Gradient behavior without gradient underlying representations:

the case of the French liaison consonant

1. Introduction. In French, some words ending in a vowel have a consonant-final variant before vowel-initial words (e.g. *petit* [pəti] ∼ [pətit] 'little-MASC' in (1a)). The consonants occurring at the end of consonant-final variants are called *liaison consonants*. Liaison consonants are challenging for phonological theory because they pattern ambiguously between stable word-final consonants (e.g. (1b)) and word-initial consonants (e.g. (1c)). For instance, in Québec French, before [i], the liaison consonant [t] has a rate of affrication that is intermediary between stable word-final [t] and word-initial [t] ((1); Côté 2014).

				Affricate realization (Québec French)
(1)	a. Liaison consonant	*peti*[t] *idiot*	'little-MASC idiot-MASC'	66.0%
	b. Word-final consonant	*peti*[t] *idiote*	'little-FEM idiot-FEM'	36.5%
	c. Word-initial consonant	[t]*imide*	'shy'	99.2%

In recent works, the gradient behavior of liaison consonants has been used to motivate different *underlying* representations for liaison consonants and non-liaison consonants, either via gradient underlying representations (Smolensky & Goldrick 2016) or lexical constructions. In these analyses, the liaison consonant is underlyingly specified as a blend between a stable word-final consonant and a word-initial consonant. It is further assumed to belong to both word 1 (W1) and word 2 (W2) or to a construction involving both W1 and W2.

2. Proposal. This paper argues that this move is not necessary. The gradient behavior of the liaison consonant can indeed be derived through constraint interaction while maintaining the two following assumptions: liaison consonants and non-liaison consonants have the *same* underlying representation and the liaison consonant *belongs only to W1*. The gradient behavior of liaison consonants essentially comes for free under the two following, independently motivated hypotheses:

(H1) Output-Variant (OV) correspondence (Kawahara 2002)
Variants of a word stand in correspondence with the base form of this word. OV-faithfulness constraints militate for the identity between these variants and the base form.

(H2) Bidirectionality of coarticulation in CV (Lindblom 1963, Sussmann et al. 1991)
A change affecting C in CV also affects V via coarticulation.

In a nutshell, these hypotheses predict that liaison consonants will be less protected against changes than stable final consonants (2.1) but more protected than word-initial consonants (2.2), explaining for instance the intermediary rate of affrication of liaison consonants in (1).

2.1. OV correspondence (=H1) provides a way to distinguish liaison consonants (1a) from stable final consonants (1b). Assume that there is an OV-faithfulness constraint requiring consonants in variants of a word to be featurally identical to the corresponding consonants in the base form of this word (=Ident_{OV}(C)). Assume further that the base form relevant for OV correspondence is the form occurring in isolation. For words with stable final consonants, the base form contains a word-final consonant (e.g. *petite* [pəti**t**] 'little-FEM'). However, for words with liaison consonants, the base form lacks a word-final consonant (e.g. *petit* [pəti(*t)] 'little-MASC'). Now suppose that a phonological process affects final consonants in the language (e.g. affrication turns final /t/ to [t^s] in (1a) and (1b)). Ident_{OV}(C) will be violated in words with stable final consonants (e.g. (1b)) but not in word variants with liaison consonants (e.g. (1a)), due to their base form lacking a final consonant. In general, stable final consonants will therefore be more protected against changes than liaison consonants, explaining why the rate of affrication is greater in (1a) than in (1b).

