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Short Communication

Regional differences in the listener's phonemic inventory affect semantic processing: A mismatch negativity (MMN) study

Angèle Brunellière *, Sophie Dufour, Noël Nguyen

Laboratoire Parole et Langage, CNRS & University of Aix-Marseille, Aix-en-Provence, France

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ABSTRACT

Using the mismatch negativity (MMN) response, we examined how Standard French and Southern French speakers access the meaning of words ending in /e/ or /ɛ/ vowels which are contrastive in Standard French but not in Southern French. In Standard French speakers, there was a significant difference in the amplitude of the brain response after the deviant-minus-standard subtraction between the frontocentral (FC) and right lateral (RL) recording sites for the final-/ɛ/ word but not the final-/e/ word. In contrast, the difference in the amplitude of the brain response between the FC and RL recording sites did not significantly vary as a function of the word's final vowel in Southern French speakers. Our findings provide evidence that access to lexical meaning in spoken word recognition depends on the speaker's native regional accent.

1. Introduction

Listeners' ability to perceive speech sounds greatly depends on the phoneme inventory of their native language (Best, McRoberts, & Sithole, 1988; Flege, 1995). For example, it is well known that adult Japanese speakers have difficulties discriminating between American English [l] and [r] because the Japanese phonemic system only has one liquid consonant to which [l] and [r] are perceptually assimilated (Miyawaki et al., 1975). Similar difficulties have been found in English-speaking adults with Hindi (Werker, Gilbert, Humphrey, & Tees, 1981), Salish (Werker & Tees, 1984) and Czech (Trehub, 1976) phonemic contrasts. The lack of perceptual sensitivity to non-native phonemic contrasts arises very early, during the first year of life. By the age of 10–12 months, infants are already less sensitive to non-native than to native phonemic contrasts (see Jusczyk & Luce, 2002, for a review). Hence, it appears that from an early period in life, speech perception processes are tuned to the phonological properties of the native language.

In event-related potential (ERP) studies, the mismatch negativity component (MMN) has been used for studying phonemic perception (for a review, Näätänen, Paavilainen, Rinne, & Ahlo, 2007). The MMN is a frontocentral negative wave generally obtained after a deviant stimulus which interrupts the repeated presentation of stimuli (e.g. same category or abstract regularity) independently of participants' attention to the stimuli (e.g. Winkler, 2007), and intracranial recordings pointed to the role of the auditory cortex in the generation of the MMN response (Näätänen et al., 2007). Like the behavioral studies, the MMN studies highlight the importance of the native language in the way in which speech is perceived (Cheour et al., 1998; Dehaene-Lambertz, 1997; Näätänen et al., 1997; Rivera-Gaxiola, Csibra, Johnson, & Karmiloff-Smith, 2000; Shafer, Schwartz, & Kurtzberg, 2004; Winkler et al., 1999). In a well-known study, Näätänen et al. (1997) presented Finnish and Estonian participants with a series of speech sounds that contained multiple repetitions of /e/ occasionally interrupted by one of three deviant phonemes: /ö/, /õ/ and /o/. /e/, /ö/ and /o/ are present in both the Estonian and Finnish phonemic inventories, whereas /õ/ occurs in Estonian but not in Finnish. In Estonian participants, an MMN was elicited by all of the deviant phonemes, and its amplitude increased with the acoustical distance between the deviant and the /e/ phoneme. Importantly, in Finnish participants, the MMN was smaller for the Estonian vowel /õ/ in spite of the fact that the acoustical distance in the F1–F2 space was greater between /e/-/õ/ than between /e/-/ö/. Moreover, in Finnish participants, the strength of the dipole in the left auditory cortex was greater for all native deviant phonemes than for the non-native one. The involvement of the auditory cortex in this study is in line with neuroimaging studies showing that the superior temporal sulcus is strongly associated with phonological processing during speech perception (for reviews, Hickok & Poeppel, 2007; Turkeltaub & Coslett, 2010).

In the present study, we ask whether similar difficulties occur within the native language for phonemic contrasts that do not exist in the listener's regional variety. Few studies have addressed this question and they have provided conflicting results. While some studies have shown similar performance in the discrimination of

* Corresponding author. Address: Laboratoire Parole et Langage, 5, av. Pasteur, 13100 Aix-en-Provence, France.
E-mail address: angele.brunelliere@lpl-aix.fr (A. Brunellière).

