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French Phrasal Phonology in a Derivational Model of PF*

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This paper investigates the relationship between two phonological rules—liaison and phrasal accent—that apply across words in French. Although both rules have been associated with a phrase-level constituent of the prosodic hierarchy (§1), we show that domains for liaison are sometimes larger and sometimes smaller than domains for phrasal accent, in violation of the core well-formedness principles of prosodic hierarchy theory (§2). We suggest that this apparent conflict comes about because liaison and phrasal accent are fundamentally different kinds of rules, applying at different stages in an articulated model of PF (§3). An advantage of this alternative treatment is that it provides an explanation for why some phonological rules are rate-sensitive while others are not.

1. Background: Liaison, Phrasal Accent, and Prosodic Hierarchy Theory

We begin with a brief discussion of the two rules under investigation. In *liaison*, a word-final latent consonant is phonetically realized before a vowel-initial word ((1)a), but only if the two words are in a sufficiently close syntactic relationship ((1)b; see §2):

(1) a. **jolis** enfants 'pretty children' [**ʒɔliz**], ?*[ʒɔli]
b. ils sont **jolis** en été 'they're pretty in the summer' [**ʒɔli**], *[ʒɔliz]

Phrasal accent is the term we use for the regular assignment of prominence within a phrasal domain in French. Unlike English, French does not have a system of lexically contrastive stress; instead, utterances are broken down into phrases of various sizes that serve as domains for *final accent* (typically H on the final non-schwa syllable), optional *initial accent* (H on the first or second non-schwa syllable of the first content word), and optional final lengthening (see §2). A given syntactic structure may correspond to more than one accent phrasing, depending in part on rate and rhythm; (2)a and (2)b, for

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example, are both acceptable parses of the same relative clause, with *malgré* ('despite') forming its own H-final accent domain in (2)a but not in (2)b:

(2) L H L H L **H** L H H L L L H L **L** L L H
a. (qui persistait)(malgré)(les efforts…) b. (qui persistait)(malgré les efforts…)
'which persisted despite the efforts…'

Much previous work on liaison and phrasal accent has assumed some version of *prosodic hierarchy theory* (Nespor and Vogel 1986, Inkelas 1989, Selkirk 1986, 1995, among others), the prevailing framework for current work on phrasal phonology. Prosodic hierarchy theory is based on the notion that phonological rules cannot operate directly on the syntax but instead must refer to a derived intermediate structure—specifically, a structure like (3)—a 'strictly layered' hierarchy of prosodic constituents:[1]

(3) **Prosodic hierarchy:** (subword constituents not shown)

Utterance	(————————————————)
Intonational phrase	(————————————) (————)
Phonological phrase	(————) (————) (————)
Prosodic word	(—) (—) (—) (—) (—) (—)

Each level of the prosodic hierarchy is created by a unique algorithm. In Selkirk 1986, for example, domains for 'unmarked' liaison are derived by inserting boundaries at right edges of heads of maximal projections (this solution is recast as a high-ranking Align constraint in OT treatments; see Selkirk 2005 and work cited there). As long as prenominal adjectives are assumed not to count as phrasal heads, this approach correctly predicts that liaison will be blocked after *enfants* in (4) but otherwise will apply wherever its phonological conditions are met (liaison application shown in bold type):

(4) Ces très**s** aimable**s** enfants]$_N$ e**n** on**t** avalé]$_V$ (Selkirk 1986:395)
these very nice children of-it have drunk
'These very nice children swallowed some of it.'

Not all phrasal rule domains can be derived by edge-based algorithms; consequently, a variety of algorithms and constraint rankings have been proposed. In particular, French phrasal accent appears to belong to a class of rules that allow *many* possible mappings from a single syntactic structure, based in part on non-syntactic factors like rate and rhythm (see Pak 2005 and work cited there for further examples). Such rules can be accommodated within prosodic hierarchy theory by leaving domains underspecified (Gussenhoven 2004, Jun 1996), adding restructuring operations (Nespor and Vogel 1986), or associating different rankings with different rates (Prieto, forthcoming).

With this much background, we can see that French is a case of potential interest because it appears to have two phrasal rules that vary under distinct sets of conditions.

[1] Various modifications to (4) have been proposed, including alternative naming conventions and additional layers. Except where noted, these proposals will not bear on the current discussion.

