009) claim.

McCloskey's (2002) analysis, based on Chomsky (2000, 2001), proposes three types of C in Irish, each conforming to one overt complementizer (cf. (6)). By assumption, movement and resumption structures differ with respect to the specification of the C head. Resmption dependencies are established by merging an operator in Spec,CP which binds a resumptive pronoun as a varialbe. Merging of this operator is brought about by an EPP-feature on C (cf. (6b)). Movement dependencies, on the other hand, are the result of a C head bearing an OP(ERATOR)- and an EPP-feature, as in (6c). The OP-feature undergoes AGREE with an element lower in the structure. The EPP-feature yields movement of this element to Spec,CP. If no dependency is established with C, C bears neihter an OP- nor an EPP-feature (see (6a)).

(6) *Featural make-up of C in Irish*
  a. go $\leftrightarrow$ C[$\varnothing$]
  b. aN $\leftrightarrow$ C[EPP]
  c. aL $\leftrightarrow$ C[EPP,OP]

McCloskey (2002) assumes movement to take place successive-cyclically through the specifier of each intermediate CP. Resumption, by contrast, may, but need not, apply successive-cyclically. As we will see later, if resumption is formed successive-cyclically, pattern (2b) emerges; if not, pattern (4c) results.

To accomodate hybrid chains, McCloskey (2002) assumes that both *wh*-phrases and resumptive pronouns are pronouns ('*pro*'). Importantly, one and the same *pro* can serve both as an operator and as resumptive pronoun within a derivation. A relevant derivation for pattern 1 of (4) is sketched in (7), where *op* designates an operator, viz. a relative pronoun which binds a resumptive.

(7) $[_{CP}$ aL … $[_{CP}$ aN … pro]]
  ① $[_{CP}$ $C_{[EPP]}$ … pro] $\rightarrow$ Merge *op*
  ② $[_{CP}$ op_i aN … pro_i] $\rightarrow$ Merge higher C
  ③ $[_{CP}$ $C_{[EPP,OP]}$ … $[_{CP}$ op_i aN … pro_i]] $\rightarrow$ Move *op*
  ④ $[_{CP}$ op_i aL … $[_{CP}$ t_i aN … pro_i]]

The lower C head comprises an EPP-feature, which triggers the merging of an operator in its specifier. This operator binds the resumptive pronoun. Morphologically, C's EPP-property leads to its being spelt out as *aN*. Subsequently, the matrix C head, bearing an EPP- and an OP-feature, is merged. Its OP-feature enters into an Agree-relation with *op*. C's EPP-feature then moves *op* into the specifier of the matrix C. Thus, a movement dependency is formed. Bearing both an OP- as well as an EPP-feature, C has the form *aL*. In a nutshell, then, chain hybridization is brought about by a hybrid operator, which acts as the head of a resumption chain and the tail of a movement chain, thus linking both dependencies with each other.[6]

The reverse dependency switch in pattern 2 of (4) is accounted for by the same reasoning: An operator in the embedded clause moves into the specifier of the lower CP, triggered by an Agree-relation and resulting in the complementizer *aL*. The higher Spec,CP is then filled by a second operator, binding the lower one. As no movement takes place to the highest C, *aN*-marking ensues. This derivation is schematized in (8).[7]

(8) $[_{\text{CP}}$ aN ... $[_{\text{CP}}$ aL ... t]]

① $[_{\text{CP}}\ \text{C}_{[\text{EPP,OP}]} \ldots op_i\ ] \rightarrow$	Move *op*
② $[_{\text{CP}}\ op_i\ \text{aL} \ldots \text{t}_i\ ] \rightarrow$	Merge higher C
③ $[_{\text{CP}}\ \text{C}_{[\text{EPP}]} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots \text{t}_i\ ]] \rightarrow$	Merge *op*
④ $[_{\text{CP}}\ op_i\ \text{aN} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots \text{t}_i\ ]]$	

In both derivations, there is an element (*op*) which may terminate one dependency while at the same time initiating another dependency, thereby chaining them together. Crucially, both dependencies can be of a different type, i.e. *op* may be a binder and a bound element at the same time.

4 Two implementations in HPSG

As far as we can tell, the existing literature on long-distance dependencies in HPSG has not yet addressed the issue of hybrid dependencies (see, however, Vaillette 2002 for a treatment of uniform chains in Irish within HPSG). We will demonstrate in this section that existing analyses may nevertheless be conservatively extended to include hybridization. Thus, for the data set under discussion there exists no principled difference between derivational approaches and HPSG and thus no reason to disregard representational approaches to syntax.

We will suggest two possible implementations, one based on lexical traces as chain initiators (Gazdar et al., 1985; Pollard and Sag, 1994), the other couched within a trace-less framework as proposed by Bouma et al. (2001). As a general background assumption, we follow Vaillette (2002), in taking resumption dependencies to involve INDEX sharing. Dislocation is construed as LOCAL sharing,

[6]Moving the pronoun in (7) instead of merging *op* is excluded because movement requires an AGREE-relation.

[7]McCloskey (2002) assumes that the EPP- and OP-feature on the embedded C have to be checked by the same element (*op* in (8)). This excludes a possible derivation in which *op* undergoes AGREE with C but a second element (e.g., a resumptive pronoun) is merged in the C's specifier.

as is standard. Interestingly, resumption and dislocation instantiate both types of unbounded dependencies identified by Pollard and Sag (1994): Resumption is a *weak* nonlocal dependency, while dislocation is a *strong* dependency.[8] To accommodate hybrid dependencies, a switching between different types of dependencies is necessary.

We will depart from Vaillette (2002) w.r.t. the question how resumption and dislocation dependencies should be represented. Vaillette (2002) assumes that the former involves percolation of a RESUMP-feature, while the latter involves the familiar SLASH-feature. In contrast, we will assume that both dependencies are construed via (differently valued) SLASH-features. The reasons for doing so are the following: First, as dislocation and resumption differ in whether they involve sharing of INDEX or LOCAL, stipulating in addition that their construal is achieved by the distinct features SLASH vs. RESUMP does not seem to contribute anything. Such a move seems to only state twice that there is a difference between resumption and dislocation, rendering this part of the theory redundant. The second reason is a conceptual one. One may capitalize on the fact that there are exactly two types of dependencies distinguished by the Irish complementizers.[9] In McCloskey's (2002) account, movement/dislocation is brought about by internal MERGE (i.e., move), while resumption results from AGREE. As MERGE and AGREE are the two fundamental operations in Minimalist syntax, an adherent of McCloskey's (2002) analysis might argue that the state of affairs in Irish receives a natural explanation in that it directly mirrors the basic operational inventory of Minimalist syntax. An HPSG account making use of a RESUMP-feature to encode one dependency and a second feature SLASH to encode another leaves it as an idiosyncratic property of Irish that its complementizers are sensitive to only two types of dependencies. After all, any number of features can be stipulated, so the co-existence of two features does not have any privileged status. If, on the other hand, the distinction between resumption and dislocation is represented only in the distinction between INDEX and LOCAL sharing—as we assume here—, then the situation in Irish receives an account along much the same lines as in the Minimalist reasoning above: Since sharing of the INDEX and LOCAL values are the *only* possible ways of forming nonlocal dependencies in HPSG, each of the Irish complementizers tracks down one mode of dependency formation. Thus, an account dispensing with the distinction between RESUMP and SLASH is immune to the conceptual criticism advanced above. Third, Borsley (2010) argues on the basis of the closely related language Welsh (which, incidentally, does not seem to have hybrid chains) that traces and resumptive pronouns behave alike for a variety of diagnostics. This leads him to conclude that both dependencies involve the SLASH mechanism. As there is no compelling reason to invoke a RESUMP feature in addition to SLASH in Irish, we take this to be an interesting convergence.

[8] A distinction equivalent to INDEX vs. LOCAL sharing in LFG is used by Asudeh (2004).

[9] We are grateful to Robert Levine (p. c.) for raising this issue and discussing its ramifications with us.

4.1 Implementation 1: Switching by designated elements

4.1.1 The system

The first account we would like to propose is modelled fairly closely after McCloskey (2002). Switching between different dependencies is accomplished by traces and resumptive pronouns, which, in virtue of their LOCAL specification, may terminate dependencies and, as a consequence of their NONLOCAL value, initiate another dependency at the same time. These elements, reminiscent of the operators in McCloskey's (2002) analysis, act as linkers between the two dependencies. The specifications of resumptive pronouns and traces are given in (9). The resumptive pronoun in (9a) initiates a resumption dependency because of its INDEX-valued SLASH-feature. Analogously, the trace (9b) triggers a dislocation dependency because of its LOCAL-valued SLASH feature.

(9) a. *Resumptive pronoun*

$$\begin{bmatrix} \textsc{synsem} & \begin{bmatrix} \textsc{local} & \begin{bmatrix} \textsc{category} & \begin{bmatrix} \textsc{head} & \textit{pron} \end{bmatrix} \\ \textsc{content} & \begin{bmatrix} \textsc{index} & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \textsc{nonlocal} & \begin{bmatrix} \textsc{inh} & \begin{bmatrix} \textsc{slash} & \begin{bmatrix} \textsc{index} & \left\{\boxed{1}\right\} \end{bmatrix} \end{bmatrix} \\ \textsc{to-bind} & \begin{bmatrix} \textsc{slash} & \{\} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

b. *Trace*

$$\begin{bmatrix} \textsc{synsem} & \begin{bmatrix} \textsc{local} & \boxed{1} \end{bmatrix} \\ \textsc{nonlocal} & \begin{bmatrix} \textsc{inh} & \begin{bmatrix} \textsc{slash} & \begin{bmatrix} \textsc{local} & \left\{\boxed{1}\right\} \end{bmatrix} \end{bmatrix} \\ \textsc{to-bind} & \begin{bmatrix} \textsc{slash} & \{\} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The percolation of the two types of dependencies is regulated by the *Nonlocal Feature Principle* (Pollard and Sag 1994, 164; also cf. Levine and Sag 2003).

(10) *Nonlocal Feature Principle*
For each nonlocal feature, the INHERITED value on the mother is the union of the INHERITED values on the daughters minus the TO-BIND value on the head daughter.

Finally, resumption and dislocation dependencies are terminated by means of the head-filler rules in (11). (11a) ends a resumption dependency (i.e., INDEX sharing); (11b) terminates a dislocation dependency (LOCAL sharing).

(11) *Head-Filler Rules*

a. (i) $$\mathrm{X} \rightarrow \begin{bmatrix}\textsc{loc}|\textsc{cont}|\textsc{index} & \boxed{1}\end{bmatrix}, \mathrm{CP}\begin{bmatrix}\textsc{inh}|\textsc{slash}|\textsc{index} & \left\{\boxed{1}, \ldots\right\} \\ \textsc{to-bind}|\textsc{slash}|\textsc{index} & \left\{\boxed{1}\right\}\end{bmatrix}$$

(ii) $$\begin{bmatrix}\textsc{dtrs} & \begin{bmatrix}\textsc{fdtr}|\textsc{ss}|\textsc{loc}|\textsc{cont}|\textsc{index} & \boxed{1} \\ \textsc{hdtr}|\textsc{ss}|\textsc{nloc} & \begin{bmatrix}\textsc{inh}|\textsc{slash}|\textsc{index} & \left\{\boxed{1}, \ldots\right\} \\ \textsc{to-bind}|\textsc{slash}|\textsc{index} & \left\{\boxed{1}\right\}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

b. (i) $$\mathrm{X} \rightarrow \begin{bmatrix}\textsc{loc} & \boxed{1}\end{bmatrix}, \mathrm{CP}\begin{bmatrix}\textsc{inh}|\textsc{slash}|\textsc{loc} & \left\{\boxed{1}, \ldots\right\} \\ \textsc{to-bind}|\textsc{slash}|\textsc{loc} & \left\{\boxed{1}\right\}\end{bmatrix}$$

(ii) $$\begin{bmatrix}\textsc{dtrs} & \begin{bmatrix}\textsc{fdtr}|\textsc{ss}|\textsc{loc} & \boxed{1} \\ \textsc{hdtr}|\textsc{ss}|\textsc{nloc} & \begin{bmatrix}\textsc{inh}|\textsc{slash}|\textsc{loc} & \left\{\boxed{1}, \ldots\right\} \\ \textsc{to-bind}|\textsc{slash}|\textsc{loc} & \left\{\boxed{1}\right\}\end{bmatrix}\end{bmatrix}\end{bmatrix}$$

(9), (10) and (11) condition the proper initiation, percolation, and termination of resumption and dislocation dependencies. The next step in our analysis is to give representations for the three complementizers in (1) that appropriately constrain their distribution. (12) provides the representations for *aL*, *aN* and *go*. The effect of (12a) is that *aL* is valid only if its VP sister contains a non-empty SLASH|LOCAL value, viz. if *aL* is crossed by a dislocation dependency. Conversely, *aN* is allowed by (12b) only if the VP's SLASH|INDEX value is a non-empty set, i.e. if *aN* is within the domain of a resumption dependency. Finally, *go* is illicit only if not in the domain of a dependency involving either LOCAL or INDEX sharing.[10]

(12) a. *Lexical entry of 'aL'*

$$\begin{bmatrix}\textsc{phon} & \langle \textit{aL} \rangle \\ \textsc{synsem} & \begin{bmatrix}\textsc{head} & \mathrm{C}\end{bmatrix} \\ \textsc{subcat} & \left\langle \overset{\mathrm{VP}}{\begin{bmatrix}\textsc{inh}|\textsc{slash}|\textsc{loc} & \textit{neset} \\ \textsc{inh}|\textsc{slash}|\textsc{index} & \textit{eset}\end{bmatrix}} \right\rangle\end{bmatrix}$$

[10]As shown by the third pattern in (4), *go* may in fact appear within the range of a resumption dependency. This is at odds with the specification in (12c). We will ignore this problem for now but return to it in section 4.5.

b. *Lexical entry of 'aN'*

$$\begin{bmatrix} \text{PHON} & \langle \textit{aN} \rangle \\ \text{SYNSEM} & \begin{bmatrix}\text{HEAD} & \mathrm{C}\end{bmatrix} \\ \text{SUBCAT} & \left\langle \overset{\mathrm{VP}}{\begin{bmatrix} \text{INH}\,|\,\text{SLASH}\,|\,\text{LOC} & \textit{eset} \\ \text{INH}\,|\,\text{SLASH}\,|\,\text{INDEX} & \textit{neset}\end{bmatrix}} \right\rangle \end{bmatrix}$$

c. *Lexical entry of 'go'*

$$\begin{bmatrix} \text{PHON} & \langle \textit{go} \rangle \\ \text{SYNSEM} & \begin{bmatrix}\text{HEAD} & \mathrm{C}\end{bmatrix} \\ \text{SUBCAT} & \left\langle \overset{\mathrm{VP}}{\begin{bmatrix} \text{INH}\,|\,\text{SLASH}\,|\,\text{LOC} & \textit{eset} \\ \text{INH}\,|\,\text{SLASH}\,|\,\text{INDEX} & \textit{eset}\end{bmatrix}} \right\rangle \end{bmatrix}$$

As the last ingredient, a device is necessary to switch between different dependencies. No new elements have to be stipulated for that purpose. The lexical representations of resumptive pronouns and traces in (9), repeated in abbreviated forms as (13) below, may terminate one dependency and at the same time initiate another one. Crucially, these dependencies need not be of the same type, thus accounting for hybrid chains.

(13) *Dependency switchers* (= (9))

a.

$$\begin{bmatrix} \text{LOC} & \boxed{1}\begin{bmatrix}\text{CONT} & \begin{bmatrix}\text{INDEX} & \boxed{2}\end{bmatrix}\end{bmatrix} \\ \text{NLOC} & \begin{bmatrix}\text{INH} & \begin{bmatrix}\text{SLASH} & \begin{bmatrix}\text{INDEX} & \left\{\boxed{2}\right\}\end{bmatrix}\end{bmatrix}\end{bmatrix} \end{bmatrix}$$

b.

$$\begin{bmatrix} \text{LOC} & \boxed{2}\begin{bmatrix}\text{CONT} & \begin{bmatrix}\text{INDEX} & \boxed{1}\end{bmatrix}\end{bmatrix} \\ \text{NLOC} & \begin{bmatrix}\text{INH} & \begin{bmatrix}\text{SLASH} & \begin{bmatrix}\text{LOC} & \left\{\boxed{2}\right\}\end{bmatrix}\end{bmatrix}\end{bmatrix} \end{bmatrix}$$

(13a) is the normal resumptive pronoun (9a). Because of its LOCAL and INDEX specifiation it may terminate resumption and dislocation dependencies. Furthermore, as its NONLOCAL|INH|SLASH|INDEX value is non-empty, it starts a resumption dependency. In the same vein, the lexical trace in (13b) = (9b) may terminate resumptions and dislocation dependencies and launches a dislocation dependency, in virtue of its non-empty NONLOCAL|INH|SLASH|LOCAL value.

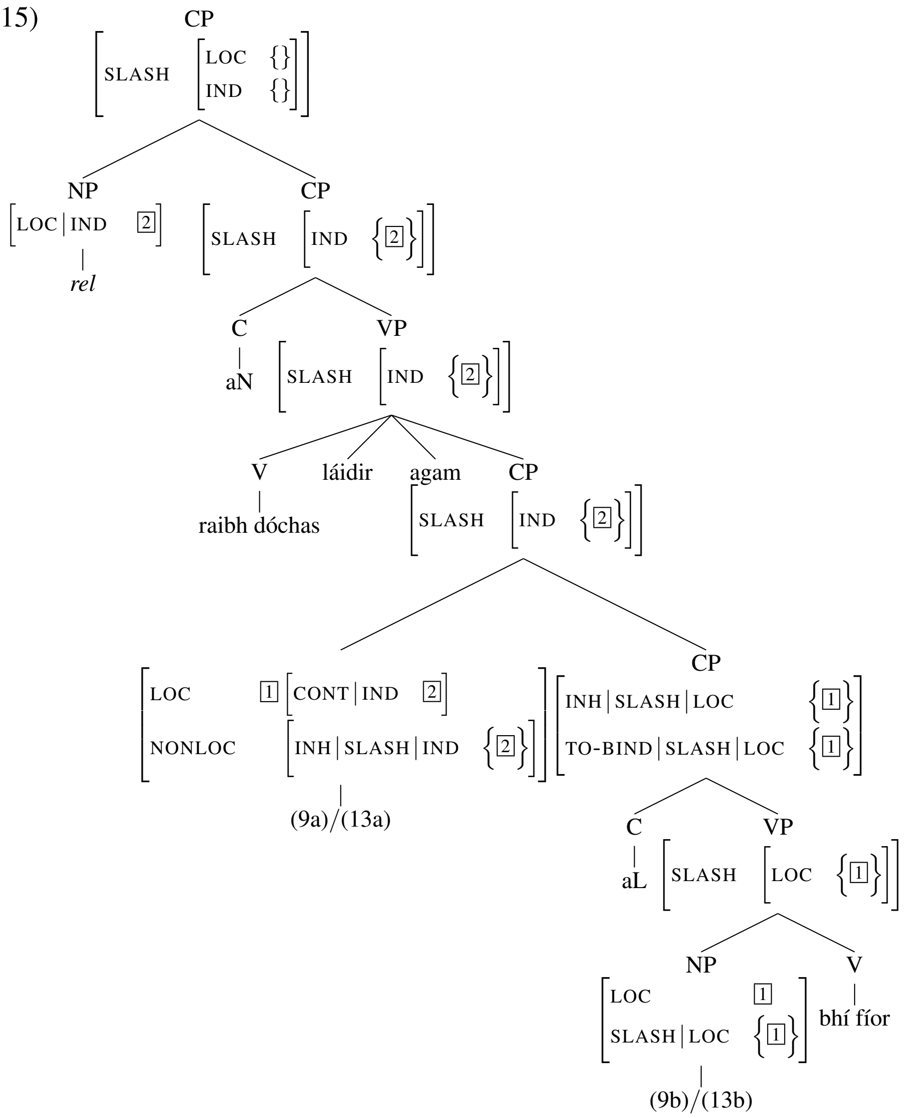
4.1.2 Example 1: aN … aL

Having established the essential mechanisms of dependency formation, percolation and termination, we will illustrate the account on the basis of two examples instantiating patterns 1 and 2 of (4). Consider first the hybrid dependency in (14).

(14) rud a raibh dóchas láidir agam a _ bhí fíor
thing aN was hope strong at.me aL was true
'something that I strongly hoped was true'

The lower clause in (14) involves a dislocation, as is evident from the complementizer *aL*. The next higher clause involves resumption, marked by *aN*. Both dependencies combined yield an association of the (covert) relative pronoun with the trace in the lowest clause. Our analysis for the pattern in (14) is given in (15).

(15)



The lower clause in (15) contains a trace (9b), which initiates a dislocation dependency ([SLASH|LOCAL {$\boxed{1}$}]). The SLASH value is percolated upward in conformity with the Nonlocal Feature Principle (10). As a consequence, the VP sister of the complementizer contains a non-empty SLASH|LOCAL value. Consequently, out of the three complementizers in (12), only (12a) is licit, leading to selection of the *aL*-complementizer in the lower clause. The specifier of the lower CP is filled with a resumptive pronoun (9a). Because of its LOCAL tag $\boxed{1}$, it terminates the dislocation dependency. Note that this conforms to the head-filler rule in (11b). At the same time, the resumptive pronoun launches a resumption dependency ([SLASH|INDEX $\boxed{2}$]), which is itself percolated upward to the next higher C domain. Because the matrix VP node now contains a non-empty SLASH|INDEX, only the complementizer *aN* (12b) is valid. As the final step, the phonologically empty relative pronoun (*rel*) terminates the resumption dependency (by (11a)).[11]

As a result of the two formally distinct dependencies in (15) the INDEX value of the relative pronoun is, by transitivity, shared with the INDEX value of the trace in the lowest clause, a result of the fact that, because the resumptive pronoun (9a) in Spec,CP of the lower clause, the INDEX tag $\boxed{2}$ is construed as part of the LOCAL value $\boxed{1}$.

4.1.3 Example 2: aL … aN

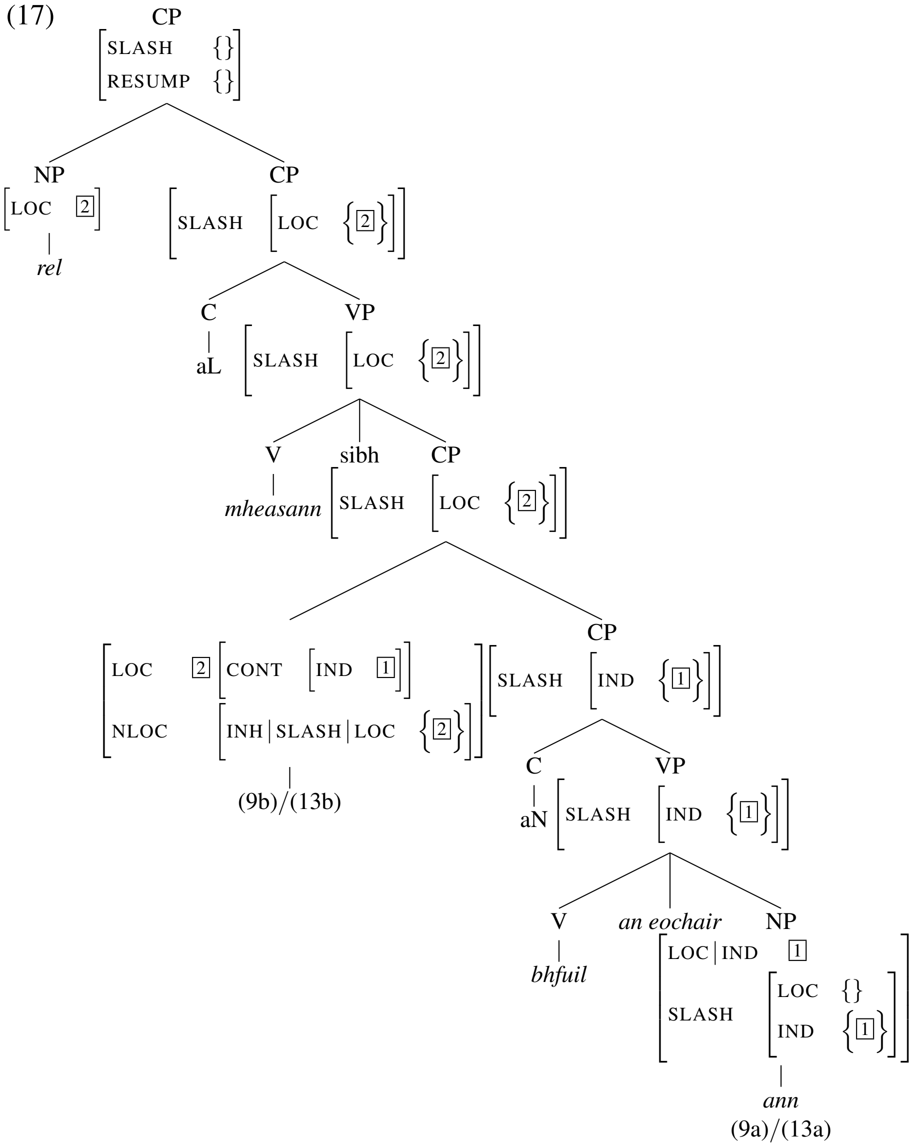
A reverse instance of a hybrid chain is given in (16). Here the lower clause involves a resumption dependency; hence the complementizer appears as *aN*. The higher clause invokes dislocation, visible by the complementizer form *aL*. We propose the analysis in (17). [12]

(16) an doras a mheasann sibh a bhfuil an eochair ann
the door aL think you aN is the key in.it
'the door that you think the key is in'

[11] Of course, the relative pronoun has itself to be associated with the head noun *rud* 'thing'. We will abstract away from this step here, noting that it may be straightforwardly implemented by INDEX sharing along the lines proposed by Pollard and Sag (1994).

[12] Strictly speaking, *ann* 'in.it' is a PP containing the resumptive pronoun. For simplicity, the structure in (17) abstracts a way from this and treats it as an NP. Nothing hinges on this.

(17)



In (17) the lower clause contains a resumptive pronoun (9a), which initiates a resumption dependency ([SLASH|INDEX 1]). As a consequence, the VP node comprises a non-empty value of SLASH|INDEX, and hence only the complementizer *aN* is allowed. The specifier of the lower C is occupied by a trace (cf. (9b)), which terminates the resumption dependency and initiates a dislocation dependency ([SLASH|LOCAL 2]). Consequently, only the complementizer *aL* may be used in the higher clause. Finally, a relative pronoun acts as the filler for the dislocation dependency.

As in the previous example, (17) involves two separate dependencies which, by transitivity, link properties of the filler of the higher dependency with the initiator of the lower dependency. Thus, in (17), the INDEX value of the relative pronoun is shared with the resumptive pronoun in the lower clause, because the LOCAL value $\boxed{2}$ contains the INDEX value $\boxed{1}$ (by the trace (9b)).

4.2 Implementation 2: Generalized switching

The analysis proposed in the preceding section makes use of special elements in Spec,CP that act as switchers between different dependencies, fairly in line with McCloskey's (2002) original analysis. In this section, we will explore an alternative based on the trace-less framework suggested by Bouma et al. (2001). The basic idea is that a shift in dependency-type could in principle also be brought about by a modification of Bouma et al.'s (2001) mechanism of *Slash Amalgamation*. The fundamental difference to the analysis above is that there are no designated switching elements. Rather, the possibility of switching is hard-wired in the percolation mechanism itself.

In contrast to the analysis above, resumption and dislocation dependencies are not introduced by phonologically empty elements but by *Slash Amalgamation* (18), adapted from Bouma et al. (2001, 20). As (18b) restricts the PERC tag in (18a) to values of LOCAL or INDEX, PERC acts as a variable over LOCAL and INDEX. As a consequence of (18), the SLASH tag of a lexical head need not be of the same type as the one of its dependent. Thus, by (18b), $\boxed{1}$ and $\boxed{2}$ in (18a) might mismatch.

(18) *Slash Amalgamation*

a. $$\textit{word} \Rightarrow \begin{bmatrix} \text{LOC} & \begin{bmatrix} \text{DEPS} & \begin{bmatrix} \text{SLASH} & \begin{bmatrix} \text{PERC} & \left\{\boxed{1}, \ldots\right\} \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{SLASH} & \begin{bmatrix} \text{PERC} & \left\{\boxed{2}, \ldots\right\} \end{bmatrix} \end{bmatrix}$$

b. $$\begin{array}{ll} & \boxed{1}\begin{bmatrix}\text{CONT}|\text{INDEX} & \boxed{2}\end{bmatrix} \\ \vee & \boxed{2}\begin{bmatrix}\text{CONT}|\text{INDEX} & \boxed{1}\end{bmatrix} \\ \vee & \boxed{1} = \boxed{2} \end{array}$$

Percolation along head projections is restricted by *Slash Inheritance* (19).

(19) *Slash Inheritance*

$$\textit{hd-val-ph} \Rightarrow \begin{bmatrix} \text{SLASH} & \begin{bmatrix} \text{PERC} & \left\{\boxed{1}, \ldots\right\} \end{bmatrix} \\ \text{HD-DTR} & \begin{bmatrix} \text{SLASH} & \begin{bmatrix} \text{PERC} & \left\{\boxed{1}, \ldots\right\} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The termination of dependencies as well as the representation of the complementizers are as in the analysis above (i.e., conditioned by (11) and (12)).

4.3 Comparison: Punctuated vs. uniform paths

The two conceivable approaches in sections 4.1 and 4.2 differ along a crucial dimension: The first implementation, making use of designated switching elements (viz., traces and resumptive pronouns), is *punctuated* in the sense of Abels and Bentzen (to appear): Switching is possible in distinguished positions only—those that allow to generate the appropriate element. In effect, switching is allowed only within the C domain, as only the specifier of C may host a trace or resumptive pronoun (apart, of course, from the lowermost position as complement of V). The second implementation (slash amalgamation), on the other hand, is *uniform*: Switching is in principle available at any phrasal level (by (18)). No projection is privileged in this respect over other projections. While both accounts are conceivable, the empirical facts in Irish favor the punctuated analysis.

Dislocation and resumption dependencies differ with respect to their locality (cf. fn. 4). Strong islands may be crossed by resumption, but are opaque for dislocation. If paths are uniform, the following representation is conceivable: An island boundary is crossed via a resumption dependency ($[\text{SLASH}|\text{INDEX}\ \boxed{1}]$); immediately above the island boundary, but still below the next higher C head, the resumption dependency could be turned into a dislocation dependency ($[\text{SLASH}|\text{LOCAL}\ \boxed{1}]$) and perlocated to the next C. This generates *aL* right above an island, which is incorrect. Only *aN* is possible in this environment.

We thus conclude that switching must not be permitted everywhere, but systematically restricted to a proper subset of all projections. Punctuated paths are therefore to be preferred empirically. This renders implementation 1 the superior one.

4.4 Double-flick chains

The two instances of hybrid chains discussed here involved exactly two clauses, each with its own dependency type (cf. (14), (16)). All examples discussed so far thus involve one instance of dependency switching. In principle, both analyses developed above allow for structures with a change from one type of dependency to another one and back again (20a,b). Empirically, it is not clear whether this is possible.

(20) *Double-flick chains*

a. [$_{\text{CP}}$ aL … [$_{\text{CP}}$ aN … [$_{\text{CP}}$ aL … t]]]
b. [$_{\text{CP}}$ aN … [$_{\text{CP}}$ aL … [$_{\text{CP}}$ aN … pro]]]

Regardless of the grammaticality status of the chains in (20), it is sufficient for our purposes to note that the same prediction is made under McCloskey's (2002) analysis. To see this, consider the abstract derivations in (21) and (22).

(21) *Derivation of (20a)*

① $[_{\text{CP}}\ op_i\ \text{aN} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots \text{t}_i\ ]] \rightarrow$ …
② $[_{\text{CP}}\ \text{C} \ldots [_{\text{CP}}\ op_i\ \text{aN} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots \text{t}_i\ ]]] \rightarrow$ Move *op*
③ $[_{\text{CP}}\ op_i\ \text{aL} \ldots [_{\text{CP}}\ \text{t}_i\ \text{aN} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots \text{t}_i\ ]]]$

(22) *Derivation of (20b)*

① $[_{\text{CP}}\ op_i\ \text{aL} \ldots [_{\text{CP}}\ \text{t}_i\ \text{aN} \ldots \text{pro}_i\ ]] \rightarrow$ …
② $[_{\text{CP}}\ \text{C} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots [_{\text{CP}}\ \text{t}_i\ \text{aN} \ldots \text{pro}_i\ ]]] \rightarrow$ Merge *op*
③ $[_{\text{CP}}\ op_i\ \text{aN} \ldots [_{\text{CP}}\ op_i\ \text{aL} \ldots [_{\text{CP}}\ \text{t}_i\ \text{aN} \ldots \text{pro}_i\ ]]]$

The first representation in (21) is the last representation of (8) above. Instead of terminating the dependencies, an additional clause is built on top of the CP. Movement of *op* targets the specifier of the highest CP, leading to *aL*-marking in the highest clause and thereby generating (20a). Analogous reasoning holds for (22), which is a straightforward continuation of (7).

The double-flick chains in (20) can thus be generated in representational and derivational frameworks alike. Regardless of their status, they do not distinguish between the two approaches. Hence, no argument for or against either account can be constructed on the basis of double-flick chains.

4.5 Points of divergence

The implementation proposed in section 4.1 is modelled on the basis of McCloskey's (2002) analysis outlined in section 3. Like McCloskey's (2002) derivational treatment, it makes use of special switching elements in Spec,CP that function as the head and the tail of dependencies. As argued in the previous section, the HPSG analysis accounts for the same set of data as McCloskey's (2002) account. Upon closer inspection, however, some non-trivial differences between the two accounts manifest themselves. In this section we will highlight two such discrepancies and argue that the empirical facts pose problems for both accounts.

Consider first the example (23). (23) contains a reason adverbial in Spec,CP. Interestingly, only *aN* is possible here; *aL* is ruled out.

(23) Cén fáth a-r / *a dúirt tú sin?
what reason aN-PAST aL said you that
'Why did you say that?'

McCloskey (2002) accounts for this pattern by assuming, following Rizzi (1990), that reason adverbials are base-generated in Spec,CP. Thus, (23) does not contain a resumptive pronoun. Nevertheless, we receive *aN*-marking. Though apparently surprising, this observation in fact follows from McCloskey's (2002) analysis without further ado. The reason is that in McCloskey's treatment the complementizers *aL* and *aN* are not sensitive to the presence of a dislocation or resumption dependency *per se*. Rather, their distribution is conditioned by the structure-building EPP- and OP-features. Crucially, these features may also be active in structures not containing dislocation or resumption dependencies. The C head in (23) contains an EPP-feature triggering MERGE of the reason adverbial in Spec,CP. The clause does not contain a resumptive pronoun but *aN* is nevertheless licit as a consequence of the bare EPP-feature on C.

This observation reveals a fundamental difference between McCloskey's (2002) account and ours. In our treatment, it is the dependencies themselves which condition the distribution of the complementizers. Empirically, however, neither conception is clearly favored over the other, as argued below. Both accounts thus have to resort to additional stipulations to accommodate the range of facts. Therefore, neither account is inherently superior.

Not all adjuncts behave like reason adverbs. Others, e.g., locatives, manner adverbials, and temporals allow both *aN* and *aL* in free alternation. Duratives and frequency adverbials are compatible only with *aL* (for examples see McCloskey, 2002, 208f.). Hence the following picture emerges: Some adjuncts allow both *aN* and *aL*, while others allow only the former and a third group only the latter. It appears that, regardless of the framework employed, these differences have to be merely stipulated. McCloskey (2002) is forced to stipulate that duratives and frequency adverbials may not bind a resumptive pronoun, while locative, manner adverbials, and temporals may do so. Likewise, it is a matter of stipulation that reason adverbials have to be base-generated in Spec,CP and may not, like other adverbials, target this position by movement.

In a similar vein, one may stipulate in the present framework that reason adverbials are licit only if they bind a resumptive pronoun. Conversely, duratives and frequency adverbials are licit in Spec,CP only if they head a dislocation dependency. Finally, locatives, manner adverbials, and temporals may use either strategy. While the emerging analyses subtly differ from McCloskey's (2002), all else being equal there is little reason to prefer one over the other.

The second point of difference between the analyses under discussion concerns the remaining hybrid pattern in (4c). The empirical generalization behind that pattern is that *aN* appears as the topmost complementizer, while all lower C heads are realized as *go* (McCloskey, 2002, 190). (24) exemplifies this pattern.

(24) [$_{\text{CP}}$ aN … [$_{\text{CP}}$ go … pro]]
fir *ar* shíl Aturnae an Stáit *go* rabh siad díleas do'n Rí
men *aN* thought Attorney the State *go* were they loyal to-the King
'men that the Attorney General thought were loyal to the King'

At first glance, this pattern seems to support McCloskey's (2002) analysis. The reason is the same as above: For McCloskey (2002) it is not the resumption dependency itself that leads to *aN*-marking but rather the EPP-property of the C heads that merges with the operator. Under the assumption that resumption need not proceed successive-cyclically, only the highest clause may contain such an EPP-property, which binds the resumptive pronoun in the lowermost clause. Because all intervening C projections thus do not contain any operator (in fact, no specifier at all), it is unsurprising that *aN* appears only in the highest clause.

No such account of (24) is forthcoming under the HPSG account suggested in section 4.1. Recall that in our treatment it is the resumption dependency itself that leads to *aN*-marking. Since in (24) the head noun obviously enters a resumption dependency with an element in the lowest clause, the crucial feature SLASH|INDEX has to be present on all intermediate heads, including all C heads. As a consequence, the HPSG system in section 4.1 does not generate (24), but only its alternative with *aN* occurring in all complementizer positions. It thus seems that McCloskey's (2002) analysis is preferable on empirical grounds.

This advantage of derivational approaches is, however, only apparent. According to the empirical generalization laid out by McCloskey (2002), if there is a *go* along the path of a resumption dependency, then only the highest complementizer may take the form *aN*. It is thus not possible to have a bottom-up sequence of complementizers involving, e.g., an arbitrary number of *go*'s, followed by one instance of *aN*, followed again by various *go*'s, and terminated by a second *aN*. However, given that certain elements may act as operators and variables at the same time—which, recall, is McCloskey's (2002) core assumption to account for hybrid chains—such a pattern is readily generated in the system of McCloskey (2002), but not in the HPSG analysis developed here. It thus emerges that both the Minimalist account as well as the HPSG analysis make predictions which are not borne out empirically, albeit in different directions. While McCloskey's (2002) analysis seems too permissive, the HPSG analysis is too restrictive. This is, after all, an interesting result. There is, however, no reason to prefer one framework over the other. Both are in need of additional stipulations to accomodate the properties of the hybrid chains of type (4c). The range of empirical facts is thus no more readily derived in one particular theory.

5 Conclusion

In this paper we have evaluated Huybregts's (2009) claim that hybrid dependencies in Irish favor derivational approaches to syntax over representational ones. We concluded that this claim is erroneous. Both McCloskey's theory and the analysis proposed here can account for hybrid chains. Therefore, no argument against either of the two families of approaches can be made on the basis of the Irish data. We have demonstrated the adequacy of HPSG to model the Irish facts by suggesting two analyses, one making use of punctuated paths, the other one employing uniform paths. Closer inspection reveals that hybrid chains favor analyses in terms of punctuated paths. This is an important result, however, it is orthogonal to the issue of derivational vs. representational accounts. All things equal, theories that are expressive enough to generate hybrid chains will also generate double-flick chains. Again, this property is shared by both representational and derivational accounts, and thus orthogonal to the distinction. We concluded the paper by identifying a crucial difference between the derivational and representational accounts. As far as this point is concerned, the Minimalist analysis and the HPSG treatment make distinct empirical predictions. First of all, this makes it clear that the two accounts are not notational variants of each other, despite their resemblance. Second, we argued that neither predictions are fully borne out. Both accounts need additional assumptions in order to extended to patterns not considered here. By itself, no framework is empirically preferred. In sum, Huybregts's (2009) claim that the Irish data clearly favor derivational over representational syntactic frameworks cannot be upheld.

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Auxiliary-Stranding Relative Clauses

Doug Arnold
University of Essex

Robert D. Borsley
University of Essex

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Université Paris Diderot, Paris 7, France

Stefan Müller (Editor)

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Abstract

A little discussed feature of English are non-restrictive relative clauses in which the antecedent is normally not an NP and the gap follows an auxiliary, as in *Kim will sing, which Lee won't*. These relative clauses resemble clauses with auxiliary complement ellipsis or fronting. There are a variety of analyses that might be proposed, but there are reasons for thinking that the best analysis is one where *which* is a nominal filler associated with a gap which is generally non-nominal: a filler-gap mismatch analysis in other words.

1. Introduction

In this paper we will investigate a type of non-restrictive (appositive, supplementary) relative clause (NRRC), which has been mentioned in various places but as far as we know never discussed in any detail. The following, where an underscore marks the gap, are typical examples:

(1) a. Kim will sing, which Lee won't ___.
b. Kim has sung, which Lee hasn't ___.
c. Kim is singing, which Lee isn't ___.
d. Kim is clever, which Lee isn't ___.
e. Kim is in Spain, which Lee isn't ___.

Here we have NRRCs in which the antecedent is not an NP and the gap follows an auxiliary. We will call such examples auxiliary-stranding relative clauses (ASRCs). ASRCs were highlighted in Ross (1969) and are briefly discussed in Huddleston and Pullum (2002), who note on p. 1523 that 'there is … a type of supplementary relative construction which strands auxiliary verbs'.[1] However, as far as we are aware, they have not hitherto received an explicit analysis in any framework. We will discuss ASRCs in some detail and consider how they might be analyzed within Head-driven Phrase Structure Grammar (HPSG). We will argue that they involve a filler-gap mismatch and that they are the product of an optional property of auxiliary verbs with a missing complement. In other words, they are a reflection of

↑ An earlier version of the paper was presented at the meeting of the Linguistics Association of Great Britain at the University of Edinburgh in September 2009. We are grateful to the audience there and at HPSG 2010 for their comments. We have benefited at various times from the comments of Emily Bender, Rui Chavez, Berthold Crysmann, Mary Dalrymple, Jean-Pierre Koenig, Bob Levine, Ivan Sag, Jesse Tseng and two anonymous reviewers for HPSG 2010. We alone are responsible for what appears here.

[1] ASRCs were also the focus of Borsley (1980).

another idiosyncrasy of a class of words which is well known for its idiosyncrasies.

The paper is organized as follows. Section 2 spells out the main properties of ASRCs and compares them with certain other types of clause. Sections 3, 4 and 5 look at three possible analyses, all of which have important weaknesses. Section 6 presents the filler-gap mismatch analysis and shows how it captures the properties of the construction. Section 7 considers two further possible analyses and looks at some further relevant data. Finally, section 8 concludes the paper.

2. Data

It is a rather well known property of NRRCs that they allow an antecedent which is not an NP. In most cases, this is, we think, unsurprising. However, as we will see, ASRCs are rather surprising.

It is not at all surprising firstly that we have a non-nominal antecedent in the following:

(2) I saw Kim in London, where I also saw Sandy ___.
(3) I saw Kim on Tuesday, when I also saw Sandy ___.

Here we have NRRCs containing the adverbial *wh*-words *when* or *where*. It is not surprising, then, the antecedents are non-nominal, a locative PP in (2) and a temporal PP in (3).

Rather different but also unsurprising in our view are examples like the following:

(4) Kim was late, which ___was unfortunate.
(5) Kim is riding a camel, which ___ is really difficult.

These examples contain the nominal *wh*-word *which* and it is associated with a gap in a nominal position, subject position in both cases. In (4), the antecedent is a clause and in (5) it is a VP. It seems to us that *which* in these examples refers to an abstract entity introduced into the discourse which can be referred to in various ways, for example by an ordinary pronoun. Thus, instead of (4), we could have (6) and (7), and instead of (5) we could have (8) and (9):

(6) Kim was late. It was unfortunate.
(7) Kim was late. This fact was unfortunate.

(8) Kim is riding a camel. It's really difficult.
(9) Kim is riding a camel. This activity is really difficult.

Hence, these examples conform to Huddleston and Pullum's (2002:1063) observation that 'supplementary relatives can be replaced by other kinds of supplements containing non-relative anaphoric expressions, notably personal pronouns or demonstratives'.

Further evidence that these examples are unsurprising comes from the fact that *which* can also be replaced by interrogative and pseudo-cleft *what*. Thus, corresponding to (4) we have (10) and (11), and corresponding to (5) we have (12) and (13).

(10) A: What ___ was unfortunate?
B: That Kim was late.

(11) What ___ was unfortunate was that Kim was late.

(12) A: What ___ is really difficult?
B: Riding a camel.

(13) What ___ is really difficult is riding a camel.

It seems to us, then, that examples like (4) and (5) pose no special problems.

We return now to ASRCs. It seems that the gap may follow any auxiliary. The following illustrate:

(14) a. Kim will sing, which Lee won't.
b. Kim has sung, which Lee hasn't.
c. Kim is singing, which Lee isn't.
d. Kim is clever, which Lee isn't.
e. Kim is in Spain, which Lee isn't.
f. Kim wants to go home, which Lee doesn't want to.

(14a) contains the modal *will*, and (14b) contains perfective *have*. (14c-e) contain *be* with a verbal, an adjectival, and a prepositional complement. Finally, (14f) contains *to*, which following Pullum (1982) and Levine (2010), we assume is a defective auxiliary verb.[2] The gap may not follow a lexical verb. Hence the following are bad:

(15) a. *Kim tried to impress Lee, which Sandy didn't try ___.
b. *Kim persuaded Lee to go, which he didn't persuade Sandy ___.

---

[2] We also find examples where *be* expresses identity, e.g. the following:
(i) Chomsky is the author of *Aspects*, which Halle isn't.

ASRCs are very different from the nominal gap examples in (4) and (5). *Which* in an ASRC cannot generally be replaced by an in-situ referring expression. The following seem quite bad:

(16) a. *Kim will sing, but Lee won't it/that.
b. *Kim has sung, but Lee hasn't it/that.
c. *Kim is singing, but Lee isn't it/that.
d. *Kim is clever, but Lee isn't it/that.
e. *Kim is in Spain, but Lee isn't it/that.
f. *Kim wants to go home, but Lee doesn't want to it/that.

Thus, ASRCs are generally an exception to Huddleston and Pullum's observation cited above.[3]

Interrogative and pseudo-cleft *what* are also generally impossible, as the following show:

(17) A: *What will Kim ___?
B: Sing.
(18) A: *What has Kim ___?
B: Sung.
(19) A: *What is Kim ___?
B: Singing.
(20) A: *What is Kim ___?
B: In Spain.
(21) A: *What does Kim want to ___?
B: Go home.

(22) *What Kim will ___ is sing.

---

[3] There seem to be some acceptable examples with an in-situ *that*. Ross (1969: 84) gives the following:

(i) They said that Tom is working hard, and he is that.

Unlike the superficially rather similar (16c), this seems to be quite good. We have also found some naturally occurring examples with an in-situ *that* following a modal, e.g. (ii) from the British National Corpus (K/KP/KPM around line 0023; it is from a conversation -- probably Central N England).

(ii) A: They all, they all huddled together and then when they started to get warm it'd pong a bit, wouldn't it?
B: It would that, yes.

This seems much better than (16a). It seems, then, that at least some auxiliaries allow an in-situ *that* under some circumstances. However, what these circumstances are is quite difficult to pin down (it seems to require a particular intonation pattern, seems not to be compatible with negation, or with an expression of disagreement – B's utterance in ii) could not be replaced with **It wouldn't that, no*.). This seems rather different from the general availability of relative which with a gap following an auxiliary.

(23) *What Kim has ___ is sung.
(24) *What Kim is ___ is singing.
(25) *What Kim is ___ is in Spain.
(26) *What Kim wants to ___ is go home.

Rather surprisingly, interrogative and pseudo-cleft *what* seem okay with an adjectival interpretation:

(27) A: What is Kim ___?
B: Clever.
(28) What Kim is ___ is clever.

We are not sure why this should be. However, apart from this, interrogatives and pseudo-clefts distinguish ASRCs and examples like (4) and (5) fairly clearly.

The examples in (14) look rather like sentences involving VP-ellipsis, or auxiliary complement ellipsis in Warner's (2000) more appropriate terminology, as in (29):

(29) a. Kim will sing, but Lee won't.
b. Kim has sung, but Lee hasn't.
c. Kim is singing, but Lee isn't.
d. Kim is clever, but Lee isn't.
e. Kim is in Spain, but Lee isn't.
f. Kim wants to go home, but Lee doesn't want to.

They are also rather like sentences involving VP-fronting, which should probably be called auxiliary complement fronting.

(30) a. They say Kim will sing, and sing he will.
b. They say Kim has sung, and sung he has.
c. They say Kim is singing, and singing he is.
d. They say Kim is clever, and clever he is.
e They say Kim is in Spain, and in Spain he is.
f. They say Kim wants to go home, and go home he wants to.

An important question about ASRCs is exactly how similar they are to auxiliary complement ellipsis sentences and auxiliary complement fronting sentences.

Like auxiliary complement ellipsis sentences, ASRCs allow the gap and the antecedent to differ in various ways. While the gap must be an auxiliary complement, this is not the case with the antecedent, as the following show:

(31) Kim rode a camel, but I never will.
(32) Kim rode a camel, which I never will.

Moreover, where the antecedent is an auxiliary complement it may still differ from the gap in certain ways. In the following, the missing complement of *would* is a base VP whereas the antecedent is a past participle VP.

(33) Kim has ridden a camel, but I never would.
(34) Kim has ridden a camel, which I never would.

Similarly, in the following, the missing complement of *have* is a past participle VP whereas the antecedent is a present participle VP.

(35) Kim is riding a camel, but I never have.
(36) Kim is riding a camel, which I never have.

A further point that is worth noting here is that the gap and the antecedent may be an NP in both auxiliary complement ellipsis sentences and ASRCs. This is because *be* can take a nominal complement. Thus, we have examples like the following:

(37) Kim is a linguist, but Lee isn't.
(38) Kim is a linguist, which Lee isn't.

The fact that we have *which* with a human antecedent in (38) shows that the relative clause is not an ordinary NRRC but an ASRC.

There are, however, some differences between ASRCs and auxiliary complement ellipsis sentences. Auxiliary complement ellipsis is an optional process. Hence the gap in an auxiliary complement ellipsis sentence can be 'filled in'. This is not possible with the gap in an ASRC:

(39) Kim will sing, but Lee won't sing.
(40) *Kim will sing, which Lee won't sing.

Moreover it seems that ASRCs but not auxiliary complement ellipsis sentences are subject to island constraints. (41) and (42) show that ASRCs are subject to the Complex Noun Phrase Constraint and the Coordinate Structure Constraint.

(41) a. Kim is singing, which I don't believe that Lee is.
b. *Kim is singing, which I don't believe the claim that Lee is.
(42) Kim has never ridden a camel, which
a. Sam has ___ and Bill probably will ___.
b. *Sam has ___ and Bill probably will ride one/a camel.

This is unlike VP ellipsis

(43) a. Kim is singing, but I don't believe that Lee is.
b. Kim is singing, but I don't believe the claim that Lee is.

(44) Kim has never ridden a camel, which
a. Sam has ___ and Bill probably will ___.
b. Sam has ___ and Bill probably will ride one/a camel.

This suggests that ASRCs like ordinary NRRCs are an unbounded dependency construction.[4]

In the following sections, we will consider how ASRCs should be analyzed. We will look at four different HPSG analyses, the second and third being somewhat similar. Three of these analyses seem unsatisfactory, but the fourth appears to provide a satisfactory account of the data.

3. A simple filler-gap analysis

We will first consider an analysis in which *which* is a pronominal counterpart of the categories that appear as complements of an auxiliary, most often a VP. This gives structures like (45), where i and j are eventive/stative indices and following Arnold (2004, 2007), j≈i means that j is anaphorically dependent on i.[5]

---

[4] There are certain restrictive relative clauses which look rather like ASRCs but are in fact rather different. Here is an example from Bob Levine:

(i) There are many books that I will read, but there is one which I definitely won't ___.

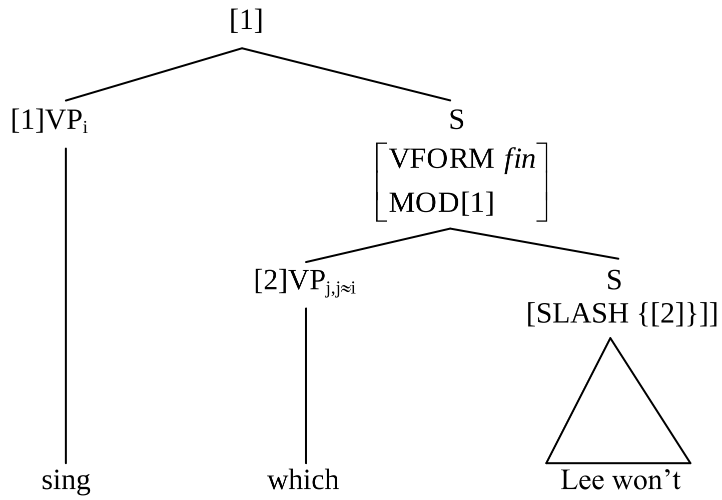
Here, we have a restrictive relative introduced by *which* with an auxiliary complement gap. However, *which* is associated not with the missing complement as a whole but with just part of its meaning. The second clause in (i) means the same as (ii).

(ii) There is one which I definitely won't read ___.

Thus, this seems a rather different phenomenon.

[5] We assume that various types of phrase, including VPs, PPs, and APs, can make available discourse referents corresponding to abstract entities of various sorts (events, states and properties etc). These can be accessed by anaphoric pronouns like *it*, *this*, and *that*, as in examples (6)-(9), and by relative *which* as in *Kim will sing, which Lee won't*. We assume they can be accessed in a similar way by VP Ellipsis. From a semantic point of view, there is no important difference between cases of VP Ellipsis, ASRCs, and cases of normal 'event' anaphora: all simply involve anaphoric dependence between an index associated with the pronoun, relative pronoun or ellipsis, and the index introduced by the antecedent. The only important difference is that the constructions are subject to different syntactic constraints. In particular, ASRCs are typically required to be adjacent to their antecedents, which is not required for normal anaphora and VP Ellipsis.

(45)



Here and subsequently we use XP to stand both for *synsem* objects and for *local* feature structures. The higher VP is a *synsem* object, while the lower VP is *local* feature structure. On this analysis ASRCs are just like ordinary appositive relatives except for the category of the gap and the antecedent. They are also essentially a special case of auxiliary complement fronting sentences. We will show that the analysis faces a number of problems.

One problem arises from the fact that ordinary VP complements of an auxiliary do not appear as fillers in a relative clause. Thus, only the (a) examples are acceptable in the following:

(46) a. This is the book, which Kim will read ___.
b. *This is the book, [read which] Kim will ___.
(47) a. This is the book, which Kim has read ___.
b. *This is the book, [read which] Kim has ___.
(48) a. This is the book, which Kim is reading ___.
b. *This is the book, [reading which] Kim is ___.

One might suppose that this is because VPs never appear as fillers in NRRCs. However, as discussed in Ishihara (1984), there are some cases where an infinitival VP or an *ing* VP appears as the filler in a relative clause, but these are not auxiliary complements.

(49) a. The elegant parties, [to be invited to one of which] ___was a privilege, had usually been held at Delmonico's.

b. John went to buy wax for the car, [washing which] ___ Mary discovered some scratches in the paint.

The fact that an ordinary VP complement of an auxiliary cannot be a filler in a relative clause makes the idea that *which* is just a pronominal counterpart of the categories that appear as complements of an auxiliary rather implausible.

A second problem arises where the auxiliary is *ought*. Consider first the following grammatical example:

(50) Kim ought to go home, which Lee ought not to ___.

Here, *to* is stranded, which we know is possible from (14f). Notice now that it is not possible to pied pipe *to*, giving (51):

(51) *Kim ought to go home, to which Lee ought not ___.

On the analysis we are considering, *which* is a VP filler in (50). It is not clear, then, why it should not be possible to have a larger VP containing *to* as a filler.

A further problem involves *not*. As discussed by Kim and Sag (2002: Section 3), this can modify a non-finite VP, and, as the following shows, this includes a fronted non-finite VP:

(52) They say Kim may be not coming, and not coming he may be ___.

If *which* can be a VP, one might expect examples in which it is modified by *not*, but they are not possible.

(53) *Kim may be not coming, not which Lee may be ___.

Thus, the idea that *which* can be a VP seems quite dubious.

A final problem is that some of the categories that appear as complements of an auxiliary also appear as complements of lexical verbs. Hence there is no obvious way within this approach to rule out examples like those in (15).

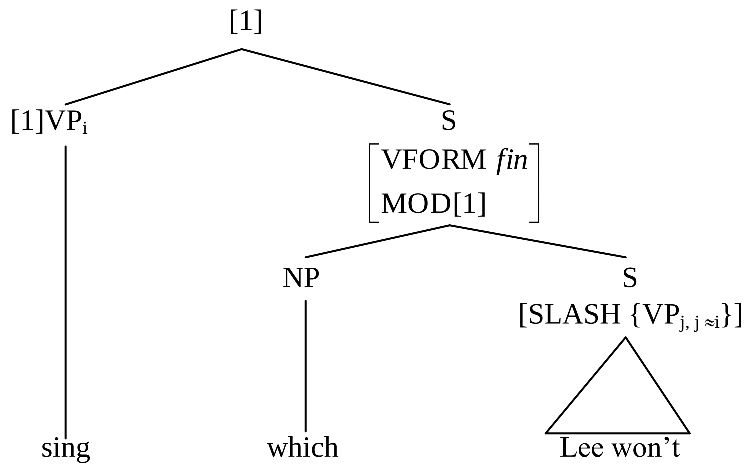
It seems, then, that there are a number of reasons for rejecting the idea that *which* in ASRCs is just a pronominal counterpart of the categories that appear as complements of an auxiliary.

4. Non-filler analysis 1: A special construction

Since the obvious filler analysis of *which* seems untenable, one might suppose that it is not in fact a filler. One possibility would be to propose that it is the ordinary nominal *which* but that it is not a filler because it does not match the SLASH value of its clausal sister.

On this approach, we would give structures like (54).

(54)



To license such structures one would require a special construction. One might propose a type *aux-stranding-rel-cl* subject to something like the following constraint (where 'which' of course is an abbreviation):

(55)

$$\textit{aux-stranding-rel-cl} \rightarrow \begin{bmatrix} \mathrm{SS} \begin{bmatrix} \mathrm{LOCAL} \mid \mathrm{CAT} \mid \mathrm{MOD}\ \mathrm{XP}_i \\ \mathrm{SLASH}\ \{\} \end{bmatrix} \\ \\ \mathrm{DTRS} < [\text{'which'}], [1][\mathrm{SLASH}\ \{\mathrm{YP}_{j,\, j \approx i}\}] > \\ \mathrm{HD\text{-}DTR}\ [1] \end{bmatrix}$$

Here, the value of SLASH on the head daughter is anaphorically dependent on the value of MOD. This ensures that it is anaphorically dependent on the antecedent of the relative clause. Other things being equal, it is preferable to avoid special constructions like this, but one might think that it is justified in this case.

There are, however, two objections to this analysis. Firstly, it is incompatible with the otherwise sound generalization that NRRCs, unlike restrictive relatives, are always head-filler structures. Secondly, it makes it look as if what is special about ASRCs is at the top of the dependency, but it seems clear that there is something special at the bottom of the dependency, where the gap must follow an auxiliary. There is no obvious way for the analysis to restrict the gap to auxiliary complement position. Thus, it is not obvious how to rule out the examples in (15). We conclude, then, that this is not a satisfactory approach.

5. Non-filler analysis 2: A head-complement analysis

Another possibility would be to propose that *which* in ASRCs is a head. More precisely, one might propose that it is a complementizer, which takes as its complement an S with a SLASH value including an eventive/stative index and heads a phrase which modifies a constituent with an eventive/stative index where the first index depends anaphorically on the second.

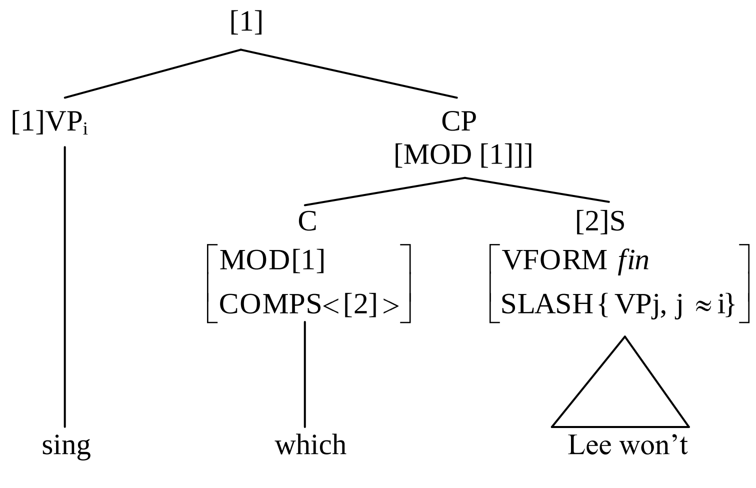
This approach does not require a special construction. It just requires *which* in ASRCs to have the following syntactic properties:

(56)

$$\left[\text{SS}|\text{LOCAL}|\text{CAT}\left[\begin{array}{l}\text{HEAD}\left[\begin{array}{l}c\\ \text{MOD XP[i]}\end{array}\right]\\ \text{COMPS} < \text{S[VFORM } \textit{fin}, \text{SLASH}\,\{\text{YP[j], j} \approx \text{i}\}] >\end{array}\right]\right]$$

Here the value of SLASH on the complement is anaphorically dependent on the value of MOD. This ensures again that it is anaphorically dependent on the antecedent of the relative clause. Given (56), we will have structures like (57).

(57)



It is quite common for a *wh*-word to turn into a complementizer. It is notable, however, that this approach makes *which* in ASRCs very different from *which* in ordinary NRRCs, which does not take a complement or modify any constituent and has a non-null REL value. This seems rather undesirable.

The two objections that we raised against the special construction analysis are also applicable here. This analysis is incompatible with the generalization that NRRCs are head-filler structures. It also misses the fact that ASRCs involve something special at the bottom of the dependency, and there is also no obvious way for the analysis to restrict the gap to auxiliary complement position.

It seems, then, that this approach too is unsatisfactory.

6. A filler-gap mismatch analysis

We turn now to an analysis which we think provides a satisfactory account of the data. This is an analysis, in which *which* in ASRCs is a filler but a nominal filler which does not match the associated gap. In other words it is a filler-gap mismatch analysis. As discussed by Webelhuth (2008), there seem to be a number of examples of filler-gap mismatches in English. For example, the ungrammaticality of (59) suggests that (58) involves a clausal filler associated with a nominal gap.

(58) That he might be wrong, he didn't think of ___.
(59) *He didn't think of that he might be wrong.

It is quite possible that not all filler-gap mismatches have the same character, but there is a fairly straightforward filler-gap mismatch analysis which can be proposed for ASRCs.

Consider first auxiliary complement ellipsis. A fairly standard HPSG approach to ellipsis treats it as involving a head with an ARG-ST list element which does not appear in its COMPS list. If we adopt this approach, we can propose that auxiliaries in auxiliary complement ellipsis sentences have the following syntactic properties, where the precise nature of XP varies from auxiliary to auxiliary:

(60)

$$\begin{bmatrix} \text{SS} \mid \text{LOCAL} \mid \text{CAT} \begin{bmatrix} \text{HEAD} \begin{bmatrix} v \\ \text{AUX} + \end{bmatrix} \\ \\ \text{SUBJ} < [1] > \\ \text{COMPS} <> \end{bmatrix} \\ \text{ARG-ST} < [1], \text{XP} > \end{bmatrix}$$

The crucial property of this feature structure is that the second member of the ARG-ST list does not appear in the COMPS list. To allow ASRCs we simply need to allow the second member of the ARG-ST list to have a SLASH feature with an appropriate value. What sort of value is this? We assume that *which* has something like the following syntactic and semantic properties:

(61)

$$\left[\mathrm{SS} \left[\begin{array}{l} \mathrm{LOCAL} \left[\begin{array}{l} \mathrm{CAT\ NP} \\ \mathrm{CONT} \left\{ \left[\begin{array}{l} \textit{param} \\ \mathrm{INDEX\,[j]} \\ \mathrm{RESTR\ [1]}\{\textit{non - person}(\mathrm{j}), [\mathrm{j}] \approx [\mathrm{i}]\} \end{array} \right] \right\} \end{array} \right] \\ \mathrm{REL} \left\{ \left[\begin{array}{l} \textit{param} \\ \mathrm{INDEX\,[i]} \\ \mathrm{RESTR\ [1]} \end{array} \right] \right\} \end{array} \right] \right]$$

This ensures that the index in the CONTENT of *which* is a non-person, which includes events/states, and that it is anaphorically dependent on the index that is its REL value (which, as with all relative clauses, is identified with the index of the antecedent). The value of SLASH is a set of local feature structures. Thus, to allow ASRCs we need to allow the LOCAL value of (61) to appear in the SLASH value of the missing complement. In other words, we need to flesh out (60) as (62), where the LOCAL value of (61) is abbreviated as $\mathrm{NP}_{\mathrm{j,\ j\approx i}}$.

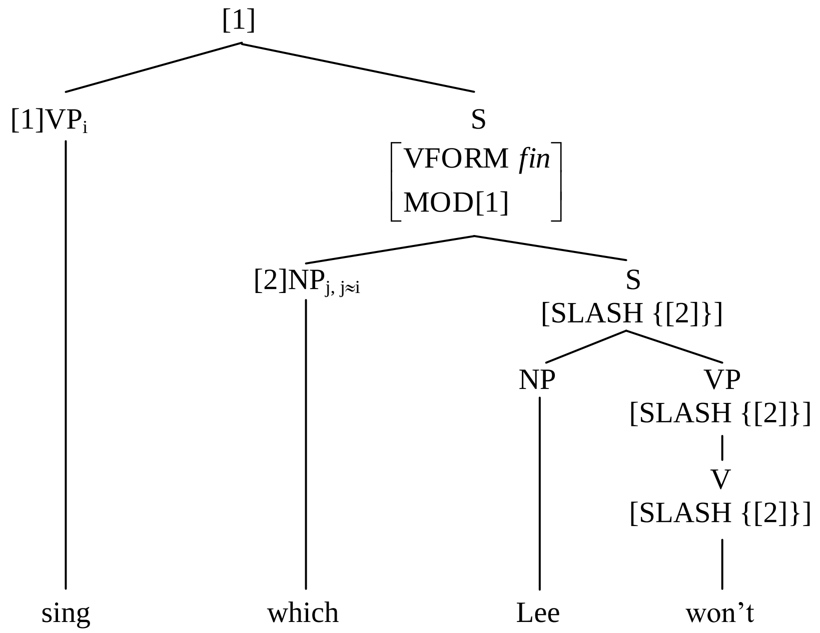
(62)

$$\left[\begin{array}{l} \mathrm{SS|LOCAL|CAT} \left[\begin{array}{l} \mathrm{HEAD} \left[\begin{array}{l} \textit{v} \\ \mathrm{AUX} + \end{array} \right] \\ \\ \mathrm{SUBJ} < [1] > \\ \mathrm{COMPS} <> \end{array} \right] \\ \mathrm{ARG\text{ - }ST} < [1], \mathrm{XPj[SLASH\,\{(NPj,\ j \approx i)\}\,]} > \end{array} \right]$$

The local feature structure within the value of SLASH is within round brackets, indicating that it is optional. If this option is not taken, we have an auxiliary complement ellipsis sentence. If it is taken, we have an ASRC. The optional SLASH value is coindexed with the missing complement but it is an NP and hence will generally differ from the missing complement. On this analysis, ASRCSs involve the type of gap assumed in the analysis of examples like (58) outlined in Bouma, Malouf and Sag (2001: 26), which Webelhuth (2008) calls a ‘dishonest gap’.

If the missing complement has a non-empty SLASH value, standard constraints will ensure that this SLASH value is passed up the tree, and the result will be an ASRC. The top of the ASRC dependency will involve the same mechanisms as other NRRCs. With these mechanisms, we will have structures like the following:

(63)



The crucial feature of this structure is that the index which is associated with the missing complement is anaphorically dependent on the antecedent. This is a result of the properties of auxiliaries and *which* and constraints on *wh*-relative clauses.

Like the other analyses this analysis predicts that ASRCs are subject to island constraints because it involves the SLASH feature and for HPSG island constraints are constraints on this feature. However, this analysis is superior to the other analyses in a number of ways.

Firstly, unlike the first and third analyses it treats *which* as the ordinary nominal *which*, which appears in other NRRCs. It requires the assumption that *which* can have eventive/stative index but this is required independently by examples like (4) and (5).

Secondly, unlike the other analyses, it only allows an auxiliary complement gap in an ASRC because an optional property of auxiliaries with a missing complement is responsible for the existence of the construction.

Thirdly, unlike the first analysis, it has no difficulty in ruling out examples with a VP filler such as (46)-(48) because it does not assume that *which* may be a VP.

Fourthly, again unlike the first analysis, it does not suggest that infinitival *to* or *not* should be possible before *which* as in (51) and (53) because it does not assume that *which* may be a VP.

Finally, it predicts the existence of complex examples with one gap in an auxiliary complement position and one in a nominal position, such as (64).

(64) Kim has often ridden a camel, which most people haven't ___, and some consider ___ too dangerous.

Such examples are unexpected on all the other analyses since for all of them the two conjuncts have different SLASH values, the first being [SLASH {VP}] and the second [SLASH {NP}]. Within the analysis we are proposing, both are [SLASH {NP}].

A further point to note about this analysis is that it predicts that it should be possible to have not just *which* but other anaphoric fillers associated with an auxiliary complement gap. The following naturally occurring examples suggest that both *that* and *this* may occur.

(65) a. They can only do their best and that they certainly will ___.
(http://www.britishcycling.org.uk/web/site/BC/gbr/News2008/200807018_Jamie_Staff.asp)

b. Now if the former may be bound by the acts of the legislature, and this they certainly may ___, ...
(Thomas Christie (1792) The Analytical review, or History of literature, domestic and foreign, on an enlarged plan, p503 (Princeton University))

c. It was thought that he would produce a thought provoking chapter, and this he certainly has ___.
(J. B. Cullingworth, ed. British planning: 50 years of urban and regional policy/, Continuum International Publishing Group, 1999, p13).

It does not seem to be possible to have *it* as a filler in an example like an ASRC:

(66) a. *Kim will sing, but it Lee won't ___.

b. *Kim is clever, but it Lee isn't ___.

c. *Kim is in Spain, but it Lee isn't ___.

However, it seems to be generally impossible to have *it* as a filler:

(67) *Kim likes beer, but it Lee doesn't like ___.

It looks, then, as if we don't need any special statement to rule out the examples in (66).

7. Further analyses and data

It seems to us that the filler gap analysis that we proposed in the last section is clearly superior to the other three analyses which we discussed. There are, however, some further analyses that should be considered and also some further relevant data. Both analyses involve the idea that *which* in ASRCs is not only the ordinary *which* but is associated with a nominal gap.

The first builds on the fact that many ASRCs have related examples with *do*. The following illustrate:

(68) a. Kim will sing, which Lee won't ___.
b. Kim will sing, which Lee won't do ___.

(68a) contains an ASRC with an auxiliary complement gap, but (68b) contains an NRRC with a nominal gap. The gap may be replaced by *it* :

(69) Kim will sing, but Lee won't do it.

There are also related *wh*-interrogatives and pseudo-clefts:

(70) A: What will Lee do ___?
B: Sing.
(71) What Lee will do ___ is sing.

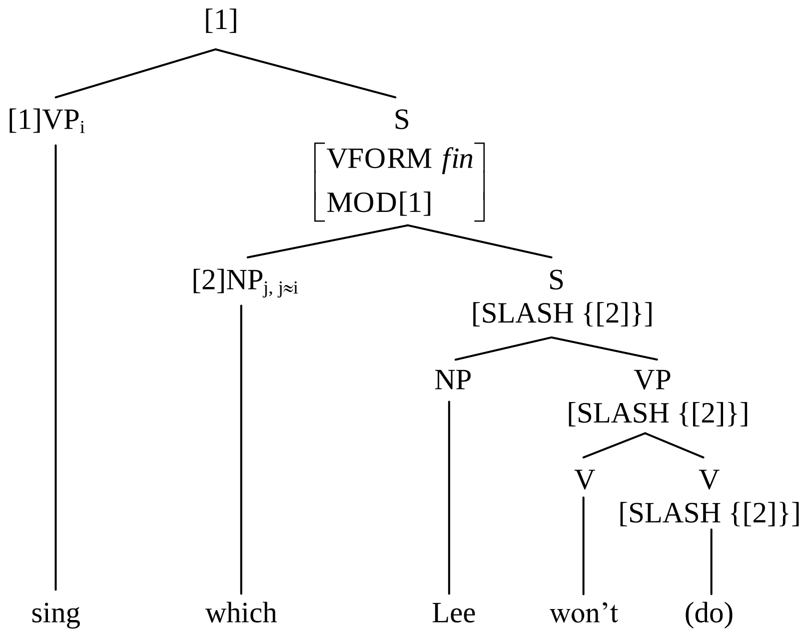
Pairs of sentences like those in (68) might lead one to propose that ASRCs are ordinary NRRCs with a phonologically null variant of *do*.[6] This might be compared to the phonologically null variant of *be* proposed in Borsley (2004) to accommodate comparative correlatives like the following:

(72) The more intelligent the students, the better the grades.

On this approach, (68a) will involve the following structure, where the bracketed *do* stands for an empty variant of *do*:

[6] Alternatively one might propose that ASRCs involve a *do* that is deleted, invoking the deletion mechanism proposed in Beavers and Sag (2004).

(73)



One point to emphasize about this approach is that the empty variant of *do* must have very specific properties. It cannot select just any nominal gap since this would allow the *wh*-interrogative in (74) parallel to that in (70) and the pseudo-cleft in (75) parallel to that in (71).

(74) *What will Lee ___?
(75) *What Lee will ___ is sing.

It will in fact have to select a gap with the LOCAL feature in (61). More importantly, it is only ASRCs with a verbal antecedent that have a paraphrase with *do*, but of course there are also ASRCs with a non-verbal antecedent such as the following:

(76) a. Kim is clever, which Lee isn't ___.
b. Kim is in Spain, which Lee isn't ___.

This means that this approach has essentially nothing to say about ASRCs with a non-verbal antecedent.

A more promising way of associating *which* in ASRCs with a nominal gap would be to stipulate that auxiliaries in addition to taking their normal complements (which may be unexpressed) may take a nominal gap. One argument in favour of this approach is that there seem to be cases elsewhere where a head takes a nominal gap but not an overt NP as a complement. As Bouma, Malouf and Sag (2001) point out, this seems to be the case with *assure* in examples like the following, highlighted by Kayne (1980) :

(77) This candidate, they assured me ___ to be reliable.

The following shows that the gap in (77) is in a position where an overt NP may not appear:

(78) *They assured me this candidate to be reliable.

In contrast it is not really clear whether dishonest gaps occur elsewhere. It looks, then, as if there may be a reason for preferring a nominal gap analysis. It can be argued, however, that it is more complex than our dishonest gap analysis. The nominal gap analysis introduces a completely new option as complement of auxiliaries whereas our analysis just allows two different values for one feature within a single option. Both approaches involve a disjunction, but ours seems simpler.

There is some further data that seems relevant here.[7] As is well known, auxiliaries allow what is known as pseudo-gapping. In addition to appearing with no complement they appear with what looks like an elliptical complement, a phrase which is interpreted as if it were part of an ordinary complement. Consider, for example, the following:

(79) Kim criticized Lee, but he didn't ___ Sandy.

As we have indicated, a verb is missing from the second conjunct. It is possible to have more than just a verb missing, as the following from Culicover and Jackendoff (2005: 293) indicates:

(80) Robin will cook the potatoes quickly, and Leslie will ___ the beans ___.

Pseudo-gapping is restricted in various ways. For example, the following from Lasnik (1999) suggest that the post-auxiliary constituent may not be an AP:

(81) a. *You probably just feel relieved, but I do ___ jubilant.
b. *Rona sounded annoyed, and Sue did ___ frustrated.

It also seems from the following examples from Culicover and Jackendoff (2005: 293, 294) that it is not possible with *to*:

(82) a. *Robin will try to cook the potatoes, and Leslie will try to ___ the beans.

[7] This was brought to our attention by Greg Stump.

b. *Whenever you want to ___ the salad, first go ahead and taste the soup.

Pseudo-gapping is relevant in the present context because for many examples there is a similar example in which the conjunction is replaced by *which*. Thus, corresponding to (79) and (80) we have the following:

(83) Kim criticized Lee, which he didn't ___ Sandy.
(84) Robin will cook the potatoes quickly, which Leslie will ___ the beans ___.

These examples relate to pseudo-gapping clauses in the same way as ASRCs relate to auxiliary complement ellipsis clauses.

It seems, then, that there are two kinds of ellipsis with auxiliaries: auxiliary-complement ellipsis, where the whole complement is missing, and pseudo-gapping, where the complement is elliptical. The latter is restricted in various ways but seems to be possible with most auxiliaries. Crucially, we have related non-restrictive relatives with *which* in both cases. If there were related examples with *which* in just one case, one might think that this is a separate phenomenon. As it is, it seems that the right view is that there are two types of ellipsis, both of which allow the crucial argument to have a non-empty SLASH value which may be realized as relative *which*. We think, then, that pseudo-gapping and related examples with *which* provide some support for the approach that we have developed to ASRCs.

8. Concluding Remarks

In this paper we have investigated the properties of ASRCs and developed a fairly simple analysis. Our analysis attributes ASRCs to an optional additional property of auxiliaries which have a missing complement. They allow a dishonest gap as their complement and this gives rise to a filler-gap mismatch. In addition to its other advantages this approach makes it easy to see how ASRCs could have arisen historically and how they might arise in the grammar of an individual. All that is required is the replacement of (60) by (62). This is a rather simple change.

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German Multiple Fronting and Expected Topic-Hood

Felix Bildhauer
Freie Universität Berlin

Philippa Cook
Freie Universität Berlin

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Abstract

This papers addresses information-structural restrictions on the occurrence of what is known as "multiple fronting" in German. Multiple fronting involves the realization of (what appears to be) more than one constituent in the first position of main clause declaratives, a clause type that otherwise respects the verb-second constraint of German. Relying on a large body of naturally occurring instances of multiple fronting with the surrounding discourse context, we show that in certain contexts, multiple fronting is fully grammatical in German, in contrast to what has sometimes been claimed previously. Examination of this data reveals two different patterns, which we analyze in terms of two distinct constructions, each instantiating a specific pairing of form, meaning and contextual appropriateness.

1 Introduction

German is classed as a V2 language, that is, normally exactly one constituent occupies the position before the finite verb in declarative main clauses. In what have been claimed to constitute rare, exceptional cases, however, more than one constituent appears to precede the finite verb, as illustrated in (1)–(3):

(1) [Dem Saft] [eine kräftigere Farbe] geben Blutorangen.
to.the juice a more.vivid colour give blood.oranges
'What gives the juice a more vivid colour is blood oranges.' R99/JAN.01605[1]

(2) [Dem Frühling] [ein Ständchen] brachten Chöre aus dem Kreis
to.the spring a little.song brought choirs from the county
Birkenfeld im Oberbrombacher Gemeinschaftshaus.
Birkenfeld in the Oberbrombach municipal.building
'Choirs from Birkenfeld county welcomed (the arrival of) spring with a little song in the Oberbrombach municipal building.' RHZ02/JUL.05073

(3) [Dem Ganzen] [ein Sahnehäubchen] setzt der Solist Klaus Durstewitz
to.the everything a little.cream.hood puts the soloist K. D.
auf
on
'Soloist Klaus Durstewitz is the cherry on the cake.' NON08/FEB.08467

There has been ongoing debate in the theoretical literature concerning the status of examples seemingly violating this V2 constraint. The examples in (4) (from

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[1]Corpus examples were extracted from *Deutsches Referenzkorpus* (DeReKo), hosted at Institut für Deutsche Sprache, Mannheim: `http://www.ids-mannheim.de/kl/projekte/korpora`

Fanselow, 1993) and (5) (from G. Müller, 2004), are similar to (1)–(3) in that both objects of a ditransitive verb are fronted. The grammaticality judgments given by these authors diverge and, as can be seen from G. Müller's assessment of the data, such constructed examples tend to be deemed at best marginal, or even ungrammatical if presented without context.