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vowels that belong to both native and non-native regional contrasts (Cutler, Smits, & Cooper, 2005; Evans & Iverson, 2004), others studies have revealed some difficulties for non-native regional contrasts compared with native ones (Conrey, Potts, & Niedzielski, 2005; Dufour, Nguyen, & Frauenfelder, 2007, 2010). In recent studies, Dufour et al. (2007, 2010) examined how Southern French speakers perceive the word-final /e/-/ɛ/ contrast. This contrast exists in Standard French but not in Southern French, which only has the close-mid /e/ vowel in this position. For example, the words *épée* "sword" and *épais* "thick" are pronounced [epe] and [epɛ], respectively, by Standard French speakers, whereas they are both pronounced [epe] by Southern French speakers. Dufour et al. (2007, 2010) observed that Southern French speakers treated word forms like [epe] and [epɛ] as homophones in a lexical decision task. This finding suggests that the words *épée* and *épais* are associated with a single phonological representation, namely /epe/ in Southern French, and that at a pre-lexical stage of phonemic categorization, both [e] and [ɛ] are assimilated to the same phoneme /e/.

To have a better understanding of how listeners perceive non-native regional phonemic contrasts, we examined semantic access triggered by the word forms [epe] and [epɛ] in Standard French and Southern French speakers. In particular, we predicted that in Standard French speakers, specific semantic networks associated with the respective meanings of *épée* and *épais* would be activated during the presentation of the word forms [epe] and [epɛ]. In contrast, in Southern French speakers, the word forms [epe] and [epɛ] were expected to activate the same semantic network including the meanings of both *épée* and *épais*. We explored semantic access through the MMN response. In addition to being sensitive to both acoustical and phonemic changes in speech sounds presented to listeners, the MMN has been recently shown to reflect long-term memory traces of language experience at various higher linguistic levels including lexical, syntactic and semantic levels (for reviews, Näätänen et al., 2007; Pulvermüller & Shtyrov, 2006). In a study comparing neurophysiological brain responses for words and pseudo-words, Pulvermüller, Shtyrov, Kujala, and Näätänen (2004) found that the MMN response was greater for word-final syllables than for the same syllables at the end of pseudo-words. Interestingly, the MMN elicited by the two words used in the study showed different scalp topographies. Specifically, the concrete Finnish word *lakki* "cap" triggered a more negative response at right lateral sites than the abstract Finnish word *lakko* "labor strike". For action-related meanings of words, Shtyrov, Hauk, and Pulvermüller (2004) showed that the topography of MMN varied as a function of the body parts associated with action words. In particular, in their study, the word *kick,* which refers to leg movements, produced a centro-posterior negativity, while the word *pick,* which refers to hand movements, produced a negativity with a maximum peak amplitude on lateral sites.

Here, we thus compared the topography of MMN responses for *épée* and *épais* when they occasionally occurred after the repeatedly presented word *épi* "ear" in a group of Standard French speakers and a group of Southern French speakers. The MMN responses were measured at three topographical sites (frontocentral, left lateral, right lateral) in passive conditions in which participants were asked to ignore the auditory stimulations and to focus their attention on silent video films. The first recording site that we chose to use was frontocentral, because it is there that the amplitude of the MMN is generally the largest. Since the words *épée* and *épais* differ in concreteness, two other sites, namely right and left lateral, were also analyzed. Indeed, most ERP studies comparing the cerebral processing of concrete and abstract words have shown that concrete words evince a larger right lateralized negative response than abstracts words (Dhond, Witzel, Dale, & Halgren, 2007; Kounios & Holcomb, 1994; Pulvermüller et al., 2004; Swaab, Baynes, & Knight, 2002). In line with these ERP studies, lesion data (Fedio, August, Patronas, Sato, & Kufta, 1997) also showed a strong involvement of the right hemisphere for the processing of concrete words.