When liaison and phrasal accent are studied in tandem, what is the exact relationship between their domains? Prosodic hierarchy theory makes a strong prediction with respect to this question, which we call the *containment prediction*:

(5) **Containment prediction:** Given a language with two phonological rules, either the two rule domains should always be coextensive, or the domain for one rule should consistently and exhaustively contain the domain for the other.

The fundamental premise of prosodic hierarchy theory is that phonological rule domains will unify into a well-formed, consistently ordered hierarchical structure. This premise, together with the idea that the constituents in the prosodic hierarchy are the *only* possible domains for phonological rules (Inkelas 1989:10), underlies the containment prediction in (5). Essentially, (5) rules out configurations like those schematized in (6). In (6)a, containment relationships have changed from one utterance to another—i.e., the levels of the hierarchy have been rearranged—against the universally inviolable Layeredness and Headedness tenets of the Strict Layer Hypothesis (Selkirk 1995:443). In (6)b, domain boundaries are misaligned, yielding an ill-formed 'constituent sharing' structure.

(6) a. *Inconsistent dominance relations:*

	Utterance A	Utterance B
Rule 1	(————)	(—) (—)
Rule 2	(—) (—)	(————)

b. *Misaligned boundaries:*

Rule 1 (————) (————)
Rule 2 (——) (———) (——)

Under the hypothesis that phonological rules are uniformly constrained by a single prosodic hierarchy, (6)a and (6)b should never occur. As it turns out, however, there are languages in which these configurations are attested. The next section shows that French is one such language.

2. Experiment: The Containment Prediction in French

2.1 Goals and Previous Work

The goal of the current study was twofold: (a) to determine whether liaison and phrasal accent are affected by speech rate in the same way; and (b) to determine whether liaison domains consistently and exhaustively contain accent domains (or vice versa), in accordance with the containment prediction (5). Previous work has yielded conflicting answers to these questions. With respect to the first question, it is generally agreed that accent domains tend to become larger in faster speech and smaller in slower speech (Fougeron and Jun 1998). This is apparently a completely regular pattern for rate-sensitive rules, including Korean obstruent voicing and Italian *raddoppiamento sintattico*; see Pak 2005 for further examples. It is not clear, however, that liaison is affected by speech rate in the same way—in fact, Selkirk (1986:375) suggests that liaison is not affected by speech rate at all. Many studies have acknowledged that style plays a role in liaison, but the effect is the opposite of what we would expect if we were to conflate style and rate (with casual/fast on the one hand and formal/slow on the other)—liaison *increases* in more formal speech (see Kaisse 1985 for discussion). Ideally, then, we

would like to isolate these two factors. One study that makes some progress in this direction is Scarborough and Jun 2003, where six speakers read news stories at self-selected normal and fast rates; since the same task was performed at both rates, style might have been held constant (presumably at a formal level), all else being equal. Scarborough and Jun report an increase from 35% (normal) to 45% (fast) in Geneva French liaison and from 29% (normal) to 31% (fast) in Parisian French liaison, but do not specify whether the normal and fast rates were elicited in the same order for all speakers. Our study is similar to Scarborough and Jun's in many respects, but was designed to isolate the effects of both style and stimulus presentation from the effects of rate.

With respect to our second question, the literature provides some preliminary evidence that liaison and accent domains are not in a consistent containment relationship. On the one hand, liaison domains sometimes appear to be larger than accent domains: Scarborough and Jun (2003) indicate that liaison sometimes applies 'across accentual phrases,' and Miller and Fagyal (2005:187) point out that liaison can cross even 'major prosodic boundaries' (e.g. (7)a). On the other hand, Post (1999) provides some evidence for the opposite containment relationship: nouns followed by branching complements or modifiers are sometimes realized without pitch-accent, suggesting that e.g. *hivers* and *autres* in (7)b might belong to the same accent domain even though liaison is forbidden between them. Taken together, these two examples correspond to the Layeredness-Headedness violation schematized in (6)a. Our study was set up to determine whether such mismatches are produced within individual speakers as well.