(4) [Kindern] [Heroin] sollte man besser nicht geben.
to.children heroin should one better not give
'One shouldn't give heroin to children.'

(5) a. ?? [Kindern] [Bonbons] sollte man nicht geben.
to.children candies should one not give
'One shouldn't give candies to children.'

b. * [Dieses billige Geschenk] [der Frau] sollte man nicht geben.
this cheap present to.the woman should one not give
'One shouldn't give the woman this cheap present.'

On the basis of corpus data, St. Müller (2003, 2005) shows that a large variety of syntactic categories, grammatical functions and semantic classes can occur preverbally in such Multiple Frontings (MFs). Building on proposals by Hoberg (1997) and Fanselow (1993), he offers a detailed HPSG analysis that treats the fronted constituents as dependents of an empty verbal head, thus preserving the assumption that the preverbal position is occupied by exactly one constituent (a VP):

(6) $[_{VP}$ [Dem Saft] [eine kräftigere Farbe] $\_{V}]_i$ geben$_j$ Blutorangen $\_{i}$ $\_{j}$.

While this account by itself correctly predicts certain syntactic properties of MFs, such as the fact that the fronted parts must depend on the same verb, it is in need of further refinement. In particular, multiple fronting seems to require very special discourse conditions in order to be acceptable (which is why out-of-context examples often sound awkward). Relying on findings from a corpus of naturally occurring data, we have identified two different information-structural environments in which MFs are licensed. Section 2 briefly sketches these two patterns, which in Section 3 we will analyze as being licensed by two related but distinct constructions, each of them instantiating a specific pairing of form, meaning and contextual appropriateness.

2 Multiple Fronting in Context

2.1 Presentational MF

One of the configurations in which MF is well attested in naturally occurring data is illustrated in (7) and (8), where the (b) line contains the MF structure and the (a) and (c) lines provide the context before and after it, respectively. We call this type *Presentational Multiple Fronting*.

(7) a. Spannung pur herrschte auch bei den Trapez-Künstlern. [. . .] Musikalisch begleitet wurden die einzelnen Nummern vom Orchester des Zirkus Busch (. . .)
‘It was tension pure with the trapeze artists. [. . .] Each act was musically accompanied by Circus Busch’s own orchestra.’

b. [Stets] [einen Lacher] [auf ihrer Seite] hatte *die Bubi Ernesto Family*$_i$.
always a laugh on their side had the Bubi Ernesto Family
‘Always good for a laugh was the Bubi Ernesto Family.’

c. *Die Instrumental-Clowns*$_i$ zeigten ausgefeilte Gags und Sketche [. . .]
‘These instrumental clowns presented sophisticated jokes and sketches.’
M05/DEZ.00214

(8) a. . . . wurde der neue Kemater Volksaltar . . . geweiht. Die Finanzierung haben die Kemater Basarfrauen übernommen. Die Altarweihe bot auch den würdigen Rahmen für den Einstand von Msgr. Walter Aichner als Pfarrmoderator von Kematen.
‘. . . the new altar in Kemate . . . was consecrated. It was financed by the Kemate bazar-women. The consecration of the altar also presented a suitable occasion for Msgr. Walter Aichner’s first service as Kematen’s parish priest’

b. [Weiterhin] [als Pfarrkurator] wird *Bernhard Deflorian*$_i$ fungieren.
further as curate will Bernhard Deflorian function.
‘Carrying on as curate, we have Bernhard Deflorian.’

c. Ihn$_i$ lobte Aichner besonders für seine umsichtige und engagierte Führung der pfarrerlosen Gemeinde. Er$_i$ solle diese Funktion weiter ausüben, „denn die Entwicklung, die die Pfarrgemeinde Kematen genommen hat, ist sehr positiv”.
‘Aichner praised him especially for his discreet and committed leading of the priestless congregation. He should carry on with his work, “for the development of the Kematen congregation has been very positive.”’
I97/SEP.36591

We take Presentational MF to be a topic shift strategy. A new entity (in italics) is introduced into the discourse and serves as a topic in the continuation. On the basis of a close examination of a large quantity of naturally occurring data, we suggest that this presented entity corresponds to the dependent (argument or adjunct) of the verb that is most topic-worthy and is thus most likely to be realized as a topic in other circumstances. We will refer to it as the verb’s ‘designated topic’, and it is, typically, the grammatical subject, but non-subjects may take on this role – as we illustrate immediately below – in the case of e. g. unaccusatives/psych verbs which presumably favor spatio-temporal or experiencer topics. Since focus and newness are not prototypical topic features cross-linguistically, it has been argued that brand new/focal entities often have to be first ‘presented’ before they can function as aboutness topics (cf. Lambrecht, 1994, for whom the type of phrases introducing brand new referents into the discourse are lowest on the scale of 'Topic Accessibility'). Interestingly, then, rather than checking/spelling out a discourse function of the fronted material, the motivating factor here is the need to shift material away from the post-verbal domain to maximize the presentational effect. Note that the pattern is not characterized adequately if the description makes reference to the subject, rather than to the 'designated topic'. The reason is that the presented element need not be the subject in all cases, as illustrated in (9b): here, the subject is actually part of the fronted material, while the newly introduced entity is coded as a locative PP. Our analysis in terms of designated topic accommodates these data, since the locative phrase, rather than the subject, plays this role in the case of *herrschen* 'to reign' (in the relevant "existential" reading). It also predicts that a subject can occur among the fronted material in a MF construction iff it is not the verb's designated topic.

(9) a. Gesucht? Schnelle Sprinter
'Wanted: fast sprinters'

b. [Weiterhin] [Hochbetrieb] herrscht am Innsbrucker Eisoval.
further high.traffic reigns at.the Innsbruck icerink
'It's still all go at the Innsbruck icerink.'

c. Nach der Zweibahnentournee am Dreikönigstag stehen an diesem Wochenende die österreichischen Staatsmeisterschaften im Sprint am Programm.
'Following the two-rink tournament on Epiphany-Day there's now the Austrian National Championship in Sprinting coming up at the weekend.' I00/JAN.00911

2.2 Propositional Assessment MF

The second configuration in which MF occurs is best described as *Propositional Assessment MF*. Examples (10c) and (11c) illustrate this type of structure.

(10) a. Bauern befürchten Einbußen
'Farmers fear losses'

b. [Nach Brüssel] [zum Demonstrieren] ist Gerd Knecht *nicht* gefahren
to Brussels to demonstrate is G. K. not gone
'G. K. did not go to Brussels for the demo'

c. aber gut verstehen kann der Vorsitzende des Lampertheimer Bauernverbands die Proteste der Kollegen.
'but the president of the Lampertheim Farmers' Association can well understand his colleagues' protest.' M99/FEB.12802

(11) a. Im Schlussabschnitt war den Berlinern das Bemühen durchaus anzumerken, vor ausverkauftem Haus ein Debakel zu verhindern.
'During the last phase of the match, it was clearly visible that the Berlin players were struggling to fight off a debacle in the packed arena.'

b. [Dem Spiel] [eine Wende] konnten sie aber nicht mehr geben.
to.the match a turn could they however not more give

‘However, they didn’t manage to turn the match around.’

c. Rob Shearer (46.) traf noch einmal den Pfosten, das nächste Tor erzielten aber wieder die Gäste.
In the 46th minute, Rob Shearer hit the post again, but it was the guests who scored the next goal.’ NUZ07/MAI.01360

We analyze Propositional Assessment MF as involving a Topic-Comment structure plus an assessment of the extent to which the Comment holds of the Topic. More precisely, we are dealing with an inverted Topic-Comment configuration, in which the fronted material constitutes (part of) the Comment, while the Topic is instantiated by a discourse-given element in the middlefield. Also in the middlefield, we regularly find an ‘evaluative’ expression, generally an adverb or particle, frequently but not exclusively negation. It must be prosodically prominent (i. e., it must probably receive the main stress of the sentence), and it expresses/highlights the degree to which the Comment holds for the Topic. Besides *nicht* ‘not’, particles/adverbs frequently found in *Propositional Assessment MF* include *nie* ‘never’, *selten* ‘rarely’, *oft* ‘often’.

3 An HPSG account

3.1 Identifying cases of MF

To account for the data within HPSG, it is necessary to appropriately constrain syntactic, semantic, and information-structural properties of a sign whenever it instantiates a multiple fronting configuration. Thus, in order to be able to specify any constraints on their occurrence, instances of multiple fronting must be identified in the first place. Since we base our proposal on Müller’s (2005) syntactic analysis of multiple fronting, this is not a major problem: on his approach, the occurrence of elements in the preverbal position in general is modeled as a filler-gap-relation, where the non-head daughter corresponds to the preverbal material (prefield) and the head daughter corresponds to the rest of the sentence (in the topological model of the German sentence, this would be the finite verb, the middlefield, and the right bracket, and the final field). In Müller’s (2005) formalization, filler daughters in multiple fronting configurations (and only in these) have a HEAD|DSL value of type *local*, that is, conforming to the analysis sketched in (6) above, they contain information about an empty verbal head, as shown in (12).[2]

(12) $\begin{bmatrix} \textit{head-filler-phrase} \\ \text{NON-HD-DTRS} \ \left\langle \begin{bmatrix} \text{HEAD|DSL} \ \ \textit{local} \end{bmatrix} \right\rangle \end{bmatrix}$

This specification then allows us to pick out exactly the subset of *head-filler-phrases* we are interested in, and to formulate constraints such that they are only

[2]The DSL (‘double slash’) feature is needed to model the HPSG equivalent of verb movement from the sentence final position to initial position. Cf. the indices in example (6) above.

licensed in some specific information-structural configurations, to which we turn next.

3.2 Information structure features

Various approaches to information structure have been proposed within HPSG, differing both in the features that are assumed to encode aspects of IS, and in the sort of objects these features take as their value (among others, Engdahl and Vallduví, 1996; Wilcock, 2001; De Kuthy, 2002; Paggio, 2005; Webelhuth, 2007). The representation we use here is based on Bildhauer (2008): following proposals such as Krifka (2007), topic/comment and focus/ground are treated as two information structural dimensions that are orthogonal to one another. We thus introduce both a TOPIC and a FOCUS feature, bundled in a IS path, which in turn is an attribute of *synsem*-objects.[3] These take as their value a list of lists of *elementary predications* (*EP*s, for short), as used in Minimal Recursion Semantics Copestake et al. (1999). In the basic case, that is, a sentence that has one topic and a single focus, the TOPIC and FOCUS lists each contain one list of *EPs*, which are structure shared with elements on the sign's RELS-list. In other words, we are introducing pointers to individual parts of a sign's semantic content. By packaging the *EP*s pertaining to a focus or topic in individual lists, we are able to deal with multiple foci/topics. The feature architecture just outlined is shown in (13), and (14) illustrates a possible instantiation of the TOPIC, FOCUS and CONT values.

(13)
$$\begin{bmatrix} \textit{sign} & \\ \text{SYNSEM} & \begin{bmatrix} \text{LOC} & \textit{local} \\ \text{NONLOC} & \textit{nonloc} \\ \text{IS} & \begin{bmatrix} \textit{is} & \\ \text{TOPIC} & \textit{list} \\ \text{FOCUS} & \textit{list} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

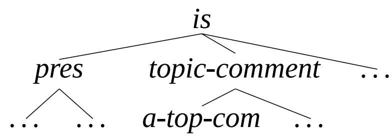
(14)
$$\begin{bmatrix} \textit{sign} & \\ \text{SYNSEM} & \begin{bmatrix} \text{IS} & \begin{bmatrix} \textit{is} & \\ \text{TOPIC} & \left\langle \langle \boxed{1} \rangle \right\rangle \\ \text{FOCUS} & \left\langle \langle \boxed{2}, \boxed{3} \rangle, \langle \boxed{4} \rangle \right\rangle \end{bmatrix} \\ \text{LOC}|\text{CONT}|\text{RELS} & \langle \boxed{1}, \boxed{2}, \boxed{3}, \boxed{4}, \boxed{5} \rangle \end{bmatrix} \end{bmatrix}$$

Next, we introduce a subtyping of *is*, given in (15). These subtypes can then be used to refer more easily to particular information-structural configurations, that is, to specific combinations of TOPIC and FOCUS values.[4] The subtypes that are

[3]Information-structure should be inside *synsem* because at least information about focus must be visible to elements (such as focus sensitive particles) that select their sister constituent via some feature (MOD, SPEC, COMPS/SUBCAT). Possibly, the situation is different with topics: we are not aware of data showing that topicality matters for selection by modifiers or heads. We leave open the question whether TOPIC is better treated as an attribute of, say, *sign* rather than *synsem*.

[4]These types are thus used as abbreviations or labels for specific combinations of attributes and their values. From a theoretical perspective, they are not strictly necessary, but we use them here for

relevant for our purpose are *pres* (‘presentational’) and *a-top-com* (‘assessed-topic-comment’, a subtype of the more general *topic-comment* type.

(15)


Those *head-filler* phrases that are instances of multiple fronting can then be restricted to have an IS-value of an appropriate type, as shown in (16).

(16) $$\begin{bmatrix} \textit{head-filler-phrase} \\ \textsc{non-hd-dtrs} \left\langle \left[\textsc{head}|\textsc{dsl}\ \ \textit{local}\right] \right\rangle \end{bmatrix} \longrightarrow \left[\textsc{is}\ \ \textit{pres} \vee \textit{a-top-com} \vee \ldots\right]$$

3.3 Modeling Presentational MF

In order to model Presentational MF, we introduce a pointer to the Designated Topic as a head feature of the verb that subcategorizes for it. The feature DT takes a list (empty or singleton) of *synsem*-objects as its value, and it states which element, if any, is normally realized as the Topic for a particular verb. This is not intended to imply that the Designated Topic must in fact be realized as the topic in all cases. Rather, it merely encodes a measurable preference in topic realization for a given verb. The statement in (17) is intended as a general constraint, with further constraints on verbs (or classes of verbs) determining which element on ARG-ST is the Designated Topic.

(17) $$\textit{verb-stem} \rightarrow \left[\textsc{head}\,|\,\textsc{dt}\ \langle\rangle\right] \quad \vee \quad \begin{bmatrix} \textsc{head}\,|\,\textsc{dt} & \langle\boxed{1}\rangle \\ \textsc{arg-st} & \langle \ldots\ \boxed{1}\ \ldots \rangle \end{bmatrix}$$

The constructional properties of Presentational Multiple Fronting are defined in (18): the Designated Topic must be located within the non-head daughter and must be focused. Figure 1 shows the relevant parts of the analysis of sentence (7) above.

(18) $$\begin{bmatrix} \textit{head-filler-phrase} \\ \textsc{is}\ \ \textit{pres} \end{bmatrix} \rightarrow \begin{bmatrix} \textsc{ss}\,|\,\textsc{l}\,|\,\textsc{cat}\,|\,\textsc{head}\,|\,\textsc{dt}\ \left\langle \left[\textsc{l}\,|\,\textsc{cont}\,|\,\textsc{rels}\ \boxed{1}\right] \right\rangle \\ \textsc{hd-dtr}\,|\,\textsc{ss}\,|\,\textsc{is}\,|\,\textsc{focus}\ \langle\boxed{1}\rangle \end{bmatrix}$$

3.4 Modeling Propositional Assessment MF

For Propositional Assessment MF, we use a special subtype of *topic-comment*, namely *a(ssessed)-top-com*. We then state that the designated topic must in fact

clarity of exposition.

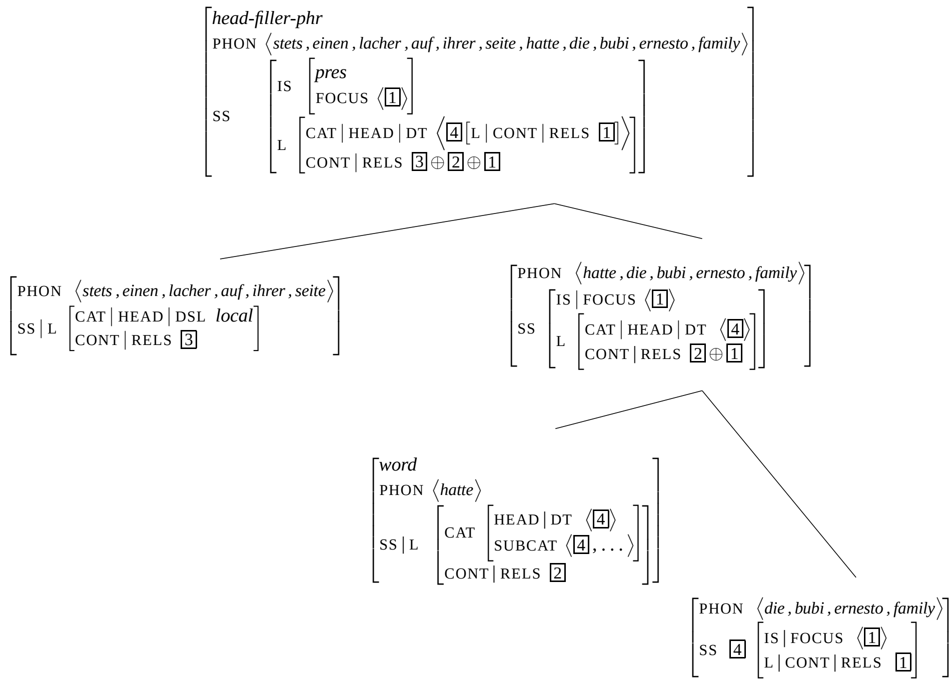


Figure 1: Sample analysis of *Presentational Multiple Fronting*

be realized as the topic, and that it must occur somewhere within the head daughter (which comprises everything but the prefield). Most importantly, the head-daughter must also contain a focused element that has the appropriate semantics (i. e. one which serves to spell out the degree to which the comment holds of the topic; glossed here as *a-adv-rel*). However, the mere presence of such an element on the RELS list does not guarantee that it actually modifies the highest verb in the clause (e. g., it could modify a verb in some embedded clause as well.) Therefore, the construction also adds a handle constraint specifying that the focused element takes scope over the main verb. This handle constraint needs to be added rather than just be required to exist among the head-daughter's handle constraints because the *outscoped* relation need not be an immediate one, i. e., there can be more than one scope-taking element involved. An appropriate handle constraint can be introduced via the C_CONT-feature, i. e. as the construction's contribution to the overall meaning. If the relevant element does not in fact outscope the main verb, the MRS will contain conflicting information and cannot be scope-resolved. In that case, the phrase's semantics will not be well-formed, which we assume will exclude any unwanted analysis due to focussing of the wrong element. The necessary specifications are stated in (19). A sample analysis of sentence (10c) above is given in Figure 2.

(19) $$\begin{bmatrix} \textit{head-filler-phrase} \\ \text{SS}\,|\,\text{IS}\ \ \textit{a-top-com} \end{bmatrix} \rightarrow \begin{bmatrix} \text{SS} & \begin{bmatrix} \text{L}\,|\,\text{CAT}\,|\,\text{HEAD}\,|\,\text{DT} & \left\langle \begin{bmatrix} \text{L}\,|\,\text{CONT}\,|\,\text{RELS}\ \boxed{1} \end{bmatrix} \right\rangle \\ \text{IS} & \begin{bmatrix} \text{TOPIC} & \langle \boxed{1} \rangle \\ \text{FOCUS} & \langle \langle \boxed{3} \rangle \rangle \end{bmatrix} \end{bmatrix} \\ \text{C\_CONT}\,|\,\text{HCONS} & \left\langle \begin{bmatrix} \textit{qeq} \\ \text{HARG} & \boxed{5} \\ \text{LARG} & \boxed{4} \end{bmatrix} \right\rangle \\ \text{HD-DTR}\,|\,\text{SS}\,|\,\text{L}\,|\,\text{CONT} & \begin{bmatrix} \text{LTOP} & \boxed{4} \\ \text{RELS} & \left\langle \boxed{3} \begin{bmatrix} \textit{a-adv-rel} \\ \text{ARG} & \boxed{5} \end{bmatrix} \right\rangle \bigcirc \boxed{1} \bigcirc \textit{list} \end{bmatrix} \end{bmatrix}$$

4 Conclusion

In the way outlined above, the relative freedom of the fronted material in St. Müller's analysis of German MF is appropriately restricted with respect to the contexts in which MF can felicitously occur. While we are not claiming to have identified these contexts exhaustively, the two configurations modeled here, if taken together, account for the majority of naturally occurring examples in our database. In sum, then, the present paper underlines the importance of examining attested examples in context and demonstrates that it is possible to further constrain a syntactic phenomenon which in the past has even been deemed ungrammatical in many (decontextualized) examples.

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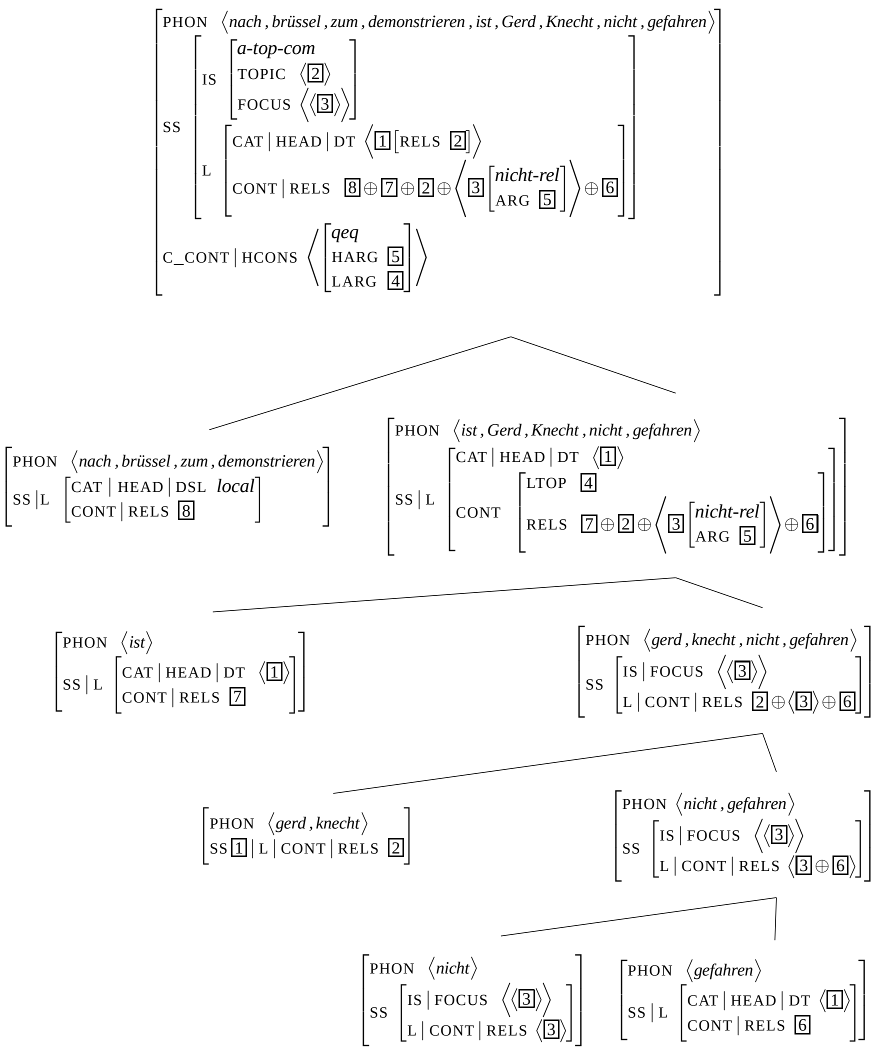

Figure 2: Sample analysis of *Propositional Assessment MF*

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An HPSG Approach to Welsh Unbounded Dependencies

Robert D Borsley
University of Essex

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Abstract

Welsh is a language in which unbounded dependency constructions involve both gaps and resumptive pronouns (RPs). Gaps and RPs appear in disjoint sets of environments. Otherwise, however, they are quite similar. This suggests that they involve the same mechanism, and in HPSG that they involve the SLASH feature. It is possible to provide an analysis in which RPs are associated with the SLASH feature but are also the ordinary pronouns which they appear to be.

1. Introduction

Welsh unbounded dependency constructions (UDCs) have received fairly extensive attention within various versions of transformational grammar, and a number of analyses have been outlined (see, for example, Hendrick 1988, Rouveret 1994, 2002, Sadler 1988, and Willis 2000, 2008). However, there has been very little discussion of Welsh UDCs within non-transformational frameworks.[1] In Borsley (2008) I discussed the properties of three Welsh UDCs: *wh*-interrogatives, clefts and free relatives. However, my main focus was on the ways in which they differ, and I said little about the similarities. It is the similarities that are the main focus of the present paper.

The most important similarity between the various UDCs is that they involve both gaps and resumptive pronouns (RPs). The obvious question is: how similar or how different are gaps and RPs ? I will show that they differ in their distribution but otherwise are quite similar. In particular they are alike in three important ways. This suggests that they involve the same mechanism, and in HPSG it suggests that both involve the SLASH feature. I will propose an analysis which treats RPs as a realization of the SLASH feature but also treats them as the ordinary pronouns that they appear to be.

Most work on Welsh UDCs has concentrated on literary Welsh. However, as Borsley, Tallerman and Willis (2007: 6) note, ‘literary Welsh is not and never has been the native language of any group of speakers’. In

↑ I have benefited from the comments of two anonymous reviewers for HPSG 2010 and also from those of Danièle Godard and Bob Levine. I am also grateful to Bob Morris Jones and David Willis for help with the data. I alone am responsible for what appears here.

[1] Harlow (1983) outlined an analysis of literary Welsh relative clauses within Generalized Phrase Structure Grammar.

view of this, I will follow Willis (2000, 2008) in focusing on the colloquial language.[2]

2. The distribution of gaps and resumptive pronouns (RPs)

We should begin by looking at the distribution of gaps and RPs. This is not an entirely simple matter, but it seems that they appear in disjoint sets of environments.

Before we proceed, we need to say something about the behaviour of pronouns and non-pronominal NPs. Pronouns, including RPs, are associated with agreement in a number of positions. In each case it is also possible to have the agreement with no visible pronoun. However, there is evidence from mutation (Borsley 1999) and agreement (Borsley 2009) that there is a phonologically empty pronoun in this situation. Non-pronominal NPs do not trigger agreement in the way that pronouns do, and we will see that nominal gaps generally behave non-pronominal NPs. A consequence of this is that it is not too hard to distinguish between true gaps and unexpressed RPs.

As one might expect, only a gap is possible in the highest subject position. Here is a simple example with the gap indicated in the normal subject position immediately after the verb:

(1) Pa fyfyrwyr enillodd ___ y wobr?
which students win.PAST.3SG the prize
'Which students won the prize?'

Notice that the verb here is third person singular although the gap is presumably plural. This is as it would be with a following non-pronominal subject:

(2) Enillodd y myfyrwyr y wobr.
win.PAST.3SG the students the prize
'The students won the prize?'

A third person plural verb appears with a third person pronominal subject, which may be unexpressed:

(3) Enillon (nhw) y wobr.
win.PAST.3PL they the prize
'The students won the prize.'

---

[2] For discussion of the relation between literary and colloquial Welsh see Borsley, Tallerman and Willis (2007: chapter 1.3).

The following shows that we cannot have either an overt RP or an unexpressed RP in the highest subject position:

(4) *Pa fyfyrwyr enillon (nhw) y wobr?
which students win.PAST.3PL they the prize
'Which students won the prize?'

We also have a gap and not an RP in the highest object position:

(5) a. Beth welest ti ___?
what see.2SG you
'What did you see?'
b. *Beth welest ti fo?
what see.2SG you he
'What did you see?'

There is no possibility of an unexpressed RP in object position. Hence there is only one version of the ungrammatical example to consider.

The data are not so clear, but it seems that embedded subject and object positions also allow gaps but not RPs. Consider first the following from Willis (2000):

(6) Pa lyfrau wyt ti 'n meddwl byddai/fyddai ___
which books be.PRES.2SG you PROG think be.COND.3SG
'n addas?
PRED suitable
`Which books do you think would be suitable ?'

Here, the *wh*-phrase is plural, but the verb preceding the gap is third person singular. This suggests that the gap is a true gap and not an unexpressed RP. Willis (2000: 556) suggests that an RP is possible in a relative clause if the particle *y*(*r*) is included and if the verb is left unmutated. He gives the following example, where *bydden* is a basic umutated verb form:

(7) ?y llyfrau yr wyt ti 'n meddwl
the books PART be.PRES.2SG you PROG think
[y bydden nhw'n addas]
PART be.COND.3PL they PRED suitable
'the books that you think would be suitable'

It is notable that this example is marked '?', suggesting that it is not fully acceptable. I will assume in subsequent discussion that such examples are ungrammatical. As for embedded objects, a gap is again fine, but an RP is quite marginal:

(8) y llyfrau yr wyt ti 'n meddwl
the books PART be.PRES.2SG you PROG think
[y darllenai Megan ___]
PART read.COND.3SG Megan
'the books you think Megan would read'

(9) ??y llyfrau yr wyt ti 'n meddwl
the books PART be.PRES.2SG you PROG think
[y darllenai Megan nhw]
PART read.COND.3SG Megan they
'the books you think Megan would read'

I shall assume that examples like (7) and (9) are ungrammatical. If they are, a question arises as to why they seem more acceptable than RPs in unembedded subject and object positions. Some psycholinguistic research by Staum and Sag (2008) may be relevant here. In an investigation of the repetition of the complementizer *that* in English, they found that examples are more acceptable the further apart the two complementizers are. I suggest, then, that RPs are more acceptable in embedded subject and object positions than in unembedded subject and object positions because they are further from the top of the dependency and the fact that they are RPs is less obvious.

I turn next to object of a non-finite verb. Things are rather complex here. We have examples like the following:

(10) Beth ydych chi 'n ei fwyta ___?
what be.PRES.2PL you PROG 3SGM eat
'What are you eating?'

The gap here is associated with agreement in the form of a clitic, which triggers soft mutation on the following verb, whose basic form is *bwyta*. In this, it is like a pronoun in this position and unlike a non-pronominal NP:

(11) Ydych chi 'n ei fwyta (o)?
be.PRES.2PL you PROG 3SGM eat he
'Are you eating it?'

(12) Ydych chi 'n bwyta cig?
be.PRES.2PL you PROG eat meat
'Are you eating meat?'

This might suggest that the gap in an example like (10) is really an unexpressed RP, and this is the conclusion that a number of researchers have reached (see Awbery 1977, Sadler 1988 and Rouveret 2002: 124). There are, however, reasons for doubting that this is right. First, as emphasized in Willis (2000: 545), an overt RP is not possible in this position:

(13) *Beth ydych chi 'n ei fwyta o?
what be.PRES.2PL you PROG 3SGM eat he
'What are you eating?'

This is not what we would expect if examples like (10) contained an unexpressed RP. Second, as noted in Borsley, Tallerman and Willis (2007: 114), colloquial Welsh allows a third person singular masculine clitic to appear when the *wh*-phrase is plural. Thus, instead of (14), (15) may occur.

(14) Pa lyfre ydych chi 'n eu prynu ___?
which books be.PRES.2PL you PROG 3PL buy
'Which books are you buying?'

(15) Pa lyfre ydych chi 'n ei brynu ___?
which books be.PRES.2PL you PROG 3SGM buy

It is also possible to have a third person singular masculine clitic when the *wh*-phrase is feminine, giving (17) instead of (16).

(16) Pa gath ydych chi 'n ei phrynu ___?
which cat be.PRES.2PL you PROG 3SGF buy
'Which cat are you buying?'

(17) Pa gath ydych chi 'n ei brynu ___?
which cat be.PRES.2PL you PROG 3SGM buy

It is possible also to have no clitic and just a soft mutated verb:

(18) Pa lyfre ydych chi 'n brynu ___?
which books be.PRES.2PL you PROG buy
'Which books are you buying?'

(19) Pa gath ydych chi 'n brynu ___?
which cat be.PRES.2PL you PROG buy
'Which cat are you buying?'

We would not expect these possibilities if the gap was an unexpressed RP. I will assume, then, that we have a true gap here. The possibility of a clitic seems to be partly the result of special constraint. However, we will see later that there is a general mechanism allowing a third person singular masculine clitic and mutation here.

As one might expect, we have gaps and not RPs in an adverbial position, e.g. (20), and as PP arguments of adjectives, e.g. (21).

(20) a. Sut gwyddost/wyddost ti hyn ___?
how know.PRES.2SG you DEM
'How do you know that?'

b. Pryd cest/gest ti dy benblwydd ___?
when get.PAST.2SG you 2SG birthday
'When did you have your birthday?'

(21) Am beth mae Gwyn yn siwr ___?
about what be.PRES.3SG Gwyn PRED certain
'About what is Gwyn certain?'

We do not have gaps as PP arguments of nouns. Rather than (22a), we have (22b), with a complex NP filler.

(22) a. *Am bwy wyt ti 'n darllen llyfr ___?
about what be.PRES.3SG you PROG read book
'About what are you reading a book?'

b. Llyfr am bwy wyt ti 'n ei ddarllen ___?
book about what be.PRES.3SG you PROG 3SGM read
'A book about what are you reading?'

We turn now to positions where only an RP is possible. An RP is possible in prepositional object position, but a gap is not possible (except in very colloquial varieties). An RP is possible in this position in a *wh*-interrogative, but it is the norm when the object of a preposition is questioned for the whole PP to be fronted. However, when the object of a preposition is relativized there is no alternative to an RP, as in (23).

(23) y dyn werthodd Ieuan y ceffyl iddo (fo)
the man sell.PAST.3SG Ieuan the horse to.3SGM he
'the man that Ieuan sold the horse to'

Like most prepositions, the preposition here shows agreement in the form of a suffix with a pronominal object including an RP, and the object may be unexpressed.[3] A gap is not possible except in very colloquial varieties. Thus, the following is ungrammatical outside such varieties.

(24) *y dyn werthodd Ieuan y ceffyl i ___
the man sell.PAST.3SG Ieuan the horse to
'the man that Ieuan sold the horse to'

This example contains the basic uninflected form of the preposition, which appears with a non-pronominal NP, as in (25).

[3] Some prepositions do not show agreement, and with such prepositions a pronoun, including an RP, must be overt. Here is a relevant example:

(i) y bêl mae o 'n chwarae efo hi
the ball bePRES.3SG he PROG play with she
'the ball that he is playing with'

(25) i 'r dyn
to the man
'to the man'

A second position where only an RP may appear is the possessor position within an NP. The following relative clause illustrates:

(26) y dyn weles i ei chwaer (o)
the man see.PAST.1SG I 3SGM sister he
'the man whose sister I saw'

As we see here, nouns show agreement in the form of a clitic with a pronominal possessor, including a possessor which is an RP, and the possessor may be unexpressed. The following example with a gap in possessor position is ungrammatical

(27) *y dyn weles i chwaer ___
the man see.PAST.1SG I sister
'the man whose sister I saw'

There is no clitic here because a clitic does not appear with a non-pronominal possessor, as (28) illustrates:

(28) chwaer y bachgen
sister the boy
'the boy's sister'

The facts are not entirely straightforward, but it seems that gaps and RPs appear in disjoint sets of environments. Gaps appears in subject position, as object of a finite or non-finite verb, as an adjunct, and as a PP argument of an adjective. RPs appear as object of a preposition and as possessors.

3. Some similarities between gaps and resumptive pronouns

If the preceding discussion is sound, gaps and RPs are in complementary distribution. In this section I will show that they are similar in some important ways.

It has been well known since Ross (1967) that unbounded dependencies are subject to the Coordinate Structure Constraint, which essentially says that an unbounded dependency may not affect one conjunct of a coordinate structure unless it affects the other(s), in which case it is commonly referred to as an across-the-board dependency.[4] In the case of Welsh, it rules out (29) while allowing (30).

(29) *y dyn [welais i ___ a gwelaist tithau Megan]
the man see.PAST.1SG I and talk.PAST.2SG you Megan
*'the man that I saw and you saw Megan'

(30) y dyn [welais i ___ a gwelaist tithau ___ hefyd]
the man see.PAST.1SG I and talk.PAST.2SG you too
'the man that I saw and you saw too'

(30) has a gap in both clauses. Consider now the following:

(31) y dyn [welais i ___ a soniais amdano fo]
the man see.PAST.1SG I and talk.PAST.1SG about.3SGM he
'the man that I saw and talked about'

(32) y dyn [welais i ___ a oeddwn i'n nabod
the man see.PAST.1SG I and be.IMPF.1SG I PROG know
ei dad o]
3SGM father he
'the man who I saw and whose father I knew'

These examples have a gap in the first clause and an RP in the second. It seems, then, that gaps and RPs have the same status as far as the Coordinate Structure Constraint is concerned.

A second similarity between gaps and RPs involves certain restrictions on tense. A notable feature of Welsh is that present forms of *bod* 'be' and for some speakers imperfect forms as well do not appear in affirmative complement clauses. Thus, (33) and for some speakers (34) too are ungrammatical.

(33) *Mae Aled yn credu [y mae Elen yn
be.PRES.3SG Aled PROG believe PRT be.PRES.3SG Elen PROG
darllen y llyfr].
read the book
'Aled believes that Elen is reading the book.'

(34) %Mae Aled yn credu [roedd Elen yn darllen
be.PRES.3SG Aled PROG believe be.IMPF.3SG Elen PROG read
y llyfr].
the book
'Aled believes that Elen was reading the book.'

---

[4] Kehler (2002) has shown that the Constraint only applies when the conjuncts are parallel in certain ways. However, this is not particularly important in the present context.

Instead of these forms, what looks like the non-finite form *bod* appears. Thus, the grammatical counterpart of (33) and (34) is (35).[5]

(35) Mae Aled yn credu [bod Elen yn darllen y llyfr].
be.PRES.3SG Aled PROG believe be Elen PROG read the book
'Aled believes that Elen is/was reading the book.'

Crucially, the ban on the present and imperfect forms of *bod* is nullified by an unbounded dependency. Thus, both the following are fine:

(36) Beth mae Aled yn credu [y mae Elen yn
What be.PRES.3SG Aled PROG believe PRT be.PRES.3SG Elen PROG
ei ddarllen ___]?
3SG read
'What does Aled believe that Elen is reading?'

(37) Beth mae Aled yn credu [roedd Elen yn ei
what be.PRES.3SG Aled PROG believe be.IMPF.3SG Elen PROG 3SG
ddarllen ___]?
read
'What does Aled believe that Elen was reading?'

Willis (2000: 556) suggests that it is only unbounded dependencies involving a gap that have this effect. He cites the following example as evidence that unbounded dependencies involving an RP do not nullify the ban:

(38) *Pa lyfrau wyt ti 'n meddwl oedden (nhw)
which books be.PRES.3SG you.SG PROG think be.IMPF.3SG they
'n addas?
PRED suitable
'Which books do you think were suitable?'

Notice, however, that this has an RP in an embedded subject position. We suggested earlier that RPs are barred from this position. I suggest that it is this and not the ban on the imperfect of *bod* that is responsible for the ungrammaticality of this example. Consider instead the following examples:

[5] Tallerman (1998) and Borsley, Tallerman and Willis (2007: 3.3) show that there is evidence that *bod*-initial clauses are probably finite, but this is not particularly important in the present context.

(39) y llyfr mae pawb yn dweud mae / roedd
the book be.PRES everyone PROG say be.PRES.3SG be.IMPF.3SG
Mair yn sôn amdano fe
Mair PROG talk about.3SGM he
'the book that everyone says Mair is/was taking about'

(40) y dyn mae pawb yn dweud mae /
the man be.PRES.3SG everyone PROG say be.PRES.3SG
roedd ei dad o 'n glyfar
be.IMPF.3SG 3SG father he PRED clever
'the man whose father everyone says is/was clever'

These examples have RPs in positions in which they are unproblematic, prepositional object position and possessor position, respectively. In both cases the RP is inside a complement clause where the verb is the present tense of *bod*. Hence, they show clearly that unbounded dependencies with an RP nullify the ban on the present and imperfect of *bod* just as much as unbounded dependencies with a gap do.

A further similarity, highlighted by Willis (2008), involves non-finite verbs that appear between the top and the bottom of an unbounded dependency. We saw in section 2 that a non-finite verb is preceded by a clitic if its object is questioned. We also noted that it is possible to have a third person singular masculine clitic when the *wh*-phrase is plural or just a soft mutated verb. We have the same possibilities with a higher non-finite verb, as the following from Willis (2008) illustrates:

(41) Beth wyt ti 'n (ei) feddwl bod hyn yn (ei)
what be.PRES.2SG you PROG 3SGM think be this PROG 3SGM
olygu ___?
mean
'What do you think this means?'

Here the object of a non-finite verb in a subordinate clause is being questioned and the verb is mutated and optionally preceded by a third person singular masculine clitic. The non-finite verb in the main clause is also mutated and optionally preceded by a clitic. Consider now the following example also from Willis (2008):

(42) y llyfr roedd pawb yn (ei) feddwl oedd Mair
the book be.IMP.3SG everyone PROG 3SGM think be.IMPF.3SG Mair
yn sôn amdano fe
PROG talk about.3SGM he
'the book that everyone thought that Mair was talking about'

Here the object of a preposition in a subordinate clause is being relativized and we have an overt RP. Again we have a non-finite verb in the higher clause and again it is soft mutated and optionally preceded by a clitic. In other words, we have exactly the same effects on a higher non-finite verb as in (41).

It seems, then, that there are three important similarities between gaps and RPs. They behave in the same way with respect to the Coordinate Structure Constraint, they both nullify the ban on the present and imperfect forms of *bod* in an affirmative complement clause, and they both allow soft mutation and an optional clitic on a higher non-finite verb. Any analysis must accommodate these similarities.

4. Islands: a further difference between gaps and resumptive pronouns?

So far we have seen that gaps and RPs appear in disjoint sets of environments but are similar in a number of important ways. It has often been suggested that RPs allow violations of island constraints. For example, Borsley, Tallerman, and Willis (2007: 146) claim that '[t]he resumptive strategy may also be used freely to void many island effects'. Clearly this is something that we need to look into.

In fact it is not clear that there is any real contrast between RPs and gaps here. Borsley, Tallerman, and Willis (2007: 147) consider the following example from Tallerman (1983: 201):

(43) Dyma 'r dyn y credodd Dafydd [y si [y
here-is the man PRT believe.PAST.3SG Dafydd the rumour PRT
gwelodd Mair (o)]].
see. PAST.3SG Mair he
'Here's the man who David believed the rumour that Mair saw.'

Here we have the relativization of the object of a finite verb inside a complex NP consisting of a noun and clausal complement. Notice that the pronoun is marked as optional. Tallerman comments that whether it is present or absent 'appears to make little or no difference to the acceptability of such sentences to native speakers'. This suggests that a gap is possible within some complex NPs since there is no possibility of an unexpressed RP here. I suggested earlier that RPs are ungrammatical as object of a finite verb. I also suggested, however, that an RP in object position may be fairly acceptable if it is some distance from the top of the dependency. I suggest that this is what we have in (43) when it contains an RP. As we might expect, similar examples with an RP in a standard RP position are also acceptable. Here is an example:

(44) Dyma 'r dyn y credodd Dafydd [y si [y
here-is the man PRT believe.PAST.3SG Dafydd the rumour PRT
cest ti 'r llythyr 'na ganddo (fo)]].
get.PAST.2SG you the letter DEM with.3SGM him
'Here's the man who David believed the rumour that you got that letter from.'

It looks, then, as if both gaps and RPs are fairly acceptable within a complex NP consisting of a noun and clausal complement.

Borsley, Tallerman, and Willis (2007: 148) also consider the following example, adapted from Tallerman (1983: 198):

(45) *Dyma 'r ffenest darais i ['r bachgen [dorrodd ____
that-is the window hit.PAST.1SG I the boy break.PAST.3SG
hi ddoe]].
she yesterday
*'That's the window that I hit the boy who broke it yesterday.'

This unquestionably contains an RP, the third person singular feminine pronoun *hi*, reflecting the fact that the antecedent *ffenest* is a feminine noun. Like (44), (45) involves a complex NP. However, whereas (44) contain a complement clause (45) contains a relative clause. This presumably accounts for their different status. As one might expect, an example like (45) but with a gap instead of the RP is also bad. Thus, it seems that neither a gap nor an RP is acceptable inside a relative clause.

It seems, then, that both gaps and RPs are possible inside the clausal complement of a noun but that both are impossible inside a relative clause. Thus, it is not obvious that there are any differences between gaps and RPs with respect to islands. It is worth adding that if we did find some differences between RPs and gaps in this area, it would not necessarily follow that the grammar needs to treat them differently. It has been argued e.g. by Kluender (1998), Levine and Hukari (2006), and Hofmeister and Sag (2010) that island phenomena are a processing matter. If this is right, any differences would not necessitate differences in syntactic analysis.

There is no doubt more to be said here, but there seems to be no evidence from island phenomena for a fundamental difference between gaps and RPs. It seems, then, that they are broadly similar, the main difference being in their local environment.

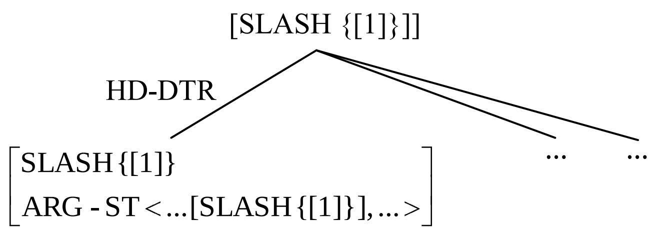
5. Towards an analysis

I will now consider how the Welsh data should be analyzed. A satisfactory analysis must be able to capture the similarities between gaps and RPs documented in section 3. These suggest that both gaps and RPs should be the realization of the SLASH feature.

In his work on Hebrew and Irish, Vaillette (2000, 2002) argues that RPs in these languages should be analysed as the realization of a separate NONLOCAL feature, which he calls RESUMP. If we adopted this approach here, the phenomena discussed in section 3 would be surprising. It would not be obvious why examples like (31) and (32) with a gap in one conjunct and an RP in the other are acceptable. It would also not be obvious why both dependencies with a gap and dependencies with an RP nullify the ban on present tense forms of *bod*, as in (36) and (37) and (39) and (40). Finally, it would not be obvious why both types of dependency allow mutation and a third person singular masculine clitic to appear on a non-finite verb, as in (41) and (42). In contrast, if we assume that both gaps and RPs are the realization of SLASH. The facts are unsurprising. This will mean that both a conjunct with a gap and a conjunct with a RP are [SLASH {NP}]. Hence, the coordinate structures in (31) and (32) will be just like that in (30). If we assume the head-driven approach to unbounded dependencies developed in Sag (1997), Ginzburg and Sag (2000) and Bouma, Malouf and Sag (2001), *bod* will be [SLASH {NP}] with both types of dependency, and we can assume that the ban on present tense forms of *bod* is nullified in this situation. Finally, non-finite verbs in the path of both types of dependency will be SLASH {NP}], and we can assume that mutation and a third person singular masculine clitic may appear in this situation.

As indicated above, I am assuming the head-driven approach to unbounded dependencies of Sag (1997), Ginzburg and Sag (2000) and Bouma, Malouf and Sag (2001). Within this approach the SLASH values of arguments in the head's ARG-ST list are reflected in the SLASH value of the head itself and the mother normally has the same SLASH value as the head. Thus, unbounded dependencies involve structures of the following form:

(46)



The relation between the SLASH values of the head and its mother is governed by the SLASH Inheritance Principle (Bouma, Malouf and Sag 2001) or the Generalized Head Feature Principle (Ginzburg and Sag 2000). The relation between the SLASH values of the head and its arguments is governed by the SLASH Amalgamation Principle. We will need something more complex than the latter for Welsh.

As this approach is developed by Ginzburg and Sag (2000) and Bouma, Malouf and Sag (2001), there may or may not be a slashed non-head daughter in a structure like (46). There is where some non-head contains a gap, but there is no slashed non-head if (46) is the bottom of the unbounded dependency. This is because they assume that gaps are represented in ARG-ST lists but not in COMPS lists and therefore not in syntactic structures. In Welsh, however, there is evidence from mutation (Borsley 1999) and agreement (Borsley 2009) that gaps should be analyzed as empty categories. Hence, I assume that both constituents containing a gap (or RP) and gaps will be sisters of a slashed head. However, I will assume, following Bouma, Malouf and Sag (2001), that they are a realization of special *gap-synsem* objects. I assume that these are required to be phonologically empty and that nominal gaps are required to be non-pronominal. The following constraints will do this:

(47) a. $[\textit{gap}] \Rightarrow [\text{PHON} \ \langle\rangle]$

b. $\begin{bmatrix} \textit{gap} \\ \text{HEAD } \textit{noun} \end{bmatrix} \Rightarrow [\text{CONTENT } \textit{npro}]$

If nominal gaps are non-pronominal they will be associated with a non-pronominal SLASH value. This suggests that a gap will never be associated with a pronominal filler. A cleft sentence such as the following looks problematic here:

(48) Nhw welodd ___ ddraig.
they see.PAST.3SG dragon
'It was they that saw a dragon.'

However, Borsley (2008) argues that the focused constituent in a cleft sentence is not a filler, partly on the basis of examples like (48). I think, then that the fact that nominal gaps are associated with a non-pronominal SLASH value is unproblematic.

Before we consider exactly what sort of analysis would be appropriate, there is one further empirical point to note. This is that it seems that Welsh does not have parasitic gaps. One might suppose that there is a parasitic gap after the verb *ddarllen* in the following example:

(49) Dyna 'r adroddiad dw i wedi ei daflu ___ i ffwrdd
there-is the report be.PRES.1SG I PERF 3SGM throw away
[heb ei ddarllen ___].
without 3SGM read
'There is the report that I throw away without reading.'

It is clear, however, that this is not a true gap but an unexpressed RP. It is possible to have an overt RP, as the following shows:

(50) Dyna 'r adroddiad dw i wedi ei daflu ___ i ffwrdd
there-is the report be.PRES.1SG I PERF 3SGM throw away
[heb ei ddarllen o].
without 3SGM read he
'There's the report which I threw away without reading.'

Now consider the following:

(51) *Dyna 'r adroddiad dw i wedi ei daflu ___ i ffwrdd
there-is the report be.PRES.1SG I PERF 3SGM throw away
[heb ddarllen ___].
without read

Here, *ddarllen* has no clitic. An unexpressed RP is only possible when agreement of some kind is present. Thus, the object here can only be a gap, and not an RP. However, this example is ungrammatical. This suggests rather strongly that Welsh does not have parasitic gaps.

The absence of parasitic gaps has an important implication. I assume, following Ginzburg and Sag (200: 168, fn. 2), that adjuncts are optional members of the ARG-ST lists of the associated head. Given this assumption, the absence of parasitic gaps means that only a single member of any ARG-ST list may contain a gap/RP. If island constraints are a processing matter, as Kluender (1998), Levine and Hukari (2006), and Hofmeister and Sag (2010) suggest, constituents containing a gap/RP will otherwise be unconstrained.

We can now consider what an analysis of the Welsh data needs to do. Given the distributional facts summarized in section 2, it seems that there are essentially two situations when a head has a non-empty SLASH value, as follows:

(52) a. If the head is a verb or an adjective, then one argument is a gap or a constituent containing a gap or RP.
b. If the head is a noun or a preposition, then one argument is an RP or a constituent containing a gap or RP.

How the facts should be captured will depend on how RPs are analysed.

One possibility is to treat RPs as much like gaps. The latter have the feature structure in (53).

(53)

$$\begin{bmatrix} \textit{gap} \\ \text{LOCAL}[1] \\ \text{SLASH}\{[1]\} \end{bmatrix}$$

Thus, one might suggest the following feature structure for RPs:

(54)

$$\begin{bmatrix} \textit{respro} \\ \text{LOCAL}[1]\text{NP}: \textit{ppro} \\ \text{SLASH}\{[1]\} \end{bmatrix}$$

Notice, however, that this associates an RP with a pronominal SLASH value. This predicts that an RP can only be associated with a pronominal filler. It is clear that this is incorrect. There is evidence from data like the following that *wh*-words are non-pronominal.

(55) a.	i	bwy	b.	*iddo	bwy
	to	who		to.3SGM	who
	‘to whom’				

These show that *pwy* ‘who’ does not trigger agreement on a preceding preposition in the way that a pronoun does. It follows that an example like the following has a non-pronominal filler:[6]

(56) Pwy	[gest	ti	’r	llythyr	’na	ganddyn	(nhw)]?
who	get.PAST.2SG	you	the	letter	DEM	with.3PL	they

‘Which boys did you get that letter from?’

This suggests that we need something more complex, e.g. the following:

(57)

$$\begin{bmatrix} \textit{respro} \\ \text{LOCAL NP}: \textit{ppro}[1] \\ \text{SLASH}\{\text{NP}:[1]\} \end{bmatrix}$$

[6] There are also examples with more complex fillers such as *pa fechgyn* ‘which boys’, which are obviously non-pronominal.

Whereas in (54) the nominal feature structure which is the value of LOCAL is identical to that in SLASH, here they are just coindexed and the nominal feature structure in SLASH is not required to be pronominal.

To implement this approach we would need a constraint ensuring that a slashed verb or adjective has a single slashed argument which is not pronominal, hence not an RP, and a constraint ensuring that a slashed preposition or noun has a single slashed argument which is not a gap, but either an RP or a constituent containing a gap or an RP. We would also need a constraint ensuring that a head with a slashed argument is itself slashed in normal circumstances. The latter would be overridden by the Welsh counterpart of an English 'tough' sentence such as (58), where an adjective takes an infinitival complement with a non-empty SLASH feature.

(58) Mae Carys yn hawdd [i Ifor ei gweld ___].
be.PRE.3SG Carys PRED easy to Ifor 3SGF see
'Carys is easy for Ifor to see.'

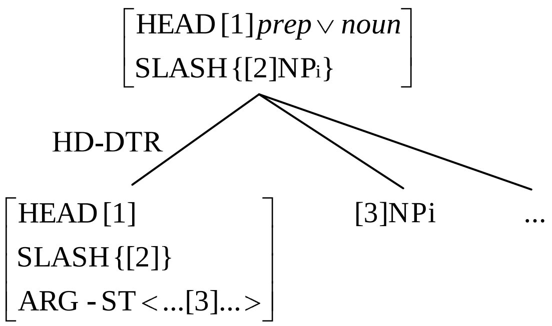
The three constraints would replace the SLASH Amalgamation Principle.

This looks like a fairly promising approach to the Welsh data. However, it has a problem in the fact that RPs in Welsh look just like ordinary pronouns. Welsh is not unusual here. According to McCloskey's (2002: 192) this is universally the case. As Asudeh (2004) points out, this casts doubt on any analysis which treats RPs as special pronouns distinct in some way from ordinary pronouns. Obviously, an approach which gives RPs a non-empty SLASH value treats them as special pronouns and hence is rather dubious.

An analysis of RPs which gives them a different feature makeup from ordinary pronouns might be compared with the standard analysis of passive participles which gives them a different feature makeup from past participles. In the latter case one expects there to be items which can only be passive participles and this is what we find. Thus, for example, *reputed* can be a passive participle, as in *Kim is reputed to be clever*, but not a past participle as in **They have often reputed Kim to be clever*. In the same way one would expect there to be items which can only be RPs, but there are no such items in Welsh or, it seems, elsewhere.

This suggests that a satisfactory analysis of RPs should treat them as the ordinary pronouns that they appear to be. Hence, it suggests that we need structures in which a slashed preposition or noun has not a slashed argument but a pronominal argument coindexed with its slashed value, as in (59).

(59)



Obviously, structures of this kind will only be possible where the SLASH value is nominal.

Within this approach, slashed verbs and adjectives will be subject to the folowing constraint:

(60)

$$\begin{bmatrix} \text{HEAD } \textit{verb} \vee \textit{adj} \\ \text{SLASH } \{[1]\} \end{bmatrix} \Rightarrow [\text{ARG-ST } L_2 \oplus <[\text{SLASH } \{[1]\}]> \oplus L_3]$$

$L_i = \textit{list}([\text{SLASH } \{\}])$

Notice that there is no need here to stipulate that the slashed argument is not pronominal since RPs are not slashed. Slashed prepositions and nouns will be subject to the constraint in (61).

(61)

$$\begin{bmatrix} \text{HEAD } \textit{noun} \vee \textit{prep} \\ \text{SLASH } \{[1][\text{INDEX } 2]\} \end{bmatrix} \Rightarrow$$

$$[\text{ARG-ST } L_3 \oplus < \text{NP:}\textit{ppro}[2] \vee \begin{bmatrix} \textit{canon} \\ \text{SLASH } \{[1]\} \end{bmatrix} > \oplus L_4]$$

$L_i = \textit{list}([\text{SLASH } \{\}])$

We have a disjunction here. This seems to be unavoidable if RPs are not slashed. Finally, to ensure that a head with a slashed argument is itself slashed in normal circumstances, we can propose the following constraint:

(62) $[\text{ARG-ST } L_1 \oplus <[\text{SLASH } ([1]\}]> \oplus L_2] \Rightarrow / [\text{SLASH } \{[1]\}]$

This is a default constraint, as indicated by '/', to accommodate examples like (58). Notice that we don't want to stipulate that a head with a pronominal argument has a coindexed slash value since the pronoun could be an ordinary pronoun. These constraints will replace the SLASH Amalgamation Principle.

The constaint on prepositions and nouns is probably more complex than it would be if RPs were slashed elements. However, the constraint on verbs and adjectives is simpler. Thus, an analysis in which RPs are slashed and one in which they are ordinary pronouns are of roughly equal complexity. However, the latter has the advantage that it has no difficulty in explaining why RPs look like ordinary pronouns They look like ordinary pronouns because that is what they are. It seems to me that this is an important argument in favour of this analysis.

6. Conclusions

In this paper I have investigated the behaviour of gaps and RPs in Welsh UDCs. I have shown that they differ in their distribution but that otherwise they are quite similar. This suggests that both should be analyzed as realizations of the SLASH feature. One way to do this would be by treating RPs as slashed elements. This, however, has the disadvantage that it cannot explain why they look like ordinary pronouns. The alternative is to treat RPs as the ordinary pronouns that they appear to be. On this approach RPs look like ordinary pronouns for the simple reason that that is what they are. This is an important advantage of the analysis.

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On the Syntax and Semantics of *vice versa*

Rui P. Chaves
University at Buffalo

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Abstract

This work focuses on the syntax and semantics of the expression *vice versa*, and shows that its syntactic distribution is much more flexible than semantically related expressions. Although *vice versa* usually appears in clausal coordinate environments, it can in principle occur in any other type of construction. Second, it can occur as an embedded verb phrase or even as a noun phrase, rather than as an adjunct. This suggests that *vice versa* is a propositional anaphor that corresponds to a converse of a propositional antecedent. Finally, although the predicates singled out to be interchanged are usually nominal, they can in fact be of virtually any part of speech. I argue that a possible account of the interpretation of *vice versa* lies at the interface between logical form (with rich decompositional lexical semantics along the lines of Pustejovsky (1995)), and pragmatics (drawing from independent work by Hobbs (1990) and Kehler (2002)).

1 Introduction

The expression *vice versa* has not received much attention beyond Fraser (1970), McCawley (1970), and Kay (1989). To my knowledge, there has never been an explicit account of its syntax and semantics. In a nutshell, *vice versa* is characterized by describing the converse of a proposition described by a preceding clause (henceforth the 'antecedent'). This is illustrated in (1). Optionally, *vice versa* can co-occur with a clause that overtly describes its the denotation, as (2) illustrates. As I will show, the traditional view that *vice versa* is an adverb is undermined by the fact that the presence of the overt clause is optional – as (1) already show – and by the fact that *vice versa* can occur in subject and complement NP environments.

(1) a. Tom kissed Mary, and vice versa.

b. Either Tom kisses Mary, or vice versa.

c.*Vice versa, and Sue likes Tom.

(2) Tom likes Mary, and vice versa, $\left\{\begin{array}{l}\text{Mary likes Tom}\\ \text{*Sue likes Tim}\end{array}\right\}$

As far as previous accounts, Fraser (1970) suggests that the interchange targets pairs of NP structures, McCawley (1970) claims that the interchange targets pairs of 'elements in a clause', and Kay (1989) claims that the interchange targets participants in the scene that is evoked by the antecedent. None of these proposals is explicit about how the distribution and interpretation of *vice versa* should proceed.

†I am very grateful to the audience of the HPSG10 conference and the anonymous reviewers for comments and lively discussion. I am particularly thankful to Berthold Crysmann, Gregory Stump, and Phillip Miller. Had I been able to address all their concerns this would have undoubtedly been a better paper. None of the above necessarily endorse or reject the proposal in this paper, and any remaining errors or omissions are exclusively my own.

This paper is structured as follows. In section 2 I discuss the syntactic properties of *vice versa* in more detail, and conclude that its syntax is rather unique when compared with semantically related expressions like *conversely*, or *contrariwise*. The evidence suggests that *vice versa* is a mixed category that can function as a clause, a verbal phrase, a nominal phrase, or an adverbial.

2 Syntactic properties

When compared with semantically related expressions like *conversely*, it is clear that *vice versa* has a more flexible distribution. While the former cannot occur without a clausal host, the latter can stand alone, as the data in (3) show. This suggests that *conversely* is simply an adverb, but that *vice versa* is not.[1]

(3) a. Fred likes Mary, and vice versa (, Mary likes Fred).

b. Fred likes Mary, and conversely *(, Mary likes Fred).

A more crucial difference is that *vice versa* can occur as an NP without a clausal host, while *conversely* cannot, as illustrated in the contrast between (4) and (5). Interestingly, in (4ab) *vice versa* is paraphrasable as a gerund clause (i.e. *they all liking it and I hating it* and *assigning an Object to a String*). I follow Malouf (2000) and Kim and Sag (2005) in assuming that gerunds and complementizers are mixed categories. They are nominal structures externally, but verbal structures internally.

(4) a. It's better that [[they all hate it and I like it], instead of [vice versa]$_{NP}$.

b. [You can assign a String to an Object] but [[vice versa]$_{NP}$ is not allowed]. [http://java.itags.org/java-intermediate/171646/]

(5) a. ?*It's better that they all hate it and I like it, instead of conversely.

b.*You can assign a String to an Object but conversely is not allowed.

The distribution of *vice versa* is not limited to S and NP environments. In (6) we can also see examples where it occurs as a base form VP, in which case it shares the subject with the antecedent clause. Note that the examples in (6a,b) involve comparative structures, not coordination.

(6) a. It is easier [[to change the font size to fit the margins]$_{VP}$ [than [vice versa]$_{VP}$]].

b. [[You can [find just as many things that Mac OS X stole from Windows]$_{VP}$] [as you can [vice versa]$_{VP}$]].

c. Can I link your blog to mine and you vice versa?[2]

[1] Of course, ellipsis allows certain adverbs to be conjoined with a sentence, as in *Kim read many books, and* (*Kim read many books*) *very quickly*. This does not seem to be possible for *conversely*.

[2] http://www.parenting-blog.net/entertainment/expecting-mums-games-to-keep-you-busy/

The data suggest that *vice versa* can correspond to any kind of verbal clause, finite or non-finite, as the examples in (7) illustrate. This is relevant because conjunction does not allow finite conjuncts to be conjoined with non-finite conjuncts, and yet such clauses can be conjoined with *vice versa*. Compare (7) and (8).

(7) a. [Fred likes Mary, and vice versa].
([FORM *fin*])

b. [To draw him to Sue, and vice versa], we must coordinate our efforts very carefully.
([FORM *inf*])

c. [Tom mentioning Sue and vice versa] both came as a big surprise.
([FORM *prp*])

(8) a.*[Tom whistled]$_{\text{FORM } fin}$ and [Mary walking]$_{\text{FORM } prp}$.

b.*Sue [[bought something]$_{\text{VFORM } fin}$ and [come home]$_{\text{FORM } prs}$].

c.*[[Tom mentioning Sue]$_{\text{FORM } prp}$ and [she mentioned him]$_{\text{FORM } fin}$] came as a big surprise.

If *vice versa* is a clausal element then it should be possible to embed it under adjunction, as if it were a regular sentence. This prediction is borne out in (9).

(9) a. [An actor who is good at comedy is also good at drama], but not necessarily [vice versa]$_{\text{S}}$.

b. [[Tom saw Mary]$_{\text{S}}$, [and probably [vice versa]$_{\text{S}}$]].

c. [[Tom helped Mary]$_{\text{S}}$ [on Tuesday]] and [[vice versa]$_{\text{S}}$ [on Thursday]].

In order to account for the distribution of *vice versa*, I adopt the type hierarchy in Figure 1, based on Malouf (2000, 95). I assume that the type *verbal* is compatible with the usual verb forms (e.g. [FORM {*fin*,*inf*,*prp*,*psp*,...}]). The exception is the part of speech *gerund*, which is not finite.

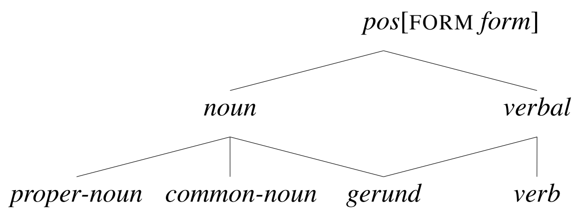

Figure 1: Gerund as a mixed category between nominal and verbal

The lexical entry for *vice versa* in (10) allows for all of the realizations discussed so far. In this paper I adopt the feature geometry of Sign-Based Construction

Grammar (Sag, 2010), since it provides a simpler feature geometry than standard HPSG Pollard and Sag (1994). Because the part of speech of this expression is type-underspecified as *verbal*, the word is compatible with any verb form, including a nominal non-finite gerundial realization and a finite verbal realization.

(10) Lexical entry for *vice versa* (preliminary version)

$$\begin{bmatrix} \textit{word} \\ \text{PHON } \langle \textit{ vice versa } \rangle \\ \text{SYN} \begin{bmatrix} \text{CAT } \textit{verbal} \\ \text{VAL } \langle \text{ (NP) } \rangle \end{bmatrix} \end{bmatrix}$$

This word can function as an S or a VP without further assumptions, given that no phrasal rule in Sag (2010) requires daughters of type *phrase*. The signature requires that the mother nodes of a syntactic tree are phrases and the daughters can be either words or phrases. Similarly, the usual labels NP, VP, and S do not require the sign to be of type *phrase*.

(11)
$$\text{NP} = \begin{bmatrix} \text{SYN} \begin{bmatrix} \text{CAT } \textit{noun} \\ \text{VAL } \langle\rangle \end{bmatrix} \end{bmatrix} \quad \text{VP} = \begin{bmatrix} \text{SYN} \begin{bmatrix} \text{CAT } \textit{verb} \\ \text{VAL } \langle \text{NP} \rangle \end{bmatrix} \end{bmatrix} \quad \text{S} = \begin{bmatrix} \text{SYN} \begin{bmatrix} \text{CAT } \textit{verb} \\ \text{VAL } \langle\ \rangle \end{bmatrix} \end{bmatrix}$$

2.1 Adverbial use

As already mentioned noted, *vice versa* can optionally combine with a clausal sister, a 'follow-up' sentence which makes it explicit in what way the reversal/interchange of the antecedent is to be interpreted. More examples are given in (12).

(12) a. Fred loves Mary, and vice versa (, Mary loves Fred).

b. I think [Fred loves Mary, and vice versa (, Mary loves Fred)].

c. It's not clear if they are ready to face Fred, let alone vice versa (, if Fred is ready to face them).

Such follow-up clauses need not be a phonological variant of the antecedent. The interchange is neither syntactic or semantic because a paraphrase suffices, as the data below illustrate. If the clause does not have the same truth conditions, oddness ensues as shown by (14).

(13) a. Market structure can influence transaction costs, and vice versa, the level of transaction costs can affect market structure.

b. Diarrhea can occur with no visible tissue damage and, vice versa, the histological lesions can be asymptomatic.

(14) Tom likes Mary, and vice versa, $\left\{ \begin{array}{l} \text{Mary likes Tom} \\ \text{*Sue likes Tim} \end{array} \right\}$

Not surprisingly, *vice versa* can be realized as a VP modifier, as (15) shows. I consider that the follow-up clause is the head of the structure rather than *vice versa*. This is motivated by cases like (16). Although *vice versa* can function as an NP, the oddness of (16) results from the impossibility of conjoining an S with an NP.

(15) It's easier to take her to the doctor than vice versa, to take the doctor to her.

(16) Boys tagged girls, and vice versa, $\left\{\begin{array}{l}\text{girls tagged boys}\\ \text{*girls tagging boys}\end{array}\right\}$

The distributional facts discussed so far in this paper can be captured by revising the lexical entry in (10) as shown in (17). As before, the fact that this word is of part of speech *verbal* allows it to occur in nominal and verbal environments. The value of SEL(ECT) allows it to optionally combine with a head clause. The subject NP is also optional, and thus *vice versa* can operate either as a VP or as an S.

(17) Lexical entry for *vice versa* (revised version)

$$\begin{bmatrix} \textit{word} \\ \text{PHON } \langle \textit{ vice versa } \rangle \\ \text{SYN} \begin{bmatrix} \text{CAT} \begin{bmatrix} \textit{verbal} \\ \text{SEL} \left\langle \left(\begin{bmatrix} \text{SYN} \begin{bmatrix} \text{CAT } \textit{verbal} \\ \text{VAL } \boxed{2} \end{bmatrix} \\ \text{SEM} \mid \text{INDEX } \boxed{s} \end{bmatrix} \right) \right\rangle \end{bmatrix} \\ \text{VAL } \boxed{2} \langle \text{ (NP) } \rangle \end{bmatrix} \\ \text{SEM} \mid \text{INDEX } \boxed{s} \end{bmatrix}$$

The tag $\boxed{s}$ ensures that the situation described by the follow-up clause is the same as the one denoted by *vice versa*, thus ruling out cases like (16). The rule that allows adverbials to combine with a head phrase is (18). This rule licenses constructions where a daughter selects the head via SELECT, such as adjunction constructions and structures where a determiner combines with a nominal host. For a more comprehensive discussion about this grammar fragment see Sag (2010).

(18)

$$\textit{head-functor-cx} \Rightarrow \begin{bmatrix} \text{MTR} \begin{bmatrix} \text{SYN } \boxed{2} \end{bmatrix} \\ \text{HD-DTR } \boxed{1} \\ \text{DTRS} \left\langle \begin{bmatrix} \text{SYN} \begin{bmatrix} \text{CAT} \begin{bmatrix} \text{SELECT } \langle \boxed{1} \rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}, \boxed{1} \begin{bmatrix} \text{SYN } \boxed{2} \end{bmatrix} \right\rangle \end{bmatrix}$$

Let us consider some examples of this analysis at work. If *vice versa* is realized as *verb* with a saturated valence, then it can be coordinated with verbal clause. The host clausal selected by SEL(ECT) clause is optional, as illustrated in Figure 2.

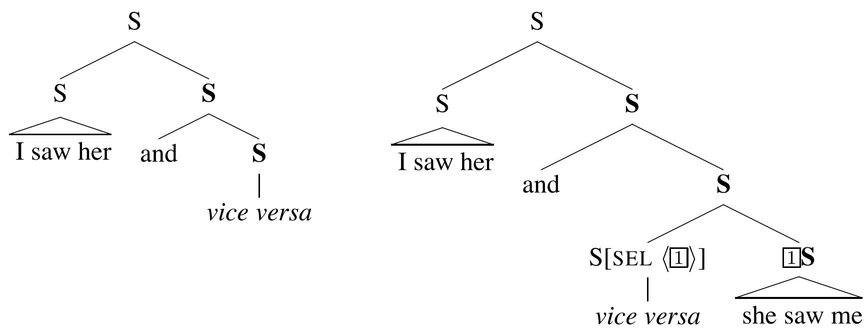

Figure 2: Clausal *vice versa* (head path in bold)

Because *vice versa* can be of type *gerund*, it can occur as an embedded NP argument, as the trees in Figure 3 illustrate. Finally, when *vice versa* is realized with a non-empty valence, then it can be a VP complement, as shown in Figure 4.

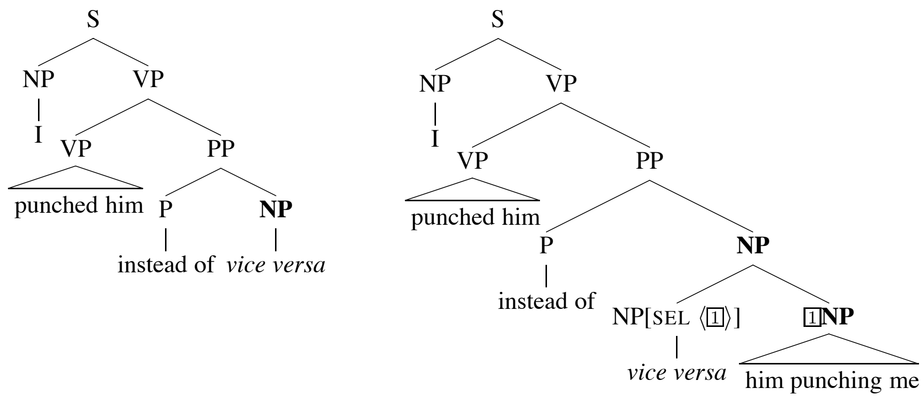

Figure 3: Noun phrase *vice versa* (head path in bold)

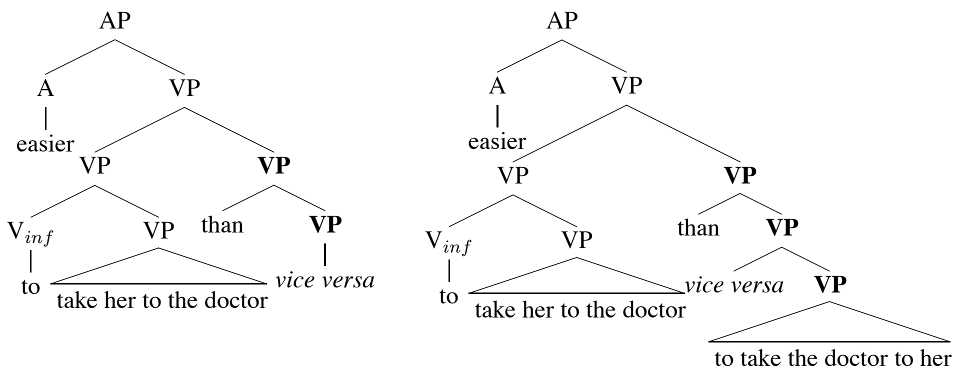

Figure 4: Verb phrase *vice versa* (head path in bold)

2.2 Intra- and extra-clausal antecedents

I now consider whether there is a syntactic relationship between *vice versa* and its antecedent, and conclude that virtually any clause can function as the antecedent.

The data in (4) above show that *vice versa* can be embedded as an NP. Interestingly, the antecedent can also be embedded in this fashion as (19) illustrates.

(19) [That Tim praised Mary]$_{\text{NP}}$ is just excellent, and so is [vice versa]$_{\text{S}}$.

This predicts that it is possible for *vice versa* to be in object position and that the antecedent can be in subject position, in the same clause. Such a prediction is borne out in the examples shown in (20).

(20) a. [A younger man falling for an older woman]$_{\text{NP}}$ is more likely than [vice versa]$_{\text{NP}}$.

b. The likelihood of [a man harassing a woman]$_{\text{NP}}$ is higher than [vice versa]$_{\text{NP}}$.

Although the interchange triggered by *vice versa* typically occurs between co-arguments of the same verb, the data in (6) and (21) show that the antecedent can be a complex sentence with more than one verb.

(21) a. [Everyone on John's friend list knows that he's dating Susan] and [vice versa].[3]

b. [Tom sang and I danced], but not vice versa.

c. [When doctors see FES in a patient, they should also look for OSA], and [vice-versa].[4]

d. [No student can sit where the teachers sit], and vice versa.

e. [What is good for Kosovo is good for Europe], and vice versa.

At last, in opposite end of the distributional spectrum, we have cases where the antecedent is not in the same sentence as *vice versa*. As noted by an anonymous reviewer, the examples like (22) show that any discourse recent/salient proposition is a potential antecedent for *vice versa*.

(22) a. (Speaker A) It seems that Fred really loves Kim.

b. (Speaker B) Yes, I agree. And vice versa.

The conclusion to draw from data discussed so far is that there are no syntactic constraints governing the relationship between *vice versa* and its antecedent. Moreover, we have also seen that the expression *vice versa* does not depend on the presence of coordination. The main constraint seems to be the existence of a preceding discourse salient proposition, suitable for a converse interpretation.

[3][http://www.brazencareerist.com/2010/09/08/3-mba-lessons-thank-you]

[4][http://www.sciencedaily.com/releases/2010/04/100401125918.htm]

2.3 Coherence-based restrictions

The *vice versa* expression can occur in various non-headed environments such as coordination (*and*, *or*, *but*, *let alone*, and *instead of*) and comparative sructures. The data in (20) show that *vice versa* can occur in subordination constructions as well, contra Fraser (1970). In (23) below, I provide evidence that *vice versa* can occur in conditionals. These data still contain coordinations, however, and contrast with the odd examples in (24).

(23) a. [I'll be happy if she helps Tom] and [surprised if vice versa].

b. The spacecraft will [[turn right if the sun is behind the moon] and [turn left if vice versa]].

c. The angle of sight must be [added to the angle of elevation if the target is above the gun] and [subtracted if vice versa].
(Encyclopædia Britannica, vol.25, p.62)

(24) a. ?*Tom will help Mary if/while vice versa.

b. ?*Some of the best chess players in the world are admittedly horrible chequers players, while vice versa.

I suspect that this contrast is due to pragmatic coherence conditions. For example, Hobbs (1990) and Kehler (2002) argue that certain connectors and constructions allow certain pragmatic *Resemblance*, *Cause-effect*, and *Contiguity* relations. In particular, conjunction is compatible with a parallel resemblance relation. I propose that *vice versa* imposes a similar *Resemblance* relation between its propositional content and the antecedent. In examples like (24) the coherence relation triggered by *if/while* applies to the same pair of clauses that the resemblance relation imposed by *vice versa*, and thus a clash occurs. In (23), however, such clash does not occur since the clauses combined via *if* are *vice versa* and its antecedent.

I thus revise (17) as shown in (25). The semantics of *vice versa* is the output P_2 of a *vice-versa* relation that applies to a propositional antecedent P_1. Crucially, the two propositions P_1 and P_2 must cohere in a resemblance relation. For more on the role of resemblance coherence see §3.2.1.