Following the above mentioned predictions, we tested which scalp topographies were elicited by the presentation of the words *épée* and *épais* in each group of participants. As it is classically observed in MMN studies, we expected to find an MMN response with a maximum at frontocentral sites for the two words in each group. We also hypothesized that the two words *épée* and *épais* would produce different scalp topographies related to their respective degree of concreteness in Standard French speakers. Since Pulvermüller et al. (2004) reported a right–left difference in laterality for the dipole sources between concrete and abstract words, we expected to find different scalp topographies between left and right lateral sites after the presentation of the words *épée* and *épais* in Standard French speakers. In addition, the activation of cortical sources related to the concreteness could be so strong for the concrete word *épée* that this could induce an increased activity at right sites, and a topography with a maximum at both frontocentral and right lateral recording sites could be observed. In contrast, because Southern French speakers treat words ending in [e] and [ɛ] vowels (Dufour et al., 2007, 2010) as homophones, the same topography of cortical response should be observed for both the words *épée* and *épais*.

2. Results

2.1. Concreteness ratings of épée and épais

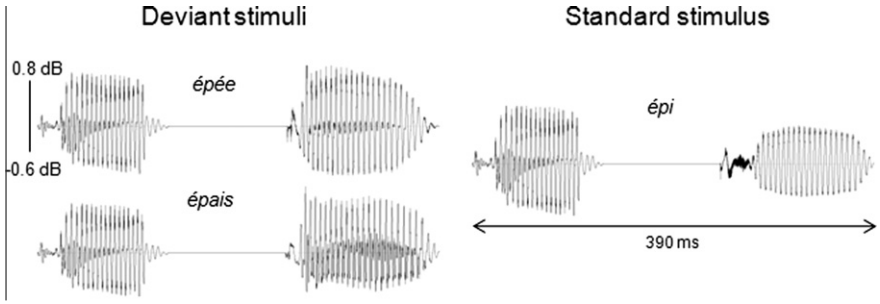
The two groups of participants were asked to estimate the degree of concreteness of *épée* and *épais* on a 0–10 scale (0: abstract; 10: concrete). Both groups judged the word *épée* as a highly concrete word with an average rating of 9.8 and 9.6, respectively (see Fig. 1). The word *épais* was judged as a less concrete word by both Standard and Southern French participants with an average rating of 6.9 and 5.2, respectively. An analysis of variance (ANOVA) conducted with factors Group (Standard vs. Southern French speakers) and Deviant (*épée* vs. *épais*) on ratings revealed an effect of Deviant ($F(1, 26) = 34.99$, $p < 0.001$) but no effect of Group ($F(1, 26) = 2.38$, $p = 0.13$) and no Deviant × Group interaction ($F(1, 26) = 1.35$, $p > 0.2$).

2.2. MMN response: global field power

An ANOVA of amplitudes of global field power in 40 ms windows around the MMN maxima peak with factors, Group (Standard vs. Southern French speakers) and Deviant (*épée* vs. *épais*), showed an effect of Deviant ($F(1, 26) = 20.11$, $p < 0.001$). The global field power was higher for *épais* (1.2 μV) than for *épée* (0.8 μV), thus indicating a greater MMN response for *épais*. Neither an effect of Group ($F(1, 26) = 0.43$, $p > 0.2$) nor a Deviant × Group interaction ($F(1, 26) = 0.11$, $p > 0.2$) were found. Similarly, an ANOVA of MMN peak latencies of global field power with factors Group (Standard vs. Southern French speakers) and Deviant (*épée* vs. *épais*) revealed an effect of Deviant ($F(1, 26) = 22.96$, $p < 0.001$). The peak of global field power occurred earlier for *épais* (493 ms) than for *épée* (552 ms), indicating that the latency of MMN response was shorter for *épais*. Neither an effect of Group ($F(1, 26) = 0.43$, $p > 0.2$) nor a Deviant × Group interaction ($F(1, 26) = 0.80$, $p > 0.2$) were found.

