Relation entre production et traitement de la liaison en français contemporain

Relationship between the production and processing of liaison in contemporary French

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Résumé

Cet article passe en revue l'état de l'art du traitement de la liaison française et discute la littérature existante dans les domaines de la production et de la perception. Nous soutenons que les études de corpus au cours des dernières décennies ont considérablement changé l'approche empirique et théorique de la liaison, en ouvrant de nouvelles questions sur des phénomènes jusque-là inexplorés; toutefois, dans le domaine psycholinguistique, la liaison est encore vue presque exclusivement comme un problème pour la segmentation des mots et pour la représentation mentale des consonnes de liaison. Nous esquissons ensuite un plan de recherche future dans la neuro-cognition des phénomènes de liaison, en discutant de la contribution des potentiels évoqués pour notre compréhension de la façon dont les locuteurs traitent différents types de liaisons en contexte.

Mots-clés

Liaison, traitement cognitif du langage, potentiels évoqués, variation linguistique, français contemporain

Abstract

This article reviews the state of the art of the processing of French liaison and discusses the existing literature in the domains of both production and perception. We argue that corpus studies in recent decades have substantially changed the empirical and theoretical approach to liaison and have opened new questions on previously unexplored phenomena; nevertheless, within the psycholinguistic domain liaison is still viewed as a problem for word segmentation and the lexical representation of liaison consonants. We then sketch a plan for future research in the neuro-cognition of liaison phenomena, discussing the contribution of event-related potentials for our understanding of how the speakers process different types of liaisons in context.

Keywords

1. INTRODUCTION

From a formal point of view, liaison is an *enchaînement* process by which the final consonant of a word is resyllabified as the onset of the following word when the two words pertain to the same prosodic constituent: *les amis* [le.za.mi] 'the friends' is formally equivalent to *l'ami* [la.mi] 'the friend' or *chaque ami* [ʃa.ka.mi] 'each friend'. Again in a formal description of the rule, resyllabification is blocked when the following word begins with a consonant, as in *chaque garçon* [ʃak.gaʀ.sɔ̃]; in this case, the liaison contexts show a slightly divergent behavior to the extent that the final consonant of the first word is not pronounced (*les garçons* [le.gaʀ.sɔ̃] and not *[lez.gaʀ.sɔ̃]), which makes the liaison consonant a phonologically "special" object of representation (Encrevé 1988, Scheer 2015).

The quantitative turn in linguistics (Joseph 2008) and the rise of corpus linguistics have radically changed the way liaison is described and understood. The strongest change perhaps concerns the analysis of the conditions in which liason could but does not apply, or does not apply as regularly as the formal rule above would predict. Why do French speakers say *est allé* 'he went' or *est encore* '(he/she) still is' with liaison less than 40% of the time (Laks et al. 2018: 294), even though the second word begins with a vowel? And why do they produce liaison only 18% of the time in the case of *étaient allés* '(they) had gone' or *étaient encore* 'they still were', despite the fact that *étaient* is a inflected form of the verb 'to be', just as *est* is?

By showing that liaison production is constrained by a multiplicity of factors, encompassing almost all grammatical levels (from orthography to prosody, phonetics, morpho-syntax, pragmatics and the lexicon) and dimensions of external variations (ranging from the speakers' social status to geography, diachrony and literacy levels), corpus studies have proposed that the complex phenomenology of liaison processes is better understood in terms of a probabilistic system of linguistic and extra-linguistic constraints (Bybee 2001 and 2005; Durand et al. 2011; Chevrot et al. 2011; Hornsby 2012 and 2020; Laks et al. 2014; Barreca & Christodoulides 2017, Pustka et al. 2022, among many others).

Crucially, as Bod (2010) explains, the study of frequency and gradience in language naturally leads to (or requires) a probabilistic view of linguistic knowledge. It is undeniable that frequency and gradience as they can be observed in synchronic variation impact language acquisition, perception, comprehension, production and the development of metalinguistic knowledge (together with diachronic change). Consequently, probabilistic linguistics sees the dynamics of language acquisition and language use as the unconscious computation of statistical generalizations over multiple input, generating a continuous updating of knowledge (expressed in terms of linguistic 'exemplars' or 'episodes', Goldinger 1998; Pierrehumbert 2001) in a multidimensional cognitive space allowing detailed storage of linguistic knowledge.

