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# Does Training Make French Speakers More Able to Identify Lexical Stress?

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## Abstract

The aim of this research is to determine whether a prosodic training could improve the ability of French-speaking listeners to identify the stressed syllable in Spanish words. For this, native speakers of French and native speakers of Spanish performed a pre-test and a post-test, involving a stress identification task. Between both tests, some of the French speakers participated in a training session, in which they were trained to perceive Spanish accentual contrasts, while the others received no training. Firstly, results show that, although their performance does not reach those of native speakers of Spanish, French-speaking listeners are able, after a short training, to learn to perceive Spanish accentual contrasts. More interestingly, results also reveal that the improvement from pre- to post-test does not depend on the mere fact of receiving training, but rather depends on the French-speaking listener's learning ability in the training session.

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## Does Training Make French Speakers More Able to Identify Lexical Stress?

Although French and Spanish belong to the same language family, they differ, among other linguistic features, in their accentual properties. In

French, primary stress appears -especially in reading and in a neutral speaking style-, on the last syllable of the rhythmic group. Therefore, it plays a demarcative role by signaling boundaries between utterances (Léon, 2011). In Spanish, stress is realized at the word level and has a distinctive function (Quilis, 1993), since it can change the meaning of a word. For example, *número* ([ˈnumero], (the/a) number), *numero* ([nuˈmero], (I) number) and *numeró* ([numeˈro], (he/she) numbered) are only distinguished by the stress pattern (proparoxytone, paroxytone and oxytone, respectively). Thus, while in Spanish, -a free-stress language-, stress plays a distinctive role at the lexical level, in French -a fixed-stress language-, stress serves as a cue to the segmentation into rhythmic groups.

The acoustic manifestation of stress also differs between the two languages. Even if duration, fundamental frequency ( $f_0$ ) and amplitude are acoustic correlates of primary stress both in French and Spanish, these acoustic cues are used in different ways in each language. Stress in French is realized by an increase in duration and, to a lesser extent, in  $f_0$  (Léon, 2011; Léon & Martin, 2000), whereas in Spanish a combination of duration and  $f_0$  seems to be responsible for stress marking (Quilis, 1981).

The different phonological status and position of stress in both languages might explain why French speakers can exhibit some difficulties when they attempt to produce and to perceive lexical stress in Spanish. In the early European texts from the Prague School it is already suggested that difficulties in production might be accounted for by the influence of the first language (L1) phonological system, which mediates the perception of a second language (L2). Hence, the L1 acts a "phonological filter" which is responsible for a "phonological deafness" affecting the perception of L2 contrasts that are not present in the L1 (Polivanov, 1931; Troubetzkoy, 1939). Using a similar metaphor, Dupoux and his coworkers (Dupoux, Pallier, Sebastián, & Mehler, 1997; Dupoux, Peperkamp, & Sebastián, 2001; Dupoux, Sebastián, Navarrete, & Peperkamp, 2008) have proposed that the notion of "stress deafness" might explain the perceptual difficulties experimented by French speakers when exposed to accentual contrasts in a free-stress language such as Spanish. Using different experimental procedures, they showed that the sensitivity to accentual contrasts depends on the cognitive load required by the task and on the phonetic variability of the stimuli presented to the participants. Dupoux and his collaborators concluded that French speakers are not able to encode distinctive lexical stress in their phonological representations, although, in certain tasks, they might be capable of using the acoustic cues that are available in the speech signal.

This might provide an explanation for the findings reported by Mora, Courtois, and Cavé (1997) and by Muñoz, Panissal, Billières, and Baqué (2009), who showed that French speakers reached relatively high percentages (70% - 83%) of correct identification of the position of the stressed syllable in Spanish words.

The role of the acoustic correlates involved in the perception of lexical stress by French speakers when exposed to Spanish stimuli has been examined in detail in a series of experiments by Schwab and Llisteri (2010, 2011a, 2011b, 2012). The results obtained so far highlight the importance of  $f_0$  variations for French speakers in the identification of the stressed syllable, as shown by Rigault (1962) in French L1. Moreover, the time needed by French listeners to detect the position of Spanish lexical stress seems to be related to amplitude variations, alone or combined with temporal changes (Schwab & Llisteri, 2011a).

In view of these findings, the present experiment aims at determining: (1) whether French-speaking listeners are able to learn to perceive Spanish lexical stress contrasts; and (2) whether training can improve their performance in identifying the position of lexical stress in Spanish words. In order to achieve these aims, we have built an experiment that involved three phases: (1) a pre-test, (2) a training session and (3) a post-test. All participants performed the pre- and post-tests, while some participants took part in a training session (Training) and some did not (No training). Moreover, since stress perception may be considered from an acoustic or from a lexical point of view, two different tasks were used in this study: (a) a stress identification task, which implies an acoustic rather than a lexical level of processing; and (b) a shape/pseudoword matching task that requires not only an acoustic, but also a lexical processing.