2.3. The topography of MMN response

The amplitude of MMN response over the three topographical sites (left lateral, LL, right lateral, RL, frontocentral, FC) was computed. In particular, a three-way ANOVA on the amplitude of MMN responses with factors Group (Standard vs. Southern French



Concreteness ratings

	épée	*épais*
Standard French	9.8	6.9
Southern French	9.6	5.2

Fig. 1. Waveforms associated with the experimental stimuli (top) and concreteness ratings for the deviant stimuli (bottom).

speakers), Deviant (*épée* vs. *épais*), and Site (Left Lateral, LL, Right Lateral, RL, and Frontocentral, FC) was performed. The results of the ANOVA are displayed in Table 1. A trend effect of Group ($F(1, 26) = 3.25$, $p = 0.08$) was observed with a greater MMN response elicited by Southern French speakers compared to Standard French ones. The effect of Deviant ($F(1, 26) = 22.11$, $p < 0.001$) was significant. As previously described in the analysis of global field power, the MMN response was larger for *épais* than for *épée*. The effect of Site was also highly significant ($F(2, 52) = 12.89$, $p < 0.001$). Frontocentral recording sites presented larger negative values than the two other sites (FC vs. LL, $F(1, 26) = 28.17$, $p < 0.05$; FC vs. RL, $F(1, 26) = 9.02$, $p < 0.05$), thus indicating a negative maximum of the MMN response at frontocentral recording sites. Also, right lateral recording sites tended to have larger negatives values than left lateral recording sites ($F(1, 26) = 3.31$, $p = 0.08$). A significant Deviant × Site interaction ($F(2, 52) = 3.37$, $p < 0.05$) was found. This interaction was due to the fact that the effect of Deviant was higher at FC recording sites than at the two other sites. The Group × Deviant × Site interaction failed to reach significance ($F(2,52) = 0.86$, $p > 0.2$).

Table 1
Three-way ANOVA results.

Factors	df	F	p
Main effects			
Group	1,26	3.25	=0.08
Deviant	1,26	22.11	<0.001*
Group × Deviant	1,26	0.14	>0.2
Sites	2,52	12.89	<0.001*
Group × Site	2,52	0.13	>0.2
Deviant × Site	2,52	3.37	<0.05*
Group × Deviant × Site	2,52	0.86	>0.2
Planned comparisons: single effects			
Standard French-épais			
FC vs. LL	1,26	12.21	<0.01*
FC vs. RL	1,26	7.25	<0.05*
LL vs. RL	1,26	0.79	>0.2
Standard French-épée			
FC vs. LL	1,26	4.92	<0.05*
FC vs. RL	1,26	0.02	>0.2
LL vs. RL	1,26	3.06	=0.08
Southern French-épais			
FC vs. LL	1,26	10.46	<0.01*
FC vs. RL	1,26	4.51	<0.05*
LL vs. RL	1,26	1.5	>0.2
Southern French-épée			
FC vs. LL	1,26	5.36	<0.05*
FC vs. RL	1,26	2.87	=0.09
LL vs. RL	1,26	0.04	>0.2
Planned comparisons: interaction with Deviant factor			
Standard French			
FC vs. LL	1,26	3.18	=0.08
FC vs. RL	1,26	5.53	<0.05*
LL vs. RL	1,26	0.3	>0.2
Southern French			
FC vs. LL	1,26	2.22	=0.15
FC vs. RL	1,26	0.39	>0.2
LL vs. RL	1,26	0.84	>0.2

FC: Frontocentral, LL: Left Lateral, RL: Right Lateral.
* Significant effects.

Following our predictions, planned comparisons were performed to analyze the differences between sites (FC vs. LL; FC vs. RL; LL vs. RL) for each Deviant (*épée* vs. *épais)* within each group of participants.

2.3.1. Standard French group

The MMN response to *épais* had a greater amplitude at FC compared to LL ($F(1, 26) = 12.21$, $p < 0.01$) and RL ($F(1, 26) = 7.25$, $p < 0.05$). Similar amplitudes at LL and RL recording sites ($F(1, 26) = 0.79$, $p > 0.2$) were observed. This is indicative of a topography of MMN response with a maximum at frontocentral recording sites (see Fig. 2). The MMN response to *épée* had a greater amplitude at FC compared to LL ($F(1, 26) = 4.92$, $p < 0.05$) and tended to have a greater amplitude at RL recording sites in comparison to LL ones ($F(1, 26) = 3.06$, $p = 0.08$). Similar amplitudes at RL and FC recording sites ($F(1, 26) = 0.02$, $p > 0.2$) were found, which indicates a predominance of the RL and FC recording sites over the LL site (see Fig. 2). Crucially, we found a significant Deviant × FC vs. RL interaction ($F(1, 26) = 5.53$, $p < 0.05$). This interaction was due to the fact that the MMN response to *épée* was similar in amplitude at the RL and FC recording sites, whereas the MMN response to *épais* had a greater amplitude at FC compared to RL. Also, we observed a marginally significant Deviant × FC vs. LL interaction ($F(1, 26) = 3.18$, $p = 0.08$), due to the fact that the negative difference between FC and LL was somewhat greater for *épais* than for *épée*.