As widely accepted, the most challenging and still unsolved question is whether and to what extent usage-based models of language processing are psychologically plausible. As correctly pointed out by Kortman (2021), a strictly related issue is that of understanding if the patterns of variation emerging from corpora can be taken as direct evidence of what is going on in speakers' mind. The risk is that of taking average data computed over large amounts of tokens as the mirror of the behavior of an individual speaker (or of a group of speakers).

In this paper, we will see that although the corpus study of liaison has increased exponentially over the last decades, leading to a renovated and more realistic account of the linguistic phenomena, the cognitive study of liaison has not progressed to the same extent. In other words, the existing psycholinguistic literature basically appears to be still oriented by the same questions as those that the formal account of liaison as a peculiar resyllabification process already raised. Questions such as how optional liaison is cognitively represented and stored, or how speakers cope with the few construction types accounting for obligatory liaison at the same time as handling the enormous amount of construction types that allow optional liaison, still seem to be beyond the scope of current psycholinguistic research. The distinction itself between mandatory (or categorical), optional (or variable) and prohibited (or 'erratic') liaison (Delattre 1947) has never undergone any kind of verification as far as its psychological plausibility is concerned. Starting from similar observations, the second part of this paper will suggest new research directions and motivate the choice of a neurophysiological approach to the study of liaison in order to start filling in these gaps.

2. THE PSYCHOLINGUISTIC STUDY OF FRENCH LIAISON

Given what has been pointed out at the beginning of the previous section, it is not surprising that French liaison has provided an excellent testing ground for theories of lexical access and, in particular, for an evaluation of the role of syllabic representations in word recognition. To the best of our knowledge, the earliest studies in this respect date back to the eighties and nineties (Matter 1986; Dejean de La Bâtie & Bradley 1995; Wauquier-Gravelines 1996; Yersin-Besson & Grosjean 1996).

As Spinelli and Meunier (2005) show, the focus of much psycholinguistic research targeting French liaison has been on whether words preceded by a liaison consonant (e.g. *italien* in *généreux italien* 'generous Italian') are less well recognized compared to when they are preceded by a vowel-final word, that is, in a context that does not blur word boundaries (e.g. in *chapeau italien* 'Italian hat'), and also compared to when they are preceded by non-liaison *enchaînement* consonants (e.g. in *virtuose italien* 'Italian virtuoso'). The hypothesis was that liaison (with *enchaînement*) makes the recognition of the beginning of the word slower, thus impairing the lexical access of vowel-initial words. This hypothesis was based on the observation, supported by an extensive literature on French and other languages, that the syllable is a fundamental unit in speech perception and that word beginnings that are misaligned with syllable structure (as in liaison contexts) are disfavoured in lexical access (e.g. Mehler et al. 1981; Norris et al. 1997).

A large body of experimental evidence has been collected that does not in fact support such a hypothesis (see Spinelli & Meunier 2005 for a review). Overall, phonological variation associated with liaison does not appear to slow down speakers' reaction times in the recognition of vowel-initial words, nor to make their judgements less accurate. Quite on the contrary, speakers have no difficulty in identifying vowel-initial words when they are presented in a liaison context. In Gaskell et al. (2002) study, liaison and *enchaînement* were shown to even facilitate word recognition: for instance, the target word *italien* was recognized faster when preceded by *généreux* 'generous' (liaison context) or by *virtuose* 'virtuous' (*enchaînement*) compared to when it was included in a syllable-aligned context (as in *chapeau italien* 'Italian hat'). The same is found in children starting from 24 months of age (Babineau & Shi 2014 and 2016; Babineau et al. 2021), thus suggesting that liaison acquisition occurs relatively early, at least as far as its effects on word identification are concerned (segmentation errors and omissions/over-generalizations in production are often reported for pre-school children, e.g. Dugua et al. 2017).

According to many authors, French speakers exploit additional cues beyond syllabic alignment to correctly recover a word's identity. Potentially ambiguous contexts such as [pətitami], which could match both *petit ami* 'small friend' (with liaison) and *petit tamis* 'small sieve', are disambiguated by a mix of lexical and sub-lexical factors. Lexical factors refer to the speakers' knowledge of what a potential word in French is, how frequent it is in speech, how frequently it co-occurs with other words etc. Among the sub-lexical factors, acoustic detail is thought to play a major role. More specifically, listeners are believed to be sensitive to subtle phonetic cues that make a liaison consonant acoustically different from a corresponding consonant in word-initial position and this is assumed to contribute to correct lexical parsing and accurate word recognition in spite of the misalignment between syllables and word edges in liaison contexts (e.g., Tremblay & Spinelli 2014b). Another source of sub-lexical information that is hypothesized to help speakers in word segmentation is the distributional information related to the probability that each individual consonant appears as a word onset or as a liaison consonant in the lexicon.