## METHOD

### Participants

Three different groups of participants took part in the experiment. The first one consisted of 29 native speakers of French (from the French part of Switzerland) with no knowledge or contact with Spanish or Italian<sup>1</sup> (hereafter "non-natives"). The second group was composed by 22 bilingual

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<sup>1</sup> Knowledge of Italian (a free-stress language, which is one of the official languages in Switzerland) might affect the performance of non-native participants in Spanish.

Spanish/Catalan speakers<sup>2</sup> with no knowledge or contact with French (hereafter "natives"). Finally, the third group included 20 native speakers of French (also from the French part of Switzerland) with no knowledge or contact with Spanish or Italian (hereafter "non-native controls" or "NN controls"). While the non-native and native groups participated in the training session, the non-native control group received no training.

## Materials

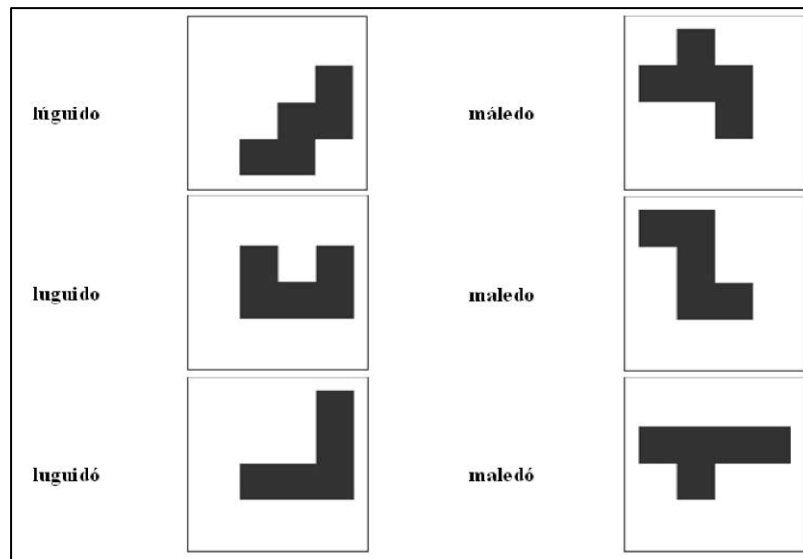
*Pre- and Post-Test.* The materials used in the pre- and post-test (taken from Llisterri, Machuca, de la Mota, Riera, and Ríos, 2005), consisted of four triplets of trisyllabic Spanish words (12 words in total). Each triplet comprised a proparoxytone (PP, médico [ˈmeðiko], (the/a) doctor), a paroxytone (P, medico [meˈðiko], (I) give a medicine) and an oxytone (O, medicó [með̞iˈko], (he/she) gave a medicine), all produced by an educated male native speaker of Peninsular Spanish.

*Training.* Two triplets of trisyllabic Spanish pseudowords (also taken from Llisterri et al., 2005) were used in the training session. As for words, these pseudowords also contrasted by the position of lexical stress (e.g. *máledo* [ˈmaleð̞o], *maledo* [maˈleð̞o], and *maledó* [maleˈð̞o]), and were recorded by the same speaker of Peninsular Spanish who recorded the words in the pre- and post-tests.

Six different visual shapes were created and randomly associated with the 6 pseudowords, as shown in **Error! Reference source not found.**

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<sup>2</sup> As Catalan is a free-stress language with the same accentual patterns as Spanish, knowledge of Catalan should not have an effect on the performance of bilingual participants in Spanish.



**Figure 1.** Visual shapes associated to the pseudowords used in the training session.

*No Training.* In the case of the participants who did not received training, 6 visual shapes were used with no oral stimuli.

### Procedure

The three groups of participants (natives, non-natives, non-native controls) performed the pre- and post-tests. Natives and non-natives participated in a training session in which they were trained to perceive accentual contrasts, while non-native controls had no training.

*Pre- and post-test.* The pre-test and post-test phases of the experiment consisted of a stress identification task performed by the three groups of participants. They heard a word and had to indicate as fast as possible the position of the stressed syllable by pressing a button in a response box. Each of the 12 Spanish words was repeated 3 times, so that a total of 36 stimuli were presented. Each participant in each test received a different randomization of the stimuli. The test lasted 3 minutes.