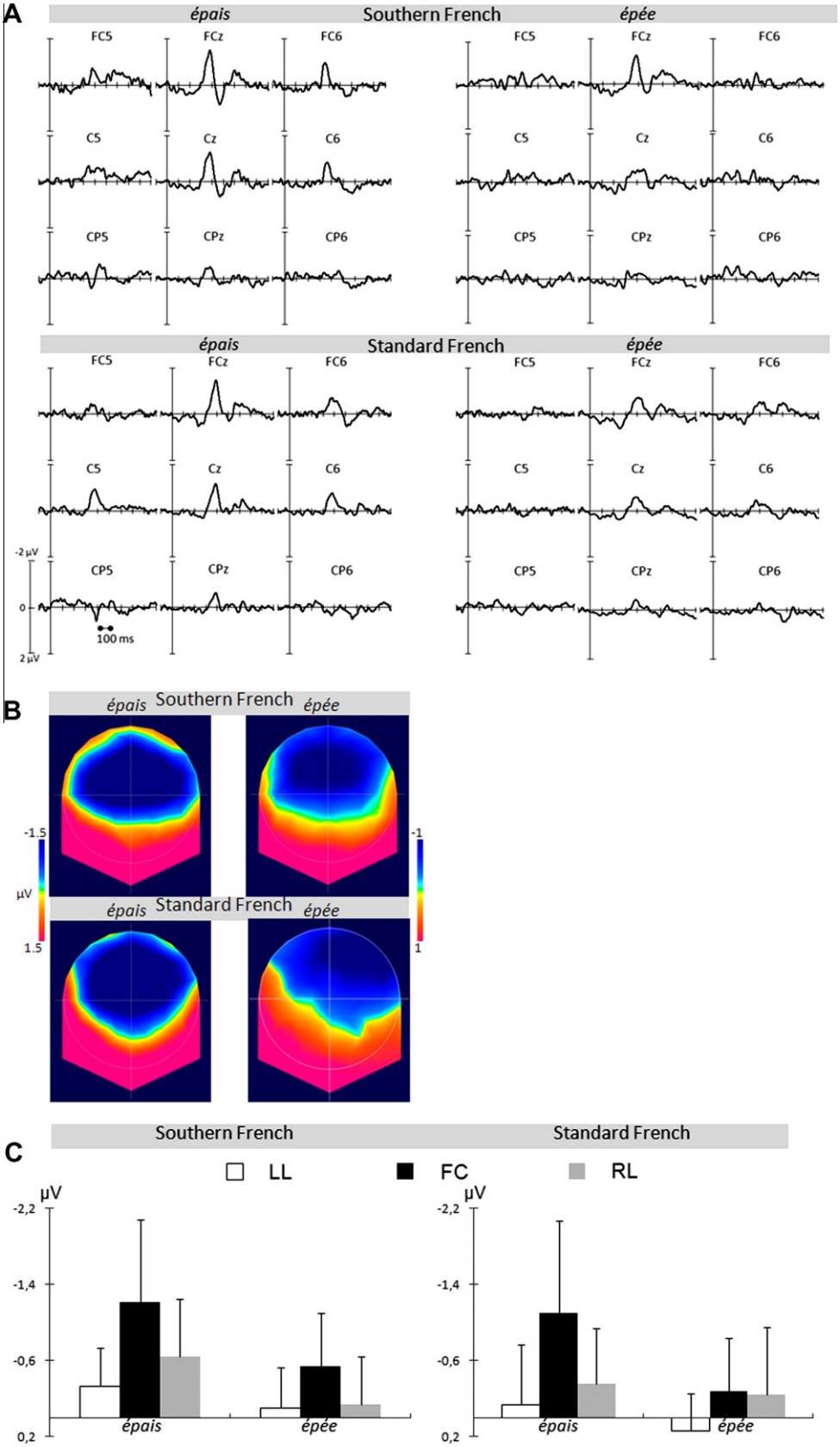


Fig. 2. (A) Waveforms of the deviant minus standard difference responses elicited to *épée* and *épais* for Standard French and Southern French participants at nine recording sites (FC5, FCz, FC6, C5, Cz, C6, CP5, CPz, CP6) in a time window between −100 and 900 ms after the onset of auditory stimulus. The unit of scalp voltage values was µV. (B) Topographical maps of the brain responses elicited to *épée* and *épais* for Standard French and Southern French participants on the maximum MMN peak amplitude of global field power. C. MMN responses elicited to *épée* and *épais* for Standard French and Southern French participants at three topographical sites, Left Lateral (LL, in white), Frontocentral (FC, in black) and Right Lateral (RL, in gray) in 40 ms time window centered on the maximum peak amplitude of global field power.

2.3.2. Southern French group

The MMN response to *épais* had a greater amplitude at FC compared to LL ($F(1, 26) = 10.46$, $p < 0.01$) and RL ($F(1, 26) = 4.51$, $p < 0.05$). Similar amplitudes at the LL and RL recording sites ($F(1, 26) = 1.5$, $p > 0.2$) were observed, reflecting a topography of MMN response with a maximum at frontocentral recording sites (see Fig. 2). Similarly to *épais*, the MMN response to *épée* had a greater amplitude at FC compared to LL ($F(1, 26) = 5.36$, $p < 0.05$) and also tended to have a greater amplitude at FC compared to RL ($F(1, 26) = 2.87$, $p = 0.09$). Similar amplitudes at the LL and RL recording sites ($F(1, 26) = 0.04$, $p > 0.2$) were observed, again showing a topography of MMN response with a maximum at frontocentral recording sites (see Fig. 2). In contrast to what was observed in