(25) Lexical entry for *vice versa* (near-final version)

$$
\left[\begin{array}{l}
\textit{word} \\
\text{PHON} \ \langle \textit{vice versa} \rangle \\
\text{SYN} \left[\begin{array}{l} \text{CAT} \left[\begin{array}{l} \textit{verbal} \\ \text{SEL} \left\langle \left(\left[\begin{array}{l} \text{SYN} \left[\begin{array}{l} \text{CAT } \textit{verbal} \\ \text{VAL } \boxed{2} \end{array}\right] \\ \text{SEM} \mid \text{INDEX } \boxed{s} \end{array}\right] \right) \right\rangle \end{array}\right] \\ \text{VAL } \boxed{2} \langle (\text{NP}) \rangle \end{array}\right] \\
\text{SEM} \left[\begin{array}{l} \text{INDEX } \boxed{s} \\ \text{FRAMES} \left\langle \boxed{P_1} = \ldots ,\ \textit{vice-versa}(\boxed{P_1},\boxed{P_2}) \right\rangle \end{array}\right] \\
\text{CTX} \left\langle \textit{res-coher}(\boxed{P_1},\boxed{P_2}) \right\rangle
\end{array}\right]
$$

3 Semantic properties

There are two major possibilities for the semantic analysis of *vice versa*. One is to assume that the interchange targets a representational level of the sentence (i.e. logical form), and another is to assume, along the lines of Kay (1989), that the interchange is contextual and targets participants in the scene that is evoked by the antecedent. These views have similarities and differences. Both accounts necessarily involve some kind of interchange, but whereas the logical form account targets the semantic representation of the antecedent, the contextual account targets the discourse model needed for the speaker to interpret the antecedent of *vice versa*. Below I suggest that was is needed is a compromise between these two views, but ultimately will be unable to flesh out a *fully* explicit account of these phenomena.

3.1 Context vs. logical form

Kay (1989) argues that the interchange triggered by *vice versa* pertains to the scene evoked by the antecedent, not necessarily denotata of linguistic expressions. I take this to mean that the interchange operates on the model used by the speaker in a particular context (the set of entities relevant for the topics under discussion as well as background knowledge). It remains unclear, however, what a scene is and how many propositions it can encompass. If a scene corresponds to a single proposition, then it may become indistinguishable from the logical form of the proposition. If a scene can be more than a proposition then one must specify what can and what cannot be part of the scene evoked by a proposition. If, on the other hand, we restrict ourselves to work on the logical form / denotation level, then we have in principle a more tangible handle on the phenomena. In this paper I shall pursue this avenue, since the alternative seems to me too speculative to attempt presently.

Kay (1989) argues that the interpretation of *vice versa* can depend on the prior, contextually determined decision whether a pronoun is given a bound variable or an anaphoric interpretation. In (26) *his* may be bound by every boy or it may refer anaphorically to a particular boy mentioned earlier. The interpretation of vice versa depends on the decision made with respect to the ambiguity.

(26) [Every boy]$_i$ loves his$_{i/j}$ mother, and vice versa.

I find this evidence unconvincing, because a logical form analysis can easily deal with the interchange, as (27) shows. All that is necessary is to interchange *mother* and *boy*. The interaction with anaphora yields the two possible readings, without further stipulations. I see no reason to resort to the contextual level. Here and throughout I use to the symbol '$\bowtie$' to describe the *vice versa* interchange.

(27) a. $\bowtie (\forall x(boy(x) \rightarrow \exists y(mother(y) \wedge of(y,k) \wedge k = x \wedge loves(x,y))))=$
$\forall x(mother(x) \rightarrow \exists y(boy(y) \wedge of(y,k) \wedge k = x \wedge loves(x,y)))$

b. $\bowtie (\exists y(mother(y) \wedge of(y,k) \wedge k = z \wedge \forall x(boy(x) \rightarrow loves(x,y))))=$
$\exists y(mother(y) \wedge of(y,k) \wedge k = z \wedge \forall x(mother(x) \rightarrow loves(x,y)))$

Similarly, Nobuyuki (2006) argues that (28) shows that more than two arguments may be interchanged. I disagree with this position, and show in (29) how the interchange of the two nominals *men* and *men* obtains the intended interpretation.

(28) Women$_i$ may bring their$_i$ husbands with them$_i$, and vice versa.
(= men$_j$ may bring their$_j$ wives with them$_j$)

(29) $\bowtie (\exists x(women(x) \wedge \exists y(men(y) \wedge married(y,k) \wedge k{=}x \wedge \diamond bring(s,x,y)))) =$
$\exists x(men(x) \wedge \exists y(women(y) \wedge married(y,k) \wedge k{=}x \wedge \diamond bring(s,x,y)))$

Kay (1989) also argues that resolution of *vice versa* can depend on an ambiguity based on anaphora of sense versus anaphora of reference, shown in (30). This utterance says either that we like our neighbors or that we like the Jones's neighbors. Depending on whose neighbors it is determined contextually that we like, those people are claimed, by vice versa, to like us. Again, I fail to see why a logical form analysis would not suffice.

(30) The Jones's don't like their next door neighbors, but we do, and vice versa.

The logical form analysis may also have some advantages over a contextual approach. First, it readily explains why *vice versa* in a sentence like *John hates Mary and vice versa* cannot mean *Sue hates Fred*, no matter what the context is.[5] Second, I am not sure how the contextual account would predict the oddness of (31), since the scene evoked by this sentence could certainly license the reference to a third domino piece. This prediction is not borne out.

[5] Imagine a context where all four individuals are in the same room, and it is common knowledge that Mary cheated on John before she started dating Fred, and that Fred cheated on Sue before she started dating John. Since the evoked scene has all of these individuals, and there are comparable relations between them, the contextual analysis wrongly predicts the impossible interchange.

(31) #A domino piece toppled another piece, and vice versa.

In what follows I focus on the semantic properties of *vice versa*, and argue that the proper analysis of the phenomena require a balance between denotations, representation, and pragmatics is called for.

3.2 Interchange phenomena

Semantically, *vice versa* requires an antecedent proposition that contains at least two interchangeable elements. Although Fraser (1970), McCawley (1970) and Kay (1989) do not agree on the details, they all argue that *vice versa* triggers the interchange of nominal entities. As such, ambiguities can arise when a clause contains more than two NPs, as Fraser (1970) first noted. Examples like (32) can have any of the interpretations listed below. Out of the blue, some of these may be less salient than others, but this is probably due to lack of context.

(32) I expect Bob to hit Kim and vice versa.

a. (= I expect Kim to hit Bob)

b. (= Bob expects me to hit Kim)

c. (= Kim expects Bob to hit me)

As one would expect, the interchange hinges on semantic role compatibility:

(33) #I like the boat, and vice versa.

Although the interchanged individuals are the same in the sentences discussed so far, there is in general no requirement that the individuals described in the antecedent are the same as the ones described by *vice versa*. For example, the preferential interpretation of (34), is one where the bears in the fist conjunct are different from the bears in the second conjunct.

(34) Many men killed many bears and vice versa.

As it turns out, a closer look at the data reveals a more complex scenario than the one suggested above. In the sentence in (35) the interchange does not target nominals, but rather predicative expressions. The question, then, is what kinds of expressions can be interchanged?

(35) a. When the room is tidy, I make it a mess, and vice versa.
(= when the room is a mess, I make it tidy)

b. Should I soak it and then crub it, or vice versa?
(= should I scrub it and then soak it?)

c. If you get lost, then you get anxious, and vice versa.
(= if you get anxious then you get lost)

The example in (36), due to an anonymous reviewer, is also consistent with an analysis based on the interchange of adjectives, as in (35).

(36) [That he is British] implies [that he is brave], not vice versa.
(= that he is brave implies that he is British)

Here and throughout I refer to the interchanged elements as φ and ψ and I assume that in principle any two semantic elements can be interchanged. Below, the interchanged expressions are depicted in bold, for perspicuity. For example, in (37) we have $\varphi =$*anxious*(s_1, x) and $\psi =$*lost*(s_2, x). The interchange consists of switching φ and ψ, and renaming the variables s_1 and s_2.

(37) $\bowtie(\exists x(you(x) \wedge (\exists s_1\, anxious(s_1, x) \rightarrow \exists s_2\, lost(s_2, x)))) =$
$\exists x(you(x) \wedge (\exists s_1\, \mathbf{lost}(\mathbf{s_1}, x) \rightarrow \exists s_2\, \mathbf{anxious}(\mathbf{s_2}, x)))$

For example, in a sentence like (38) the interchanged elements are the subject and the object. We can obtain the intended interchange as shown below.

(38) a. Tom saw Mary, and vice versa.

b. $\bowtie(\exists x(Tom(x) \wedge \exists y(Mary(y) \wedge saw(s, x, y))) =$
$\exists x(\mathbf{Mary}(\mathbf{x}) \wedge \exists y(\mathbf{Tom}(\mathbf{y}) \wedge see(s, x, y)))$

More complex examples like (39) are obtainable in exactly the same way, by interchanging argument NPs. In (39b) the interchanged NPs contain adjectives and are co-arguments of the same adjective, and in (39c) the interchanged NPs are oblique complements of the same nominal predicate *role*.

(39) a. Tom sang and Mary danced, and vice versa.
(= Mary sang and Tom danced)

b. This short man was afraid of that tall woman, and vice versa.
(= that tall woman was afraid of this short man)

c. This article focuses on the role of cognitivism in literature and vice versa.
(= on the role of literature in cognitivism)

This line of analysis can presumably even handle cases like (40), where the order of NPs is not matter, only the variable interchange. In this case, the entire NP *every boy* is interchanged with *Mary*. Whereas in (28) the interchanged targeted are merely nominal predicates and not full NPs, the data in (40) show that this is not always the case. Thus, the interchange triggered by *vice versa* is quite flexible.

(40) Every boy saw Mary, and vice versa.

$\bowtie(\exists y(Mary = y \wedge \forall x(boy(x) \rightarrow see(s, x, y)))) =$
$\exists \mathbf{x}(\mathbf{Mary} = \mathbf{x} \wedge \forall \mathbf{x}(\mathbf{boy}(\mathbf{x}) \rightarrow see(s, x, y)))$

Alas, matters are even more complex than this, as (41) shows. In this case, it seems as if two propositions are interchanged. It is as if '$\bowtie$' can interchange any pair of representations that are comparable/parallel in some way.

(41) Whenever the geese cackle, the dog barks, and vice versa.
(= whenever the dog barks, the geese cackle)

Consider now the data in (42). While it is not possible to interchange *Bob* with any NP conjunct in (42a), the example in (42b) suggests otherwise. The latter requires φ =*Bob*(x) and ψ =*Mia*(y). Again, this evidence indicates that the interchange triggered by *vice versa* is very flexible, and that unobserved interchanges are preempted by other factors rather than being structurally impossible.

(42) a. [Bob] saw [Mia and Kim], and vice versa.
(= Mia and Kim saw Bob)

b. [Bob] heard [Mia and her singing], and vice versa.
(= Mia heard Bob and his singing)

3.2.1 On the role of coherece

I believe the answer again hinges on coherence relations, namely, on resemblance. For example, Kehler (2002) argues that resemblance identifies commonalities and contrasts between corresponding sets of entities:

> For each relation, the hearer identifies a relation p_1 that applies over a set of entities $a_1 \ldots a_n$ from the first sentence S_1, and a corresponding relation p_2 that applies over a corresponding set of entities $b_1 ... b_n$ from the second sentence S_2. Coherence results from inferring a common (or contrasting) relation p that subsumes p_1 and p_2, along with a suitable set of common (or contrasting) properties q_i of the arguments a_i and b_i.
>
> (Kehler, 2002, 15)

For example, in a sentence like *Dick Gephardt organized rallies for Gore, and Tom Daschle distributed pamphlets for him* the parallel arguments p_1 and p_2 correspond to the relations denoted by *organizing rallies for* and *distributed pamphlets for* respectively. The common relation p that subsumes these is roughly *do something to support*. The parallel elements a_1 and b_1 are Dick Gephardt and Tom Daschle, who share the common property q_1 of being high-ranking democratic politicians. The parallel elements a_2 and b_2 correspond to the meanings of *Gore* and *him*, which share a trivial common property q_2 in that they denote the same individual. Kehler (2002) argues that this kind of relation explains why medial gapping and ATB extraction pattern with symmetric coordination and not other structures.

I conjecture that the resemblance relation *res-coher* introduced by the lexical entry of *vice versa* plays a pivotal role in its interpretation (see (25)). I propose that the antecedent's semantics S_1 determines the semantics of *vice versa* (S_2) as follows. *res-coher* requires that S_1 and S_2 identify the relations $p_1(a_0, ..., a_{i-1}, a_i, a_{i+1}, ..., a_j, a_{j+1}, ..., a_n)$ and $p_1(a_0, ..., a_{i-1}, a_j, a_{i+1}, ..., a_i, a_{j+1}, ..., a_n)$, respectively. In other words, the only difference between the identified relations is that a_i and a_j are interchanged. On independent grounds, these two elements must be comparable for the resemblance relation to hold, and thus we predict that adjectives cannot be interchanged with prepositions, that a non-predicative NP cannot be interchanged with a verb, and so on. The interchanged ψ/a_i and φ/a_j parallel elements can be simple nouns, complex nominal structures, adjectives, verbs, or even propositions. Thus, the semantics S_2 is whatever proposition is identified by the relation $p_1(a_0, ..., a_{i-1}, a_j, a_{i+1}, ..., a_i, a_{j+1}, ..., a_n)$, which in turn is determined by interchanging two arguments of $p_1(a_0, ..., a_{i-1}, a_j, a_{i+1}, ..., a_i, a_{j+1}, ..., a_n)$. The latter is identified by S_1 in the canonical way. In sum, S_1 determines S_2 via p_1 and its interchanged variant. We can thus drop the mnemonic relation $\bowtie$ and more explicitly state how the interchange is computed in (43).

(43) Lexical entry of *vice versa* (final version)

$$
\begin{bmatrix}
\textit{word} \\
\text{PHON } \langle \textit{ vice versa } \rangle \\
\text{SYN} \begin{bmatrix} \text{CAT} \begin{bmatrix} \textit{verbal} \\ \text{SEL} \left\langle \left(\begin{bmatrix} \text{SYN} \begin{bmatrix} \text{CAT } \textit{verbal} \\ \text{VAL } \boxed{2} \end{bmatrix} \\ \text{SEM} \mid \text{INDEX } \boxed{s} \end{bmatrix} \right) \right\rangle \end{bmatrix} \\ \text{VAL } \boxed{2} \langle \text{ (NP) } \rangle \end{bmatrix} \\
\text{SEM} \begin{bmatrix} \text{INDEX } \boxed{s} \\ \text{FRAMES} \left\langle \begin{bmatrix} \textit{anaph-fr} \\ \text{ARG1 } \boxed{S_1} \\ \text{ARG2 } \ldots \end{bmatrix}, \boxed{S_2} \begin{bmatrix} \textit{frame} \\ \text{SIT } \boxed{s} \end{bmatrix} \right\rangle \end{bmatrix} \\
\text{CTX} \left\langle \textit{res-coher}\left(\boxed{S_1}, \boxed{S_2}, p_1(..., a_i, ..., a_j, ...), p_1(..., a_j, ..., a_i, ...) \right) \right\rangle
\end{bmatrix}
$$

Depending on which two a_i and a_j are singled out from the antecedent, we may get a variety of different patterns. Again, their choice hinges on pragmatics and parallelism rather than syntactic or semantic structure. For example, adnominal modifiers usually 'follow' the interchange, as show in (44). Here, *vice versa* does not mean *a black dog chased a black cat*.

(44) A white dog chased a black cat, and vice versa.

However, in the preferential interpretation of (45a) the interchange does not extend to the adjunct *armed with a gun*. The interchange only applies to *Hatfield* and *McCoy*. This contrasts with the data point in (45b), arguably because restrictive relative clauses are not appropriate for pronouns.

(45) a. Any Hatfield who owns a gun will shoot at a McCoy, and vice versa.
(= any McCoy who owns a gun will shoot at an Hatfield)

b. Any Hatfield who carries a gun will shoot at me, and vice versa.
(= I will shoot at any Hatfield who carries a gun)

More examples are given in (46). In sentence (46a) the interchange applies to the adjectives *black* and *white*, whereas in (47) it applies only to the nouns *bishops* and *pieces*. This evidence is consistent with my analysis.

(46) a. In chess, any black pawn can capture any white piece, and vice versa.
(= any white pawn can capture any black piece)

b. The black bishops were surrounded by white pieces, and vice versa.
(= the white bishops were surrounded by black pieces)

Usually, the entire NP denotation is interchanged, as shown in (47). These cases are in stark contrast with (46). I believe the difference stems from discourse coherence. If the first conjunct describes a specific black cat and a specific white dog, then it is not coherent to continue the discourse by making reference to a specific white cat and a specific black dog.

(47) a. One black cat chased that white dog, and vice versa.
(= that white dog chased one black cat)
($\neq$ one black dog chased that white cat)

b. A black cat chased a white dog, and vice versa.
(= a white dog chased a black cat)
($\neq$ a black dog chased a white cat)

In (48) I provide another example of partial interchange, this time involving the NP embedded in the specifier of the subject, and the PP-embedded complement NP.

(48) About 20% of men's underwear is bought by women, and vice versa.
(= about 20% of women's underwear is bought by men)

My account is general enough to obtain the indented result for all of the above. For example, (47) boils down to interchanging the individuals denoted by the subject NP with the individuals denoted by the object NP, and (46) is obtained by interchanging part of the denotation of the adjectives. Following standard accounts of the semantics of adjectives, I represent *black* as a state-denoting function $black(P, C, x)$ where C is a comparison class and P is a variable that picks out the part of x that the property represented by black is applied to in order to assess truth.[6] In (46), the obtained $p_1(..., a_i, ..., a_j, ...)$ and $p_1(..., a_j, ..., a_i, ...)$ correspond to the semantic representations in (49), where a_i and a_j are the states denoted by the adjectives. When the semantics of *vice versa* is computed from $p_1(..., a_j, ..., a_i, ...)$, the correct adjectives are paired with the denotations a_i/a_j.

(49) $\exists x(bishops(x) \wedge \exists z\, color(z) \wedge \exists s_1\, black(s_1, x) \wedge$
$\exists y(pieces(y) \wedge \exists s_2\, white(s_2, y) \wedge \exists e\, surround(e, y, x))$

$\exists x(bishops(x) \wedge \exists s_1\, \mathbf{white(s_1, y)} \wedge$
$\exists y(pieces(y) \wedge \exists s_2\, \mathbf{black(s_2, x)} \wedge \exists e\, surround(e, y, x)))$

We can also in principle deal with puzzling cases noted by Fraser (1970,277) and McCawley (1970,279). where the quantifiers do not seem to follow the interchanged nouns. In (50) the *there*-existential is incompatible with the universally quantified NP *every buyer*. My account can account for this because the narrow scope reading of the indefinite denotes more than one seller. Thus, we can interchange the sellers and buyers denoted by the universally quantified subject.

(50) For every buyer there must be a seller and vice versa.
(= for every seller there must be a buyer).

Let us now consider (51). Here, the bears/men described in the first conjunct do no have to be the same ones that are described in the second conjunct. However, the key to dealing with such cases lies in the semantics of these quantifiers.

(51) Many men killed many bears, and vice versa.

Kamp and Reyle (1993, 391), Nouwen (2003), and many others provide good evidence that quantifiers like *many* introduce discourse referents for for the maximal set as well as for the reference set. The maximal set is anaphorically recoverable by *they* as shown in (52). The examples in (52c,d) are mine, and show that the same is true of *most* and *no*. Since the maximal sets for men and bears are available in the semantic representation of *many men killed many bears*, then these can be targeted for interchange. Thus, the *many* quantifiers in either conjunct of (50) are free to select similar or different subsets of men/bears.

(52) a. Few women from this village came to the feminist rally. No wonder. They dont like political rallies very much.
(*they = all women*)

b. Few MPs attended the meeting. They stayed home instead.
(*they = all MPs*)

[6] The contextual factor is motivated by examples like *Anna is tall* (*for a woman*), the mereological argument is motivated by *you said that the apple was completely red, but it's red only on the outside, not on the inside*, and the state is motivated by degree/comparative constructions like *not as black as*.

c. I think most diplomats are probably corrupt. They are (all) legally untouchable because of their diplomatic immunity.
(*they = all diplomats*)

d. No student came to the party. They were too busy with exams.
(*they = all students*)

The same analysis extends to (53). The determiner *no* also introduces a maximal set as (52d) shows, which is therefore available for the interchange phenomena.

(53) a. No philosopher can trust any linguist, and vice versa.
(= no linguist can trust any philosopher).

b. No student can sit where teachers sit and vice versa.
(= no teacher(s) can sit where students sit)

c. No student can sit where these teachers sit and vice versa.
(= these teachers cannot sit where students sit)

Finally, we can also handle cases that exhibit scope ambiguities. Several native speakers report that *vice versa* has two possible readings in (54). The paraphrases (54a) and (54b) appear to mirror the scope resolution of the antecedent (arguably because of our coherence conditions, which cause conjoined sentences to have parallel scopings). This is compatible with our analysis, since we can interchange nominal denotations. If the indefinite *a bear* gets a narrow scope reading in the antecedent, then we can interchange the hunters and various bears, as in (54a). Conversely, if the indefinite gets a wide scope reading in the antecedent, then we can interchange the hunters and a unique bear, as in (54b).

(54) Every hunter saw a bear and vice versa.

a. (= every bear saw a hunter)

b. (= a bear saw every hunter)

3.2.2 Lexical decomposition

McCawley (1970) noted puzzling examples like (55), which are for many speakers better than (33). McCawley also noted exceptions, such as (56).

(55) a. Many Frenchmen have learned Italian and vice versa.
(= Many Italians have learned French)

b. Westerners are fascinated by the Orient, and vice versa.
(= Orientals are fascinated by the West)

c. Few philosophers take biology courses, and vice versa.
(= Few biologists take philosophy courses)

(56) *Many Frenchman have learned Sanskrit, and vice versa.
(≠ Many Sanskrit speakers have learned French)

The data can be captured if we adopt a decompositional analysis of morphologically complex nouns. For example, if *Westerners* breaks down as 'people from the West', then we can obtain the intended interpretation by interchanging *Orient* and *West*: *people from the Orient are fascinated by the West*. Similarly, if *Italian* means the language 'that speakers from Italy speak' and *Frenchmen* means (at least) 'people from France' then we can obtain the intended interpretation by interchanging *Italy* and *France*, thus obtaining the representations in (57).

(57) $\exists x(\mathit{France}(x) \wedge \mathsf{Many}_y(\mathit{people}(y) \wedge \mathit{of}(y,x) \wedge$
$\exists z(\mathit{Italy}(z) \wedge \exists k(language(k) \wedge of(k,z) \wedge learn(s,y,k))))$

$\exists x(\mathbf{Italy}(x) \wedge \mathsf{Many}_y(\mathit{people}(y) \wedge \mathit{of}(y,x) \wedge$
$\exists z(\mathbf{France}(z) \wedge \exists k(language(k) \wedge of(k,z) \wedge learn(s,y,k)))))$

The case of (56) is out because *Sanskrit* and *France* are not parallel elements: one is a language and the other is a country. Moreover, there is no English compound noun that can express the concept *person from Sanskrit*, since *Sanskrit* is not a geographical region.

There are other cases like (58) (David Miller, p.c.), that may require extra steps, although not all speakers accept this data point. In this example, we interchange background information evoked by the nouns *Mexicans* and *English*. Assuming a decompositional analysis that contains information-rich descriptions of lexical semantics and world knowledge, as in QUALIA roles of Pustejovsky (1995), the first conjunct of (58) means something like 'many people natively from Mexico (where language X is spoken), speak the English language (which is natively spoken in Y)'. Then, by interchanging *Mexico* (and its official language X) and *English* (and its dependent geographical location Y), we can obtain the converse: 'many people natively from Y (where the English language is spoken), speak the X language (which is natively spoken in Mexico)'.

(58) (?) Many Mexicans speak English, and vice versa.
(= Many English speakers speak Spanish)

4 Conclusion

This work makes various contributions to the syntactic and semantic analysis of *vice versa*. This expression is exceptional in that it can occur in a number of different syntactic environments, as an adverbial, a nominal, or a (finite/non-finite) verbal structure. Furthermore, *vice versa* can occur in coordinate and non-coordinate structures alike, although there are some limitations based on coherence factors. There is no limitation to what kind of preceding clause can serve as an antecedent, as these can be located in a conjunct, and embedded phrase, the same clause as *vice versa*, or in different sentences altogether. All of these facts can be captured straightforwardly by a typed-underspecified mixed category analysis of the lexical entry. Matters are less clear in the realm of semantics. The main difficulty lies in identifying the relevant generalization that encompasses all of the possible patterns of interchange. The latter are fairly complex and exhibit various degrees of flexibility (nouns, verbs, adjectives, clauses or entire phrases can be interchanged). Moreover, certain examples are ambiguous, and in theory allow more interpretations for *vice versa* than speakers can detect. Arguably, simpler alternative interpretations, context, and pragmatic factors interfere to make these alternatives less accessible.

In this work I have argued that a pure contextual analysis and a pure logical form analysis are difficult to formulate. Rather, the phenomena are best dealt with by logical form constraints stated at the pragmatic coherence level, drawing from work by Hobbs (1990) and Kehler (2002). In essence, the semantics of *vice versa* corresponds to a proposition that corresponds to a relation that coheres with the relation associated with the antecedent's semantics. The relations are argued to be the same with the exception of the interchanged denotata. Various cases involving quantifiers like *many* and *few* involve the interchange of maximal sets, which has independent support from anaphora phenomena (Kamp and Reyle 1993,391). Other cases still, are argued to hinge on a lexical decomposition analysis of lexical semantics that may include information-rich descriptions along the lines of Pustejovsky (1995).

The account proposed in this paper crucially relies on aspects of pragmatics and coherences which have been argued to be central in explaining certain aspects of a number of other phenomena (Kehler 2002). However, it must be noted that the computation of such coherence relations is less than clear, and necessitates further research. Until this is accomplished, the current account of the interchange phenomena triggered by *vice versa* is difficult to make more explicit, and consequently, test in a more objective manner.

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Coherence with adjectives in German

Philippa Cook
Freie Universität Berlin

Bjarne Ørsnes
Freie Universität Berlin

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Abstract

Coherence generally refers to a kind of predicate formation where a verb forms a complex predicate with the head of its infinitival complement. Adjectives taking infinitival complements have also been shown to allow coherence, but the exact conditions for coherence with adjectives appear not to have been addressed in the literature. Based on a corpus-study (supplemented with grammaticality judgements by native speakers) we show that adjectives fall into three semantically and syntactically defined classes correlating with their ability to construct coherently. Non-factive and non-gradable adjectives allow coherence, factive and gradable adjectives do not allow coherence and non-factive and gradable adjectives are tolerated with coherence. On the basis of previous work on coherence in German we argue that coherence allows a head and a dependent of this head to be associated with different information structural functions. In this sense coherence is like an extraction structure, when the extracted constituent has a different information structural status that the constituent from which it is extracted. Following literature on the information structural basis of extraction islands, we show how the lack of coherence with factive adjectives follows from their complements' being information structurally backgrounded, while the infinitival complements of non-factive adjectives tend to a higher fusion with the matrix clause. We also show that coherence is observed with attributive adjectives as well, arguing that coherence is not a distinct verbal property. Finally we provide an analysis of coherence with adjectives within HPSG.

1 Introduction

Originating with the ground-breaking work on non-finite verbs in German in Bech (1955/1983) coherence refers to a kind of complex predicate formation, which has primarily been studied for verbs taking infinitival complements. Depending on the governing verb, an infinitival complement can either be incoherent or coherent as exemplified for the verb *versuchen* ('to try') in (1) and (2).[1]

(1) sie habe ebenfalls versucht, [es ihm beizubringen], behauptete Britta [2]
she had also tried it him to teach claimed Britta
'she had also tried to teach him it, Britta claimed'

(2) Wir glauben, dass sie ihn mehrfach [zu ermorden versucht] haben[3]
We think that they him repeatedly to kill tried have

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[1] The examples are extracted from the *Digitales Wörterbuch der Deutschen Sprache* of the Berlin-Brandenburgische Akademie der Wissenschaften (http://www.dwds.de) and *COSMAS-II* of the Institut für Deutsche Sprache (IDS) in Mannheim (http://www.ids-mannheim.de/cosmas2/web-app/).

[2]Degenhardt, Franz Josef, Für ewig und drei Tage, Berlin: Aufbau-Verl. 1999, p. 297.

[3]Salzburger Nachrichten, 27.04.1995; ETA-Attentate sind ein "Berufsrisiko" für Spitzenpolitiker.

'We think that they have tried to kill him several times.'

In the incoherent construction in (1) the infinitival complement forms a separate constituent with a distinct grammatical function. The infinitival complement *es ihm beizubringen* ('to teach him') is extraposed. In the coherent construction in (2) the infinitival complement is completely integrated into the matrix clause. The infinitive forms a complex predicate with the embedding verb *versuchen* ('try') and the complements of the infinitive can occur interspersed with the complements of the matrix clause and can even scramble to the left of the subject ("Long scrambling"). In addition, an adjunct embedded within the infinitive can take scope over the matrix verb. This is shown in (2) for the adjunct *mehrfach* ('repeatedly'). The intended reading is that *they made several attempts to kill him* and NOT *they made attempts to kill him several times*. This scoping is only expected if the infinitival complement does not form a phrase on its own.[4]

Adjectives taking infinitival complements (henceforth: IAs) such as *bereit* ('willing to') or *eifrig* ('eager to') have also been shown to be able to construct incoherently as as well coherently, i.e. to be able to form complex predicates with their infinitival complements (Askedal, 1988, 1999, 2008; de Kuthy and Meurers, 2001; Gallmann, 1997; Zifonun et al., 1997). Cf.

(3) dass die Kammer von Anfang an **bereit** war, [einen
that the chamber from beginning PART prepared was a
Vergleich abzusegnen][5]
compromise to accept

'that the chamber was prepared to accept a compromise from the very beginning

(4) Daß [ihm] Knaack und Wellmann [zu helfen **bereit** waren], ...[6]
that him Knaack and Wellmann to help prepared were

'that Knaack and Wellmann were prepared to help him'

In (3) the infinitive forms a separate (extraposed) constituent, in (4) the infinitive forms a complex predicate with the adjective. The dative object *ihm* ('him') of the infinitive *helfen* ('help') has been scrambled to the left of the subject of the copular verb *waren* ('was') ('Long Scrambling') while the infinitive *helfen* ('to help') forms a single complex predicate with the adjective *bereit* ('prepared to') and the copula *waren* ('were').

This striking similarity between adjectives and verbs taking infinitival complements begs the question whether all IAs can construct coherently or whether adjectives – just like verbs – differ in their ability to construct coherently. And if

[4]Further differences between the incoherent and the coherent construction will be discussed below.

[5]Degenhardt, Franz Josef, Für ewig und drei Tage, Berlin: Aufbau-Verl. 1999, p. 142.

[6]Wilamowitz-Moellendorff, Ulrich von, Erinnerungen 1848-1914, Leipzig: Koehler, 1928., p. 73589.

so, how can this difference in the ability to construct coherently be explained. To our knowledge this question has not yet been addressed in the literature. A second question concerns the verbal status of "coherence". Askedal (1988, p. 122) claims that coherence is only relevant for verb dependent adjectives. Since verb dependent adjectives form complex predicates with their governing verb (Müller, 2002), coherence is thus essentially situated in the verbal domain. The question is, however, whether attributively used adjectives with infinitival complements really always construct coherently. To our knowledge this question has not been addressed in the literature either.

In this paper we show that IAs essentially fall into three classes: optionally coherent adjectives, weakly incoherent adjectives and strongly incoherent adjectives.[7] The distinction between these three classes has semantic correlates: The first class consists of non-factive, ungradable adjectives, the second class consists of non-factive, gradable adjectives and the third class consists of factive, gradable adjectives. While the first and the third class are very uniform in their syntactic behaviour, the class of weakly incoherent adjectives has an intermediate status. These adjectives can construct coherently but are very reluctant to do so. Building on the analysis of the information structure of coherent and incoherent constructions in Cook (2001) we show how factivity can form the basis of an information structural account of the divergent syntactic behaviour of the adjectives. This account also explains the constraints on extractability and linearization of the infinitival complement within the sentence bracket for the different adjective classes. We further show that coherence is also observed in attributive structures and we provide an analysis of coherent and incoherent adjectives within HPSG.

2 Adjectives and the incoherent/coherent distinction

The adjectives under consideration in this study are adjectives selecting a subject and an infinitival complement. Adjectives taking infinitival complements as subjects such as *spannend* ('exciting') do not have a bearing on the coherence/incoherence-distinction since infinitival subjects are always incoherent. [8] An example of an adjective with a subject and an infinitival complement is given in (5).

(5) Der in Europa festgestellte Typ A ist imstande, eine Epidemie zu
the in Europe observed type A ist capable an epidemic to
verursachen.[9]
cause
'The type A observed in Europe is capable of causing an epidemic.'

[7] As noted in Reis (2001) there are no obligatory coherent adjectives in German.

[8] Exceptional cases of "split-subject"-infinitives are mentioned in (Askedal, 1988) and are not dealt with here.

[9] Salzburger Nachrichten, 21.11.1995; Influenza vom Typ A ist zu europaweiter Epidemie bereit Virologe .

IAs select oblique complements, i.e. complements headed by a preposition as in (6). When the adjective combines with an infinitival complement, the complement is (optionally) doubled with a pronominal adverb containing the preposition as its second part (viz. (7).

(6) Ich bin gar nicht überrascht [über den Inhalt des Briefes][10]
I am at all not surprised over the content of this letter
'I am not surprised at the contents of this letter at all'

(7) Er war zunächst etwas überrascht (darüber), [mich auf dem
he was at first somewhat surprised thereover me on the
Herausfordererthron zu sehen] [11]
throne of the challenger to see
'At first he was a little surprised to see me on the throne of the challenger'

All IAs exhibit subject control and they denote a relation between an experiencer and a "subject-matter"-argument (Landau, 2001). The overwhelming tendency is for IAs to construct incoherently. The infinitival complement forms a separate constituent which is either extraposed or in the first position of the clause (SPEC of CP).[12] However, as occasionally noted in the literature, these adjectives can also construct coherently (see references above). In the example in (8) the adjective *bereit* ('prepared to') constructs coherently with the infinitive *zu zahlen* ('to pay'). The example illustrates two diagnostics for coherence: We find Long Scrambling of the dative object *ihm* ('him') and an adjunct *nicht* ('not') taking scope over the governing adjective although it is linearized before the infinitive.

(8) Er wollte nur das Geld. Das [ihm] die "Presse" aber [nicht]
he wanted only the money. Which him the "Presse" however not
zu zahlen bereit war.
to pay prepared was[13]
'He only wanted the money. Which, however, the "Presse" was not prepared to pay him.'

Parallel to verbs taking infinitival complements, IAs are also found in constructions that are not easily identified as either coherent or incoherent. IAs are also found in the so-called Third Construction where the infinitive occurs in the extraposed position and a dependent of the infinitive occurs within the embedding construction (Hinrichs and Nakazawa, 1998; Wöllstein-Leisten, 2001).

(9) Wer [den Preis] nicht bereit ist [zu zahlen], . . . [14]
who the price not prepared is to pay

[10]Brief von Irene G. an Ernst G. vom 05.04.1938, Feldpost-Archive mkb-fp-0270, p. 304.

[11]Moers, Walter, Die 13 1/2 Leben des Käpt'n Blaubär, Frankfurt a.M.: Eichborn 1999, p. 540.

[12]Intraposed incoherent infinitives appear to be very rare with adjectives. We return to this issue below.

[13]Die Presse, 07.10.1997, Ressort: Inland; Die Ehre des Walter Meischberger.

[14]www.tweakpc.de/.../45000-windows-vista-wird-guenstiger-post441238.html (24/2 2010).

'whoever is not prepared to pay the price'

And parallel to verbs taking infinitival complements, intraposed infinitival constructions can be structurally ambiguous. In (10), the infinitive can be incoherently linearized in the middle field (indicated with square brackets), or it can be coherent with the infinitive as part of a verbal complex and the object linearized in the middle field (indicated with brackets).

(10) fraglich ist, ob die Niederlande ([ihre Gebiete in Amerika) (aufzugeben] bereit sind)[15]
questionable is if Holland its territories in America to give up prepared is
'the question is whether Holland is prepared to give up its territories in America'

Thus IAs appear to be exactly like verbs taking infinitival complements in that the very same constructions are observed with adjectives as with verbs. The question is, however, whether adjectives - just like verbs - differ as to whether they allow coherence. And if so, what kind of adjectives allow coherence.

3 Coherent and incoherent adjectives

To find out which adjectives allow coherence we investigated the syntax of app. 80 IAs in the two corpora *Digitales Wörterbuch der Deutschen Sprache* and *Cosmas* of the Institut für Deutsche Sprache in Mannheim. This investigation confirms that adjectives generally tend to construct incoherently, but also that the IAs split in their ability to construct coherently. Some adjectives occur in both the coherent and the incoherent construction while others only occur in the incoherent construction. The following table gives some examples.

Coherent and incoherent	**Only incoherent**
Disposition	*Emotion*
fähig ('able')	beunruhigt ('disturbed')
abgeneigt ('disinclined')	dankbar ('grateful')
imstande ('able')	verwundert ('surprised')
kompetent ('competent')	zuversichtlich ('confident')
willig ('willing')	eifrig ('eager')

Interestingly, the adjectives in the two classes are semantically coherent. The adjectives in the first class denote a relation of personal disposition towards the denotation of the infinitival complement (**Disposition**). This group corresponds

[15] o.A., Übersicht über die Weltbevölkerung nach Erdteilen, in den 144 Staaten, in den von 14 Staaten abhängigen Gebieten und in den 142 Millionenstädten [30.05.68], in: Archiv der Gegenwart 38 (1968), p. 13945

to the group of *Dispositionsadjektive* (‘Dispositional Adjectives’) in the semantic classification of IAs in Stark (1988), even though our classification is based on syntactic criteria. The adjectives in the second class denote a relation of emotional attitude towards the denotation of the infinitival complement (**Emotion**) (cf. also the psychological predicates in Landau (2001)).

The optionally coherent (i.e. Disposition) adjectives share a host of further properties. The adjectives in this class are all ungradable. They do not license intensifying *so* (‘so’) as gradable predicates otherwise do (Umbach and Ebert, to appear).

(11) * Peter ist so imstande / willig
Peter is so capable / willing

The majority of these adjectives selects the preposition *zu* (‘towards’) for their complement, i.e. they optionally occur with the pronominal adverb *dazu* (‘there-towards’) when selecting an infinitival complement. The adjectives are non-factive and do not presuppose the truth of their complement. On the contrary, the infinitival complement is future-oriented, hence unrealized. Finite complements are very rare compared to infinitival complements. For all the adjectives in this group. finite complements are attested, but they are not accepted by all speakers.[16]

(12) auch die SPD, so Fraktionschef Gebhard Schönfelder, ist
also the SPD according.to Fractionleader Gebhard Schönfelder is
bereit, dass die Straße umbenannt wird[17]
prepared that the street renamed is
‘according to fraction leader G.S. the SPD is also prepared to have the street renamed’

The second class, i.e. the class of adjectives that only construct incoherently is much more heteregeneous. They only share one property: they are all gradable, i.e. they license intensifying *so* (‘so’):

(13) Peter ist so verwundert / eifrig.
Peter is so surprised / keen
‘Peter ist so surprised/eager.’

Otherwise two distinct subgroups can be discerned within this class. The first subgroup are adjectives such as *erpicht* (‘keen on’), *zuversichtlich* (‘confident’) and *eifrig* (‘eager’). They denote a certain attitude of the subject referent towards the denotation of the VP. Most of the adjectives in this subgroup tend to

[16] In examples such as (12) there appears to be a kind of semantic coercion taking place. The example in (12) can be interpreted to mean that the SPD is prepared to to accept that the street is renamed, i.e. the infinitive is omitted.

[17] Nürnberger Nachrichten, 27.04.2006; Verschwindet – Meiser-Straße? – Streit um Ex-Bischof: Auch SPD ist für Umbenennung.

select the preposition *auf* (‘on’) (and concomitantly the pronominal adverb *darauf* (‘thereon’)). They are very rare with finite complements and they are non-factive. Just like the adjectives in the first class they select future-oriented, hence unrealized VP denotations We term these adjectives *Attitudinal adjectives*.

The second subgroup comprises adjectives such as *verwundert* (‘surprised’), *dankbar* (‘grateful’) and *überrascht* (‘surprised’). The majority of the adjectives in this subgroup selects the preposition *über* (‘over’) (and concomitantly the pronominal adverb *darüber* (‘thereover’) and for these adjectives finite clauses with *dass* (‘that’) appear to be the preferred complementation. Infinitival complements are restricted to verbs of perception, such as: *erfahren* (‘learn’), *entdecken* (‘discover’) and *sehen* (‘see’), or passive or perfect infinitives when the matrix copula is in the present (cf. (Norrick, 1978, p. 33) for English). We term these adjectives *Emotion Adjectives*.

(14) Monika Walser, [. . .], ist überrascht, mit solchen Überlegungen
Monika Walser is surprised with such speculations
konfrontiert zu werden.[18]
confronted to be
‘Monika Walser is surprised to be met with such speculations’

The Emotion Adjectives are factive, i.e. they presuppose the truth of their complement also under negation. Furthermore they allow interpolation of *die Tatsache* (‘the fact’) when occurring with a finite clause (Norrick, 1978) and occasionally also when occurring with an infinitival complement.

(15) Beim Blick auf die gigantische Kulisse und das schwarz-rote
At sight of the gigantic schene and the black-red
Fahnenmeer war ich [glücklich] wie nie zuvor über [die Tatsache],
sea of flags was I happy as never before over the fact
Club-Fan zu sein.[19]
club-fan to be
‘Looking at the gigantic scene and the sea of black and red flags I felt as happy as ever to be a club-fan.’

4 Coherent and incoherent adjectives revisited

In view of the heterogeneity of the adjectives in the class of (apparently) obligatorily incoherent adjectives we decided to take a closer look at the syntax of IAs in German. We carried out a pilot study where informants judged the grammaticality of constructed sentences with adjectives from the three classes above. In this study we not only tested the ability to construct coherently, we also tested whether the

[18]St. Galler Tagblatt, 16.02.2000, Ressort: TB-SG (Abk.); Scharf beobachtete Spende.

[19]Nürnberger Zeitung, 29.05.2007, p. 4; Das Final-Tagebuch einer echten Cluberin Die gröte Belohnung für ein strapaziertes Fan-Herz.

adjectives allow *wh*-extraction out of the infinitival complement and whether the adjectives allow their infinitival complement to be intraposed, i.e. to be linearized within in the middle field of the matrix construction. These two last cases are illustrated for an Emotion Adjective below (along with the judgements).

(16) * [Was$_i$] war die Polizei verwundert, e_i bei dem Fahrgast zu entdecken?
what was the police surprised at the passenger to discover
'What was the police surprised to discover on the passenger?'

(17) * Die Polizei war [die Waffe bei dem Fahrgast zu entdecken] sehr verwundert.
the police was the weapon at the passenger to find very surprised
'The police was very surprised to find the weapon on the passenger.'

The pilot study confirmed our initial observations from the corpus, namely that one class of adjectives allows coherence, while another class of adjectives does not lend themselves easily to coherence. However, it also revealed that the group of seemingly incoherent adjectives is not as homogeneous as the corpus investigation suggested. The class of Disposition Adjectives is fine with all the tested constructions: incoherence, coherence, *wh*-extraction and intraposition. The class of Attitudinal Adjectives prefers to construct incoherently. However, coherence, *wh*-extraction and intraposition are not as severely rejected as is the case with the last group of adjectives, the Emotion Adjectives. The class of Emotion Adjectives only allows the incoherent construction as far as we can tell at present. So we end up with three classes of adjectives. The following table summarizes the findings of the pilot study.

Class	**Incoherent**	**Coherent**	***wh*–extraction**	**Intraposition**
Disposition	OK	OK	OK	OK
Attitude	OK	??	?	?
Emotion	OK	*	*	*

The pilot study suggests a connection between the ability to construct coherently and the ability to allow extraction out of the infinitival complement and intraposition. When an adjective allows coherence (albeit reluctantly) it also allows extraction and intraposition. The study further reveals that the Attitudinal Adjectives have an intermediate status: certain properties pull towards coherence, other pull towards incoherence. If we try to relate the result of the pilot study to (some of) the properties uncovered above, we arrive at the following picture.

+/−**C**	**Weakly** −**C**	**Strongly** −**C**
−factive, −grad	−factive, +grad	+factive, +grad
Disposition	*Attitudinal*	*Emotion*
fähig abgeneigt imstande kompetent bereit	eifrig interessiert erpicht zuversichtlich	beunruhigt dankbar verwundert verblüfft

Non-factivity and non-gradability pattern with coherence, while gradability and factivity pattern with incoherence. The Attitudinal Adjectives are in the middle: non-factivity pulls towards coherence, gradability pulls towards incoherence.

Parallel to the verbs we thus find that there is a continuum between optional and obligatory incoherence (cf. a.o. Cook (2001); Sabel (2002)). This continuum appears to correlate with semantically defined classes of adjectives, the parameters being factivity and gradability. In the next section we will provide an explanation for the correlation between factivity and coherence - and between coherence and extraction/intraposition.

5 The information structure basis of the incoherent/coherent distinction

In this section, we will present our claim that the incoherent/coherent distinction has a basis in information structure (IS) and we will argue that the behaviour of the different classes of IA finds a natural explanation under this claim. Information struture refers to the context-dependent way in which an utterance may be structured with respect to notions such as topic and focus. We assume two distinct levels of partioning (following e.g. Krifka (2007) and many others), namely Topic – Comment and Focus – Background.

For the classes of IAs that allow both coherence and incoherence (i.e. the disposition and attitudinal classes), we argue that the actual choice between incoherence and coherence is conditioned by issues of information Structure, cf.(Cook, 2001) for the same proposal for infinitival complements of optionally coherent verbs such as e.g. *versuchen*('try'). While previous HPSG teatments of coherence with verbs taking non-finite complements have formally modelled this optionality, they have never actually offered a motivation as to what governs the choice in actual use. In this respect, the present proposal covers new ground. The crux of our claim for the IAs which allow either construction mode is that in discourse contexts in which the VP-proposition of the infinitival complement constitues a discreet IS unit not involving any VP-internal IS partitioning, the incoherent structure is used. The coherent mode of construction (i.e. complex predicate formation), on the other hand, is chosen in discourse contexts in which any argument can instantiate topic or focus i.e. in which the VP-proposition may be internally information structurally partioned. In this repect, then, the behaviour of the complex predicate is analagous to that of a simplex verb in permitting information structural statuses (Topic, Focus) to be, in principle, distributed throughout the clause. We will discuss the class of emotion IAs, which only licenses incoherence, in the following section where we will argue that this behaviour has its source in the fact that their complement is obligatorily backgrounded. This, in turn, also relates to information structuring since as we we will show below.

We now turn to evidence supporting our claim. Recall that there are certain constructions which may only occur with coherence. These include, for example, Long Scrambling, and wide scope readings of modifiers, as illustrated in section 1 above. Conversely, there are certain constructions which are only found with incoherence, e.g. extraposition of the infinitival complement seen in section 1. There are further constructions associated either only with coherence or only with incoherence not yet discussed here, an overview of which can be found in Müller (2002, 2.1.2). First, we will focus on incoherence and the lack of VP-internal IS partioning we claim one finds there. What is immediately striking in connection with this claim is the fact that most of the constructions that are associated with (and taken as diagnostics of) incoherence have in common that the lexical material corresponding to the VP-proposition must be linearized as one contiguous syntactic unit which can – we believe – be argued to be isomorphic with one single, non-internally-partioned information structural unit. We will illustrate this with respect to the following diagnostics of incoherence: (i)the acceptability of relative clause pied-piping, (ii) the ungrammaticality of partial VP-fronting and (iii) the ungrammaticality of cluster fronting. In each case we see that for these constructions the emotion IAs pattern with verbs classed as obligatorily incoherent in the literature such as e.g. ”*berreden*(‘convince’). First, relative clause pied-piping is a relativization strategy in which the infitival VP is pied.pied and realised at the left periphery tpgetehr with the realtive pronoun, as shown in () here. We see that it maintains a contiguously realized VP-unit and it is acceptable only with incoherent predicates.

(18) a. ein Buch, **das zu lesen** er sie überredet hat (-C verb)
a book which to read he her persuaded has

b. ein Buch, **das zu lesen** er glücklich war (-C emotion adj.)
a book which to read he happy was

Second, partial VP-fronting is a topicalization strategy which demands split linearization of the VP-unit. The zu-infinitive is in initial position and its dependent direct object is realized in the middle field. It is not licensed by incoherent predicates in contrast to coherent ones as shown by the following contrast:

(19) a. * **zu lesen** hat er sie **das Buch** überredet (-C verb)
to read has he her the book persuaded

b. * **zu lesen** war er **das Buch** enttäuscht (-C emotion adj.)
to read was he the book disappointed

(20) a. **zu lieben** hat er **das Pferd** versucht (+C verb)
to love has he the horse tried

b. **zu lieben** war er **das Pferd** bereit / fähig (+C disposition adj.)
to love was he the horse willing / able

Finally, cluster fronting is a topicalization strategy which also demands split linearization of the VP-unit since a purely verbal string is fronted. It is out for incoherent predicates in contrast to coherent one sas shown here:

(21) a. * **zu lesen** überredet hat er sie **das Buch** (-C verb)
to read persuaded has he her the book

b. * **zu lesen** enttäuscht war er **das Buch** (-C emotion adj.)
to read disappointed was he the book

By contrast, it is fine for coherent predicates

(22) a. zu lieben versucht hat er das Pferd (+C verb)
to love tried has he the horse

b. zu lieben bereit/fähig war er das Pferd (+C disposition adj.)
to love willing/able was he the horse

It is highly plausible to assume that topicalized strings in V2 languages such as German (which normally reserve the initial position in main clause declaratives for the instantiation of one IS function; be it topic, focus or contrast) must constitute one IS unit. It also seems plausible to extend this assumption to the case of relative clause-pied piping. Above all, this set of data are introduced here to reinforce our claim by illustrating that certain constructions which split up the VP-unit syntactically are ruled out with incoherence and that, if one believes this structural split reflects an IS split or partitioning within the VP, this supports our idea that the incoherent mode of construction is typified by the absence of IS-partioning within the VP-denotation.We summarize this in tabular form here:

	Coherent	**Incoherent**
relative cl. pp.	*	OK
partial VP-fronting	OK	*
cluster fronting	OK	*

Concluding this section, we comment briefly on the relation between coherence and the possibility of IS partioning. The constructions associated with (or diagnostic of) coherence (e.g. Long Scrambling, Cluster fronting) all involve the VP-proposition not forming a syntactic constituent; and arguably, we belive, not forming an IS unit either and thus we propose that the VP-proposition of coherent predicates is not constrained to map to a single, discreet, non-partioned IS-unit. We assume that within this group of IAs allowing both modes of construction, there will be variation in the degree to which particular adjectives tends towards the incoherent or the coherent mode of conctruction. Our pilot study has already revealed that disposition adjectives alternate more freely than the attitudinal adjectives, which tend more towards the incoherent mode of construction. We would hope that further study of the IS behaviour of these adjectives will permit a more fine-grained analysis of this gradience to be put forward.

6 Emotion IAs and obligatory incoherence

Recall from our pilot study reported above that the infinitival complements of the emotion IAs such as *enttäuscht* ('disappointed'), *deprimert* ('depressed'), *verwundert* ('surprised') resisted coherence strongly and were even opaque for wh-extraction. A pertinent question is, of course, why it should be the case that it is precisely the emotion IAs that demand incoherence and resist extraction and, whether our claim about the IS basis of the coherence dichotomy can shed any light on this fact ?

We will argue that the VP-proposition of emotion adjectives lacks internal IS partitions and that this is even grammatically (for us, lexically) encoded rather than just being, say, an IS preference. In turn, we assume that the possibility of having VP-internal IS partitions is necessary for licensing extraction out of that VP (as well as being necesary for licensing coherence, as we argued in the preceding section). We propose that the properties of the incoherent (emotion) adjectives which cause them to lack this IS partition-potential (and thus to be opaque for extraction) are the following: The VP-proposition of emotion adjectives is (i) **presupposed** and (ii) **backgrounded**. Since we assume both a Topic–Comment partition and an orthogonal Focus–Background, this means that the complements of emotion IAs would appear to lack both partitions. Let us consider first the link between presupposed status and the presence of a Topic–Comment partition. Evidence for the status of the complement of emotion IAs as presupposed comes from the well-known negation test for presupposition. The complement of emotion adjectives is not in the scope of matrix negation, as illustrated here for *verwundert* ('surprised'):

(23) Peter war nicht verwundert, von der Sache zu erfahren
Peter was not surprised about the issue to hear
= he DID hear about it

Further, there is evidence to suggest that presupposed complements do not have the status of assertions and, in turn,there is evidence to suggest that non-asserted propositions lack a Topic–Comment partition (Ebert et al., to appear; Kuroda, 2005).[20]

[20]Further indirect support for this line of thinking might come from the combination of the ideas that (i) only asserted clauses permit embedded root phenomena (Hooper & Thompson 1973)and (ii)

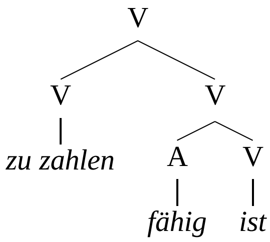
The final ingredient in our account of the emotion IAs' opaqueness for extraction concerns the status of their complement as backgrounded. There is a body of literature addressing the issue of constraints on extraction out of so-called backgrounded constituents see e.g. Erteschik-Shir and Lappin (1979), Goldberg (2006, Chap. 7) Ambridge and Goldberg (2008); Valin and LaPolla (1997) where it is claimed that the complements of certain predicate classes is not "the main point of the utterance", or is not "part of potential focus domain". These complements thus constitute islands for extraction. We assume that extracted elements (fillers) are discourse prominent (Top/Foc) and that these may only originate in complement types that instantiate such the relevant IS partitions. Complements of emotion IAs lack this partition and we therefore see that incoherence in German, which we claim to occur when the VP-denotation lacks IS partitions, blocks/degrades extraction just like islands do.

7 The structure of coherent adjectives

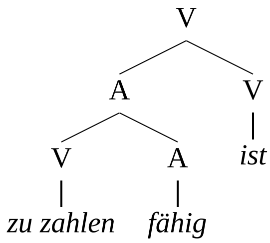
In this section we discuss the syntactic structure of adjectives constructing coherently with their infinitival complement. However, we also have to take into account that these adjectives occur as predicatives of copular verbs. We follow previous analyses of copula verbs and assume that the copula constructs coherently with the predicative adjective, i.e. it forms a complex predicate with the adjective (Müller (2002) a.o.). Thus, for the string in 24 two (binary branching) structures can be envisaged. The two structures are depicted below as A) and B).

(24) zu zahlen fähig ist
to pay capable is
'capable of paying'

A)



B)



In the structure in A) the copula combines with the adjective to form a complex predicate, and this complex predicate in turn combines with the infinitive to form another complex predicate. In this structure, coherence is indeed a verbal property, since a (complex) verb combines with the infinitive. In the structure in B), the adjective combines with the infinitive to form a complex adjective and this complex adjective in turn combines with the copula to form a complex predicate. The

that embedded root phenomena require a Topic–Comment partition. Both of these claims, however, require further substantiation. Further in this vein, the class of embedders of root phenomena in English overlaps to some extent with the licensors of embedded verb-second in German (Meinunger, 2006) for which it has also been argued that they have assertive character e.g. Truckenbrodt (2006).

crucial question is whether we can find an environment in which an adjective constructs coherently with an infinitive without the intervention of a copula verb. Such an environment would be the attribuive use of an adjective selecting an infinitival complement.

Coherence has been argued to be a property of verbs, and Askedal (1988, p. 122) even claims that the attibutive use of adjectives is irrelevant to the notion of coherence. Many of the usual tests for determining coherence are in fact inapplicable for attributive structures given that scrambling and fronting of verbal substrings do not occur within attributive structures. However, the scope of sentential adverbs such as negation still serves to identify coherent structures. If a negation occurring before an infinitive is able to scope over an attributively used adjective, the construction must be coherent. Attributive use of adjectives with infinitival complements is very rare due to the complexity of the resulting structure.[21] However, these structures do occur in authentic texts.[22] Cf. the following examples.

(25) der die Kosten der Generalsanierung des Aufzuges nicht zu
the the expenses of.the main restoration of.the elevator not to
tragen bereite Liegenschaftseigentümer [23]
cover prepared apartment owner
'the owner who is not prepared to cover the cost of a major refurbishment of the elevator'

(26) Maresa Hörbiger als die Konventionen ihres Standes [nicht zu
Maresa Hörbiger as the conventions of.her class not to
sprengen fähige] Gabriele,...[24]
break capable Gabriele
'M.H. as Gabriele, who is not able to break the conventions of her class'

In (25) the intended reading is *the owner is not prepared to pay for the main restoration* and in (26) the intended reading *she is not able to break the conventions of her class*. Thus, in these two cases an adjunct embedded within the infinitive is able to scope over the adjective, indicating that the adjective does indeed form a complex predicate with the infinitive. With Emotion Adjectives in attributive use the negation element can only scope over the embedded infinitive. The intended reading in (27) is *the mother is worried NOT to hear from her daughter* with the adjunct taking scope only over the infinitive and not the embedding adjective.

(27) ? Die von ihrer Tochter nicht zu hören beunruhigte Mutter
the from her daughter not to hear worried mother
'the mother who was worried not to hear from her daughter'

[21]The attributive use of these adjetives is even doomed "ungrammatical" in Weber (1971, p. 198).

[22]Interestingly these examples often contain errors. In the example in (26) a definite article is missing.

[23]Peter Garai: Die Gemeinschaftsanlage. Wohnrechtliche Blätter 22, 6-11 (2009), p. 9.

[24]Tiroler Tageszeitung, 26.05.1999, Ressort: Regional Osttirol; Theaterreihe klang hoffnungsvoll aus.

As these examples show, the adjective is able to construct coherently without the intervention of a copula verb. This shows that the structure in B) above is independently needed and this is the structure we will assume for adjectives constructing coherently.

8 An HPSG-Analysis

We follow previous work on coherence in HPSG (a.o Hinrichs and Nakazawa (1994); Meurers (2000); Müller (2002); Müller (2009)) and treat complex predicate formation as argument attraction. A lexical head combines with a subcategorized lexical head and inherits the argument structure of the incorporated element. The lexical entry for *bereit* (‘willing to’) (Disposition) is shown below.

$$\left[\begin{array}{l} \text{PHON} \; \langle \textit{bereit} \rangle \\ \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \left[\begin{array}{l} \text{HEAD} \left[\begin{array}{l} \textit{adj} \\ \text{SUBJ} \left\langle \text{NP}_{\boxed{1}} \right\rangle \\ \text{GRAD} \; - \end{array}\right] \\ \text{COMPS} \; \boxed{2} \oplus \left\langle \left[\begin{array}{l} \text{HEAD} \left[\begin{array}{l} \textit{verb} \\ \text{VFORM} \; \textit{zu\_inf} \\ \text{SUBJ} \left\langle \text{NP}_{\boxed{1}} \right\rangle \end{array}\right] \\ \text{COMPS} \; \boxed{2} \end{array}\right] \right\rangle \end{array}\right] \\ \text{CONTEXT} \mid \text{BACKGROUND} \left\{ \right\} \end{array}\right]$$

Following the analysis of non-finite verbs in Müller (2009), adjectives have a HEAD-feature SUBJ. The intuition is that the subject of adjectives (and non-finite verbs) never maps to the valency lists. It has to be raised by a copula verb (or another raising verb) or mapped to the MOD-feature when the adjective is inflected. The co-indexation of the SUBJ of the adjective and the SUBJ of the embedded infinitive accounts for the control properties, i.e. that the subject of the adjective is the controller of the unexpressed subject of the infinitive. Following Pollard and Sag (1994) we assume that the feature CONTEXT encodes the appropriateness conditions for the use of the lexical item. The truth of the proposition of the subcategorized verbal complement does not belong to the appropriateness conditions of the adjective, i.e. this proposition is not presupposed and the embedded proposition can have its own internal TC and FB articulation. This is the crucial prerequisite for coherence. The adjective is further lexically specified to be non-gradable. Gradability is treated as a syntactic feature, but nothing hinges on this decision. It can equally well be a semantic notion as long as degree-adverbs (for reasons of selection) can impose restrictions on the gradability of the modified constituent. Note further that gradability is treated as a HEAD-feature. This accounts for the fact that degree-adverbs such as the intensifying *so* (‘so’) selects an A’: *er ist so [stolz auf seinen Sohn]* (‘he is so proud of his son’).

The crucial insight of the analysis of complex predicate formation in Müller (2009) is that one single lexical entry can account for both the coherent and the incoherent construction. The lexical entry for *bereit* (‘willing to’) shows that the adjective selects a verb specified to be a *zu*-infinitive. However, the lexial entry does not say anything about the COMPS-list. In the incoherent construction the COMPS-list of the selected verb is empty, and the adjective combines with a VP. Consequently, no arguments are inherited from the selected verb onto the adjective and $\boxed{2}$ is empty. In the coherent construction the adjective combines with a V and the entire COMPS-list is inherited onto the adjective.

Next we turn to the lexical entry for the Emotion Adjective *verwumdert* (‘surprised’) which is obligatorily incoherent.

$$
\begin{bmatrix}
\text{PHON } \langle \textit{verwundert} \rangle \\
\text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \begin{bmatrix} \text{HEAD} \begin{bmatrix} \textit{adj} \\ \text{SUBJ} \langle \text{NP}_{\boxed{1}} \rangle \\ \text{GRAD } + \end{bmatrix} \\ \text{COMPS} \left\langle \begin{bmatrix} \text{LOC} \begin{bmatrix} \text{HEAD} \begin{bmatrix} \textit{verb} \\ \text{VFORM } \textit{zu\_inf} \\ \text{SUBJ} \langle \text{NP}_{\boxed{1}} \rangle \end{bmatrix} \\ \text{COMPS} \langle \rangle \end{bmatrix} \\ \text{NLOC} \begin{bmatrix} \text{SLASH} \{\} \end{bmatrix} \end{bmatrix} : \boxed{2} \right\rangle \end{bmatrix} \\
\text{CONTEXT} \begin{bmatrix} \text{BACKGROUND} \{\boxed{2}\} \end{bmatrix}
\end{bmatrix}
$$

The obligatorily incoherent adjective *verwundert* selects a VP, a verb phrase constrained to have an empty COMPS list. A condition for the use of an Emotion Adjective is that the embedded proposition obtains, i.e. the proposition is presupposed. Therefore the embedded proposition is a member of the BACKGROUND set, and the prerequisite for constructing coherently is not met. Note further that the adjective is specified to be gradable. Finally the SLASH set of the embedded complement is specified to be empty. In this way extraction out of the subcatagorized complement is blocked.

The following LP-statement accounts for the observation that a VP-complement of an adjective cannot be intraposed. The LP-statement says that a VP cannot linearly preceed a selecting gradable adjective.

$\boxed{1}$ VP $\not\gg$ ADJ $\begin{bmatrix} \text{HEAD} \mid \text{GRAD} + \\ \text{COMPS} \left\langle \boxed{1} \right\rangle \end{bmatrix}$

The following schema based on Müller (2009) accounts for the formation of a complex predicate with an adjective or a verb as the head, given the lexical entries presented above.

$$\textit{complex\_pred} \rightarrow$$
$$\begin{bmatrix} \text{SYNSEM} & \begin{bmatrix}\text{LOC} \mid \text{CAT} \mid \text{COMPS}\ \boxed{1}\end{bmatrix} \\ \text{HEAD–DTR} & \begin{bmatrix} \text{SYNSEM} \mid \text{LOC} \mid \text{CAT} \begin{bmatrix}\text{HEAD}\ \textit{adj} \vee \textit{verb}\end{bmatrix} \\ \text{COMPS}\ \boxed{1} \bigoplus \left\langle \boxed{2} \right\rangle \end{bmatrix} \\ \text{NONHEAD–DTR} & \left\langle \begin{bmatrix}\text{SYNSEM}\ \boxed{2} \mid \text{LOC} \mid \text{CAT} \mid \text{LEX} +\end{bmatrix} \right\rangle \end{bmatrix}$$

The head daughter is the embedding predicate (A or V) selecting the non-head daughter through the COMPS feature. The non-head daughter is the selected infinitive constrained to be LEX +. Note that the rest of the COMPS-list is passed onto the mother node, i.e. to the resulting complex predicate.

The present approach does not account for the gradience of the coherence/incoherence-distinction observed with both verbs and adjectives. As extensively discussed in Cook (2001) some verbs lend themselves more easily to coherence than others. We have observed a comparable continuum for IAs: Attitudinal Adjectives tend to incoherence but are not as bad in the coherent construction as Emotion Adjectives. Coherence appears to be an option for non-factive adjectives, but Attitudinal Adjectives are degraded since they are gradable in contrast to the Disposition Adjectives. A complete account of this would require weighted schemas for complex-predicate formation.

9 Conclusion

In this paper we have shown that adjectives can indeed construct coherently even in attributive constructions lacking a copular verb. Furthermore we have shown (i) that adjectives split as to whether they allow coherence and (ii) that coherence correlates with transparency for extraction. The class of Disposition Adjectives allow all kinds of structures, the class of Emotion Adjectives only allows incoherence and the class of Attitudinal Adjectives allow coherence, but is very reluctant to do so. We finally showed that coherence with adjectives has an information structural basis. The prequisite for coherence with adjectives is the non-factivity of the adjectives. This was explained as an information structural constraint on coherence. Presupposed complements are bacgrounded and do not allow a separte topic-focus-articulation within the complement.

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Usage-based Preferences in Written Sentence Production: The Role of Local and Global Statistics

Barbara Hemforth
LPNCog, CNRS, IUPPD-Université Paris-Descartes

Michel Fayol
LAPSCO, CNRS, Université Blaise Pascal, Clermont-Ferrand

Sébastien Pacton
LPNCog, CNRS, IUPPD-Université Paris-Descartes

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Abstract

In this paper, we will discuss the role of different levels of frequency distributions in sentence processing and in written production, looking at French homophones. A comparison of experimental data and corpus statistics will demonstrate that lexical frequencies as well as local and global coherences have to be taken into account to fully explain the empirically established patterns.

Introduction

One of the central issues in research on human language processing concerns the factors influencing ambiguity resolution as well as the comprehension and production of complex sentences. Two general approaches are playing an important role here: (i) The specific architecture of the human language processing system is assumed to lead to predictable choices in cases of ambiguity resolution as well as to increased difficulty for certain constructions (Frazier & Fodor, 1980). Central to this approach are assumptions about architectural limits of the cognitive system such as limitations in working memory capacity (Gibson, 1998; Just & Carpenter, 1992; Lewis & Vasishth, 2005) or possibly executive functions (e.g. inhibition of irrelevant structures). (ii) Distributional properties, in particular the frequency of usage of certain constructions have been proposed to be a major factor more recently. In these approaches linguistic experience may interact with architectural constraints, or capacity-based explanations may even be replaced with ones based on experience alone (MacDonald & Christiansen, 2002).

Frequency effects may concern the lexical frequency of a word, or in cases of ambiguities, the relative frequencies of the respective meanings of the word, it may concern predictions derived from the preceding sentence context, which may include the full phrase marker constructed so far or only the immediately preceding word(s). These different levels of frequency information are currently under discussion in the sentence processing literature (e.g. Tabor, Juliano, & Tanenhaus, 1997, Tabor, Galantucci, & Richardson, 2004; Gibson, 2006; Konieczny, 2005). In this paper, we will discuss in how far hypotheses developed for sentence comprehension can explain sixth graders' spelling errors in French. We will thus investigate the influence of frequency effects on spelling errors on three levels: lexical frequency effects will be studied looking at syntactic category disambiguation for homophones compared to non-homophones, the global syntactic prediction will be based on the probability of a given category given the full preceding syntactic context, and the local syntactic prediction will be based on the immediately preceding word only.

Lexical category disambiguation seems to be strongly determined by the relative frequencies of usage of the respective category (MacDonald, 1993, 1994). Lexical frequencies, such as the frequencies of the verb's alternative argument structures, the frequency of the verb in active versus passive voice, and the frequency of the verb as a past tense versus as a past participle form play an important role in classical garden-path sentences like The horse raced past the barn fell, where raced is much more frequent as a past tense verb than as a past participle (MacDonald, Pearlmutter, & Seidenberg, 1994).

Upcoming syntactic structure can also be predicted by lexical frequencies of verbs. In a recent visual world eyetracking experiment on ditransitive constructions (1a,b) Tily, Hemforth, Arnon, Shuval, Snider and Wasow (2008), verbs occurring more often with double object constructions (such as teach) were compared with verbs occurring more often with a prepositional object (such as read) following the analyses provided by Bresnan Cueni, Nikitina, and Baayen (2007).

(1) a. The lady will read / teach the children the poem.

b. The lady will read / teach the poem to the chidren.

Participants were presented with sentences aurally while looking at quasi-scenes containing the objects referred to in the sentences. Eye-movements time-locked to the verb clearly reflected the anticipation of upcoming arguments compatible with the frequency of occurrence of the respective verb-frame (participants would prefer looking at the *poem* right after hearing *read*, while they preferred looking at the *children* right after hearing *teach*). The eye-movement patterns thus clearly suggest anticipation of syntactic structure based on the frequency of verb-frames.

Global syntactic expectations have been shown to play a role as well. An example for context dependent preferences of syntactic category ambiguities can be found in Tabor, Juliano, and Tanenhaus (1997). In their experiments, they compared sentences like (2a,b) and (3a,b).

(2) a. That cheap hotel was clean and comfortable to our surprise.

b. That cheap hotels were clean and comfortable surprised us.

(3) a. The lawyer insisted that cheap hotel was clean and comfortable.

b. The lawyer insisted that cheap hotels were clean and comfortable.

In a self-paced reading experiment, the determiner reading of "that" was easier to process in sentence initial position (shorter reading times on "hotel was clean"), whereas, postverbally, the complementizer reading was easier (shorter reading times on "hotels were clean"). The dynamic model proposed by Tabor et al. (1997) to explain this pattern of results includes a context dependent component which is sensitive to the fact that the word *that* is more frequent as a determiner in the beginning of a sentence whereas the complement reading is more frequent after verbs taking sentential complements (such as *insisted*). Lexical category frequencies are thus calculated taking the syntactic context into account.

Whereas both readings of *that* are viable in the global syntactic contexts in the studies presented so far, more recent data suggest that the local syntactic context plays a role for syntactic category resolution as well, even in cases where the global context excludes one of the interpretations. Evidence for an interaction of lexical and local syntactic prediction effects comes from Tabor, Galantucci, & Richardson (2004) who found increased reading times for the ambiguous participle *tossed* in sentences like (4) compared to an unambiguous participle (*thrown*) although no main verb reading is possible at this point from a global perspective. Locally, however, the substring *the player tossed a Frisbee* forms a coherent sentence. Readers seem to be perturbed by this local interpretation.

(4) The coach smiled at *the player tossed a Frisbee* by the opposing team.

Similarly, in a visual world study with auditory presentation of the materials, Konieczny et al. (2009) find evidence for a temporary interpretation of the substring *die Astronautin überrascht den Ausserirdischen* (the astronaut surprises the alien) in a sentence like (5), although again this analysis is impossible given the global structure of the sentence. *Überrascht* is lexically ambiguous between an adverb (*surprisedly*) and a main verb (*surprises*) reading. Given that German sub-clauses require that the finite verb occur at the end of the clause, only the adverb reading is globally possible in a sentence like (5). Still, participants got distracted by the local substring compared to sentences with an unambiguous adverb such as *ungläubig* (*incredulously*).

(5) Die Tatsache, dass *die Astronautin überrascht den Außerirdischen* entdeckte, erregte Aufsehen.
The fact, that the astronaut[fem] surprisedly/surprises the alien discovered, caused a sensation.
"The fact that the astronaut suprisedly discovered the alien, caused a sensation."

Tabor et al. (2004) as well as Konieczny (2005, Konieczny et al., 2009) explain their respective results, claiming that the syntactic expectation of upcoming linguistic input is influenced not only by the syntactic context provided by the phrase structure of the sentence constructed so far, but equally by local substrings constructed automatically in parallel irrespective of their global viability. Note that in both studies cited here, homophones (or homographs) are compared to non-homophones (or non-homographs) in contexts where one of the categories is only possible in the local context and excluded in the global context.

Gibson (2006) proposes an alternative to the dynamic model of Tabor et al. (1997, 2004), claiming that the patterns of results can often be explained by a combination of context independent lexical category frequencies (unigram bottom-up statistics) and syntactic top-down statistics. Gibson defines the lexical-bias (LB) for a syntactic category c_i as in (6).

(6) LB(c_i) = (the context-independent probability of c_i (w)) * (the smoothed syntactic expectation weight for c_i in the syntactic environment).

A central factor in this formula is smoothing. Gibson argues that the probability of rare events is very hard to estimate given already that corpus studies can necessarily only cover a sample of all utterances. Moreover, language processing is very robust so that speakers often accept even fairly unusual constructions. The minimal probability of a syntactic expectation is arbitrarily set to .01. The relative syntactic expectation for a syntactic category c_i should thus be set to p(c_i) + .01, with p(c_i) being estimated from a corpus.

With this minimal syntactic expectation, the high probability of the main verb reading of a verb like *tossed* in Tabor et al.'s experiments (or equally the high probability of the main verb reading of *überrascht* in Konieczny et al.'s experiments) will thus exert a certain influence even though only a past participle reading is possible in the global context of the sentence (or equally only the adverb reading is possible in Konieczny et al.'s experiments).

In a series of self-paced reading experiments, Gibson (2006) demonstrates that the high frequency of *that* as a complementizer results in increased reading times even in contexts only allowing for a determiner (7) compared to unambiguous determiners such as *those* or *this*, thus substantiating the relevance of context-independent lexical category frequencies.

(7) The lawyer for that skilled surgeon asked for a raise.

The increased processing load for *that* in the context of a preposition like *for* was similar to the processing load in a context with a verb that does not subcategorize for a sentential complement such as *visited* in (8), although it might be argued that the local prediction of a compementizer is generally increased in the context of a verb (Tabor et al., 2004).

(8) The lawyer visited that skilled surgeon.

Our central question in this paper is whether and in how far predictions originally stemming from sentence comprehension can be used to explain spelling errors. The lexical category ambiguities studied in the experiments presented so far, were all homographs and homophones at the same time. In French, due to its silent morphology, you consistently find homophones, which are ambiguous with respect to their syntactic categories whereas they are fully unambiguous in their written form. French thus allows us to have a very direct measure of syntactic category disambiguation just looking at orthographic error rates in writing.

The French language moreover allows us to vary homophones vs. non-homophones with and without local predictions (verb/noun homophones) and homophones vs. non-homophones with varying local and global predictions (adjective/verb homophone).

We will apply an adaptation of Gibson's formulae to experimental results from Pacton, Fayol, and Hemforth (in prep.), showing that we need at least a combination of global (sentence level) statistics and unigram (lexical) frequencies to explain agreement errors for French adjective/verb homophones and a combination of local statistics and unigram frequencies to explain agreement errors for verb/noun homophones. These results can be derived from corpus counts, showing that local predictions for verb/noun homophones are much stronger in the constructions under investigation than those for adjective/verb homophones. While the relative strength of local and global predictions seems to play an important role, only a combination of all three levels can finally explain the full pattern of results. Studying both types of homophones and thus both types of syntactic category ambiguities, finally allows us to give a more detailed picture of the processes under investigation.

Before presenting the experiments, we will describe the phenomena in more detail in the following section.

French adjective-verb and verb-noun homophones

In many languages, such as English, reference to the oral language is useful for morphological markers because the number differences are orally marked on the nouns (farm / farms) and on the verbs (chatter / chatters), and because adjective-noun agreement is marked in oral and written language. French spellers, however, often run into difficulties when using category specific plural markers because reference to the oral language is mostly impossible. Number markers for nouns (∅ in the singular form vs. –s in the plural form), adjectives (∅ in the singular form vs. –s in the plural form) and verbs (∅ in the singular form vs. –nt in the plural form) are not audible. Because of this inaudibility, French conceals many homophones that are not homographs (i.e., words that are pronounced identically but are spelled differently). For example, the word *timbre* is written in the plural form with *–s* when it is a noun (*les timbres*, the stamps), with *–nt* when it is a verb (*ils timbrent*, they stamp); and these two plural forms, as well as the singular noun (*le timbre*, the stamp) and the singular verb (*il timbre*, he stamps) are all pronounced identically. Similarly, *bavarde* is written in the plural form with *–s* when it is an adjective (*les femmes bavardes*, the talkative woman, literally: the women talkative), with *–nt* when it is a verb (*les femmes bavardent*, the women chatter); and these two plural forms, as well as the singular adjective (*la femme bavarde*, the talkative woman) and the singular verb (*la femme bavarde*, the woman chatters) are pronounced identically. The silent inflectional morphology of French thus implies that writing a French word mostly involves decisions on its syntactic category that can only be inferred from an interaction of the word itself and its syntactic context. Systematic and extended explicit grammar lessons involving exercises in which children have to apply grammatical rules, in particular in second to fifth grades, do not prevent the occurrence of substitution errors (adding *–s* to a verb), especially for noun/verb homophones (e.g., *ils timbrent*, they stamp, spelled *ils timbres*) even in adults (Totereau, Thévenin & Fayol, 1997; Totereau, Barrouillet and Fayol; 1998).

Under standard writing conditions, most educated adults inflect nouns and verbs correctly, whether they have a homophone counterpart or not. Substitution errors only arise when adults' cognitive load is increased. In naturalistic situations, this can be observed when adults are more focused on the meaning of their message than on its orthographic correctness (e.g., university students' writing in exam situations). Experimentally, homophone effects can be demonstrated by using a dual-task paradigm aimed at elevating writers' cognitive load (Fayol, Hupet & Largy, 1999; Hupet, Fayol & Schelstraete, 1998; Largy, Fayol & Lemaire, 1996).

According to Totereau et al. (1998), although adults know the rule "if plural and verb then *–nt*" and how to apply this rule, they do not systematically perform the syntactical analysis in order to identify the syntactic category of the item to be marked. Rather, they retrieve from memory associations between stem and inflection (e.g., the association between *timbre* and *–s*) or whole instances (*timbres*). For a stem such as *trouve* (find) which can only be a verb, or *nuage* (cloud) which can only be a noun, whatever the syntactic structure in which they occur, the retrieval procedure and the application of the explicitly taught grammatical rules work towards the same response. However, for words, which can be either nouns or verbs, these two procedures can work towards different responses, because the writer can retrieve from memory the nominal instead of the verbal form (e.g., *timbres* instead of *timbrent*) and vice-versa.

Totereau et al.'s interpretation of their data corresponds to an explanation based on lexical frequencies. However, in their experiments for adults in particular, words were embedded in syntactic contexts that may exert a specific influence as well. Writers may thus rely on their sensitivity to the fact that certain syntactic categories are more likely to occur in a given position than others without necessarily taking the global sentence structure into account. For instance, in a sentence like (9) writers could add *–nt* to the stem *bavard_* because they are sensitive to the fact that verbs often occur in a post-nominal position.

(9) Les femmes bavardent au coin de la rue.

The women are chatting on the corner of the street.

A local plural noun would thus demand for a verb with the plural ending *-nt*. Importantly, the succeeding syntactic context does not always confirm local predictions as in the previous example. For instance, in a sentence like (10), the third word is not a verb but the plural adjectival form of the adjective/verb homophone *bavarde*.

(10) Les femmes bavardes du village sont bruyantes.

The talkative women of the village are noisy.

In French, inflected adjectives do not only occur next to nouns but equally after copula verbs (e.g., forms of "être", to be). The key point here is that, while adjectives can occur in both positions (11), inflected verbs can occur in post-nominal position as in (9) but not after a finite copula verb.

(11) Les femmes bruyantes du village sont bavardes.

The noisy women of the village are talkative.

Thus, while writers' sensitivity to the fact that verbs frequently occur after nouns in French could lead them to inflect erroneously some adjectives with *–nt*, their sensitivity to the fact that verbs ending with *–nt* never follow a verb in French could prevent them from erroneously adding *–nt* to an adjective in these positions.