(7) a. qu'il fau**t** *(pause)* interdire
'that one must forbid'
Liaison: (…faut interdire)
Accent: (…faut)(interdire)

b. **hivers**$_{[HL]}$ autres$_{[L]}$ qu'en Afrique
'winters other than in Africa'
Liaison: (hivers)(autres…)
Accent: (hivers autres…)

2.2 Design and Procedures

Two reading experiments were conducted. For *Experiment 1,* four speakers were recorded (three women and one man, all from Paris environs, ages 20-26). Speakers were presented with nine made-up news stories (634 words total) and told to read them with no special instructions about rate. Next they were told to read the same text slowly; finally they were told to read the same text fast. For *Experiment 2*, 15 speakers were recorded (7 women and 8 men, 13 from France and 2 from Switzerland, ages 18-28). Two separate texts were prepared (673 words total); each speaker read one text fast and one text slow. The ordering of fast-slow readings, and associations between each half and each speed, were counterbalanced. To elicit each speed, speakers were told to imagine that the news station had made a mistake and allotted too much/little time for them to read the news and that they needed to compensate by reading slower/faster than usual.

Each text contained potential liaison environments involving the plural marker /z/ in syntactic configurations that have previously been associated with Frequent, Optional, and Rare/Forbidden application (De Jong 1990, Moisset 2000, among others). The Frequent category included prenominal quantifiers and adjectives; the Optional category

consisted of nouns followed by adjectives; and the Rare/Forbidden category included sequences of postnominal adjectives, nouns followed by PPs or other phrasal modifiers, and non-pronominal subjects followed by verbs. Texts were printed on paper with normal punctuation and capitalization. None of the tokens were set up to contain narrow or contrastive focus, and no special instructions about intonation or pronunciation were given. Speakers were told to start over from the beginning of the sentence if they coughed or made a mistake, but were not given examples of what counted as mistakes.

(8) **Example:** Des membres du gouvernement et des représentants des syndicats industriels italiens vont se réunir, mercredi 12 octobre, afin de discuter des retards inexpliqués dans la construction ferroviaire en Haute-Savoie.
'Government officials and Italian industrial union representatives will meet Wed. Oct. 12 to discuss unexplained delays in railroad construction in Haute-Savoie.'

2.3 Analysis and Results

1. Effect of speech rate on liaison
With respect to our first question—whether rate has the same effect on liaison as on phrasal accent—it is instructive to consider first the following results from Experiment 1.

Table 1. Liaison Application by Speech Rate (Experiment 1)

Speaker	*Normal*		*Slow*		*Fast*	
1M1	54.8%	23/42	58.1%	25/43	65.9%	27/41
1F2	57.1%	24/42	66.7%	28/42	61.9%	26/42
1F3	27.9%	12/43	32.6%	14/43	37.5%	15/40
1F4	41.9%	18/43	45.2%	19/42	45.2%	19/42
Total	**45.3%**	77/170	**50.6%**	86/170	**52.7%**	87/165

If liaison is affected by speech rate in the usual way, then we should expect slow speech to have the least liaison and fast speech the most, with normal speech somewhere in between. Instead, the normal reading (performed first) had the lowest liaison rates for all four speakers in Experiment 1. When only slow and fast rates are compared (performed rsp. second and third), there is no consistent rate effect: 1M1 and 1F3 increase slightly while 1F2 decreases slightly. None of these differences are statistically significant, nor do they consistently correlate with differences among self-selected speech rates.[2]

In Experiment 2, no texts were repeated and the ordering of elicited rates varied from speaker to speaker. Table 2 shows liaison application by syntactic environment corresponding to predicted domains for Frequent, Optional, and Rare liaison (see §2.2). The only context where we find a significant difference between the two rates is the Optional category, which consists entirely of plural nouns followed by adjectives

[2] Self-selected speech rates (syllables/second, based on same sample of each text): 1M1 (3.87s/5.90f), 1F2 (3.82s/5.82f), 1F3 (3.24s/5.83f), 1F4 (4.55s/4.85f), 2F1 (4.47s/4.97f), 2F2 (3.99s/5.66f), 2F3 (5.85s/6.42f), 2F4 (4.55s/6.38f), 2F5 (5.52s/6.26f), 2F6 (5.72s/6.69f), 2F7 (5.30s/6.27f), 2M1 (4.23s/6.70f), 2M2 (4.84s/6.06f), 2M3 (4.85s/6.11f), 2M4 (4.55s/6.41f), 2M5 (6.52s/6.10f), 2M6 (5.98s/5.94f), 2M7 (4.66s/6.33f), 2M8 (5.58s/6.77f)

(χ^2=6.61). However, the difference is the reverse of the expected pattern: liaison *decreases* in faster speech.[3] Furthermore, as shown in the last two pairs of columns, we found that there was a tendency to increase liaison in the Optional environment on speakers' second readings, regardless of text or rate.