Standard French participants, the Deviant × FC vs. RL interaction was not significant ($F(1, 26) = 0.39$, $p > 0.2$), thus indicating that the observed difference between RL and FC did not vary as a function of the deviant (*épée* vs. *épais*). Finally, the Deviant × FC vs. LL interaction was not significant.

3. Discussion

Using the MMN response, we examined how Standard French and Southern French speakers access the meaning of words ending in /e/ or /ɛ/ vowels. Because Southern French speakers do not distinguish between /e/-/ɛ/ minimal pairs of words in an auditory lexical decision task (Dufour et al., 2007, 2010), we predicted that the auditory presentation of words such as *épée* and *épais* would activate the same semantic network in this group of participants. In contrast, because Standard French individuals both distinctly produce and perceive words ending in /e/ and /ɛ/ (Dufour et al., 2007; Fagyal, Kibbee, & Jenkins, 2006), we predicted that word forms such as [epe] and [epɛ] would activate different semantic networks. Our results showed that in both Standard and Southern French speakers, the amplitude of MMN response was greater for *épais* than for *épée* and its latency was shorter for *épais*. Because the MMN response is sensitive to acoustical variations (Näätänen et al., 2007), such findings may result from the fact that the vowel [i] of the repeatedly presented stimulus *épi* is acoustically more distant from the final vowel [ɛ] in *épais* than from the final vowel [e] in *épée*. These observations are particularly interesting since they suggest that at least at an acoustical level, Southern French speakers do not perceive the word-final /e/-/ɛ/ vowels in the same way.