The hypothesis of an acoustic marking of liaison consonants is supported by experimental evidence produced by a relatively small but consistent group of studies. The hypothesis is theoretically plausible considering that word-initial segments tend to be lengthened and articulatorily strengthened as a consequence of a universal tendency to phonetically mark prosodic domains (e.g. Fougeron 2001; Cho & Keating 2001). If lexical word-initial consonants are lengthened, liaison consonants escaping prosodic-induced lengthening should be shorter than lexical word-initial consonants. This is precisely what some studies have reported, although with some variation in the data.

One factor of variation is the type of consonant. For instance, according to Wauquier-Gravelines (1996) (cited in Nguyen et al. 2007) [n] shows the same acoustic duration when it appears in a liaison context (e.g. *son avion* 'his/her plane') and when it is the first consonant of a word (e.g. *son navire* 'his/her ship'), but in the case of [t], a liaison consonant is significantly shorter than a matched word-initial

consonant (average values: 50 and 70 msec respectively). Tremblay and Spinelli (2014a) found a different picture: [z] was significantly shorter in a liaison context compared to a lexical word-initial context, whereas no difference was found when the same comparison concerned [t]. Again differently, Spinelli et al. (2002) found that in 96 two-word phrases produced by one native French speaker, [t] in liaison contexts (such as *petit agneau* 'small lamb') was significantly shorter (15%) than [t] in illegal liaison contexts (such as *demi t agneau* 'half t lamb') and also shorter than [t] in non-liaison *enchaînement* contexts (such as *mérite agneau*, 'merits lamb'). Although these data suggest that there might be acoustic-phonetic cues to liaison, it should be noted that the illegal liaison contexts and the non-liaison *enchaînement* contexts were meaningless and syntactically incorrect phrases whereas the liaison contexts were meaningful phrases. Therefore, it cannot be ruled out that performance dynamics related to frequency factors, rather than the different lexical status of the consonant, caused the observed phonetic effects, since word frequency is highly inversely correlated to acoustic duration (Gahl 2008, among many others). Lastly, a shortening of liaison consonants compared to lexical word-initial consonants (e.g. in *dernier oignon* as compared to *dernier rognon*), also amounting to 10-17% (depending on specific subcorpora), was found by Spinelli et al. (2003) too. However, as in the other studies reviewed so far, the speech materials used for the measurements consisted of a list of experimental stimuli developed for a series of lexical access experiments. Although the list included some fillers, the speaker might have emphasized the pronunciation of lexical word-initial consonants (in e.g. *dernier rognon*) as a reaction to the presence of lexically different but theoretically homophone stimuli (such as *dernier oignon*). Thus the question arises of whether it is possible to generalize these findings to speech produced in more naturalistic contexts. A similar reasoning applies to the acoustic data in the study by Gaskell et al. (2002), where the small size of the dataset and the lack of phonetic balancing in the context surrounding the target consonants are an objective empirical limitation.

Other studies have found no duration differences between liaison consonants and lexical word-initial consonants. For instance, in Yersin-Besson and Grosjean (1996) the duration ratio between [n] in *son oeuf* 'his egg' (liaison context) and [n] in *son neuf* 'new sound' (lexical word-initial nasal) was close to 1, suggesting an almost identical duration in the two contexts. In Nguyen et al. (2007), a liaison consonant, which could be [z] or [n], was found not to differ in duration from a corresponding consonant in word-initial position. When the preceding vowel was analysed, the same result was found. The dataset was slightly bigger and phonetically more controlled than in the studies mentioned above, but the measurements were still taken from a corpus of 20 pairs of sentences which were repeated 5 times by only one speaker. Babineau et al. (2017) also reported variable and inconsistent differences in the acoustics of liaison and non-liaison consonants, leading to the conclusion that French adults do not use disambiguating liaison-related acoustic cues in identification/segmentation tasks involving potentially ambiguous liaison contexts.[1]

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[1] In a couple of studies in which the durational difference between liaison and non-liaison consonants was said to play a role in facilitating the correct parsing of ambiguous sequences, consonant durations were