Sentences like (10) and (11) do, however, not only differ with respect to their locally preceding syntactic context. The adjective in (10) is also in the canonical position of the main verb in a typical French sentence. Thus, local as well as global syntactic predictions favor a verb as the current syntactic category. This is not the case in a sentence like (12). Here, the homophone occurs in a post-nominal position, it is thus locally viable as a verb and not only as an adjective. Given that the preceding noun is the direct object of the sentence, the interpretation of the homophone as a verb is however excluded from a global perspective including the phrase structure of the whole sentence.

(12) Le boulanger regarde les femmes bavardes du village.

Lit.: The baker is watching the woman talkative of the village.

Finally, bottom-up lexical information may reduce or even exclude errors for adjectives without verb homophones as such as "bruyantes" in (11).

Similar predictions as for adjective/noun homophones can be derived from the verb/noun homophones discussed earlier. In a sentence like (13), locally as well as globally, *montre(-nt)* which is ambiguous between *la montre* (the watch) and *montrer* (to show) can only be interpreted as a plural marked verb. Adding *les*, which is ambiguous between the definitive article (the) and a clitic plural pronoun, before the verb changes the situation considerably (14). Given that *les* is much more frequent as a definite article than as a pronoun, locally, the substring *les montre (-s/-nt)* can be taken as determiner plus noun. Globally, however, this interpretation is not possible.

(13) Il y a beaucoup de monde sous le chapiteau. Les magiciens <u>montrent</u> leur nouveau spectacle.

There is a big crowd under the circus dome. The magiciens show their new performance.

(14) Quelques articles sont encore à vendre. Les marchands les <u>montrent</u> aux clients.

Lit.: Some goods are still for sale. The merchants them show to the clients.

As for adjective/noun homophones, bottom-up lexical biases may reduce or even annihilate local predictions for verbs without a noun homophone (e.g. *les marchands les exhibent aux clients*, the merchants exhibit them to the clients).

Pacton, Fayol, & Hemforth (in prep.) ran a series of experiments where they used a dictation task with 6th graders. The logic behind this choice was that 6th graders (about 11 to 12 years-old) generally master the fairly frequent kinds of syntactic constructions of relevance here, however, their orthographic post-editing skills are less developed than those of adults who only make a significant number of the expected mistakes under increased cognitive load. The dictation task in French necessarily requires syntactic category resolution. It is moreover a task our participants are highly used to and therefore a fairly natural task tapping into the processes we are interested in.

In Pacton et al.'s study, the following pattern of errors was established:

- Homophones generally provoked more substitution errors than non-homophones

For adjective/verb ambiguities (*les femmes bavardes* / *bavardent*)

- Most substitution errors occurred in post-subject positions
- Post-copula-verb and post direct-object positions were highly comparable with respect to error rates (much lower than post-subject).

For verb/noun ambiguities (*Ils les montrent* / *les montres*)

- Substitution errors occurred mostly and very strongly following the word *les*

Corpus analyses and predictions

We used two databases to calculate syntactic predictions and lexical biases. For the syntactic predictions we used the French Treebank Corpus (Abeillé, Clément, & Toussenel, 2003). The corpus is based on 1 million words from the newspaper *Le Monde*, fully annotated and disambiguated for parts of speech, inflectional morphology, compounds and lemmas, and syntactic constituents. It is the only corpus parsed to the level we are interested in available in French. The constructions, we are looking at are highly frequent in French so that the use of an adult corpus seems justified. Still given the high frequency of the constructions, we only used a randomly chosen 13602-word subcorpus.

Since 6th graders language competence surely differs from that of adults with respect to vocabulary, we used the MANULEX (Lété, Sprenger-Charolles, & Colé, 2004) for lexical biases. MANULEX is based on a corpus of 1.9 million words extracted from 54 readers used in French primary schools between first and fifth grades. The database contains two lexicons: the word form lexicon (48886 entries) and the lemma lexicon (23812 entries).

Adjective/verb homophones

Table 1 shows the lexical, local, and global biases for verbs in the different conditions. Figure 1 shows expectancies based on lexical*local, lexical*global, and lexical*local*global predictions Syntactic and lexical expectancies are smoothed (.01 is added to the corpus-based probabilities, contrary to Gibson, 2006, we also smoothed lexical biases using the same kind of reflection he proposes for syntactic biases).

		Lexical bias for verb (lemma)	Local bias for verb (compared to adjective)	Global bias for verb
Adjectives with verbal homophones	Post-nominal/subject	.51	.19	.46
	Post-verbal	.51	0	0
	Post-nominal/object	.51	.19	0
Adjectives without verbal homophones	Post-nominal/subject	0	.19	.46
	Post-verbal	0	0	0
	Post-nominal/object	0	.19	0

Table 1: Statistics for adjective/noun homophones

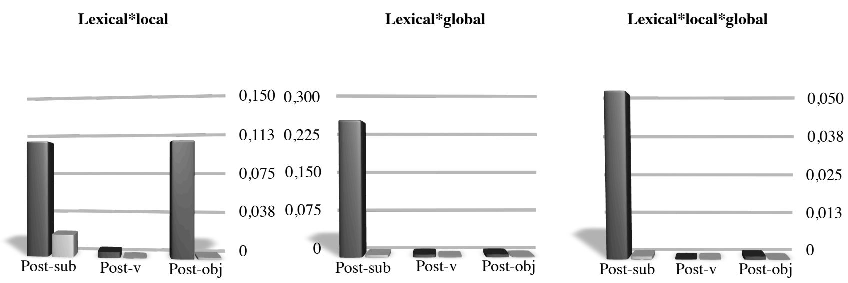

Figure 1: Predictions of adjective/verb substitution errors

Only two of the three predictions correspond to the empirical data, where in particular adjective/verb homophones following the subject noun lead to a high number of substitution errors (verbal -nt instead of adjectival –s). Substitution errors can thus not be explained by local biases alone. A combination of lexical and global frequencies as well as a combination of lexical, local, and global frequencies, however, both predict the empirically established pattern.

Verb/noun homophones

Calculating the local bias is slightly more complicated for verb/noun homophones since the word *les* is ambiguous between a determiner and a clitic pronoun. In the *Le Monde* sub-corpus that we used for calculating syntactic predictions, *les* was a determiner in 97% of the cases. In 85% of these cases, a plural noun directly followed the determiner. The local bias can thus be estimated as .97*.85=.82.

Table 2 shows lexical, local, and global frequencies of nouns. Figure 2 shows the corresponding predictions of combinations of lexical * local, lexical * global bias, as well as lexical * local * global bias. Syntactic and lexical expectancies are smoothed (.01 is added to the corpus-based probabilities).

		Lexical bias for noun (lemma)	Local bias for noun (compared to verb)	Global bias for noun
Verbs with noun homophones	Post-subject	.48	0	0
	Post-les	.48	.82	0
Verbs without noun homophones	Post-subject	0	0	0
	Post-les	0	.82	0

Table 2: Statistics for verb/noun homophones

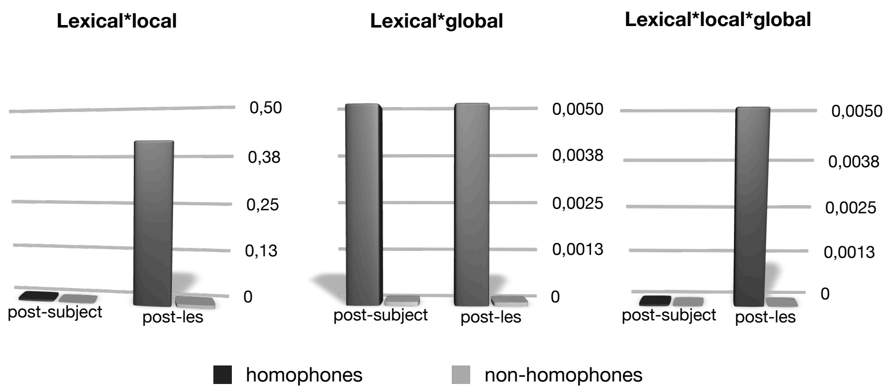

Figure 2: Predictions of verb/noun substitution errors

Neither lexical statistics alone, nor a combination of global and lexical statistics can explain the empirical data for verb/noun homophones, where a high number of substitution errors was found following the word *les* (nominal –s instead of verbal –nt). Only combinations of lexical statistics with local statistics (+ eventually global statistics) are compatible with the data.

Discussion

To explain the whole set of results we need a combination of bottom-up statistics (lexical frequencies), local top-down statistics (local coherence), and global top-down statistics. Predictions at different levels of the syntactic structure of the sentences are obviously underlying the disambiguation of syntactic category ambiguities in 6th graders.

Assuming that the spelling errors actually reflect comprehension errors (at least in part) in the dictation task, these results make clear predictions for sentence comprehension in general as well. They thus contribute to the discussion of which levels of analysis are relevant for the explanation of syntactic expectancy effects. Before these generalizations will be possible, we will, however, have to extend our empirical data base to direct comprehension tests and to adult populations.

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Arabic Nominals in HPSG: A Verbal Noun Perspective

Md. Sadiqul Islam
Bangladesh University of Engineering and Technology, Dhaka

Mahmudul Hasan Masum
Bangladesh University of Engineering and Technology, Dhaka

Md. Shariful Islam Bhuyan
Bangladesh University of Engineering and Technology, Dhaka

Reaz Ahmed
Bangladesh University of Engineering and Technology, Dhaka

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Abstract

Semitic languages exhibit rich nonconcatenative morphological operations, which can generate a myriad of derived lexemes. Especially, the feature rich, root-driven morphology in the Arabic language demonstrates the construction of several verb-derived nominals (verbal nouns) such as gerunds, active participles, passive participles, locative participles, etc. Although HPSG is a successful syntactic theory, it lacks the representation of complex nonconcatenative morphology. In this paper, we propose a novel HPSG representation for Arabic nominals and various verb-derived nouns. We also present the lexical type hierarchy and derivational rules for generating these verb-derived nominals using the HPSG framework.

1 Introduction

HPSG analyses for nonconcatenative morphology in general and for Semitic (Arabic, Hebrew and others) languages in particular are relatively new (Bhuyan and Ahmed, 2008b; Mutawa et al., 2008; Kihm, 2006; Bhuyan and Ahmed, 2008c; Riehemann, 2000; Bird and Klein, 1994; Bhuyan and Ahmed, 2008a; Islam et al., 2009). However, the intricate nature of Arabic morphology motivated several research projects addressing the issues (Beesley, 2001; Buckwalter, 2004; Smrž, 2007). HPSG representations of Arabic verbs and morphologically complex predicates are discussed in (Bhuyan and Ahmed, 2008b,a,c). An in-depth analysis of declensions in Arabic nouns has been presented in (Islam et al., 2009). The diversity and importance of Arabic nominals is broader than that of their counterparts in other languages. Modifiers, such as adjectives and adverbs, are treated as nominals in Arabic. Moreover, Arabic nouns can be derived from verbs or other nouns. Derivation from verbs is one of the primary means of forming Arabic nouns, for which no HPSG analysis has been conducted yet.

Arabic noun can be categorized based several dimensions. Based on derivation, Arabic nouns can be divided into two categories as follows:

1. Non-derived nouns: These are not derived from any other noun or verb.
2. Derived nouns: These are derived from other nouns or verbs.

An example of a non-derived, static noun is حِصَانٌ (*ḥiṣānun* - which means “horse”): it is not derived from any noun or verb and no verb is generated from this word. On the other hand, كَاتِبٌ (*kātibun* - which means “writer”) is an example of

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a derived noun. This word is generated from the verb كَتَبَ (*kataba*) which means "He wrote" in English. This simple example provides a glimpse of the complexity of the derivational, nonconcatenative morphology for constructing a noun from a verb in Arabic. In this paper, we analyze and propose the HPSG constructs required for capturing the syntactic and semantic effects of this rich morphology.

An HPSG formalization of Arabic nominal sentences has been presented in (Mutawa et al., 2008). The formalization covers seven types of simple Arabic nominal sentences while taking care of the agreement aspect. In (Kihm, 2006), an HPSG analysis of broken plural and gerund has been presented. Main assumption in that work evolves around the Concrete Lexical Representations (CLRs) located between an HPSG type lexicon and phonological realization. But in that work the authors have not addressed other forms of verbal nouns including participles. Our contributions to an HPSG analysis of Arabic nouns presented in this paper are as follows:

- We capture the syntactic and semantic effects of Arabic morphology in Section 3.1.
- In Section 3.1 we formulate the structure of attribute value matrix (AVM) for Arabic noun.
- We indicate the location of verb-derived nouns in the lexical type hierarchy in Section 3.2.
- We extend the basic AVM of nouns for verbal nouns (Section 3.3).
- We propose lexical construction rules for the derivation of verbal nouns from verbs in Section 3.3.

2 Verb Derived Noun in Arabic Grammar

2.1 Arabic morphology

Arabic verb is an excellent example of nonconcatenative root-pattern based morphology. A combination of root letters are plugged in a variety of morphological patterns with priorly fixed letters and particular vowel melody that generates verbs of a particular type which has some syntactic and semantic information (Bhuyan and Ahmed, 2008b). Figure 1 shows how different sets of root letters plugged into a vowel pattern generate different verbs with some common semantic meanings.

Besides vowel pattern, a particular verb type depends on the root class[1] and verb stem. This root class is determined on basis of the phonological characteristics of the root letters. Root classes can be categorized on basis of the number of root letters, position or existence of vowels among these root letters and the existence of a gemination (tashdeed). Most Arabic verbs are generated from triliteral

[1] We call a set of roots, which share a common derivational and inflectional paradigm, a root class.

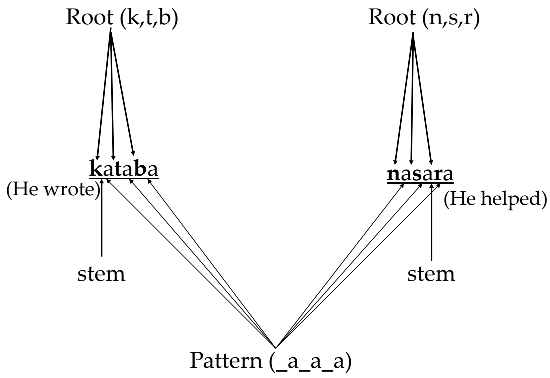

Figure 1: Root-pattern morphology: 3rd person singular masculine sound perfect active form-I verb formation from same pattern

and quadriliteral roots. In Modern Standard Arabic five character root letters are obsolete. Phonological and morphophonemic rules can be applied to various kinds of sound and irregular roots. Among these root classes, *sound root class* is the simplest and it is easy to categorize its morphological information. A sound root consists of three consonants all of which are different (Ryding, 2005). On the other hand, *non-sound root classes* are categorized in several subtypes depending on the position of weak letters (i.e., vowels) and gemination or hamza. All these subtypes carry morphological information.

From any particular sequence of root letters (i.e., triliteral and quadriliteral), up to fifteen different verb stems may be derived, each with its own template. These stems have different semantic information. Western scholars usually refer to these forms as Form I, II, …, XV. Form XI to Form XV are rare in Classical Arabic and are even more rare in Modern Standard Arabic. These forms are discussed in detail in (Ryding, 2005). Here we give examples of each of the well-known ten verb forms.

1. Form I (Transitive): *kataba* (كَتَبَ) – "He wrote".

2. Form II (Causative): *kattaba* (كَتَّبَ) – "He caused to write".

3. Form III (Ditransitive): *kātaba* (كَاتَبَ) – "He corresponded".

4. Form IV (Factitive): *aktaba* (أَكْتَبَ) – "He dictated".

5. Form V (Reflexive): *takattaba* (تَكَتَّبَ) – "It was written on its own".

6. Form VI (Reciprocity): *takātaba* (تَكَاتَبَ) – "They wrote to each other".

7. Form VII (Submissive): *inkataba* (اِنكَتَبَ) – "He was subscribed".

8. Form VIII (Reciprocity): *iktataba* (اِكتَتَبَ) – "They wrote to each other".

9. Form IX (Color or bodily defect): *iḥmarra* (اِحمَرَّ) – "It turned to red".

10. Form X (Control): *istaktaba* (اِستَكتَبَ) – "He asked to write".

It is worth mentioning that Form−I has eight subtypes depending on the vowel following the middle letter in perfect and imperfect forms. Some types of verbal noun formation depend on these subtypes. Any combination of root letters for Form−I verb will follow any one of these eight patterns. We refer these patterns as Form IA, IB, IC, . . ., IH. These subtypes are shown in Table 1 with corresponding examples. For example, the vowels on the middle letter for Form−IA: nas**a**ra yans**u**ru are a and u for perfect and imperfect forms, respectively. Similarly, other forms depend on the combination of vowels on these two positions. Not all kinds of combinations exist. In Form−IH, the middle letter is a long vowel and there is no short vowel on this letter. No verbal noun is derived from Form−IH subtype. In summary, we can generate different types of verbal nouns based on these verb forms, root classes and vowel patterns.

Table 1: Subtype of Form I.

Form	Example	Perfect mid-vowel	Imperfect mid-vowel
Form−IA	نَصَرَ يَنصُرُ (*naṣara yanṣuru*)	a	u
Form−IB	ضَرَبَ يَضرِبُ (*ḍaraba yaḍribu*)	a	i
Form−IC	فَتَحَ يَفتَحُ (*fataḥa yaftaḥu*)	a	a
Form−ID	سَمِعَ يَسمَعُ (*samiʿa yasmaʿu*)	i	a
Form−IE	كَرُمَ يَكرُمُ (*karuma yakrumu*)	u	u
Form−IF	حَسِبَ يَحسِبُ (*ḥasiba yaḥsibu*)	i	i
Form−IG	فَضُلَ يَفضِلُ (*faḍula yafḍilu*)	u	i
Form−IH	كَادَ يَكَادُ (*kāda yakādu*)		

2.2 The classification of verbal nouns

In this section we discuss the eight types of nouns derived from verbs (LearnArabicOnline.com, 2003-2010a):

1. Gerund (إسم مَصدَر - *ism maṣdar*)- names the action denoted by its corresponding verb.
2. Active participle (إسم الفَاعِل - *ism alfāʿil*)- entity that enacts the base meaning i.e. the general actor.
3. Hyperbolic participle (إسم المُبَالَغَة - *ism almubālaġah*)- entity that enacts the base meaning exaggeratedly. So it modifies the actor with the meaning that actor does it excessively.
4. Passive participle (إسم المَفعُول - *ism almafʿuwl*)- entity upon which the base meaning is enacted. Corresponds to the object of the verb.
5. Resembling participle (اَلصِفَةُالمُشَبَّهَة - *alṣifatu'lmušabbahah*)- entity enacting (or upon which is enacted) the base meaning intrinsically or inherently. Modifies the actor with the meaning that the actor does the action inherently.
6. Utilitarian noun (إسم الآلَة - *ism alālah*)- entity used to enact the base meaning i.e. instrument used to conduct the action.
7. Locative noun (إسم الظَرف - *ism alẓarf*)- time or place at which the base meaning is enacted.
8. Comparative and superlative (إسم التَفضِل - *ism altafḍil*)- entity that enacts (or upon whom is enacted) the base meaning the most. In Arabic, this type of word is categorized as a noun, but it is similar to an English adjective.

Examples of these eight types of verbal nouns are presented in Table 2. Each of these types can be subcategorized on the basis of types of verbs. To understand complete variation of verb and its morphology we should have some preliminary knowledge of the Arabic verb.

3 HPSG Formalism for Verbal Noun

In this section we model the categories of verbal nouns and their derivation from different types of verbs through HPSG formalism. We adopt the SBCG version of HPSG (Sag, 2010) for this analysis. We discuss different HPSG types of root verbs and verbal nouns and then propose a multiple inheritance hierarchical model for Arabic verbal nouns. We give an AVM for nouns and extend it for verbal nouns then propose how to get a sort description of an AVM for verbal nouns from the type hierarchy. Finally, we propose construction rules of verbal nouns from root verbs.

Table 2: Different types of verbal nouns.

Source verb	Verb derived noun	Example	Meaning
ʿalima (alima) means “he knew”	Gerund	أَلعِلمُ (*alʿilmu*)	“Knowing”
	Active participle	عَالِمٌ (*ʿālimun*)	“One who knows”
	Hyperbolic participle	عَلَّامَةٌ (*ʿallāmatun*)	“One who knows a lot”
	Passive participle	مَعلُومٌ (*maʿluwmun*)	“That which is known”
	Resembling participle	عَلِيمٌ (*ʿaliymun*)	“One who knows intrinsically”
	Utilitarian noun	مِعلَمٌ (*miʿlamun*)	“Through which we know”
	Locative noun	مَعلِمٌ (*maʿlimun*)	“Where/when we know”
	Comparative and Superlative	أَعلَمُ (*ʾʿlamu*)	“One who knows the most”

3.1 AVM of Arabic nouns

We modify the SBCG feature geometry for English and adopt it for Arabic. The SBCG AVMs for nouns in English and Arabic are shown in Figure 2 and Figure 3, respectively.

The PHON feature is out of the scope of this paper. The MORPH feature captures the morphological information of signs and replaces the FORM feature of English AVMs. The value of the feature FORM is a sequence of morphological objects (formatives); these are the elements that will be phonologically realized within the sign’s PHON value (Sag, 2010). On the other hand, MORPH is a function feature. It not only contains these phonologically realized elements but also contains their origins. MORPH contains two features - ROOT and STEM. ROOT feature contains root letters for the following cases:

1. The root is characterized as a part of a lexeme, and is common to a set of derived or inflected forms

2. The root cannot be further analyzed into meaningful units when all affixes are removed

$$\begin{bmatrix} \textit{noun-lex} & \\ \text{PHON} & [\,] \\ \text{FORM} & [\,] \\ \text{ARG-ST} & list(sign) \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & \ldots \\ \text{SELECT} & \ldots \\ \text{XARG} & \ldots \\ \text{LID} & \ldots \end{bmatrix} \\ \text{VAL} & list(sign) \\ \text{MRKG} & mrk \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & i \\ \text{FRAMES} & list(frame) \end{bmatrix} \end{bmatrix}$$

Figure 2: SBCG noun AVM for English

$$\begin{bmatrix} \textit{noun-lex} & \\ \text{PHON} & [\,] \\ \text{MORPH} & \begin{bmatrix} \text{ROOT} & list(letter) \\ \text{STEM} & list(letter) \end{bmatrix} \\ \text{ARG-ST} & list(sign) \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & \ldots \\ \text{DEF} & \ldots \\ \text{SELECT} & \ldots \\ \text{XARG} & \ldots \\ \text{LID} & \ldots \end{bmatrix} \\ \text{VAL} & list(sign) \\ \text{MRKG} & mrk \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & \begin{bmatrix} \text{PERSON} & \ldots \\ \text{NUMBER} & \ldots \\ \text{GENDER} & \ldots \\ \text{HUM} & \ldots \end{bmatrix} \\ \text{FRAMES} & list(frame) \end{bmatrix} \end{bmatrix}$$

Figure 3: SBCG noun AVM for Arabic

3. The root carries the principal portion of meaning of the lexeme

In rest of the cases,the content of this feature is empty.

The STEM feature contains a list of letters, which comprise the word or phrase or lexeme. We can identify any pattern in the lexeme by substituting the root letters to the placeholders in STEM. As an example, the ROOT of the lexeme ‘kataba’ contains ‘k’, ‘t’ and ‘b’ and the pattern of the STEM is $(\_a\_a\_a)$. Without the existence of this pattern, the ROOT is irrelevant. Thus a pattern bears the syntactic information and a ROOT bears the semantic information. Lexemes which share a common pattern must also share some common syntactic information. Similarly, lexemes which share a common root must also share some common semantic information. STEM is derived from the root letters by nonconcatenative morphology.

The SYN feature contains CAT, VAL and MRKG features. We modify the CAT feature of SBCG to adopt it for Arabic language. Note that, for all kinds of verbal nouns the sort description of the CAT feature is *noun*. In Arabic there are only three parts of speech (POS) for lexemes or words: noun/pronoun, verb and particle. Any verbal noun serving as a modifier is also treated as noun. In that case, the list of FRAMES under SEM feature will contain the *modifier-frame*. In the case of the Arabic noun, the CAT feature consists of CASE, DEF, SELECT, XARG and LID features.

The DEF feature denotes the value of definiteness of an Arabic noun. There are eight ways by which a noun word or lexeme may be definite (LearnArabicOnline.com, 2003-2010b). Personal pronouns such as “he”, “I” and “you” are inherently definite. Proper nouns are also definite. أَللّٰهُ (*ʾal-lāhu*) is another instance of definite lexeme. These examples confirm that definiteness must be specifiable at the lexeme level. The article al also expresses the definite state of a noun of any gender and number. Thus if the state of a noun is definite, the noun contains yes as the value of DEF, otherwise its value will be no. There is a significant role of this definiteness (DEF) feature in Arabic. A nouns and its modifier must agree on the DEF feature value. For example, اَلكِتَابُ الأَحمَرُ (*alkitābu ’l-ʾaḥmaru*) means “the red book”. اَلكِتَابُ (*alkitābu*) means “the book” and أَحمَرُ (*ʾaḥmaru*) means “red”. As “red” is used as a modifier for “the book”, the definiteness prefix al has been added to أَحمَرُ yielding اَلأَحمَرُ.

The agreement features are PERSON, NUMBER, GENDER and HUM. These are contained inside the INDEX feature under SEM. The HUM feature denotes humanness. Depending on languages, agreement may have gender, human/non-human, animate/inanimate or shape features (Pollard and Sag, 1994). In Arabic, Humanness is a crucial grammatical factor for predicting certain kinds of plural formation and for the purpose of agreement with other components of a phrase or clause within a sentence. The grammatical criterion of humanness only applies to nouns in the plural form. As an example, “these boys are intelligent” (هَـؤُلَاْء الَاولَادُ أَذكِيَاْء - *haʾulāʾ alāwlādu ʾadkiyāʾ*) and “these dogs are intelligent” (هَـذِهِ

الكِلَابُ ذَكِيَّةٌ - *haḏihi ’lkilābu ḏakiyyatun*). Both sentences are plural. But the former refers to human beings whereas latter refers to non-humans. So the same word “intelligent” (*ḏakiyyun*) has taken two different plural forms in two sentences: أَذْكِيَاء (*ʾaḏkiyāʾ*) and ذَكِيَّةٌ (*ḏakiyyatun*). In the case of boys, it is in the third person masculine plural form (أَذْكِيَاء - *ʾaḏkiyāʾ*) whereas in case of dogs, it is in the third person feminine singular form (ذَكِيَّةٌ - *ḏakiyyatun*). If the noun refers to a human being then the value of HUM is yes, otherwise it is no. Thus, along with PERSON, NUMBER and GENDER, we keep HUM as an agreement feature.

The value of PERSON for Arabic noun can be $1st$, $2nd$ or $3rd$. There are three number values in Arabic. So, the value of NUMBER can be sg, $dual$ or pl denoting singular, dual or plural, respectively. The GENDER feature contains either $male$ or $female$ value.

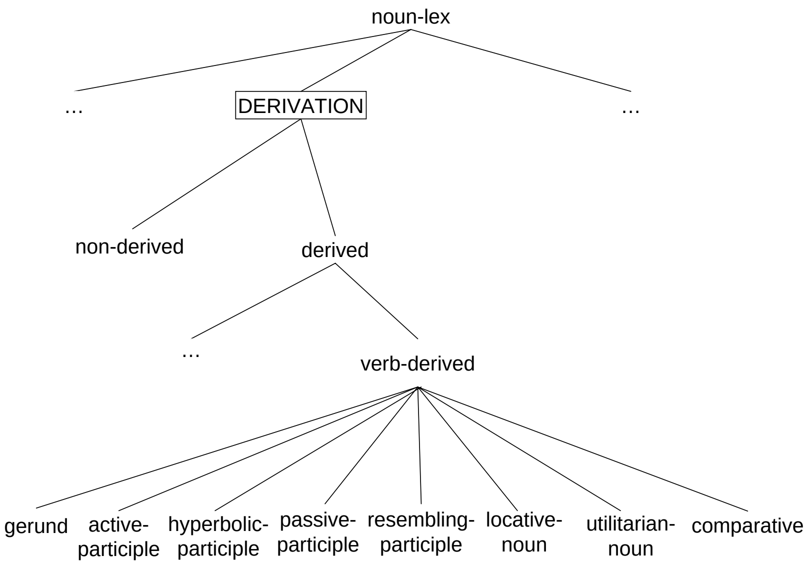

Figure 4: Lexical type hierarchy of Arabic noun lexeme.

3.2 Type Hierarchy of Verbal Noun

As mentioned in Section 2.1, the derivation of verbal nouns from verbs depends on the number of root letters, the verb form and the root type. In Figure 4 we give a type hierarchy of Arabic verbal nouns.

As shown in Figure 4, eight types of verbal nouns are immediate daughters

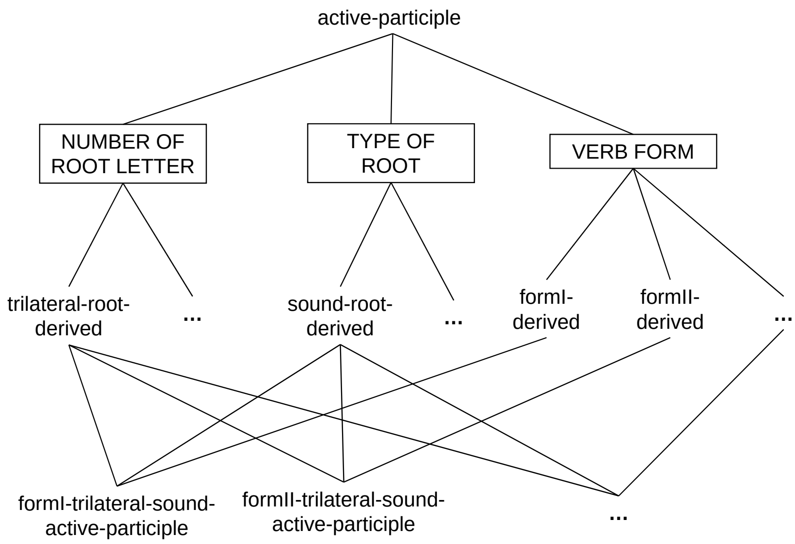

Figure 5: Lexical type hierarchy of Active participle.

of *verb-derived-noun*. Each of these eight different verbal nouns can be subcategorized on the basis of the properties of the root verb, which are mentioned in Section 2.1. Each verb carries distinct information on these properties, which form the dimensions of classification for verbs. So, the three dimensions for root verbs are: number of root letter, type of the root and verb form. For lack of space we discuss in detail only the subtypes of active participles.

In Figure 5, *active-participle* is at the root. Categorizing it along the number of letter in root verb, we get two types of active participles, derived from triliteral and quadriliteral root verb. Some verbal nouns are generated from triliteral roots only. For example, comparative and superlative nouns are derived only from triliteral Form-I verbs. Also, verbal nouns derived from triliteral roots have known patterns. Again classifying the active participle along the root type, we find several types of roots and thus verbal nouns. Categorizing along the verb form dimension, we get Form-I, . . ., Form-X active participles. Categories in one dimension cross-classifies with categories in other dimensions and forms different subtypes like *form-I-triliteral-sound-active-participle*, *form-I-triliteral-sound-passive-participle*, *form-I-triliteral-sound-gerund*, etc. Not all these forms generate all types of verbal nouns— i.e. some of these forms do not have corresponding verbal nouns of all types. For example, locative nouns are generated from triliteral Form-I root verbs only. So for this type of verbal noun, classifying along other Forms does not generate any new type.

3.3 Construction Rule for Verbal Nouns

Before discussing the construction rules, we discuss a sample AVM for an active participle. After this, we will discuss other verbal nouns as well.

$$
\begin{bmatrix}
\multicolumn{2}{l}{\textit{kaatibun-form-IA-trilateral-sound-active-participle-lex}} \\
\text{MORPH} & \begin{bmatrix} \text{ROOT} & \left\langle k, t, b \right\rangle \\ \text{STEM} & \left\langle k, a, a, t, i, b, u, n \right\rangle \end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ & \\ \text{CASE} & nominative \\ \text{DEF} & no \\ \text{SELECT} & none \\ \text{XARG} & none \\ \text{LID} & none \end{bmatrix} \\ \text{VAL} & \langle\rangle \\ \text{MRKG} & none \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{INDEX} & \boxed{i} \begin{bmatrix} \text{PERSON} & 3rd \\ \text{NUMBER} & sg \\ \text{GENDER} & masc \\ \text{HUM} & yes \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{write-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & i \\ \text{UNDGR} & j \end{bmatrix} \right\rangle \end{bmatrix}
\end{bmatrix}
$$

Figure 6: AVM for active participle

A sample AVM for an active participle is shown in Figure 6. All features of this AVM except SEM have been discussed before. SEM contains two features: INDEX and FRAMES. The INDEX feature registers reference to a discourse entity. FRAMES is the list of semantic frames which contains a frame for active participles which is the action frame. In this example the action frame is the *write-fr* which denotes write frame. This frame contains three indices: one for actor, another for the undergoer of the action (i.e. object) and the last one is for action or event.

We do not store this AVM as a lexical entry. Rather, this AVM is recognized by our lexical construction rules. The construction rule in Figure 7 shows how a verbal noun can be constructed from a verb. As we use the SBCG version of HPSG, the construction rule contains two parts: MTR which contains the AVM of the verbal noun and DTRS which contains the AVM of the base verb. This rule demonstrates how a Form−IA triliteral sound active participle is recognized from the lexeme of Form−IA triliteral sound root verb. The construction rule contains three placeholders for the three root letters. Thus from this construction rule, an active participle generated from letters ‘k’, ‘t’ and ‘b’ or ‘n’, ‘s’ and ‘r’ can be recognized. Note that there is no difference between constructing an active participle from a sound triliteral Form IB−IF verb and a sound triliteral Form−IA verb. The construction of the active participle from Form−I verb is most regular. Other constructions are complex. For some verbs other forms even do not exist. Thus it requires further analysis.

$$
\begin{bmatrix}
\textit{form-IA-trilateral-sound-active-participle-lex-cxt} & \\
\text{MTR} & \begin{bmatrix}
\textit{form-IA-trilateral-sound-active-participle-lex} & \\
\text{MORPH} & \begin{bmatrix}\text{STEM} & \left\langle \boxed{1}, a, a, \boxed{2}, i, \boxed{3}, u, n \right\rangle\end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix}\text{CAT} & \begin{bmatrix}\textit{noun} & \\ \text{CASE} & nominative\end{bmatrix} \\ \text{VAL} & \langle\rangle\end{bmatrix} \\
\text{SEM} & \begin{bmatrix}\text{INDEX} & i \\ \text{FRAMES} & \left\langle \begin{bmatrix}\textit{event-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & i\end{bmatrix} \right\rangle\end{bmatrix}
\end{bmatrix} \\
\text{DTRS} & \left\langle \begin{bmatrix}
\textit{form-IA-trilateral-sound-active-perfect-3rd-sg-masc-verb-lex} & \\
\text{MORPH} & \begin{bmatrix}\text{STEM} & \left\langle \boxed{1}, a, \boxed{2}, a, \boxed{3}, a \right\rangle\end{bmatrix} \\
\text{SYN} & \begin{bmatrix}\text{CAT} & \begin{bmatrix}\textit{verb} & \\ \text{VFORM} & perfect \\ \text{VOICE} & active\end{bmatrix}\end{bmatrix} \\
\text{SEM} & \begin{bmatrix}\text{INDEX} & s \\ \text{FRAMES} & \left\langle \begin{bmatrix}\textit{event-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & i\end{bmatrix} \right\rangle\end{bmatrix}
\end{bmatrix} \right\rangle
\end{bmatrix}
$$

Figure 7: Lexical rule for active participle construction

Like that of the active participle, the construction of the passive participle from Form-I trilateral sound root verb is simple. There is just one pattern for this construction. So for all Form-I subtypes, the construction rule of figure 8 will be applicable. Derivation from other forms of verbs is complex and not regular. For some forms this type of participle does not exist either, which requires further analysis.

The verbs from which passive participles are derived should be transitive. For this reason, in the AVM of the DTR, the ARG-ST feature is not empty and its semantic index is co-indexed with the undergoer index in the *event-fr*. Note that the ARG-ST of the DTR contains one sign for object only, and it is in accusative case. It does not contain any sign for the actor. This is because, in Arabic, the actor is implicitly mentioned in the verb and the verb does not syntactically require the actor. If a subject is explicitly mentioned in the sentence, it can be parsed by phrasal construction rule.

$$
\begin{bmatrix}
\multicolumn{2}{l}{\textit{form-IA-trilateral-sound-passive-participle-lex-cxt}} \\
\text{MTR} & \begin{bmatrix}
\multicolumn{2}{l}{\textit{form-IA-trilateral-sound-passive-participle-lex}} \\
\text{MORPH} & \begin{bmatrix}\text{STEM} & \left\langle m, a, \boxed{1}, \boxed{2}, u, u, \boxed{3}, u, n \right\rangle\end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix}\text{CAT} & \begin{bmatrix}\multicolumn{2}{l}{\textit{noun}} \\ \text{CASE} & nominative\end{bmatrix} \\ \text{VAL} & \langle\rangle\end{bmatrix} \\
\text{SEM} & \begin{bmatrix}\text{INDEX} & i \\ \text{FRAMES} & \left\langle\begin{bmatrix}\multicolumn{2}{l}{\textit{event-fr}} \\ \text{SIT} & s \\ \text{ACTOR} & j \\ \text{UNDGR} & i\end{bmatrix}\right\rangle\end{bmatrix}
\end{bmatrix} \\
\text{DTRS} & \left\langle \begin{bmatrix}
\multicolumn{2}{l}{\textit{form-IA-trilateral-sound-passive-perfect-3rd-sg-masc-verb-lex}} \\
\text{MORPH} & \begin{bmatrix}\text{STEM} & \left\langle \boxed{1}, a, \boxed{2}, a, \boxed{3}, a \right\rangle\end{bmatrix} \\
\text{ARG-ST} & \left\langle \boxed{4} \begin{bmatrix}\text{SYN} & \begin{bmatrix}\text{CAT} & \begin{bmatrix}\multicolumn{2}{l}{\textit{noun}} \\ \text{CASE} & accusative \\ \text{OPT} & -\end{bmatrix}\end{bmatrix} \\ \text{SEM} & \begin{bmatrix}\text{INDEX} & i\end{bmatrix}\end{bmatrix} \right\rangle \\
\text{SYN} & \begin{bmatrix}\text{CAT} & \begin{bmatrix}\multicolumn{2}{l}{\textit{verb}} \\ \text{VFORM} & perfect \\ \text{VOICE} & active\end{bmatrix} \\ \text{VAL} & \left\langle \boxed{4} \right\rangle\end{bmatrix} \\
\text{SEM} & \begin{bmatrix}\text{INDEX} & s \\ \text{FRAMES} & \left\langle\begin{bmatrix}\multicolumn{2}{l}{\textit{event-fr}} \\ \text{SIT} & s \\ \text{ACTOR} & j \\ \text{UNDGR} & i\end{bmatrix}\right\rangle\end{bmatrix}
\end{bmatrix} \right\rangle
\end{bmatrix}
$$

Figure 8: Lexical rule for passive participle construction

A locative noun can be generated from triliteral Form-I root verbs only. There are two patterns of derivation, and which pattern will be used for derivation is predictable. Form IA, IC, ID, IE and IG use the construction rule shown in Figure 9, whereas Form IB and IF use the construction rule shown in Figure 10.

In the AVM of a locative participle, we introduce a semantic frame *locative-fr*. This frame has two features. These are the index for the event and the index for the location of the event. The event index of this frame is co-indexed with the event index of *event-fr*. Thus it implements the location constraint of this participle.

$$
\begin{bmatrix}
\textit{form-IA-trilateral-sound-locative-participle-lex-cxt} & \\
\text{MTR} & \begin{bmatrix}
\textit{form-IA-trilateral-sound-locative-participle-lex} & \\
\text{MORPH} & \begin{bmatrix} \text{STEM} & \left\langle m, a, \boxed{1}, \boxed{2}, a, \boxed{3}, u, n \right\rangle \end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & nominative \end{bmatrix} \\ \text{VAL} & \langle\rangle \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{INDEX} & i \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{event-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & j \end{bmatrix}, \begin{bmatrix} \textit{locative-fr} & \\ \text{SIT} & s \\ \text{LOCATION} & i \end{bmatrix} \right\rangle \end{bmatrix}
\end{bmatrix} \\
\text{DTRS} & \left\langle \begin{bmatrix}
\textit{form-IA-trilateral-sound-locative-perfect-3rd-sg-masc-verb-lex} & \\
\text{MORPH} & \begin{bmatrix} \text{STEM} & \left\langle \boxed{1}, a, \boxed{2}, a, \boxed{3}, a \right\rangle \end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & perfect \\ \text{VOICE} & active \end{bmatrix} \\ \text{VAL} & \langle\rangle \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{INDEX} & s \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{event-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & j \end{bmatrix} \right\rangle \end{bmatrix}
\end{bmatrix} \right\rangle
\end{bmatrix}
$$

Figure 9: Lexical rule for the locative participle construction from Form IA sound root verb

Figure 11 shows the construction rule for comparative participles. We have introduced a new semantic frame *compare-fr* inspired by the analysis of Farkas, et.al. (Farkas and Kiss, 2000). This frame has three features. The first feature is “COMPARED”, which contains the index for the object that we want to compare. The second feature is “COMPAREWITH”. This feature contains the index for the object with which we want to compare. The last feature is the dimension of com-

$$
\left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{form-IB-trilateral-sound-locative-participle-lex-cxt}} \\
\text{MTR} & \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{form-IB-trilateral-sound-locative-participle-lex}} \\
\text{MORPH} & \left[\text{STEM} \quad \left\langle m, a, \boxed{1}, \boxed{2}, i, \boxed{3}, u, n \right\rangle\right] \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{noun}} \\ \text{CASE} & nominative \end{array}\right] \\
\text{VAL} & \langle\rangle
\end{array}\right] \\
\text{SEM} & \left[\begin{array}{ll}
\text{INDEX} & i \\
\text{FRAMES} & \left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{event-fr}} \\ \text{SIT} & s \\ \text{ACTOR} & j \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{locative-fr}} \\ \text{SIT} & s \\ \text{LOCATION} & i \end{array}\right] \right\rangle
\end{array}\right]
\end{array}\right] \\
\text{DTRS} & \left\langle \left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{form-IB-trilateral-sound-locative-perfect-3rd-sg-masc-verb-lex}} \\
\text{MORPH} & \left[\text{STEM} \quad \left\langle \boxed{1}, a, \boxed{2}, a, \boxed{3}, a \right\rangle\right] \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \left[\begin{array}{ll}
\text{CAT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{verb}} \\ \text{VFORM} & perfect \\ \text{VOICE} & active \end{array}\right] \\
\text{VAL} & \langle\rangle
\end{array}\right] \\
\text{SEM} & \left[\begin{array}{ll}
\text{INDEX} & s \\
\text{FRAMES} & \left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{event-fr}} \\ \text{SIT} & s \\ \text{ACTOR} & j \end{array}\right] \right\rangle
\end{array}\right]
\end{array}\right] \right\rangle
\end{array}\right]
$$

Figure 10: Lexical rule for locative participle construction from Form IB sound root verb

parison.

This participle has an optional syntactic requirement, which is contained in the ARG-ST feature. The case of the required sign must be genetive. Its semantic index is co-indexed with the index of "COMPAREWITH" in *compare-fr*.

$$
\begin{bmatrix}
\textit{form-IA-trilateral-sound-comparative-participle-lex-cxt} & \\
\text{MTR} & \begin{bmatrix}
\textit{form-IA-trilateral-sound-comparative-participle-lex} & \\
\text{MORPH} & \begin{bmatrix} \text{STEM} & \left\langle a, \boxed{1}, \boxed{2}, a, \boxed{3}, u \right\rangle \end{bmatrix} \\
\text{ARG-ST} & \left\langle \boxed{4} \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & genetive \\ \text{OPT} & + \end{bmatrix} \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{INDEX} & j \end{bmatrix} \end{bmatrix} \right\rangle \\
\text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & nominative \end{bmatrix} \\ \text{VAL} & \left\langle \boxed{4} \right\rangle \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{INDEX} & i \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{event-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & i \end{bmatrix}, \begin{bmatrix} \textit{compare-fr} & \\ \text{COMPARED} & i \\ \text{COMPAREWITH} & j \\ \text{DIMENSION} & s \end{bmatrix}, \right\rangle \end{bmatrix}
\end{bmatrix} \\
\text{DTRS} & \left\langle \begin{bmatrix}
\textit{form-IA-trilateral-sound-comparative-perfect-3rd-sg-masc-verb-lex} & \\
\text{MORPH} & \begin{bmatrix} \text{STEM} & \left\langle \boxed{1}, a, \boxed{2}, a, \boxed{3}, a \right\rangle \end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{verb} & \\ \text{VFORM} & perfect \\ \text{VOICE} & active \end{bmatrix} \\ \text{VAL} & \langle\rangle \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{INDEX} & s \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{event-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & i \end{bmatrix} \right\rangle \end{bmatrix}
\end{bmatrix} \right\rangle
\end{bmatrix}
$$

Figure 11: Lexical rule for comparative participle construction

The construction of the remaining four types of verbal nouns is complex and we cannot resolve these by construction rules. We have to list the lexical entries for these verbal nouns individually. The reasons are discussed below.

Each verb form has a gerund that uses the most unpredictable pattern. Modeling its construction rule is a vast area of research. For now we can only list lexical entries for all gerunds individually.

$$
\begin{bmatrix}
\textit{kattaabun-hyperbolic-participle-lex} & \\
\text{MORPH} & \begin{bmatrix} \text{ROOT} & \left\langle k, t, b \right\rangle \\ \text{STEM} & \left\langle k, a, t, t, a, a, b, u, n \right\rangle \end{bmatrix} \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \textit{noun} & \\ \text{CASE} & nominative \\ \text{DEF} & no \end{bmatrix} \\ \text{VAL} & \langle\rangle \\ \text{MRKG} & none \end{bmatrix} \\
\text{SEM} & \begin{bmatrix} \text{INDEX} & \boxed{i} \begin{bmatrix} \text{PERSON} & 3rd \\ \text{NUMBER} & sg \\ \text{GENDER} & masc \\ \text{HUM} & yes \end{bmatrix} \\ \text{FRAMES} & \left\langle \begin{bmatrix} \textit{write-fr} & \\ \text{SIT} & s \\ \text{ACTOR} & i \\ \text{UNDGR} & j \end{bmatrix}, \begin{bmatrix} \textit{modifier-fr} & \\ \text{ARG} & i \end{bmatrix} \right\rangle \end{bmatrix}
\end{bmatrix}
$$

Figure 12: Sample lexical entry for ‘kattaabun’ hyperbolic participle

Hyperbolic Participles are generated only from triliteral sound Form-I root verbs. But not all verbs possess a corresponding hyperbolic participle. There are eleven patterns for deriving hyperbolic participles from verbs. However, we can not predict from the root letters which of these eleven patterns will be used; neither can we infer the existence of a hyperbolic participle for the given root letter. So we have to list a lexical entry for each of these hyperbolic participles. Figure 12 shows a sample lexical entry for hyperbolic participle kattaabun which means the person who writes a lot. We have used the *modifier-fr* frame to capture the modification constraint.

Resembling Participles are similar to hyperbolic participles. They are generated only from triliteral sound FORM-I root verbs. There exists a large number of derivational patterns in this case. So, it is not feasible to formulate a lexical construction rule for these nouns. Thus in this case we also need to give the lexical entries. Figure 13 shows the lexical entry for katiibun which means a person who always writes. Like hyperbolic participle, here we have used the *modifier-fr* frame to capture the modification constraint.

Utilitarian Nouns are also generated from triliteral sound Form-I root verbs only. There are four patterns of derivation. For a given set of root letters it is unpredictable which pattern will be used. For this reason, despite the limited number of patterns, we have to list the lexical entries exaustively.

$$
\left[\begin{array}{ll}
\multicolumn{2}{l}{\textit{katiibun-resemble-participle-lex}} \\
\text{MORPH} & \left[\begin{array}{ll} \text{ROOT} & \left\langle k, t, b \right\rangle \\ \text{STEM} & \left\langle k, a, t, i, i, b, u, n \right\rangle \end{array}\right] \\
\text{ARG-ST} & \langle\rangle \\
\text{SYN} & \left[\begin{array}{ll} \text{CAT} & \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{noun}} \\ \text{CASE} & nominative \\ \text{DEF} & no \end{array}\right] \\ \text{VAL} & \langle\rangle \\ \text{MRKG} & none \end{array}\right] \\
\text{SEM} & \left[\begin{array}{ll} \text{INDEX} & \boxed{i}\left[\begin{array}{ll} \text{PERSON} & 3rd \\ \text{NUMBER} & sg \\ \text{GENDER} & masc \\ \text{HUM} & yes \end{array}\right] \\ \text{FRAMES} & \left\langle \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{write-fr}} \\ \text{SIT} & s \\ \text{ACTOR} & i \\ \text{UNDGR} & j \end{array}\right], \left[\begin{array}{ll} \multicolumn{2}{l}{\textit{modifier-fr}} \\ \text{ARG} & i \end{array}\right] \right\rangle \end{array}\right]
\end{array}\right]
$$

Figure 13: Sample lexical entry for ‘katiibun’ resemble participle

4 Conclusion

In this paper, we have captured the morphology of the Arabic verbal noun by extending the MORPH, SYN and SEM features. We have provided a detailed analysis of verbal nouns generated from triliteral sound Form I verbs. We have also devised inflectional rules which can be used to construct verbal nouns of different number and gender.

Immediate extensions of this work could be the modeling verbal noun from triliteral non-sound Form I verb and the analysis of verbal nouns based on quadriliteral verbs. An important aspect to note is that for some verb forms, there exists no specific construction rules, while for certain combination of root letters fixed construction patterns exist. Classifying these roots is an important research area not considered yet.

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Korean Comparative Constructions: A Constraint-Based Approach and Computational Implementation

Jong-Bok Kim
Kyung Hee

Jaehyung Yang
Kangnam

Sanghoun Song
University of Washington

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Abstract

The complexity of comparative constructions in each language has given challenges to both theoretical and computational analyses. This paper first identifies types of comparative constructions in Korean and discusses their main grammatical properties. It then builds a syntactic parser couched upon the typed feature structure grammar, HPSG and proposes a context-dependent interpretation for the comparison. To check the feasibility of the proposed analysis, we have implemented the grammar into the existing Korean Resource Grammar. The results show us that the grammar we have developed here is feasible enough to parse Korean comparative sentences and yield proper semantic representations though further development is needed for a finer model for contextual information.

1 Types of Korean Comparative Constructions

Comparison constructions, involving comparing two participants in terms of the degree of some gradable property relating to them, are encoded differently in each language. Korean also employs quite different morphological and syntactic properties from languages like English and even Japanese (cf. Kim and Sells 2010). As illustrated in the following two main types of comparatives in (1), Korean uses the optional comparative marker *te* 'more', the postpositional standard marker *pota* 'than' as basic elements in forming comparatives (cf. Jhang 2001, Choe 2008, Kim and Sell 2009):

(1) a. tongsayng-i hyeng-pota chayk-ul (te) manhi ilkessta
young.bro-NOM old.bro-than book-ACC more many read
'The younger brother read more books than his older brother.'

b. tongsayng-i [[hyeng-i _ ilk-un] kes-pota] (te) manhi
young.bro-NOM old.bro-NOM read-MOD *k*es-than more many
ilkessta
read
'The younger brother read more than his older brother did.'

Phrasal comparatives (PC) in (1a) involve two compared nominals whereas clausal comparatives (CC) in (1b) have core clausal properties. With the strong motivation for capturing the truth conditionally identical meaning between phrasal and clausal comparatives, it is commonly assumed that phrasal comparatives are derived from clausal sources through deletion rules (cf. Bresnan 1973, Pancheva 2006, Bhatt and Takahashi 2007).

To see if all Korean comparatives can be grouped into these two clausal and phrasal types, we extracted comparative sentences from the sample examples in the verbal (*vv*) and adjectival (*va*) lexical entries of the Sejong Electronic Dictionary (compiled on the basis of the 100 million words of the Sejong Corpus):

†This work was supported by the Korea Research Foundation Grant (KRF-2009-A00065).

(2) Comparative Sentences from the Sejong Electronic Dictionary

	total entry #	sample Ss #	NP-*pota* Ss	CM *pota* Ss
va entries	4,389	14,816	196	6
vv entries	15,181	52,981	298	35
Total	19,570	67,797	486	41

As indicated here, from the total 67,797 sample sentences in the adjectival (va) and verbal (vv) lexical entries, we extracted total 486 comparative sentences including an NP-*pota* 'than' expression and 41 sentences where *pota* is used as a comparative marker (CM). We analyzed these 486 sentences and could identify 9 additional types that cannot be identified either as PC or CC examples, including the following two types:

(3) a. John-un seykey kkilok-pota ppalli talliessta
John-TOP world.record-than fast ran
'John ran faster than the world record.'

b. ku-uy ima-ka na-pota te pantulkel-yess-ta
he-GEN forehead-NOM I-than more shiny-PAST-DECL
' (lit.) His forehead is more shiny than me.'

The presumed source sentence for (3a) 'the world record runs' does not make any sense. Examples like (3b) are also peculiar since the friend's forehead is syntactically compared with not my forehead but 'me', which is not possible in English. Such an empirical investigation tells us that we cannot reduce all phrasal comparatives to corresponding clausal comparatives as often assumed in the transformational framework.

In this paper, we provide a surface-based, lexicalist analysis that can parse the complex Korean comparative constructions as well as a context-dependent semantic analysis. We then sketch the results of implementing our analysis within the LKB system.

2 Parsing the Structure

2.1 Clausal Comparatives

A rich set of empirical data indicates that the clause-like complement in CC is in fact a free relative NP headed by *k*es. Previous literature has assumed that the noun *kes* is a complementizer introducing a CP (e.g., Lee 2002, Park 2009). However, rich evidence undermines this assumption. For example, the complement clause of *pota* can occur only in the NP position, and *k*es in clause-like comparatives can be replaced by a common noun and even be preceded by a determiner:

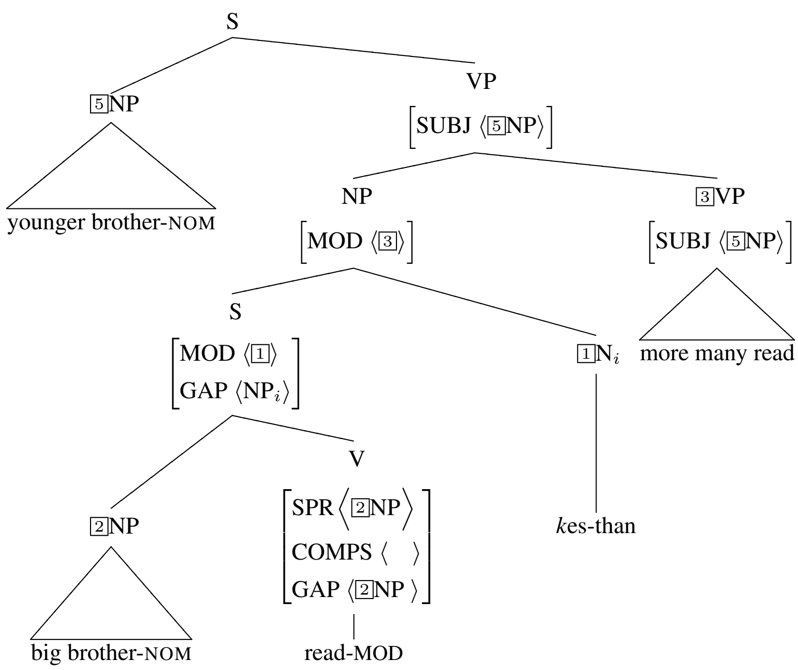
(4) John-un [Tom-i sa-n (ku) kes/chayksang]-pota pissan
John-TOP Tom-NOM buy-MOD the kes/desk-than expensive
chayksang-ul sa-ass-ta
desk-ACC buy-PAST-DECL
'John bought a more expensive desk than what Tom bought.'

If *k*es in comparatives were simply a complementizer, such a behavior would not be expected. In addition, the noun *k*es cannot refer to a person. This restriction also holds in comparative constructions, indicating its nominal status:

(5) John-un [Tom-i manna-n *kes/salam]-pota chakha-n
John-TOP Tom-NOM meet-MOD *k*es/person-than honest-MOD
salam-ul mannassta
man-ACC met
'John met a more honest man than Tom met.'

Based on these observations, we assume that clausal-like comparatives basically involve a relative clause headed by the noun *k*esas represented in the following structure for (1b):

(6)



As given in the structure here, the comparative marker *pota* is attached to the noun *kes*, heading the complex NP consisting of *kes* and an S with a missing element. Like a relative clause, the gapped object of *ilk-un* 'read-MOD' in the modifier S is coindexed with the head noun *k*es. The complex NP functioning as standard expression also modifies the gradable predicate *te manhi ilkessta* 'more many read'. The structure thus assumes that clausal comparatives are in fact NP-phrasal comparatives.

There are also cases where *kes* clauses with no syntactic gap as in (7). Within the relative clause analysis we adopt here, such gapless examples are expected when considering Korean also has amount relative clauses. In fact, all the clause-like comparatives with no overt gap can be reinterpreted as amount or degree relative clause with the replacement by a noun like *cengto* 'degree', *sokto* 'speed', or *kil* 'way':

(7) a. John-un [Mary-ka talli-n kes/degree]-pota te ppali
John-TOP Mary-NOM run-MOD kes/degree-than more fast
kel-ess-ta
walk-PAST-DECL
'John walked faster than the speed that Mary ran'.

b. [wuli-ka ka-nun kil]-i [haksayng-tul-i o-nun
we-NOM go-MOD way-NOM student-PL-NOM come-MOD
kes/pangpep-pota] phyenha-ta
kes/way-than convenient-DECL
'For us to go is a more convenient way than for students to come.'

2.2 Phrasal Comparatives

The standard marker *-pota* can be attached to a nominal element, allowing only an NP-*pota* phrase. This NP-*pota* phrase has rather flexible distributional possibilities. For example the standard expression NP-*pota* can either precede or following the associate NP. However, when the standard phrase is semantic-case marked, the possibility of scrambling the NP-*pota* disappears:

(8) *chaykpang-eyse tosekwan(-eyse)-pota kongpwu-ka te cal
bookstore-at library-at-than study-NOM more well
toynta
become
'It is better to study at a bookstore than at a library.'

Another intriguing property is that Korean allows more than one NP-*pota* phrase. In such case too, these standard expressions must be adjacent:

(9) a. yenge-pota cwungkwuke-pota hankwuke-ka elyep-ta
English-than Chinese-than Korean-NOM difficult-DECL
'(lit.) Korean is more difficult than English and Chinese.'

b. *yenge-pota hankwuke-ka cwungkwuke-pota elyep-ta
English-than Korean-NOM Chinese-than difficult-DECL

This again indicates that NP-*pota* forms a constituent with the associate NP that follows it. This contrast indicates that the *pota*-phrase cannot be scrambled freely, in addition suggesting that there should be a configuration where the two compared individuals are combined. The most natural position is the standard and the compared parameter in adjacent positions. Based on the observations that the simple NP-*pota* prefers to combine with the associate NP when it is immediately followed, as illustrated in the following for (9a):

(10) [$_{NP}$ English-than [$_{NP}$ Chinese-than [$_{NP}$ Korean-NOM]]] difficult-DECL

As indicated here, the standard expression combines with the associate NP, forming a bigger NP.[1] This analysis, assuming the existence of base-generated phrasal comparatives, thus treats the 'standard' and compared phrase as a kind of NP modifying structure.

The ordering patterns we observe from our 486 samples also provides support for this kind of analysis:

(11)

Ordering Patterns in the Sejong Electronic Dictionary

Word Ordering Patterns	Frequency
Pattern 1: NP-*pota* + NP-associate	136
Pattern 2: NP-*pota* YP NP-associate	240
Pattern 3: NP-associate + NP-*pota*	5
Pattern 4: NP-associate YP NP-*pota*	105
Total	486

The NP-*pota* standard expression can immediately precede its associate (Pattern 1) but there is no example where it immediately follows the associate (Pattern 3) though the standard expression can follow it when there is an intervening expression (Pattern 4). We interpret the rare instances of Pattern 3 as supporting evidence for the postulation of the NP-modifying structure, allowing the two NPs in Pattern 1 to combine first, but not those two NPs in Pattern 3. We believe that this NP modifying structure can support the preference to have an coordination-like NP structures for Korean as for English (cf. Napoli 1983).

As Pattern 2 and 4 orderings, they are many contexts where the NP-*pota* and its associate are not adjacent with no precedence constraint. In order to capture such flexible, distributional possibilities of the standard of comparison NP-*pota* expression in a surface-oriented grammar, we assume that in addition to the coordination-like structure, the NP-*pota* 'than' can also syntactically modify a verbal element. For example, (3a) will have the following VP modifying structure:

(12) [$_{S}$ John-TOP [$_{VP}$ world.record-than [$_{VP}$ fast ran]]]

[1] The coordination marker *-wa* 'and' behaves similar to *pota* in many respects: they attach only to an NP, can follow the associate NP, can have multiple identical phrases in order. See Kim and Sells (2009).

In this structure, the NP-*pota* (world.record-than) modifies the verbal predicate *fast ran*, forming a modifier structure. An issue can arise from assuming two different functions of the NP-*pota*, one modifying the following associate NP and the other modifying a verbal predicate. This may be a burden to the grammar, but seems to be inevitable when considering the distributional possibilities and preferences of the NP-*pota* as well as its semantic interactions.

3 Contextual Dependent Interpretation

In terms of semantics, phrasal comparatives appear to be similar to clausal comparatives. For example, the PC in (1a) and the CC in (1b) will have the identical LF structure:

(13) [[MORE]] (λd the younger brother is d-much tall) (λd the older brother is d-much tall).

As noted earlier, the rational move to capture this kind of systematic meaning relationships between phrasal and clausal comparatives seems to posit a clausal source and then compute the semantics in a compositional way. In a compositional analysis as given in (13), the complement of *than* denotes a set of degrees compared to the degree in the matrix clause while the comparative morpheme (MORE) denotes a relation between two sets of degrees. The main gist of such an analysis is that the *than*-clause and the main clause provide a predicate of degrees.

However, there are many obstacles to compose the meaning of comparatives in a compositional way in Korean as hinited earlier. The first issue is the status of the functor 'MORE' that selects two propositional arguments. In languages like Korean, the comparative marker is not present in syntax always: that is, unlike *more* in English, its counterpart *te* 'more' is optional in most cases. Within a compositional analysis where the comparative marker *more* is a functor taking two degree-denoting arguments, we need to assume an invisible comparative morpheme. A second major issue that arises from such a compositional analysis is the existence of many comparative constructions whose interpretations are context-dependent. One such clear instance concerns the head-deletion type as we have seen in (3). Our 486 examples include dozens of examples where the standard expression NP-*pota* is not the expression that is really compared:

(14) a. nay yenge sillyek-un Chelswu-pota nasta
my English ability-TOP Chelswu-than better
'(lit.) My English is better than Chelswu.'

b. i ccok-eyse tangki-nun him-i ce ccok-pota nemwu yakhay
this side pulling-MOD power-NOM that side-than more week
'(lit.) The pulling power in this side is much weaker than that side.'

In such examples, the NP complement of *pota* does not express the head element which is compared with the associate NP. For example in (14b), the compared elements are not this side and that side: they are the power in both sides. The standard expression thus just sets the context which will help us to conjecture the target of comparison. Such examples strong support the assumption that comparison highly depends on context.

As Beck et al. (2004) and Oda (2008) suggest, there are many cases in languages like Japanese where the interpretation of comparatives also hinge on context. In such a context-dependent analysis, the standard expression denotes just a set of individuals, setting a context for comparison. Within this context-dependent, non-degree abstraction analysis, comparatives are assumed to have a similar meaning to the English expression ‘compared to’. Given these kinds of paraphrase, the truth conditions of comparatives can be something like the following:

(15) $\max(\lambda d \text{ Mary wrote } d\text{-many papers}) > c$

$\text{c} = \text{the number made salient by the utterance context}$

$: - \text{the number of papers John wrote}$

The variable *c* is a contextually provided degree whose value is provided by the complement of *pota* ‘than’. This means the value of *c* is inferred from the set of individuals denoted by the standard NP-*pota* expression. This context-dependent analysis, providing contextual information for the value of a free variable *c*, means that there is no degree movement in the matrix clause.[2]

Adopting this contextual dependent analysis, we treat all the NP-*pota* as a modifier whose semantic argument is just the standard expression. In addition, the NP-*pota* introduces the contextual background relation *contextual-comparison*, reflecting its context-setting function. We can represent this as lexical information:

(16)
$$\begin{bmatrix} \textit{n-than-mod} \\ \text{SYN} \begin{bmatrix} \text{HEAD} \mid \text{POS } \textit{noun} \\ \text{MOD } \left\langle \text{XP[IND } \boxed{1}] \right\rangle \end{bmatrix} \\ \text{SEM} \begin{bmatrix} \text{IND } i \\ \text{RELS } \left\langle \begin{bmatrix} \text{PRED } \textit{pota\_rel} \\ \text{ARG1 } i \end{bmatrix} \right\rangle \end{bmatrix} \\ \text{CNXT} \mid \text{BKGR} \begin{bmatrix} \text{PRED } \textit{contextual-comparison} \\ \text{ARG1 } \boxed{1} \\ \text{ARG2 } i \end{bmatrix} \end{bmatrix}$$

[2]An alternative parametric view between English type comparatives and Japanese type comparatives are given by Kennedy (2007). The analysis maintains that languages may differ in whether the comparative morphology selects a standard of type *d* (degree comparison) or type *e* (individual comparison) with assuming two different comparative morphemes (more), one for a clausal and the other for phrasal. An issue for such an analysis is the optionality of the comparative morphology in Korean.

The lexical entry syntactically modifies either a nominal or a verbal element. However, in terms of semantics, the NP projected from this word has an individual index. Notice that we introduce the relation *contextual-comparison* whose arguments are linked to both the modifying predicate and the standard expression. This supertype has two subtypes realized in syntax: *n-than-nmod* and *n-than-vmod*, depending on what the phrase projected from this word modifies. Each of these two subtypes will have the following lexical specifications:

(17)

a. $$\left[\begin{array}{l} \textit{n-than-nmod} \\ \text{SYN} \left[\begin{array}{l} \text{HEAD} \mid \text{POS } \textit{noun} \\ \text{MOD} \left\langle \left[\begin{array}{l} \text{DEG } + \\ \text{POS } \textit{nominal} \\ \text{IND } j \end{array}\right] \right\rangle \end{array}\right] \\ \text{SEM} \mid \text{RELS} \left\langle \left[\begin{array}{l} \text{PRED } \textit{than\_rel} \\ \text{ARG1 } i \\ \text{ARG2 } j \end{array}\right] \right\rangle \end{array}\right]$$

b. $$\left[\begin{array}{l} \textit{n-than-vmod} \\ \text{SYN} \left[\begin{array}{l} \text{HEAD} \mid \text{POS } \textit{noun} \\ \text{MOD} \left\langle \left[\begin{array}{l} \text{DEG } + \\ \text{POS } \textit{verbal} \\ \text{IND } \textit{e1} \end{array}\right] \right\rangle \end{array}\right] \\ \text{SEM} \mid \text{RELS} \left\langle \left[\begin{array}{l} \text{PRED } \textit{than\_rel} \\ \text{ARG1 } i \end{array}\right] \right\rangle \end{array}\right]$$

The NP-*pota* projected from (17a) will combine with its associate NP. In this case, the relation *contextual-comparison* takes these two NPs as its arguments, leading us a clear semantic composition too. Meanwhile, the NP-*pota* projected from (17b) modifies a gradable predicate. The NP-*pota* projected from such a word will syntactically modify a predicate. In this case, the relation *contextual-comparison* takes different arguments: one is the modifying predicate and the other is the standard NP expression itself. The interpretation is almost similar to 'compared to'.

This line of approach assumes that the standard of comparison is inferred from context, and comparisons are made by pragmatics. This is different from a compositional analysis in which the semantics of comparison is compositionally derived. Though it appears that the analysis leaves the burden of proper meaning composition to context, this way of direction is rather unavoidable when considering highly context-dependent properties of the comparative constructions in Korean, i.e., head-noun deleted comparatives.

4 A Computational Implementation:

The analysis we have presented so far has been incorporated in the typed-feature structure grammar HPSG for KRG (Korean Resource Grammar) aiming at working with real-world data (cf. Copestake 2002 for English, Kim and Yang 2004, Kim 2004 for Korean.) To check the computational feasibility of the analysis, we have implemented the analysis into the LKB (Linguistic Knowledge Building) system.[3]

[3]The current Korean Resource Grammar, version 2.0, as of July 2009, has 659 lexical types and 114 phrasal types, 99 grammar rules, 304 inflectional rules, 39,688 lexical entries, and 1198 test-suite sentences, and 77% successful parsing rates.

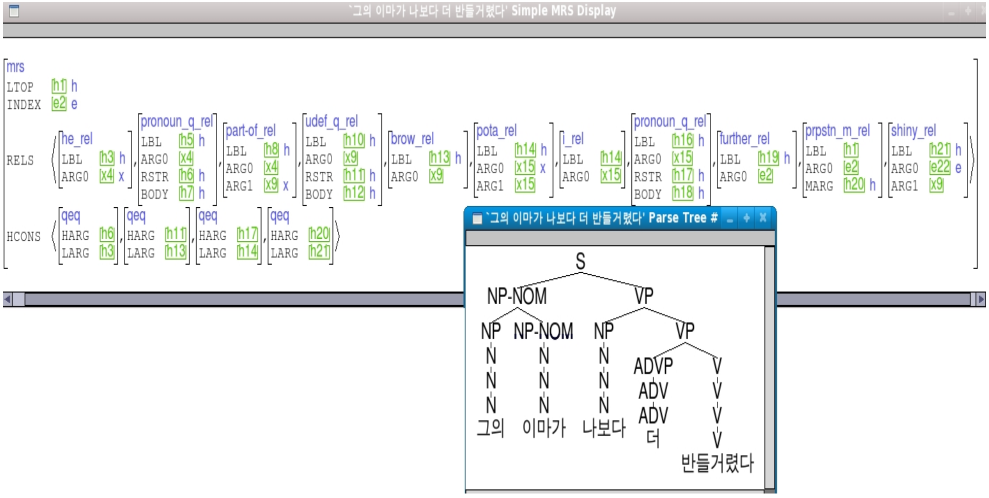


Figure 1: Parsed Tree and MRS for the gapless clausal comparative *His forehead is more shiny than mine*

'krg/comparative/research/sj/comparative' Coverage Profile							
Aggregate	total items ♯	positive items ♯	word string ϕ	lexical items ϕ	distinct analyses ϕ	total results ♯	overall coverage %
$5 \leq$ *i-length* < 10	59	59	5.93	34.70	119.64	55	93.2
$0 \leq$ *i-length* < 5	41	41	3.73	26.50	12.79	39	95.1
Total	**100**	**100**	**5.03**	**31.32**	**75.31**	**94**	**94.0**

Figure 2: Profile of the Two Test Suites

As the first step we selected 100 test suite sentences from our 486 sample sentences as well as literature. Figure 1 is one sample syntactic and semantic structure that our implementation produces as the parsing results for the sentence (3b). The small box in Figure 1 indicates parsed tree structures whereas the big box denotes the MRS representations. In terms of the syntactic structure, we can observe the grammar thus generates the structure in which the standard phrase NP-*pota* modifying the predicate. We can notice here that the MRS, though not clearly visible, also provides a proper *pota* 'than' semantic relation. The contextual comparison is given in the contextual information.

In addition, as a way of evaluating the computational feasibility of the analysis, we also established two `[incr tsdb()]` test suites; the 'baseline' to be parsed with the existing KRG (Korean Resource Grammar) and the 'comparative' to be parsed with the new grammar. Figure 2 is the resulting profile we obtained: As shown in Figure 2, the overall coverage of 'comparative' is 94% as shown below, which is the same as that of 'baseline', but the resulting readings of 'comparative' (6,043) are almost twice as many as those of 'baseline' (3,083), which means our revised grammar yields the promising parsing results as well as the same results that the previous one does.[4]

In terms of computational implementation, there still are more issues for our analysis to be resolved. However, we can observe that the grammar implemented in the LKB system is feasible enough to extend to more complex data in a process of building a comprehensive KRG.

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[4]The unparsed sentences have to do with unwritten grammars for meta-linguistic comparatives and comparative forms of adverbs. Several issues still remain to be tackled: reducing the number of parsed readings and checking the grammar with more data as well as even with negative (ungrammatical) sentences.

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The Family of English Cognate Object Constructions

Manfred Sailer
Univesity of Göttingen

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Abstract

In the Cognate Object Construction (COC) a typically intransitive verb combines with a postverbal noun phrase whose head noun is morphologically or semantically cognate to the verb. I will argue that English has a family of COCs which consists of four different types. The COCs share common core properties but differ with respect to some of their syntactic and semantic properties. I will capture the “cognateness” between the verb and the noun in all COCs by token identities at the level of their lexical semantic contribution. I will use an inheritance hierarchy on lexical rule sorts to model the family relations among the different COC types.

1 Introduction

In a *Cognate Object Construction* (CO construction, COC) a typically intransitive verb combines with an NP which has the same meaning or the same morphological stem. Classical examples form Sweet (1891) are as in (1).

(1) a. fight a good fight
b. sleep the sleep of the just

In addition to this semantic and morphological characterization, we only speak of a COC if the verb is highly restricted with respect to the nouns that it may combine with. Consequently, in (2-a) and (2-b) we have a real CO, while in (2-c) the noun *dance* can be considered a regular direct object and in (2-d) the noun *growth* is on par with other extension NPs.

(2) a. Smith died a gruesome death/ *a murderer/ *a suicide.
b. Sam lived a happy life/ *something happy.
c. Smith danced a jolly dance/ a jig.
d. The tree grew a century's growth/ a century's expansion within only ten years. (Nakajima, 2006)

While the distinction between real COs and apparent COs seems important, authors differ with respect to how they classify individual examples. It seems, thus, that an adequate characterization of the COC should also provide a basis for explaining why the (2-c) and (2-d) examples are sometimes taken as COCs.

In this paper I will pursue two arguments: First, all English cognate objects have argument status. Second, nonetheless we need to distinguish different types of cognate objects, which correlate with the interpretive possibilities of the CO. I

[†]I would like to thank Silke Höche, Sebastian Löbner, Diana Massam Asya Pereltsvaig, and Gert Webelhuth for comments and help with access to the relevant literature. I am grateful to Sylvia Anderson for proofreading. All errors are mine.

The corpus data have been retrieved from the British National Corpus (BNC) using the corpus interface at corpus.byu.edu/bnc.

will address the syntax of the construction in Section 2 and its semantics in Section 3. In Section 4 I will present my analysis and I will conclude in Section 5.

2 Formal Properties of English Cognate Objects

In this section I will argue that all COs in English should be syntactically treated as complements (Section 2.1). Nonetheless, there are reasons to distinguish formally between two types of COCs. In Section 2.2 I will substantiate this second claim on the basis of corpus data collected in Höche (2009).

2.1 Adjunct vs. Complement

A major issue in the discussion of English COs is the question of whether they should be analyzed as adjuncts or complements. The adjunct analysis goes back to Jones (1988) but has also been maintained in Moltmann (1989) and Huddleston and Pullum (2002). Proponents of a complement analysis, on the other hand, are Quirk et al. (1985), Massam (1990), and Kuno and Takami (2004). Nakajima (2006) proposes that some English COs are complements, some are adjuncts.

Jones (1988) assumes the following empirical properties as the genuine properties of the COC:

(3) a. Obligatory modification: Dan slept a *(peaceful) sleep.
b. Manner paraphrase: Dan smiled a happy smile. = Dan smiled happily.
c. No passive: *A happy smile was smiled by Dan.
d. COs are indefinite: *Dan smiled the happy smile.
e. COs are non-referential:
*Maggi smiled a happy smile and then her brother smiled it.

To account for (some of) these properties, Jones analyzes COs as adjuncts: Adjuncts don't passivize, they can express manner, and are typically non-referential. Thus, the properties in (b), (c), and (e) follow immediately.

In subsequent work, such as Massam (1990), Macfarland (1995), and Kuno and Takami (2004), it was argued that there are counterexamples to each of the properties in (3). Some of these data are given in (4).

(4) a. No modification:
A smile was smiled somewhere. (Kuno and Takami, 2004)
b. No manner paraphrase: Alex has laughed the last laugh.
$\neq$ Alex has laughed lastly/ ?in the last way.
c. Passive: The last laugh has now been laughed.
(Kuno and Takami (2004); Höche (2009); see also (4-a))
d. Definite COs: You've got to live your life. (BNC, Höche (2009))
e. Referential COs: Marie Jollie sighed a sigh that said many things.
(www.writerscafe.org/writing/paddleduck/609427/, 5.10.2010)

An additional strong argument against the adjunct analysis of COs, brought forth in Massam (1990), is the observation that COs are not compatible with overt realizations of direct objects as in (5). Adjuncts are not sensitive to the number of complements a verb takes as they attach later than complements.

(5) a. They fought a heroic fight.
 b. They fought the enemy heroically/ *a heroic fight.

Nakajima (2006) argues that English has two distinct types of COCs. A similar position can be found for a variety of other languages in Pereltsvaig (1999). The important bit of evidence for English comes from sentences like (6). Nakajima observes two readings for (6-a): A manner reading (*she lived happily*) and a non-manner reading in which *life* is seen as an abstract entity.[1] Passive is possible only with the second reading, which is therefore classified as an argument reading, whereas the manner reading is called an adjunct reading.

(6) a. The woman lived a happy life. (manner and non-manner reading)
 b. A happy life was lived by the woman. (only non-manner reading)

I agree with Nakajima's intuition about the interpretation of (6), i.e., that COCs which do not show the properties in (3) should be analyzed differently from the classical manner COs. Nonetheless, the data in (5) clearly supports the argument analysis for all English COCs.

2.2 Different Types of Cognate Objects in English

Höche (2009) presents a quantitative study of more than 3,000 occurrences of cognate verb-noun combinations in the British National Corpus (BNC). I will show that COs of the form "indefinite article – adjective – noun" cover a large part of her overall data, but that they are under-represented in passives. From this I conclude that even though all English COs are syntactically arguments, there is reason to distinguish two types of COs: One type is restricted to indefinite NPs with a manner modifier and does not passivize. The other type is less constraint in form and syntactic flexibility.

The quantitative results in Höche (2009) confirm that the generalizations in (3) are empirically problematic. Höche (p. 209) shows that while 44.8% of the COs occur with an adjectival modifier, 34.4% of the COs occur without any modifier at all. This makes it highly questionable that modification should be obligatory. If there is no modifier, it is not clear what a manner paraphrase should be. Even in cases where there is a modifier, i.e. an additional element in the CO, this is not necessarily an adjective. A manner paraphrase is not straightforward for PPs and relative clauses in the CO.

Höche investigated the passivizability of COs as well. Quoting from corpus literature, Höche estimates the overall occurrence of passives in English at a rate

[1] I will turn to the abstract entity reading in Section 3.

of 2–24% of the clauses, depending on genre, style, etc. Within her COC corpus, the percentage of passive clauses with a COC is 13.9% (Höche, 2009, p. 173). This suggests that COCs passivize just as frequently as other constructions. Finally, the restriction to indefinites can be questioned on a quantitative basis as well: Höche (p. 200) counts 55.5% of all COs as indefinite, and 43.8% of the COs as definite (with 0.7% as uncategorizable).

