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Mapping vowel sounds onto phonemic categories in two regional varieties of French: An ERP study

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Abstract:

This study examines ERP correlates of the different processes associating two phones to one vs. two phonemic categories in two regional varieties of French. Two groups of French listeners are compared, respectively exploiting two regional varieties, with a contrast between the mid-low /ɛ/ and the mid-high /e/ for Northern French (NF) but not for Southern French (SF). It is expected that the competition between the two close categories /e/ vs. /ɛ/ in NF could induce an ERP modulation in the processing of /ɛ/ compared to a phoneme /a/ with no close competitor, serving as control. In contrast, there should be no difference in ERP response in /ɛ/ vs. /a/ in SF, where there is no competition between the close neighbors /e/ and /ɛ/. The participants of the two groups listened to words containing either /ɛ/ or /a/ in a go/no-go semantic categorization task in which the critical /ɛ/ and /a/ words did not require an overt behavioral response. We found a significant difference in the N400 amplitude between the two conditions in the NF but not in the SF variety. The fact that the ERP modulations appear on the N400 component suggests that lexical access is influenced by the regional variety of the speakers.

Keywords: phoneme perception, phonological representations, phonetic ambiguity,

lexical access.

1. Introduction

The nature and organization of cognitive processes enabling the human brain to decode acoustic speech signals in order to extract the adequate information before connecting to the lexicon remain a challenge for speech scientists. They could involve a sequence of stages including acoustic/phonetic analysis, segmentation, phonetic categorization, and then lexical access (McQueen & Cutler, 2010). However, the precise structure of these processes is far from clear, as evidenced by the multiplicity of computational models attempting to capture the complexity of these processes into computationally implemented and experimentally addressable principles (e.g. Gaskell & Marslen-Wilson, 1997; McClelland & Elman, 1986; Norris & McQueen, 2008).

The neurocognitive tools provided by electrophysiology (EEG) may shed some light on the cognitive processes in charge of lexical access from sound through the analysis of evoked response potentials (ERPs; see a review in Molfese et al., 2005). The rationale is that specific properties of the speech decoding process could provide electrophysiological correlates in the sequence of associated ERPs that help to shed light on the nature and organization of the underlying mechanisms (Hagoort, 2008). This has led to various studies exploring the nature of the categorization and phonological processing at work in speech decoding (e.g. Mitterer et al., 2006; Tavaby et al., 2009; Sun et al., 2015; Fort et al., 2017).

In this domain, the analysis of regional variants of a given phonological system appears as a useful framework for experimentation. Indeed, similar phonetic contrasts can be related to close but different phonological interpretations by individuals of two dialectally-different groups, which could lead to differences in neurocognitive responses in spite of the use of similar acoustic inputs and lexical structures.

This is the framework that we will exploit in the present study, focusing on two French varieties, namely Northern French (NF) vs. Southern French (SF), which subtly differ in their vowel systems and provide an interesting case for testing the existence of a possible difference in treatment when the system contains two acoustically close phonemes as is the case in NF but not in SF. Indeed, the word-final vowels /e/ and /ɛ/ ([ep**e**] épée "sword" vs. [ep**ɛ**] épais "thick") are distinct phonemic categories in NF. However, in the SF variety, there is no /e/ and /ɛ/ phonological contrast. Surface forms [e] and [ɛ] do exist but their occurrence is governed by syllabic structure. SF speakers produce the mid-low version [ɛ] in closed syllables (CVC.) and the mid-high segment [e] in open syllables (CV.), e.g. [f**ɛ**t] vs. [f**e**te] for the imperative vs. the infinitive of the verb "to celebrate". Note that in NF where both /e/ and /ɛ/ occur freely in open

syllables as in [ep**e**] épée "sword" vs. [ep**ɛ**] épais "thick", they cannot be contrasted in closed syllables in which there is only /ɛ/ as in [f**ɛ**t]. Nonetheless, since /e/ and /ɛ/ refer to two distinct phonemic categories in NF as in /f**ɛ**t/ and /f**e**te/, the phonemic contrast between /e/ and /ɛ/ would directly result in different representations in the lexicon. On the contrary, in SF, the /e/ vs. /ɛ/ contrast is not phonological and there would be a phonological productive rule associating these two allophones in the surface phonological layer to a single E category in the deep structure (i.e. /f**E**t/ for [f**ɛ**t] and /f**E**te/ for [f**e**te]), before lexical access[1].