*Training.* A shape/pseudoword matching task (similar to the one described in Dufour, Nguyen, and Frauenfelder, 2010) was used for training. This particular kind of task was chosen because it implies not only a low-level acoustic processing, but also a lexical processing, since the participants had to learn to associate each shape with a pseudoword

(and with its corresponding stress pattern). The training session consisted of five blocks: four with feedback on the correct response, followed by one with no feedback. This final block allowed to evaluate participants' performance at the end of training.

In this training phase, four shapes were presented on the screen and the participants heard one of the six pseudowords. They were instructed to click on the shape that they thought corresponded to the pseudoword. In the first four blocks of stimuli, the participants received feedback: after each response, the three distractor shapes disappeared, leaving only the correct shape on the screen, and the pseudoword was presented again. In the last block, the participants received no feedback: all four shapes disappeared, and the next trial started. Each of the 6 pseudowords was repeated 6 times in each block, so that 36 stimuli per block and a total of 180 stimuli were presented. Each participant received a different randomization of the stimuli. The training session lasted 25 minutes.

**No Training.** The group of participants who did not receive training (i.e., non-native controls) had to perform a task consisting in clicking as fast as possible on a shape that appeared on the screen, without hearing any auditory input. Five blocks of shapes were also used, with a different randomization for each participant. The session lasted 10 minutes.

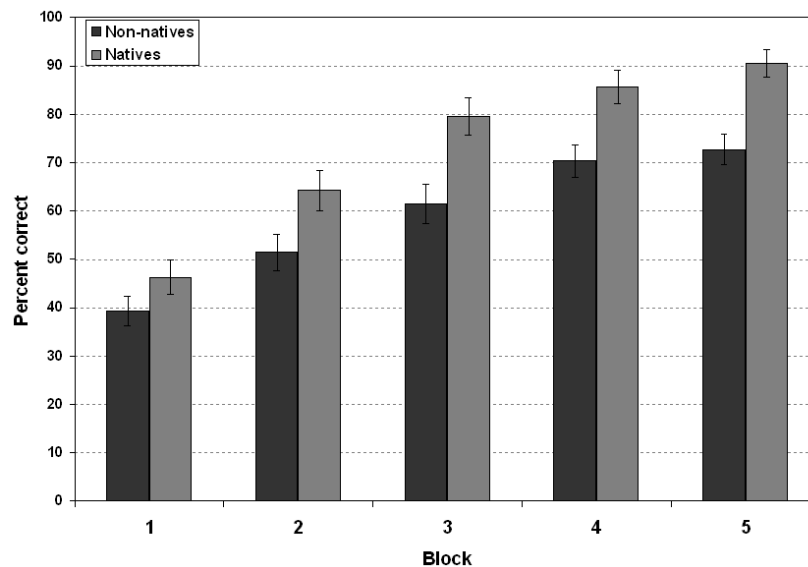
## Data Analysis

Some participants (natives, non-natives and non-native controls) had to be excluded because of memorization difficulties and/or an important number of missing data caused by very slow responses. The entire data set of 6 natives, 8 non-natives and 6 non-native controls was removed from the analysis, which leads to 16 natives, 22 non-natives and 14 non-native controls. Analyses were performed on the correct/incorrect participants' responses in the training phase as well as in the pre- and post-test phases. Reaction times (in ms) from the end of the auditory stimulus were examined in the post-test phase only. We analyzed the data by means of mixed-effects logistic and linear regression models (Baayen, Davidson, & Bates, 2008), in which participants and pseudowords were entered as random terms. Statistical analyses were run with the statistical software R (R Core Team, 2013) and mixed-effects models were computed with the package lme4 (Bates & Sarkar, 2007). For clarity's sake, the results and figures are presented in percentages, although all statistical analyses have been performed on raw data.

## RESULTS AND DISCUSSION

### Training

The first goal of this research was to determine whether French-speaking listeners are able to learn to perceive Spanish lexical stress contrasts. To this end, we examined whether the response (correct vs. incorrect) was influenced by the group (natives and non-natives), the block (1, 2, 3, 4 and 5) and the pattern (PP, P, O), or by an interaction between these variables. Given that the pattern had no effect on the responses, a new analysis was run without it. Figure 2 presents the results, with PP, P, and O data grouped together.



**Figure 2.** Percent correct in the training session as a function of block and group. Error bars are the standard error of the mean.