As anticipated above, phonotactic preferences have also been assumed to play a role in lexical access. Some studies have shown that native French listeners use distributional cues to segment liaison-initial words in speech (Tremblay 2011; Tremblay & Spinelli 2013); English learners of L2 French apparently do the same (Tremblay & Spinelli 2014a; Tremblay et al. 2018). For instance, one distributional preference consists in the fact that although both [z] and [t] are potential liaison consonants in French, [z] is much more frequent as a liaison consonant than as a word-initial consonant, whereas [t] is much more frequent as a word-initial consonant than as a liaison consonant. The reasoning is that the probability of occurrence of consonants in liaison and word-initial contexts could contribute to determining the accuracy with which speakers segment liaison-initial words in speech. In a series of eye-tracking studies, when the ambiguous stimuli contained [t], both native and non-native speakers showed higher proportions of eye fixations to consonant-initial words (e.g. *parfait tableau* 'perfect painting') than to liaison-initial words (e.g. *parfait abri* 'perfect shelter'), but they showed the reverse pattern when the stimuli contained [z] (Tremblay 2011; Tremblay & Spinelli 2013). In the acoustic domain, the stimuli displayed the same pattern already mentioned by Tremblay and Spinelli (2014a), i.e., liaison [z] was significantly shorter than lexical word-initial [z] but liaison [t] had the same duration as lexical word-initial [t]. The authors then concluded that in certain conditions acoustic and distributional cues 'work together' in resolving segmentation ambiguities, but in other conditions the distributional cues are strong enough to impact on word processing even in the absence of concomitant acoustic cues.

In sum, the evidence supporting the hypothesis of an acoustic marking of liaison consonants and its role in word segmentation comes from a non-negligible set of studies, and should be considered with attention. On the other hand, the datasets analysed are small, the phonetic context surrounding the target consonants is not always perfectly controlled and the lexical stimuli are limited to minimal or quasi-minimal pairs, which can lead to hyper-differentiation in production (Baese-Berk & Goldrick 2009). Large-scale and well-designed acoustic studies would therefore be needed to ascertain if the observed durational differences are also present in spontaneous conversational speech.

Moreover, it should be noted that the research reviewed thus far has mostly focused on the temporal parameter: the analyses have concerned the duration of the target consonant and, in some cases, of the preceding vowel (very rarely on the VOT: Dejean De La Bâtie 1993; Wauquier-Gravelines 1996). The relative duration of consonants and preceding vowels has also been taken into account (Tremblay &

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manipulated so as to increase the difference between the two contexts (Shoemaker 2014; Gustafson & Bradlow 2016). Manipulations produced stimuli whose durations were still within the range of variation which was attested in the naturally recorded stimuli, and the studies showed that, when lexical ambiguity is maximal (as in les ailes 'the wings' vs. les zèles 'the zeals'), speakers may rely on such exaggerated acoustic differences to correctly assign the word to either category of vowel-initial or consonant-initial words.

Spinelli 2014b). It is however possible that other acoustic parameters in addition to duration play a role in distinguishing liaison contexts from lexical sequences and that some of them span over units that are larger than the segment. This is what Coquillon and Astésano, in an unpublished study (2008), suggest: their analysis of the speech of one speaker from Marseille shows that there is a different f0 pattern in the liaison and non-liaison context (steeper f0 slope from the consonant to the following vowel in non-liaison contexts).[2] Non-durational and non-local acoustic cues such as the relative intensity of segments and the micro-prosodic contour of the surrounding syllables could therefore be usefully investigated in the future. However, the elicitation context is crucial, not only for a reliable acoustic study of local and non-local cues, but also to ascertain whether speakers do rely on such fine-grained acoustic information in the processing of words and word chunks in natural speech production interaction. More ecological paradigms of investigation should therefore be elaborated.

Already in 2013, Wauquier and Shoemaker noted that "the vast majority of psycholinguistic investigation deals with contexts of obligatory liaison". Ten years later, the situation does not appear to have changed.