There are numerous demonstrations in the literature that speakers perceive sounds in relation to the phonological system of their native language (see Best, McRoberts, & Sithole, 1988; Flege, 1995; Kazanina et al., 2006; Pallier et al., 2001). For example, using magnetoencephalographic (MEG) recordings, Kazanina et al. observed a mismatch negativity response, namely a neural marker for change detection, when two sounds [d] and [t] belong to distinct phonemic categories in the listener's language (i.e. in Russian speakers), but not when they were allophones of the same phonemic category (i.e. in Korean speakers). In respect to French regional varieties, Dufour et al. (2007) have examined in a long-lag repetition priming experiment how Southern French speakers perceive standard French word forms such as [epɛ] in comparison to [epe]. Dufour et al. observed a decrease in reaction times on the word form /epe/ épée "sword" when the word form /epɛ/ épais "thick" was presented first, and to the word form /epɛ/ when the word form /epe/ was presented first. Importantly, this priming effect between members of minimal pairs was exactly of the same magnitude as in case of a repetition of the same words, that is when /epe/ and /epɛ/ were encountered for a second time. In contrast, no priming effect between members of minimal pairs was observed in Northern French speakers. Together, these findings suggest that Southern French speakers treated word forms like [epe] and [epɛ] as homophones, and that the words *épée* and *épais* are both associated with a single phonological representation (i.e. /epE/) in the Southern French mental lexicon. This claim was confirmed in a subsequent EEG study by Brunellière et al. (2011) examining how Northern French and Southern French speakers access the meaning of words ending in /e/ or /ɛ/ vowels. In an oddball paradigm in which a deviant stimulus (i.e. /epe/ or /epɛ/) interrupts the repeated presentation of same stimuli (i.e. /epi/), the authors examined the topographies of the MisMatch Negativity (MMN) response associated to the detection of deviant stimuli as a function of their concreteness (i.e. /epe/ concrete meaning "sword"; /epɛ/ abstract meaning "thick"). Brunellière et al. showed that the words /epe/ and /epɛ/ induce two different topographies of the MMN in Northern French speakers. In contrast, no difference in the

topography of the MMN was induced by the deviant words /epe/ and /epɛ/ in Southern French speakers, and the topography induced by these two word forms was similar to that induced by the word form /epɛ/ in Northern French speakers. Hence, the same semantic network is activated by [epe] and [epɛ] in Southern French speakers, with an access to the abstract meaning (/epɛ/), likely because it is more frequently used in everyday conversations. In a more general way, these findings confirm that words like /epe/ and /epɛ/ are treated as homophonous in Southern French speakers, and consequently the same cortical networks are activated by minimal pairs of words such /epe/ and /epɛ/.

In this study, we sought to examine further how words involving vowels such as /e/ or /ɛ/ subject to regional variation are processed in NF and SF speakers. In particular, we attempted to directly probe lexical access by presenting words in isolation, and by focusing on specific ERP components known to be involved in spoken word recognition (e.g. Desroches, Newman, & Joanisse, 2009, Dufour, Brunellière and Frauenfelder, 2013). The P200 component, a positive wave peaking around 200 ms over frontal regions, is known to reflect phonemic processing (Dehaene-Lambertz, 1997; Dehaene-Lambertz, Dupoux, & Gout, 2000), while the N400, a negative deflection peaking around 400 ms after word onset with a centroparietal distribution (Desroches et al., 2009) has been used to probe lexical processing, going from activation of a set of lexical candidates to the selection of the target word from this activated set. More precisely, our hypothesis in the elaboration of this study was that the specific competition between the two acoustically related phonemes /e/ vs. /ɛ/ in NF would result in an increase in ERP responses associated with spoken word recognition for NF subjects compared with SF subjects. Indeed, if we consider the word /sɛk/ (*dry*), lexical access would be more complex for NF subjects since there would be two potentially active cohorts that would prime words beginning either with /sɛk/ and thus the target word itself sec /sɛk/ “dry” or with /sek/ (e.g. sequence /sekãs/ “string”, etc). On the other hand, there would be only one cohort activation for SF subjects since there is only one phoneme E that would intervene in a single cohort /sEk/ for activating word representations in the speakers' mental lexicon.