Although the performance is globally better in natives than in non-natives (73% and 59%, respectively; effect of group:  $F(1, 6395) = 5.3$ ,  $p < .05$ ), both groups show a learning progression along the training session (effect of block:  $F(4, 6395) = 141.6$ ,  $p < .001$ ). Nevertheless, the differences between natives and non-natives are not always similar across all the blocks (interaction Group  $\times$  Block:  $F(4, 6395) = 8.4$ ,  $p < .001$ ). Except in the first block, natives perform significantly better than non-natives (Block 1:  $\beta = 0.31$ ,  $z = 1.20$ , n.s.; Block 2:  $\beta = 0.58$ ,  $z = 2.21$ ,  $p < .05$ ; Block 3:  $\beta = 0.99$ ,  $z = 3.71$ ,  $p < .001$ ; Block 4:  $\beta = 0.97$ ,  $z = 3.53$ ,  $p < .001$ ; Block 5:  $\beta = 1.37$ ,  $z = 4.75$ ,  $p < .001$ ), suggesting that the learning process is similar for both



groups at the very beginning of training, but that, after a short phase of familiarization, natives present less difficulties in performing the task than non-natives. Moreover, it is interesting to note that the performance in the fifth block (with no feedback) differs significantly from the fourth block for natives (90.5% and 85.58%, respectively;  $\beta = 0.53$ ,  $z = 2.70$ ,  $p < .01$ ), but not for non-natives (72.72% and 70.38%, respectively;  $\beta = 0.13$ ,  $z = 1.14$ , n.s.). Two reasons might explain the absence of difference in non-natives. Firstly, the pressure caused by the absence of feedback might have interfered with their performance progression. Secondly, non-natives might have reached a ceiling effect, which would suggest that their performances cannot be improved beyond this stage.

These findings suggest that French-speaking listeners are able to learn lexical stress contrasts. In other words, they have the capacity to integrate (at least, temporarily) and retrieve the accentual information, although their performance is not as good as the native Spanish performance<sup>3</sup>.

### Pre- and Post-tests

The second goal of the research was to determine whether the French-speaking participants -who were trained to perceive Spanish stress- have improved, thanks to the training they received, their ability to identify lexical stress from pre- to post-test. To assess this, we examined whether the response (correct vs. incorrect) was influenced by the group (natives, NN controls and non-natives), the experiment (pre- and post-test) and the pattern (PP, P, O), or by an interaction between these variables.

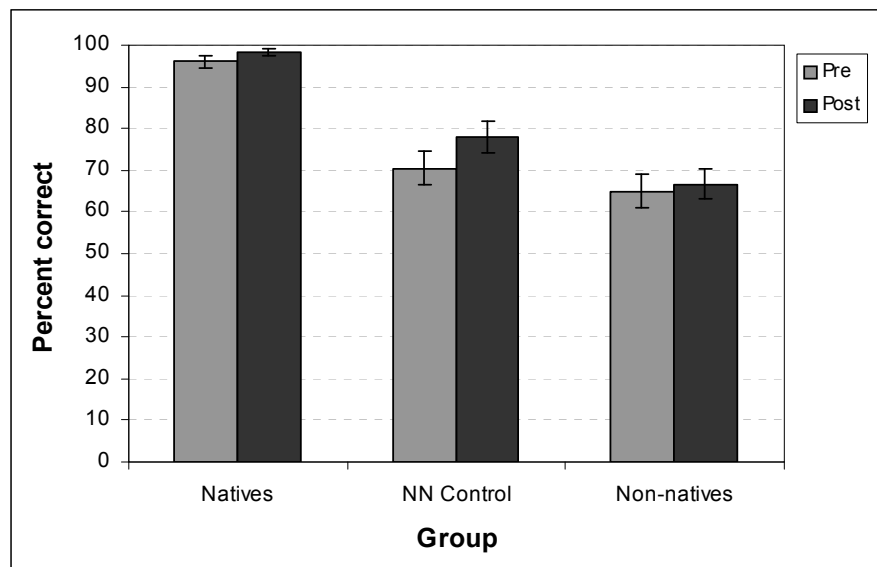
Analyses showed an effect of group ( $F(2, 3699) = 30.18$ ,  $p < .001$ ), an effect of experiment ( $F(1, 3699) = 9.45$ ,  $p < .001$ ), an effect of pattern ( $F(1, 3699) = 9.11$ ,  $p < .001$ ), an interaction Group  $\times$  Pattern ( $F(2, 3699) = 2.66$ ,  $p < .05$ ) and, more interestingly for the purpose of the present research, an interaction Group  $\times$  Experiment ( $F(2, 3699) = 3.34$ ,  $p < .05$ ). Figure 3, that illustrates this interaction, presents the percentage of correct responses as a function of the group and the experiment.