3. POSSIBILITIES FOR A NEURO-COGNITIVE APPROACH TO FRENCH LIAISON

In the second part of this chapter, we propose new research directions and motivate the use of a neuro-physiological approach to shed light on how speakers cope with the processing of liaison variation. Many of the following reflections are at the origin of an ongoing neuro-physiological study of French liaison (Celata, De Flaviis, Floquet, Laks and Isel, in preparation) in which native adult speakers are asked to listen to a short text in which different types of liaison are produced according to the contemporary norm *and* erroneously (i.e., non-realization of mandatory liaisons, realization of forbidden liaisons, and dispreferred realizations of optional liaisons). As we will discuss below, an analysis of how the speakers process in real time liaison *violations* (as compared to 'correctly produced' liaisons) might be a powerful window into how different types of liaison, including optional liaisons, are cognitively represented, which in turn might lead to significant advances in our understanding of the variability of liaison phenomena in production.

Over the past forty years, the use of electroencephalography (EEG) with event-related brain potentials (ERP) in the cognitive neuroscience of language (see Kutas & Hillyard 1980 for a seminal study) has allowed us to make considerable progress in our understanding of the neuro-cognitive processes underlying different language activities such as comprehension (processing), production, or acquisition in human

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[2] An attempt at characterizing liaison consonants in terms of their articulatory dynamics can be found in Grosson's (2011) acoustic and EPG study of [z] and [n]. The study shows that the latency between the acoustically defined vowel centre and the EPG-defined consonant centre is smaller in the case of liaison consonants, which is not unexpected given the shorter acoustic duration of liaison consonants. The EPG profile of [n] in liaison contexts also reveals a slightly lower linguopalatal contact, compared to non-liaison contexts.

beings (Friederici, 2011; Kutas & Federmeier, 2011 for reviews). The success of EEG in psycholinguistic studies of written or spoken language processing lies in its ability to trace and to disentangle *in real time* different cognitive processes whose chronometry is in the millisecond range.

Spoken and written sentence comprehension requires rapid integration of multiple sources of linguistic information such as phonological, morphological, syntactic, semantic, and lexical information conveyed by meaningful linguistic units of different sizes (i.e., word, sentence, text) (Isel et al., 2007). EEG makes available the crucial timing to study the interplay between the various cognitive processes responsible for these multiple sources of linguistic information (Isel et al., 2007). Moreover, this recording technique makes it possible to decide whether these processes work sequentially or in parallel, and whether they interact, by taking into consideration the exact moment in the ongoing stimuli at which this interplay occurs. Consequently, EEG makes it possible to differentiate the early *versus* the late stage of processing for a given language process. EEG is therefore particularly useful for investigating multifaceted language phenomena in very short segments of the speech signal. This is the case with French liaison.

Let us now see how ERP markers can provide crucial evidence about the mechanisms involved in the processing of liaison consonants as a function of the typology of the liaison referred to at the beginning (categorical, variable, and prohibited liaison). Based on previous neurocognitive models of language comprehension which describe ERPs as reflecting different levels of linguistic analysis (see Friederici, 2002, 2011; Isel 2017; Isel & Kail, 2019 for reviews), it is possible to ask whether liaison processing involves lexical (N400), syntactic (ELAN/P600) or morphosyntactic (LAN/P600) analysis. Before describing the lexical, syntactic and morphosyntactic ERP components, we first introduce an ERP component usually assumed to mark phonological processes, namely, the mismatch negativity (MMN). Usually, MMN occurs shortly after 100 ms and is thought to reflect the discrimination of acoustic and phonemic categories (Näätänen et al., 1997; Näätänen et al. 2007). Using an oddball paradigm (standard/deviant), MMN is generally elicited by a small change in the acoustic stream. This suggests that MMN may indicate an automatic mechanism of auditory change detection (Garrido et al. 2009). The elicitation of MMN has been interpreted as discordance between the new auditory input and the sensory-memory trace of the standard stimulus. The MMN is therefore thought to reflect a preattentive memory-based comparison by which listeners detect changes in their environment (Näätänen et al. 1989). This comparison mechanism is determined by both the salience of the acoustic change and the expertise that listeners have in processing a specific auditory stimulus. The MMN peaks at about 100–250 ms from change onset and is fronto-centrally distributed; it exhibits the strongest intensity in temporal and frontal areas of topographic scalp maps. Its neural generators are located in both temporal (the auditory cortex) and frontal areas (the prefrontal cortex) (Näätänen et al. 2001). The underlying brain mechanisms are assumed to be automatic, as the MMN has been found in sleeping participants or patients in a coma (Martynova et al. 2003). Schirmer et al. (2005) showed that the easier a stimulus is to discriminate, the earlier

and larger the MMN is. Therefore, the MMN represents a useful objective tool to study early sensory processes elicited by speech change.