Our results also show that the words *épée* and *épais* induce two different cortical topographies in Standard French speakers for whom the /e/-/ɛ/ opposition exists. In particular, in Standard French speakers, an MMN response with a maximum at frontocentral recording sites was observed for *épais*. In contrast, these speakers showed no predominance of the frontocentral recording sites relative to the right lateral sites for the word *épée*. Indeed, for this group of participants, the amplitude of the MMN response elicited by the word *épée* was of similar amplitude at right lateral and frontocentral recording sites. As shown in Fig. 2, the lack of difference between right lateral and frontocentral recording sites for *épée* was due to a reduction of activity at frontocentral sites. As noted earlier, the global mean activity was reduced for *épée* with respect to *épais* due to its smaller acoustical distance from the standard *épi*. Hence, the reduction of activity at frontocentral sites is easily explained by the acoustical distance between the word *épée* and the standard *épi*[1]. As the word *épée* has a higher degree of concreteness than the word *épais*, we could have expected an increase in activity at right lateral sites. Such an increase in activity was however not observed, likely because the activity at right lateral sites was affected by two factors (acoustical deviance and concreteness) which produced divergent effects. In contrast, the observed differences between frontocentral and right lateral sites in Southern French speakers were not modulated by the type of stimulus (*épée* vs. *épais*). Hence, while processing differences were found at frontocentral and right lateral sites between the words *épée* and *épais* in Standard French speakers, this was not the case in Southern French speakers. The lack of processing differences at frontocentral and right lateral sites between *épée* and *épais* in Southern French speakers suggests that the two word forms are associated with the same semantic representations.

Although the critical difference between right and left sites as a function of the degree of concreteness did not emerge in our study, the lack of difference between frontocentral and right lateral sites for the word *épée* in Standard French speakers is to a certain extent consistent with previous ERP studies showing the implication of the right sites during concrete word processing (Dhond et al., 2007; Kounios & Holcomb, 1994; Pulvermüller et al., 2004; Swaab et al., 2002). The fact that different cortical topographies were elicited by *épée* and *épais* only in Standard French speakers could be accounted for by a difference in the degree of concreteness for *épée* vs. *épais* in this group but not in the Southern French group. However, concreteness ratings for the two words did not significantly differ between the two groups of speakers. One may also ask to what extent lexical frequency could account for the differential brain responses to *épée* and *épais* in Standard French speakers. Subjective lexical frequencies obtained on a 0–10 scale at the end of the experiment indicated that *épais* was judged as being of higher frequency than *épée* by both groups (respective mean values: 5.9; 2.8). However, stronger responses for low frequency words compared to high frequency words have been reported in the left hemisphere (Assadollahi & Pulvermüller, 2003; Sereno, Rayner, & Posner, 1998). As this was not the case in the present study, our differential brain response between *épée* and *épais* in Standard French speakers is likely not due to lexical frequency. Interestingly, the topography observed for the words *épée* and *épais* in Southern French speakers presented no right lateralized response. This suggests that Southern French speakers activate the abstract meaning instead of the more concrete meaning when both the word forms [epe] and [epɛ] were presented. A possibility to account for such a finding is that the abstract meaning is more frequently used than the concrete one in the everyday conversations. More studies are nonetheless required to examine this issue.

To conclude, this study examined whether access to lexical meaning is affected by regional differences in the listener's phonemic inventory, in conditions in which the listener's attention was disengaged from the auditory stimulus. Our findings reveal that semantic access of final /e/ and /ɛ/ words differs according to the listener's regional accent. The lack of differences in cortical topographies between *épée* and *épais* only in Southern French speakers is consistent with previous observations (Dufour et al., 2007, 2010) showing that Southern French but not Standard French speakers treat words ending in [e] and [ɛ] as homophonous. This provides evidence that access to lexical meaning in spoken word recognition depends on the listener's native regional accent. Hence, brain networks encoding word units appear to be shaped by our various linguistic exposures.

4. Methods

4.1. Participants

Fourteen Southern French speakers (nine women, five men, 17–36 years, mean age = 21,7) and 14 Standard French speakers (eight women, six men, 17–35 years, mean age = 23,2) from the University of Aix-Marseille participated in the experiment after

[1] Note that this factor is likely responsible for the smaller activation at both frontocentral and right lateral sites for *épée* than for *épais* in Southern French speakers.

having given written informed consent[2]. All were right-handed (handedness assessed using the Edinburgh Inventory) and reported having no neurological or hearing impairment.

4.2. Stimuli

A native Standard French female speaker produced the four French words *épée*, *épais*, *épi* and *épate* ("swagger") several times. We selected one repetition of each word so as to get the best possible match in fundamental frequency (F0), intensity, and maximal sound energy across the four tokens. The intensity peak, the duration of closure for the consonant /p/ and the duration of the final vowel were normalized across the tokens *épée*, *épais* and *épi*. We used an identical initial phoneme /e/ excerpted from the word *épate* so that the deviants (*épée* and *épais*) and standard (*épi*) stimuli began to acoustically differ from the /p/ consonant (see Fig. 1).The initial phoneme /e/ was spliced onto the syllables /pe/, /pɛ/ and /pi/, respectively excerpted from the initial tokens /epe/, /epɛ/ and /epi/. All stimuli were 390 ms in duration.