Table 2. Liaison Application by Speech Rate and Reading Order (Experiment 2)

Context	*Slow*	*Fast*	*First reading*	*Second reading*
Frequent	85.4% 111/130	85.3% 110/129	83.7% 108/129	86.9% 113/130
Optional	**51.0**% 80/157	**36.5**% 57/156	**35.0**% 55/157	**52.6**% 82/156
Rare	8.5% 12/141	8.6% 12/139	6.4% 9/141	10.8% 15/139

These results raise a number of interesting questions, which we unfortunately cannot address in detail here.[4] The important result for present purposes is a negative one: speech rate was not found to have a clear effect on liaison application.

2. Effect of speech rate on accent domains

We examined the f_0 contour of selected phrases from each text in Praat and tallied the number of accent domains per token. In parsing our tokens, we used the diagnostics given by Jun and Fougeron (2002), who follow other work (see their paper for references) in showing that French accent domains regularly end with (L)H 'final accent' and optionally carry (L)H 'initial accent' as well. In (2)a, for example, *qui persistait* and *les efforts* each have both initial and final accent, while *malgré* has final accent only; we know that *malgré* is its own accent domain because a given domain generally has at most two H tones. In many cases, phrasing is ambiguous—e.g., if two adjacent disyllabic words are both LH (*jolis*$_{[LH]}$ *enfants*$_{[LH]}$), it is not obvious whether the two words form separate accent domains or a single domain with both initial and final accent, especially if there is no clear difference in pitch or duration between the two H-toned syllables. In such cases, we averaged the possible values (e.g., 2 or 3 domains = 2.5).[5]

Results are given in Table 3. All four speakers in Experiment 1 moved in the direction of having fewer phrases in faster speech, and speech rate appeared to have the expected effect in Experiment 2 as well.

[3] Individual speakers varied considerably in the Optional environment: 2F2, 2M1, and 2M5 rarely or never applied liaison at either rate; 2M6 applied it in all but one case; 2M4 and 2M7 had more liaison in faster speech; and the remaining speakers (to varying extents) had more liaison in slower speech.

[4] One explanation for the results in Table 2 is that some speakers might have associated the slower rate with a more formal style, despite our attempts to minimize this kind of interference. There also appears to be a 'rehearsal effect' at work here, whereby speakers might have increased liaison application as they became accustomed to the task of reading, even when they were not repeating the same texts. A question for future work is whether similar effects are found when fast and slow rates are compared in other speech styles (e.g., in a corpus of spontaneous speech).

[5] We recognize that some of these ambiguous cases could have resulted from a tendency not to realize initial accent in fast speech. For the sake of comparison, consider our results from Experiment 2 when only unambiguous values are counted (based on 4 tokens with at least 7 unambiguous values out of 12): Slow = 3.53 avg. domains/token, Fast = 3.25 avg. domains/token.

Table 3. Average Accent Domains per Token[6] by Speech Rate

	Speaker	*Slow*	*Fast*
Experiment 1 (one text)	1-M1	2.22	1.94
	1-F2	2.29	1.79
	1-F3	2.42	1.76
	1-F4	2.09	1.85
	(Avg.)	**2.20**	**1.82**
Experiment 2 (Text A)	(Avg.)	**4.45**	**4.21**
Experiment 2 (Text B)	(Avg.)	**3.63**	**3.40**

3. Liaison domains are sometimes larger and sometimes smaller than accent domains.
We found numerous Layeredness-Headedness violations parallel to (6)a, in which an individual speaker showed evidence for one containment relationship in one utterance and the reverse relationship in another. Some examples are included in Table 4. The first column of the table indicates the speaker; the second column shows cases where accent domains are larger than liaison domains; and the third column shows cases where liaison domains are larger. Typically columns 2 and 3 correspond to fast and slow rates rsp., but not always: both of 2M5's tokens, for example, are taken from his slow reading.