To test for processing differences in words as a function of the speakers’ regional variety, it was unfortunately not possible to select a sufficient number of words that contrast the /e/ and /ɛ/ vowels either in minimal pairs of words containing open syllables such as /epe/ and /epɛ/ as this was the case in past studies (Dufour et al., 2007; Brunellière et al., 2011) or in minimal pairs of words containing closed syllables due to phonological rules in French. For example,

although there are numerous CVC words in French with the /ɛ/ vowel, there exist no CVC words in French with the vowel /e/. Thus, to test our hypothesis that the word recognition process would evoke different ERP responses in NF compared to SF, we used only words containing the mid-low vowel /ɛ/, and we compared these words with control words containing the vowel /a/ which is common to the two French varieties under investigation. The participants were engaged in a go/no-go semantic categorization task in which the critical /ɛ/- and /a/-words did not require an overt behavioral response. All other things being equal, we expected to find differences in processing of /ɛ/-words compared to /a/-words in NF speakers but not in SF, due to the presence of acoustically close /e/ cohort neighbors in NF.

Importantly, /a/ in French is a vowel acoustically far from most other vowel competitors, being the only low vowel in the system. Acoustic data confirm that /a/ is indeed well separated from other oral vowels in the formant space, while the acoustic contrast between neighbor pairs such as /e/ vs. /ɛ/ is much reduced in Northern French (see e.g. Strange et al., 2007; Ménard et al., 2008). Other competitors might exist for /a/ in French such as the back /ɑ/ or the nasal /ɑ̃/. However, the contrast between low /a/ and back /ɑ/ is not present in Southern French and has been lost by most speakers of Northern French, including speakers from the present corpus recorded in Grenoble. The nasal /ɑ̃/ is characterized by lower values of F1 and F2 rather well separated, acoustically and perceptually, from the oral /a/ in French (Maeda, 1993; Carignan, 2014). Hence, /a/-words, which are not subject to regional variety, and are rather well separated from acoustic competitors in both French variants, are hypothesized to be processed in the same way in both NF and SF speakers and to constitute the control condition. Hence, we attempt to assess the additional competition for /ɛ/-words triggered by /e/ cohort words in NF speakers, supposed to be absent in SF speakers.

2. Methods

2.1. Participants

The NF group consisted of fifteen Northern French speakers (11 female, 18-38 years, mean = 23) and the SF group consisted of fifteen Southern French speakers (11 female, 19-32 years, mean = 22) that took part in the experiment. The NF group was tested at the GIPSA-lab in Grenoble, and the SF group was tested at the “Laboratoire Parole et Langage” in Aix-en-Provence.

Before starting the experiment, all participants signed the consent to participate. All were right-handed (handedness assessed using the Edinburgh Inventory, Oldfield, 1971) and none reported a neurological or auditory problem. A linguistic questionnaire enabled to check that participants tested in Grenoble are indeed speakers of the NF variety and that participants tested in Aix-en-Provence are indeed speakers of the SF variety. We also checked with a reading test that members of the NF group had two different phonemes /ɛ/ and /e/ and members of the SF group had one single phoneme /E/ (see section 2.3 for more details). All participants received a remuneration of twenty Euros.