While Höche tends to reject the classical generalizations, I think that a more refined look at her data is fruitful. The distribution of the various properties in the data leads us to see that COs of the form "indefinite determiner – adjective – noun" make up a prominent subpart of the data and that COs of this type typically have the properties in (3). In contrast to this, I claim that there are COs whose internal structure is less restricted. This second type of COs can best be identified if the CO is definite, but it also occurs with indefinite COs, as we saw in (6-b). I will present three arguments that support the existence of the more restricted type of COC.

First, indefinite COs tend to occur with a modifier, whereas definite COs don't: We saw that the overall ration of unmodified COs in Höche's data is 43.8%. Among the unmodified COs, 64% are definite. This is even more striking since there are less definite than indefinite COs in the corpus.

Second, definite and indefinite COs show affinity to different kinds of modifiers, where the indefinites prefer adjectival modifiers. The table in (7) is a contingency table that displays how often indefinite COs and COs starting with a definite determiner occur with a PP or an adjective. Given the total numbers I calculated the expected values in each cell, which are given in brackets.[2]

(7) Adjectives or PPs as modifier (expected values in brackets):

	Adjective		PP		total
indefinite CO	788	(697)	137	(221)	925
CO with *the*	174	(255)	164	(81)	338
total	952		302		1263

The table shows that indefinite COs occur more often than expected with an adjective, but less often with a PP. For definite COs, this pattern is reversed. Moreover, indefinite COs have a strong preference for adjectives, but there is no clear tendency for definite COs.

Third, a look at the data on passives is informative: All examples of passives in Höche (2009) contained a CO with a definite determiner or a possessive expression. Very few examples of indefinite COs in passive are given in the literature. Kuno and Takami (2004) provide some examples of this type, given in (8).

(8) Examples of indefinite COs in passive (Kuno and Takami, 2004, p. 133)

a. A smile was smiled somewhere. (=(4-a))

b. Life can be lived in many different ways.

[2]The data used in (7) is not directly given in Höche (2009). I am grateful to Silke Höche for retrieving it from her data base and making it accessible to me.

c. Laughs are laughed, and some cheeks blush.

It is important for my point that all these examples are unmodified. Therefore, they do not have a manner paraphrase. These examples are of the same type as (6-b), i.e., they violate more than one of the properties in (3).

This closer look at the BNC data reveals that English has two COCs: One type of COC shows the classical properties in (3). Formally this type has a CO of the form "indefinite article – adjective – noun." The second type of COC is more flexible in form and also in its syntactic and semantic properties. The second type may contain indefinite COs, but definite and quantified COs are also possible here. It is important to note that the two constructions can only be identified on the basis of quantitative data because for both definites and indefinite COs, instances respecting or violating the classical properties can be found. If we look at the overall data pattern, however, we see that both the original intuitions behind the COC from Jones (1988) and the criticism brought forward against them in Massam (1990) are justified and do not contradict one another because they refer to different types of COCs. In the following I will look at the semantic properties of English COCs and relate them to their formal properties.

3 The Semantics of English Cognate Objects

Just as there are two prominent syntactic analyses of the COC there are two distinct approaches to its semantics. First, Moltmann (1989) analyzes COs as predicates over events. Second, Macfarland (1995) and Kuno and Takami (2004) treat them as the entities that result from the verbal event, i.e., they are analyzed as *effected objects*. In most of the literature, an adjunct analysis is combined with an event reading (Jones, 1988; Moltmann, 1989; Huddleston and Pullum, 2002), and a complement analysis with an effected object reading (Quirk et al., 1985; Macfarland, 1995; Kuno and Takami, 2004). However, this is not strictly necessary. Massam (1990) treats COs as syntactic complements which denote an event. This shows that, even though I follow the complement analysis of COs, this does not restrict my analytic possibilities as far as semantics are concerned.

I will argue that both event and effected object readings are attested in COCs (Section 3.1). Furthermore, we need to assume a difference between concrete (or particular) and abstract (or generic) COs (Section 3.2). This leads to a total of four semantically different COCs. In (9) I tried to construct as clear examples of the various types as possible.

(9) a. Alex lived a happy life. (particular event reading)
b. Bailey sighed a sigh that said many things. (concrete effected object)
c. Cameron slept the sleep of the just. (generic event reading)
d. Devin smiled the smile of reassurance. (abstract effected object)

I will show for each of the four readings in (9) that it corresponds to one of the readings that are independently available to the NPs occurring as COs.

3.1 COs Denoting Events or Effected Object

The examples in (10) show that an NP headed by nouns such as *smile* can denote an event or an object. This systematic ambiguity of nominalizations is widely accepted and discussed (see Ehrich and Rapp (2000) for an overview and some tests). In the event reading, the noun *smile* refers to the action of smiling. Events have a duration and, consequently, can occur as the subject of verbs such as *last* as in (10-a). Objects, on the other hand, can appear and disappear: Example (10-b) shows that such a reading is possible for *smile*. In the object reading, the noun *smile* refers to a particular constellation of the facial muscles.

(10) a. But the smile lasted less than a heartbeat. (BNC, event)
b. A smile appeared on his face. (BNC, object)

The sentences in (10) refer to a particular event, respectively to a concrete muscular constellation.

3.1.1 The Particular Event Reading

A noun like *smile* or *life* can occur in its particular event reading inside a COC. If the CO denotes a concrete event, then this is exactly the event that the verb refers to. This results in a COC of the type that Jones (1988) and Moltmann (1989) looked at. The empirical test for this reading is the availability of a manner paraphrase.

(11) Alex lived a happy life (=(9-a)) = Alex lived happily

Here, the CO typically has the form “indefinite article – adjective – noun”, i.e., it belongs to the special pattern that we identified in the corpus data. For this kind of COC a violation of the properties in (3) either leads to unacceptability or to the loss of the manner reading, as we saw in (6-b).

Researchers such as Moltmann (1989) and Mittwoch (1998) made use of event variables (Parsons, 1990) to model the particular event reading of COCs. I will follow this line of analysis. This leads to a semantic representation of the example sentence from (9-a)/(11) as given in (12).

(12) $\exists e(\mathbf{live}(e) \wedge \mathbf{happy}(e) \wedge \mathbf{Arg}_1(e, \mathbf{Alex}))$

Ignoring tense, this representation expresses the proposition that there is an event e which is a ‘living’-event. This event happens happily and Alex is its participant.

3.1.2 The Concrete Effected Object Reading

Kuno and Takami (2004) claim that COs denote a result of the verb’s activity. The result interpretation should lead to the prediction that COs are referential and COCs are telic. This is plausible for some examples, as shown by the compatibility with an *in*-PP as in (13-a), but not for others, as in (13-b).

(13) a. Mayflies live their lives in a day. (Massam, 1990, p. 178)
b. #She smiled a winning smile in 10 seconds. (Real-Puigdollars, 2008)

Sentence (9-b) above is an instance of the concrete object meaning of a COC. The noun *sigh* refers to a concrete exhalation sound, probably combined with a particular facial expression. What is special in the COC is that this object comes into existence by the very activity expressed in the verb, i.e., it is an *effected object*, also called a *resultant object*. Many of the COC examples from Kuno and Takami (2004) are of this type. This reading can be identified by the use of non-manner modifiers such as quantificational expressions in (14-a) or modifiers that express physical qualities of the effected object as in (14-b). This reading can also allow for pronominal reference to the CO. The German example in (14-c) indicates by the gender agreement that the masculine pronoun *ihn* in the second sentence is coreferential with the effected object, which is a masculine noun, and not with the verbal event. In the latter case a neuter form of the pronoun would be required.

(14) a. Many questions were asked, many foods shared, many new games learned, and many, many laughs were laughed.
(www.vfp.org/volVoices/volunteer_UK.html, 10.10.2010)
b. That precise same scream was screamed by the murder victim.
(Kuno and Takami, 2004, p. 127)
c. Christine seufzte [einen lauten Seufzer]$_i$. Diana hörte ihn$_i$ noch
Christine sighed a loud sigh. Diana heard it even
im Nebenzimmer.
in the room next door.

In (15) I provide a semantic representation of the concrete effected object reading. In the formalization, I again use an event variable for the event expressed by the verb. This event has a participant: the subject. The event causes the existence of an object x, which is a sigh.[3]

(15) Bailey sighed a deep sigh. (=(9-b))
$\exists e(\textbf{sigh}(e) \wedge \textbf{Arg}_1(e, \textbf{Bailey})$
$\wedge\textbf{CAUSE}(e, \exists x_{obj}(\textbf{sigh}(x) \wedge \textbf{Arg}_1(x, \textbf{Bailey}) \wedge \textbf{deep}(x))))$

Let us briefly address the issue of compositionality. In (16) I show which parts of (15) are contributed by the basic verb, the CO, and the construction. The basic verbal meaning is given in (16-a). We saw above hat the concrete object reading

[3] Note that I assume a sorted universe, i.e., there are eventualities, objects, and kinds, as we will see in Section 3.2. I use the variables $e, e', \ldots$ for eventualities and the subscripts obj and k for objects and kinds respectively. Consequently, the denotation of predicates like **smile** differs depending on the sort of their argument. For example, **smile**(e) is true iff e is a smiling event, **smile**(x_{obj}) is true iff x is a smile in the object sense.

of the CO is one of the possible readings of the NP. This reading is represented in (16-b). The constructional meaning, given in (16-c), determines how the meanings of the verb the CO are connected.

(16) Meaning contributions of the individual parts in (15)::
 a. basic meaning of the verb: $\exists e(\textbf{sigh}(e) \wedge \textbf{Arg}_1(e, \ldots) \ldots)$
 b. meaning of the CO: $\exists x_{obj}(\textbf{sigh}(x) \wedge \textbf{Arg}_1(x, \textbf{Bailey}))$
 c. constructional meaning: $\ldots \wedge \textbf{CAUSE}(\ldots e \ldots, \ldots x \ldots)$

In my analysis in Section 4, I will encode the COC as an instance of a valence-changing verbal construction. I will follow Müller (2006) and encode such constructions in HPSG using a lexical rule. The lexical rule will, then, introduce the constructional meaning.

In this subsection I argued for the existence of both an event reading and an effected object reading for COs. In both cases the agent of the verbal event must also be the one argument of the CO. In the particular event reading, the noun and the verb denote the same event. Therefore, the agent of the verb and the implicit argument of the noun must be the same. Similarly, if the CO is an effected object, as in (9-b), the CO must denote the sigh of the sigher.

3.2 Concrete and Abstract Denotations of COs

In the COCs considered so far we built the meaning on the basis of the particular event reading and the concrete object reading of the nominalization. I will now show that the relevant nouns have additional, more abstract readings. With the more abstract reading I refer to a kind reading. In formal semantics, kinds have been explored since Carlson (1980). Kinds are treated as abstract entities. They occur as arguments of kind-level predicates such as *be extinct/ widespread/ common/ rare*, see (17-a). To make the kind reading explicit, we can use special paraphrases using nouns such as *kind*, *sort*, *type*, *species* and others (Wilkinson, 1995). This is illustrated in (17-b).

(17) a. The dodo is extinct.
 b. = The species of the dodo is extinct.

Woisetschlaeger (1983) argues that relational nouns are usually ambiguous between an abstract (or kind) reading and a concrete reading that refers to an instance of this kind. He illustrates this with examples as the following.

(18) There was the wedding picture of a young couple among his papers.

World knowledge tells us that (i) a concrete copy of a picture was among the papers, (ii) there may be one “official wedding picture” of the couple, but there certainly are many copies of it. So, a singular definite relational NP can refer to the (definite) general concept of wedding picture, the kind in Carlson's terminology, or to an (indefinite) concrete copy, i.e., to an instantiation or realization of this kind.

The nouns that occur as COs are relational nouns, since they have at least one argument, the argument that corresponds to the agent in the verb. We expect to find the abstract reading of these nouns if they occur with an overt syntactic realization of this argument.

(19) a. Then, the smile of contentment appeared. (*type of*-insertion possible) (www.scenesofvermont.com/blog/, 15.10.2010)
b. The (type of) dance of a dervish usually lasts about 10 minutes.

The example in (19-a) illustrates the kind reading of the noun *smile*. The NP describes a particular type of smile, namely that of contentment. We can insert an explicit kind noun such as *type* without changing the meaning. This is a further argument that we have to do with a kind-NP here. Finally, since the NP occurs as the subject of the verb *appear*, we know that it is used to refer to an object. In other words, the NP *the smile of contentment* is used in (19-a) to refer to "an instance of the type of smile of contentment."

In example (19-b) the verb *last* enforces an event reading on the subject. At the same time, a *type of*-paraphrase is possible, which indicates a kind reading. In the case of events, this is called a *generic event* or an *event type* rather than an event kind. So, in (19-b), the subject refers to an instance of a generic event.

The examples above show that, by virtue of being nominalizations, the nouns occurring as COs can be used as referring to abstract kinds or generic events or to instances of such abstract entities. In the rest of this subsection I will show that these two readings are also possible inside COCs.

3.2.1 Generic Event COs

In (20-a) the CO must be interpreted as a generic event. It cannot be analyzed along the lines of the particular event COC from Section 3.1.1. The reason is that the subject, *I*, is not necessarily identical with the argument of the noun *life*, which is *a slave*. In addition, (20-b) shows that a *kind of*-paraphrase is possible.

(20) a. For two long years I lived the life of a slave. (BNC)
b. = For two long years I lived the kind/type of life of a slave.

Kind COs typically specify an indefinite or generic definite participant which differs from the subject but occupies the corresponding semantic role inside the CO. Kind COs are referential, which is also evidenced by the possibility to form a wh-question as in (21).

(21) What kind of life did you life for two years? The life of a slave.

There are naturally occurring examples of COCs with explicit *kind of*-paraphrases, some of which I give in (22).

(22) a. Of course, when thinking of DJ's, everybody has a clear idea of what kind of life they live.
(www.electronicsession.com/, 8.10.2010)
b. The native peoples had lived a kind of life many of us yearn for. (www.youmeworks.com/clingfree.html, 8.10.2010)

I rely on the standard formalization of kinds as in Carlson (1980) or Wilkinson (1995). I assume the two interpretations of the NP *the life of a slave* in (23), where I use **R** for the realization relation, i.e., $\mathbf{R}(e', e_k)$ is true iff e' is a particular event which is a realization of a generic event e_k. While the definite kind NP is ambiguous between the two readings, the corresponding indefinite *a life of a slave* can only have the interpretation in (23-b).

(23) a. kind reading of *the life of a slave*:
$\iota e_k : \forall e'(\mathbf{R}(e', e) \leftrightarrow \exists x(\mathbf{slave}(x) \wedge \mathbf{life}(e') \wedge \mathbf{Arg}_1(e', x)))$
b. "instance of a kind" reading of *the/a life of a slave*:
$\lambda P \exists e''(P(e'') \wedge \mathbf{R}(e'', \iota e_k : \forall e'(\mathbf{R}(e', e)$
$\leftrightarrow \exists x(\mathbf{slave}(x) \wedge \mathbf{life}(e') \wedge \mathbf{Arg}_1(e', x))))$

In a COC the event described by the verb is interpreted as an instance of the kind expressed in the CO. I assume that the CO is used in its kind-denoting way in (23-a). As for the concrete object reading, a lexical rule introduces a relation that combines the basic meaning of the verb with the meaning of the CO. In this case, we need the realization relation, **R**. The resulting interpretation of (20-a) is given in (24). The constructional meaning has the effect that the event denoted by the verb, e, is an instantiation (i.e. realization) of the kind denoted by the CO, e'_k.

(24) $\exists e(\mathbf{life}(e) \wedge \mathbf{Arg}_1(e, \mathbf{speaker})$
$\wedge \mathbf{R}(e, \iota e'_k : \forall e''(\mathbf{R}(e'', e') \leftrightarrow \exists x(\mathbf{slave}(x) \wedge \mathbf{life}(e'') \wedge \mathbf{Arg}_1(e'', x)))))$

3.2.2 Abstract (Kind) Object COs

The fourth possible reading of the CO is the abstract effected object reading, as in (9-d). The availability of a *kind of*-paraphrase shows that this is an abstract reading.

(25) Devin smiled the (kind of) smile of reassurance.

There are two typical syntactic patterns of this reading, as illustrated in (26): In (26-a) the CO is definite and followed by a PP which embeds an abstract noun. In (26-b) there is a possessive determiner and a further modifier.

(26) a. ...she smiled the smile of reassurance and of calm. (BNC)
b. Sachs smiled his irresistible smile. (BNC)

In (26-a) the PP does not fill the argument slot of the "smiler." Instead, it is a modifier whose meaning can be paraphrased as "indicating reassurance." In the examples the concrete smile is an effected object and an instance of the kind specified in the CO. This leads to the following semantic representation:

(27) Devin smiled the smile of reassurance. (=(9-d))

$$\exists e(\textbf{smile}(e) \wedge \textbf{Arg}_1(e, \textbf{Devin}) \wedge \textbf{CAUSE}(e, \exists x_{obj}(\textbf{R}(x, \iota y_k(\forall z(\textbf{R}(z,y) \leftrightarrow \textbf{smile}(z) \wedge \textbf{indicate-reassurance}(z))))))))$$

The abstract effected object reading has the most complicated semantic representation of the four discussed in this paper. The basic meaning of the verb is as in the other readings. The CO has its kind reading, which is the expressed in the ι-term $\iota y_k(\ldots)$. The constructional meaning combines the effected object reading by the introduction of the **CAUSE** relation with the instantiation reading, expressed by the realization relation **R**.

In this section I argued that the NPs that occur as COs can receive various interpretations and that these interpretations can be found also in their CO use. The semantic representation of the particular event COC is the simplest, since the verb and the CO refer to the same event. For the other types of COC, there is a special constructional meaning contribution that determines how the interpretation of the CO is related to the verbal event. This can be in the form of an effected object relation, as a realization relation or as both.

4 Analysis

The central innovation of my HPSG analysis is the focus on the "cognateness" of the verb and the head noun of CO. I will model this relatedness as an identity of semantic contributions. For all types of COCs the core lexical semantic contribution of the verb and the noun are identical. For the particular event COC this identity goes even further, such that the referential indices of the verb and the noun are identical as well. In Section 4.1 I will briefly present the framework that allows the use of this kind of identities.

To account for the similarity between the four types of COCs, I will develop an analysis as a family of constructions in the sense of Goldberg and Jackendoff (2004). This family behavior will be encoded by organizing the COCs in a sort hierarchy (Section 4.2). In Sections 4.3–4.5 I will present the analysis for the individual COC types.

4.1 Framework

An identity-based analysis is not straightforwardly compatible with a semantic combinatorics as proposed in Pollard and Sag (1994). However, the introduction of tools of underspecified semantics into HPSG as in *Underspecifed DRT* (Frank and Reyle, 1995), *Minimal Recursion Semantics* (MRS, Copestake et al. (2005))

and others have opened up new analytic possibilities. I will use the framework of *Lexical Resource Semantics* (LRS, Richter and Sailer (2004)) because it allows me to stick to a standard semantic representation language and, more importantly, the idea of identities of semantic contributions has been employed in LRS accounts of other phenomena (such as negative concord and multiple interrogatives).

In LRS, like in other frameworks of underspecified semantics, the semantic contribution of a sign is a list of expressions from a semantic representation language — here some version of predicate logic. These expressions may contain "holes", i.e., they need not be fully specified. The semantic expressions associated with a sign occur in the sign's PARTS value. The PARTS list of a phrase is the concatenation of the PARTS lists of its daughters. The logical form of an utterance, i.e. the semantic representation of its reading, is the result of combining all contributed expressions in such a way that all "holes" are filled. At each combinatorial step there may be constraints on how these holes can be filled. These constraints restrict the set of possible readings of a sentence in the appropriate way.

Richter and Sailer (2004) argue that if two signs combine to form a phrase, it is in principle possible that some of the elements on their PARTS list are token identical. This has the effect that, even though two words may contribute a particular semantic operator, say negation, the overall clause may only have one negation in its semantic representation.

In addition to the PARTS list, LRS assumes some features that capture the lexical semantic contribution of a word. These are the INDEX value, which encodes the referential index of a sign, and its MAIN value, which expresses the main lexical semantic contribution of the sign. For example, the INDEX value of the verb *smile* is some eventuality variable e, its MAIN value is the semantic constant **smile**.[4]

In LRS we assume a distinction between local and non-local semantic features. This distinction is motivated in Sailer (2004). The lexical semantic features such as INDEX and MAIN occur inside the CONTENT feature. For the non-local semantics a feature L(OGICAL-)F(ORM) is defined on each sign. The feature PARTS is located inside the LF value.

4.2 The Family of English Cognate Object Constructions

As said above, the COC is a construction that manipulates the valence of the input verb. Müller (2006) has argued that such constructions are best analyzed by means of lexical rules. Since Meurers (2001) it is common to encode lexical rules in HPSG as objects of the sort *lexical-rule* which embed two lexical signs, one being the input, the other being the output of the lexical rule. Meurers presents various ways to incorporate this idea into an HPSG grammar. The most common of these has been adapted for example in Sag (2007). Here, lexical rules are seen as giving rise to unary-branching syntactic structures in which the output of the lexical rule is the mother and the input is the only daughter. To be neutral about the concrete

[4]The features PARTS, INDEX, and MAIN have a function similar to that of the features RELS, INDEX, and KEY in MRS.

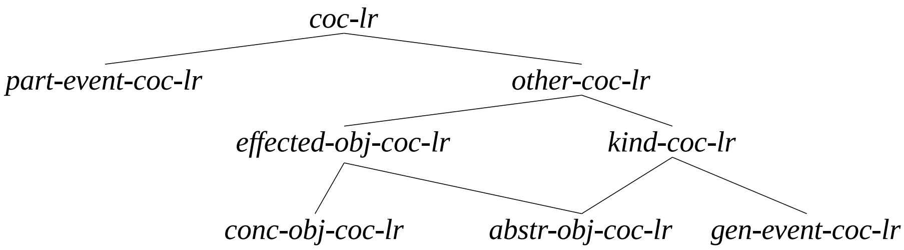

Figure 1: Sort hierarchy for the English COC family

cognate-object-construction-lexical-rule:

$$\left[\begin{array}{ll} \text{SYNS LOC} & \left[\begin{array}{ll}\text{CAT} & \left[\text{HEAD } \textit{verb}\right] \\ \text{CONT} & \left[\begin{array}{ll}\text{INDEX} & e\\ \text{MAIN} & \boxed{1}\end{array}\right]\end{array}\right] \\ \text{ARG-ST} & \left\langle \boxed{2} \right\rangle \end{array}\right] \mapsto \left[\text{ARG-ST } \left\langle \boxed{2}, \text{NP}\left[\text{LOC }\left[\text{CONT }\left[\text{MAIN } \boxed{1}\right]\right]\right]\right\rangle\right]$$

Figure 2: Constraint on the sort *cognate-object-construction-lexical-rule*

implementation of lexical rules, I will write them in the format "*XX-lexical-rule*: $\delta_{in} \mapsto \delta_{out}$", where *XX-lexical-rule* is the sort of a lexical rule, δ_{in} is a description of the input sign, and δ_{out} is a description of the output sign.

I will introduce a sort *cognate-object-construction-lexical-rule* (*coc-lr*). To model the family behavior of the English COC types, I will introduce subsorts of the sort *coc-lr*. The sort hierarchy below *coc-lr* is given in Fig. 1. Ultimately, there are four maximally specific subsorts, each corresponding to one of the COC types discussed in Section 3. The intermediate sorts serve the purpose of capturing common properties of the various COC types.[5]

There is a constraint on the top sort in Fig. 1 that expresses the general properties of all COCs. In my analysis there are three such conditions: (i) The input must be an intransitive, unergative verb. (ii) The output has an additional argument NP. (iii) To account for the cognateness, the new argument NP must make the same basic lexical semantic contribution as the verb. Fig. 2 shows this constraint on the sort *coc-lr*, where I ignore the restriction to unergative verbs. Note that this constraint needs to be read in the following way: For each object of sort *coc-lr*, the input sign must satisfy the description preceding the "$\mapsto$"-arrow and the output sign must satisfy the description following the arrow. The cognateness condition is implemented as identity on the MAIN values, for which I use the tag $\boxed{1}$.

We saw in the empirical section that the particular event COC is syntactically more restricted than the other three types. For this reason, the sort *coc-lr* has two

[5]The usually convention with lexical rules is that everything that is not explicilty altered in the outpus specification of a lexical rule stays as in the input (Meurers, 2001). I assume that this convention is only applied at maximally specific lexical rule sort and respects all inherited constraints.

particular-event-coc-lr:

$$\left[\text{SYNS LOC}\left[\text{CONT}\left[\text{INDEX}\ \boxed{4}\right]\right]\right] \mapsto \left[\text{ARG-ST}\left\langle \ldots, \left[\text{LOC}\left[\begin{array}{l}\text{CAT HEAD}\left[\begin{array}{ll}\text{PRED} & +\\ \text{DEF} & -\end{array}\right]\\ \text{CONT}\left[\text{INDEX}\ \boxed{4}\right]\end{array}\right]\right]\right\rangle\right]$$

Figure 3: Constraint on the sort *particular-event-coc-lr*

immediate subsorts: the sort *part(icular)-event-coc-lr* which captures the properties of the particular event COC, and the sort *other-coc-lr*, which captures the other types. The other types violate the restrictions in (3). The sort *other-coc-lr* has two subsorts as well: the sort *effected-obj(ect)-coc-lr* and the sort *kind-coc-lr*. The sort *effected-obj-coc-lr* accounts for the two effected object readings and introduces a **CAUSE** relation to the semantics. The sort *kind-coc-lr* accounts for the abstract readings discussed in Section 3.2. It requires that the CO be a kind and it introduces a realization relation to the semantic representation. These two sorts have two subsorts each, with one overlapping.

The subsorts of *effected-obj-coc-lr* are those that model the COCs with an effected object as the CO, such as the concrete effected object COC, modelled by the sort *conc(rete)-obj-coc-lr*, and the abstract effected object COC, modelled by *abstr(act)-obj(ect)-coc-lr*. The latter type of COC contains a realization relation. For this reason, it is also a subsort of *kind-coc-lr*, as is *gen(eric)-event-coc-lr*, which encodes the properties of the generic event COC.

4.3 Analysis of the Particular Event COC

The inheritance in the hierarchy in Fig. 1 makes it possible to write simple additional constraints on the subtypes of *coc-lr*. For example, the constraint on the sort *part-event-coc-lr* is given in Fig. 3. All that remains to be said in this constraint is that (i) the INDEX of the CO and the verb must be identical, indicated with the tag $\boxed{4}$, and (ii) that the CO is an indefinite predicative category.

Every instance of the particular event COC must obey the constraints on the sorts *coc-lr* and *part-event-coc-lr*. This combination leads to a description of the lexical rule as in Fig. 4. This figure can be used to show how my analysis captures the core properties of the particular event COC.

This rule turns an intransitive verb into a verb with two elements on its ARG-ST list, the original subject and the CO. These properties follow from the general constraint on COCs in Fig. 2. In addition to an identity of the MAIN values, the constraint on the specific COC type in Fig. 3 requires that the INDEX values of the verb and the CO be identical. The CO is specified as a predicative NP. This excludes passivization as predicative complements do not passivize in English.

To illustrate the effect of the lexical semantic identities I sketch the semantic combinatorics for sentence (9-a). In (28) the rows in the table show the PARTS lists of the individual signs. The cells in each row separate elements of the PARTS list.

$$\begin{bmatrix} \text{SYNS LOC} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HEAD} & \textit{verb} \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{INDEX} & e \\ \text{MAIN} & \boxed{1} \end{bmatrix} \end{bmatrix} \\ \text{ARG-ST} & \left\langle \boxed{2} \right\rangle \end{bmatrix} \mapsto \begin{bmatrix} \text{ARG-ST} & \left\langle \boxed{2}, \text{NP} \begin{bmatrix} \text{LOC} & \begin{bmatrix} \text{CAT HEAD} & \begin{bmatrix} \text{PRED} & + \\ \text{DEF} & - \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{INDEX} & e \\ \text{MAIN} & \boxed{1} \end{bmatrix} \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

Figure 4: Description resulting from combining the constraints on *coc-lr* and *part-event-coc-lr*

For better readability, I have arranged the cells in such a way that they all add up to the overall semantic representation of the sentence. I have underlined the MAIN value of each sign. The verb *smiled* contributes its MAIN value, **smile**, its INDEX, e, as well as the specification of the semantic role of the subject, $\textbf{Arg}_1(e, \ldots)$, and an existential quantification over the index. The noun *smile* makes a similar semantic contribution. Due to the lexical rule, the MAIN value of the noun and its index are identical with those of the verb. The adjective *happy* predicates over the index of the noun. The index identity between the noun and the verb has the effect that *happy* actually predicates over the eventuality expressed by the verb.

(28) [Alex [smiled$_V$ [a happy smile$_N$]$_{NP}$]$_{VP}$.]$_S$

smiled$_V$:	$\exists e($	$\underline{\textbf{smile}}(e)$		$\wedge$	$\textbf{Arg}_1(e,$		$))$
smile$_N$:		$\underline{\textbf{smile}}(e)$					
happy$_A$:			$\wedge\underline{\textbf{happy}}(e)$				
NP:		$\underline{\textbf{smile}}(e)$	$\wedge\textbf{happy}(e)$				
VP:	$\exists e($	$\underline{\textbf{smile}}(e)$	$\wedge\textbf{happy}(e)$	$\wedge$	$\textbf{Arg}_1(e,$		$))$
Alex:						$\underline{\textbf{Alex}}$	
S:	$\exists e($	$\underline{\textbf{smile}}(e)$	$\wedge\textbf{happy}(e)$	$\wedge$	$\textbf{Arg}_1(e,$	**Alex**	$))$

The lexical rule in Fig. 4 accounts for most of the properties in (3) but not for the obligatory modification requirement. This property follows from an independently motivated principle. My analysis of the particular event COC depends on the possibility that different words in a clause make the same meaning contribution. If this is allowed, the question arises how far such an identity may go. It seems reasonable to assume that in a phrase, the semantic contributions of the daughters should be distinct to some degree. This is expressed in the principle in (29).

(29) Principle of Semantic Discernibility:
In each phrase, for each daughter d with a non-empty PARTS list: The semantic contribution of d must not be fully included in that of another daughter.

The principle in (29) is sufficient to exclude instances of particular event COs without a modifier. Consider (28) again. Without the adjective *happy*, the semantic contribution of the CO would only be $\textbf{smile}(e)$. At the VP level, the CO's semantic *other-coc-lr*:

$$\begin{bmatrix} \text{SYNS LOC} & \left[\text{CONT} \left[\text{INDEX } \boxed{4}\right]\right] \\ \text{LF PARTS} & \boxed{3} \end{bmatrix} \mapsto \begin{bmatrix} \text{ARG-ST} \left\langle \ldots, \left[\text{LOC} \begin{bmatrix} \text{CAT HEAD} \left[\text{PRED } -\right] \\ \text{CONT} \left[\text{INDEX } \boxed{5}\right] \end{bmatrix}\right] \right\rangle \\ \text{LF PARTS } \boxed{3} \oplus \mathit{list} \oplus \left\langle \ldots \wedge \textbf{REL}(\boxed{4}, \ldots \boxed{5} \ldots) \right\rangle \oplus \mathit{list} \end{bmatrix}$$

$$\textbf{and } \boxed{4} \neq \boxed{5}$$

Figure 5: Constraint on the sort *other-coc-lr*

contribution would be fully included in the semantics of the head daughter. This would be a violation of the semantic discernibility requirement in (29).

We will see in the following subsection that the Principle of Semantic Discernibility allows for unmodified instances of the other types of COCs.

4.4 Analysis of the Concrete Effected Object COC

The concrete effected object COC is modelled with the lexical rule sort *conc-obj-coc-lr*. This is a subsort of the sorts *other-coc-lr* and *effected-obj-coc-lr*. For this reason, I will first introduce the constraints on these two sorts.

The COCs other than the particular event COC do not obey the restrictions in (3). In particular, they can passivize, the CO need not be modified and the choice of the determiner is free. In the semantic analysis in Section 3, (16) illustrated that the CO contributes a semantic index of its own and that there is a constructional meaning contribution which tells us how the referent of the CO relates to the event expressed by the verb. This is encoded in the constraint on the sort *other-coc-lr* given in Fig. 5.

The CO in the output is specified as non-predicative. This implies that there are no syntactic reasons to block passivization for these COC readings. There are no restrictions on the definiteness of the CO either.

There is a requirement that the indices of the verb and the CO be distinct ($\boxed{4} \neq \boxed{5}$). Therefore, the CO's semantic contribution is always discernible from that of the verb, even if there is no modifier inside the CO. Thus, we correctly capture the observation that the modifier restriction from (4-a) does not hold for these COCs.

In addition, the PARTS list of the output must be longer than that of the input: It contains a relation that relates the index of the verb and the index of the CO. In the figure I use the symbol **REL** as a placeholder of an arbitrary binary relation. Depending on the subtype of COC, this will be filled by the **CAUSE** relation or the realization relation **R**.

We can now turn to the special properties of the effected object readings. They all contain occurrence of the relation **CAUSE** in their semantic representation. Thus, we can formulate the constraint on the sort *effected-obj-coc-lr* in Fig. 6. It says that the PARTS list of the output contains the relation **CAUSE**.

Finally, there is a constraint on the sort *conc-obj-coc-lr*, given in Fig. 7. For the concrete effected object reading, the **CAUSE** relation is the only constructional *effected-object-coc-lr*:

$$\begin{bmatrix}\text{SYNS LOC} & \begin{bmatrix}\text{CONT} & \begin{bmatrix}\text{INDEX} & \boxed{4}\end{bmatrix}\end{bmatrix}\\ \text{LF PARTS} & \boxed{3}\end{bmatrix} \mapsto \begin{bmatrix}\text{LF PARTS}\ \boxed{3} \oplus \textit{list} \oplus \langle \ldots \wedge \textbf{CAUSE}(\boxed{4}, \ldots)\rangle \oplus \textit{list}\end{bmatrix}$$

Figure 6: Constraint on the sort *effected-object-coc-lr*

concrete-object-coc-lr:

$$\begin{bmatrix}\text{LF PARTS} & \boxed{3}\end{bmatrix} \mapsto \begin{bmatrix}\text{LF PARTS}\ \boxed{3} \oplus \langle \ldots \wedge \textbf{REL}(\ldots, \ldots)\rangle\end{bmatrix}$$

Figure 7: Constraint on the sort *concrete-object-coc-lr*

semantic contribution. To achieve this, it suffices to limit the growth of the PARTS list of the output: Only one relation can be introduced.

4.5 Analysis of the Kind COCs

In this subsection I will sketch the analysis of the two kind readings from Section 3.2. The kind readings are modelled by a subsort of *other-coc-lr*. Therefore, the cognateness is restricted to identity of MAIN values and the CO is syntactically free. The constraint on the sort *kind-coc-lr* is analogous to the constraint on the sort *effected-obj-coc-lr*, with the difference that the relation introduced is the instantiation/realization relation. In addition, the index of the CO must be an abstract entity, a kind. This is summarized in Fig. 8.

The verb's PARTS list, $\boxed{3}$, is extended to allow for the integration of the CO's semantic contribution. It now includes the relation **R** and the index of the CO must occur inside the second argument of this relation.

For the generic event COC we require that there be no constructional meaning contribution other than the realization relation. This is achieved by a constraint on the sort *gen-event-coc-lr*, which is analogous to the constraint in Fig. 7 above. The constraint is given in Fig. 9.

We saw in Section 3.2.2 that semantic representation of the abstract effected object COC contains both a **CAUSE** operator and a realization relation. In the family encoding of the COC types, this follows by making the sort *abstr-obj-coc-lr* inherit from both the sort *effected-obj-coc-lr* and the sort *kind-coc-lr*. The only thing that remains to be said in the constraint on the sort *abstr-obj-coc-lr* is that

kind-coc-lr:

$$\begin{bmatrix}\text{LF PARTS} & \boxed{3}\end{bmatrix} \mapsto \begin{bmatrix}\text{ARG-ST}\ \left\langle \ldots, \begin{bmatrix}\text{LOC} & \begin{bmatrix}\text{CONT} & \begin{bmatrix}\text{INDEX} & x_k\end{bmatrix}\end{bmatrix}\end{bmatrix}\right\rangle \\ \text{LF PARTS}\ \boxed{3} \oplus \textit{list} \oplus \langle \ldots \wedge \textbf{R}(\ldots, \ldots x_k \ldots)\rangle \oplus \textit{list}\end{bmatrix}$$

Figure 8: Constraint on the sort *kind-coc-lr*

generic-event-coc-lr:

$$\left[\text{LF PARTS } \boxed{3}\right] \mapsto \left[\text{LF PARTS } \boxed{3} \oplus \left\langle \ldots \wedge \textbf{REL}(\ldots, \ldots) \right\rangle\right]$$

Figure 9: Constraint on the sort *generic-event-coc-lr*

abstract-object-coc-lr:

$$\left[\text{LF PARTS } \boxed{3}\right] \mapsto \left[\text{LF PARTS } \boxed{3} \oplus \left\langle \ldots \wedge \textbf{REL}(\ldots, \ldots) \right\rangle \oplus \left\langle \ldots \wedge \textbf{REL}(\ldots, \ldots) \right\rangle\right]$$

Figure 10: Constraint on the sort *abstract-object-coc-lr*

there is no further constructional meaning, i.e., again, we have to restrict the size of the output's PARTS list. This is done in Fig. 10.

In this section I provided an HPSG account of the syntactic and semantic properties of the English COC presented in Sections 2 and 3. The use of LRS is important for my analysis in various ways. First, LRS allows me to express the cognateness condition, which I formalize as an identity of the main lexical semantic contribution of the verb and the CO. Second, I derive the properties of the particular event COC by assuming an identity of the indices of the verb and the CO. Third, as LRS singles out individual meaning contributions as elements of the PARTS list, constructional meaning contributions can be added at various places in the inheritance hierarchy to capture the family resemblance among the different COCs.

5 Conclusion

In this paper I have proposed a new analysis of the English cognate object construction. I singled out the particular event COC as being syntactically and semantically distinct from other types of COCs. I argued that the cognate object is syntactically and semantically more independent in these other constructions: The CO has its own index and it is linked to the semantics of the verb by an additional constructional semantic contribution. The existence of four COC types is directly derived from the possible readings of the NPs that occur as COs.

There are a number of open issues concerning the English COC. I will briefly address two of them which relate to the question of cognateness of the CO. One problem is why the data in (2-c) and (2-d) are often considered instances of the COC as well. In the case of all real COCs we have an enforced identity of the MAIN values. In HPSG identities may arise if they are not explicitly excluded by a constraint. For this reason, nothing prevents incidental MAIN identities in examples such as (2-c) or (2-d). In the case of such incidental identities the structures satisfy the conditions on the output specified in the constraint on *other-coc* in Fig. 5. This provides a natural explanation why such sentences are sometimes treated as cognate object constructions.

Another issue concerns examples like (30). Kuno and Takami (2004) use such examples to argue that the CO need not be a strict cognate, but may refer to a subset of the events expressed by the verb.

(30) Let's wipe our brows and smile a graduation grin. (Macfarland, 1995)

To allow for head nouns in the CO that are not strictly cognate to the verb, but only hyponyms of real cognates, it is necessary to loosen the restriction on MAIN identity. Instead, we would have to require that the MAIN value of the CO stands in hyponymic relation to the MAIN value of the verb.

Besides being the first analysis of the COC in HPSG, the present account is semantically more differentiated than previous analyses of the COC in other frameworks. It also provides further empirical support for the use of techniques of underspecified semantics within theoretical linguistics.

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Persian Object Clitics and the Syntax-Morphology Interface

Pollet Samvelian
Université de Paris 3

Jesse Tseng
CNRS

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Abstract

This paper presents a descriptive overview and formal analysis of the use of pronominal clitics for realizing various types of arguments in Persian, with particular emphasis on object clitics in the verbal domain. We argue that pronominal clitics behave more like suffixes than independent syntactic elements; in cases where they take syntactic scope over an NP or a PP, they must be phrasal affixes. We propose an HPSG analysis to account for the morphosyntactic aspects of verbal suffixation of object clitics, possessive clitics, preverbal object clitics, and clitic doubling constructions. Finally, we explore extensions of the analysis to periphrastic verb forms, and we compare our proposals for Persian to previous HPSG work on clitic phenomena in other languages.

1 Introduction and data

1.1 Forms and functions

Persian has two sets of personal pronoun forms: full forms (1a) and enclitic forms (1b) (Lazard, 2006, §87, §91).[1]

(1) a. full forms:

	sg	pl
1	man	mâ(hâ)
2	to	šomâ(hâ)
3 (anim.)	u	išân (išun)
3 (inan.)	ân (un)	ânhâ (in(h)â)

b. enclitic forms:

	sg	pl
1	**-am**	**-emân** (**-emun**)
2	**-at** (**-et**)	**-etân** (**-etun**)
3	**-aš** (**-eš**)	**-ešân** (**-ešun**)

Full pronouns and enclitic pronouns can be used, often interchangeably, to express nominal arguments in a variety of constructions, but their morphosyntactic properties are highly divergent. We will consider two kinds of pronominal functions.

First, pronouns can be used to realize the nominal argument of a noun, adjective, or preposition:[2]

(2) adnominal argument (e.g. possessive):

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[1] Colloquial/familiar variants are shown in parentheses. With a few exceptions, the examples in this paper adopt literary/formal pronunciation.

[2]In addition to familiar categories (person/number, etc.), the following abbreviations are used in glosses: DDO = the definite direct object marker *râ*, EZ = the *ezafe* linking vowel *(y)e*, IPF = imperfective, SBJ = subjunctive.

pesar-e Maryam / pesar-e **u** / pesar-**aš**
son-EZ Maryam / son-EZ PRO.3SG / son-3SG

'Maryam's son / her son / her son'

(3) object of preposition:

barâ-ye Maryam / barâ-ye **u** / barâ-**yaš**
for-EZ Maryam / for-Z PRO.3SG / for-3SG

'for Maryam / for her / for her'

As we can see from these examples, full pronouns basically have the same syntactic distribution as NPs, like the proper noun *Maryam*.

Second, pronouns can be used to express an argument of a verb.[3]

(4) a. (mâ) Maryam-râ did-im / (mâ) **u**-râ did-im
we Maryam-DDO saw-1PL we PRO.3SG-DDO saw-1PL
'We saw Maryam.' / 'We saw him/her.'

b. (mâ) did-im-**aš**
we saw-1PL-3SG
'We saw her/him/it.'

Again, the full pronoun *u* has an NP-like distribution, very different from that of the enclitic *-aš*, which in this case is attached directly to the verb.

Clitic doubling is possible in colloquial registers. In other words, a single argument can be realized simultaneously as a syntactic complement (ordinary NP or full form pronoun) and as a clitic on the verb.

(5) Maryam-râ did-im-**aš** / u-râ did-im-**aš**
Maryam-DDO saw-1PL-3SG PRO.3SG-DDO saw-1PL-3SG
'We saw Maryam.' / 'We saw him/her.'

1.2 Preverbal object clitics

Instead of appearing with the verb as in the previous examples, object clitics can be realized on a variety of hosts to the left of the head verb. For example, Persian has a large number of compound predicates consisting of a lexical verb and a "preverb", typically a noun, adjective, or adverb that can be treated as a kind of grammaticalized complement. A direct object clitic can appear on either one of these elements:

(6) a. bâz kard-im-**aš**
open did-1PL-3SG
'We opened it.'

[3] See fn. 8 for the forms of the subject agreement markers (e.g. *-im*), which are not to be confused with the object clitics under discussion here.

b. bâz-**aš** kard-im
open-3SG did-1PL

An object clitic can also attach to a phrasal host, in most cases a PP:

(7) a. [PP ru-ye miz] gozâšt-im-**aš**
on-EZ table put-1PL-3SG
'We put it on the table.'

b. [PP ru-ye miz]-**aš** gozâšt-im
on-EZ table-3SG put-1PL

Clitics in preverbal position are sometimes ambiguous, allowing either an object clitic reading, or an adnominal clitic reading. For example, the PP in (7b) could instead be interpreted as a possessive: *ru-ye* [*miz-**aš***] 'on **his/her** table'.

Preverbal realization of object clitics is subject to various constraints. First, a single argument cannot be cliticized twice (as a preverbal clitic and as a clitic on the verb):

(8) *bâz-**aš** kard-im-**aš**
open-3SG did-1PL-3SG
(intended) 'We opened it.'

However, as we saw for clitics on the verb in (5), a preverbal clitic can double an NP object (in colloquial registers):

(9) a. dar-râ bâz-**aš** kard-im
door-DDO open-3SG did-1PL
'We opened the door.'

b. ketâb-râ [PP ru-ye miz]-**aš** gozâšt-im
book-DDO on-EZ table-3SG put-1PL
'We put the book on the table.'

Preverbal clitics are also sensitive to the syntactic function of their host. As we just saw in examples (6)–(7), they can attach to another complement of the verb. Adjuncts, on the other hand, cannot host object clitics:

(10) a. [PP dar xiâbân] did-im-**aš**
in street saw-1PL-3SG
'We saw him/her/it in the street.'

b. *? [PP dar xiâbân]-**aš** did-im
in street-3SG saw-1PL

(11) a. zud did-im-**aš**
early saw-1PL-3SG
'We saw him/her/it early'

b. * zud-**aš** did-im
early-3SG saw-1PL

Although they are attached to a host on their left, preverbal object clitics are also subject to a strong contextual constraint to their right: they must be immediately followed by the head verb. In the following example, the object clitic can attach to the preverb *nešân*, but not to the preceding PP complement:[4]

(12) a. (ketâb-hâ-râ) [be doxtar] nešân-**ešân** dâd-im
book-PL-DDO to girl show-3PL gave-1PL
'we showed them (the books) to the girl'

b. * (ketâb-hâ-râ) [be doxtar] **-ešân** nešân dâd-im
book-PL-DDO to girl -3PL show gave-1PL

Two clitic objects are possible in some ditransitive constructions, but they cannot appear on the same host. The only possibility in such cases is to have one preverbal clitic immediately before the verb, and one clitic on the verb (13d).

(13) a. ketâb-râ be to nešân dâd-im
book-DDO to PRO.2SG show gave-1PL
'We showed you the book.'

b. nešân *dâd-im-**at-aš** / *dâd-im-**aš-at**
show gave-1PL-2SG-3SG / gave-1PL-3SG-2SG

c. *nešân-**at-aš** / *nešân-**aš-at** dâd-im
show-2SG-3SG / show-3SG-2SG gave-1PL

d. nešân-**at** dâd-im-**aš** / nešân-**aš** dâd-im-**at**
show-2SG gave-1PL-3SG / show-3SG gave-1PL-2SG
'We showed it to you.'

As this previous example illustrates, beneficiary arguments can sometimes be realized as object clitics. This possibility is quite restricted, however, and it may be related to the fact that with some verbs, the beneficiary argument can be realized either as a *be*-PP as in (13a), or as an accusative NP (Lazard, 2006, §176.1). The constraints governing these alternations are not completely understood. We note furthermore that PP complements disallow clitic doubling:

(14) * ketâb [$_{PP}$ be to] nešan-**at** dâd-im / nešan dâd-im-**at**
book to PRO.2SG show-2SG gave-1PL / show gave-1PL-2SG
(intended) 'We showed a book to you.'

2 Arguments for affixal status

It is rarely straightforward to decide whether a clitic-host sequence should be analyzed syntactically or morphologically, because by definition, clitics present a

[4]Example (12b) is ungrammatical given the intended interpretation (indicated by the bracketing). The sentence is acceptable, however, with a possessive interpretation of the clitic: *be* [*doxtar-**ešan***] 'to **their** daughter'.

combination of word-like and affix-like properties. In this section, we will review a number of phonological and morphological facts that suggest strongly that pronominal enclitics in Persian are best analyzed as suffixes.

2.1 Phonological effects

Certain phonological adjustments can be observed when a vowel-initial pronominal clitic attaches to a vowel-final host. Some vowel sequences (e.g. *i-e*, *i-a*, *e-a*) are allowed (15a), but in other cases, the hiatus is broken by the insertion of the glide *y*:

(15) a. gorbe + **aš** → gorbe-**aš** 'his/her cat'
b. pâ + **-aš** → pâ-**yaš** 'his/her foot'
c. pâ + **-emân** → pâ-**yemân** 'our foot'

In colloquial Persian, the initial vowel of the clitic is often elided in such cases:[5]

(16) a. pâ + **-eš**, pâ + **-emun** → pâ-**š**, pâ-**mun** 'his/her foot, our foot'
b. did-i + **eš** → did-i-**š** 'saw-2SG-3SG' ⇝ 'you saw him/her/it'

Similar effects can be found with other clitics and at other morpheme boundaries. For example, glide insertion occurs before the *ezafe* linking vowel and before subject agreement markers.[6]

(17) a. xâne + **-e** → xâne-**ye** 'house-EZ'
b. mi-farmâ + **-ad** → mi-farmâ-**yad** 'IPF-order-3SG' ⇝ 'he orders'

In contrast, such effects are not observed at the boundary between two syntactic words. For example, there is no glide insertion between a preposition and its NP object:

(18) bâ âb / *bâ **y**-âb; tu âb / *tu **y**-âb 'with water; in the water'

While the foregoing examples show that pronominal clitics are more closely bound to their hosts than the elements in an ordinary syntactic combination, these facts are not wholly incompatible with a syntactic approach. A pronoun like *-aš* could be taken to be a syntactic word with a special marking like [+CLITIC] (to distinguish it from the full pronoun *u* 'he/she'). This marking could then license the phonological adjustments described above (vowel elision and glide insertion) as productive, "low-level" strategies for resolving hiatus.

This approach runs into difficulties, however, with the following data, involving prepositions. In colloquial Persian, some prepositions can combine with a clitic object, as we saw in (3) above.[7] The prepositions *be* and *bâ* exhibit unexpected

[5] For the pronunciation of the clitics, see fn. 1.

[6] See Lazard (2006, §22, §118).

[7] Those that cannot could be assumed, within a syntactic analysis, to subcategorize for a [−CLITIC] complement. This would account for contrasts like the following:

morphophonological effects with clitic objects. The initial vowel of the clitic can be elided (19a), just as in (16) above. Glide insertion, however, is not possible (19b); instead, we find idiosyncratic forms containing an inserted *h* (19c).

(19) a. be + **-eš**, bâ + **-emun** → be-**š**, bâ-**mun** ‘to him, with us’
b. *be-**yeš** (*be-**aš**), *bâ-**yemun** (*bâ-**yemân**)
c. be-**heš**, bâ-**hâmun**

We could assume, following de Fouchécour (1981, p. 82), that these two prepositions have long forms *behe* and *bâhâ*, used exclusively with [+CLITIC] complements (while the forms *be* and *bâ* are compatible with all types of complements). But this would not explain why only vowel elision can apply to the resulting syntactic combinations, and not glide insertion. We prefer to analyze these preposition + clitic sequences as grammaticalized morphological compounds, for which such gaps and idiosyncrasies are more typical and can be dealt with in terms of familiar morphological notions such as allomorphy, suppletion, and defectivity.

2.2 Co-occurrence constraints

It is clear from the examples we have seen up to now that pronominal clitics allow “promiscuous attachment” to a wide range of hosts, in particular phrasal hosts. This could be taken as an argument in favor of syntactic combination. We will show in this section, however, that clitics are in fact sensitive to the lexical and morphological properties of their hosts, and that these facts cannot always be accounted for by syntactic means, such as subcategorization.

First of all, let us consider some cases that are potentially compatible with a syntactic approach. Participles, for example, can combine with a (possessive) pronominal clitic when used adjectivally (20a), but in verbal constructions they cannot host object clitics (20b):

(20) a. pirârhan-e šoste-**aš**
dress-EZ washed-3SG
‘her washed dress’

b. * (pirâhan-râ) šoste-**aš**, va sepas ân-râ otu kard
dress-DDO washed-3SG, and then it-DDO iron did
‘He/she washed the dress and then ironed it.’

Similarly, while we have seen many examples of object clitics attached to simple past tense and present tense verbs, present perfect forms do not allow this:[8]

(i) dar man / tâ man inside me, until me ([−CLITIC])
(ii) *dar-am / *tâ-yam inside me, until me ([+CLITIC])

[8]The present perfect involves a participial form followed by an enclitic form of the auxiliary *budan* ‘be’, which we assume, following Bonami and Samvelian (2009), to be a suffix. This auxiliary

(21) a. bâz kard-im-**aš** (= 6a)
open did-1PL-3SG
'We opened it.'

b. * bâz karde-im-**aš**
open done-1PL-3SG
(intended) 'We have opened it.'

The contrasts in (20)–(21) clearly cannot be explained phonologically. But the hosts involved do have distinct lexical representations, and so they could impose different constraints on the realization of their direct object: [±CLITIC] in the (a) examples, and [−CLITIC] in the (b) examples. Note, however, that the verb *karde-im* in (21b) does in fact allow a clitic object, if it is preverbal:

(21) c. bâz-**aš** karde-im
open-3SG done-1PL
'We have opened it.'

The syntactic analysis could still be saved, for example by introducing further features to distnguish clitics on the verb and preverbal clitics, but we prefer to treat the ungrammaticality of (20b) and (21b) as a morphological fact: pronominal clitics are suffixes, and the verb forms in these examples are simply incompatible with this type of suffixation.

Other systematic restrictions on pronominal enclisis present even more problems for the syntactic approach. As we saw above in (13c-d), there can be at most one pronominal clitic per host. This is true even if the clitics have distinct syntactic functions and scope. Compare, for example, sentence (7b), repeated here as (22a), and (22b), in which the PP complement happens to end with a possessive clitic:

(22) a. [$_{PP}$ ru-ye miz] **-aš** gozâšt-im (= 7b)
on-EZ table -3SG put-1PL
'We put it on the table.'

b. * [$_{PP}$ ru-ye miz-**at**] **-aš** gozâšt-im
on-EZ table-2SG -3SG put-1PL
(intended) 'We put it on **your** table.'

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clitic is distinct from the subject agreement suffixes found with other verb forms, although the two paradigms are nearly identical:

(i) a. subject agreement suffixes:

	sg	pl
1	-am	-im
2	-i	-id (-in)
3	**-ad** (-e)	-and (-an)

b. enclitic auxiliary *budan*:

	sg	pl
1	-am	-im
2	-i	-id (-in)
3	**-ast** (-e)	-and (-an)

Note also that the 1sg form in both paradigms is identical to the 1sg object clitic, *-am* (1b). To avoid confusion, no examples with 1sg subjects are used in this paper.

Under a syntactic analysis, the clitic *-aš* combines with a PP in both cases, and given standard assumptions about locality, it should not be sensitive to the detailed morphological structure of a particular word within the PP. On the other hand, if *-aš* is a suffix, i.e. morphologically integrated into the right-most word of the host PP, then the contrast between *miz-**aš*** and **miz-**at-aš*** can be explained straightforwardly at the lexical level, by formulating restrictions on multiple suffixation.

Pronominal clitics also cannot co-occur with *ezafe*, which we have already encountered in several examples. This linking element, with the form *(y)e*, licenses the realization of NP-internal dependents to the right of the head noun. Following Samvelian (2007), we treat *ezafe* as a phrasal suffix. In example (23a), the noun *lebâs* must carry this suffix in order to combine with the adjective *sefid*, and the resulting phrase must be suffixed in order to combine with a possessive NP or full pronoun. In contrast, the second *ezafe* must not appear if the possessive pronoun is realized as a clitic (23b).

(23) a. lebâs-e sefid-**e** Maryam / lebâs-**e** sefid-**e** u
dress-EZ white-EZ Maryam / dress-EZ white-EZ PRO.3SG
'Maryam's white dress / her white dress'

b. lebâs-e *sefid-**e-yaš** / lebâs-e sefid-**aš**
dress-EZ white-EZ-3SG / dress-EZ white-3SG
'her white dress'

The fact that no *ezafe* appears on the adjective in (23b) indicates clearly that *-aš* is not a syntactic dependent within the NP. Instead, it is a suffix that attaches to the adjective morphologically (although, as a phrasal affix, it has syntactic and semantic scope over the whole NP).

Samvelian (2007) demonstrates that pronominal clitic + *ezafe* sequences are also excluded. In the following example, the relative clause must take *ezafe* to allow the realization of the genitive/possessive NP *in dâstân* 'of this novel' to the right. This is impossible in (24a), however, because the last word of the relative clause, *mihan-**aš*** 'his homeland', already carries a pronominal suffix:

(24) a. *qahremân-e [$_{RC}$ rânde šode az mihan-**aš**] **-e** in
hero-EZ driven become from homeland-3SG -EZ this
dâstân
novel
(intended) 'the hero of this novel, (who is) driven away from his homeland'

b. qahremân-e [$_{RC}$ az mihan-**aš** rânde šode] **-ye** in dâstân
hero-EZ from homeland-3SG driven become -EZ this novel

If the suffixed PP is moved away from the right edge of the relative clause, the incompatibility disappears, and the relative clause can receive the *ezafe* suffix (24b). Again, these facts would be difficult to analyze if *-aš* and *-(y)e* were syntactic elements, but they are readily explained if we assume that both forms are suffixes that cannot appear simultaneously on the same word.

2.3 Extraction

A last piece of evidence for the affixal status of pronominal clitics involves extraction. An object clitic must be fronted along with its host constituent (25b):

(25) a. mi-xâh-i fardâ bâz-**aš** bo-kon-i
IPF-want-2SG tomorrow open-3SG SBJ-do-2SG
'You want to open it tomorrow.'

b. bâz-**aš** [$_S$ agar mi-xâh-i fardâ ___ bo-kon-i]
open-3SG if IPF-want-2SG tomorrow SBJ-do-2SG
'If you want to open it tomorrow ... '

c. *bâz [$_S$ agar mi-xâh-i fardâ ___-**(y)aš** bo-kon-i]
open if IPF-want-2SG tomorrow -3SG SBJ-do-2SG

d. ***-aš*** [$_S$ agar mi-xâh-i fardâ bâz-___ bo-kon-i]
3SG if IPF-want-2SG tomorrow open SBJ-do-2SG

The clitic cannot simply be stranded and attach to a new host (25c).[9] And unsurprisingly, the clitic cannot be fronted without its host (25d). These facts are not wholly incompatible with an analysis of clitics as specially marked [+CLITIC] syntactic elements, with several additional assumptions and stipulations. But they follow automatically if *baz-**aš*** is analyzed as a single word (that is nevertheless interpreted as realizing two separate arguments of the verb).

In section 1.2, we stated that preverbal clitics had to immediately precede the verb; recall example (12). We can see now that this constraint is both too strong and too weak. Too strong, because the fronted clitic in (25b) is exempt from this constraint. Too weak, because the ungrammatical example (12b) remains ungrammatical even if the preverb *nešân* is extracted:

(26) *nešân [$_S$ agar ketâb-hâ-râ [be doxtar] **-ešân** ___ dâd-im]
show if book-PL-DDO to girl -3PL gave-1PL
(intended) 'if we showed the books to the girl'

The correct generalization appears to be, therefore, that preverbal clitics must be hosted by the least oblique complement of the verb, and that within the clause (i.e. if they are not extracted along with their host) they must appear immediately before the verb.

[9] Recall from (11) that preverbal clitics cannot attach to adverbial modifiers.

3 HPSG analysis of object clitics

3.1 Morphophonological functions

We adopt the insights of Miller and Sag (1997) in order to analyze the morphological realization of pronominal clitics as affixes. We briefly review the original analysis of French clitics, before presenting our proposed extension of the model to the Persian data.

Miller and Sag treat subject and object pronominal clitics in French as affixes on the verb. A sentence like *Je vous les donne* 'I give them to you' is thus analyzed as a single syntactic word, consisting of the finite verb *donne* and three pronominal affixes: *Je-vous-les-donne*.

The key technical device in their analysis is the morphophonological function $\mathbf{F}_{PRAF}$, which takes as input the inflected form of the verb (in I-FORM), its HEAD value (which determines prefixal vs. suffixal realization of pronouns), and its ARG-ST value. Elements on the ARG-ST list are typed as either *canonical-* or *affix-synsem* objects, and of course they carry grammatical specifications like the case and agreement features of each argument. Given this information, $\mathbf{F}_{PRAF}$ outputs the appropriate phonological form for the cliticized verb.

(27) *clitic-wd* →

$$\begin{bmatrix} \text{MORPH} & \begin{bmatrix} \text{FORM} & \mathbf{F}_{PRAF}(\boxed{0},\boxed{1},\boxed{2}) \\ \text{I-FORM} & \boxed{0} \end{bmatrix} \\ \text{SYNSEM} & \begin{bmatrix} \text{LOC} \mid \text{CAT} & \begin{bmatrix} \text{HEAD} & \boxed{1} \\ \text{ARG-ST} & \boxed{2} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

For Persian, we propose a similar function, $\mathbf{F}_{pron}$, which requires four parameters instead of three. These include, of course, the I-FORM of the host and its ARG-ST list. The HEAD value is also necessary, not to determine the position of pronouns (unlike in French, Persian pronouns are always suffixed) but because $\mathbf{F}_{pron}$ is defined for both verbal and non-verbal hosts. Finally, the fourth parameter is the EDGE | RIGHT value, which contains the PRONARG feature, whose function will be explained in section 3.3 below.

(28)
$$\begin{bmatrix} \text{MORPH} & \begin{bmatrix} \text{FORM} & \mathbf{F}_{pron}(\boxed{1},\boxed{2},\boxed{3},\boxed{4}) \\ \text{I-FORM} & \boxed{1} \end{bmatrix} \\ \text{SSM} \mid \text{LOC} \mid \text{CAT} & \begin{bmatrix} \text{HEAD} & \boxed{2} \\ \text{ARG-ST} & \boxed{3} \\ \text{EDGE} \mid \text{R} & \boxed{4}\begin{bmatrix} \text{PRONARG} & \textit{index} \vee \textit{none} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

3.2 Suffix appearing on the verb

The following examples involve the inflected ditransitive verb *gozâšt-im* ‘we put’, for which we assume the following basic lexical description:[10]

(29) *gozâšt-im* ‘put-1PL’ ⇝ ‘we put’

$$\begin{bmatrix} \text{MORPH} & \begin{bmatrix} \text{FORM} & \mathbf{F}_{pron}(\boxed{1},\boxed{2},\boxed{3},\boxed{4}) \\ \text{I-FORM} & \boxed{1}\ \textit{gozâšt-im} \end{bmatrix} \\ \text{HEAD} & \boxed{2}\ \textit{verb} \\ \text{ARG-ST} & \boxed{3}\left\langle \text{NP}_{\textit{1pl}}, \text{NP}[\textit{acc}], \text{PP}\right\rangle \\ \text{EDGE} \mid \text{R} & \boxed{4}\begin{bmatrix}\text{PRONARG} & \textit{none}\end{bmatrix} \end{bmatrix}$$

For our purposes, the I-FORM value can be a simple phonological string, but in actuality it contains a richer morphological representation.[11] In this description, the verb’s accusative NP argument and its PP argument are underspecified, so the value of $\mathbf{F}_{pron}$ is as yet undetermined.

In the first example, the ARG-ST list in (29) is instantiated to require a canonical PP argument, but an NP argument of type *affix-synsem* with 3sg agreement features.

(30) *gozâšt-im-**aš*** ‘put-1PL-3SG’ ⇝ ‘we put it’

$$\begin{bmatrix} \text{FORM} & \mathbf{F}_{pron}(\textit{gozâšt-im}, \textit{verb}, \boxed{3}, [\text{PRONARG}\ \textit{none}]) = \textit{gozâšt-im-}\boldsymbol{\textit{aš}} \\ \text{ARG-ST} & \boxed{3}\left\langle \text{NP}_{\textit{1pl}}, \text{NP}_{\textit{3sg}}[\textit{aff}], \boxed{\textit{PP}}\ \text{PP}[\textit{canon}]\right\rangle \\ \text{COMPS} & \left\langle \boxed{\textit{PP}} \right\rangle \end{bmatrix}$$

Given an ARG-ST of this form as input, the effect of $\mathbf{F}_{pron}$ is to add the suffix *-aš* to the inflected verb. Following HPSG argument mapping principles, non-canonical *synsem* objects such as affixes are not mapped to the valence lists. In this case, the affix NP is not mapped to COMPS and therefore will not give rise to an additional, syntactic realization of the direct object. The PP argument, on the other hand, is mapped to COMPS and therefore realized canonically:

(31) [$_{\text{PP}}$ ru-ye miz] gozâšt-im-**aš**
on-EZ table put-1PL-3SG
‘We put it on the table.’

Recall from example (5) above that clitic doubling is observed in colloquial Persian. To account for this, $\mathbf{F}_{pron}$ adds an optional pronominal suffix corresponding to a canonical argument:[12]

[10] As explained below in section 3.5, we further assume that all elements on ARG-ST in this basic (underived) lexical entry carry the feature [PRONARG *none*].

[11] See Bonami and Samvelian (2009) for a treatment of Persian verbal morphology using Paradigm Function Morphology within HPSG.

[12] As it stands, our formulation implies free variation between the presence and absence of the suffix. In reality, the stylistic effects associated with clitic doubling would need to be incorporated

(32) *gozâšt-im**(-aš)*** 'put-1PL(-3SG)' ⇝ 'we put'

$$\begin{bmatrix} \textsc{form} & \mathbf{F}_{pron}(\textit{gozâšt-im}, \textit{verb}, \boxed{3}, [\textsc{parg}\ \textit{none}]) = \textit{gozâšt-im}\textbf{\textit{(-aš)}} \\ \textsc{arg-st} & \boxed{3}\left\langle \text{NP}_{\textit{1pl}}, \boxed{np}\ \text{NP}[\textit{canon}], \boxed{pp}\ \text{PP}[\textit{canon}] \right\rangle \\ \textsc{comps} & \left\langle \boxed{np}, \boxed{pp} \right\rangle \end{bmatrix}$$

In this case, the verb may be suffixed, but the NP argument is still mapped to COMPS and gives rise to the realization of a syntactic complement:

(33) ketâb-râ [$_{\text{PP}}$ ru-ye miz] gozâšt-im**(-aš)**
book-DDO on-EZ table put-1PL(-3SG)
'We put the book on the table.'

3.3 Suffix appearing on a non-verbal host

Pronominal clitics can also attach to nouns and adjectives and some other non-verbal categories. In the general case, the host is a phrase, but in HPSG, syntactic phrases cannot undergo suffixation. A lexicalist analysis of phrasal affixation is possible, though, if we separate the morphological effects of the suffix (at the lexical level) and its syntactic and semantic effects (at the phrasal level).

The morphological realization of clitics on non-verbal hosts is exactly the same as in the case of verbal suffixation, so it is handled by the same function $\mathbf{F}_{pron}$. The following example illustrates the suffixation of the 3sg suffix *-aš* to the adjective *sefid* 'white':

(34) *sefid**-aš*** 'white-3SG'

$$\begin{bmatrix} \textsc{morph} & \begin{bmatrix} \textsc{form} & \mathbf{F}_{pron}(\boxed{1}, \boxed{2}, \boxed{3}, \boxed{4}) \\ \textsc{i-form} & \boxed{1}\ \textit{sefid} \end{bmatrix} \\ \textsc{head} & \boxed{2}\ \textit{adj} \\ \textsc{arg-st} & \boxed{3}\langle\ \rangle \\ \textsc{edge}\mid\textsc{r} & \boxed{4} \end{bmatrix}$$

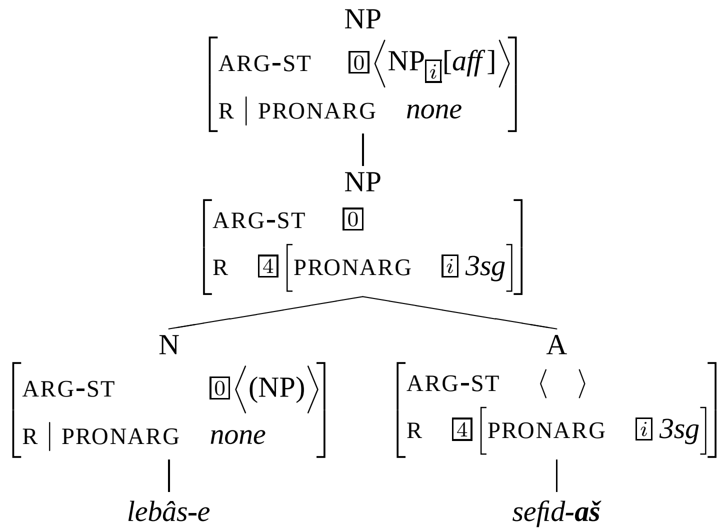
$$\sqsubset \begin{bmatrix} \textsc{morph} & \begin{bmatrix} \textsc{form} & \mathbf{F}_{pron}(\boxed{1}, \boxed{2}, \boxed{3}, \boxed{4}) = \textit{sefid-}\textbf{\textit{aš}} \end{bmatrix} \\ \textsc{edge}\mid\textsc{r} & \boxed{4}\begin{bmatrix} \textsc{pronarg} & \begin{bmatrix} \textsc{per} & \textit{3rd} \\ \textsc{num} & \textit{sg} \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

Unlike the examples in the previous section, $\mathbf{F}_{pron}$ does not constrain the host's ARG-ST list (which in this case is empty). The only constraint that $\mathbf{F}_{pron}$ imposes is that the presence of the suffix (i.e. its 3sg index) must be recorded in PRONARG. We introduce this feature to handle the mismatch between the morphological scope of the suffix (a single word) and its syntactic/semantic scope (a phrase or clause).

into the grammatical description and added as an additional parameter to $\mathbf{F}_{pron}$.

To see how this works, consider our analysis of example (23b) above.[13]

(35) [$_{\text{NP}}$ *lebâs-e sefid*] ***-aš*** ‘dress-EZ white-3SG’ ⇝ ‘her white dress’



As we have just seen, the suffixed adjective *sefid-**aš*** has a non-empty PRONARG value, but at the lexical level, the interpretation of this 3sg index is not yet determined. The common noun *lebâs* has an optional NP argument on its ARG-ST list (linked to a possessive relation in its semantic content), which is also uninstantiated at the lexical level. These two pieces of information can only be associated when the entire phrase *lebâs-e sefid-**aš*** is constructed.

This is why we defined PRONARG as a right edge feature. In branching phrases, the value of EDGE | RIGHT is shared between the rightmost daughter and the mother. We further assume that ARG-ST propagates as a HEAD feature. The result of this sharing of information can be seen in (35), where the relevant specifications are accessible when the head-adjunct phrase is formed. At this point, we can apply a unary syntactic rule that establishes the link between the PRONARG index and the possessive NP argument, and that also “discharges” the PRONARG value.

3.4 Preverbal object clitics

The PRONARG feature is also crucial in our analysis of the preverbal object clitics presented in section 1.2. In these cases, the clitic is again suffixed to the rightmost word of a phrase, but instead of realizing an argument of that phrase (like the possessive in the previous example), a preverbal object clitic must be interpreted at the level of the whole clause.

Example (7b), repeated here as (36a), contains a preverbal object clitic attached to a PP. Example (36b) involves the same structure, but with clitic doubling.

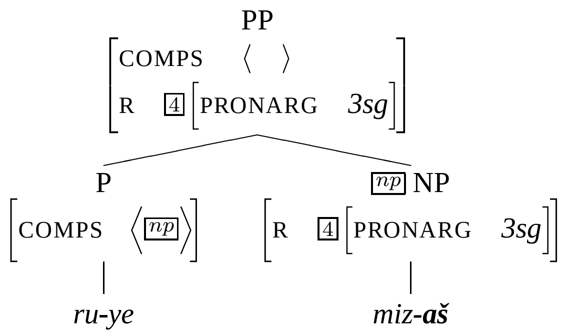
[13] We leave aside the analysis of the *ezafe* suffix in this example. We return briefly to the issue of *ezafe* in section 3.5, but for a full discussion, see Samvelian (2007).

(36) a. [$_{PP}$ ru-ye miz] **-aš** gozâšt-im
on-EZ table -3SG put-1PL
'We put it on the table.'

b. <u>ketâb-râ</u> [$_{PP}$ ru-ye miz] **-aš** gozâšt-im
book-DDO on-EZ table -3SG put-1PL
'We put the book on the table.'

The following figure shows the analysis of the suffixed PP complement found in these sentences:[14]

(37) [$_{PP}$ *ru-ye miz*] ***-aš*** $\rightsquigarrow$ 'on the table' + uninterpreted 3sg pronoun



Just as in (34) above, $\mathbf{F}_{pron}$ adds a suffix to the noun *miz* and the corresponding index becomes the value of the PRONARG attribute. This PRONARG value could be discharged at the NP level as in the previous section, giving rise to a possessive interpretation ('on his/her table'), but instead, in this case PRONARG continues to propagate to the level of the PP, where it remains uninterpreted.

To complete the analysis of the sentences in (36), we need to modify the verb *gozâšt-im* 'we put' so that it can accept the suffixed PP in (37) as its complement, as opposed to the ordinary PP that we saw in earlier examples like (31) and (33). We propose the following lexical rule:

(38)
$$\begin{bmatrix} \textsc{head} & \textit{verb} \\ \textsc{arg-st} & \boxed{1}\left\langle \ldots, \mathrm{NP}_{\boxed{i}}[\textit{acc}], \ldots \right\rangle \oplus \left\langle \boxed{2}\begin{bmatrix}\textsc{pronarg} & \textit{none}\end{bmatrix} \right\rangle \end{bmatrix}$$
$$\mapsto \begin{bmatrix} \textsc{arg-st} & \boxed{1} \oplus \left\langle \boxed{2'} \begin{bmatrix} \textit{non-aff} & \\ \textsc{pronarg} & \boxed{i} \end{bmatrix} \right\rangle \end{bmatrix}$$

where $\boxed{2}$ and $\boxed{2'}$ are identical except for their PRONARG values

The effect of this rule is to add the index of an accusative NP argument to the PRONARG value of the last element of ARG-ST, which corresponds to the least oblique argument. This argument thus becomes the clitic host, and it must not

[14]*Ru-ye* is in fact a grammaticalized nominal element with the *ezafe* suffix, but here we analyze it simply as a preposition.

itself be cliticized. The specification *non-aff* is compatible with either canonical realization or extraction (*gap-synsem*).

The change from [PRONARG *none*] to [PRONARG *index*] on the host argument ensures that the rule can only apply once: There can be only one preverbal clitic per clause. On the other hand, the original accusative NP remains on ARG-ST and its description is not further specified or modified in any way.

In the case of *gozâst-im*, the output of applying rule (38) to the basic lexical entry in (29) is as follows:

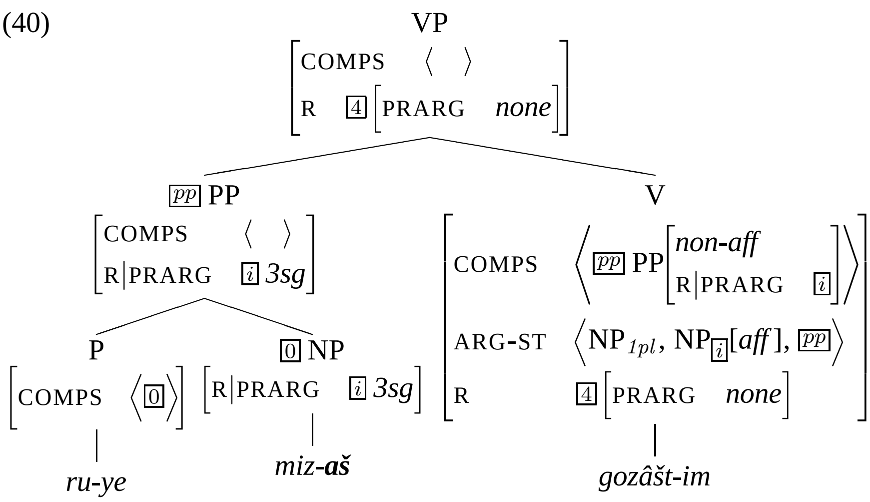
(39) *gozâšt-im* 'put-1PL' $\rightsquigarrow$ 'we put'

$$\begin{bmatrix} \text{FORM} & \mathbf{F}_{pron} = \textit{gozâst-im} \\ \text{HEAD} & \textit{verb} \\ \text{ARG-ST} & \left\langle \text{NP}_{\textit{1pl}}, \text{NP}_{\boxed{i}}[\textit{acc}], \text{PP}\begin{bmatrix} \textit{non-aff} & \\ \text{PRONARG} & \boxed{i} \end{bmatrix} \right\rangle \end{bmatrix}$$

As indicated, the morphophonological function $\mathbf{F}_{pron}$ does not add a pronominal suffix to the verb if the corresponding index appears in the PRONARG value of an ARG-ST element.

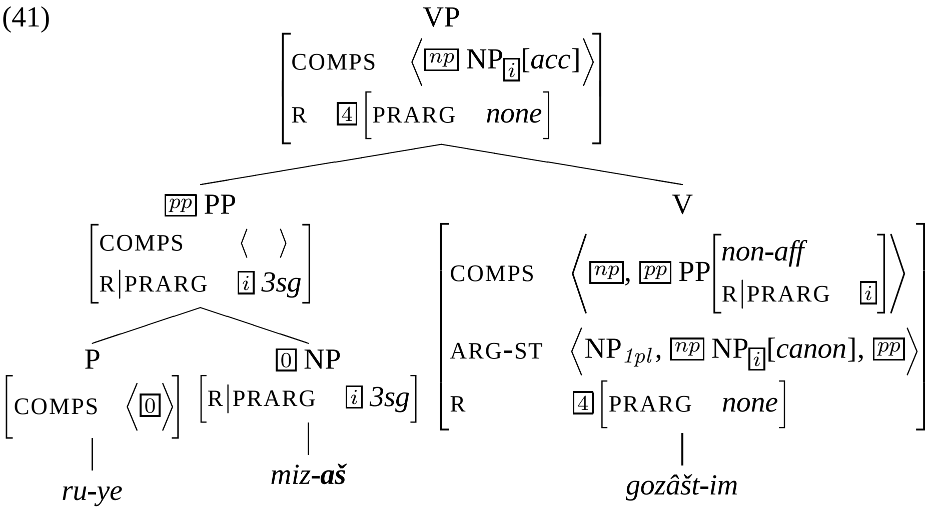
The accusative NP can be further instantiated as either affixal or canonical. In the first case, it is not mapped to COMPS, and the argument is only realized once, as in (36a), which we analyze as follows:

(40)



On the other hand, the accusative NP in (39) can be instantiated as canonical, giving rise to clitic doubling, as in example (36b), with the following (partial) analysis:

(41)



Unlike in (40), in this derivation the VP is not saturated, so it can still combine with the syntactic NP[*acc*] complement corresponding to the clitic ***-aš***.

3.5 Remaining details

In this section we fill in a few remaining gaps in our formal analysis.

First, we assume that verbs (and other heads) are lexically specified as having only [PRONARG *none*] arguments:

(42) $$\textit{lexeme} \rightarrow \left[\text{ARG-ST} \quad \textit{list}\left(\left[\text{PRONARG} \quad \textit{none} \right] \right) \right]$$

Without this constraint, spurious object clitic pronouns, not corresponding to any argument, could be freely instantiated:

(43) * dar-râ bâz-**at** kard-im
door-DDO open-2SG did-1PL
'We opened the door.' + uninterpreted 2sg pronoun

With (42) in place, unless the verb *kard-im* explicitly undergoes a derivational process like the lexical rule in (38), its complement *bâz* cannot host a preverbal clitic.

The fact that (38) only applies to arguments of the verb accounts for the ungrammaticality of adjunct hosts, as illustrated in (10)–(11).