Consider the two tokens from speaker 2M5. In the first, *chocolats au lait* is realized as a single accent domain (-*lats* and *au* are both L-toned, suggesting that -*lats* does not end an accent domain). On the other hand, liaison is generally forbidden between nouns and PPs (and correspondingly does not apply here), indicating that this accent domain contains two separate liaison domains ((9)a). In the second token, liaison applies between *généreux* and *avocats*. But there are three H's distributed over these two words (*généreux* has both initial and final H), indicating that they form separate accent domains—i.e., liaison domains now appear to be *larger* than accent domains ((9)b).[7]

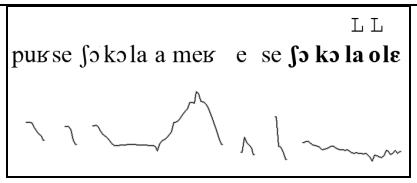
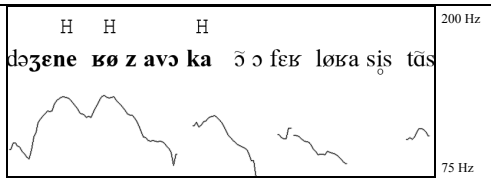
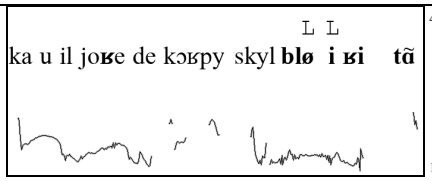
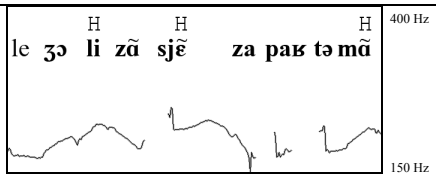
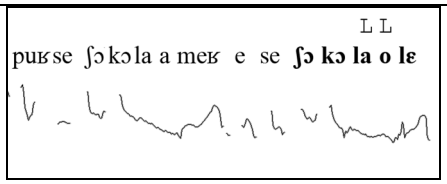
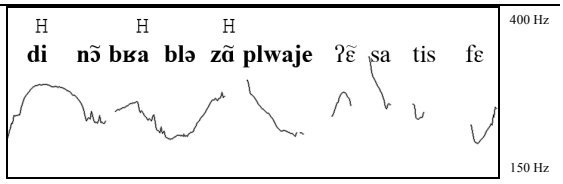
(9) a. *Accent:* (ses chocolats au lait)
Liaison: (ses chocolats)(au lait)

b. *Accent:* (de généreux)(avocats)
Liaison: (de généreux avocats)

[6] Data for Experiment 1 are based on 18 tokens containing 2-7 words, 7.24 avg. syllables/token. For Text A of Experiment 2 we analyzed 5 tokens containing 6-11 words, 15.20 avg. syllables/token; and for Text B we analyzed 6 tokens containing 5-9 words, 12.84 avg. syllables/token. Speakers 2F1, 2F2, and 2M1 in Experiment 2 read earlier versions of Texts A and B that did not include many of these tokens; these speakers are therefore excluded from Table 3.

[7] Jun and Fougeron (2002:156ff) point out that accent domains can end with L instead of H if (i) a final H is overridden by a L% 'intonational phrase' boundary tone; or (ii) a final H would otherwise be immediately flanked by two other H tones (HHH→ HLH). None of the relevant L tones in Table 4 appear to be produced under such conditions, nor do they display other signs of accent/stress (e.g. increased duration). Conversely, Jun and Fougeron show that an accent domain can have more than two initial H tones in case a sequence of 4+ L-toned syllables would otherwise result. Again, this is not what appears to be going on in Table 4. The second H-toned syllable in *jolis an**ciens** appartements* is lengthened considerably, suggesting that it bears a true domain-final accent rather than an extra initial accent, and the other examples do not appear to provide potential contexts for sustained lapses of this type.

Table 4. Domain Containment Reversals within Individual Speakers

	Accent > Liaison: two words form a single accent domain even though liaison is rare/forbidden between them	**Liaison > Accent:** liaison applies between 2+ words belonging to separate accent domains
2M5		
	pour ses chocolats amers et ses **chocolats au lait** 'for its bitter chocolates and milk chocolates'	de **généreux avocats** ont offert leur assistance 'generous lawyers have offered their assistance'
1F2		
	cas ou il y aurait des corpuscules **bleus irritants** '[in] case there are irritating blue corpuscles'	les **jolis anciens appartements** 'the pretty former appartments [of the king of Brittany]'
2F7		
	pour ses chocolats amers et ses **chocolats au lait** 'for its bitter chocolates and milk chocolates'	**d'innombrables employés** insatisfaits 'innumerable dissatisfied employees'

Note: Pitchtracks are scaled for duration; tokens that fill an entire column width are 2.25 s.