4.3. Design

The deviant stimuli *épée* and *épais* were presented in two separate blocks against the standard stimulus *épi*. In each block, there were 798 (83.3%) standard stimuli and 160 (16.7%) deviant stimuli. The blocks were pseudo-randomized with a minimum of two standard stimuli occurring between two deviant stimuli. The stimulus onset asynchrony was 1000 ms and stimuli were presented binaurally via headphones. In an acoustically and electrically shielded cabin, participants were instructed to watch short silent video films and to ignore auditory signals. Two silent video films were used, one during the first block and the other during the second block. The order of blocks was counterbalanced across participants, while the order of the video films remained constant. The duration of each block was approximately 20 min. At the end of the experiment, the participants were asked to rate the concreteness of the two French words *épée* and *épais* presented in a written form on a 0–10 scale (0: abstract; 10: concrete).

4.4. EEG recording and data processing

The electrical signal (sample rate 1024 Hz) was recorded during auditory stimulation with a 64-channel BioSemi ActiveTwo AD-box. Individual electrodes were adjusted to a stable offset lower than 20 mV. The EEG epochs, starting at 100 ms before stimulus onset and ending 900 ms after it, were averaged for each item and for each participant. Epochs were accepted under an artefact rejection criterion of 100 μV. All participants had at least 100 accepted trials for the *épée* and *épais* deviant stimuli. The EEG data were filtered offline by a bandpass filter (1–30 Hz) and corrected by a baseline of 100 ms before stimulus onset. Data from bad channels for each participant were interpolated (Perrin, Pernier, Bertrand, Giard, & Echallier, 1987) and the EEG signal was transformed using the average reference. The MMN response was obtained by subtracting the ERP response elicited by the standard stimuli from that elicited by the deviant stimuli in each block[3].

4.5. Statistical analyses

Two-way ANOVAs were conducted with factors Group (Standard vs. Southern French speakers) and Deviant (*épée* vs. *épais*) on amplitudes of global field power (Lehmann & Skrandies, 1980) in 40 ms windows around the MMN maxima peak and MMN peak latencies of global field power. In Standard French speakers, the 40-ms-wide windows that we used were situated between 434 and 473 ms after stimulus onset for *épée* and between 363 and 403 ms for *épais*. In Southern French speakers, the windows were from 441 ms to 481 ms for *épée* and from 356 ms to 393 ms for *épais*. Then, we extracted the amplitude of the MMN response for three topographical sites of interest (Left Lateral, LL, Right Lateral, RL and Frontocentral, FC) on 40-ms-wide windows placed around the maxima of the peak amplitude of global field power. For each topographical site, six electrodes were chosen: Left Lateral (FT7, FC5, FC3, T7, C5, C3), Right Lateral (FT8, FC6, FC4, T8, C6, C4) and Frontocentral (FC1, FC2, FCz, C1, C2, Cz). A three-way ANOVA on the amplitude of MMN responses with factors Group (Standard vs. Southern French speakers), Deviant (*épée* vs. *épais*), and Sites (LL, RL, and FC) was performed. The Greenhouse-Geisser correction was applied (Greenhouse & Geisser, 1959) and the corrected *p* values are reported.

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[2] Because Standard French speakers were students in the South of France, they were inevitably exposed to Southern French pronunciations. Before running the experiment, we ensured through a reading task that our Standard French speakers distinctly pronounced the /e/ and /ɛ/ vowels. Also, we ensured that our Southern French speakers only pronounced the /e/ vowel in word-final position.

[3] Another possibility for estimating the MMN response would consist in subtracting the ERP response to the two critical word forms [epe] and [epɛ] presented in separate homogenous blocks from the ERP response to these words presented as deviant stimuli. However, because there are no such control responses in our study, we performed the classical MMN subtraction used in passive auditory oddball paradigm.

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