The various clitic co-occurrence constraints discussed in section (2.2) are handled by $\mathbf{F}_{pron}$. For example, multiply-suffixed forms like **dâd-im-**__aš-at__ in (13b) and **miz-**__at-aš__ in (22b) are simply never produced by $\mathbf{F}_{pron}$, no matter what the input. The incompatibility of clitic pronouns and *ezafe* can be accounted for because $\mathbf{F}_{pron}$ has access to all of the right edge features of the host. Since *ezafe* is a phrasal affix, there must be a corresponding (boolean) feature EDGE | RIGHT | EZ that encodes its presence. $\mathbf{F}_{pron}$ will only add a pronominal suffix to a host that carries the specification [−EZ] (absence of *ezafe*), and similarly, the morphophonological function $\mathbf{F}_{ez}$ that realizes *ezafe* requires its host to have the feature [PRONARG *none*].

As the final ingredient of our formal analysis, we need to formulate a linear precedence constraint to ensure that preverbal clitics appear immediately before the verb. Although the lexical rule (38) ensures that the host is the least oblique argument, we must still prevent modifiers and other intervening elements from appearing in the syntactic realization of the clause. The following LP rule requires the clitic host (i.e. any complement with a non-empty PRONARG specification) to immediately precede the head verb:

(44) $\overset{\text{COMP-DTR}}{\left[\text{PRONARG} \quad \textit{index}\right]} \ll \overset{\text{HD-DTR}}{\text{V}}$

This constraint specifies the grammatical functions of the elements involved. As a result, it correctly applies in head-complement phrases such as (12), but does not exclude head-filler phrases like (25).

Finally, we saw at the end of section 1.2 that some beneficiary arguments can also be realized as clitics. The definition of $\mathbf{F}_{pron}$ and the formulation of the lexical rule in (38) can be modified to accommodate the examples in (13), with an additional constraint on clitic doubling to account for (14). However, a more thorough empirical investigation is required before beneficiary arguments can be fully incorporated into our formal analysis.

4 Further questions and discussion

4.1 Clitics in periphrastic constructions

Thus far, our analysis of object clitics only covers clauses containing a single, simple verb form. Persian also has a variety of periphrastic verb forms, with highly divergent properties. A descriptive overview and an HPSG analysis of these constructions can be found in Bonami and Samvelian (2009). It remains to be seen whether the present proposals can be extended in harmony with that account.

The periphrastic constructions include the passive voice and several compound tenses, and they vary with respect to the following properties: the relative order of the finite auxiliary and the lexical verb, the morphosyntactic status of the auxiliary element (word or affix), the morphological form of the lexical verb (finite or non-finite/participial), and finally (and most importantly for us) the realization and placement of object clitics.

We already saw an example of a compound tense, the present perfect ("compound present" in the terminology of Bonami and Samvelian), in example (21) in section 2.2. In this tense, the auxiliary verb *budan* is realized as a suffix on the participle; in other words, the present perfect is not truly periphrastic. The resulting suffixed form is incompatible with further object clitic suffixation. This type of incompatibility can be integrated into the definition of $\mathbf{F}_{pron}$, which has access to the HEAD features of the verb (in particular, VFORM). Note that this restriction has no effect on the preverbal clitic in (21c), which is still correctly licensed by lexical rule (38).

The following examples illustrate the past perfect ("complex bounded past") tense, which involves a full form of the auxiliary *budan*, to the right of the participle. The auxiliary can host an object clitic (45a), but the participle cannot (45b).

(45) a. bâz karde bud-im-**aš**
open done was-1PL-3SG
'We had opened it.'

b. * bâz karde-**aš** bud-im
open done-3SG was-1PL

c. bâz-**aš** karde bud-im
open-3SG done was-1PL

The clitic on the head verb *bud-im* in (45a) and the preverbal clitic in (45c) are handled correctly by our analysis. To block the realization of the preverbal clitic in (45b), we assume that the participle *karde* is disqualified as a clitic host in the definition of $\mathbf{F}_{pron}$ (again via the HEAD | VFORM specification). We saw the effects of this morphological restriction on this same participial form in a different syntactic context in example (20b) in section 2.2.

Finally, we consider the future tense, which is the only compound tense where a non-finite lexical form appears to the right of the finite auxiliary. It is also the only construction where both the auxiliary and the lexical verb can host an object clitic:

(46) a. be Maryam xâh-im dâd-**aš**
to Maryam want-1PL give-3SG

b. be Maryam xâh-im-**aš** dâd
to Maryam want-1PL-3SG give
'We'll give it to Maryam.'

Bonami and Samvelian (2009) treat *xâh-im dâd* as a single inflected form. At first glance the clitic placement in (46b) seems problematic for this analysis, but in fact, since $\mathbf{F}_{pron}$ has access to the internal morphological structure of this verb form (encoded in the I-FORM value), it can be defined to realize the clitic *-aš* either as a suffix or as an infix.

While this approach is technically feasible, there appears to be no additional motivation for allowing infixation in the morphology of Persian. For this and other reasons (e.g. word order facts not taken into account by Bonami and Samvelian), it is useful to explore alternative, syntactic analyses of the future tense. We note some parallels between this structure and impersonal modal constructions:

(47) a. (u-râ) mi-tavân did-**aš**
PRO.3SG-DDO IPF-can saw-3SG

b. (u-râ) mi-tavân-**aš** did
PRO.3SG-DDO IPF-can-3SG saw
'One can see him/her.'

The "downstairs" lexical verb appears in the same bare stem form as in the future tense, and it can take an object clitic in the usual way, through head suffixation (47a). The clitic in (47b) cannot be analyzed as a preverbal clitic using the lexical rule in (38), because the modal is not a complement of *did*. On the contrary, *did* is a complement of the "upstairs" modal, and so (47b) is an instance of clitic climbing, for which we adapt the argument composition analysis proposed for related phenomena in Romance (Abeillé and Godard, 2002). We suggest following a similar approach for the future tense data in (46).

4.2 Cross-linguistic considerations

Similar cliticization phenomena are found in other Western Iranian languages. Sorani Kurdish, for example, also has preverbal object clitics. In fact, as the following examples from Bonami and Samvelian (2008) show, preverbal placement is the only possibility:

(48) a. min [$_{\text{PP}}$ ba Narmîn] **-î** da-lê-m
I to Narmîn 3SG IPF-tell-1SG
'I am telling it to Narmin.'

b. * min [$_{\text{PP}}$ ba Narmîn] da-lê-m-**î**
I to Narmîn IPF-tell-1SG-3SG

Our analysis of Persian can be easily adapted to account for this data.

Pronominal clitics are of course also found in many other language families. We already mentioned French pronominal clitics in section 3. More generally, pronouns in the Romance languages exhibit many of the same phenomena observed in Persian: the existence of weak (clitic) forms and strong forms, the affixal status of clitic forms used to realize the arguments of a verb, limited mobility (e.g. clitic climbing), and clitic doubling.

There are differences: unlike in Persian, Romance object clitics generally are not also used to realize dependents within the NP, Romance exhibits proclisis in addition to enclisis, and subject pronouns can also have clitic realization in Romance. In spite of these differences, there seems to be a rich common ground for comparative studies from a formal perspective.

As discussed in section 3.1, our analysis of Persian is inspired by Miller and Sag (1997), and we hope that further work (in particular on clitics in multi-verb structures) will be able to draw on existing HPSG analyses of Romance, and also provide new insights and develop analytical tools to improve upon earlier work.

Clitic phenomena in the Slavic languages have also received attention in HPSG in recent years, and should also be taken into account within this formal comparative perspective. A particularly striking parallel can be observed in the "floating" auxiliary clitics in Polish analyzed by Kupść and Tseng (2005). Much like Persian object clitics, these auxiliary clitics can appear either suffixed to the verb (49a), or attached to a dependent phrase to the left of the verb:

(49) a. Dlaczego [tak długo] nie pisała **-ś**?
why so long NEG written.FSG -2SG
'Why haven't you written in such a long time?'

b. Dlaczego [tak długo]-**ś** nie pisała?

c. Dlaczego-**ś** [tak długo] nie pisała?

The HPSG analyses proposed for Polish and Persian have very little in common in fact, primarily because auxiliaries and objects have completely different argumental properties. Nevertheless, the remaining morphosyntactic aspects of the analyses of the two languages, specifically concerning the constraints on the position of clitics within the clause, could be brought closer together.

We believe that existing analyses of clitic phenomena, such as those mentioned here, are now available in sufficient number to allow the development of a more general theory of clitics in HPSG. These efforts will provide a formal framework for typological research and guide us in the study of the many clitic phenomena, in Persian and in other languages, that await description and formal analysis.

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Part II
Contributions to the Workshop

Inflectional Defaults and Principal Parts: an Empirical Investigation

Dunstan Brown
University of Surrey

Roger Evans
University of Brighton

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Abstract

We describe an empirical method to explore and contrast the roles of default and principal part information in the differentiation of inflectional classes. We use an unsupervised machine learning method to classify Russian nouns into inflectional classes, first with full paradigm information, and then with particular types of information removed. When we remove default information, shared across classes, we expect there to be little effect on the classification. In contrast when we remove principal part information we expect there to be a more detrimental effect on classification performance. Our data set consists of paradigm listings of the 80 most frequent Russian nouns, generated from a formal theory which allows us to distinguish default and principal part information. Our results show that removal of forms classified as principal parts has a more detrimental effect on the classification than removal of default information. However, we also find that there are differences within the defaults and principal parts, and we suggest that these may in part be attributable to stress patterns.

1. Introduction

The particular challenge which languages with inflectional classes pose is that these classes create an additional layer of complexity which is more or less irrelevant from the perspective of syntax. Linguists can provide principled analyses of such inflectional classes, and typically have a good idea of what the main ones in a language are. However, our understanding of inflectional classes could be improved by exploring how well linguistically informed analyses correspond to those which are obtained using unsupervised learning techniques, with few built-in assumptions. This would provide some external validation for such analyses.

We need first to be clear about the way in which inflectional classes are complex. They represent a particular kind of morphological complexity which it is important to distinguish from other phenomena which may be associated with these terms. Consider the Turkish verb in (1), discussed by Baerman et al. (2009).

(1) alıyorduysam
al-ıyor-du-isa-m
take-CONTINUOUS-PST-CONDITIONAL-1SG
'if I was taking'

Here a large number of inflectional suffixes are attached to the root. But this large number is a direct reflection of the distinctions relevant for syntax. So this is no more complex than the underlying requirements of syntax and is therefore quite straightforward. In Figure 1, in contrast, there is complexity in Russian nouns arising solely from membership of inflectional classes with no corresponding syntactic requirement.[1]

	'deed' Class IV	'factory' Class I	'country' Class II	'bone' Class III
NOM SG	del-o	zavod	stran-a	kost′
ACC SG	del-o	zavod	stran-u	kost′
GEN SG	del-a	zavod-a	stran-i	kost′-i
DAT SG	del-u	zavod-u	stran-e	kost′-i
PREP SG	del-e	zavod-e	stran-e	kost′-i
INS SG	del-om	zavod-om	stran-oj	kost′-ju
NOM PL	del-a	zavod-i	stran-i	kost′-i
ACC PL	del-a	zavod-i	stran-i	kost′-i
GEN PL	del	zavod-ov	stran	kost′-ej
DAT PL	del-am	zavod-am	stran-am	kost′-am
PREP PL	del-ax	zavod-ax	stran-ax	kost′-ax
INS PL	del-am′i	zavod-am′i	stran-am′i	kost′-am′i

Figure 1: Russian inflectional classes (phonological transcription)[2]

This complexity cannot be explained by the role of gender assignment. The words *strana* 'country' and *kost'* 'bone', for example, both require feminine gender on agreeing items, but inflect differently. On the other hand, the words *delo* 'deed' and *zavod* 'factory' require different gender agreement (neuter and masculine respectively), but share many inflections in the singular, while all the classes share many inflections in the plural. Hence, the relationship between the noun inflectional classes (IV, I, II and III) and gender is not a direct one. Gender is relevant for syntax, as it is an agreement category. Inflectional class, on the other hand, is not relevant for syntax, as

[1] We have placed IV to the left of I in Figure 1, because they can be treated as belonging to a superclass (see Corbett and Fraser, 1993).
[2] The phonolological transcription assumes that /i/ has two allophonic variants. It is retracted to the allophone [ɨ] after non-palatalized consonants. The nominative plural form /zakoni/, for example, will be realized with [ɨ], but /kost'i/ retains [i] since [t'] is soft. An automatic rule of palatalization applies before the vowel /e/. The marker ′ indicates that a consonant is palatalized.

the distinction between class II and III for example has no ramifications in the rules of agreement. This is pure morphological complexity whereby one and the same grammatical distinction can be expressed in a number of different ways. This is additional structure which is not relevant from the point of view syntax. In other words, it is complexity associated with autonomous morphology in the sense of Aronoff (1994).

1.1 Defaults and principal parts

The question naturally arises therefore as to what makes morphological complexity of this type learnable. Two theoretical notions can be mustered when describing the properties of inflectional classes. One is the traditional notion of *principal part*. This is the form, or set of forms, which make it possible to infer the other forms of a lexeme. The other notion is *default*. Finkel and Stump (2010) define the canonical principal part as both highly predictive and highly unpredictable. That is, given a canonical principal part we can predict all the other forms in a lexeme's paradigm. Conversely, the other forms in the paradigm would not predict a canonical principal part. Using this terminology we can see that a default is the mirror image of this. A canonical morphological default is a form which does not serve to predict the other forms in a lexeme's paradigm, but is highly predictable (in the limiting case because all lexemes have it).

As is clear from Figure 1 some items should be good as principal parts for identifying their inflectional class, whereas others are defaults. There are good theoretical grounds for assuming that, at some level, Russian has four nouns inflectional classes. If we analyze Russian declensions as a default inheritance hierarchy, we can treat certain classes, such as I and IV, as belonging to a superclass (labelled `N_O` by Corbett and Fraser 1993 in their Network Morphology analysis).

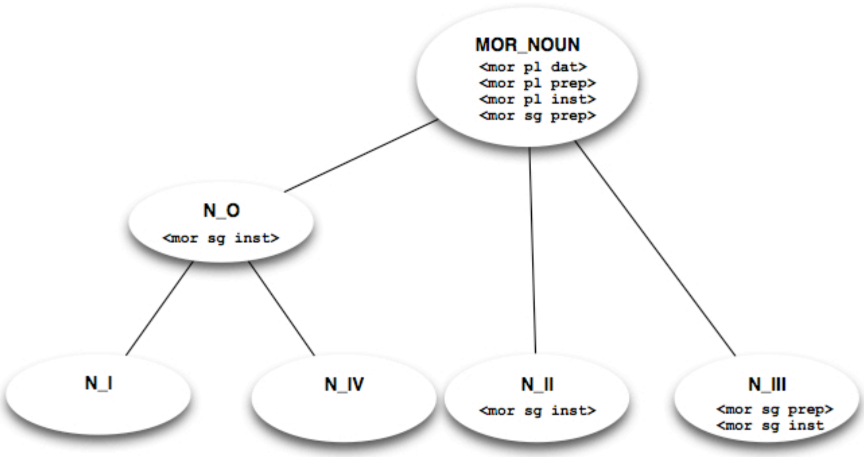

Figure 2: defining defaults and principal parts in terms of inheritance

In Figure 2 we consider 6 of the 12 paradigm main paradigm cells for Russian in terms of the notion principal part and default. We give the locations where something has to be said about the realization of these 6 cells. (We do not give any information about the 6 other paradigm cells in Figure 2.) The paradigm cells plural dative, plural instrumental and plural prepositional (represented by the paths `<mor pl dat>`, `<mor pl inst>`, `<mor pl prep>`) are the most default-like, because they are not overridden by any of the lower nodes.[3] The rules which define them are therefore located at the highest node only. Knowing the plural dative, prepositional or instrumental is of no help in inferring the other forms in the paradigm of a given noun. On the other hand, they are predictable. We can have the highest degree of certainty about what a noun's plural dative, prepositional and instrumental will look like. Examination of Figure 1 shows that we can be fairly certain about the singular prepositional inflection of a noun. It is only class III which has a different realization for this, and this is reflected in the fact that something (`<mor sg prep>`) needs to be stated at `N_III` about the singular prepositional.

The singular instrumental (`<mor sg inst>`), on the other hand, has to be stated at three locations (`N_O`, `N_II` and `N_III`). Knowing the singular instrumental is more helpful in facilitating prediction of other forms, although it will not distinguish between class I and class IV. The singular prepositional is therefore more default-like than the singular instrumental, which we can consider more principal-part-like. Given the analytical decisions taken to place defaults at different points in the hierarchy (e.g. Corbett and Fraser 1993; Brown et al. 1996; Baerman, Brown and Corbett 2005; Brown and Hippisley forthcoming) we can test to see whether there is a reflex in the learning of inflectional classes by systematic removal of information. We can compare the default-like with the principal-part-like information (the latter being located lower in the hierarchy at the declension class nodes, as with the singular instrumental).

1.2 Classification, defaults and principal parts

In this paper we explore how well an unsupervised learning method classifies nouns into inflectional classes, and consider the degree to which these classes match with ones which have been identified for Russian. The ability to classify the items must rely on information from the paradigm cells, but only with systematic testing can we determine which information plays a significant role. Given that the classification must be based on paradigm cell

[3] Figure 2 is actually a simplification in that the plural dative, instrumental and prepositional are defaults at the `MOR_NOMINAL` level, because the rules associated with them can generalize over the other nominal classes (such as adjectives and pronouns). This is discussed in Brown and Hippisley (forthcoming).

information, it is a task which is related to what Ackerman *et al.* (2009) call the Paradigm Cell Filling Problem (PCFP):

> "What licenses reliable inferences about the inflected (and derived) surface forms of a lexical item?"
> (Ackerman *et al.* 2009: 54)

Ackerman *et al.* (2009) claim that the tractability of this problem is guaranteed by the fact that inflectional classes are constrained to reduce entropy, so that not all instances of particular inflectional exponents are equally probable. Finkel and Stump (2007) appeal to the traditional notion of principal parts so as to reduce the entropy down to zero. Paradigm cells such as the instrumental singular appear to be very informative as to class. The underlying analysis with which we have created the dataset for the experiments has itself a gradient notion of default. We have other defaults which have an intermediate status, as with the singular prepositional. For example, knowing the nominative plural narrows down the set of possible classes (I-III). And a default may sometimes even help distinguish between classes. This is true for the nominative plural in that class I has the default form, while class IV does not. Our aim, then, is to determine what role these different notions play in the unsupervised learning of inflectional classes. The work we present here is an initial step towards understanding this.

The ideal unsupervised method should be quite robust and independent of format, with very few theoretical assumptions built in. Goldsmith and O'Brien (2006) use a feed-forward backpropagation neural network with one hidden layer to simulate the learning of Spanish conjugation classes. The hidden layer allows for a better classification into these classes. They also simulated the acquisition of German noun declensions using this method. The method we use is relatively independent of data format and does not make use of a hidden layer. There are, of course, some issues with it, which we discuss in section 2.1.

We apply our chosen unsupervised learning method to full paradigms generated from an underlying default-based theory of Russian. This allows us to test how well linguists' intuitions about inflectional classes fare when tested with few built-in assumptions. We use the full paradigms of the 80 most frequent noun lexemes from Zasorina's (1977) frequency dictionary. This allows us to consider how readily inflectional class membership can be inferred from high frequency data, where that are lots of items which appear to be fuzzy or partial members of a class. We can then see how well the classification performs by removing default and principal parts information.

An additional complication to our task is that stress patterns play a role in Russian noun inflection, and these cross-classify the noun declension. The task of inferring an inflectional class and the appropriate stress pattern results is a greater challenge. Combined with the fact that there is a rich tradition of research on Russian to draw from, this additional complexity makes the language an important testing ground for methods for inferring and validating inflectional classes. Particularly among high frequency nouns, there are items which may have the right affixes for a particular inflectional class but stress patterns which may associate them with nouns which belong to another inflectional class, or certain cells of a nouns' paradigms have affixes which are not typical for the class with which they are best associated. We are currently working on separating out the role of the stress patterns from the declensions, and will not discuss this in great detail in this paper.

2. Unsupervised learning of inflectional classes

Our empirical investigation of these notions from morphological theory employs an unsupervised machine learning technique to derive inflectional classes from sets of noun paradigm tables. We use compression-based similarity to cluster nouns into classes, where nouns in the same class are considered to have more similar paradigm tables than nouns in different classes. The core of our method is CompLearn[4], a machine-learning system which relates arbitrary data objects according to their 'similarity' (section 2.1). However, CompLearn does not implement the actual clustering of similar data into classes, so we need to introduce some simple heuristics to achieve this additional step (section 2.2). These two components provide the basic framework for a method for learning inflectional classes. We discuss methods for evaluating the results of the learning task (section 2.3), and finally summarise the complete experimental method (section 2.4).

2.1 Compression-based machine learning

The machine-learning paradigm that we use is the compression-based approach described in Cilibrasi and Vitányi (2005) and Cilibrasi (2007), as implemented in the CompLearn tools. This approach has two main components: (a) the use of compression (in the sense of standard compression tools such as zip, bzip etc.) as the basis of a measure for comparing data objects and (b) a heuristic clustering method, which relates objects according to their similarity using this measure. Together, these components provide a general purpose unsupervised method for clustering arbitrary digital data objects. Cilibrasi (2007) provides examples of its application to fields as diverse as genetics in mammals and viruses, music, literature, and genealogical relatedness of languages.[5]

[4] http://www.complearn.org

[5] Other work using compression-based techniques in relation to the study of language includes Juola (1989) and Kettunen et al. (2006). This research focused on compressing corpus data. While Juola's work addresses morphology, it is concerned with measuring complexity in terms

The basic operation of the CompLearn method is as follows. The input to the system is a set of data objects, each of which is simply a computer file containing some (unconstrained) digital data. Given two such data objects, CompLearn determines how similar they are by calculating the *normalized compression distance* (NCD) between them. This exploits the notion of a *compression function* which attempts to make a data object smaller by detecting repeated patterns in the data and representing them more compactly (as commonly used by computer operating systems to reduce the size of large files). NCD measures the difference between data objects by comparing how well they compress jointly and separately – if there is a benefit to compressing them jointly, this must be because the compression algorithm has found commonalities between them, and we interpret this as meaning they are similar. The more benefit that is gained, the more similar the two data objects are.

Given two data objects *x* and *y* and a compression function *c*, NCD is defined as:

$$(2) \qquad NCD(x,y) = \frac{C(xy) - \min\{C(x),C(y)\}}{\max\{C(x),C(y)\}}$$

Normalized compression distance (Cilibrasi and Vitányi, 2005: 7; Cilibrasi, 2007)

Here, *C(x)* is the size of the compressed version of *x* using *c*, and *C(xy*) is the size of the compressed version of *x* and *y* concatenated. In essence, NCD measures the maximal additional size needed to compress both objects together compared with compressing one. The denominator normalizes the result to approximate to [0,1], where 0 means the objects are identical (compressing both together has the same cost as compressing one) and 1 means the objects are completely dissimilar (compressing both together has the same cost as compressing each one individually). The effectiveness of NCD depends on the power of the compression function *c*, and in particular its ability to exploit 'similarities' in the objects which are not explicitly visible. But 'off-the-shelf' compressors such as bzip2[6] are very effective at this, even with completely arbitrary data objects.

Given a set of *n* data objects, CompLearn first computes a distance matrix, recording the NCD between each pair of objects. From this, CompLearn creates an unordered tree representing clustering relationships implicit in the distance matrix. An example of an unordered tree is shown in Figure 3[7] below. In this tree, each data object is represented by a leaf node, and the tree

of the overall informativeness of a text. We are, however, not aware of any previous application of a compression-based approach to the clustering of inflectional classes.

[6] http://www.bzip.org

[7] The node styling in figure 2 is a manual addition, as discussed in section 4.2 below.

structure is designed to correlate the distance between data objects in the tree (that is, the number of tree edges between them) with their NCD distance. Thus data objects close together in the tree are similar, while those far apart are dissimilar[8].

Constructing such a tree from the distance matrix is a challenging computational task. In CompLearn, the structure of the tree is topologically constrained to comprise *n* leaf nodes (corresponding to the data objects) and *n-2* internal nodes, each of order 3. Finding a tree with this structure which is the best fit for the distance matrix is an NP-Hard problem (Cilibrasi 2007, p49), so a best approximation to the optimal tree is constructed using a hill-climbing simulated annealing heuristic approach. Initially an arbitrary tree (meeting the topological constraints) is constructed with the *n* data objects as leaves. Then constraint-preserving modifications to the tree's internal structure are applied randomly, in accordance with a probability distribution which favours frequent small-scale changes to tree structure, with occasional larger-scale reorganisations to avoid getting stuck in local maxima. Each new tree is scored according to how well it pairs up similar data objects and separates dissimilar data objects and on each iteration the best-scoring tree generated so far is retained. The process stops when either the best possible score is attained, or there is no further improvement after a large number (circa 100000) of attempted modifications.

Cilibrasi shows that this procedure produces trees which are good approximations of the relations expressed in the distance matrix. However, as the method has a random probabilistic element, multiple runs on the same data may deliver different results. So it is important to execute multiple runs to check that any solution found is stable (and even then, it may not be the only stable solution).

2.2 Extracting classes from unordered trees

The unordered tree structure returned by CompLearn represents relatedness in the data set, but does not directly generate 'classes'. Indeed every internal node in the tree in figure 3 can be interpreted as a valid partition of the leaves into three clusters of 'related' leaf nodes (the clusters being the leaves reachable from each of the three edges leaving the node), and similarly every edge divides the set of leaves into two clusters. The tree structure itself does not tell us which clusters to choose, it just constrains the set of possible (or sensible) clusters – clusters that respect the relatedness structure of the tree and do not, for example, pick out odd leaves from disparate segments in the tree.

[8] The tree-drawing algorithm used to draw this tree is 'neato' in the Graphviz package (http://www.graphviz.org). This applies its own heuristics to lay out the tree so that nodes close together in the tree are generally also grouped together. This means that it is reasonably safe to interpret the visual clustering of the tree as correlating broadly to tree distance which in turn correlates broadly to distance in the NCD matrix.

In order to derive sensible classes from the tree we start off with a simple assumption: that no single class contains more than half the leaves. This assumption only works if we have some idea of what classes we expect to find, and can control the input data set sufficiently to achieve it – in the current context we can do this fairly easily. As soon as we make this assumption, we can impose order on the tree, by identifying an internal node that splits the tree into clusters, none of which contains more than half the leaves, and nominating it as the root of an ordered tree (there will be at most two such nodes in the tree, and we can pick either one). Once the tree is ordered in this way, its structure provides a natural hierarchy of clusters that respect the relatedness structure of the original unordered tree.

The task of finding a set of classes in such a tree becomes 'find a set of internal nodes in the tree which form a disjoint cover of the leaves (that is, which together dominate all the leaves with no overlaps)'. To do this, we need to know (a) how many classes we think there are, (b) how to identify candidate class sets in the tree of that size and (c) how to decide between competing possible class sets. Once again we have to appeal to our intuitions about the problem to decide how many classes to look for, but we can explore solutions for nearby cases as well. We identify candidate class sets by moving down the tree from the root, successively breaking classes into smaller parts represented by their child nodes until we have at least the requested number of classes.[9]

Our approach to choosing between class sets makes use of a function which generates a score for each class in the set. We choose the set for which the variance of these scores is smallest, that is, the set in which the classes are closest to having the same score. We have experimented with three such class measurement functions:

- **count:** this function simply counts the number of leaves in each class. Hence the best class set is the one in which the classes are closest to being the same size as each other.
- **max:** this function returns the maximum NCD score between leaves in the class. The best class set is one which distributes outliers between the classes, without much regard for the distribution of other leaves between the classes.
- **avg:** this function returns the average NCD score between leaves in the class. The best class set for is one where all the classes capture about the same amount of difference among their leaves (visually, they are about the same size, but unlike **count**, they may be different densities).

[9] The ordered tree is binary except for its root node, which is ternary. So in most cases a class is split into two parts. As a special case we allow the root node to represent two classes, one containing two subtrees the other one (in all possible ways), to avoid overcommitting to the initial three-way distribution of classes.

2.3 Evaluating inflectional class results

In order to assess the success of our approach, we need a way of evaluating the inflectional classes returned by the machine learning method. We achieve this by comparing the returned classes with a predefined 'right answer' based on our theoretical intuitions. We have experimented with three ways of representing the 'right answer':

- **gold standard:** we simply stipulate what the correct class for each data object is, based on our theoretical intuitions. This is a reasonable objective measure of how well the classification algorithm meets our theoretical expectations.
- **classified gold standard:** we create a data set in which each data object is represented just by its gold standard answer (so for example, the noun *strana* is represented simply by the string 'classII') and run the classification algorithm over this set. The result aims to represent the best possible classification that can be achieved using the classification algorithm (without any noise in the input), so that comparison with this set is a good subjective measure of how well the algorithm is coping with the additional noise in 'real' data inputs. However, the data objects are very small, so the compression algorithm may not distinguish between them very well.
- **classified exemplars:** we create a data set as in the previous case, but this time each data object is represented by an exemplar data object of the right class (the same exemplar for all objects in one class). As above, classifying this set aims to represent the best possible classification, but by using a richer input representation the compression function may be more effective at calculating NCD scores.

Each of these alternative 'right answers' results in a classification for the input data objects. Each experimental run results in another classification for the data objects. In order to evaluate an experiment, we create a mapping between classes in the experimental result and classes in the right answer, and then count how many data objects respect this mapping – that is, how many of them occur in the right answer class that the mapping predicts for them. There are many ways to construct such a mapping between the classifications, and we choose a mapping which maximises the agreement score.

2.5 Summary of the experimental method

In summary, the basic experimental method we use is as follows:

1. Prepare a data set as a set of files, one for each data object;
2. Create the NCD distance matrix from the data set;
3. Create an unordered tree using the probabilistic simulated annealing method (repeating several times to assess stability);

4. Order the tree by identifying a root node, and determine the best classification using one of the three scoring functions (count, max or avg);
5. Evaluate the classification against one of the ‘right answer’ classifications (gold standard, classified gold standard, or classified exemplars).

3. Experimental data

3.1 Data format

In order to apply this methodology to the learning of inflectional classes, we use noun paradigm table listings as the data objects. An example of such a listing, for the noun *strana* (country), is given in (1). [10]

```
(1) mor sg nom = stran ^ a @".
    mor sg acc = stran ^ u @".
    mor sg gen = stran ^ i @".
    mor sg dat = stran ^ e @".
    mor sg inst = stran ^ o @" ^ j ( u ).
    mor sg prep = stran ^ e @".
    mor sg prep loc = stran ^ e @".
    mor pl nom = stran ^ i.
    mor pl acc = stran ^ i.
    mor pl gen = stran.
    mor pl dat = stran ^ a ^ m.
    mor pl inst = stran ^ a ^ m'i.
    mor pl prep = stran ^ a ^ x.
```

These listings include morphological feature information and the forms themselves in phonological transcription. The caret (^) marks concatenation and the symbol combination @" marks stress.

Such a listing is represented in a plain text file, and the algorithm described above is run over a set of such files. Thus the compression function is applied to such listings individually, and concatenated together in pairs, in order to compute NCD scores. We briefly note a number of features of this representation which may have some bearing on the performance of the algorithm:

1. The list of forms is always presented in the same order in each file. We have not yet explored whether mixing up the order has any bearing on the results.

---

[10] The `prep` attribute is used in this dataset to represent the prepositional case (i.e. PREP SG and PREP PL in figure 1). This is also called the locative in many descriptions. The combination `mor sg prep loc` is used to represent the ‘second locative’ . The noun in this case does not really have a separate second locative as the form is the same as for the standard prepositional (or locative). This is discussed in detail by (Brown 2007).

2. We assume that systematic variation of the morphological terms ('sg', 'pl', 'nom' etc.) will not have a significant impact on the results, as the compression algorithm detects the patterns rather than the content.
3. The inclusion of some morphological segmentation information (ie the use of the caret for concatenation) means that the data incorporates some assumptions about morphological structure. However this structure in itself does not determine morphological classes, which is the main focus of our interest. Nevertheless it would be interesting in future to compare our results with using completely unsegmented surface forms.
4. The inclusion of individual noun stems probably does have a significant bearing on the results, as without them many of the listings would be almost identical. However we think that removing stem information would make the learning task too unrealistic to be of interest.
5. The inclusion of stress markers may well have an impact on performance, as stress patterns cut across morphological classes. Stress is not the main focus of the present paper, but we make some observations about it in section 4.

3.2 Data sets

The data set for our experiments are full paradigm listings (as described above) of the most frequent 80 nouns from Zasorina's (1977) frequency dictionary of Russian. They were generated from a Network Morphology theory representing the first 1500 most frequent noun lexemes implemented in the default-inheritance-based lexical representation language DATR (Evans and Gazdar 1996). Within these 80 nouns, we can distinguish five classes – the four theoretically motivated classes introduced in section 1, plus a small class of irregular nouns classed as 'other'. Table 1 lists the nouns included in each class:

Class 1	***Class II***	***Class III***	***Class IV***	***Other***
čelovek (person)	armija (army)	cel' (goal)	delo (affair)	leta (summer/ year)
den' (day)	bor'ba (struggle)	čast' (part)	dviženie (movement)	ljudi (people)
dom (house)	doroga (way)	dejatel'nost' (activity)	gosudarstvo (state)	
drug (friend)	forma (form)	dver' (door)	lico (face)	
glaz (eye)	golova (head)	mat' (mother)	mesto (place)	
god (year)	kniga (book)	molodëž' (young people)	obščestvo (society)	
gorod (town)	komnata (room)	mysl' (thought)	okno (window)	
konec (end)	mašina (car)	noč' (night)	otnošenie (relation)	
mir (world)	nauka (science)	oblast' (area)	pis'mo (letter)	

narod (folk)	noga (leg)	pomošč' (help)	proizvodstvo (production)	
otec (father)	partija (party)	poverxnost' (surface)	rastenie (plant)	
raz (occasion)	pravda (truth)	put' (way)	razvitie (development)	
stol (table)	rabota (work)	reč' (speech)	slovo (word)	
svet (light)	ruka (hand)	skorost' (speed)	solnce (sun)	
tovarišč (comrade)	sila (force)	smert' (death)	steklo (glass)	
trud (labour)	storona (side)	step' (steppe)	uslovie (condition)	
vopros (question)	strana (country)	svjaz' (connection)	veščestvo (substance)	
zavod (factory)	voda (water)	vešč' (thing)	xozjajstvo (economy)	
	vojna (war)	vlast' (power)	znakomstvo (acquaintance)	
	zemlja (country)	vozmožnost' (possibility)		
		zhizn (life)		
Size = 18	**Size = 20**	**Size = 21**	**Size = 19**	**Size = 2**

Table 1: Data set (with English glosses) arranged in theoretically motivated ('gold standard') classes.[11]

As discussed in section1, our theoretical model gives us a clear idea of which lines in the paradigm listings correspond to default information and which correspond to principal parts. We remove each type of data independently, so in our experiments, we used three variants of these data sets:

1. Full paradigms, to establish the baseline performance of the method with 'complete' knowledge.
2. Paradigms with default information removed.
3. Paradigms with principal part forms removed.

4. Experimental results

4.1 Validating 'right answer' sets

Our first experiment compared the three alternative versions of the 'right answer' classification, by creating 'classified gold standard' and 'classified exemplar' sets as described above, and classifying them into 5 classes, using each of the three class measurement functions. The evaluating scores for the

[11] The lexemes are given here in transliteration. The actual fragment generates paradigm listings in a lower ASCII phonological transcription.

resulting classifications against the hand-crafted 'gold standard' classification are shown in table 2.

	Class measurement function		
	Count	***Max***	***Avg***
Classified gold standard	77	60	77
Classified exemplar	77	80	80

Table 2: Evaluation scores (out of 80) for classification of 'right answer' data sets against gold standard (number of classes = 5)

These results suggest that the basic classification method performs reasonably well when given 'perfect' data, but that there is a clear benefit to giving it the richer data inputs provided by the exemplar cases. The scores for the 'count' function are interesting, because the algorithm would be trying to find a solution with close to 16 nouns in each class, for which we would expect a much lower score (as at least 14 of the nouns classified as 'other' would be wrong). The fact that the evaluation scores are high suggests that the tree is modeling the relational structure of the data well, and only permits solutions which are close to the correct balance. The relatively low classified gold standard/max score may be indicative of the fact that the data is too simple, so that distances between data objects are all similar and so the 'max' classification is fairly arbitrary.

There results encourage us to focus on the exemplar version of the 'right answer' data, and the 'max' and 'avg' measurement functions, in the remaining experiments.

4.2 Validating full paradigms

In our second experiment we classified the full paradigm data sets and evaluated the results against the true gold standard and the classified exemplar set. The unordered tree resulting from the classification process is shown in figure 3, and the results of the evaluations in table 3.

These results show a consistent level of classification success of about 55/80 (69%) for the real data. It is interesting that the results are the same for all three measurement functions. This may suggest that the constraints captured in the tree structure itself are more significant than different approaches to evaluating classification sets. The leaves in figure 3 are styled to illustrate how the gold standard right answers distribute across the clustering structure of the tree. It is evident that the class II nouns cluster very well, class III fairly well, with a small group of outliers, while classes I and IV are fairly confused (which is perhaps consistent with the Network Morphology account of the close relationship between these classes).

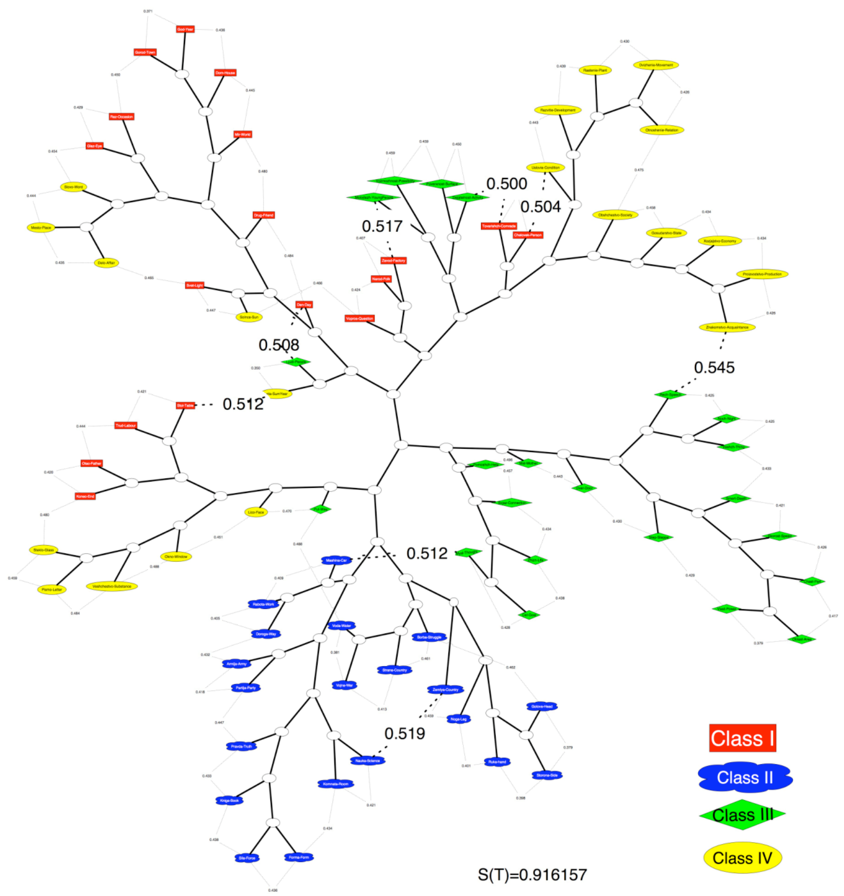

Figure 3: Classification of the full paradigm set – colours/shapes of the leaf nodes correspond to the 'right answer' (gold standard). The tree score (S(T)) is an indication that this tree is considered a good model of the underyling distance matrix.

	Class measurement function		
	Count	***Max***	***Avg***
Gold standard	55	55	55
Classified exemplar	56	55	55

Table 3: Evaluation scores (out of 80) for classification of full paradigm data sets against two 'right answer' representations (number of classes = 5)

4.3 Removing defaults

In our third experiment, we removed single lines associated with default value specifications systematically from all the paradigm listings, reclassified the data and evaluated the results against the gold standard.[12] The results are shown in table 4.

Form removed	Class measurement function		
	Count	***Max***	***Avg***
(none)	*55*	*55*	*55*
PREP PL	54	55	55
DAT PL	54	55	52
ACC PL	54	55	50
INS PL	54	55	50
PREP SG	54	55	50
NOM PL	37	35	39

Table 4: Evaluation scores (out of 80) for classification of paradigm data sets with individual default values removed evaluated against the gold standard (number of classes = 5)

This table shows that removal of information provided by default in general makes very little difference to the performance of the classifier. The one exception is the nominative plural case, discussed further in section 5 below.

4.4 Removing principal parts

In our last experiment, we remove single lines associated with principal parts, and so considered essential identifiers of the inflectional class. Results of the evaluation against the gold standard are given in table 5.

[12] Results against the classified exemplar set were the same for the 'max' and 'avg' measures. For 'count' they varied slightly, but not systematically.

Form removed	Class measurement function		
	Count	***Max***	***Avg***
(none)	*55*	*55*	*55*
GEN SG	54	55	61
NOM SG	53	42	50
GEN PL	54	46	46
ACC SG	42	43	43
DAT SG	42	38	39
INS SG	41	38	38

Table 5: Evaluation scores (out of 80) for classification of paradigm data sets with individual principal part values removed evaluated against the gold standard (number of classes = 5)

Here we see much greater variation in the impact of the removal of the data on the classification performance, consistent with the claim that these values are more significant to correct classification. We also see some, but not all, case show a significant variation in performance between measurement functions, which may be an indication of a difference in outlier distribution.

5. Discussion

5.1 Analysis

The results in section 4 indicate that there is little effect on classification when more default-like cells are removed. In contrast, a greater effect appears to be observable when principal-parts-like cells are removed. For example, removal of the oblique plural forms (dative plural, instrumental plural and prepositional plural) has a minimal effect on the correct classification in comparison with the base case, which reflects the fact that these are defaults for all nouns. In contrast the instrumental singular is clearly a good class identifier, as removing it from the paradigm tables has the most significant effect on classification performance.

There are, however, two instances where the effect is not as expected. When the genitive singular is removed a classification score of 61 is achieved relative to the gold standard using the ‘avg’ measurement function. This compares with 55 for the base set, indicating that classification seems to be improved when the genitive singular is absent. More subtly, this effect is not observable when the ‘max’ function is used. This suggests that the genitive singular may contribute to greater variation from average similarity within classes, possibly attributable to the fact that there are essentially two allomorphs shared across the four classes (see Figure 1). Interestingly, if there were no superclass `N_O`, this particular paradigm cell would be a violation of Carstairs-McCarthy’s (1994) No Blur principle, which essentially requires that a realization is either a default or a class identifier. The second case is the removal of the nominative plural, which has a greater effect than we might expect for a default-like cell. We conjecture that this could be connected with the fact that the inclusion of stress patterns in the dataset give it a greater role in identifying classes than just the affixal morphology would indicate.

5.2 Conclusions

We have presented data from an empirical investigation of defaults and principal parts where we determine the role they play in grouping high frequency nouns by removing the different elements individually and systematically. The experiments so far indicate that there is potentially an observable effect. Removal of default-like information typically has less of an effect than removal of principal parts information.

We have used a naturally occurring data set (the 80 most frequent noun lexemes) to avoid idealizing the task too much. These nouns include a range of complications and irregularities not shown in figure 1, but nevertheless we are able to show some interesting effects. In addition, our data includes stress information which complicates the classification task, because stress patterns cross-classify the nouns in ways which are not straightforwardly predictable from inflectional class and cannot be accounted for purely in phonological terms (see Brown *et al.* 1996). In ongoing work we are checking the degree to which our current results for principal parts and defaults are dependent on data format and exploring the impact of the stress information on the classification task.

5.3 Future work

Our experiments indicate that this approach has significant potential for investigating the role of morphological complexity of the type we have defined earlier. There are a number of core areas which our future work will concentrate on. Further investigation needs to be carried out on the methodology in terms of its stability and evaluation of the clustering. We will also compare our results with the static principal parts analyses which can be created with the online tool referred to in Finkel and Stump (2007). In particular, we can compare the Finkel and Stump scores with the results obtained for our clusterings when the principal parts information is removed. We will also investigate the role of stress in the Russian system and carry out a controlled comparison of the stress patterns and their interaction with inflectional classes. As we can generate the paradigm sets from the underlying theory we can also alter that to eliminate segmentation information and determine its role in classifying inflectional classes.

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Classic Problems at the Syntax-Morphology Interface: Whose are They?

Greville G. Corbett
University of Surrey

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Abstract

There are fascinating problems at the syntax-morphology interface which tend to be missed. I offer a brief explanation of why that may be happening, then give a Canonical Typology perspective, which brings these problems to the fore. I give examples showing that the phenomena could in principle be treated either by syntactic rules (but these would be complex) or within morphology (but this would involve redundancy). Thus 'non-autonomous' case values, those which have no unique form but are realized by patterns of syncretism, could be handled by a rule of syntax (one with access to other features, such as number) or by morphology (with resulting systematic syncretisms). I concentrate on one of the most striking sets of data, the issue of prepositional government in Latvian, and outline a solution within Network Morphology using structured case values.

1 Background[1]

Syntacticians have devoted considerable effort to understanding the constraints on the distribution of features. Less effort has gone into justifying the feature inventories for particular languages. This was a concern of members of the Set-theoretical School, a tradition which is of continuing relevance (see van Helden 1993 and Meyer 1994 for an overview). The work of Zaliznjak is particularly useful for our topic (e.g. Zaliznjak 1973), since he highlights problems whose solution involves complicating either the syntax or the morphology. Two later trends have conspired to background the

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problems I address. The first is the trend within formal grammar towards simpler syntax. This started with work on Generalized Phrase Structure Grammar (Gazdar, Klein, Pullum & Sag 1985), which demonstrated how much can be achieved using a leaner theoretical apparatus. It was also explicit in appropriately limiting the scope of syntax, which means that the issues I shall raise appear to some to fall outside syntax. The second is the growing acceptance of morphology as a component deserving of separate study, with its own issues. Some therefore concentrate on core morphological issues, leaving aside boundary problems. Hence the potential for a crack, down which complex and interesting issues may fall.

2 An example

As a brief illustration, the Russian preposition *po*, which expresses a wide span of meanings, has the following behaviour for some speakers/writers (there is ongoing variation). Specifically in the phrase *skučat´ po* 'to long for, miss', we find *po* (in one system at least) with the dative of nouns and the locative of pronouns (see also Iomdin 1991):[2]

Russian (from the writings of Andrej Platonov 1899-1951)

(1) skuča-l-a po rebenk-u (not: *po rebenk-e* in this corpus)
miss-PST-SG.F for child-SG.DAT
'missed (her) child'

(2) skuča-et po nem (not: *po nemu* in this corpus)
miss-3SG for 3SG.LOC
'is missing him'

Other prepositions do not behave in this way; thus *k* 'towards' governs the dative, of nouns and pronouns alike, while *o* 'about, concerning' governs the locative, of both nouns and pronouns. What then can we make of (1) and (2)? There are at least two analyses. According to the morphological approach, we can say that there is an extra case value (call it the DAT-LOC). It has no unique form, being syncretic with the dative for nouns and the locative for pronouns. The disadvantage of this analysis is that we have introduced an extra case value just for a few such expressions; moreover the extra case value has no separate form, it is 'non-autonomous' (Zaliznjak 1973: 69-74). The alternative, the syntactic approach, requires a rule of government which is certainly not simple, since it needs to specify different values for phrases

[2] *Po* is challenging in its various senses and in different Slavonic languages; see for example Przepiórkowski (2008) on Polish.

according to the type of their head. In contrast, the normal situation in Russian is that government operates ‘canonically’, without reference to a noun/pronoun distinction, or to any other part of speech.

Thus we have two types of analysis, and it is not self-evident which is to be preferred. This is one example of several such interface problems, which are our topic.

3 Canonical typology

As a tool for identifying and highlighting such examples, we adopt the approach of Canonical Typology. Adopting a canonical approach means that we take definitions to their logical end point, and this enables us to build theoretical spaces of possibilities. Only then do we investigate how this space is populated with real instances. Canonical instances are those that match the canon: they are the best, clearest, the indisputable ones. Given that they have to match up to a logically determined standard, they are unlikely to be frequent. They are more likely to be rare, and may even be non-existent. This is not a difficulty. The convergence of criteria fixes a canonical point from which the phenomena actually found can be calibrated.

4 Canonical morphosyntactic features and their values

We set out an idealized world, and then concentrate on phenomena that “ought” not to happen, particularly those where there are two solutions, both troublesome.

Canonical morphosyntactic *features and values* have been described in terms of two overarching principles (covering ten converging criteria). The important part for our analysis is the two principles given here (detail on the criteria can be found in Corbett 2010).

Principle I (morphological):

> *Features and their values are clearly distinguished by formal means (and the clearer the formal means by which a feature or value is distinguished, the more canonical that feature or value).*

Principle II (syntactic):

> *The use of canonical morphosyntactic features and their values is determined by simple syntactic rules.*

5 Classic problems: the two principles in conflict

We find interesting problems when our two principles are in conflict; consider first this paradigm from Classical Armenian:

SINGULAR	PLURAL	
azg	*azgk'*	NOMINATIVE
azg	*azgs*	ACCUSATIVE
azgi	*azgs*	LOCATIVE
azgi	*azgac'*	DATIVE

Classical Armenian *azg* 'people' (from Baerman 2002)

Figure 1: Non-autonomous case value

In this example, which is more general than the limited Russian instance above, there is no unique form for the accusative; its forms are always syncretic. There are two alternatives:

- we recognize an accusative case value. At the same time, we accept that it is a less canonical feature value than the nominative or dative. It is non-autonomous, and so it goes against Principle I, the morphological principle.
- we have a rule of syntax, which states that transitive verbs govern the nominative for singular NPs and the locative for plural NPs. This avoids having a non-autonomous case value, but it goes against Principle II, the syntactic principle, in requiring a complex syntactic rule.

Faced with such issues, the more usual choice in recent times has been to opt for simple syntax, and thus to accept a non-autonomous case value. There are fully analogous instances with other morphosyntactic features: gender, and person. For explicit discussion of alternative analyses in comparable but not identical circumstances see Goddard (1982) and Fedden (2007).

6 A canonical space for morphosyntax

We now move on to some new morphosyntactic criteria, in addition to the ten covered by the two principles above, hence numbered 11 to 15. Each of these criteria in different ways can be seen as exemplifying and maintaining the principle of **simple syntax**. They are listed for completeness; the most important for present purposes is Criterion 13.

6.1 Canonical government: governors govern

Criterion 11: A canonical rule of government consists of what the governor requires and the domain of government (and only that).

6.2 Canonical agreement: controllers control agreement

Criterion 12: A canonical rule of agreement consists of the feature specification of the controller and the domain of agreement (and only that).

6.3 Canonical interaction: morphosyntactic features 'mind their own business'

Criterion 13: The distribution of morphosyntactic feature values is constrained by the rules of government and agreement; it is not canonical for the values of other morphosyntactic features to have a role.

6.4 Canonical interaction of part of speech classifications and features: no effect on feature values

Criterion 14: Part of speech classification is accessible to morphosyntactic features; it is not canonical for it to be accessible to determine their values.

6.5 Canonical limit on lexical eccentricity

Criterion 15: Lexical items may have idiosyncratic inherent specification but may not canonically have idiosyncratic contextual specification.

7 The classic morphosyntactic problem: Latvian

The Baltic language Latvian deserves special attention since there are several conflicting lines of argument. To get to grips with the issues, it makes sense to start from the way in which the data are typically presented:

(3) Latvian noun paradigm (typical presentation: Veksler & Jurik 1978: 25)

galds 'table'	SINGULAR	PLURAL
NOMINATIVE	gald-s	gald-i
GENITIVE	gald-a	gald-u
ACCUSATIVE	**gald-u**	gald-us
INSTRUMENTAL	**gald-u**	**gald-iem**
DATIVE	gald-am	**gald-iem**
LOCATIVE	gald-ā	gald-os

The key point is that the instrumental singular is syncretic with the accusative, while the instrumental plural is syncretic with the dative. This is not something special about this class of noun; the same pattern of syncretism runs right through the language, including the personal pronouns. In fact there are no uniquely instrumental forms, hence if we assumed an instrumental case value it would be non-autonomous.

The instrumental, if recognized, is almost always found together with the preposition *ar* 'with'. If we do not recognise the instrumental, then we have a preposition, *ar* 'with', which takes different case values according to whether the governed element is in the singular or the plural. Such a situation is not what we expect, and it is not 'simple syntax'. Now consider these examples (Veksler & Jurik 1978: 87, and compare the discussion in Fennell 1975 and Holvoet 1992):

(4) Grūti dzīvot bez draug-a
hard live.INF without friend-SG.GEN
'It's hard to live without a friend.'

(5) Grūti dzīvot bez draug-iem
hard live.INF without friend-PL.DAT/INS
'It's hard to live without friends.'

We see that other prepositions, according to the traditional account, take different case values in the singular and plural. In fact all prepositions take the dative (=instrumental) in the plural.

There are good arguments for not recognising an instrumental case value. We could simply say that *ar* is a preposition which takes the accusative in the singular and which, when it governs a plural, behaves like all other prepositions in taking the dative plural (as do those which everyone agrees take the accusative in the singular). However, this approach flies in the face of the notion of simple syntax, since it goes against Criterion 13 (§6.3).

If, however, we wish to maintain a simple rule of government, we need to recognize a non-autonomous case value, governed by prepositions like *ar* 'with' and *par* 'about'; we could even call it 'instrumental', but for clarity here let us label it ACC-DAT. This looks like the traditional position. Left like this, the analysis is hardly tenable. The problem is the prepositions like *bez* 'without', as in (4) and (5), which similarly take the dative in the plural. To have a simple rule of government we need to recognize a further case value, the GEN-DAT. We do not, of course, need a third for the dative, since here the same value is found in the singular and the plural. Thus our rule of government can be simple, provided we accept the cost of having an additional two non-autonomous case values. The issues are interesting in their own right, but also more generally, as an illustration of interface problems which need to be considered from the perspective of simple syntax and a clearly-defined morphology.

8 Towards an analysis

There have been several attempts to analyse the Latvian data, based on different (often implicit) assumptions about syntax and morphology. The previous sections have clarified our assumptions somewhat, and we should attempt to tackle the problem from both the syntactic and the morphological direction.

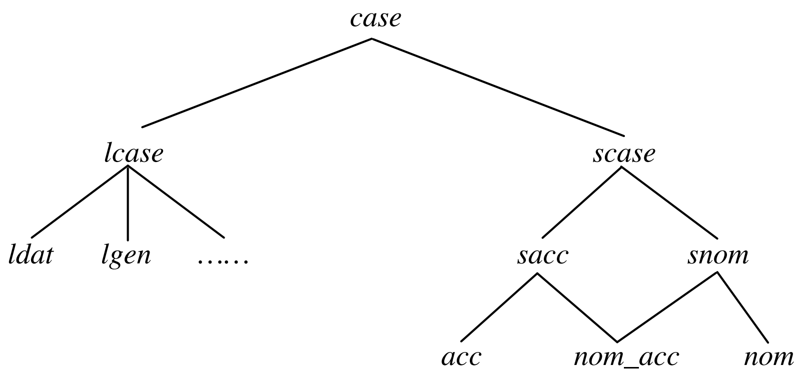
8.1 Syntax: HPSG

There are ideas within the HPSG literature that appear promising and relevant (thanks to Ivan Sag for pointing these out). First, Levine, Hukari & Calcagno (2001: 205) investigate parasitic gap examples like this:

(6) Robin is someone who even good friends of believe should be closely watched.

They need to allow an item like English *who* to be both accusative and nominative; their solution involves a novel sort hierarchy for case (2001: 207-210):

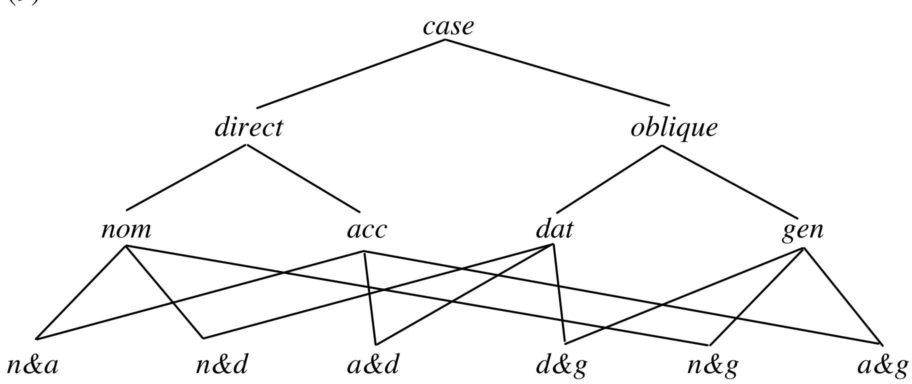
(7)



The interest is in the *scase* (structural case) part of the hierarchy. It includes an additional case value *nom_acc* and this satisfies any selectional requirement for nominative and accusative. In this approach, saying that a verb assigns *snom* to its subject is an abbreviation for saying it takes *nom* or *nom_acc*. The relevant forms have these specifications:

(8) whom [CASE *acc*]
who [CASE *nom_acc*]

Sag (2003) takes this further, when analysing coordinate structures where the conjuncts have different feature specifications (including the well-known German examples involving different case values). For these he proposes the following hierarchy of types (Sag 2003: 278):
(9)



If we think of the Russian *po* construction (§2), and stay with the simplest scenario assuming a rigid distinction between nouns and pronouns, we could propose an additional case value *dative_locative*; this would be the case value required by *po* in the construction we examined. But this leaves a substantial problem: *po* does not simply take any item that is dative or locative; we still need to specify that *dative_locative* is identical to pure dative for nouns and pure locative for pronouns.

There are two important points for our purposes. First, these analyses involve adding feature values; the syntax is kept simple, and there are additional feature values which introduce complications into the morphology. Moreover there is a relaxation of the standard HPSG assumptions; the requirement that feature structures be sort-resolved is abandoned (Sag 2003: 274). And second, the examples we have been examining are in one respect more challenging than those which have figured to date in the HPSG literature cited in this section: the extra dimension is that the additional values do not apply generally. Thus the Russian problem of government of *po* involved part of speech (noun versus pronoun in the simplest instance), while Latvian involved number.

More generally, the issue is not one of special syntactic constructions, as have figured in the instances those authors deal with, it is one of getting the right inflectional form. In some instances this form is clear-cut and not subject to variability. The particular problems we have concentrated on involve prepositions (there are comparable examples in other languages which do not, however); we could look for a 'weakened' featural requirement specifically for prepositions, which need not bring with it a general relaxation of the feature system. In other words, an analysis that pins the difficulty on the governor would be attractive.

Thus we should consider: (a) how we set up the features; (b) whether we can tie any special device uniquely to the case controller. With these possibilities in mind we turn to the morphology.

8.2 Morphology: Network Morphology

We look for an analysis within Network Morphology, which is an inferential-realizational theory; see, for example, Corbett & Fraser (1993), Evans, Brown & Corbett (2002), Brown & Hippisley (in progress). A bibliography of work in this framework can be found at: http://www.surrey.ac.uk/LIS/SMG/Network Morphology Bibliography.htm. Network Morphology gives a central place to defaults, which are layered, and analyses are represented and implemented in the lexical knowledge representation language DATR (Evans & Gazdar 1996).

Idea 1: In Latvian, certain prepositions take the *accdat* case, but *nothing* has an *accdat* case value, that is, no lexical entry includes a form with this featural description. (We use *accdat* to make it clear that this is an atomic value.) High in the morphological hierarchy, we could have statements of this type:

```
MOR_NOMINAL:
      <mor pl accdat> == "<mor pl dat>"
      <mor sg accdat> == "<mor sg acc>"
```

The effect is that any nominal (noun, pronoun or adjective) for which the *accdat* is required, will "provide" the dative if plural, and the accusative if singular.

The architecture of Network Morphology theories involves different hierarchies, related to each other by defaults. The morphological hierarchy just mentioned accounts for the lexeme's purely morphological behaviour, while the lexemic hierarchy takes care of its interface to syntax. (They are comparable to the content paradigm and form paradigm of Paradigm Function Morphology, earlier known as the morphological and syntactic paradigm, see Stump 2002: 149-153, 178.)

An alternative (Dunstan Brown, personal communication) is to state the regularity in the lexemic hierarchy:

```
NOMINAL:
      <syn pl accdat> == "<mor pl dat>"
      <syn sg accdat> == "<mor sg acc>"
```

In both, a similar rule is necessary for the *gendat* of course. This means that we miss the generalization that all prepositions take the dative in the plural.

This has the advantage of placing the statement right on the syntax-morphology interface. The Latvian data do not offer any unambiguous pointer as to which hierarchy is the preferable place; this is another instance of how uniquely tricky the Latvian data are. (Some other comparable instances may prove more helpful here in having specific morphological quirks, which would suggest the correct place is the morphological hierarchy.)

Idea 2: We have a 'structured case'; prepositions in Latvian take *prep acc*, *prep gen* or *prep dat* (for discussion of structured case values see Brown 2007 and Corbett 2008: 17-22). No noun, adjective or pronoun has a prepositional case form. In the lexemic hierarchy, we have these equations:

```
NOMINAL:
      <syn pl prep> == "<mor pl dat>"
      <syn sg prep> == "<mor sg>"
```

The first line states the surprising fact: all plural nominals governed by a preposition stand in the dative. The second states compactly that government in the singular is fully usual: any extension of the path on the left will also occur on the right. Thus, from the second line can be inferred (it is not stated explicitly):

```
      <syn sg prep acc> == "<mor sg acc>"
      <syn sg prep gen> == "<mor sg gen>"
      <syn sg prep dat> == "<mor sg dat>"
```

This analysis has several advantages. The feature system is made more complex for one case value only, the structured prepositional case, which exists alongside the remaining simple case values (nominative, accusative, genitive, dative, instrumental, locative). Structured cases are established as necessary in analyses of other languages. In Latvian, the structured prepositional case can be governed only by prepositions. It is non-autonomous: the realization of its values is mediated through the lexemic hierarchy, which locates the issue appropriately at the syntax-morphology interface. Thus we recognize the additional values (available for government by prepositions only), in order to keep the syntax simple, but they are dealt with by the lexemic hierarchy; no lexical item has a separate form for these values, as shown by the fact that they do not appear in the morphological hierarchy.

9 Conclusion

These data at the syntax-morphology interface present remarkable analytical challenges. They are thrown into relief by the Canonical Approach. The general point is that these unusual but recurring interface phenomena require a combined approach, rather than being allowed to escape the attention of both syntacticians and morphologists. The specific outcome is that we can treat the Latvian case problem using structured case values: the syntax remains simple, there is a complication of the feature system, and this is linked specifically to the case governor, the preposition. The structured case values have no additional morphological forms and the patterning of forms is handled, in the morphology, using a Network Morphology approach.

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Discontinuous Negation in Hausa

Berthold Crysmann
Universität Bonn and Universität des Saarlandes

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Abstract

Investigating the morphological and syntactic properties of discontinuous negative marking in Hausa, I shall suggest a constructional approach involving edge inflection, accounting simultaneously for the morphologically bound nature of the initial marker and its interaction with the TAM system, haplology of the final marker, and wide scope over coordination.

1 Data

Hausa, a major Chadic language spoken by around 35 million in Northern Nigeria and neighbouring Niger, exhibits three different ways of expressing VP negation: in the subjunctive, negative force is signalled by an independent "inhibitive marker" *kadà*, in the continuative, it is expressed by long high negative marker *bā*, whereas in all other tense/aspect/mood (TAM) categories, a discontinuous marker *bà ... ba* is used, consisting of initial low *bà/bȁ* and final short high *ba*.[1] Although negation is signalled twice in these cases, only single, not double negation is expressed.

(1) kadà kì bā shì kōmē (*ba) !
NEG 2.SG.F.SUBJ give him anything NEG
'Don't you (f.) give him anything.' (Newman, 2000, 364)

(2) bā tȁ sōyà kȁzā (*ba).
NEG.CONT 3.SG.F.CONT fry chicken NEG
'She is not frying chicken.' (Newman, 2000, 360)

(3) yārinyȁ bà tà dāwō *(ba).
girl NEG 3.SG.F.CPL return NEG
'The girl didn't return.' (Newman, 2000, 357)

Word order in Hausa is strictly SVO, with tense/aspect/mood (TAM) markers immediately preceding the lexical verb. With discontinuous VP negation, the initial marker is found strictly left-adjacent to the TAM markers, sometimes undergoing fusion with these markers (see section 1.2).

(4) mȁlàmai bà sù ji kōmē ba
teachers NEG 3.P.CPL hear anything NEG
'The teachers did not hear anything.' (Newman, 2000, p. 357)

In contrast to French *pas*, final *ba* surfaces at the end of the VP, following all core arguments (Newman, 2000; Jaggar, 2001). In this respect, the position

[†]I am gratefully indebted to the audience of the HPSG workshop on Morphology and Formal Grammar for their stimulating comments, in particular Jesse Tseng and Doug Arnolds.

[1]In Hausa, both tone and vowel length are lexically and grammatically distinctive. Throughout this paper, I mark long vowel with macron, leaving short vowels unmarked. As for tone, a grave accent marks low, circumflex marks falling, whereas vowels not marked for tone are high.

of negative markers is similar to that in Colloquial Brazilian. However, unlike Brazilian, neither initial nor final marking is optional in Hausa.

(5) bà zā mù ƙārà cî gàba dà karàntà wannàn littāfī̀ ba
NEG FUT.1.P repeat eat ahead with read this book NEG
'We won't continue reading this book.' (Jaggar, 2001, p. 454)

(6) bà à kashḕ shi [dà bindigā̀] ba
NEG 4.S.CPL kill him with gun NEG
'He wasn't killed with a gun.' (Jaggar, 2001, p. 452)

Although VP-final *ba* tends to follow complements in general, heavy, typically sentential, constituents may extrapose: This can be observed with relative clauses (see (7)), sentential complements (see (8)), and indirect questions (see (9)). Despite the possibility for extraposition, in situ realisation is possible in all these cases.

(7) Relative clauses

a. Bà sù yi sallàh tā̀re dà mutā̀nē$_i$ ba [dà$_i$ sukà zō masallācī]
NEG 3.P.CPL do prayer together with people NEG REL 3.P.CPL come mosque
'They didn't pray together with the people who came to the mosque.' (Ibrahim & Gusau)

b. Bà sù yi sallàh tā̀re dà mutā̀nē$_i$ [dà$_i$ sukà zō masallācī] ba
NEG 3.P.CPL do prayer together with people REL 3.P.CPL come mosque NEG
'They didn't pray together with the people who came to the mosque.'

(8) Sentential complements

a. Bài kàmātà ba [Tankò yà biyā hàrājī̀]
NEG.3.S.M.CPL be.appropriate NEG Tanko 3.S.M.SBJ pay tax
'It's not appropriate that Tanko pay tax.' (Newman, 2000, p. 359)

b. Bài kàmātà [Tankò yà biyā hàrājī̀] ba
NEG.3.S.M.CPL be.appropriate Tanko 3.S.M.SBJ pay tax NEG
'It's not appropriate that Tanko pay tax.' (Newman, 2000, p. 359)

(9) Indirect questions

a. bàn san [kō wā̀ ya zō] ba
NEG.1.S.CPL know who 3.S.M.CPL come NEG
'I don't know who came.' (Jaggar, 2001, p. 454)

b. bàn sanī̀ ba [kō wā̀ ya zō]
NEG.1.S.CPL know NEG who 3.S.M.CPL come
'I don't know who came.' (Jaggar, 2001, p. 454)

The most fundamental question concerning discontinuous negative marking is: which of the two parts carries inherent negative force, and which one should better be conceived in terms of agreement? In principle, there are four logical possibilities:

Initial: Only initial *bà* carries negative force. Marking of the TAM marker's VP complement by final *ba* is a subcategorisation requirement of certain negative TAM markers.

Final: Final free form *ba* is inherently negative, whereas bound initial *bà* is not.

Joint: Initial and final exponents are part of a single but discontinuous lexical item, separated in surface syntax, e.g., along the lines of Crysmann (2003).

Neither: Neither the initial nor the final part of discontinuous negative marking carries negative force per se. Instead negation is introduced constructionally (Fokkens et al., 2009), with presence of negation being signalled by initial and final edge inflection.

Investigating the morphological and syntactic properties of discontinuous negative marking, I shall conclude that a constructional approach involving edge inflection is the only viable option to account, simultaneously, for the morphologically bound nature of the initial marker and its interaction with the TAM system (§1.2), haplology of the final marker (§1.1), and wide scope over coordination (§1.3).

1.1 Haplology

The first piece of evidence regarding the question as to which marker carries negative force comes haplology, which applies to final, not initial markers of negation: If the right edge of an outer negation coincides with that of an inner negation, only a single final exponent of negation is found, i.e., one of the two adjacent exponents is obligatorily suppressed.

(10) a. bàn ga yāròn dà bài tàimàki Lādì ba
NEG.1.SG.CPL see boy REL NEG.3.SG.CPL help L. NEG
(*ba)
NEG
'I didn't see the boy who didn't help Ladi.' (Newman, 2000)

b. bàn cē̂ [bài cikà àlkawàrin-sà ba] (*ba)
NEG.1.S.CPL say NEG.3.S.M.CPL fill promise-his NEG NEG
'I didn't say he didn't keep his promise.' (Jaggar, 2001, p. 455)

As pointed out by Newman (2000), this haplology only ever applies among final markers of negation. It does not apply, if final negative *ba* is followed by the sentence-final question tag *bā/bā̂*, nor does it apply, if final *ba* appears adjacent to the initial *bà* of a following negated VP.

(11) shī nḕ dìrēbàn dà bài zō ba bâ
him FOC driver REL NEG.3.S.M.CPL come NEG Q
'Is he (not) the driver that didn't come?' (Newman, 2000, p. 360)

(12) yārinyàr [dà bà tà hanā̀ mu barcī ba] bà tà
girl REL NEG.3.S.F.CPL prevent us sleeping NEG NEG.3.S.F.CPL
zō ba
come NEG
'The girl who did not prevent us from sleeping did not come.' (Newman, 2000, p. 359)

More importantly, negative haplology never applies to the initial marker. There is one construction in Hausa that meets the appropriate structural conditions, yet fails to exhibit haplology of the initial marker: negative equational constructions are marked by a discontinuous pair *bā̀ ... ba* which, inter alia, can be used to negate an already negated sentence.

(13) bā̀ bà zā mù tàfi ba (*ba) nè:
NEG NEG FUT.1.PL go NEG NEG COP
'It is not that we are not going.' (Newman, 2000)

While haplology obligatorily applies to final *ba*, it fails to target adjacent initial markers of negation.

The haplology facts provide us with the first important piece of evidence to choose among the analytic alternatives listed above: given that the distinction between single and double negation is neutralised under final negative haplology, we have direct evidence against any approach that localises negative force with the final part of the discontinuous marker.

The particular tree-configurations involved in negative haplology enable us to discard yet another option: while it is possible, in principle for domain-based analyses to collapse identical elements into a single domain object, an analysis along such lines needs to presuppose that relative clauses do not compact, an assumption which is hardly defensible, in the general case, and even less so for a configurational language such as Hausa. Percolation of edge features across relative clause boundaries, however, is a well attested phenomenon (cf. Zwicky, 1987; Miller and Halpern, 1993).

1.2 Morphological integration

The discontinuous marker of VP negation shares some striking similarity with the equally discontinuous marker of sentential negation *bā̀ ... ba*, the main phonological difference being the length of the vowel of the initial marker. Concerning the marker of VP negation, Newman (2000) observes that there is some variability as to the length of the initial *bà(a)* While the initial marker of sentential negation is obligatorily long, the initial marker of VP negation is equally obligatorily short in the completive aspect. Other TAM categories are found both with long and short initial markers of negation, with a preference for short *bà* in the case of future TAM, and preference for long *bā̀* with potential and habitual TAM categories. In order to account for the variability, Newman (2000) further suggests that the alternation should be understood as that between a free form and a clitic.

Although an analysis of the bound initial VP-negation marker *bà* as a clitic variant of the marker *bā̀* might indeed be tempting, there are nevertheless both phonological and morphological arguments against such an analysis, at least as far as completive aspect is concerned.

First, the obligatory selection of short form *bà* in the completive does not follow from any general phonological processes of the language: despite the fact that the exponents of person/number agreement in the negative completive are literally identical to those found in the future paradigm (cf. Table 2), they combine with short *bà* in the negative completive, yet long *zā* in the future. Thus, the fact that the exponents of person/number agreement in the negative completive display a particular selection for the shape of the initial marker of negation suggests that we are confronted with a morphological, rather than a surface-phonological property.

Second, the morphological perspective on negative TAM markers in Hausa is further supported by the fact that the exponents of TAM and subject agreement found in the negative paradigms may systematically differ from the forms attested in the corresponding affirmative paradigms (absolute and relative), cf. table 1.

		Absolute		Relative		Negative	
1		nā	mun	na	mukà	bàn / (bà nì)	bà mù
2	m	kā	kun	ka	kukà	bà kà	bà kù
	f	kin		kikà		bà kì	
3	m	yā	sun	ya	sukà	bài / bà yà	bà sù
	f	tā		ta		bà tà	
4		an	—	akà	—	bà à	—

Table 1: Completive paradigms

Conversely, a cliticisation account of short form *bà* begs the question why prosodic attachment should trigger not only deletion of non-adjacent segmental material on the host, but also what factors could be made responsible for the suprasegmental changes in grammatical tone. Likewise, the change in vowel quality from *nā/na* to *nì* in the first singular cannot be derived on the basis of general phonological processes of the language. Note further that the application

Third, since the negative completive neutralises the contrast between relative and absolute completive marking, a cliticisation account needs to provide two distinct sets of reduction rules, one for each set of markers. Besides the fact that the exact nature of these reduction rules is highly stipulative, providing two such rule sets makes the entire approach quite baroque, thereby sacrificing much of the initial parsimony.

An alternative analysis that dispenses with uncontrolled deletion is to assume that initial *bà* cliticises not to forms of the affirmative completive paradigm, but rather to TAM markers from a different paradigm. A candidate paradigm whose forms also occur independently is the neutral TAM marker (or "Grundaspekt"). While most of the forms in this paradigm are segmentally and suprasegmentally identical to those found in the negative completive, the first singular is not.

		Neutral/Subjunctive		Future		Negative Completive	
		sg	*pl*	*sg*	*pl*	*sg*	*pl*
1		'ǹ/nà	mù	zân/zā nì	zā mù	bàn / (bà nì)	bà mù
2	m	kà	kù	zā kà	zā kù	bà kà	bà kù
	f	kì		zā kì		bà kì	
3	m	yà	sù	zâi/zā yà	zā sù	bài / bà yà	bà sù
	f	tà		zā tà		bà tà	
4		à	—	zā à	—	bà à	—

Table 2: "Grundaspekt", Future, and Negative Completive

However, apart from the idiosyncrasy in the first singular, there are also syntactic reasons to doubt the viability of such an approach: first, the neutral TAM, which is used in infinitive contexts and in sequences of events, does not combine with negation (Newman, 2000). The homophonous subjunctive does, but as stated above, the marker of negation used in the subjunctive is the (continuous) inhibitive marker *kadà*, not *bà*. Second, if the TAM marker itself does not carry aspectual force, how is completive aspect introduced? If the TAM marker is indeed the neutral or subjunctive, completive aspect cannot be associated with it. However, the relevant aspectual force cannot be associated with the initial marker of negation either: if it were, we would have to concede that there is a completive *bà* distinct, from, e.g., future *bà*. a move, which ultimately undermines the initial motivation for the cliticisation hypothesis.

To summarise, the lack of syntactic compositionality and the morphophonological properties of negative completive TAM markers militate strongly against a cliticisation apporach. Instead, I shall suggest that the selection of exponents in the negative paradigms is best understood in purely morphological terms.

1.3 Wide scope over coordinate structures

The third set of data we are going to present relates to negative marking in coordinate structures (cf. Newman, 2000): If a coordination of VPs is negated, discontinuous markers of negation wrap around both conjuncts, i.e., the first conjunct is marked with the initial marker of negation, whereas the last conjunct is marked with the final marker. Non-initial TAM markers appear in the affirmative, rather than negative form.

(14) bà mù ci mun shā ba
NEG.1.PL.CPL eat 1.PL.ABS.CPL drink NEG
'We didn't eat and drink. (Newman, 2000, 360)'

(15) bà tà shārè ɗākì: tā yi wankā
NEG.3.SG.F.CPL sweep hut 3.SG.F.ABS.CPL do bathing
tā tàfi makarantā ba
3.SG.F.ABS.CPL go school NEG
'She didn't sweep the hut, bathe and go to school.' (Newman, 2000, 360)

What is particularly interesting here is that the alternation between relative and absolute TAM markers[2] is only neutralised on the conjunct bearing an overt initial marker of negation. Non-initial conjuncts, however, fully maintain the contrast.

(16) a. bà tà tāshì **tā** zō ba
NEG.3.S.F.CPL get up 3.S.F.ABS.CPL come NEG
'She hasn't got up and come.' (Jaggar, 2001, p. 166)

b. Mammàn nē bài zō ajì̄ **ya** ɗàuki
Mamman FOC NEG.3.S.M.CPL come class 3.S.M.REL.CPL take
jarràbâ̄wā ba
exam NEG
'It was *Mamman* who didn't come to class and take the exam.' (Jaggar, 2001, p. 166)

The coordination facts just reviewed present us with an analytic paradox: while the morphology suggests that the initial marker of negation is essentially contained within a conjunct, syntactic diustribution of markers on peripheral conjunctions, as well as the semantic scope suggest that negation is actually outside the coordinate structure.

1.4 Synopsis

Before we procede towards our (formal) analysis of discontinuous negative marking in Hausa, let us briefly come back to our initial question regarding the locus of negative force. On the basis of the evidence just reviewed, we are now in a position to eliminate all but the constructional approach.

Initial: The hypothesis of the initial marker as the locus of negative force shares some initial plausibility based on the parallelism to continuous negative marking. However, while the morphological integration with the TAM markers

[2]In essence, forms from the relative set are used in clauses involving a filler, as witnessed by focus movement, wh-extraction and relativisation. Otherwise forms from the absolute set are used. See Jaggar (2001, 2006); Newman (2000) and Wolff (1993) for an overview.

suggests that initial *bà/bȁ* is contained within the first conjunct, wide scope over coordinated VPs suggests the opposite.

Final: Associating negative force with final *ba* not only introduces an undesirable asymmetry into the description of Hausa, between initial negation in the subjunctive and continuative vs. final negation elsewhere, but also fails to explain why the true locus of negative force may undergo haplology whereas the concording initial markers do not.

Joint: The idea of postulating a discontinuous lexical item attacks the issue of where to locate negation head on. However, this approach is plagued by a number of empirical problems. First, in order to capture the haplology facts, a special proviso is needed to conflate adjacent identical final markers in surface syntax, but to block conflation of initial markers. Second, wide scope over coordination militates against an analysis wich locates both negative force within individual conjuncts.

Neither: The constructional approach (Fokkens et al., 2009) dissociates the introduction of negative force from its exponence. This dissociation is indeed a necessary prerequisite for solving the paradox that negative force may be located outside coordinate structures, whereas negative marking is truly contained within peripheral conjuncts. Furthermore, an edge inflection approach to negative marking is not only empirically supported by the clearly peripheral realisation of final markers, but also independently motivated by the existence of other edge marking phenomena in the language, most notably definiteness marking at the right edge of relative clauses.

In the remainder of this paper I shall develop a formal treatment of discontinuous negative marking in Hausa in terms of edge feature percolation that reconciles the morphologically bound nature of the initial marker with the scope facts.