Under certain conditions, the MMN response is followed by a positive-going ERP deflection, i.e., the P3a, peaking at 250–300 ms after stimulus onset (Paavilainen et al. 1989), which serves as an additional marker of change detection (Schröger & Wolff 1998). The P3a was initially observed in active target detection paradigms by comparing ERPs in response to targets and non-targets (Sutton et al. 1965). P3a is thought to reflect a reorienting or a covert shifting of attention (Friedman, et al. 2001). It is typically regarded as marking involuntary orientation of attention toward the deviant stimulus in oddball paradigms (Parmentier 2013).

To the best of our knowledge, no ERP studies have investigated the processing of liaison phenomena in French. A recent oddball MMN study (Do Carmo-Blanco et al., 2022) aimed to examine the oscillatory correlates of homophone perception in French. These authors used the first syllable of French homophonous nominal utterances such as *la locution* [la#lɔkysjɔ] as opposed to *l'allocution* [l#alɔkysjɔ]. These syllables differ in non-contrastive subphonemic features, such as pitch and duration. The results showed that subphonemic deviance elicited intertrial phase coherence (ITC) differences in the theta band (5-12 Hz) at the Fz electrode site in the classical MMN time window. It should be noted that phase coherence across trials can be measured through ITC, which reflects the extent to which oscillation phase values in a particular frequency and time point are consistent over trials. Do Carmo-Blanco and colleagues (2022) proposed that the processing of subphonemic deviation in speech signals reflected by the MMN, might rely on mechanisms of phase resetting. ITC might facilitate the synchronous firing of functional networks involved in the processing of subphonemic deviance. In sum, MMN could be fruitfully used not only to clarify the impact of fine-grained phonetic detail in the processing of liaison consonants as previous behavioral research has already done (see above), but also to establish if the auditory detection of a liaison consonant in a context in which liaison is forbidden or statistically dispreferred is perceived as a phonological error or not.

According to a classical view (e.g. Gougenheim 1938; but see Laks 2005 for a criticism), French liaison is particularly frequent in plural /s/-ending nouns, adjectives and pronouns and therefore it should be at least partly interpreted as a morphosyntactic rule marking plural forms in the sentence. It follows from this view that a violation in liaison production (for instance, the cancellation of a mandatory or very frequent liaison consonant) could increase the processing cost of recognizing the (morpho)syntactic category of the word. This hypothesis is more specific and narrower than the hypothesis examined so far that resyllabification in obligatory liaison contexts increases the processing cost of vowel-initial word recognition (see above). A neurophysiological approach can provide the means to test this additional possibility. Specifically, the Early Left Anterior Negativity (ELAN) may be a good candidate to verify if liaison helps (or perturbs) the recognition of the syntactic category of words. Traditionally, ELAN is viewed as the first sentence-level ERP component correlating with the identification of the syntactic category of a word (e.g., verb, noun, preposition etc.) (Friederici, 2011). ELAN occurs in response to a word category violation 120–200 ms after word onset or after the part of the word

which provides the word category information (e.g., the inflection as in *refine* versus *refinement*). According to Friederici (2002), based on this word category information, the initial local phrase structure can be built (e.g., verb phrase, noun phrase, prepositional phrase). Importantly, the latency of the ELAN correlates with the location of the word category identification point in the critical word.