2.2. Stimuli

35 target words containing the vowel /ɛ/ (e.g. sec [sɛk] 'dry') and 35 target words containing the vowel /a/ (e.g. sac [sak] 'bag') were selected from Lexique (New et al., 2001), a lexical database for French. Among the 35 target words of each category (/ɛ/ vs. /a/), there were 28 CVC and 7 CCVC words. All the target words were non-animal nouns. The set of words also comprised 31 animal names (go-trials; 8 CV, 15 CVC, 4 CCV(C) and 4 CVCC), 39 other words serving as fillers (6 CV, 22 CVC, 7 CCV(C) and 4 CVCC), and 10 words for practice, two of which were animal names (9 CVC and 1 CCVC) (see Annex 1). The /ɛ/- and /a/-words were controlled on frequency (taken from the psycholinguistic database for French, lexique.org, New et al., 2001), with a mean logarithmic frequency of 1.41 for /ɛ/-words and 1.26 for /a/-words (unpaired t-test, $t(68)=0.56$; $p>.20$). Note that the selected C/ɛ/C words (e.g. /bɛt/) have in average 11.5 neighbors (range: 1-83) that begin with C/e/C phonemes (e.g. /betiz/).

The recording was realized in an anechoic chamber with a ZOOM H2 digital recording system placed on a tripod about 30 cm from the speaker's mouth. The microphone was set to a unidirectional mono configuration and the audio signal sampled at 44,100 Hz. The stimuli were recorded by a Northern French male speaker, known to have the Northern pronunciations. Previous acoustic measurements on a number of utterances confirmed that the speaker distinctly produces the /ɛ/ vowel, clearly separated from the neighbor /e/ vowel in the formant space. Note that, importantly, acoustic measurements on vowel utterances by Northern French speakers (Ménard et al., 2008) show that while formant values for /e/ and /ɛ/ are always clearly different though less separated than e.g. /ɛ/ and /a/, there is no correlation between individual variations for /e/ and for /ɛ/. Hence, since only /ɛ/-words and /a/-words are used in this study, formant

values for /e/ for this speaker are not directly relevant in further discussions. We selected one repetition of each word in order to obtain the best match between fundamental frequency (F0), intensity and duration over the whole set, with a special attention to the total duration of the word and the duration of the consonant or cluster before the vowel. The average word duration for the condition /ɛ/ is 425 ms (78 ms for the consonant preceding the vowel) and 421 ms for the condition /a/ (78 ms for the consonant preceding the vowel). Finally, all word stimuli were normalized in intensity and played at 70dB SPL.

2.3. Design and procedure

The experiment was created using the E-Prime v.2.0 software. It consisted of two blocks. The first block composed of 10 stimuli was dedicated to training, and the second block composed of 140 stimuli corresponded to the experimental session. In each block, the stimuli were presented in random order.

The experiment took place in an anechoic chamber with the light off. A fixing point appeared on a computer screen placed in front of the participant 500 ms before the audio stimulus onset and remained for 2000 ms from the audio stimulus onset. The participant was asked to stay immobile and to try to avoid eye blinks all along the presence of the fixing point. She/he was requested to click on the space key when hearing an animal name. Hence, importantly, no overt response was expected for the target stimuli, which were the words with /a/ or /ɛ/. There was then a 1000 ms rest period during which the participant could blink if necessary, before the next stimulus started. The audio stimuli were presented throughout an audio headset. The duration of the experiment was about 25 minutes.

At the end of the experiment, the participants had to read aloud a set of sentences like: “Ce chevalier porte une épée” (“This knight carries a sword”) or “Ce tissu est épais” (“This piece of cloth is thick”) to check for their realization of mid vowels. Indeed, this type of sentence makes it possible to contrast /e/ and /ɛ/ in the final word and in open syllables, with a contrast between /e/ for the last vowel in “épée” and /ɛ/ for the last vowel in “épais” in NF. A check was realized with the Praat software (Boersma & Weenink, 2018) to analyze the F1 values of the vowel productions, checking whether the participant produced one or two phonemes (2 phonemes= NF vs. 1 phoneme=SF). A paired t-test comparing F1 values between [e] and [ɛ]

confirmed that there was no significant difference for SF speakers (t (14) = 0,88 p>.05) while there was a significant difference for NF ones (t (14) = 21,32 p<.001).