2 Analysis

2.1 Two approaches to edge inflection

Current approaches to edge inflection can be assigned to one oif two traditions: pharsal affixation approaches, pioneered by Anderson (1992, 2005), where morphological rules attach affixes directly to non-terminal phrase markers, and edge feature percolation approaches, which crucially distribute morphosyntactic features at the periphery of phrasal constituents. Morphological realisation of these features, however, is effected by standard morphological rules operating in the lexicon. This latter approach has a firm tradition in GPSG (Gazdar and Pullum, 1982; Gazdar et al., 1985), starting with the works of Nevis (1985) and Zwicky (1987). The most articulate theory of this kind to date is the approach developed by Halpern and Miller (Miller and Halpern, 1993; Halpern, 1995) which provides a general theory of edge feature percolation based on the distinction between trigger and marking features. Within HPSG, Jesse Tseng has argued in a series of papers for the introduction of edge features into the feature geometry. Although his work stays close in spirit to the GPSG proposals, he dispenses with the distinction between trigger and marking features.[3]

The two theories of edge inflection make slightly different predictions regarding the Hausa facts: under an Anderson-style approach, phrasal attachment should be insensitive to the morphological properties of the word which happens to surface at the relevant edge. Also, if affixation applies to phrases directly, without any percolation of edge features, the presence of phrasal affixes on more deeply embedded constituents should be invisible. In the light of the Hausa data, phrasal affixation clearly makes the wrong predictions: neither haplology of the final marker, nor the selection of morphological forms of the host word should be expected. Edge feature percolation, which ultimately handles aspects of morphological realisation at the lexical, not the phrasal level, actually predicts the occurrence of exactly this kind of interaction.[4]

2.2 Edge feature percolation

Before we embark on our analysis proper, I will briefly lay out the basic principles of edge feature percolation assumed here. In essence, I shall follow quite closley the earlier proposals by Miller and Halpern (1993) and Halpern (1995) and distinguish edge features into trigger features, which launch an edge inflection dependency, and marking features. Following Tseng (2003) I shall assume that edge features will be further distinguished into LEFT and RIGHT features. The value of these feature is a list of edge features, permitting the existence of more than one dependency at any partricular edge. Percolation of feature values is governed by an Edge Feature Principle similar to HPSG's Nonlocal Feature Principle (Pollard and Sag, 1994).

Edge Feature Principle: The right (left) MARK feature of the right (left) daughter is the concatenation of the right (left) MARK and TRIG features of the mother.

(17) *phrase* →

[3]Kupść and Tseng (2005) do introduce a trigger feature. In contrast to Miller and Halpern (1993) and Halpern (1995), however, their trigger feature is introduced on a lexical node and percolates up, whereas the Miller/Halpern-style trigger features do not percolate at all. The Polish cliticisation data for which this rather unconstrained percolation mechanism was introduced have meanwhile received an alternative linearisation-based analysis (Crysmann, 2006, to appear), obviating the need for trigger feature percolation.

[4]In more recent work, Anderson et al. (2006) concede the necessity to enrich the theory of phrasal affixation to accomodate interactions lexical properties in Nias, Kuuk Thaayorre and Somali. However, if edge inflection alone can account for both phrasal and morphological cases of peripheral realisation, Anderson's revised theory should be dispreferred on Occamian grounds.

$$\begin{bmatrix} \text{SS} & \begin{bmatrix} \text{EDGE} & \begin{bmatrix} \text{MARK}|\text{RIGHT} & \boxed{2} \\ \text{TRIG}|\text{RIGHT} & \boxed{1} \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \mathit{list} \oplus \left\langle \begin{bmatrix} \text{SS}|\text{EDGE}|\text{MARK}|\text{RIGHT} & \boxed{1} \oplus \boxed{2} \end{bmatrix} \right\rangle \end{bmatrix}$$

(18) *phrase* →

$$\begin{bmatrix} \text{SS} & \begin{bmatrix} \text{EDGE} & \begin{bmatrix} \text{MARK}|\text{LEFT} & \boxed{2} \\ \text{TRIG}|\text{LEFT} & \boxed{1} \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{SS}|\text{EDGE}|\text{MARK}|\text{LEFT} & \boxed{1} \oplus \boxed{2} \end{bmatrix} \right\rangle \oplus \mathit{list} \end{bmatrix}$$

As stated above, the edge feature principle determines the direction of feature percolation. Furthermore, if a trigger feature is encountered at some point in the tree, a corresponding marking feature must be retrieved. The principle by itself, however does not yet guarantee that each marking feature must correspnd to some trigger feature. This can be ensured by a principle such as follows:

MARK feature licensing: every MARK feature must be licensed by a corresponding TRIG feature

Essentially, there are two situations to be controlled for: first, termination of edge dependencies must be a property of root nodes, and second, MARK features are only ever licensed on a peripheral node.

(19) Root node marking condition

$$\mathit{root} \rightarrow \begin{bmatrix} \text{SS}|\text{EDGE}|\text{MARK} & \begin{bmatrix} \text{LEFT} & \langle\rangle \\ \text{RIGHT} & \langle\rangle \end{bmatrix} \end{bmatrix}$$

(20) Non-peripheral marking condition

a. *phrase* →

$$\begin{bmatrix} \text{DTRS}\ \mathit{list}\left(\begin{bmatrix} \text{SS}|\text{EDGE}|\text{MARK}|\text{RIGHT}\ \langle\rangle \end{bmatrix}\right) \oplus \left\langle \begin{bmatrix}\ \end{bmatrix} \right\rangle \end{bmatrix}$$

b. *phrase* →

$$\begin{bmatrix} \text{DTRS}\ \left\langle \begin{bmatrix}\ \end{bmatrix} \right\rangle \oplus \mathit{list}\left(\begin{bmatrix} \text{SS}|\text{EDGE}|\text{MARK}|\text{LEFT}\ \langle\rangle \end{bmatrix}\right) \end{bmatrix}$$

By (non-persistent) default, the TRIG features of phrasal signs and MARK features of lexical signs will be the empty list.

2.3 Discontinuous negation

As suggested by the scope data above, discontinuous negative marking in Hausa, both initial and final, should be regarded as edge marking of a phrasal construction that carries negative force. Thus, extending the proposal by Fokkens et al. (2009) from head feature percolation to edge feature percolation I suggest that negation in these cases is introduced by a unary phrase structure schema that restricts its mother's SS|EDGE|TRIGGER|LEFT and SS|EDGE|TRIGGER|RIGHT features to the value <*neg*>.

(21)
$$\begin{bmatrix} \text{C-CONT} & \begin{bmatrix} \text{RELS} & \left\langle \begin{bmatrix} \text{PRED} & \textit{neg-rel} \\ \text{ARG} & \boxed{1} \end{bmatrix} \right\rangle \\ \text{HCONS} & \left\langle \begin{bmatrix} \textit{outscopes} & \\ \text{HARG} & \boxed{1} \\ \text{LARG} & \boxed{2} \end{bmatrix} \right\rangle \end{bmatrix}, \\ \text{SS}|\text{EDGE} & \begin{bmatrix} \text{TRIG}|\text{LEFT} & \langle \textit{neg} \rangle \\ \text{TRIG}|\text{RIGHT} & \langle \textit{neg} \rangle \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{SS}|\text{L} \begin{bmatrix} \text{CONT}|\text{HOOK}|\text{LTOP}\ \boxed{2} \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

As captured by the MRS description above, negation semantically outscopes the local top handle of its syntactic daughter. Thus, the constructional introduction of semantics enables us to fix semantic scope by syntactic attachment.

Note further that the negation construction does not specify any syntactic constraints as to which daughters it can be applied. As a consequence, the phrase structure schema above will serve to introduce both sentential negation and VP negation.

According to the Edge Feature Principle, the daughter node in this construction will have non-empty lists for the corresponding left and right MARK features, from where they will percolate down along the periphery.

2.4 Right edge marking

Having established how the edge dependency is launched by a unary prase structure schema carrying negative force, we can now turn to the introduction of the exponents of negative marking, starting with the final marker *ba*.

Making the straightforward assumption that (final) *ba* is the only lexical item in Hausa that has a non-empty specification for the relevant marking feature SS|EDGE|MARKING|RIGHT, we can model quite directly that constructionally introduced negation must be expressed at the right edge. By (non-persistent) lexical default, all other lexical entries specify the empty list.

(22) Final marker (preliminary version):

$$\begin{bmatrix} \text{PH} & \left\langle \text{ba} \right\rangle \\ \text{SS} & \begin{bmatrix} \text{L} & \begin{bmatrix} \text{CONT} & \begin{bmatrix} \text{RELS} & \langle\rangle \\ \text{HCONS} & \langle\rangle \end{bmatrix} \end{bmatrix} \\ \text{EDGE} & \begin{bmatrix} \text{MARK}\,|\,\text{RIGHT} & \left\langle \mathit{neg} \mid \mathit{list}(\mathit{neg}) \right\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The possibility for final *ba* to undergo haplology, i.e. its potential to function as the exponent of more than one negation is captured in the above lexical description by constraining *ba* to express an at least 1-elementary list of *neg*-marking features. Put differently, haplology is treated here in terms of a single lexical item discharging more than one edge inflection dependency at a time.

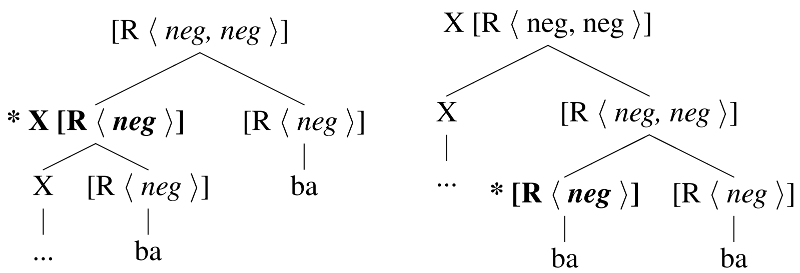
The remaining question regarding the syntax of the final marker relates to its attachement site: Given the Edge Feature Principle, it is clear that any edge marker much be in the syntactic scope of all triggers it marks, i.e., attachment must be low. But how low exactly must final *ba* attach? Since Hausa is a head-initial language, there is often more than one potential attachment site at the right periphery. In order to contain spurious ambiguity, I shall suggest that *ba* attaches to the preceding lexical item. Moreover, lowest attachment is the only principled choice that is at the same time compatible with both VP and sentential negation. Thus, we can give the following revised lexical entry for *ba*:

(23) Final marker (final version):

$$\begin{bmatrix} \text{PH} & \left\langle \text{ba} \right\rangle \\ \text{SS} & \begin{bmatrix} \text{L} & \begin{bmatrix} \text{CAT} & \begin{bmatrix} \text{HD} & \begin{bmatrix} \text{SPEC} & \begin{bmatrix} \text{LEX} & + \\ \text{EDGE}\,|\,\text{MARK}\,|\,\text{LEFT} & \langle\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix} \\ \text{CONT} & \begin{bmatrix} \text{RELS} & \langle\rangle \\ \text{HCONS} & \langle\rangle \end{bmatrix} \end{bmatrix} \\ \text{EDGE} & \begin{bmatrix} \text{MARK}\,|\,\text{RIGHT} & \left\langle \mathit{neg} \mid \mathit{list}\left(\mathit{neg}\right) \right\rangle \end{bmatrix} \end{bmatrix} \end{bmatrix}$$

The low attachment hypothesis not only provides a solution for the problem of spurious ambiguity, but it also enforces haplology, because the only two possible ways a sequence of more than one *ba* could ever arise is for the second to attach to the first, or else for the second to attach to a lexical constituent already marked for *ba*.

(24)



In any case, as illustrated schematically by the tree structure above, the first *ba* will end up either in a non-peripheral position itself, or the lexical constituent it marks will be non-final. However, both situations are already ruled out by the principle of MARK feature licensing.

2.5 Left edge marking

Analogous to final *ba*, the initial marker *bà̀* as well as negative TAM paradigms will be the only lexical items with a non-empty specification for the left marking feature. In order to abstract out common properties of negative TAM categories and the initial marker of sentential negation, I shall postulate a lexical type *l-neg-marking* from which both types of initial negative markers inherit.

(25) $\textit{l-neg-marking} \rightarrow \left[\text{EDGE} \left[\text{MARK} \begin{bmatrix} \text{LEFT} & \left\langle \textit{neg} \right\rangle \\ \text{RIGHT} & \langle\rangle \end{bmatrix}\right]\right]$

Since the negative TAM categories, appear in the same syntactic position as their affirmative counterparts, namely as VP-initial finite verbal heads, nothing special must be said about these markers, except that forms in the discontinuous negative paradigms are instances of *l-neg-marking*, whereas forms in the corresponding affirmative paradigm are not and will carry the (default) specification [SS|EDGE|MARK|LEFT <>]. A sample lexical entry for the fused 3rd singular masculine negative completive marker is given below.

$$
(26)\quad
\begin{bmatrix}
\textit{l-neg-marking} & \\
\text{PH} & \langle \text{bài} \rangle \\
\text{SS}\,|\,\text{L} & \begin{bmatrix}
\text{CAT} & \begin{bmatrix}
\text{HD} & \begin{bmatrix}
\text{AGR} & \boxed{0}\begin{bmatrix}\text{PER} & \textit{3}\\ \text{NUM} & \textit{sg}\\ \text{GEND} & \textit{m}\end{bmatrix} \\
\text{VFORM} & \textit{fin}
\end{bmatrix} \\
\text{VAL} & \begin{bmatrix}
\text{SUBJ} & \left\langle \boxed{1}\begin{bmatrix}\text{L}\,|\,\text{CAT}\,|\,\text{HD}\,|\,\text{AGR} & \boxed{0}\end{bmatrix}\right\rangle \\
\text{COMPS} & \left\langle \begin{bmatrix}\text{L} & \begin{bmatrix}
\text{CAT} & \begin{bmatrix}\text{HD} & \begin{bmatrix}\text{VFORM } \textit{infin}\end{bmatrix} \\ \text{VAL} & \begin{bmatrix}\text{SUBJ} & \langle\boxed{1}\rangle \\ \text{COMPS} & \langle\rangle\end{bmatrix}\end{bmatrix} \\
\text{CONT} & \begin{bmatrix}\text{HOOK}\,|\,\text{INDEX } \boxed{2}\end{bmatrix}
\end{bmatrix}\end{bmatrix}\right\rangle
\end{bmatrix}
\end{bmatrix} \\
\text{CONT} & \begin{bmatrix}\text{HOOK}\,|\,\text{INDEX } \boxed{2}\ \textit{event}\ \begin{bmatrix}\text{TAM } \textit{completive}\end{bmatrix}\end{bmatrix}
\end{bmatrix}
\end{bmatrix}
$$

As depicted in the lexical entry above, negative TAM markers, just like affirmative TAM markers, are analysed as auxiliaries, combining with an untensed VP, inheriting the yet unrealised subject of their VP complement (=raising).

Since the syntactic position of TAM markers, and, therefore, negative TAM markers is fixed to the position immediately preceding VP, it follows from the very nature of edge feature percolation that the trigger feature licensing this left edge inflection must strictly dominate VP as well. As a consequence, the VP-final realisation of closing *ba* follows without any further stipulation.

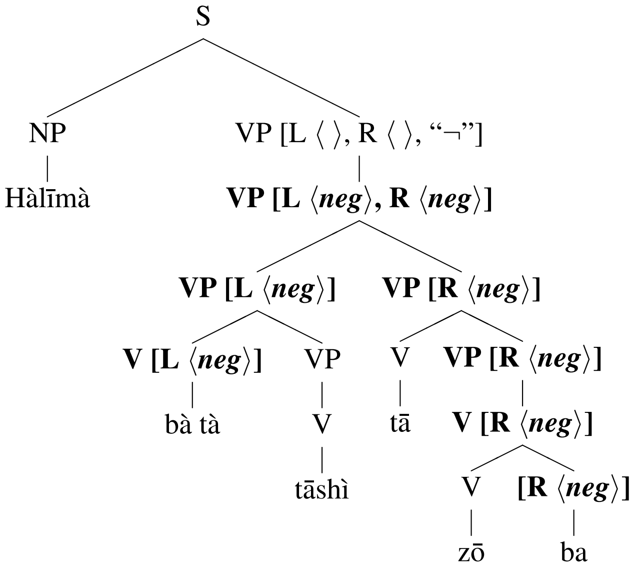
According to Newman (2000), discontinuous marking of negation outside the TAM system is effected by *bȁ ... ba*: in addition to sentential negation, this discontinuous marker is used for constituent negation of NPs and PPs, but not VPs. Since the only common property of all these environments is their degree of saturation, I suggest that the initial marker *bȁ* selects (via SPEC) a fully saturated phrase as its attachment site (see (27)).

$$
(27)\quad
\begin{bmatrix}
\textit{l-neg-marking} & \\
\text{PH} & \langle \text{bȁ} \rangle \\
\text{SS} & \begin{bmatrix}\text{L} & \begin{bmatrix}
\text{CAT} & \begin{bmatrix}\text{HD} & \begin{bmatrix}\text{SPEC} & \begin{bmatrix}\text{L}\,|\,\text{CAT}\,|\,\text{VAL} & \begin{bmatrix}\text{SUBJ} & \langle\rangle \\ \text{COMPS} & \langle\rangle \\ \text{SPR} & \langle\rangle\end{bmatrix}\end{bmatrix}\end{bmatrix}\end{bmatrix} \\
\text{CONT} & \begin{bmatrix}\text{RELS} & \langle\rangle \\ \text{HCONS} & \langle\rangle\end{bmatrix}
\end{bmatrix}\end{bmatrix}
\end{bmatrix}
$$

Once we make this assumption, the linear position of final *ba* will, again, be a mere corollary of the attachment of the initial marker and the Edge Feature Principle.

Before we close our discussion of discontinuous negative marking, let us briefly return to the case of wide scope over coordination. We have seen above that the attachment properties of negative TAM markers determine the tree-structural position of constructional negation. However, with initial conjuncts in coordinated VPs, there are actually two positions available that are consistent with both the subcategorisation requirements of the initial marker and the MARK feature licensing principle: either, negation immediately dominates the minimal VP, in which case we get a narrow scope reading, with the final marker contained in the first conjunct, or else, it dominates the coordinate structure, in which case the final marker must appear at the right edge of the final conjunct and the sentence will receive a wide scope reading of negation.

(28)



It should be clear that negative TAM markers on non-initial conjuncts can only ever signal narrow scope, owing to the fact that the MARK Feature Licensing principle rules out left edge features on non-left nodes.

2.6 Lexical negation

Having provided an account of discontinuous negative marking in Hausa, the obvious remaining question is as to how continuous negation fits into this picture. Thus, a brief remark is in order concerning non-discontinuous markers of negation, such as continuative TAM and the inhibitive marker *kadà*. Given that there is no evidence that these TAM markers can scope higher than what is expected by their surface position, I suggest they inherently carry negative force and do not function as edge inflection. The difference between discontinuous an continuous negation in Hausa will be reduced to the difference between lexical and constructional negation.

(29)

$$
\left[\text{SS}\left[\begin{array}{ll}
\text{L} & \left[\begin{array}{ll}
\text{CAT} & \left[\text{VAL}\left[\begin{array}{ll}\text{SUBJ} & \langle\boxed{1}\rangle\\ \text{COMPS} & \left\langle\left[\text{L}\left[\begin{array}{ll}\text{CAT} & \left[\begin{array}{ll}\text{HD} & \textit{verb}\\ \text{VAL}|\text{SUBJ} & \langle\boxed{1}\rangle\end{array}\right]\\ \text{CONT} & \left[\text{HOOK}\left[\begin{array}{ll}\text{INDEX} & \boxed{2}\\ \text{LTOP} & \boxed{3}\end{array}\right]\right]\end{array}\right]\right]\right\rangle\end{array}\right]\right]\\
\text{CONT} & \left[\begin{array}{ll}\text{HOOK} & \left[\begin{array}{ll}\text{INDEX} & \boxed{2}\ \textit{event}\left[\text{TAM}\ \textit{continuative}\right]\\ \text{LTOP} & \boxed{4}\end{array}\right]\\ \text{RELS} & \left\langle\left[\begin{array}{ll}\text{PRED} & \textit{neg-rel}\\ \text{LBL} & \boxed{4}\\ \text{ARG1} & \boxed{5}\end{array}\right]\right\rangle\\ \text{HCONS} & \left\langle\left[\begin{array}{ll}\textit{qeq} & \\ \text{HARG} & \boxed{5}\\ \text{LARG} & \boxed{3}\end{array}\right]\right\rangle\end{array}\right]
\end{array}\right]\\
\text{EDGE}|\text{MARK} & \left[\begin{array}{ll}\text{L} & \langle\rangle\\ \text{R} & \langle\rangle\end{array}\right]
\end{array}\right]\right]
$$

As depicted in the lexical entry of the negative continuous marker given above, negative force is directly contributed by the content value of the marker. Just like the non-continuative TAM markers, this marker also subcategorises for a VP, inheriting the yet unrealised subject valency. The semantic scope of negation is fixed lexically, outscoping the local top handle of its VP complement. Since auxiliaries are assumed to be heads, the handle of the negation relation will be the new local top handle of the auxiliary-VP complex, in accordance with HPSG's Semantics Principle (Pollard and Sag, 1994; Copestake et al., 2005).

3 Conclusion

We have seen that morphological and scopal properties of discontinuous negation in Hausa give rise to an analytical paradox. Using a constructional approach to the introduction of negative force, combined with edge inflection, a unified account of these properties could be provided that also captures the observed haplology effects. Finally, it has been shown that Hausa discontinuous negative marking constitutes yet another phenomenon that favours the edge feature percolation approach over Anderson-style phrasal affixation.

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Verb Inflection in Chiquihuitlán Mazatec: a Fragment and a PFM Approach

Jean-Léo Léonard
Paris 3, IUF

Alain Kihm
CNRS, Paris 7

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Amuzgo has been the hardest language we've had the good fortune to work on. Furthermore, we have seen no signs of complications in one area being compensated for by simplifications in other areas. The phonology is extremely challenging, the morphology defies coherent analysis in a most stubborn way, and from that little we've seen of the syntax, it is not especially simple. (Smith Stark & Tapia García 1986)

1. Introduction

This contribution intends to shed a new light on Mazatec verbal inflection within the framework of current research on Otomanguean phonology and morphology, disclosing the underlying simplicity of superficially intricate representations. Moreover, Mazatec and other Otomanguean languages appear as an exciting field of empirical work for frameworks such as Paradigm Function Morphology (Stump 2001). This field of research has indeed long been a rather exclusive preserve for Tagmemics-inspired studies, which brought to the fore chains of complex sound patterns and morphemes (see Longacre 1965, and compare with Longacre 1957), or complex sets of ordered rules (Jamieson 1982, Cuevas Suárez 1982S. Realizational approaches seem to better capture the fabrics of Otomanguean inflection, however. Moreover, there are few languages that empirically highlight the notion of inflectional class as well as Otomanguean languages do. Prospects for an extended survey of stem formation, stem class patterning and morphophonemic constraints at segmental and suprasegmental level in Otomanguean languages will therefore be suggested, on the basis of this case study of Mazatec, one of the most famous languages of the family as far as "complexity" is concerned.

2. The language

2.1. External data

Chiquihuitlán Mazatec (ChM) is a Mazatec dialect. Mazatec is an Eastern Otomanguean language spoken by about 200,000 people, located in the northeastern part of the state of Oaxaca, Mexico. ChM speakers number about 2500 people. The dialect is known for being rather divergent with respect to other Mazatec dialects.

2.2. Phonology

ChM is a tone language. There are four level tones traditionally numbered from 1 (high, H) to 4 (low, L) through 2 (high mid, M^+) and 3 (low mid, M)

(Jamieson 1982); and tonal glides M/L-H/M^+ (upglides) or the reverse (downglides). For greater ease of reading, we shall use accents in our transcriptions: e.g. *á* instead of a^1, *a* instead of a^2 or a^3, *à* instead of a^4, *â* for all downglides, and *ă* for all upglides. A drawback of this system is that it conflates high mid and low mid. This we can remedy when necessary – which it is not always – by assuming two tone registers: high (H and M^+) and low (M and L), and underlining high register mid vowels: $\underline{a} = a^2$.

There are three front vowels in ChM: /i/, /e/, /æ/; two back (round) vowels: /u/,/o/; and one low vowel: /a/. All can be nasalized, which we shall notate by writing an *n* to their right. Nasalized /æ̃/ raises to /ẽ/ written *en*, a phenomenon with some consequence, as we shall see. Two laryngeal components are the voiced glottal stop /ʔ/ and its unvoiced counterpart /h/. The glottal stop actually breaks up the vowel rather than it precedes it: *ʔV* = /VʔV/. Glottalization is then realized as creaky voice or creakiness. Likewise /h/ in /Vh/, /ChV/, or /hCV/ shows up as breathiness. Creakiness and breathiness affect the whole syllable.

3. ChM verb inflection

3.1. Outline

ChM verb inflection involves eighteen largely arbitrary (morphomic) verb classes marked by as many monosyllabic stem-forming prefixes consisting in a consonant and a vowel. Verb roots are themselves CV monosyllables. The concatenation of prefixes with roots then gives rise to bisyllabic stems.

Prefixes vary phonologically according to the person-number (p/n) features of the subject and (seemingly) the verb's aspect. Subject agreement is also marked by p/n suffixes, the vowels of which fuse with the roots' vowels. The CVCV sequences manifesting such structures /prefix-root.p/n_{SU}/ are traditionally called "couplets" (Longacre 1957; Rensch 1976).

ChM verbs inflect for three aspects: completive (COMPL), continuative (CONT), and incompletive (INCOMPL). There is in addition a morphologically unmarked so-called "neutral" aspect, which we interpret as absence of aspect specifications (see later on).

Subjects can be specified for seven p/n categories: 1sg, 2sg, 3def, 3indef, 1pl.incl ("we" including the addressee), 1pl.excl ("we" excluding the addressee), 2pl. We leave 3indef aside, as its formation and use are complex and poorly described. The interesting fact is then that 3(def) ONLY EXPRESSES PERSON, not number. Number with 3rd person subjects is syntactically indicated by free pronouns or NP's overtly marked for plurality, or it is retrieved from context.

A subject's p/n is therefore simultaneously marked on the verb through three parallel "subsystems" (Jamieson 1982): (i) the final vowel of the verb stem resulting from fusion of the root vowel and the vowel of the p/n suffix; (ii) the stem-forming prefix; (iii) the verb-form's tone pattern. Third person shows the root's lexical vowel and can therefore be considered the base form. Verb-forms other than 3 are represented in (1):

T1 T2

(1) $<_{W} <_{St} \text{ prefix } <_{R} \text{ C}\boxed{\text{V> suffix}}>>$

W means "word", St means "stem", R means "root". T1-T2 describes the tone pattern applied to the verb-form. Either tone or both can be tonal glides. The vowels resulting from the fusion of root vowels with p/n suffix vowels are called stem vowels.

3.2. Verb class prefixes

Verb class prefixes come in pairs pref1/pref2. Pref1 is associated with the p/n values {3} and {1sg}, Pref2 with the other p/n values. In five classes pref1 and pref2 are identical. The list below is for neutral verb forms.

Class 1: *be-*	
Class 2: *ba-*	
Class 7: *hba-*	
Class 10: *bu-*	Intransitive verbs
Class 15: *bi-*	

Class 11: *ba-* / *ča-*	
Class 3: *bo-* / *čo-*	
Class 4: *bu-* / *ču-*	
Class 16: *bu-* / *ntu-*	
Class 8: *ci-* / *nin-*	
Class 9: *su-* / *nun-*	
Class 12: *ka-* / *ča-*	
Class 14: *ba-* / *nan-*	
Class 13: *hba-* / *nan-*	Transitive verbs
Class 18: *hba-* / *čha-*	
Class 17: *hi-* / *či-*	
Class 6: *hi-* / *čhi-*	
Class 5: *hu-* / *čhu-*	

Table 1: ChM verb classes for neutral verb forms (revised from Jamieson 1982:145-146)

We kept Jamieson's numbering, but changed the ordering of the classes so as to regroup one-prefix classes, on the one hand, and to put a number of formal parallels into relief, on the other hand.

As can be inferred from Table 1, arbitrariness in verb class assignment is not total: the one-prefix VC's 1, 2, 7, 10, and 15 comprise intransitive verbs, whereas transitives belong to all other VC's with paired prefixes. There are apparently but few exceptions: e.g. *bečhi̱* (*bechji*) 's/he pays', although transitive, goes into class 1.[1] Class 8 is not arbitrary either, for it has causative meaning, deriving verbs from all lexical categories. Classes 1, 8, 10, 11, and 15 are the most frequent.

Notice that some prefixes occur in several classes: *ba*- in 1, 11 (pref1), 14 (pref1); *bu*- in 10, 16 (pref1); *hba*- in 7, 13 (pref1), 18 (pref1); *hi*- in 17 (pref1), 6 (pref1); *ča*- in 11 (pref2), 12 (pref2); *nan*- in 13 (pref2), 14 (pref2). Despite this, however, it is a striking fact that no pref1 ever occurs as a pref2 and vice versa. Both sets are entirely disjoint, in other words. Several prefixes are identical but for the vowel: *be*-, *ba*-, *bu*-, *bi*-, *bo*-; *nan*-, *nin*-, *nun*; *čha*-, *čhi*-, *čhu*-; *ča*-, *čo*-, *ču*-. Whether this is a significant observation or not, we do not know.

A few roots inflect without a verb class prefix, e.g. *ncabe̱* (*ntsabe*) 'play' (Jamieson 1982:146).

3.3. Tone patterns

Whatever the tone pattern of base form 3, other p/n's tone patterns fall into four tone pattern classes (TPC's) A, B, C and D. Subclasses B/Ba and D/Da differ by the 1sg tone pattern. The TPC's below are for neutral verb forms:

	Singular	Plural	
1	M-H	M-MH	inclusive
		M-HL	exclusive
2	M-H	M-H	

Table 2: TPC A

	Singular	Plural	
1	H-H	M^+-M^+	inclusive
		M^+-M^+L	exclusive
2	M^+-M^+	M^+-M^+	

Table 3: TPC Ba

	Singular	Plural	
1	M-H	M^+-M^+	inclusive
		M^+-M^+L	exclusive

[1] For full words we give both Jamieson's phonological transcription and Mazatec orthography based on Spanish, unless they happen to be identical.

2	M^+-M^+	M^+-M^+	

Table 4: TPC Bb

	Singular	Plural	
1	HL-M	HL-LM^+	inclusive
		HL-ML	exclusive
2	HL-M	HL-M	

Table 5: TPC C

	Singular	Plural	
1	H-H	M-M^+	inclusive
		M-M^+L	exclusive
2	M-M^+	M-M^+	

Table 6: TPC Da

	Singular	Plural	
1	M-H	M-M^+	inclusive
		M-M^+L	exclusive
2	M-M^+	M-M^+	

Table 7: TPC Db

Three-syllable verbs enter the same TPC's, but their first syllable is uniformly mid tone: cf. Db *bikuya* 'I teach', *bikuyún* 'you(pl) teach'. From Tables 1-7 we extract twelve tone patterns listed below with the forms they apply to:

1. $\underline{H}$-H 1sg Ba, Da
2. M-H 1sg A, Bb, Db; 2sg A; 2pl A
3. M-M^+ 2sg Da-b;1pl.incl Da-b;2pl Da-b
4. $\underline{M}^{\pm}$-M^+ 1pl.incl Ba-b, 2pl Ba-b
5. $\underline{H}$L-H 1sg C; 2sg C
6. $\underline{H}$L-M 2pl C
7. $\underline{H}$L-$\underline{L}M^+$ 1pl.incl C
8. $\underline{H}$L-M$\underline{L}$ 1pl.excl C
9. M-$\underline{M}$H 1pl.incl A
10. M-H$\underline{L}$ 1pl.excl A
11. M^+-$M^+\underline{L}$ 1pl.excl Ba-b
12. M-$M^+\underline{L}$ 1pl.excl Da-b

As mentioned above, all these patterns can be extended leftward with an additional syllable bearing mid tone.

We assume an OCP-faithful basic pattern L-H.[2] All monotonously rising patterns conform to it. In the list above this is the case of patterns 2 (M-H) and 3 (M-M^{+}). Such OCP-faithful patterns, we provisionally notate as X. All other patterns somehow deviate from X, and we accordingly underline the offending tones. For instance, the first H in (1) is underlined because L should appear in its place for the pattern to abide by the OCP.

When the observed deviations are radical as in 1 ($\underline{\text{H}}$-H), we call them Y. They may also be due to an additional offending tone to the left and/or the right of X as in 5 ($\underline{\text{H}}$L-H), 6 ($\underline{\text{H}}$L-M), 8 ($\underline{\text{H}}$L-M$\underline{\text{L}}$), 10 (M-H$\underline{\text{L}}$), and 12 (M-M$^{+}\underline{\text{L}}$), and we then call them X’. Finally, deviation may involve an additional offending tone inside X as in 7 ($\underline{\text{H}}$L-$\underline{\text{L}}$M^{+}) and 9 (M-$\underline{\text{M}}$H). We then designate the deviating pattern as Z. Notice that 4 ($\underline{\text{M}}^{\pm}$-M^{+}) and 11 (M^{+}-M$^{+}\underline{\text{L}}$) can be brought back to X and X’ respectively if the initial M^{+} is simplified to M.

We thus establish four types of patterns: (i) X, OCP-faithful (2, 3, 4); (ii) Y, anti-OCP (1); (iii) X’, marginally OCP-unfaithful (5, 6, 8, 10, 11, 12); (iv) Z, internally OCP-unfaithful (7, 9).

Now X’ is nothing more than X beginning (5, 6) or ending (10, 11, 12) with a downglide, or both (8). Z is similarly reduced to X and X’ if we assume that the respectively low and mid tones of the second syllables of 7 and 9 result from spreading of the low and mid tones of the first syllables. Pattern 7 then becomes an X with initial downgliding, while 9 becomes a simple X.

This gives us two basic tone patterns: (i) anti-OCP (1); (ii) OCP with or without downgliding (all others).

Concerning the relation of tone patterns with TPC’s, it is noteworthy that tone glides on both syllables (patterns 7 and 8) only occur in the 1st plural inclusive or exclusive cells of TPC C. As a general rule, 1PL.EXCL ends with a downglide in addition to an OCP-faithful pattern: cf. A M-HL, Ba-b M$^{(+)}$-M^{+}L, C HL-ML, Da-b M-M^{+}L; whereas 1PL.INCL is OCP-faithful with or without an initial downglide.

Tone patterns are thus a property of verb-forms. No lexical tone preassigned to roots need be assumed.

3.4. Verb classes and tone pattern classes

There is no predictability from a stem’s VC to its TPC and vice versa. VC’s and TPC’s independently concur to form inflection classes (IC’s). Given this, our goal is not to list all existing IC’s (109 according to Baerman & Corbett 2010), but to bring to light the regular formal operations whose interaction yields such a variety.

[2] OCP = Obligatory Contour Principle.

3.5. Mazatec person-number suffixes

The following presentation builds on Jamieson (1982:140), with significant revisions:

	Singular	Plural	
3	**-he*		
1	*-ʔa*	*-yan*	inclusive
		-yin	exclusive
2	*-ye*	*-yun*	

Table 8: ChM p/n suffixes

3 **-he* is reconstructed (Veerman-Leichsenring 2000:330). In contemporary ChM the 3rd person suffix is invisible, since fusing it with the root's vowel does not modify the latter (see above). Recall that p/n suffixes do not appear as such in inflected verb forms, precisely because of fusion with the root vowels to yield stem vowels (see above). They are apparent in the free pronouns, however (Veerman-Leichsenring 2000:329):

	Singular	Plural	
3			
1	*nga-ʔà*	*ngà-yǎn*	inclusive
		ngà-yîn	exclusive
2	*ngà-ye*	*ngà-yún*	

Table 9: ChM free pronouns

As can be seen, ChM 1st and 2nd person free pronouns consist in a root NGA, a complementizer, to which the p/n suffixes attach in their pristine state. The 3rd person free pronoun is entirely different, in contrast, and it has three forms: *ča̲* (cha) 'he', *nà* 'she', *čû* (chû) 'it (animals)'.[3]

4. Realization and morphophonological rules for neutral aspect paradigms

4.1. A choice of paradigms

We give here seven neutral aspect paradigms. As already explained, the six verb-forms result from attaching p/n suffixes (see Table 8) to stems *modulo* a few morphophonological processes (see below). Under each paradigm we tabulate the various verb-forms according to their faithfulness to the OCP.

[3] These three pronouns probably proceed from honorific classifiers.

I. Root: NTI 'THROW AWAY'. Root V: /i/. VC 12 (see Table 1). TPC A (see Table 2). IC 12A

	Singular	Plural	
3	*ka-ntí*		
1	*ka-ntǽ*	*ča-ntěn*	inclusive
		ča-ntîn	exclusive
2	*ča-ntí*	*ča-ntún*	

Table 10: neutral paradigm of NTI 'THROW AWAY' (*kantí*, *kantǽ*, *chantí, chantěn, chantîn, chantún*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x	x	x	x	x	x
–OCP						

Table 11: OCP-faithfulness

II. Root: SE 'REMEMBER'. Root V: /e/. VC 11 (see Table 1). TPC Bb (see Table 4). IC 11Bb

	Singular	Plural	
3	*bà-se̱*		
1	*bà-sǽ*	*ča-se̱n*	inclusive
		ča-sîn	exclusive
2	*ča-se̱*	*ča-su̱n*	

Table 12: neutral paradigm of SE 'REMEMBER' (*bàsé, bàsǽ, chasé, chasén, chasîn, chasún*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x	x	x	x	x	x
–OCP						

Table 13: OCP-faithfulness

III. Root: ŠTÆ ‘WRAP’. Root V: /æ/. VC 2 (see Table 1). TPC Ba (see Table 3). IC 2Ba

	Singular	Plural	
3	*ba-štæ*		
1	*bá-štǽ*	*ba-šten*	inclusive
		ba-štîn	exclusive
2	*ba-šte*	*ba-štun*	

Table 14: neutral paradigm of ŠTÆ ‘WRAP’ (*baxtǽ, báxtǽ, baxté, baxtén, baxtîn, baxtún*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x		x	x	x	x
–OCP		x				

Table 15: OCP-faithfulness

IV. Root: ČU ‘REACH’. Root V: /u/. VC 1 (see Table 1). TPC C (see Table 5). IC 1C

	Singular	Plural	
3	*bè-čú*		
1	*bê-ču*	*bê-čŭn*	inclusive
		bê-čîn	exclusive
2	*bê-či*	*bê-čun*	

Table 16: neutral paradigm of ČU ‘REACH’ (*bèchú, bêchu, bêchi, bêchŭn, bechîn, bêchun*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x	x	x	x	x	x
–OCP						

Table 17: OCP-faithfulness

V. Root: ŠO ‘STACK’. Root V: /o/. VC 1 (see Table 1). TPC Ba (see Table 3). IC 1Ba

	Singular	Plural	
3	*be-šo*		
1	*bé-šó*	*be-šon*	inclusive
		be-šîn	exclusive

2	*be-še*	*be-šun*	

Table 18: neutral paradigm of ŠO ‘STACK’ (*bexó, béxó, bexé, bexón, bexîn, bexún*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x		x	x	x	x
–OCP		x				

Table 19: OCP-faithfulness

VI. Root: ČHA ‘CLOSE’. Root V: /a/. VC 1 (see Table 1). TPC A (see Table 2). IC 1A

	Singular	Plural	
3	*be-čhá*		
1	*be-čhá*	*be-čhăn*	inclusive
		be-čhîn	exclusive
2	*be-čhé*	*be-čhún*	

Table 20: neutral paradigm of ČHA ‘CLOSE’ (*bechjá, bechjá, bechjé, bechjăn, bechjîn, bechjún*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x	x	x	x	x	x
–OCP						

Table 21: OCP-faithfulness

VII. Root: SMIN ‘LOOSE’. Root V: /in/. VC 8 (see Table 1). TPC A (see Table 2). IC 8A

	Singular	Plural	
3	*ci-smín*		
1	*ci- smén*	*nin-smĕn*	inclusive
		nin-smîn	exclusive
2	*nin-smín*	*nin-smún*	

Table 22: neutral paradigm of SMIN ‘LOOSE’ (*tsismín, tsismén, ninsmín, ninsmĕn, ninsmîn, ninsmún*)

	3	1SG	2SG	1PL.INCL	1PL.EXCL	2PL
+OCP	x	x	x	x	x	x
–OCP						

Table 23: OCP-faithfulness

4.2. Paradigm function rules for paradigms I-VII

To account for these seven paradigms we first need a general rule for forming verb stems. Then three rule blocks are required: a verb class prefix block, a p/n suffix block, and a TP block.

4.2.1. Verb stem formation rule – This rule can be formulated as follows: if a phonological sequence CV is a verb root, the combination of this root with a prefix pref-CV^{α} is a verb stem, where V^{α} realizes the fusion of the root vowel with the p/n suffix V_R*$V_{p/n}$. As mentioned, a few verb roots do not require prefixes to become stems.

4.2.2. Verb class prefix rule block – We adopt the rule style used in Bonami & Boyé (2010). In the rules under (2) below, X is a verb root/stem indexed for a given inflection class, here 12A . Feature set σ applies to X and the result of the functional application appears to the right of the double-shaft arrow. We only illustrate the rules for paradigm I, as the same rules but for the exponents account for all other paradigms.

(2) (a) X_{V12A}, σ:{AGR:{PERS:3}} ⇒ *ka*⊕X
(b) X_{V12A}, σ: {AGR: {PERS:1, NUM:sg}} ⇒ *ka*⊕X
(c) X_{V12A}, σ: { } ⇒ *ča*⊕X

The systematic identity of the exponence of {AGR:{PERS:3}} and {AGR: {PERS:1, NUM:sg}} poses a problem, as we can see no convincing way to unify these two features. What do 3 and 1SG have in common that would allow us to assume an overarching category subsuming both? Since we cannot guess, we have to content ourselves with writing two separate rules and accounting for the identity by means of metarule (3), which simply states that for every inflection class the realization rules for 3 and 1SG return the same exponent:

(3) ∀IC, $X_{Vn,}$ σ: {AGR:{PERS:3}} = X_{Vn}, σ: {AGR:{PERS:1, NUM:sg}} ⇒ $pref_i$⊕X.

The empty braces in (2c) mean that all remaining values of AGR satisfy the rule. Note these values do have something in common: they are neither 3 nor 1SG, the elsewhere or default case in different terms.

4.2.3. Person-number suffix rule block – In contrast with other p/n suffixes, the 1PL.EXCL and 2PL suffixes do not vary across IC's: they uniformly show up as *-ín* and *-ún*, which suggests their vowels /i/ and /u/ do not fuse with the various root vowels. To explain this absence of fusion, we assume there is simply no root vowel to fuse with because the 1PL.EXCL and 2PL suffixes select a vowelless variant or short form of the stem, whereas the other suffixes select the whole pref-CV or long form of the stem. We formalize such a differential selection by means of the following Feature Cooccurrence Restriction (FCR – Gazdar et al. 1985:27; Bonami & Boyé 2010):

(4) {AGR:{PERS:1/2, NUM:pl., CLUS:ex/undef}} ⊃ {FORM:short}

The feature CLUS ("clusion") has two values, ex(clusive) and in(clusive), in association with 1st person plural; it is undefined with other person-number combinations. Given this, the p/n suffix rule block (for all paradigms) is as follows:

(5) (a)X_{Vn}, σ: {AGR: {PERS:3}} ⇒ X
(b) X_{Vn}, σ: {AGR: {PERS:1, NUM:sg}} ⇒ X⊕*ʔa*
(c) X_{Vn}, σ: {AGR: {PERS:2, NUM:sg}} ⇒ X⊕*ye*
(d) X_{Vn}, σ: {AGR: {PERS:1, NUM:pl, CLUS:in}} ⇒ X⊕*yan*
(e) X_{Vn}, σ: {AGR: {PERS:1, NUM:pl, CLUS:ex}} ⇒ X⊕*yin*
(f) X_{Vn}, σ: {AGR: {PERS:2, NUM:pl}} ⇒ X⊕*yun*

X is the verb stem formed by the rules under (2) or their equivalents for other paradigms. In (5e) and (5f), X is the short form as *per* (4).

4.2.4. Tone pattern rule block – The following rules obtain for paradigm I:

(6) Xv_{12A} σ: { } ⇒ $X^{M\text{-}H}$
Xv_{12A} σ: {AGR{PERS:1, NUM:pl, CLUS:in}} ⇒ $X^{M\text{-}MH}$
Xv_{12A} σ: {AGR{PERS:1, NUM:pl, CLUS:ex}} ⇒ $X^{M\text{-}HL}$

X is the word-form resulting from the verb class prefix and person-number suffix rules, plus the morphophonological rules below.

4.3. Morphophonological rules

The p/n suffix rules in (5) input the morphophonological (MP) rules (7)-(12) below. Rule (7), for instance, says that the contact of a [+front], [+/–high], and [+/–nasal] root vowel, i.e. /i/, /æ/, or /en/, with the 1st person singular suffix -*ʔa* results in a [+front], [–high], [+/–nasal] word final vowel, i.e. /æ/ or /en/ (recall that /en/ is the realization of */æn/).

(7) $<_W <_{St}$ pref $<_R CV_{[+front,\ +/–high,\ +/–nasal]}$>> $ʔa_{1sg}$> → $<_{W/St}$ pref $<_R CV_{[+front,\ –high,\ +/–nasal]}$>>: /ka-nti.ʔa/ → *ka-ntǽ* (*kantǽ*) 'I throw away' (I). Cf. also /ba-se.ʔa/ → *bà-sǽ* (*bàsǽ*) 'I remember' (P II); /ba-štæ.ʔa/ → *bá-štǽ*

(*báxtǽ*) ‘I wrap’ (III); /ci-smin.ʔa/ $\rightarrow$ /ci-smǽn/ $\rightarrow$ [ci-smén] (*tsismén*) ‘I loose’ (VII).

(8) $<_{W} <_{St} \text{pref} <_{R} CV_{[-\text{front}, +/-\text{high}, -\text{nasal}]}>> \text{ʔa}_{1sg}> \rightarrow <_{W/St} \text{pref} <_{R} CV_{[-\text{front}, +/-\text{high}, -\text{nasal}]}>>$: /be-ču.ʔa/ $\rightarrow$ *bê-ču* (*bêchu*) ‘I reach’ (IV). Cf. also /be-šo.ʔa/ $\rightarrow$ *bé-šó* (*béxó*) ‘I stack’ (V); /be-čha.ʔa/ $\rightarrow$ *be-čhá* (*bechjá*) ‘I close’ (VI).

(9) $<_{W} <_{St} \text{pref} <_{R} CV_{[+/-\text{round}, +\text{high}, +/-\text{nasal}]}>> \text{ye}_{2sg}> \rightarrow <_{W/St} \text{pref} <_{R} CV_{[-\text{round}, +\text{high}, +/-\text{nasal}]}>>$: /ča-nti.ye/ $\rightarrow$ *ča-ntí* (*chantí*) ‘you(sg) throw away’ (I). Cf. also /be-ču.ye/ $\rightarrow$ *bê-či* (*bêchi*) ‘you(sg) reach’ (IV); /nin-smin.ye/ $\rightarrow$ *nin-smín* (*ninsmín*) ‘you(sg) loose’ (VII).

(10) $<_{W} <_{St} \text{pref} <_{R} CV_{[+/-\text{round}, -\text{high}, -\text{nasal}]}>> \text{ye}_{2sg}> \rightarrow <_{W/St} \text{pref} <_{R} CV_{[-\text{round}, -\text{high}, -\text{low}, -\text{nasal}]}>>$: /ča-se.ye/ $\rightarrow$ *ča-se̱* (*chasé*) ‘you(sg) remember’ (II). Cf. also /ba-štæ.ye/ $\rightarrow$ *ba-šte̱* (*baxté*) ‘you(sg) wrap’ (III); /be-šo.ye/ $\rightarrow$ *be-še̱* (*bexé*) ‘you(sg) stack’ (P V); /be-čha.ye/ $\rightarrow$ *be-čhé* (*bechjé*) ‘you(sg) close’ (VI).

(11) $<_{W} <_{St} \text{pref} <_{R} CV_{[+\text{front}, +/-\text{nasal}]}>> \text{yan}_{1pl.incl}> \rightarrow <_{W/St} \text{pref} <_{R} CV_{[+\text{front}, +\text{mid}, +\text{nasal}]}>>$: /ča-nti-yan/ $\rightarrow$ *ča-ntěn* (*chantěn*) ‘we(incl) throw away’ (I). Cf. also /ča-se.yan/ $\rightarrow$ *ča-se̱n* (*chasén*) ‘we(incl) remember’ (II); /ba-štæ.yan/ $\rightarrow$ *ba-šte̱n* (*baxtén*) ‘we(incl) wrap’ (III); /nin-smin.yan/ $\rightarrow$ *nin-směn* (*ninsměn*) ‘we(incl) loose’ (VII); /nin-khen-yan/ $\rightarrow$ *nin-khěn* (*ninkjěn*) ‘we(incl) feed’.

(12) $<_{W} <_{St} \text{pref} <_{R} CV_{[-\text{front}, -\text{nasal}]}>> \text{yan}_{1pl.incl}> \rightarrow <_{W/St} \text{pref} <_{R} CV_{[-\text{front}, +\text{nasal}]}>>$: /be-šo.yan/ $\rightarrow$ *be-šo̱n* (*bexón*) ‘we(incl) stack’ (V); /be-čha.yan/ $\rightarrow$ *be-čhǎn* (*bechjǎn*) ‘we(incl) close’ (VI); /be-ču.yan/ $\rightarrow$ *bê-čǔn* (*bêchǔn*) ‘we(incl) reach’ (IV).

The inputs and outputs of rules (7)-(12) are morphophonological strings, that is phonological sequences with the morphological labellings W (word), St (stem), and R (root) and separate representations of the stem-forming prefixes and the p/n suffixes. Roman numerals refer back to the paradigms in 4.1.

No MP rules are required for 1PL.EXCL and 2PL assuming /-in/ and /-un/ to be the postconsonantal forms of /-yin/ and /-yun/.

The morphophonological rather than simply phonological character of the rules is confirmed by the fact that they do not require adjacency to apply, as shown by the following evidence:

(13) *binčarkun* (*bincharkun*) $<_{W} <_{St} \text{bi} <_{R} \text{nča+rkun}> \text{he}/\varnothing>$ ‘s/he scares’

(14) *binčerkunyin* (*bincherkunyin*) $<_{W} <_{St} \text{bi} <_{R} \text{nče+rkun}> \text{ye}>$ ‘you(sg) scare’

/NČA-RKUN/ PUT-FEAR ‘scare’ is a complex root comprising the verbal root NČA ‘PUT’ and the so-called “directional” suffix *-rkun* ‘fear’.[4] The crucial fact is that suffixing 2SG *-ye* to the stem /bi-nča-rkun/ still mutates the /a/ root vowel “over” or “through” *-rkun*. Notice that the nasal vowel of *-rkun* ought to mutate as well. It exceptionally does not before 2SG *-ye* and 1PL.EXCL *-yin*, and it is the vowel of *-ye* that raises and nasalizes, hence /in/.

In some cases, the “directional” suffix has amalgamated with the root, which therefore turns into a simplex bisyllabic root and is treated as such by the MP rules: only the last vowel mutates: cf. *ci-nteya* (*tsinteya*) ‘s/he changes’, where /ya/ is a former directional suffix, vs. *ci-nteye* (*tsinteye*) ‘you(sg) change’ ← /ci-nteya-ye/ (cf. rule 9).

5. The marking of aspect

5.1. Completive and continuative aspects

Completive and continuative aspects are expressed by prefixing *ka-* and *ti-* respectively to the neutral form without further modifications:

(15) *ka-ča-se* (*kachase*) ‘you(sg) remembered’
(16) *ti-ba-šte* (*tibaxte*) ‘you(sg) are wrapping’

Hence the following completive and continuative aspect rule block, where X is the neutral verb form issuing from all preceding rule blocks:

(17) (a) X_V σ: {ASP:comp} ⇒ *ka*⊕X
(b) X_V σ: {ASP:cont} ⇒ *ti*⊕X

The prefixes receive mid tone in accordance with the rule for associating tone patterns with three-syllable verb forms (see 3.3). Completive and continuative aspect formation supports our assumption that the so-called neutral aspect actually means no aspect specification, as a unification problem would arise otherwise.

5.2. Incompletive aspect

Incompletive aspect is expressed through (a) a seemingly distinct set of verb class prefixes; (b) distinct tone patterns. The prefixes for incompletive aspect are listed in the following table:

Class 1: *kue-*	
Class 2: *kua-*	
Class 10: *ku-*	Intransitive verbs

[4] “Directional” is the term used by Jamieson (1982).

Class 15: *kui-*	
Class 7: *khua-*	

Class 3: *sko-* / **čo-*	
Class 4: *sku-* / **ču-*	
Class 16: *sku-* / **ntu-*	
Class 11: *kua-* / **ča-*	
Class 12: *ska-* / **ča-*	
Class 13: *khua-* / **nan-*	Transitive verbs
Class 14: *kua-* / **nan-*	
Class 18: *khua-* / **čha-*	
Class 17: *si-* / *ši-*	
Class 6: *ski-* / **čhi-*	
Class 5: *sku-* / **čhu-*	
Class 8: **ci-* / **nin-*	
Class 9: **su-* / **nun-*	

Table 24: ChM verb class prefixes for incompletive aspect (revised from Jamieson 1982:149)

The starred non-3/1SG prefixes are identical with their neutral counterparts. This turns out to be the case for all of them except in class 17 which has *ši-* instead of *či-*. In contrast, only two 3/1SG prefixes are identical with the neutral counterparts, namely in classes 8 and 9. All prefixes for 3/1SG or all person-number values show a /ku/ or /sku/ formative, except in classes 8, 9 and 17.

In view of this evidence, we conclude that incompletive aspect formation is fundamentally similar to completive and continuative aspect formation as it consists in prefixing (*s*)*ku-* to the neutral aspect word-form (including the prefix). The difference is that *ka-* and *ti-* do not trigger morphophonological processes; whereas *(s)ku-* does.

For instance, we analyse verb class 1 incompletive *kue-* as /ku-be-/, with an MP rule deleting intervocalic /b/. Likewise, we analyse classes 2, 11 and 14 *kua-* as /ku-ba-/; class 10 *ku-* as /ku-bu-/; class 15 *kui-* as /ku-bi-/; classes 7, 13 and 18 *khua-* as /ku-hba-/ (involving /b/ deletion plus breathiness spread to the new syllable); class 3 *sko-* as /sku-bo-/; classes 4 and 16 *sku-* as /sku-bu-/; class 12 *ska-* as /sku-ka-/; class 6 *ski-* as /sku-hi-/; class 5 *sku-* as /sku-hu-/.

Notice that the phoneme notated as *b* (or *ƀ*) is realized as a bilabial continuant /β/ with a [w] allophone before back vowels (Jamieson 1977). This makes intervocalic deletion highly plausible. The same is true of /h/ in verb classes 5 and 6. In the exceptional classes 8 and 9, in contrast, the neutral verb class prefixes do not begin with /b/ or /h/, but with /c/ and /s/, which presumably would not delete. But why doesn't *(s)ku-* attach to the neutral verb form nevertheless, yielding **(s)kuci-* and **(s)kusu-*? We have no answer to that question. The fact that class 17 *si-* / *ši-* does not seem to involve *(s)ku-* prefixation (cf. the neutral counterparts *hi-* / *či-*), on the other hand, could be accounted for by assuming *si-* to be a causativizing prefix, whose /s/ allomorph would appear in the *sku-* variant of the incompletive prefixes.

The incompletive aspect tone patterns, on the other hand, depend on the number of syllables, the tone pattern class, person-number value, and the inflection class.

With three-syllable verb forms, the initial mid tone of the neutral form is replaced by a low tone: cf. neutral *butaya* 'I study' vs. incompletive *skùtayá* 'I will study' (Jamieson 1982:150). Neutral bisyllabic verbs pertaining to TPC C do not change their tone pattern: cf. neutral *bâhnen* (*bâjnen*) 'I pick fruits' vs. *kuâhnen* (*kuâjnen*) 'I will pick fruits'. Other cases are more complex and we cannot enter into details here (see Jamieson 1982:150-151). We only examplify with the incompletive paradigms of SE 'REMEMBER' (cf. II in 4.1) and ŠTÆ 'WRAP' (cf. III in 4.1):

	Singular	Plural	
3	*kuà-se*		
1	*kuà-săe*	*čà-sěn*	inclusive
		čà-sîn	exclusive
2	*čà-se*	*čà-sun*	

Table 25: incompletive paradigm of SE 'REMEMBER'

	Singular	Plural	
3	*kuà-štæ*		
1	*kuá-štǽ*	*kua-šte̲n*	inclusive
		kua-štîn	exclusive
2	*kua-šte̲*	*kua-štu̲n*	

Table 26: incompletive paradigm of ŠTÆ 'WRAP'

With SE (TPC Bb), the incompletive signature seems to be a low tone on the verb class prefix at all p/n's. Moreover, SE's and ŠTÆ's paradigm appear globally regular and OCP-faithful, despite one salient infringement of OCP (H-H) in 1SG of ŠTÆ's paradigm.

6. The marking of polarity

All previous examples have positive polarity. Here is a negative neutral paradigm (to be compared with Table 12):

	Singular	Plural	
3	*ba-sǐn*		
1	*ba-sěn*	*ča-sěn*	inclusive
		ča-sîn	exclusive
2	*ča-sǐn*	*ča-sǔn*	

Table 27: negative neutral paradigm of SE ‘REMEMBER’

As can be gathered from this table, the exponent of negation is -*in* suffixed to the output of the p/n rule block:

(18) $X_V\ \sigma$: {POL:neg} $\Rightarrow X\oplus$*in*

MP rules similar to (7)-(12) account for the final vowel mutations due to -*in* suffixation: compare *bà-sǽ* (*bàsǽ*) ‘I remember’ and *ba-sěn* (*basěn*) ‘I do not remember’.

Negative polarity entails tone pattern changes (see Jamieson 1982:158-162). In 1PLEXCL the downglide starts as an upglide: $M^{+}HL$. Moreover, owing to vowel mutations, only the tone pattern distinguishes positive from negative in forms ending in a nasal vowel: compare *ča-se̲n* (*chasén*) ‘we(incl) remember’ with *ča-sěn* (*chasěn*) ‘we(incl) do not remember’. Length may also play a role, since tone glides are longer than level tone vowels.

Negative polarity is expressed in the same way in the incompletive aspect: compare *kua-sǽ* (*kuasǽ*) ‘I will remember’ with *kua-sěn* (*kuasěn*) ‘I will not remember’.

7. Conclusion

We only examined a small fragment of ChM verb inflection and cannot therefore draw any firm conclusions as to the language as a whole. A definite impression however prevails: despite bewildering apparent complexity, ChM is rather simple and regular in its morphological processes. The three levels root-stem-word are well distinguished. Prefixation builds stems from roots and ensures aspect and partial p/n contrasts; suffixation builds fully p/n-inflected word-forms from stems. Negation ought probably to be considered a kind of inflection. Tone patterns also contribute to p/n and aspect-polarity contrasts.

Complexity comes from the interaction of these processes. First, morphophonological processes blur the stem-word boundary and hide root vowels and p/n (and negative polarity) exponents within single coalesced vowels – although not enough that an account in terms of synchronic ablaut would be justified. Verb class prefixes are absorbed by the preceding incompletive aspect prefix, giving the apparence of a special set of aspectually inflected prefixes. Secondly, verb class prefixes and tone patterns independently and unpredictably concur to yield many inflection classes, thus possibly placing heavy memory load on ChM native learners.

It is worth noting that the grammar we have described here is presently undergoing some erosion among younger speakers. Maybe under Mexican Spanish influence, synthetic 2nd and 3rd persons plural get increasingly syncretized in a number of Mazatec dialects, for instance in Jalapa and San Miguel Soyaltepec.

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Hindi Noun Inflection and Distributed Morphology

Smriti Singh
Indian Institute of Technology Bombay

Vaijayanthi M Sarma
Indian Institute of Technology Bombay

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1 Introduction

This paper[1] primarily presents an analysis of nominal inflection in Hindi within the framework of Distributed Morphology (Halle & Marantz 1993, 1994 and Harley and Noyer 1999). Müller (2002, 2003, 2004) for German, Icelandic and Russian nouns respectively and Weisser (2006) for Croatian nouns have also used Distributed Morphology (henceforth DM) to analyze nominal inflectional morphology. This paper will discuss in detail the inflectional categories and inflectional classes, the morphological processes operating at syntax, the distribution of vocabulary items and the readjustment rules required to describe Hindi nominal inflection. Earlier studies on Hindi inflectional morphology (Guru 1920, Vajpeyi 1958, Upreti 1964, etc.) were greatly influenced by the Paninian tradition (classical Sanskrit model) and work with Paninian constructs such as root and stem. They only provide descriptive studies of Hindi nouns and verbs and their inflections without discussing the role or status of affixes that take part in inflection. The discussion on the mechanisms (morphological operations and rules) used to analyze or generate word forms are missing in these studies. In addition, these studies do not account for syntax-morphology or morphology-phonology mismatches that show up in word formation. One aim of this paper is to present an economical way of forming noun classes in Hindi as compared to other traditional methods, especially gender and stem ending based or paradigm based methods that give rise to a large number of inflectional paradigms. Using inflectional class information to analyse the various forms of Hindi nouns, we can reduce the number of affixes and word-generation and readjustment rules that are required to describe nominal inflection. The analysis also helps us in developing a morphological analyzer for Hindi. The small set of rules and fewer inflectional classes are of great help to lexicographers and system developers. To the best of our knowledge, the analysis of Hindi inflectional morphology based on DM and its implementation in a Hindi morphological analyzer has not been done before. The methods discussed here can be applied to other Indian languages for analysis as well as word generation.

[1] **Acknowledgements**
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2 Inflection in Hindi Nouns

Hindi nouns show morphological marking only for number and case. Number can be either singular or plural and can be represented as a binary valued feature [±pl]. Singular [-pl] is the default value for number which is morphologically unexpressed while plural or the non-default value [+pl] may be phonologically realized. Case marking on Hindi nouns is either direct or oblique. Marked (oblique) nouns show cumulative exponence for case and number, e.g., *-e* in *ləɽk-e (boy-oblique)* and *-õ* in *rājā-õ (kings-oblique)* for singular-oblique and plural-oblique respectively. Gender, an inherent, lexical property of Hindi nouns(masculine or feminine) is not morphologically marked, but is realized via agreement with adjectives and verbs. We must point out that (1) a few nouns may be in either gender given the context, e.g., *dost* or *mitr (friend)* and that (2) natural sex distinction in humans *ləɽkā-ləɽkī (boy-girl), bəccā-bəccī (baby-boy and baby-girl)*, in a few animals *ghoɽā-ghoɽī (horse-mare)* and some kinship terms *dādā-dādī (paternal grandpa-grandma), māmā-māmī (maternal uncle-aunt)* are marked using specific stem endings, i.e., feminine nouns tend to end in vowel */ī/* while masculine nouns tend to end in */ā/*. This is, however, not generally the case, for example *pānī (water)* is masculine and *mālā (garland)* is feminine.

In the following tables we show the inflections selected by Hindi nouns. Table 1 shows that Hindi feminine nouns of inflection Type 1 are marked *null* for all number-case values. Type 2 and Type 3 nouns inflect only in the plural for both case values. Table 2 shows the inflection for masculine Hindi nouns. Inflection is seen again in Type 2 and 3 nouns in the plural for both case values and in the singular for only Type 2 nouns in the oblique.

Table 1: Types of Inflections for Hindi Feminine Nouns

	Type 1		**Type 2**		**Type 3**	
	Direct	Oblique	Direct	Oblique	Direct	Oblique
Singular	***null***	***null***	***null***	***null***	***null***	***null***
Examples	*āg 'fire', pyās 'thirst'*	*āg, pyās*	*nədī 'river', šəkti 'power'*	*nədī, šəkti*	*lətā 'vine', rāt 'night'*	*lətā, rāt*
Plural	***null***	***null***	***-yā̃***	***-yõ***	***-ẽ***	***-õ***
Examples	*āg, pyās*	*āg, pyās*	*nədi-yā̃, šəkti-yā̃*	*nədi-yõ, šəkti-yõ*	*lətā-ẽ, rāt-ẽ*	*lətā-õ, rāt-õ*

Table 2: Types of Inflections for Hindi Masculine Nouns

	Type 1		Type 2		Type 3	
	Direct	Oblique	Direct	Oblique	Direct	Oblique
Singular	***null***	***null***	***null***	***-e***	***null***	***null***
Example	*krodh ‘anger’, pyār ‘love’*	*krodh, pyār*	*ləɽkā ‘boy’, bəccā ‘baby’*	*ləɽk-e, bəcc-e*	*ādmī ‘man’, ghər ‘home’*	*ādmī, ghər*
Plural	***null***	***null***	***-e***	***-õ***	***null***	***-õ/-yõ***
Example	*krodh, pyār*	*krodh, pyār*	*ləɽk-e, bəcc-e*	*ləɽk-õ, bəcc-õ*	*ādmi ghər*	*ādmi-yõ, ghər-õ*

3 Noun Classification Systems for Hindi in the Literature

Traditional classification (from the Paninian perspective) of Hindi nouns is based on gender and stem endings. This system does not allow two nouns of different genders or different stem endings to be in one class. With two genders and around nine stem endings (*ā, ī, i, ū, u, o, O/au, yā* and *consonant*), we get at least eighteen classes. In addition, nouns that have one of these stem endings but take *null* for all case-number values are put into different inflectional classes. This results in a large number of nominal classes (approximately thirty) that display similar inflectional behaviour. Many readjustment rules are also required to explain the phonological changes in the inflected forms. Table 3 provides one example of nouns placed in different classes because of different stem endings even though they take similar inflectional markers and belong to the same gender.

Table 3: Hindi Feminine Nouns Taking Similar Inflections

	consonant ending	***ā ending***	***ū ending***	***u ending***	***au ending***
Noun	***rāt ‘night’***	***mātā ‘mother’***	***bəhū ‘daughter-in -law’***	***ritu ‘season’***	***lau ‘flame’***
Pl-dir	*rāt-ẽ*	*mātā-ẽ*	*bəhu-ẽ*	*ritu-ẽ*	*lau-ẽ*
Pl-obl	*rāt-õ*	*mātā-õ*	*bəhu-õ*	*ritu-õ*	*lau-õ*

Kachru (2006) categorizes Hindi nouns into five declension types as given in Table 4 below. This classification is based on how Hindi nouns decline for gender, number and case. The classification criteria, however, are not clear.

Each class includes both masculine and feminine nouns. The last three declensions include nouns with identical stem endings *i, ū* and *consonant* respectively while the first two do not, i.e., the masculine nouns in the first declension are *ā* ending while feminine nouns are *ī* ending and the second declension has *ī* ending masculine nouns and *ā* ending feminine nouns. Further, rules that describe affix insertion, stem alternation/modification are also missing from the discussion.

Table 4: Kachru's Classification of Hindi Nouns (Kachru, 2006, p52-53)

		[-pl, -obl]	[pl,+obl]	[+pl,-obl]	[+pl,+obl]
Class 1 *Masc: ā, Fem: ī ending*	**Masc**	*ləɽkā 'boy'*	*ləɽk-e*	*ləɽk-e*	*ləɽk-õ*
	Fem	*ləɽkī 'girl'*	*ləɽkī*	*ləɽki-yā̃*	*ləɽki-yā̃*
Class 2 *Masc: ī, Fem: ā ending*	**Masc**	*sāt^{h}ī 'friend'*	*sāt^{h}ī*	*sāt^{h}ī*	*sāt^{h}i-yõ*
	Fem	*kənyā 'girl'*	*kənyā*	*kənyā-ẽ*	*kənyā-õ*
Class 3 *i ending*	**Masc**	*pəti 'husband'*	*pəti*	*pəti*	*pəti-yõ*
	Fem	*sidd^{h}i 'success'*	*sidd^{h}i*	*sidd^{h}i-yā̃*	*sidd^{h}i*
Class 4 *ū ending*	**Masc**	*sāɽū'co-brother'*	*sāɽū*	*sāɽū*	*sāɽu-õ*
	Fem	*bəhū 'daughter-in-law'*	*bəhū*	*bəhū-ẽ*	*bəhū-õ*
Class 5 *consonant ending*	**Masc**	*siyār 'jackal'*	*siyār*	*siyār*	*siyār-õ*
	Fem	*cīl 'eagle'*	*cīl*	*cīl-ẽ*	*cīl-õ*

We see in Table 4 that the feminine nouns in Classes 2, 4 and 5 show similar inflectional behaviour as they are marked with *-ẽ* and *-õ* in the plural, direct and the plural, oblique respectively. Similarly, the feminine nouns in Classes 1 and 3 take similar inflections. The masculine nouns in Classes 2, 3, 4 and 5 are marked with *-õ* or *-yõ* in the plural, oblique and *null* for all other combinations of number and case values. Since many of these classes group together quite naturally they should be merged. This classification appears to be neither intuitive nor systematic.

4 Inflection-based Noun Classes for Hindi Nouns

We propose that nominal classes in Hindi should be formed based entirely on the inflectional behaviour of nominal forms. Consequently, all feminine nouns in Table 3 can be put in a single class. The feminine nouns in Classes 2 and 4 in Kachru's classification scheme given in Table 4 belong in this class. Class 1 and Class 3 feminine nouns in her classification may be merged to form another class. Masculine nouns in Classes 2, 3, 4 and 5 can be merged into one class, while the masculine nouns in Class 1 form a separate class. This classification is similar to that of Shapiro (2000), summarized in Table 5, who identifies four inflectional classes based on the inflectional behaviour of Hindi nouns, two each for masculine and feminine nouns. Shapiro, however, does not give any reasons for his classification strategy nor the rules to derive the inflectional forms.

Table 5: Shapiro's Classification of Hindi Nouns (Shapiro, 2000, p31-33, 38-39)

	Feminine		**Masculine**	
	Class I	**Class II**	**Class III**	**Class IV**
Sg-dir	*null*	*null*	*null*	*null*
Sg-obl	*null*	*null*	*-e*	*null*
Pl-dir	*-yã̃*	*-ẽ*	*-e*	*null*
Pl-obl	*-yõ*	*-õ*	*-õ*	*-yõ/-õ*

Shapiro also does not discuss the behaviour of nouns that are marked *null* for all case-number pairs. We put these nouns in Class A along with Type 1 feminine and Type 1 masculine nouns seen in Tables 1 and 2 respectively. The five proposed nominal classes along with the exponents (leaving out vocative case inflections) are shown in Table 6 below.

Table 6: Inflectional Classes and Suffixes for Hindi Nouns

	Class A	**Class B**	**Class C**	**Class D**	**Class E**
Sg-dir	*null*	*null*	*null*	*null*	*null*
Sg-obl	*null*	*null*	*null*	*-e*	*null*
Pl-dir	*null*	*-yã̃*	*-ẽ*	*-e*	*null*
Pl-obl	*null*	*-yõ*	*-õ*	*-õ*	*-yõ/-õ*

The inflection based nominal classification system, permits us to describe the inflectional behaviour of Hindi nouns using a very small set of affixes and readjustment rules. All nouns of one class display similar inflectional behaviour for all case-number pairs. In the following we discuss briefly some identifiable properties of each class.

Class A: Includes those nouns (masculine and feminine) that take *null* for all case-number values such as *pyār (love), krodh (anger), bhūkh (hunger), pyās (thirst), mithās (sweetness),* etc. These nouns are typically abstract or uncountable[2].

Class B: Includes */ī/, /i/* or */yā/* ending feminine nouns that take *-yā̃* for the features [+pl, -oblique] and *-yõ* for [+pl, +oblique] such as *ləɽkī (girl), šəkti (power)* and *dibiyā (small box), guɽiyā (doll),* etc.

Class C: Includes feminine nouns that take *-ẽ* for the feature [+pl] and *-õ* for [+pl, +oblique] such as *rāt (night), mālā (garland), bəhū (daughter-in-law), ritu (season), lO (flame),* etc.

Class D: Includes masculine nouns that end in */ā/* or */yā/* such as *ləɽkā (boy), dhāgā (thread), lohā (iron), kuā̃ (water well),* etc. A few kinship terms such as *bhətījā (paternal nephew), bhā̃jā (maternal nephew), sālā (borther-in-law)* (Guru, 1920) are also a part of this class. Nouns borrowed directly from Sanskrit such as *rājā (king), pitā (father), yuvā (youngster), devtā (God), kərtā (doer),* etc. are excluded.

Class E: Includes masculine nouns that inflect only for the features [+pl, +oblique]. The nouns in this class end with /ū/, /u/, /ī/, /i/ or a consonant. Examples are *ālū (potato), sādhū (saint), mālī (gardener), kəvi (poet), ghər (home), khet (farm),* etc. The */ā/* ending *tatsam* masculine nouns borrowed from Sanskrit such as *rājā (king), pitā (father), yuvā (youngster),* etc. also belong to this class.

There are significant advantages to forming inflection based noun classes. First the classification is based on the choice of inflectional markers for four case-number pairs rather than on the stem endings or gender property of nouns which do not uniquely describe the inflectional behaviour of nominals in Hindi. Gender or stem endings are stored as lexical features of the nouns. Second, this approach yields fewer nominal classes, and this economy is coupled with greater generalization of nominal inflectional behaviour. Many stem alternation patterns are properly left to the domain of phonology.

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[2] According to classical Hindi Grammar, these nouns are *bhāvavācək (abstract) or guŋavācək (qualitative)* nouns (Guru, 1920).

5 Syncretism and Allomorphy in Hindi Nouns

In DM, syncretism is defined as the realization of a single vocabulary item (affix) that is matched with more than one set of features on a terminal node. Intra-class syncretism in Hindi is exhibited by suffix *-e* of Class D that consists of */a/* ending masculine nouns. This suffix marks nouns of the same class for two different set of morphological features [+pl, -oblique] as well as [-pl, +oblique]. Some of the nominal suffixes are also allomorphic. The two suffixes, *i.e., -õ and -yõ* which realize the features [+pl, +oblique] for Classes B and C are phonologically conditioned allomorphs selected based on the phonological form of the stem. Nouns that end in the vowels /ī/, /i/, or */yā/* take the suffix *-yõ* while all other vowel and consonantal ending nouns take -*õ*. Allomorphy in Hindi is also driven by etymological origins of the words. Masculine *tatsam* nouns such as *rājā (king)* and *pitā (father)* do not behave like *non-tatsam /ā/* ending words such as *ləṛkā (boy)* and *dhāgā (thread).* All */ā/* ending Hindi nouns take *-e* for the features [-pl, +oblique] and [+pl, -oblique] (except those in Class A). But, *tatsam* nouns do not inflect for these features in the language of origin, Sanskrit, and appear to retain the same behaviour in Hindi as well.

6 Predicting Inflectional Class for New Lexemes

Using the inflection based nominal classification system, let us see how a new noun lexeme entering the language could be assigned gender and how we could predict its inflectional class. Gender can be assigned in two ways to a new lexeme 1) by virtue of its phonological form and 2) by semantically mapping the noun to an existing noun in Hindi. In Hindi, most of the masculine nouns end in *ā* while feminine nouns end in *ī*. If the new lexeme ends in one of these vowels, it is relatively easy to assign it gender. Certain new words such as *kār (car)* or *moṭər (motor)* refer to *'gāṛī' (vehicle)* in Hindi which is feminine. Both borrowed words are assigned feminine gender. After gender is lexically assigned to the new lexeme, its inflectional class can be predicted using the procedure outlined in Figure 1. A masculine noun may or may not be inflected - based on its semantic property. If it is an abstract noun or a mass noun it will fall into the non-inflecting Class A irrespective of its phonological form. On the other hand, a countable lexeme will fall into one of the two masculine classes based on its phonological form. For example, *zirauks (xerox)* and *pepər (paper)* are both consonant final nouns that fall into the second masculine class, Class E. Similar procedures apply to feminine nouns as well.

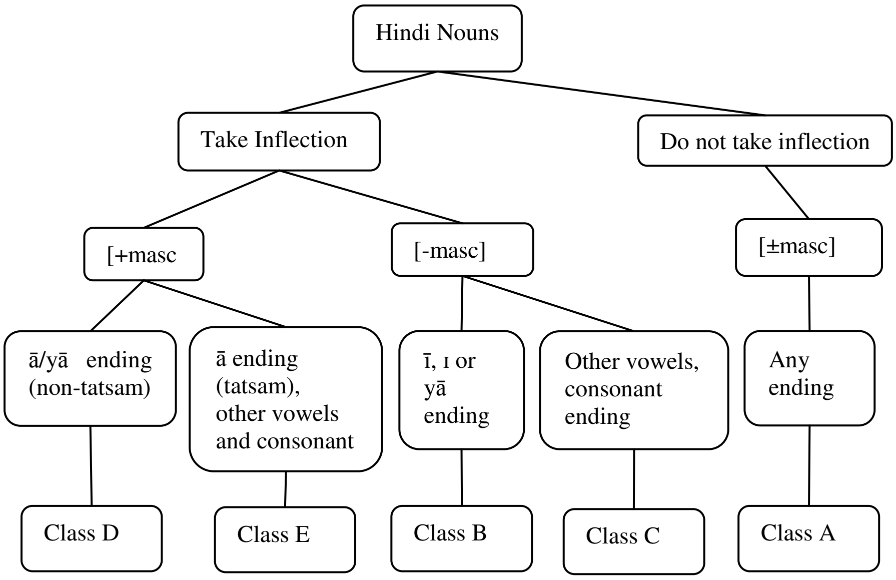

Figure 1: Diagrammatic Representation of New Noun Classification in Hindi

7 Morphological Operations and Hindi Nouns

In DM, before vocabulary insertion, the terminal nodes available in the syntactic structure undergo morphological operations such as merger, fusion, fission, and impoverishment (Halle & Marantz 1993, Harley & Noyer 1999). The operations account for the mismatches between the syntactic and morphological structures of word forms. In Hindi, where number and case inflections are marked cumulatively on a noun, a terminal node with case-number features accompanies the N node for all nouns in the syntactic tree. The noun node raises up the tree by head movement and merges with the case-number node (after fusion of case and number node). Thus, even though syntax provides insertion nodes for root, case and number, only two remain available for final insertion after morphological operations are applied. This results in a structure where two kinds of morphemes (root and an affix) are inserted in the two nodes. The final surface form is realized as a single word with two morpheme pieces such as *rājā-õ (kings-pl-oblique), ləɽki-yā̃ (girls-pl-direct), māli-yõ (gardeners-pl-oblique),* etc.

After syntax and the application of morphological operations, vocabulary items are inserted into terminal nodes to provide connections between phonological and grammatical features. This is called **vocabulary insertion** in DM. These vocabulary items are underspecified and compete for insertion at the terminal nodes. The items are arranged in order of specificity (highly specified followed by less specified ones) and feature hierarchy (plural entries followed by those for singular). The more specific entries succeed over less specified items. The vocabulary items for Hindi nouns are given below in (1).

(1) **Vocabulary Insertion Rules**

[±pl, ±oblique] ↔ null / Class A	----------- *1*
[+pl, +oblique] ↔ -yõ / Class B & E (Stem ending ī or yā)	----------- *2*
[+pl, +oblique] ↔ -õ	----------- *3*
[+pl] ↔ -yā̃ / Class B	----------- *4*
[+pl] ↔ -ẽ / Class C	----------- *5*
[+pl] or [-pl, +oblique] ↔ -e / Class D	----------- *6*
[±pl] ↔ null	----------- *7*
	(elsewhere rule)

Rule 1 applies when a noun root is specifically marked for Class A. It inserts *null* for all case-number values. Rule 2 is for those */ī/* and */yā/* ending nouns that take *-yõ* for the features [+pl, +oblique]. Rule 3 inserts *-õ* for the features [+pl, +oblique] for all other nouns. Rule 4 and 5 are specific for plurals of Class B and Class C respectively. Rule 6 applies to Class D nouns in [+pl] and [-pl, +oblique]. Rule 7 is the elsewhere rule that entails *null* insertion for the remaining plural and singular noun forms.