Moreover, the processing of morphosyntactic violations is usually associated with a biphasic electrophysiological pattern (Left Anterior Negativity – LAN, 300–450 msec and P600 after 500 msec; for a review, see Isel & Kail, 2018; Molinaro et al. 2011). While the LAN is thought to reflect an early detection of morphosyntactic mismatch, the P600 is assumed to mark controlled processes of syntactic reanalysis and repair (for a review, see Friederici, 2011). The functional interpretation of the P600 has changed to some degree over the past years. Initially, it was taken to reflect syntactic processes in general (Hagoort et al., 1993), processes of syntactic reanalysis and repair (Friederici et al. 1996), or the difficulty of syntactic integration (Kaan et al. 2000). However, later studies found the P600 to vary not only as a function of syntactic variables, but also to reflect the interaction of syntactic and semantic anomaly at the sentence level (Gunter et al. 2000 among others), suggesting that the P600 might reflect sentence-level integration processes of syntactic and semantic information. More recently, the functional role of the P600 was challenged by studies reporting P600 effects for sentence-level semantic violations (Kim & Osterhout, 2005 among others). For example, sentences like *The hearty meal was devouring* led to a P600 (Kim & Osterhout, 2005). Different explanations were put forward for "semantic P600" effects: plausibility/semantic attraction between the verb and an argument (Kim & Osterhout, 2005), thematic processing cost (Hoeks et al., 2004), and interaction of thematic and semantic memory (Kuperberg et al., 2007). Recently, DeLong et al. (2014) proposed that a parietal post-N400 positivity (PNP) may be linked to reanalysis or repair following impaired interpretation due to syntactic or semantic incongruity. In contrast, the more anterior late positivity may relate to violations of lexical predictions involving semantically congruent (plausible) substitutions. Concerning liaison, the neural correlate of a syntactic-semantic incongruity could arise in sentences in which a mandatory liaison is not produced as expected: for instance, if *nous avons* 'we have' or *dans une (heure)* 'in one (hour)' were produced without liaison. In these cases, the presence of a liaison consonant in the phonetic output is an obligatory marker of the syntactic category of the first word (either pronoun followed by verbal form, or preposition followed by a determiner, respectively).

However, a semantic incongruity could also arise in sentences in which a frequent, but not mandatory, liaison is not produced as expected: for instance, *quatrième aux Jeux Olympiques de Berlin* 'fourth in the Berlin Olympic Games' would not sound ungrammatical to a native French listener if it was produced without the expected liaison between *Jeux* and *Olympiques*: it would simply be interpreted as containing the singular noun *Jeu Olympique*, 'Olympic Game', which is rather unusual at the semantic and pragmatic level. *Jeux Olympiques* is a good example of those lexical chunks or 'frozen' constructions stored as such in the mental lexicon (Bybee 2005). If this is the case, then a modulation of the amplitude of the N400, rather than LAN - P600, should be expected when the liaison is not

canonically realized. The N400 component is a negative-going component at posterior sites peaking at around 400 ms after stimulus onset. In psycholinguistics, this well-known lexical-semantic ERP was reported in the seminal study of Kutas and Hillyard (1980). It was shown that the visual processing of a semantically incongruous final word in English sentences, for instance the word *socks* in **He spread the warm bread with socks* elicited a larger negativity with a maximum voltage around 400 ms after the beginning of the presentation of the incongruent stimulus compared to the processing of the word *work* in *It was his first day at work*. A few years later, Van Petten and Kutas (1990) highlighted that the N400 can also mark access to the mental lexicon (Carreiras et al., 2005 among others) as the N400 amplitude systematically varied as a function of the lexical frequency of a word. The lower the lexical frequency of a word, the larger the amplitude of the N400.

To sum up, it is possible to expect different neural correlates for the processing of different types of liaison as traditionally defined (Delattre 1974) and as recently discussed within large-scale corpus studies of liaison. We also hypothesize that these differences are maximally visible in association with a paradigm that asks listeners to auditorily process liaison violations, that is, errors in the production of liaison, instead of only focusing on liaisons produced according to the shared 'norm' attested by corpus data. Since the neural response to linguistic stimuli can be recorded during simple listening to auditory stimuli, ecological settings which make use of sentences or short texts (instead of lists of isolated words or word pairs) can be used. Establishing such relatively innovatory experimental settings is a challenge that should be tackled to push our theoretical knowledge forward in the domain of how speakers process those complex language phenomena that cannot be adequately described in terms of a computationally simple 'rule'.

4. CONCLUSIONS

The use of EEG to study the neurocognitive mechanisms underlying the processing of liaison consonants by French listeners as a function of the typology of liaison is very promising. This should inform us at a fine granularity level about the nature of the language processes involved, i.e., phonological, syntactic, morpho-syntactic or lexical as a function of the type of liaison, i.e., categorical, forbidden, and optional. Beyond the empirical challenge, the study of the neurophysiology of liaison should also provide significant theoretical evidence for lending support to competing views of liaison as a (mostly) probabilistic or (mostly) rule-governed phenomenon. Further experimental work should also be run to study the perceptual salience of consonants at the juncture of two words as a function of the local context (i.e., syllabic structure, lexical frequency, bigram frequency, concreteness of the word involved in the resyllabification) but also of the sentential context leading the language processing system to compute both lexical-semantic and syntactic expectations of the upcoming lexical information.

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