2.2. Together with OV correspondence, the bidirectional nature of coarticulation (=H2) provides a way to distinguish word-final consonants (e.g. (1a) and (1b)) from word-initial consonants (e.g. (1c)). Suppose that a phonological process affects all prevocalic consonants, whether within a word or across words (e.g. affrication turns /t/ to [t^s] before [i] in all (1a-c)). Due to the bidirectional nature of coarticulation (=H2), this process will also affect the following vowel. This vowel is the initial vowel of W2 in the case of final consonants (e.g. word-initial [i] in (1a-b)) and the vowel following the relevant consonant within the same word in the case of initial consonants (e.g. the [i] following word-initial [t] in (1c)). How could affrication affect [i] in (1)? There is evidence from Japanese that high vowels are more reduced spectrally after voiceless fricatives than after other consonants (Beckman & Shoji 1984). Assuming a similar spectral reduction after affricates/fricatives in Québec French, affrication actually involves the following mapping: /ti/ $\rightarrow$ [tˢi̥], where [i̥] is the spectrally reduced allophone of /i/. Now suppose that there is an OV-faithfulness constraint requiring vowels in variants of a word to be featurally identical to the corresponding vowels in the base form of this word (=Ident$_{\mathrm{OV}}$(V)). In case of a change affecting final consonants, this constraint is violated by the initial vowel of W2 because changing the final consonant of W1 entails changing also the initial vowel of W2 via (H2) (e.g. *idiot(e)* is realized as [i̥]*diot(e)* after [tˢ] in (1a) and (1b), in violation of OV faithfulness, which requires [i]*diot(e)*). However, in case of a change affecting word-initial consonants, Ident$_{\mathrm{OV}}$(V) is not violated: if a process like affrication has already happened in the base form, there is no way for OV faithfulness to block it (e.g. *timide* is already realized as [tˢi̥]*mide* in the base). In general, final consonants will therefore be more protected against changes than initial consonants, explaining why the rate of affrication is smaller in (1a) and (1b) than in (1c).

3. Application. The model captures the gradient behavior of the liaison consonant at a conceptual level but can it also match the specific frequencies of affrication in (1)? To test this hypothesis, we fit the grammatical model described above to Côté's count data using Maxent (Hayes & Wilson 2008). In addition to the two OV faithfulness constraints discussed above, there is one markedness constraint *ti that drives affrication. (We leave aside the constraint that motivates insertion of the liaison consonant, arguably *VV, because no information is provided about the frequency of realization vs. non-realization of the liaison consonant in the data.)

/(t)#i/	*ti $w = 4.86$	Ident$_{\mathrm{OV}}$(C) $w = 1.23$	Ident$_{\mathrm{OV}}$(V) $w = 4.19$	H	Freq
[ti]	1			4.86	.34
[tˢi̥]			1	4.19	.66

(a) Liaison consonant (Base$_{\mathrm{W1}}$=[...V#], Base$_{\mathrm{W2}}$=[#i...])

/t#i/	*ti $w = 4.86$	Ident$_{\mathrm{OV}}$(C) $w = 1.23$	Ident$_{\mathrm{OV}}$(V) $w = 4.19$	H	Freq
[ti]	1			4.86	.64
[tˢi̥]		1	1	5.42	.36

(b) Stable word-final consonant (Base$_{\mathrm{W1}}$=[...t#], Base$_{\mathrm{W2}}$=[#i...])

ti	*ti $w = 4.86$	Ident$_{\mathrm{OV}}$(C) $w = 1.23$	Ident$_{\mathrm{OV}}$(V) $w = 4.19$	H	Freq
[ti]	1			4.86	.01
[tˢi̥]				0	.99

(c) Word-initial consonant (Base=[tˢi̥...])

Now we assume that the candidate with affrication also features a change in vowel quality. (We leave aside the constraint that motivates bidirectional coarticulation because no information is provided about the frequency of [i] vs. [i̥] allophones). Constraint violations of candidates [ti] and [tˢi̥] are shown in Tableaux (a-c) for the three relevant conditions. The intermediary status of the liaison consonant appears clearly in the violation profiles of faithfulness constraints.

For each model parameter (i.e. constraint weights and candidates' harmony scores), Tableaux (a-c) show the mean of their posterior distribution as estimated by a Bayesian logistic regression implemented in Rjags. The tableaux also show the predicted frequencies for the two candidates in each condition. These frequencies perfectly match the attested frequencies ($r^2 = 1$).

4. Conclusion. It is possible to maintain conservative assumptions about the liaison consonant while still explaining its gradient behavior. Two independently motivated hypotheses (output-output correspondence, bidirectionality of coarticulation) played a key role in the explanation. The paper concludes by showing that the analysis can be extended to deal with other properties of liaison consonants, in particular the fact that they disfavor high vowel laxing (cf. *pet*[it] *idiot* vs. *pet*[ɪt] *idiote*) and that some vowel-initial W2 (*h-aspiré* words) disfavor liaison consonants in W1.