3. An Alternative Model: Different Stages of Rule Application

The examples presented in Table 4 show that at least some speakers treat liaison and phrasal accent as applying to distinct domains that are not consistently ordered with respect to each other. The result is a violation of one of the fundamental predictions of prosodic hierarchy theory (5).[8] Moreover, this is not an isolated finding. Hyman (1987),

[8] One might ask whether a uniform prosodic-hierarchy treatment could be preserved by distinguishing two separate hierarchical levels associated with liaison, one above and one below the phrasal-accent level (a potentially appealing possibility, since Selkirk (1986) independently posits separate levels for different kinds of liaison). The trouble is that in the current context, there would be no principled basis for this distinction—it is not the case that the larger domain would correspond to larger syntactic structures, or to less frequent liaison application, for example. Another way to maintain a uniform prosodic-hierarchy treatment might be to claim that liaison domains are always larger than accent domains, but that liaison is an *optional* rule that may or may not apply throughout a given domain (see Féry 2004 for a possible implementation). Under such a proposal, however, there would be no clear way to make any distinctions within the larger liaison domain, e.g. to account for why liaison is obligatory between determiners and nouns but forbidden between nouns and PPs; instead, any such patterns would go unexplained. Conversely, it might be possible to formulate a new tonal analysis of French, in which either the L tones in column 2 belong to separate domains or the H tones in column 3 belong to the same domain. The challenge would be figuring out how to allow these mismatches while preserving sufficient distinctions

for example, shows that domains for vowel shortening in Luganda are sometimes larger and sometimes smaller than domains for L deletion, resulting in another Layeredness-Headedness violation; interestingly, Seidl (2001:50) reports that the vowel-shortening rule is rate-sensitive while L deletion is not. A different kind of mismatch, corresponding to the constituent-sharing structure in (6)b, is found in both Xiamen and the closely related Haifeng dialect, where it is possible for tone sandhi domains to cross intonational boundaries without exhausting entire intonational phrases (Chen 1987:143). In light of these data, one might ask whether alternatives to the prosodic-hierarchy approach are available. Following Pak (2005), we adopt the proposal in (10):

(10) **Proposal:** Liaison and phrasal accent are fundamentally different kinds of rules, applying at different stages in the PF module. Phrasal accent belongs to a class of rules that apply late in PF—after heads have been chained together for input to the performance system—and can therefore be influenced by factors like tempo during online speech production. Liaison applies earlier in the derivation, before information about speech rate has become available.

According to (10), liaison and phrasal accent—while both 'phrasal rules' in a general sense—have a fundamentally distinct status in the grammar. This is not a new idea in itself: both Kaisse (1985) and Selkirk (1986) argue for distinct stages of rule application, with earlier rules operating either on the morphosyntax or on domains derived from it, and late rules guided by principles of 'fast speech' or 'phonetic implementation.' In more recent work, however, such hybrid treatments have been rejected in favor of the view that phonological rules apply *only* to the constituents in the prosodic hierarchy (Inkelas 1989). The alternative adopted in Hayes (1990) and Post (2000) is based on the idea that liaison is a *lexical* rule, generating allomorphs whose insertion is conditioned by potentially non-local syntactic information ('precompiled phrasal phonology'). While we share the basic intuition that liaison and phrasal accent apply at different stages, we do not endorse the notion of a 'lexicon' as a locus for phonological processes or combinatory operations.[9] In our treatment, both liaison and phrasal accent apply post-syntactically, and neither type of rule necessarily refers to the prosodic hierarchy in (3).

We assume that PF is a derivational component, in which a series of postsyntactic operations take place to convert hierarchical syntactic structures into phonetic strings. Following Embick and Noyer 2001, Embick 2005, we assume that PF operations include:

(11) a. a series of *linearization* operations, which (i) add information about left-adjacency relations to branching nodes in the syntax; (ii) augment (i) by establishing left-adjacency relations between pairs of heads ('concatenation'); and (iii) chain heads into longer strings for input to the performance system
b. *vocabulary insertion*, which inserts the phonological content of function morphemes (taken to be abstract feature bundles in the narrow syntax)
c. a set of highly constrained *movement/rebracketing* operations

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for a useful model of French intonation. We could not give up the idea that final accent is uniformly domain-final, for example, without also sacrificing a great deal of predictive power.

[9] See e.g. Marantz 1997 for arguments against the Lexicalist view.