2.4. EEG recording and data processing

The electrical signal from the brain was recorded during auditory stimulation with a 64-channel BioSemi system with ActiveTwo AD-box in the two experimental sites (sample rate 2048 Hz, bandpass filter at 0.16-100 Hz). Individually, all electrodes were adjusted to obtain a stable impedance below 20 mV and referenced to the left and right mastoid for visualization purposes. In addition to the 64 scalp electrodes, three additional electrodes were attached below the left eye and to the right of the right eye to monitor for vertical and horizontal eye movements, respectively.

The EEG data were filtered off-line using the EEGLAB software (Delorme & Makeig, 2004) (with a sample rate at 256 Hz and a bandpass filter at 1-30 Hz) and re-referenced to the average of the left and right mastoids. The EEG epochs, starting 100 ms before stimulus onset and ending 800 ms after it, were averaged for each item and each participant. Epochs were accepted under an artifact rejection criterion of +/- 6 μV. Data from bad channels were interpolated for each participant (Perrin, Pernier, Bertrand, Giard, & Echallier, 1987).

2.5. Statistical analyses

Analyses were conducted on both the P200 and N400 components. For the two groups of participants, two time windows were selected around the peak amplitude of each component after visual inspection: the P200 window was set between 180-320 ms and the N400 window was set between 450-600 ms after stimulus onset. To provide appropriate scalp coverage to identify the components of interest, the scalp surface was divided into 6 regions of interest (ROIs) each composed of six representative electrodes: Frontal Left (AF7, AF3, F7, F5, F3, F1), Frontal Right (AF8, AF4, F8, F6, F4, F2), Fronto-Central Left (FC5, FC3, FC1,C5, C3, C1), Fronto-Central Right (FC6, FC4, FC2, C6, C4, C2), Centro-Parietal Left (CP5, CP3, CP1, P5, P3, P1) and Centro-Parietal (CP6, CP4, CP2, P6, P4, P2). An anova was performed on the two time windows with between-participant factor Group (NF vs. SF) and within-participant factors Word (/ɛ/-words vs. /a/-words), Hemisphere (Right vs. Left) and Site (Frontal vs.

Fronto-Cental vs. Centro-Parietal). Note that the factor laterality tested potential lateral effects between left and right sites, and the factor site tested the topography of effects following the frontal–parietal line. When sphericity was violated, a Greenhouse-Geisser correction was applied and the corrected p values are reported. Bonferroni correction was used in *post hoc* comparisons.

3. Results

On Fig. 1 we display averaged ERPs in response to words containing [ɛ] vs. [a], separately for the NF and SF participants, at twelve representative recoding sites.

