Integrating phonological and non-phonological factors for a comprehensive model of liaison realization

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Liaison is a sandhi phenomenon in French by which a latent consonant at the end of one word (W1) is realized at the beginning of the next word if the second word (W2) begins with a vowel. Delattre (1966) proposes a typology consisting of three different liaisons: blocked liaison as in (1); obligatory liaison as in (2); and variable liaison as in (3).

(1) *l'enfant arrive*	/lã.fã a.ʁiv/ → [lã.fã.a.ʁiv]	'the child arrives'
(2) *nous allons*	/nu(z) al.ɔ̃/ → [nu.za.lɔ̃]	'we go'
(3) *nous **sommes allés***	/sɔm(z) a.le/ → [sɔ.ma.le] OR [sɔm.za.le]	'we went'

Many analyses of liaison up to this point are based largely on Delattre's typology with few modifications despite diachronic shifts that have happened since, as well as advancements in our methodologies and the data we can now access. In a reconsideration of liaison typology, Laks and Peuvergne (2017) find some decline in the realization of obligatory liaison, in addition to rapid shifts in the proposed categories of variable liaison, ultimately finding some permeability between the well-established categories. These findings underpin the importance of refining and shifting the established categories. Delattre's typology relies solely on the grammatical categories of W1 and W2; however, more recent work has shown that liaison is affected by other morphosyntactic factors, such as phrase structure (Selkirk 1980; Laks 2005); lexical factors (some expressions always elicit liaison *de temps_en temps*); sociolinguistic factors including speaker age, sex, level of education, socioeconomic status, and linguistic register (cf. Durand and Lyche 2008 for a more detailed overview of these factors).

In this paper, we propose a revised model of liaison that integrates both phonological and non-phonological factors. Our model not only allows for a more holistic picture of liaison realization but also some degree of porosity between the preestablished categories. Building upon this new model of liaison, we propose an analysis of its realization formalized within the lens of maximum entropy (MaxEnt) grammar (Goldwater and Johnson 2003) to exploit the flexibility and permeability of new approach. MaxEnt is a constraint-based theory of grammar similar to Optimality Theory (OT); however, unlike OT which ranks its constraints in hierarchies of strict domination in which C_1 dominates C_2 which in turn dominates C_3, MaxEnt allows for a gradient constraint ranking, by which constraints are assigned a numerical weight via an online error-driven machine learning algorithm. It has been suggested that the gradience afforded by theories of weighted constraints allows for the grammar to capture phonologically variable structures – an area of great difficulty for many other formal analyses. Moreover, recent advancements in theories of weighted constraints also allow for the incorporation of extraphonological factors (such as syntactic and sociolinguistic factors) into the grammar as a means of scaling the weight of faithfulness constraints along the lines of the respective variables (Coetzee 2016). We believe that such a framework that can quantitatively account for liaison realization while also accounting for pertinent extraphonological factors may shed some necessary light on our understanding of this complex phenomenon and the need for a new typology.

Data for this study come from the *Projet phonologie du français contemporain* corpus (PFC; Durand, Laks, and Lyche 2002). A total of eight survey points were selected: four each from Northern France and Southern France. Data were first subject to descriptive statistics before being fit to a series of generalized linear mixed-effects regression models in R which sought to predict liaison realization from combinations of the linguistic and sociolinguistic factors available in the PFC. The purpose of the regression model was to select the appropriate scaling factors to be incorporated into the constraint-based grammar.

The results of this model were then used to inform the formal analysis. We begin with the Optimality-Theoretic grammar of liaison realization proposed by Eychenne (2011) as a point of departure. Eychenne's analysis appeals to markedness constraints on syllable well-formedness (specifically ONSET and NOCODA), alignment constraints, and faithfulness constraints (MAX) that militate against consonant deletion. Coetzee (2016) argues that in the case of phonological variation, nonphonological factors influence speakers' tendencies towards faithfulness: the phonological grammar defines what patterns are possible, while the scaling factors determine how a structure varies within the limits established by the grammar. For this analysis, since older speakers tend to realize more liaisons, a positive scaling factor for speaker age is exerted on the series of MAX constraints to maximize their role in the grammar. We also find that the MAX constraints are weighted more heavily in the north than in the south. The syntactic categories of W1-W2 and the lexical frequency of W1 were also taken into consideration.

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