We also propose an impoverishment rule in (2) that deletes [-oblique] when the number feature is present. This means that the entries specified for number (singular or plural) need not be specified for [-oblique] feature (or for direct case). Thus the rules *[-pl, -oblique] ↔ null* and *[+pl, -oblique] ↔ null* can be replaced by a single rule, *i.e., [±pl] ↔ null.*

(2) **Impoverishment Rule**
[-oblique] → null / [±pl]

Affixation also yields some phonological changes. We propose the following Readjustment rules for Hindi:

(3) **Readjustment Rules**

Stem final /ā/ → null / Class D with -e or -õ	----------- *8*
Stem final /ū/ → u / -ẽ or -õ	----------- *9*
Stem final /ī/ → i / -yā̃ or -õ	----------- *10*

The first readjustment rule (rule 8) deletes the stem final vowel of Class D nouns that take either *-e* or *-õ*, e.g., *ləɽkā-e, ləɽkā-õ* and *sāyā-õ* and create *ləɽke, ləɽkõ* and *sāyõ* respectively. Rules 9 and 10 are not class specific and result in final vowel shortening in nouns (masculine or feminine) that end in either /ū/ or /ī/. Thus, *bəhū-ẽ* and *bahū-õ* become *bəhuẽ* and *bəhuõ* while *ləɽkī-yā̃* and *ləɽkī-yõ* become *ləɽkiyā̃* and *ləɽkiyõ* respectively.

8 DM Based Hindi Morphological Analyzer

A morphological analyzer aims to recover from an inflected word its base form (stem) by stripping off possible affixes. To this base, phonological (readjustment) rules are applied to generate the root. A search is made for this root in the lexicon to determine if there is a match. This process can also yield multiple roots belonging to multiple lexical categories. Morphological information for roots and suffixes is also provided. In order to develop such a system, a root lexicon, affixal entries and phonological rules are needed. We developed a Hindi lexicon with forty thousand noun root entries. These roots were manually categorized into five classes and were then marked with information about the inflectional class, lexical category, gender and stem ending. Vocabulary items or affixal rule entries were developed that provide information about the context(s) in which affixes appear. Since these rules are bidirectional, these can be used to analyze as well as generate nominal forms. We provide an example below of the analysis of a noun using the DM based morphological analyzer.

- Input noun form: *ləɽkiyā̃ (girls)*
- Rule (vocabulary item) applicable: *[+pl] ↔ -yā̃ / Class B (rule 4)*
  Output after extracting out the suffix → Stem: *ləɽki*, Suffix: *yā̃*
- Readjustment Rule applied: *Stem final /ī/→i/ -yā̃ or -õ (rule10)*
- Apply the rule in the reverse direction to get the root and look for it in the lexicon.
- If found, output the root which is *ləɽkī (girl)*. If not, try applying another applicable rule.

The actual output of the system for the input words शहरों (šəhərõ) 'cities' and मौक़े (mauke) 'chances' is given below.

(4) Token: शहरों, Total Output: 1

[Root: शहर, Class: E, Category: noun, Suffix: ों]

[Gender: +masc, Number: +pl, Case: +oblique]

(5) Token: मौक़े, Total Output : 1

[Root: मौक़ा, Class: D, Category: noun, Suffix: े]
[Gender: +masc, Number: -pl, Case: +oblique]
[Gender: +masc, Number: +pl, Case: -oblique]

It may be noted that we require a few more affixal rules to implement the morphological analyzer since the analyzer works on Hindi data in the devanagri script, the new set of rules is given below in (6). Rules 3, 5, 6, 9 and 10 have been split into *a* and *b* to account for different devanagri characters for the phonemes */õ/, /ẽ/, /e/, /ū/* and /ī/ respectively. . We have also made some modification to our previous list of Stem Readjustment rules (rules 8-10 in (3)) for the same reason.

(6) **Vocabulary Insertion Rules (revised)**

[±pl, ±oblique] ↔ null /Class A ------------ *1*
[+pl, +oblique] ↔ -यों / Class B and E (Stem ending ī, i or yā) ------------ *2*
[+pl, +oblique] ↔ -ों / Class C and E [NC], Class D -----------*3a*
[+pl, +oblique] ↔ -ओं ----------- *3b*
[+pl] ↔ -याँ / Class B ------------ *4*
[+pl] ↔ -ें / Class C [NC] -----------*5a*
[+pl, -oblique] ↔ -एँ / Class C -----------*5b*
[+pl] or [-pl, +oblique] ↔ -े / Class D [Nā] -----------*6a*
[+pl] or [-pl, +oblique] ↔ -ए / Class D -----------*6b*
[±pl] ↔ null ------------ *7*

(Note: *NC: noun stem ending in a consonant, Nā: Noun stem ending in ā)*

(7) Readjustment Rules (revised)

Stem final -ा or -आ → ϕ / Class D [Nā] with -े or -ों ------------ *8*
Stem final -ू → -ु / -एँ or -ओं -----------*9a*
Stem final -ऊ → -उ / -एँ or -ओं -----------*9b*
Stem final -ी → -ि / -याँ or -यों ----------*10a*
Stem final -ई → -इ / -याँ or -यों ----------*10b*

9 Evaluation, Results and Future Directions

We performed the test on 14480 Hindi noun forms extracted from news items sourced from the website www.bbc.co.uk/Hindi and carried out manual evaluation to verify the results. The system was able to identify and produce correct root and morphological analysis for 12784 nouns (more than half of which had more than one possible stem) while 1696 remain unidentified. Out of these 1696 noun forms, about 900 were unique forms. Analysis showed that many of these words (two hundred) were left unidentified because of either incorrect or variant spelling. Hyphenated compound nouns (350) too remain unidentified. A large number of the remaining unrecognized entries were uninflected nouns for which the lexicon lacked entries. The current system does not produce any output for these uninflected nouns. The types of unidentified words with their counts are given in Table 7 and Table 8 below.

Table 7: Results of DM Based Hindi Morphological Analyzer

Testing Results	
Total Number of Words in the Testing Corpus	14480
Number of words correctly analyzed	12784
Total number of unidentified words	1696
Total number of unique unidentified words	900

Table 8: Types of Unidentified Words and their Counts

Unique unidentified/unknown words (900)	
Words with incorrect or variant spelling	200
Hyphenated words	350
Missing root entry in the lexicon	350

Below are various types of errors faced by the system and the examples of each error type.

- Roots not available in the lexicon:
  इंटरनेट *'internet'*, मेमरी *'memory'*, टॉयलेट *'toilet'*
- Spelling variants, Urdu-Hindi letter alternations, nasal vs. nasalization etc.:

क़ैदियों/कैदियों prisoners', हफ़्ते/हफ्ते 'weeks', क्रान्तिकारी/क्रांतिकारी 'revolutionists', कम्पनियों/कंपनियों companies', स्तम्भ /स्तंभ 'pillar'

- Hyphenated words:
  दाह-संस्कार 'cremation', वर्ण-भेद 'casteism'
- Incorrect spelling:
  भैसों (correct spelling: भैंसों) 'buffaloes', कीर्ती (correct spelling: कीर्ति) 'fame', कर्ज (correct spelling: क़र्ज़) 'debt'
- Adjectives/qualifiers functioning as nouns:
  सैंकड़ों 'thousands', तीनों 'all three'

We would like to emphasize that there was no instance of failure at analysis of a nominal form as long as the root was available in the lexicon. In addition, roots for a number of forms including borrowed words from English taking Hindi nominal inflections such as *kār-ẽ (car-s), moṭər-õ (motor-s), pepərõ (paper-s)* for which roots are missing in the dictionary are also, interestingly, suggested by the system. This is done by applying a rule that is applicable for the given form (*i.e.,* if there was a match between the suffix in the word form and in the rule). Thus, the morphological analysis that is discussed here finds reliable, natural extension in other Natural Language Processing systems and tools such as Part-of-Speech Taggers and Parsers.

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Lexical Relatedness and the Lexical Entry – a Formal Unification

Andrew Spencer
University of Essex

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Abstract

Based on the notion of a lexicon with default inheritance, I address the problem of how to provide a template for lexical representations that allows us to capture the relatedness between inflected word forms and canonically derived lexemes within a broadly realizational-inferential model of morphology. To achieve this we need to be able to represent a whole host of intermediate types of lexical relatedness that are much less frequently discussed in the literature. These include transpositions such as deverbal participles, in which a word's morphosyntactic class changes (e.g. verb ⇒ adjective) but no semantic predicate is added to the semantic representation and the derived word remains, in an important sense, a "form" of the base lexeme (e.g. the 'present participle form of the verb'). I propose a model in which morphological properties are inherited by default from syntactic properties and syntactic properties are inherited from semantic properties, such as ontological category (the *Default Cascade*). Relatedness is defined in terms of a Generalized Paradigm Function (perhaps in reality a relation), a generalization of the Paradigm Function of Paradigm Function Morphology (Stump, 2001). The GPF has four components which deliver respectively specifications of a morphological form, syntactic properties, semantic representation and a lexemic index (LI) unique to each individuated lexeme in the lexicon. In principle, therefore, the same function delivers derived lexemes as inflected forms. In order to ensure that a newly derived lexeme of a distinct word class can be inflected I assume two additional principles. First, I assume an Inflectional Specifiability Principle, which states that the form component of the GPF (which defines inflected word forms of a lexeme) is dependent on the specification of the lexeme's *morpholexical signature*, a declaration of the properties that the lexeme is obliged to inflect for (defined by default on the basis of morpholexical class). I then propose a Category Erasure Principle, which states that 'lower' attributes are erased when the GPF introduces a non-trivial change to a 'higher' attribute (e.g. a change to the semantic representation entails erasure of syntactic and morphological information). The required information is then provided by the Default Cascade, unless overridden by specific declarations in the GPF. I show how this model can account for a variety of intermediate types of relatedness which cannot easily be treated as either inflection or derivation, and conclude with a detailed illustration of how the system applies to a particularly interesting type of transposition in the Samoyedic language Sel′kup, in which a noun is transposed to a similitudinal adjective whose form is in paradigmatic opposition to case-marked noun forms, and which is therefore a kind of inflection.

[†]The discussion of Selkup is based on joint work with Irina Nikolaeva. Early versions of this paper have been delivered to seminar audiences at the Universities of Surrey and Essex. I am grateful to members of those audiences, and to participants in the HPSG 2010 *Morphology and Formal Grammar* workshop for helpful comments.

1 Introduction: Types of lexical relatedness

There are many ways in which words may be related to each other. The most obvious ways are by regular inflection and regular derivation. Inflection can be thought of as a function which maps a lexeme's representation or index and a set of morphosyntactic features to a cell in a paradigm, characterized as a word form and the same set of morphosyntactic features. Derivation can be thought of as a function which relates a full characterization of a lexeme (its basic form, its syntax, and its semantic representation) to another lexeme. In Sag et al. (2003) two distinct types of lexical rule achieve these mappings. However, it's important to realize that inflection and derivation are just two very specific types of relatedness. When we consider the full set of possibilities for ways in which words can be related systematically we find we need a more nuanced approach to the definition of relatedness.

Among the commonly observed types of relatedness we can note the following (other types can be observed in addition to these):

- (contextual) inflection
- (inherent) inflection
- asemantic transposition
- transposition with added semantic predicate
- asemantic argument structure alternation
- argument structure alternation with added semantic predicate
- asemantic derivation
- (canonical) derivation

Contextual inflection is opposed to inherent inflection (the terms are due to Booij 1994). Contextual inflection refers to inflection which is not associated with any addition of content to the lexical representation. Agreement morphology on a syntactic target is a prime example (e.g. the 3sg agreement in English non-past verbs). Inherent inflection is inflection which (ultimately) is associated with some kind of semantic interpretation. The plural and past tense morphology of English and Dutch which Booij cites as instances of inherent inflection are better thought of as processes which realize feature values on word forms, which then regulate the way that entire phrases are interpreted semantically. Such inflection therefore doesn't involve the addition of a semantic predicate to a lexical representation (in this respect my approach to such matters differs from the analyses in, say, Sag et al. 2003). Clear-cut cases of meaning-changing inherent inflection are found with languages such as Hungarian which have rich case systems including a series of semantic/local cases, bearing meanings similar to spatial adpositions in other languages. In many instances such case forms have a purely adverbial function (they don't function as 'structural cases' for instance) and the natural way of treating them is to say that they add some kind of spatial modificational meaning, such as 'from the inside of (the box)' or 'in the capacity of (a ship)' (see Spencer 2010, 145).

(Asemantic) transposition refers to a type of word which appears to be derived from a more basic lexeme and which has a different morpholexical/syntactic category from that base lexeme, but which preserves the content of the base lexeme (see Spencer 2005 for more detailed discussion). A typical example is an active deverbal participle. In many languages such a participle functions exactly like an attributive adjective, for instance, agreeing in nominal features with its head noun, while retaining the meaning, argument structure and sometimes even tense/aspect properties of the original verb. Because such transpositions change word category, and require the word to be inflected in the manner of the new category (e.g. an adjective rather than a verb) they are sometimes characterized as a type of derivation. Yet derivational morphology is principally a way of creating new lexemes with the addition of a semantic predicate and (asemantic) transpositions crucially add no content to the lexical representation of the base. In that respect they are less derivation-like than, say, inherent inflection.

Some transpositions are not entirely asemantic: a participle may add nuances of aspect, for instance, and action nominalizations may well add nuances such as 'name of event/name of process/name of proposition' and others (Spencer, 2010). However, such transpositions are not typical derivational relations because it's far from clear that we are creating an entirely new lexeme. For instance, the German nominalized infinitive (or 'verbal nominal', Bierwisch 2009) brings with it an atelic interpretation which is not found with the basic verb (or with alternative nominalizations in *-ung*). But the regularity of the construction makes it look like a nominalized form of the verb and not like a completely new lexeme.

Asemantic argument structure alternations are most famously represented by constructions such as the English passive, or, slightly more controversially, the English 'Dative shift' double object ('applicative') alternation. The morphosyntax of these constructions is complicated in English (periphrastic in the case of the passive, zero morphology/conversion in the case of the double object construction), but in many languages the morphology is perfectly regular. Argument structure alternations may also regularly add a semantic predicate, most famously the causative alternation. In languages in which these alternations are regular, lexically unrestricted, productive and so on it appears to all intents and purposes as though we are dealing with a type of inflection. Indeed, the morphology of such alternations often has the character of inflectional morphology. In many languages (e.g. Latin, Greek, Sanskrit) it would be perverse to treat a passive verb form as a distinct lexeme from the active verb form. However, where, say, causative alternations are concerned, descriptive practice varies, because the additional causative predicate (and the additional causer argument) give the impression of lexical derivation. Nonetheless, in the case of truly productive and regular morphology it is perverse to regard even the causative as derivation rather than inflection. It is precisely the existence of such morphological alternations that make the 'inflection/derivation' dividing line so hard to draw.

Canonical and indisputable derivation adds a semantic predicate to the lexical representation and hence changes the ontological category of the derived word. As a result, the syntactic and hence morphological category of the derived word is changed. However, we should be aware of the fact that huge swathes of the lexicon of a language might well be related to each other in a purely formal manner without any regular semantic relationship whatever. Prefixed verbs in Indo-European languages generally (especially Slavic, Greek, German, Sanskrit, ...) are a case in point. It is an indisputable fact about the German verb lexicon that the vast majority of its members can be analysed as a prefix+stem combination. Moreover, these verbs are constructed from a small number of prefixes and a recurrent set of stems. However, in a very large number of cases (perhaps the majority depending on how you define 'lexical entry') there can be no systematic semantic relation between the base verb and its prefixed derivates or between the verbs derived from a single stem by different prefixes. Thus the verb *versprechen* 'promise' is clearly derived from *ver-* and *sprechen* (note the conjugation!) but its meaning cannot be related to that of either *ver-* or *sprechen*. Indeed, both stem and prefix are cranberry morphs. A quick glance through any dictionary of German will immediately convince you that this is a general fact about the German verb. Thus, the grammar of German has to have a way of recording that fact that verbs are generally of the form (meaningless) prefix + (meaningless) stem (Spencer, 2001).

Any complete account of lexical relatedness has to have a way of describing these relationships and capturing the fact that they are typically systematic features of a language's lexicon. Moreover, the various intermediate types of lexical relatedness make it very difficult to draw a principled distinction between any one pair of types. In particular, there is absolutely no justification in elevating (canonical) inflection and (canonical) derivation to unique types of relatedness. Rather, in the spirit of the hierarchical lexicon, what we need is a way of characterizing the individual ways in which words may be related to each other, by 'factorizing' lexical relatedness into its components, and defining the various intermediate types of relatedness in terms of sets of choices from among those components (Spencer, 2010). However, defining a type hierarchy of lexical relatedness is a relatively trivial task. Much more difficult is building a model of lexical representation which will allow us to capture such relationships in an explicit grammatical description. This is the task I address in this paper.

2 Paradigm-based approaches to lexical relatedness

I will take as my starting point the assumption that morphology, and hence, morphologically expressed lexical relatedness, is to be defined in terms of a paradigm-based model of some kind, for instance, the Paradigm Function Morphology (PFM) model of Stump (2001). Paradigm-based (realizational-inferential) models of morphology are defined over a notion of 'lexeme'. In such a model, inflectional morphology defines the set of word forms which realize various morphosyntactic properties sets (MSPSs) for a given lexeme (e.g. from PRINT, {*print, prints, printing, printed*}. By contrast, a derivational process, say, Subject Nominalization (SubjNom), yields a new lexeme PRINTER with its own inflected word forms {*printer, printers*}. These are not word forms of the lexeme PRINT. In the classical PFM model inflection is defined by a paradigm function (PF) which specifies the word forms realizing a given MSPS for that lexeme.

Now, Stump treats fully regular (paradigmatic) derivation in the same way as inflection, at least from the formal point of view. He discusses PrivativeAdjective formation in English, in which an adjective with the meaning 'lacking N' is derived from a noun with the meaning 'N'. In Stump's account, this process is governed by a derivational feature δ. The paradigm function applied to the pairing of noun lexeme and the feature δ then delivers the *-less* suffixed form: PF($<$friend, $\delta>$) = $<$friend-less, $\delta>$. But this approach leaves several questions open.

1. How do we reconfigure the classical model to reflect the fact that derivation involves the addition of a semantic predicate, not just the realization of a morpholexical feature?

2. How do we ensure that the derived lexeme inflects in the appropriate way (i.e. ensuring that PRINTER inflects as a noun rather than a verb, and ensuring that FRIENDLESS doesn't inherit the singular/plural distinction from the base noun FRIEND)?

3. How do we capture types of lexical relatedness intermediate between inflection/derivation, especially transpositions, inherent (meaning-changing) inflection, argument structure alternations?

4. Given point 1, how do we nevertheless account for the fact that derived lexemes often undergo semantic drift while still exhibiting the morphological idiosyncrasies of the regular derivate, e.g. *transmit* $\sim$ *transmission* (of a car), and often show no semantic relatedness (German *versprechen*)?

I propose a model of lexical representation and lexical relatedness for use in any realizational-inferential model which permits us to treat inflection, all the various kinds of derivation, and all intermediate types of lexical relatedness as the result of the same formal class of operations at a certain level of abstraction. An additional property is that this model will also define the basic lexical entry itself using the same formal machinery as that used for defining relatedness between distinct word. Effectively, a lexical entry is defined as a representation which is (trivially) related to itself.

This model of lexical representation will crucially depend on the idea that lexical entries/lexical representations are in general underspecified for default properties, exactly as argued in Sag et al. (2003). Indeed, I assume that it would be straightforward, in principle, at least, to encode my proposals in some fairly standard model of the HPSG lexicon. I will not do this however, for the following reasons. First, I am not sufficiently competent in the formalism of HPSG to do this. Second, there are important differences between certain aspects of the proposals I make here and the standard ways of structuring lexical entries in HPSG (not least to do with the role of the Lexeme Identifier or LID, Sag 2007) which require more careful attention than I can give here. Third, my aim is to remain as formally neutral as possible so that my proposals can be implemented in other frameworks that might deploy similar apparatus (specifically, default inheritance) and a detailed formalization might hinder such ‘cross-platform’ comparison.

3 Lexical representations

I assume that a lexical representation is at least a four-dimensional object as in (1):[1]

(1)
$$\begin{bmatrix} \text{FORM} & \begin{bmatrix} \begin{bmatrix} \text{STEM0} & \text{/draw/} \\ \text{STEM1} & \text{/drew/} \\ \text{STEM2} & \text{/draw-n/} \end{bmatrix} \\ \text{MORCAT Verb} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{SYNCAT} & \text{VERB} \\ \text{A-STR} & \langle \text{SUBJ, OBJ} \rangle \end{bmatrix} \\ \text{SEM} & [_{Event}\ \text{DRAW(x,y)}] \\ \text{LI} & \textsc{draw}1 \end{bmatrix}$$

The LI is the Lexemic Index, an arbitrary label unique to each lexeme. The LI has much in common with Sag’s (2007) notion of Lexeme Identifier, LID, the main difference being that the LI in my model is not tied to semantic representations in the way the LID is. In fact, the LI is best thought of as a unique integer functioning much like a ‘key’ in a database, serving to identify each separate lexeme and hence acting as a record of our decisions on how exactly lexical entries are individuated. For instance, we may ask ourselves whether two related meanings of a word constitute mild polysemy or frank homonymy. For instance, does the word PLAY represent one lexeme or two in the contexts *to play chess* and *to play soccer*? In the former case the verb would have the same LI in both uses, while if we decided to treat this as two separate verbs we would give it two distinct LIs.

Note that I have furnished the representation in (1) with an attribute [MORCAT Verb], in addition to a syntactic attribute [SYNCAT VERB]. The reason for this apparent profligacy of feature marking is that we frequently find mismatches between

[1] I assume without comment that ‘past tense’ forms in English are really morphomic stems, here ‘STEM1’. For one thing, this is the only way to make sense of the fact that the *-ed* form of a regular verb realizes three entirely different functions: past tense, perfect participle, passive participle.

syntactic and morphological category. A natural history of some of these is provided in Spencer (2002, 2005, 2007). For instance, in Spencer (2002) I discuss instances in which a noun is derived by conversion from an adjective but retaining the morphology (and even some of the morphosyntax) of that adjective. A German example would be the noun *Angestellte(r)* ‘employee’, which is formally an adjective (though one which itself is derived by transposition from a verb, as a passive participle). By default, of course, a word inherits its morphological category from its syntactic category.

The semantic representation follows the practice of authors such as Jackendoff (2002) in representing explicitly the ontological category. It seems reasonable that such information about a lexeme should reside in its semantic representation. Of course, in the default case the ontological category of a major lexical class will determine the syntactic category, after the manner of the ‘notional’ theory of word classes (Lyons 1966, Spencer 2005). For the mappings *Thing* ⇒ noun, *Property* ⇒ adjective, *Event* ⇒ verb this is fairly obvious (though I don’t pretend to understand how to characterize the ontology object ‘Property’). For other categories the mapping is less clear. In Jackendoff (1990) the category *Place* generally corresponds to a prepositional phrase (he is discussing English exclusively) but a simplex word denoting a place, such as *France* or *home* is likely to be a noun (or sometimes an adverb) in English. In many languages with a spatial inflectional case system, inflected forms of nouns can denote places.

4 The Default Cascade

As should be obvious from the previous section I take it as obvious that the morphosyntactic properties of a given level will, in general, derive from the properties of the SEM representation by virtue of default specification: a word denoting an ontological Event will, by default, be a syntactic verb which will, by default, be a morphological verb. I enshrine this observation in the *Default Cascade*, illustrated schematically in (2):

(2) The Default Cascade (illustrative)

$$\begin{array}{lcl} \text{SEM=}[_{\textit{Event}}\ \mathscr{P}\langle\ldots\rangle] & \Rightarrow & \text{SYNCAT=VERB} \\ \text{SEM=}[_{\textit{Event}}\ \mathscr{P}\langle \text{x, y}, \ldots\rangle] & \Rightarrow & \text{A-STR=(SUBJ, OBJ, \ldots)} \\ \text{SYNCAT=VERB} & \Rightarrow & \text{MORCAT=Verb} \end{array}$$

and so on.

The principle of the Default Cascade runs through the notion of lexical entry: for example, in many complex inflectional systems we find that a given lexeme is inflected over a whole series of stems (see Aronoff 1994; Stump 2001 for an extended justification of the stem notion in inflection and derivation). The normal expectation is that each stem inflects according to one and the same inflectional class (i.e. a second conjugation verb can be expected to take second conjugation inflections throughout its paradigm). Of course, this, like any default in the cascade can be overridden, either in the lexical representation itself or by a rule.

An important assumption about lexical entries that I shall be making is that an inflecting lexeme is associated with a *morpholexical signature* (m-l signature), a declaration of the MSPS which that lexeme (must) inflect for. Such an assumption seems to be implicit (and sometimes explicit) in most discussions of lexical entries and it's difficult to see how we could engineer inflectional morphology without it. When we come to consider more subtle cases, including lexical representations which deviate from default mappings in various ways, we will find that specifying such a declaration of MSPSs is far from trivial.[2] For the present we can take the specification of MSPSs as part of the Default Cascade.

5 Generalizing the Paradigm Function

Recall that canonical derivation crucially creates a distinct lexeme (with distinct LI) by adding a semantic predicate. I therefore generalize the definition of PF: a Generalized PF (GPF) maps an entire lexical representation (<FORM, SYN, SEM, LI>) to another lexical representation. The GPF is an ensemble of four component functions, f_{form}, f_{syn}, f_{sem}, f_{li}. Each function is defined over an ordered pair <LI, {set of features}>.

For 'pure' (i.e. contextual) inflection the GPF is non-trivial only for the FORM attribute. For the SYN, SEM, LI attributes it is the identity function (relation). For instance, the English GPF for Xs = 3sgPresIndic of any (nonmodal) verb, with LI VERB, root form X (i.e. Stem0(VERB)), will be informally represented as in (3) (this is essentially identical to the PF in the classical model):

(3)	f_{form}(VERB, {3sg})	=	X-s
	f_{syn}(VERB, {3sg})	=	identity function
	f_{sem}(VERB, {3sg})	=	identity function
	f_{li}(VERB, {3sg})	=	identity function

The role of the m-l signature is made explicit in the *Inflectional Specifiability Principle*, (4):

(4) *Inflectional Specifiability Principle (ISP)*:
The f_{form} component of the Generalized Paradigm Function maps a set of forms to cells in the property paradigm defined by the lexeme's morpholexical signature.

The effect of the Inflectional Specifiability Principle is that a bare lexical entry is uninflectable. This is because a bare lexical entry for a well-behaved lexeme lacks

[2] See Spencer (2002) for detailed discussion. Some of the mismatches I have in mind are discussed under the rubric of 'paradigm linkage' in Stump (2006).

a morpholexical signature and hence by (4) cannot (yet) be inflected.[3]

For (regular) derivation, GPF non-trivially maps all four component representations of the base lexeme to distinct outputs, including an enriched semantic representation, addressing Q2 above. Thus, for the SubjNom process applied to WRITE we might have (5):

(5) GPF for SubjNom process by *-er* suffixation (preliminary formulation):

$$
\begin{array}{lcl}
f_{form}(\textsc{write}, \{SN\}) & = & \text{Stem0}(\textsc{write}) \oplus \text{er} \\
 & = & \text{MORCAT = N} \\
 & & \text{(by Default Cascade, from SYN)} \\
f_{syn}(\textsc{write}, \{SN\}) & = & \text{SYNCAT = N} \\
 & & \text{(by Default Cascade, from SEM)} \\
f_{sem}(\textsc{write}, \{SN\}) & = & [_{Thing}\text{PERSON, x, such that WRITE(x, \ldots)}] \\
f_{li}(\textsc{write}, \{SN\}) & = & \textsc{writer}
\end{array}
$$

where {SN} is a (morpholexical) feature which defines the SubjNom relation, and Stem0(WRITE) is the root form of the lexeme WRITE.

At this point it is worth considering where such a model lies in Stump's (2001) classification of morphological theories. Stump divides morphological models using a 'realizational/incremental' axis and a 'lexical/inferential' axis (Stump, 2001, 1-3). The classical morpheme model is lexical and incremental: morphemes are stored lexical representations and the form/meaning of a complex word is obtained by 'summing' the forms/meanings of the component morphemes. Paradigm Function Morphology is realizational/inferential: rules realize feature bundles (they don't add any content to the representation) and they do so on the basis of default inheritance logic, by permitting us to infer the form of one word on the basis of the forms of other words. A example of a model which is inferential-incremental is Aronoff's (1976) model of word formation expressed in terms of word formation rules. Some of the Generalized Paradigm Functions that I shall be appealing to do not fit neatly into Stump's typology. This is because they have the character of a inferential-realizational system at the level of FORM but the character of inferential-incremental systems at the level of SYN or SEM representations. Thus, for classical derivation such as that illustrated in (5) the functions f_{sem}, f_{li} are 'incremental' while f_{form} remains 'realizational/inferential'. (See below for f_{syn}.)

I now refine the notion 'lexical entry'. Many words are like DRAW in that they are distinct homonymic lexemes which share the same (irregular) morphology. I

[3]Strictly speaking, of course, it is only word classes that inflect that are obliged to have a m-l signature, and it is only languages that have inflecting word classes that are obliged to make any reference to m-l signatures and the ISP. This means that a complete and universal theory of lexicon has to type grammars, and word classes within grammars, as 'inflecting' or 'non-inflecting', so that the m-l signature is defined only for the inflecting type. I leave aside this consideration, noting that it raises a number of interesting conceptual and definitional issues.

represent this sharing of properties by permitting the FORM, SYN, and SEM attributes of the basic lexical entry to be defined over sets of LIs rather just a single LI. Thus, for a verb such as DRAW, which has the same (irregular) morphology in both of its (unrelated, homonymous) meanings, the FORM properties are given by $f_{form}(\{\text{DRAW1, DRAW2}\}) = \{draw, drew, drawn\}$, while the SEM attributes for each meaning are defined separately: f_{sem}(DRAW1) = MAKE_ GRAPHITE_ IMAGE_ OF(x,y), but f_{sem}(DRAW2) = EXTRACT(x,y) (or whatever). Similarly, exact synonyms share SEM values but have distinct FORM entries. The SubjNom process can now be written more generally as (6), where X=Stem0(VERB):

(6)	f_{form}(WRITE, {SN})	=	Xer
		=	MORCAT = N
	f_{syn}(WRITE, {SN})	=	SYNCAT = N
	f_{sem}(WRITE, {SN})	=	[$_{Thing}$PERSON, x, such that WRITE(x, ...)]
	f_{li}(WRITE, {SN})	=	WRITER = SN(WRITE)

In (6) I reflect that fact that the SubjNom process is regular and paradigm-driven by defining a derived LI, obtained by applying the SN feature to the base verb's LI, so that for any verb, with LI VERB, which has a SubjNom, the LI of that SubjNom will be SN(VERB). For irregular SubjNoms such as '*fly* (an aircraft) ∼ *pilot*', SN(FLY) is defined suppletively as PILOT. I now assume the Category Erasure Principle, (7):

(7) *Category Erasure Principle*:
Assuming the ordering SEM > SYN > FORM, any GPF which alters a categorial representation automatically deletes the category specification of lower attributes.

By the Inflectional Specifiability Principle it is impossible to inflect a lexeme without a m-l signature and the m-l signature requires a morpholexical category specification. Hence, the output of a category-changing GPF cannot be inflected until the Default Cascade applies so as to redefine the SYNCAT/MORCAT values of the deverbal nominalization as 'N/Noun'. Note that 'category-changing' may refer to purely morphomic categories such as 'perfect stem' (for instance, where its inflectional class is different from that of the lexeme as a whole), so this property is not specific to derivation. (Of course, any value can be respecified by the GPF itself in the case of non-default category specifications.) Thus, application of GPF(WRITE, {SN}) in (6) will erase SYNCAT, MORCAT specifications and the Default Cascade will redefine these, furnishing the derived lexeme with the m-l signature of a noun (Q1).[4]

[4]For morphology which Stump calls 'headed' this categorial erasure doesn't apply. For instance, asemantic prefixation of *stand* by *under-* preserves the morphological irregularity of the base verb. I assume with Stump that such cases are structurally distinct from, say, SubjNom, so that in effect the prefixed derivative inherits the inflection of the unprefixed lexeme.

For transpositions the GPF changes just the FORM, SYN attributes (Q3). In (8) I give the representation for the Russian participle *komandujušč-* from the verb *komandovat′* ‘to command (e.g. army)’. All forms of the verb, including the participle, take an instrumental case marked complement. The participle inherits that property from the stipulation in the lexical entry for the verb as a whole:

$$
\begin{array}{lll}
\text{(8)}\quad f_{form}(\text{VERB}, \{\text{ActPart}\}) & = & \text{Stem0}(\text{VERB}, \{\text{ActPart}\}) \\
 & & \oplus\ \text{jušč} \\
\quad\quad f_{syn}(\text{VERB}, \{\text{ActPart}\}) & = & \\
\quad\quad\quad \text{SYNCAT}(\text{VERB}, \{\text{ActPart}\}) & = & \text{A} \\
\quad\quad\quad \text{A-STR}(\ \text{VERB}, \{\text{ActPart}\}) & = & \text{identity function} \\
\quad\quad\quad (= <\ \text{subj, obj[instr]}> \text{ by default}) & & \\
\quad\quad f_{sem}(\text{VERB}, \{\text{ActPart}\}) & = & \text{identity function} \\
\quad\quad f_{li}(\text{VERB}, \{\text{ActPart}\}) & = & \text{identity function}
\end{array}
$$

The representation in (8) correctly makes the participle a form of the verb lexeme, retaining the verb’s a-structure, but stipulating the change SYNCAT $\Rightarrow$ A (hence, by the Default Cascade, MORCAT $\Rightarrow$ Adj).

To summarize the lexical machinery: a morphological process, such as inflection, derivation, transposition, …, is defined as a set of mappings over the set $<$FORM(LI, {features}), SYN(LI, {features}), SEM(LI, {features})$>$. Representations must be furnished with a m-l signature to be inflected. The CEP and the Default Cascade guarantee that categorial features are redefined appropriately in the regular cases. For instance, the Russian present active participle transposition in (8) results as follows: The {ActPart} property is defined as part of the m-l signature of a verb, hence GPF(KOMANDOVAT′, {ActPart}) is well-defined. The functions f_{sem}, f_{li} are the identity functions, as is the A-STR component of f_{syn} ($f_{syn|a\text{-}str}$), thus guaranteeing that the subcategorization “obj = instr. case” is inherited by the participle. The GPF maps the SYN|SYNCAT value to A, overriding the default SYNCAT=V. FORM|MORCAT category information is thereby erased by the CEP and the Default Cascade specifies MORCAT=Adj and respecifies the m-l signature accordingly (in fact, placing the participle in the default adjectival inflectional class).

Given this machinery we can now represent the basic lexical entry of a lexeme as a kind of trivial GPF where the set of triggering properties is empty, $\{e\}$. Hence, for WRITE we have (9):

$$
\begin{array}{lllll}
\text{(9)}\quad f_{form}(\text{WRITE}, \{e\}) & = & \text{Stem0}(\text{WRITE}, \{e\}) & = & \text{raıt} \\
 & = & \text{Stem1}(\text{WRITE}, \{e\}) & = & \text{rout} \\
 & = & \text{Stem2}(\text{WRITE}, \{e\}) & = & \text{rıt-n} \\
\quad\quad f_{sem}(\text{WRITE}, \{e\}) & = & [_{Event}\text{WRITE(x,y)}] & & \\
\quad\quad f_{li}(\text{WRITE}, \{e\}) & = & \text{WRITE} & &
\end{array}
$$

SYNCAT=V, MORCAT=Verb and the m-l signature are given by the Default Cascade. The specifications for Stem1, Stem2 will override the forms otherwise provided by regular inflection, namely {raɪtəd}. The specification 'identity function' in (8) is now interpreted to mean that, e.g., $f_{syn|a\text{-}str}$(VERB, {ActPart}) = $f_{syn|a\text{-}str}$(VERB, {*e*}). This will be given by default, since the GPF will not itself specify a value for $f_{syn|a\text{-}str}$(VERB, {ActPart}).

We now obtain the result that the output of regular, category-changing derivation is equivalent to the lexical entry for the derived lexeme. In other words, we can show that f_{li}(WRITE, {SN}) ≡ f_{li}(SN(WRITE), {*e*}) and so on for the GPF of WRITER generally. The Default Cascade will furnish the m-l signature required to inflect the new lexeme without the need for further machinery. In this way we fully answer Q1.

Derivational morphology frequently defines multiply polysemous/homonymous lexical entries that have non-compositional semantics or other irregularities. Thus, alongside regular *friendless* we find adjectives such as *clueless, priceless, hopeless, . . .* In ordinary English *clueless* almost always means just 'stupid'. In such a case the SEM and LI attributes are not given by applying all four PrivAdj functions to the LI CLUE. Rather, we have a 'lexical referral', under which the regular output of the PrivAdj process serves as a 'redundancy rule' specifying the form, but not the meaning, of the derived word. Thus, the SEM attribute of CLUELESS is lexically stipulated to be STUPID(x) and the LI is CLUELESS (NB *not* PRIVADJ(CLUE)!) but the FORM attribute can be defined as f_{form}(CLUELESS, *e*) = f_{form}(CLUE, {PrivAdj}). This fractionation of form from meaning is particularly valuable when semantic drift preserves idiosyncratic allomorphy (*car transmission*) (Q4). The existence of non-compositional derivates doesn't prevent the standard defaults associated with PrivAdj from applying, to give additional entries with the compositional (if less likely) meanings 'lacking a clue/price/hope', alongside the more frequent meanings.

There is an important class of derivational categories which contradict the Default Cascade. In many languages an adjective can be converted into a noun syntactically while remaining an adjective morphologically. For instance, the Russian adjective BOL′NOJ 'sick' converts into a noun meaning '(doctor's) patient' (synonymous with PACIENT). It is easy to show that the derived noun is a noun and not an adjective modifying a null noun. Moreover, the semantic representation of the noun is distinct from that of the adjective because 'X is a patient' doesn't entail 'X is sick'. Yet the converted noun inflects exactly like the adjective,[5] and it is the apparent target of agreement processes, just like the original adjective. For instance, it obligatorily has feminine gender forms when the referent is female and it takes genitive plural inflections when modified by numerals 2–4 rather than genitive singular inflections.[6] Now, if the derivational process creating the noun BOL′NOJ from the homophonous adjective were well behaved it would force the adjective root to inflect like a noun, by virtue of the CEP, (7). That principle must therefore be

[5]Unlike what we see in many Indo-European languages, the Russian adjective inflectional class is significantly different from that of any noun class.

[6]Compare the similar mismatch with German nouns such as ANGESTELLTE(R) mentioned above.

circumvented by means of a ‘referral’ written into the conversion process, which effectively defines the m-l signature of the derived noun to be identical to that of the base adjective lexeme, despite the fact that syntactically the derived word is a noun in all respects, except for its ‘agreement’ properties (nouns, of course, are never the target of agreement, they are agreement controllers).

We noted that inherent inflection can add a semantic predicate to the semantic representation of the inflected lexeme, as though we were dealing with derivation. For instance, many of the ‘semantic’ case suffixes in languages such as Hungarian have no grammatical role but act effectively like PPs in English. Thus, the suffix *-ként* ‘as, in the capacity of’ has no function other than to add the IN THE CAPACITY OF predicate to the base noun semantics. But *-ként* satisfies all the morphological properties of a case suffix and cannot be said to create a distinct lexeme. It is therefore part of the inflectional system (Kiefer, 1987, 2000). Such inherent inflection can be distinguished from derivation by allowing the f_{sem} function to introduce a semantic predicate while defining f_{li} as the identity function.[7] Entertainingly, it is difficult in the generalized model to decide whether some highly regular non-category-changing derivation might be inherent inflection. For instance, should *unhappy*, *re-print* be treated as {AdjPol:Neg}, {Asp:Repet} inflected forms of HAPPY, PRINT or as derived lexemes which preserve SEM category and hence escape the CEP? This indeterminacy accurately mirrors the shakiness of the intuitions of linguists and especially of dictionary writers in such cases.

I conclude with a particularly interesting case of lexical relatedness found in the Samoyedic (Uralic) language, Selkup. In their grammar of this language Kuznecova et al. explicitly point to the pervasiveness of transpositions in Selkup morphosyntax and describe a wide variety of transpositional processes under their heading of ‘representation’ (*representacija*): thus a noun transposed to an adjective (a relational adjective) is the ‘adjectival representation’ of that noun (Kuznecova et al., 1980).

Selkup nouns share the general structure of Uralic nouns in having three suffix position slots, for number ([Number:{singular, dual, plural and collective}]), possessor agreement ([PossAgr:{person/number}]) and case ([Case:{nominative, accusative, genitive, instrumental, caritive, translative, coordinative, dative-allative, illative, locative, elative, prolative, vocative}]). The three features are paradigmatic, i.e. the values of [Number], [PossAgr], [Case] are mutually exclusive. A typical example of a fully inflected noun is shown in (10) (Kuznecova et al., 1980, 201):

(10) qoː-iː-nyt-kɔːlyk
leader-PL-2PL.POSS-CAR
‘without your(3+) leaders (3+)’

In addition to these clearly inflectional forms, there are three major ‘adjectival

[7] Whether and how the CEP is deployed depends on the individual morphologies of the languages concerned.

representation of nouns'. These are denominal forms derived by suffixation:

(11) Adjectival representations of Selkup nouns

associative representation	kana-l′	'dog's, pertaining to dogs'
similitudinal representation	alako-ššal′	'similar to a boat'
locative representation	mɔːt-qyl′	'located in the/a house'

The adjectival representations of nouns serve for attributive modification. Unlike canonical inflection, the similitudinal and locative representations add semantic content to the noun denotation, essentially creating a representation of the form SIMILAR_TO(N) and LOCATED_IN(N). The semantics of these predicates means that such a word will denote a property as well as denoting an object.

Here I focus on the similitudinal representation of nouns. Kuznecova et al. (1980) make a clear distinction between true adjectives and adjectival representations of nouns in terms of their morphosyntax. The two types are similar in that both can function only as modifiers and do not differ in their external distribution, but adjectival representations of nouns are analyzed as part of the nominal paradigm (and hence, are in this sense inflectional). The crucial difference is that, unlike true adjectives, the associative and similitudinal adjectival representations have (inflectional) possessive forms. Thus, in addition to the associative form of the unpossessed noun *qaqly* sledge', *qaqly-l′* 'pertaining to a sledge', we have forms such as *qaqly-nɪː-l′* 'pertaining to our.DU sledge' and *qaqly-ntyty-l′* 'pertaining to their.(3+) sledge', where *-nɪː-* and *-ntyty-* are possessive affixes.

(12) (mat) pɔːra-ny-šal′ qum
I.GEN size-1SG-SIM man
'man of my size (lit. man similar to my size)'

Although it is not itself a case suffix in any traditional sense of the term, the similitudinal belongs functionally to the same set of suffixes as the case suffixes. It should therefore be treated as the output of an inflectional process, on a par with case marking, but deriving a word which shares some of the properties of an adjective. Not surprisingly, there is no traditional term for this type of lexical relatedness so I shall call it an 'inflectional transposition'. In the case of the similitudinal it is an instance of meaning-changing inflectional transposition.

(13) a. GPF(SLEDGE, <sg, unpossessed, associative>)

	maps	to
FORM:	qaqly-	qaqly-l′
SYN:	N	A*[N*]
SEM:	[SLEDGE(x)]	[SLEDGE(x)]
LI:	SLEDGE	SLEDGE

b. GPF(SLEDGE, <sg, 2pl.possessor, associative>) ‘pertaining to your(pl) sledges’

	maps	to
FORM:	qaqly-	qaqlynty-ty-l′
SYN:	N	A*[N*]
SEM:	[SLEDGE(x)]	[SLEDGE(x)]
LI:	SLEDGE	SLEDGE

The syntactic representations are meant to reflect that fact that the base noun component is to some extent syntactically accessible in some cases of transposition of this sort – in Selkup, for instance, the noun can be modified even in the ‘adjectival representation’ as in (12). A more detailed description of how this can be achieved is given in Spencer (1999), and for detailed discussion of a specific example of this kind of category ‘mixing’ see Nikolaeva (2008).

Finally, we must account for the fact that the transposition is meaning changing, so that the GPF adds a semantic predicate to the inflectional transposition, without, however, changing the lexemic status of the output:

(14) GPF(SLEDGE, <sg, 2pl.possessor, similitudinal>) ‘similar to your(pl) sledge’

	maps	to
FORM:	qaqly-	qaqlyn-ty-ššal′
SYN:	N	A*[N*]
SEM:	[SLEDGE(x)]	[SIMILAR_TO(x, y)[SLEDGE(y)]]
LI:	SLEDGE	SLEDGE

6 Conclusions

I have argued for the need for a formal model of lexical relatedness that is capable of capturing all the attested types of lexical relatedness without having to shoehorn intermediate cases into categories of inflection or derivation. Once we take into account the full richness of lexical relatedness cross-linguistically it becomes immediately apparent that we need an enriched conception of the way lexical entries can be related to each other. This is especially evident in the case of the Selkup inflectional transpositions, but even for the much commoner situation found with, say, deverbal participles or (purely) relational adjectives, some machinery such as that proposed here will be necessary. As a result we can cast both canonical inflection and canonical derivation as the output of the same formal operation, the Generalized Paradigm Function. This is an important result for realizational-inferential approaches to morphology because it means that we no longer have to draw a strict (if implicit) distinction between inflection and derivation. That distinction is all but entailed in classical paradigm-based realizational approaches (of a kind which are presupposed, for instance, in Sag et al. 2003 and Sag 2007) and is a serious impediment to finding a unified model which doesn't have to make completely arbitrary and unmotivated choices in the case of intermediate types of lexical relatedness. In effect, the GPF states that a form of the verb PRINT such as *printed* is lexically related to a form of the derived lexeme PRINTER (say, *printers*), but only distantly. Moreover, the notion of lexical entry itself turns out to be a special case of lexical relatedness as defined by the GPF.

My proposals hinge on the idea that information common to several different types of lexical entry can be factored out in the form of a default inheritance hierarchy. A crucial innovation in my approach is the use of defaults to define the morpholexical signature of a lexeme, together with the principle of Inflectional Specifiability and the Category Erasure Principle. These allow us to define (canonical) regular/productive derivational morphology as a form of lexical relatedness which is semantically driven: the change in semantic representation mediated by derivation entrains natural changes in the rest of the representation by default. The use of this simple set of devices thus permits us to capture a notion of 'overwriting' inherent in derivational processes, without losing sight of the fact that most of the changes are predictable. It is even possible to provide a natural description of polysemy due to lexicalization, as in *clueless* (which, of course, would render the standard model relational rather than functional).

The proposals are formally non-trivial, and future work must focus on establishing a secure formal basis for these types of representation and integrating them into a fully-operational grammar fragment.

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How Many Conversions from Verb to Noun Are There in French?

Delphine Tribout
LLF and Université Paris Diderot-Paris 7

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Abstract

In this paper, I discuss verb to noun conversion in French. The properties of the input verb and the output noun are presented and a formal representation is proposed using the SBCG framework. The use of such a formalism based on constraints and multiple inheritance highlights the difficulties in defining what exactly is a conversion rule. I propose that the different properties of the input verb and the output noun can be thought of as different dimensions of classification, which characterize the verb>noun conversion rule.

1 Introduction

1.1 A definition of conversion

Conversion is a lexeme formation process characterized by two main properties. On the one hand the base lexeme and the derived lexeme are phonologically identical, as the examples in (1) show. In English, GLUE as a verb is identical to GLUE as a noun. As for French, the verb COLLER is identical to the noun COLLE, the inflectional marks being not taken into account.

(1) engl. (A) GLUE > (TO) GLUE
(TO) WALK > (A) WALK

fr. COLLE > COLLE(R)
MARCHE(R) > MARCHE

Thus, conversion is very different from affixation processes like those presented in (2), which always add some phonological material to the base lexeme in order to form the derived lexeme. In HOSPITALIZE and PRESENTATION the added material is a suffix, whereas in UNTIE the added material is a prefix.

(2) HOSPITAL > HOSPITALIZE
PRESENT > PRESENTATION
(TO) TIE > UNTIE

On the other hand, the two lexemes involved in a conversion necessarily are from two different parts of speech. This can be seen in the examples (1) where GLUE or COLLE are nouns whereas (TO) GLUE or COLLER are verbs and (TO) WALK or MARCHER are verbs whereas (A) WALK or MARCHE are nouns. Once again this is very different from affixation, which can form a lexeme within the same part of speech, like *un-* prefixation in English which forms a verb out of a verb.

Both noun to verb conversion and verb to noun conversion are very productive processes in French. In this paper I will only focus on verb to noun conversion.

1.2 Conversion within Sign-Based Construction Grammar

In the lexeme-based theory of morphology adopted here (see (Matthews, 1972), (Aronoff, 1994)), the basic unit of morphology is the lexeme, which is defined as a multidimensional object having at least a form, a meaning and a syntactic category. Since the lexeme has properties of different kind, a feature structure based formalism, like Sign-Based Construction Grammar framework (henceforth SBCG, (Sag, 2010)), seems to be an appropriate means to formally represent the lexemes and the lexemes formation rules. SBCG is a feature structure formalism based on attribute-value structure, and is a constraints based declarative model.

In this model, the constructions are organized in a hierarchy of types, which is presented in Figure 1. The *lexical-cxt* type and the *phrasal-cxt* are two sub-types of *construction*. The *lexical-cxt* type further has three sub-types: *derivational-cxt* (*deriv-cxt*), *inflectional-cxt* (*infl-cxt*) and *post-inflectional-cxt* (*pinfl-cxt*).

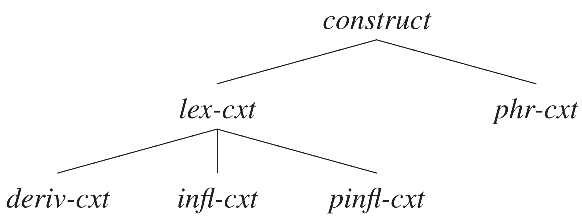

FIGURE 1: Hierarchy of constructions in SBCG, taken from (Sag 2010)

Each sub-type of the hierarchy inherits the properties of its super-type and has its specific ones. These properties are defined as features structures associated to each type. For instance, to the *deriv-cxt* type is associated the contrainst in (3), which stipulates that the derived lexeme (identified as *mother* –MTR feature), has a non empty list of lexical signs as bases (identified as *daughters* –DTRS feature).

(3) $$\textit{deriv-cxt} : \begin{bmatrix} \text{MTR} & \textit{lexeme} \\ \text{DTRS} & \textit{nelist(lex-sign)} \end{bmatrix}$$

In order to account for conversion, I propose to distinguish two sub-types of *deriv-cxt*: an *affixation-cxt* type and a *conversion-cxt* type, as sketched in Figure 2. The *conversion-cxt* type can be further divided into different sub-types of conversion, such as *v2n-conv-cxt* to account for verb to noun conversion, or *n2v-conv-cxt* to account for noun to verb conversion. Since I will only focus on the verb to noun conversion, I leave the hierarchy unfinished. Thus, conversion (*conv-cxt*) can be defined by the constraint (4).

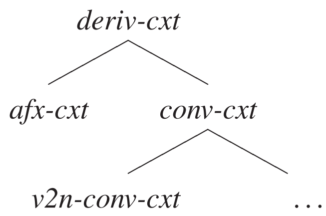

FIGURE 2: Sub-types of *deriv-cxt* and *conv-cxt*

(4)
$$\textit{conv-cxt}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{PHON} & <\phi> \\ \text{SYN} & \begin{bmatrix}\text{CAT} & Y\end{bmatrix} \\ \text{SEM} & \begin{bmatrix}\text{FRAMES} & L_1 \oplus \ldots\end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{PHON} & <\phi> \\ \text{SYN} & \begin{bmatrix}\text{CAT} & X\end{bmatrix} \\ \text{SEM} & \begin{bmatrix}\text{FRAMES} & L_1\end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

This constraint says

i) that on phonological level the two lexemes are identical (PHON features),

ii) that the two lexemes have different categories (CAT features), and

iii) that the derived lexeme's meaning includes that of the base lexeme (SEM features).

Having defined conversion in this way, verb to noun conversion is thus only characterized by the constraint in (5) which says that the derived lexeme is a noun and the base lexeme is a verb. The other properties of the verb to noun conversion, like those regarding the phonological features, follow from the inheritance of the *conv-cxt* type.

(5)
$$\textit{v2n-conv-cxt}: \begin{bmatrix} \text{MTR} & \begin{bmatrix}\text{SYN} \mid \text{CAT} & \textit{noun}\end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix}\text{SYN} \mid \text{CAT} & \textit{verb}\end{bmatrix} \right\rangle \end{bmatrix}$$

2 Stem spaces for verbs and nouns

2.1 Presentation

Based on the notion of morphome from (Aronoff, 1994), Bonami and Boyé (2002) propose that each French verb has a list of indexed morphomic stems, organised in stem space. The verbal stem space worked out by Bonami and Boyé (2002) is presented in Table 1. The stem slots are linked to one another by implicative rules. For instance by default stem 2 is identical to stem 1, stem 3 is identical to stem 2... Each slot is used to build a part of the paradigm: for instance stem 1 is used to inflect the present 1^{st} and 2^{nd} person plural forms (*lavons, lavez, finissons, finissez, mouron, mourez, buvons, buvez*) and all imperfect forms (e.g. *buvais, buvais, buvait, buvions, buviez, buvaient*).

#	stem's use	LAVER	FINIR	MOURIR	BOIRE
1	imperfect, pres. 1|2pl	lav	finis	muʁ	byv
2	present 3pl	lav	finis	mœʁ	bwav
3	present sg	lav	fini	mœʁ	bwa
4	present participle	lav	finis	muʁ	byv
5	imperative 2sg	lav	fini	mœʁ	bwa
6	imperative 1|2pl	lav	finis	muʁ	byv
7	pres. subjv. sg & 3pl	lav	finis	mœʁ	bwav
8	pres. subjv. 1|2pl	lav	finis	muʁ	byv
9	infinitive	lave	fini	muʁi	bwa
10	future, conditional	lav	fini	muʁ	bwa
11	simple past, past subjv.	lava	fini	muʁy	by
12	past participle	lave	fini	mɔʁt	by

TABLE 1: Stem space of LAVER '(to) wash', FINIR '(to) finish', MOURIR '(to) die' and BOIRE '(to) drink'

Bonami and Boyé (2005) propose that adjectives have a stem space too. This stem space is presented in Table 2. Stem 1 is used to inflect the masculine form (*joli, petit, grand, fin*), while stem 2 is used to inflect the feminine form (*jolie, petite, grande, fine*) and to derive lexemes (e.g. *joliment* 'prettily', *petitesse* 'smallness', *grandeur* 'greatness', *finesse* 'thinness').

As for nouns, based on the adjectival stem space worked out by Bonami and Boyé (2005), Plénat (2008) proposes the stem space presented in Table 3. Stem 1 is used to form the singular (*fleur, dent, plomb, bouton*), while stem 2 is used to derive lexemes (e.g. *fleuriste* 'florist', *dentiste* 'dentist', *plombier* 'plumber', *boutonnière* 'buttonhole').

#	JOLI	PETIT	GRAND	FIN
1	ʒoli	pəti	gʁɑ̃	fɛ̃
2	ʒoli	pətit	gʁɑ̃d	fin

TABLE 2: Stem space of JOLI ‘pretty’, PETIT ‘small’ GRAND ‘great’ and FIN ‘thin’

#	FLEUR	DENT	PLOMB	BOUTON
1	flœʁ	dɑ̃	plɔ̃	butɔ̃
2	flœʁ	dɑ̃t	plɔ̃b	butɔn

TABLE 3: Stem space of FLEUR ‘flower’, DENT ‘tooth’ PLOMB ‘lead’ and BOUTON ‘button’

2.2 Consequences for lexeme-formation rules

The postulation of stem spaces has consequences on lexeme-formation rules. Indeed, since lexemes have a stem space, morphological rules must take a whole stem space as input and build a whole stem space as output. For instance, as pointed out by (Bonami and Boyé, 2006), the *-aire* suffixation forms stem 2 of the adjective by suffixing /ɛʁ/ to the noun stem 1, and *-eur/-euse* suffixation forms stem 1 of the adjective by suffixing /œʁ/ to the verb stem 1, and stem 2 of the adjective by suffixing /øz/ to the verb stem 1. The constraints proposed by (Bonami and Boyé, 2006) to account for these two lexeme-formation rules are presented below in (6) and (7).

(6)
$$\textit{-aire-adj-lxm}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{STEMS} & \begin{bmatrix} \text{SLOT-2} & \boxed{1} \oplus \text{ɛʁ} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{adj} \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{STEMS} & \begin{bmatrix} \text{SLOT-1} & \boxed{1} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{noun} \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

(7)
$$\textit{-eur/-euse-adj-lxm}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{STEMS} & \begin{bmatrix} \text{SLOT-1} & \boxed{1} \oplus \text{œʁ} \\ \text{SLOT-2} & \boxed{1} \oplus \text{øz} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{adj} \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{STEMS} & \begin{bmatrix} \text{SLOT-1} & \boxed{1} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{verb} \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

As for conversion, the consequence is a new definition of the process. Instead of the identity between the PHON features of the two lexemes, as stated in constraint (4), conversion is now characterized by the identity between one stem of the base lexeme and one stem of the derived lexeme, as presented in the constraint (8).

(8)
$$\textit{conv-cxt} : \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{STEMS} & \begin{bmatrix} \text{SLOT-n} & \boxed{1} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & Y \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{FRAMES} & L_1 \oplus \ldots \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{STEMS} & \begin{bmatrix} \text{SLOT-m} & \boxed{1} \end{bmatrix} \\ \text{SYN} & \begin{bmatrix} \text{CAT} & X \end{bmatrix} \\ \text{SEM} & \begin{bmatrix} \text{FRAMES} & L_1 \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

2.3 Postulating an additional verb stem : stem 0

The new definition of conversion presented in (8) still encounters a problem with second conjugation verbs. Indeed, with second conjugation verbs the form of the noun is never identical to that of the verb, nor to any of the verbal stems, because the verbs systematicaly present an ending /i/ or /is/ which is absent from the noun, as can be seen in Table 4.

Noun			**Verb**			
Lexeme		Stem 2	Lexeme		Stem 1	Stem 3
COLLE	'glue'	kɔl	COLLER	'(to) glue'	kɔl	kɔl
CLOU	'nail'	klu	CLOUER	'(to) nail'	klu	klu
FLEUR	'blossom'	flœʁ	FLEURIR	'(to) blossom'	flœʁis	flœʁi
FARCE	'stuffing'	faʁs	FARCIR	'(to) stuff'	faʁsis	farsi

TABLE 4: Examples of noun>verb conversion with 1^{st} and 2^{nd} (below the double line) conjugation verbs

For conjugation, Bonami and Boyé (2003) have argued that there is no strong argument in favor of inflectional classes in French. So that the ending /i/-/is/ of the second conjugation verbs (e.g. *(je) finis* '(I) finish', *(nous) finissons* '(we) finish') must not be analyzed as part of the inflectional marks and can be considered as part of the stems. However, in derivation 2^{nd} conjugation verbs behave differently from other verbs, since they always have an additionnal /i/ or /is/. I thus propose to add a new stem to the verbal stem space worked out by Bonami and Boyé : stem 0. This additional stem is only used for derivation, and is identical to stem 3 minus the final /i/ for 2^{nd} conjugation verbs, whereas it is identical to stem 3 for all other verbs.

With that stem 0, one stem of the converted verb is identical to one stem of the base noun, as shown in Table 5. So that the definition in (8) still holds.

Noun		**Verb**			
Lexeme	Stem 2	Lexeme	Stem 0	Stem 1	Stem 3
COLLE	kɔl	COLLER	kɔl	kɔl	kɔl
CLOU	klu	CLOUER	klu	klu	klu
FLEUR	flœʁ	FLEURIR	flœʁ	flœʁis	flœʁi
FARCE	faʁs	FARCIR	faʁs	faʁsis	farsi

TABLE 5: Noun>verb conversion using stem 0

Thus, stem 0 allows us to account for every noun>verb conversion, whatever conjugation group the derived verb belongs to. Moreover, besides conversion, this stem 0 is relevant for all derivational rules involving a second conjugation verb, such as adjective to verb conversion (e.g. ROUGE ‘red’ > ROUGIR ‘turn red’) or deadjectival *en-* prefixation (e.g. RICHE ‘rich’ > ENRICHIR ‘enrich’).

3 Properties of verb>noun conversion

3.1 Verb stem selection

Most of the time stem 0 is the base of the derived noun, like the examples in Table 6.

Verb				**Noun**		
Lexeme		Stem 0	Stem 3	Lexeme		Stem 2
DANSER	‘(to) dance’	dɑ̃s	dɑ̃s	DANSE	‘(a) dance’	dɑ̃s
MARCHER	‘(to) walk’	maʁʃ	maʁʃ	MARCHE	‘(a) walk’	maʁʃ
SAUTER	‘(to) jump’	sot	sot	SAUT	‘(a) jump’	sot
BONDIR	‘(to) leap’	bɔ̃d	bɔ̃di	BOND	‘(a) leap’	bɔ̃d
ENCHÉRIR	‘(to) bid’	ɑ̃ʃeʁ	ɑ̃ʃeʁi	ENCHÈRE	‘(a) bid’	ɑ̃ʃɛʁ

TABLE 6: Verb>noun conversions selecting stem 0

Bonami, Boyé and Kerleroux (2009) have shown that a thirteenth stem is needed in the verbal stem space to account for derived lexemes in *-ion, -if* and *-eur/-*

rice such as CORRÉLATION 'correlation' derived from CORRÉLER '(to) correlate', FORMATEUR 'formative' derived from FORMER '(to) form', or ALTERNATIF 'alternative' derived from ALTERNER '(to) alternate'. This stem is hidden to inflection rules and is only used in derivation. By default it is identical to stem 11 $\oplus$ /t/. Table 7 presents some examples of lexemes derived from stem 13 of their base verb.

Verb		Stem 11	Stem 13	Derivative
ALTERNER	'to alternate'	altɛʁna	altɛʁnat	ALTERNATEUR, ALTERNATIF
CORRÉLER	'to correlate'	koʁela	koʁelat	CORRÉLATION, CORRÉLATIF
DÉFINIR	'to define'	defini	definit	DÉFINITION, DÉFINITIF
FORMER	'to form'	fɔʁma	fɔʁmat	FORMATION, FORMATEUR

TABLE 7: Examples of lexemes derived from stem 13

Kerleroux (2005) has shown that this stem 13 can be selected by verb>noun conversion too, like in the case of the examples in Table 8.

Verb				Noun	
Lexeme		Stem 0	Stem 13	Lexeme	Stem 2
CORRÉLER	'(to) correlate'	koʁɛl	koʁelat	CORRÉLAT	koʁelat
CONCEVOIR	'(to) conceive'	kɔ̃swa	kɔ̃sɛpt	CONCEPT	kɔ̃sɛpt
DÉFENDRE	'(to) defend'	defɑ̃	defɑ̃s	DÉFENSE	defɑ̃s
FORMER	'(to) form'	fɔʁm	fɔʁmat	FORMAT	fɔʁmat
POSTULER	'(to) postulate'	postyl	postylat	POSTULAT	postylat

TABLE 8: Verb>noun conversions selecting stem 13

As for the data in (9) I consider them as verb to noun conversion too. Only, those nouns are based on stem 12 of the verb (past participle stem). There are two main reasons for considering them as conversion : first, no affix is added so that they cannot be analyzed as suffixed nouns ; second, the noun is always identical to the past participle stem of the verb, whatever its conjugation is, as shown in Table 9.

(9)	ARRIVER	'(to) arrive'	> ARRIVÉE	'arrival'
	DÉCOUVRIR	'(to) discover'	> DÉCOUVERTE	'discovery'
	SORTIR	'(to) go out'	> SORTIE	'exit'
	VENIR	'(to) come'	> VENUE	'coming'

In this particular case it might be difficult to tell whether the nouns are derived from the past participle word-form or stem. But the meaning of those nouns is a

Verb			Noun	
Lexeme	Stem 0	Stem 12	Lexeme	Stem 2
ARRIVER	aʁiv	aʁive	ARRIVÉE	aʁive
DÉCOUVRIR	dekuvʁ	dekuvɛʁt	DÉCOUVERTE	dekuvɛʁt
SORTIR	sɔʁ	sɔʁti	SORTIE	sɔʁti
VENIR	vjɛ̃	vəny	VENUE	vəny

TABLE 9: Verb>noun conversions selecting stem 12

good argument in favor of the stem base, since those nouns do not show any piece of the meaning of the inflected past participle word-form. Indeed, the meaning of ARRIVÉE is not 'something which has arrived' but it is 'the action of arriving' or 'the location where one arrives', nor is the meaning of VENUE 'something which has come' but it is 'the action of coming'.

As we have seen, different stems of one verb can serve as the base of a converted noun. In the main case the input stem is stem 0. But, as the examples in Table (8) and Table (9) show, stem 13 and stem 12 can be the input of conversion too. It seems that there are 3 sub-cases of verb to noun conversion, depending on which verbal stem is selected as input. The *v2n-conv-cxt* can thus be divided into three sub-types : *stem-0-conv*, *stem-12-conv* and *stem-13-conv*, as illustrated in the Figure 3.

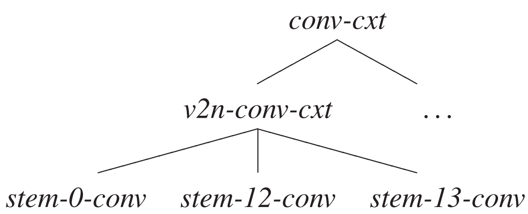

FIGURE 3: Hierarchy of verb>noun conversion

To each sub-type of verb>noun conversion is also associated the constraints (10)-(12).

(10)
$$\textit{stem-0-conv}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{STEMS} \mid \text{SLOT-2} & \boxed{1} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{STEMS} \mid \text{SLOT-0} & \boxed{1} \end{bmatrix} \right\rangle \end{bmatrix}$$

(11)

$$\textit{stem-12-conv}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{STEMS} \mid \text{SLOT-2} & \boxed{1} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{STEMS} \mid \text{SLOT-12} & \boxed{1} \end{bmatrix} \right\rangle \end{bmatrix}$$

(12)

$$\textit{stem-13-conv}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{STEMS} \mid \text{SLOT-2} & \boxed{1} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{STEMS} \mid \text{SLOT-13} & \boxed{1} \end{bmatrix} \right\rangle \end{bmatrix}$$

Constraint (10) says that the noun stem 2 is identical to the verb stem 0 and accounts for nouns like MARCHE, SAUT, BOND... (11) says that the noun stem 2 is identical to the verb stem 12 which accounts for nouns such as ARRIVÉE, DÉCOUVERTE, VENUE... And (12) says that the noun stem 2 is identical to the verb stem 13 and accounts for nouns like RÉSULTAT, DÉFENSE, CONCEPT...

3.2 Noun meaning

On the output side, the converted nouns can have a wide range of meanings. They can denote the same event as the base verb like those in (13a), the result of the process denoted by the verb as in (13b), the patient of the process (13c), the agent of the process (13d), a location related to the process (13c) or an instrument helping to realize the process (13f).

(13) a.	process	st-0	MARCHER	‘walk’	>	MARCHE	‘walk’
		st-12	ARRIVER	‘arrive’	>	ARRIVÉE	‘arrival’
		st-13	DÉFENDRE	‘defend’	>	DÉFENSE	‘defence’
b.	result	st-0	AMASSER	‘heap up’	>	AMAS	‘heap’
		st-12	RELEVER	‘take in’	>	RELEVÉ	‘statement’
		st-13	CRACHER	‘spit’	>	CRACHAT	‘spit’
c.	patient	st-0	AFFICHER	‘put up’	>	AFFICHE	‘poster’
		st-12	COUVER	‘brood’	>	COUVÉE	‘brood’
		st-13	POSTULER	‘postulate’	>	POSTULAT	‘postulate’
d.	agent	st-0	GUIDER	‘guide’	>	GUIDE	‘guide’
		st-13	RENIER	‘renounce’	>	RENÉGAT	‘renegade’
e.	location	st-0	DÉCHARGER	‘dump’	>	DÉCHARGE	‘dump’
		st-12	ENTRER	‘enter’	>	ENTRÉE	‘entrance’
		st-13	ACCÉDER	‘access’	>	ACCÈS	‘access’
f.	instr.	st-0	RÉVEILLER	‘wake up’	>	RÉVEIL	‘alarm-clock’

The different meanings a noun may have are independent from the verb stem it is derived from. Event nouns can be derived from the three possible input stems as shown in (13a). Result nouns can be derived from stem 0 (AMAS) as well as from stem 12 (RELEVÉ) or stem 13 (CRACHAT). Patient nouns can be derived from the three verbal stems too, but these are much less common than event and result nouns. Location nouns can derive from the three verbal stems, but only two of them derive from stem 13. Instrument meaning is restricted to nouns derived from stem 0. As for agent nouns, they are very few : about ten agent nouns derive from stem 0 like GUIDE, and only two from stem 13 : RENÉGAT and SYNDICAT.

Those six semantic types of converted nouns can be seen as six sub-types of verb>noun conversion, so that the hierarchy of *v2n-conv-cxt* can be represented in the Figure 4.

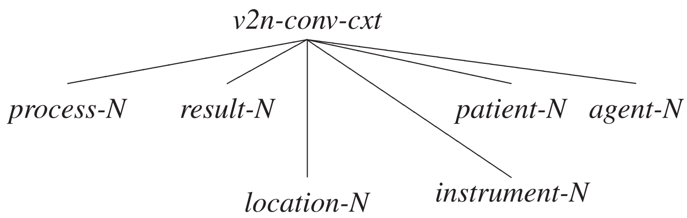

FIGURE 4: Semantic sub-types of verb>noun conversions

To each semantic sub-type can be associated a constraint like for example, the constraint in (14) for the event nouns, or the constraint (15) for patient nouns[1]. For the process sub-type, the constraint in (14) only says that the semantics of the noun is identical to the semantics of the verb. As for the patient type, the constraint in (15) stipulates that the semantics of the noun includes the semantics of the verb, and that the noun refers to the patient of the process denoted by verb.

(14)

$$\textit{process-N}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{SEM} & \boxed{1} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{SEM}\ \boxed{1} \begin{bmatrix} \text{INDEX} & s \\ \text{FRAMES} & \left\langle \begin{bmatrix} \text{SIT}\ s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

[1] Constraints associated to the other semantic sub-types are presented in (Tribout, 2010)

(15)

$$\textit{patient-N}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{SEM} & \begin{bmatrix} \text{INDEX} & j \\ \text{FRAMES} & \langle \boxed{1} \rangle \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{SEM} & \begin{bmatrix} \text{INDEX} & s \\ \text{FRAMES} & \left\langle \boxed{1} \begin{bmatrix} \textit{agent-pat-fr} & \\ \text{AGENT} & i \\ \text{PAT} & j \\ \text{SIT} & s \end{bmatrix} \right\rangle \end{bmatrix} \end{bmatrix} \right\rangle \end{bmatrix}$$

3.3 Noun gender

As for the gender, converted nouns can be either masculines or feminines. There are no constraints with respect to the semantic type of the noun, as shown in Table 10. Nor are there any constraints with respect to the selected stem of the verb, although some combinations are lacking.

	Masculine nouns			**Feminine nouns**		
	st-0	st-12	st-13	st-0	st-12	st-13
process	SAUT	DÉFILÉ	ASSASSINAT	MARCHE	ARRIVÉE	DÉFENSE
result	AMAS	RELEVÉ	CRACHAT	ENTAILLE	EMPREINTE	RÉPONSE
patient	RABAT		POSTULAT	AFFICHE	COUVÉE	PROMESSE
agent	GUIDE		RENÉGAT	MARMOTTE		
location	DÉBARRAS	DÉBOUCHÉ	ACCÈS	DÉCHARGE	ENTRÉE	
instr.	RÉVEIL			RALLONGE		

TABLE 10: Noun gender according to the selected verb stem and the noun meaning

Masculine and feminine nouns can be seen as 2 sub-types of converted nouns as illustrated in Figure 5. To these sub-type are associated the constraints (16) and (17). The constraint in (16) only says that the derived noun is masculine, while the constraint in (17) says that the derived noun is feminine.

(16)

$$\textit{masc-conv-N}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{noun} \\ \text{GENDER} & \textit{masc} \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{SYN} \mid \text{CAT} & \textit{verb} \end{bmatrix} \right\rangle \end{bmatrix}$$

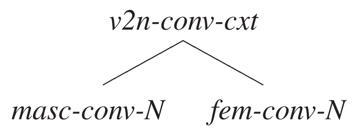

FIGURE 5: Sub-types of verb>noun conversions according to noun gender

(17)

$$\textit{fem-conv-N}: \begin{bmatrix} \text{MTR} & \begin{bmatrix} \text{SYN} & \begin{bmatrix} \text{CAT} & \textit{noun} \\ \text{GENDER} & \textit{fem} \end{bmatrix} \end{bmatrix} \\ \text{DTRS} & \left\langle \begin{bmatrix} \text{SYN} \mid \text{CAT} & \textit{verb} \end{bmatrix} \right\rangle \end{bmatrix}$$

4 Defining the verb>noun conversion rule

To account for those properties of the base verb and the derived noun, the conversion rule must specify the verbal stem taken as input, the meaning of the derived noun as well as its gender. It has been shown that on the verb stem level the *v2n-conv-cxt* type can be further divided into three sub-types : *stem-0-conv*, *stem-12-conv* and *stem-13-conv*. On the semantic level *v2n-conv-cxt* type can be divided into six sub-types : *process-N*, *result-N*, *patient-N*, *agent-N*, *location-N* and *instrument-N*. And, on the noun gender level, *v2n-conv-cxt* type can be divided into *masc-conv-N* and *fem-conv-N*. Thus, there are three different hierarchies of *v2n-conv-cxt* according to the property we want to focus on, as illustrated in Figure 6.

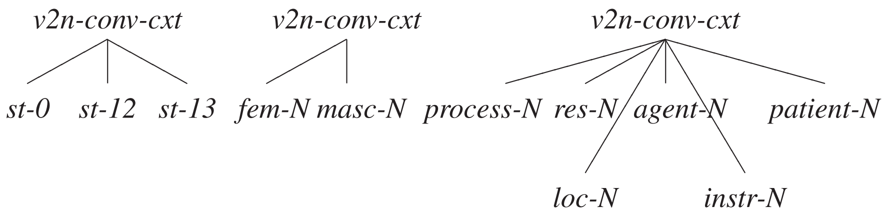

FIGURE 6: Problematic hierarchies of *v2n-conv-cxt*

In order to solve this conflict between different hierarchies, the three discussed properties of verb>noun conversion can be thought of as three different dimensions of classification, as illustrated in Figure 7. Each converted noun inherits a property of these three dimensions of classification by means of multiple inheritance.

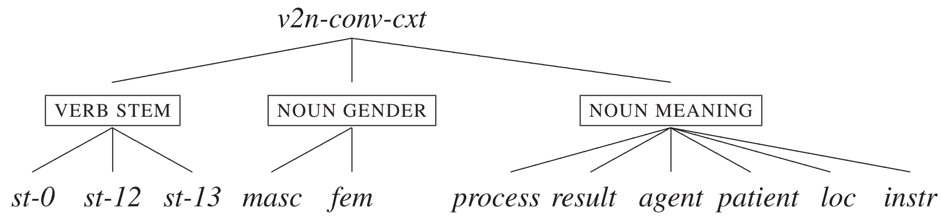

FIGURE 7: *v2n-conv-cxt*'s dimensions of classification

The inheritance of one property from each of the three dimensions of classification leads to 36 possible distinct cases. However it is worth noting that only 27 distinct combinations between a verb stem, a gender and a meaning are observed. This is still a wide range of possibilities, even if some combinations are less common than others. It thus seems that verb to noun conversion is unable to make any prediction about the output. The 27 observed combinations are presented in Figure 8, wich is hardly readable. This figure raises the question of the exact definition of the conversion rule, leading to the question of the number of verb to noun conversions in French. Is there only one verb to noun conversion rule identified by the top node of the tree in Figure 8 and the contraint in (5)? In that case the output of the rule is unpredictable. Or are there 27 distinct and highly specific rules accounting for the different observed cases? Or else, 3 conversion rules depending on the input verb stem, or 6 rules depending on the derived meaning? It seems that what speakers must know about verb>noun conversion when using it are the three dimensions of classification presented in Figure 7. Indeed, even though nine of them were not observed, there is no reason to think that some combinations are impossible.

5 Conclusion

The different properties of verb>noun conversion have been presented and it has been shown that these properties can be thought of as different dimensions of classification. The verb>noun conversion rule can thus be characterized in terms of these dimensions of classification. The question that arises now is wether these dimensions of classification are peculiar to verb>noun conversion.

As already pointed out in (Bonami et al., 2009), different deverbal lexeme-formation rules use different verb stem as input such as stem 1, stem 3 or stem 13. As for noun meaning, *-ion*, *-age*, *-ment*... suffixations in French, which form a noun out of a verb, produce the same semantic types of nouns as verb>noun conversion. Moreover, those deverbal nouns can be masculine or feminine depending

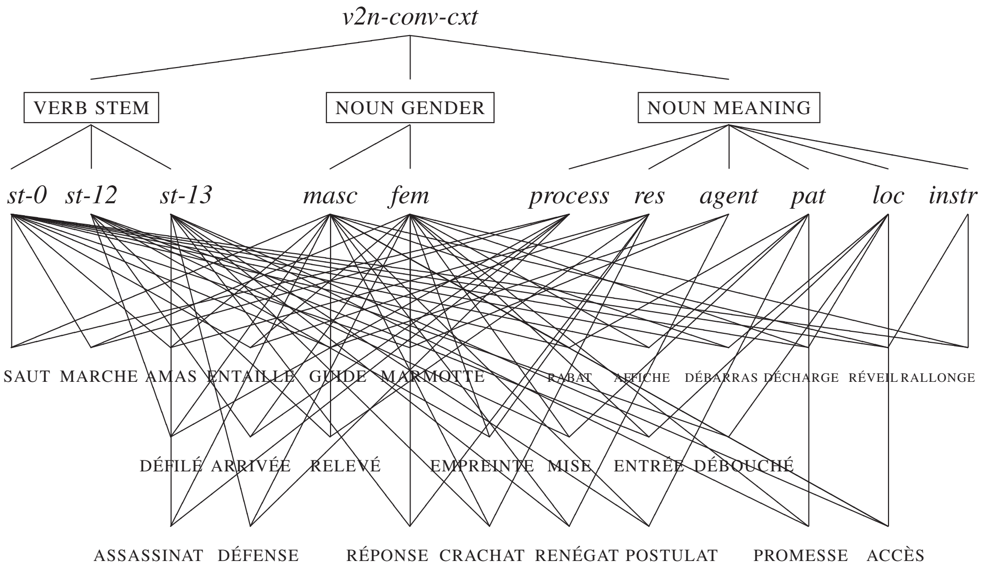

FIGURE 8: The 27 observed combinations between a verb stem, a noun gender and a noun meaning

on the suffixation rule. It thus seems that the dimensions of classification proposed for verb>noun conversion are not peculiar to this derivational process, and should be shared by other nouns forming deverbal rules. How to represent this in the SBCG framework is still in question.

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