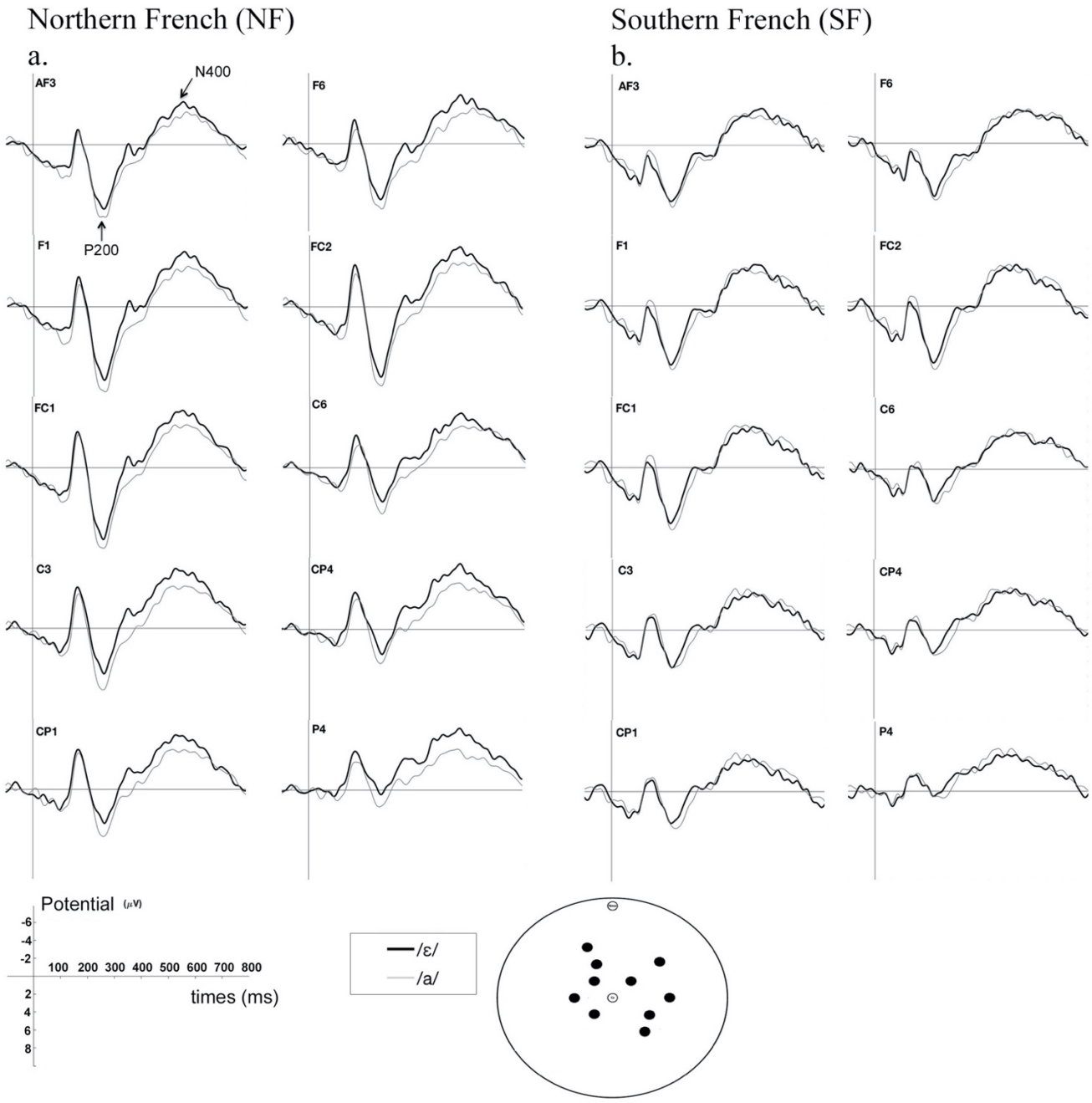


Fig. 1. Waveforms of the ERP response (in μV) for the two conditions /ε/ and /a/ for the two groups NF (Grenoble) and SF (Aix-en-Provence) at twelve recording sites (F3 F4; FC3 FC4; FC1 FC2; C5 C4; C1 C2; CP1 CP4) in a time window between -100 and 800 ms after the onset of auditory stimulus.

3.1. P200 (180-320 ms)

A main effect of Site was observed ($F(2,56) = 81.55$; $p<.0001$) showing more positive values on frontal sites than on frontocentral sites ($p< .01$), and more positive values on frontocentral sites than on centroparietal sites ($p<.0001$). A three-way interaction between Group, Hemisphere and Site was also found ($F(2,56) = 4.21$; $p<.05$). This interaction was due to a stronger effect of sites on the left hemisphere for the Northern group ($F (2,28 = 4.01$; $p<.05$). No other effect was found.

3.2. N400 (450-600 ms)

The main effect of Site was significant ($F(2,56) = 16.19$; $p<.0001$) showing more negative values on both frontocentral and centroparietal sites than on frontal sites. The effect of Site significantly interacted with Hemisphere ($F(2,56) = 19.17$; $p<.0001$) due to a stronger effect of sites on the right hemisphere. Crucially here the factor Word was involved in a significant three-way interaction with the factors Group and Sites ($F(2,56) = 4.02$; $p<.05$). This interaction revealed that for the Northern group, /ɛ/-words generated more negative values than /a/-words on the three sites with a greater difference on both frontocentral (/ɛ/ = -5,01 μV ; /a/ = -3,73 μV) and centroparietal sites (/ɛ/ = -5,49 μV ; /a/ = -3, 85 μV) (ps <.0001) than on frontal sites (/ɛ/ = -2,57 μV ; /a/ = -1,52 μV) ($p <.01$). In contrast, for the Southern group no significant difference between /ɛ/- and /a/-words was observed (ps>.20).