The idea is that a given structure undergoes a series of changes in PF as the operations in (11) apply to it. Phonological rules apply at various stages in the derivation, so that a given rule is constrained by the structure as it exists at that particular point (see Seidl 2001 for another proposal in this spirit).[10] The two types of rules we distinguish here are crucially ordered before and after 'chaining' ((11)a-iii), the last of a series of linearization operations that strings heads together for input to the performance system. In the remainder of the paper we briefly lay out some possibilities for how liaison and phrasal accent might be analyzed under this hypothesis.

Our approach allows for a number of possible approaches to liaison. *(a)* To the extent that the end-based algorithm proposed in Selkirk 1986 makes correct predictions, it could be adopted in a modified form under (10) as well—i.e. we could posit an operation that inserts a boundary to the right of certain heads. *(b)* On the other hand, it is possible that there is no such operation, and that the strings in which liaison is possible are coextensive with certain kinds of spell-out domains or phases. *(c)* A third possibility is that liaison applies between (11)a-ii and (11)a-iii—i.e., to concatenated pairs of heads whose morphosyntactic features are still visible—so that it might be stated roughly as:

(12) **Liaison:** Associate an extrasyllabic final consonant to the preceding syllable in the environment ($\_\__D \frown X$), ($\_\__P \frown X$), ($\_\__A \frown X_N$), … (where $\frown$ is a binary concatenation operator establishing left-adjacency between two heads)[11]

In fact, some combination of possibilities (b) and (c) seems likely: learners distinguish among specific morphosyntactic features in applying liaison, but the rule is also constrained insofar as it does not cross certain syntactic boundaries, which may turn out to correspond to boundaries between spell-out domains (see Pak, in preparation, for further details).

Crucially, liaison will have already applied by the time information about speech rate becomes available, and thus will not vary under the same conditions as phrasal accent. We envision phrasal accent—along with other rate-sensitive rules and intonational phrasing in general—as the reflex of an operation that scans along a chained string of heads until it inserts a boundary. The resulting 'chunks' vary in size depending on rate, weight, and eurythmy, becoming larger in fast speech and slower in slow speech, perhaps for 'physiological reasons having to do with breath capacity' (Nespor and Vogel 1986:194). Boundaries of various strengths may be inserted; in French, for example, a 'strong' boundary (//) is associated with distinct boundary tone and optional pause, while a 'weak' boundary (/) delimits what we have been calling an accent domain.

(13) T-U-V-W-X-Y-Z … → T-U // V / W // X -Y-Z …

[10] Seidl distinguishes between rules that apply before and after morphological rebracketing ((11)c) but does not use rate-sensitivity as a primary distinguishing factor.

[11] We assume that certain roots and function morphemes in French are specified as having extrasyllabic final consonants. Liaison is then taken to be the first step of a three-step process; the second step deletes an unsyllabified consonant, and the third step (resyllabification) typically causes a coda consonant to become the onset of the following vowel-initial syllable (but not always; see e.g. (7)a).

Assuming some version of cyclic spell-out, it is also possible that the placement of intonational boundaries is circumscribed by the size of spell-out domains (or phases), as well as by the way that separate spell-out domains are linearized with respect to each other (see Pak, in preparation, for discussion). For example, it is possible that two spell-out domains that are sufficiently 'close' (in a way that remains to be defined) can be combined into a single chain, which is then broken down by rhythmic principles, resulting in pairs like *(une chose*$_{[H]}$*)(facile à voir)* vs. *(une chose*$_{[L]}$ *facile) (à récupérer)* ('an easy thing to see/get (rsp.)'; Dell 1984:91). Conversely, items like parentheticals might be introduced into the structure so late so that they interrupt the mechanism in (13), resulting in obligatory intonational breaks.

The viability of this general approach, in which intonational phrasing interacts with the mechanisms that linearize separate spell-out domains with respect to each other, rests on the empirical question of exactly how much structure rate-sensitive rules need to see—an important area of inquiry for future work. For the moment, we have laid the groundwork for an explanation for why some phrasal rules are rate-sensitive while others are not, a question that is not directly addressed within prosodic hierarchy theory. The apparent domain mismatches presented in this paper are accounted for naturally under the hypothesis that there are distinct stages of domain formation in PF. The proposal outlined here can be extended to similar hierarchy violations in other languages, and ultimately promises to shed light on the nature and ordering of PF processes.

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