4. Discussion

In this study, we sought evidence for processing differences between /ɛ/- and /a/-words in NF speakers but not in SF speakers. It appears that there is indeed a difference in N400 amplitude between /ɛ/- and /a/-words in the NF speakers – and not in the SF speakers – and no difference between words in P200 amplitude in any group. In line with our expectations, a processing cost associated to the /ɛ/ vowel was found in the NF participants, localized at a lexical level of processing with larger N400 amplitudes for /ɛ/- than for /a/-words. Such an observation is in accordance with Brunellière et al.'s (2011) finding that /e/- and/ /ɛ/-words activate two distinct brain networks in Northern but not in Southern French speakers. These two close networks, and here, these two close lexical networks, likely compete for recognition in the Northern French

speakers, thus making harder to process /ɛ/-words in comparison to /a/-words in Northern French speakers – but not in Southern French speakers. This processing cost observed for words containing /ɛ/ compared with /a/ in NF but not in SF can be understood by analyzing the structure of the lexical cohort progressively primed by the acoustic stimulus corresponding to CɛC syllabic structure words. Let us take the example of the first word in Annex 1 that is "belle" (meaning "the nice girl"). Assuming few activation of competitor word cohorts beginning for instance by the phonemic sequence /ba/ or /bi/ as in the words /bal/ or /bil/ because the vowels in these cohorts are acoustically distant, in SF the acoustic stimulus containing the medial /ɛ/ should prime a major cohort of words beginning by the phonemic sequence /bEl/ and containing the single phonemic category /E/ for both the /e/ and /ɛ/ vowels. However, in NF speakers, the input [bɛl] should prime two competing cohorts respectively beginning by /bɛl/ and /bel/, considering the strong acoustic similarity between the two vowels /e/ and /ɛ/. The competition between these two cohorts could be related to a number of psycholinguistic models of word recognition such as TRACE (McClelland & Elman, 1986) or Shortlist (Norris, 1994) with inhibitory links between words, which induce a processing cost for words involved in a strong competition process, and thus like words containing /ɛ/ vowel in the NF group. Interestingly, the present work contrasting two systems quite close acoustically and lexically but differing in their phonological content enables to provide an EEG correlate of the complexity of phonological decoding in NF compared with SF, which leads to difference in the way the same acoustic stimuli are processed.

In a more general way, such a processing difficulty in Northern French participants has already been reported in a same-different task with CV syllables containing /e/ and /ɛ/, even if these listeners indeed succeed to distinguish these two vowels in their phonological system (Brunellière et al. 2009). Although, Brunellière et al. (2009) did not compare Northern and Southern French speakers, they examined how Northern French speakers from Geneva, who systematically distinguish the sounds [e] and [ɛ] in their production, process the /e/ vs. /ɛ/ contrast in comparison with the /ø/ vs. /y/ contrast which is phonologically more robust in French. Brunellière et al. showed that the change from /e/ to /ɛ/ and vice versa was not detected as early as the change from /ø/ to /y/. In particular, an EEG response to the change from /ø/ to /y/ was observed on the P200 component while an EEG response to the change from /e/ to /ɛ/ appeared later than P200, on the MMN component around 300 ms. Hence, difficulty at a pre-lexical processing level was observed in Brunellière et al. (2009) while here, we observe a

difficulty at a lexical level (N400) only. The discrepancy between Brunellière et al. (2009) and this study regarding the locus at which processing difficulty occurs is likely due to the use of different tasks. Brunellière et al. (2009) used a same-different task in which participants had to decide whether isolated syllables (/be/ and /bɛ/) were identical or different. This task inevitably engages the participants' attention at a pre-lexical level of representations and in particular on vowels of interest, and difficulties in distinguishing the /e/-/ɛ/ vowels emerged. In the present study, participants had to access lexicon to successfully categorize an item within a predefined semantic category, hence ERP modulation appeared mainly at this level.

Together, the results of the present study and those of Brunellière et al. (2009) therefore reveal an asymmetry in the locus of the difficulties encountered by NF and SF speakers. Indeed, even if in Brunellière et al. (2009) the discrimination of the /e/-/ɛ/ contrast took more time than the discrimination of a control contrast, NF speakers succeeded in discriminating between the /e/ and /ɛ/ vowels with a performance reaching 92% of correct responses. The reasoning is that in NF speakers, the successful – but difficult – discrimination between the /e/ and /ɛ/ vowels at a pre-lexical level of processing leads to the activation of two competing cohorts at the lexical level, and thus difficulty with the /e/-/ɛ/ vowels occur at this late stage of processing for these speakers. The situation appears to be different in SF speakers. Although Brunellière et al. (2009) did not test the performance of Southern French speakers in the discrimination of the /e/-/ɛ/ vowels at a pre-lexical level of processing, it is expected, based on previous studies (e.g. Dufour et al. 2007), that SF speakers should have more difficulty than NF speakers with the /e/-/ɛ/ vowels at this stage with an assimilation of these two vowels to the same /E/ category. The reasoning is hence that in SF speakers, the difficulty of discrimination between the /e/ and /ɛ/ vowels at a pre-lexical level of processing would prevent the activation of two competing cohorts, in favor of only one /E/ cohort. This would thus reduce the competition at the lexical level of processing, and remove or decrease the processing cost at this stage in SF speakers. More studies are required to examine this claim in more details.

To conclude, the present study confirms that two regional varieties of the same language with slightly different phonological systems lead to observable ERP counterparts in EEG experiments (see also Brunellière et al., 2011). Although the number of participants included in the present study closely corresponds to the number of participants classically tested in EEG/MEG studies (see for example, Brunellière et al., 2009; 2011; Do Carmo-Blanco et al.,

2019; Kazanina et al., 2006; Näätänen et al., 1997), a recent paper (Brysbaert, 2019) suggests to test between 100 and 200 participants for group comparisons in order to have a powered statistical design. Furthermore, although the separation between /e/ and /ɛ/ classes is known to be smaller than between /a/ and other vowel competitors for most NF speakers (Strange et al., 2007; Ménard et al., 2008), the present data could vary depending on the precise acoustic content of /ɛ/- and /a/-words depending on the selected speaker. Still, even though the present study calls for replication with larger groups of participants and possibly varied speakers and tested stimuli, it nonetheless constitutes other evidence that speakers of the same language process differently a given lexical input in relation with their regional dialect and with the phonological and phonetic differences associated with these local variations.

Footnote

1: Northern French actually corresponds to what is often referred to as "Standard French". By contrast, "Southern French" is the variant used by speakers in the most Southern regions of France (see Durand, 1990; Durand & Lyche, 2004, for a systematic description of differences between the two variants at the phonetic, phonological and prosodic levels). Importantly, Grenoble in the present study, or Geneva in previous studies by our group, do correspond to regions that are situated further north than these most Southern regions, and hence speakers from these cities belong to the Northern French variant. By contrast, the Southern French speakers in this study reside in the region of Aix-Marseille. Northern French speakers systematically distinguish [e] and [ɛ] sounds in their production. The neutralization of the /e/ vs. /ɛ/ contrast in Southern French is classically described as the existence of an archiphoneme E which sets its form /e/ vs. /ɛ/ depending on the syllabic context.

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Annex 1:

/ɛ/	/a/
belle	balle
bête	batte
baisse	basse
bec	bac
bègue	bague
bèche	bache
père	part
pèle	pale
peine	panne
terre	tare
dette	date
fer	phare
fesse	face
veine	vanne
caisse	casse
guerre	gare
neige	nage
net	nate
mère	mare
mèche	mache
lèche	lâche
verre	var
naine	nan
messe	masse
raide	rade
sel	sale
sec	sac
chaire	char
tresse	trace
crèche	crash
graisse	grace

grêle	grale
grêve	grave
brève	brave
blette	blatte