Firstly, we observe that natives are not only better than non-natives ( $\beta = 4.77$ ,  $z = 7.90$ ,  $p < .001$ ) and NN controls ( $\beta = 0.4.26$ ,  $z = 6.72$ ,  $p < .001$ ), but, more interestingly, that they improve from pre- to post-test ( $\beta = 0.92$ ,  $z = 2.27$ ,  $p < .05$ ). This suggests that the mere fact of repeating the exact same task improves the performance.

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<sup>3</sup> These results are in agreement with those found in a previous study with a smaller number of non-native participants (Schwab & Llisterra, 2011b).

Then, regarding the French-speaking listeners, we note that the NN controls (with no training) improve from pre- to post-test ( $\beta = 0.51$ ,  $z = 3.10$ ,  $p < .01$ ), whereas, surprisingly, non-natives with training do not improve ( $\beta = 0.1$ ,  $z = 0.90$ , n.s.). Moreover, the difference between NN controls and non-natives marginally increases from pre- to post-test ( $\beta = 0.81$ ,  $z = 1.92$ ,  $p = .055$ ).



**Figure 3.** Percentage of correct responses as a function of the group and the experiment. Error bars are the standard error of the mean.

To summarize, we have found that (1) the difference between the non-natives with training and the NN controls with no training is larger in the post-test than in the pre-test, and (2) the non-natives do not improve from pre to post-test, contrary to the NN controls. We have attempted to explain these unexpected results taking into account several hypotheses.

One explanation might be that the NN controls were more accurate as a result of being slower than non-natives in their responses during the post-test. To test this, we examined the reaction times of the correct responses in the post-test for the non-natives and the NN controls. Contrary to our hypothesis, results showed that the NN controls were not slower than the non-natives ( $F(1, 909) = 0.03$ , n.s.).

Another explanation might be found in the musical expertise of the non-natives and the NN controls, as some studies have shown that the musical aptitude can have an influence on the perception of prosodic phenomena (Marques, Moreno, Castro, & Besson, 2007; Schön, Magne, & Besson, 2004). Thus, we asked the French-speaking participants to indicate

if they had (on a scale from 1 to 7) the ear for music and the sense of rhythm, if they played a musical instrument and if they were able to sing in tune. As can be seen in Table 1, none of these aspects significantly differed between the NN controls and the non-natives. Thus, the musical expertise does not explain the unexpected difference between the non-natives and the NN controls.

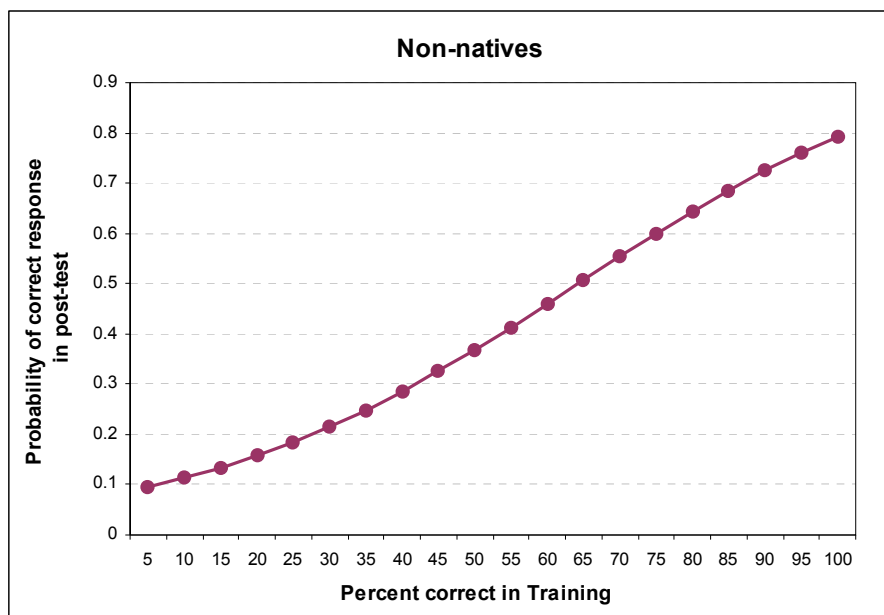
**Table 1.** Musical expertise of the NN controls and non-natives

	<b>NN controls N = 14</b>	<b>Non- natives N = 20<sup>4</sup></b>	<b>Statistical analysis</b>
Ear for music	3.57	4.05	t(31) = 0.8, n.s.
Sense of rhythm	5	4.95	t(32) = 0.9, n.s.
Musical instrument	8	10	$\chi^2(1, N= 34) = 0.17,$ n.s.
Singing in tune	7	8	$\chi^2(1, N= 34) = 0.33,$ n.s.

Finally, it could be that the improvement from pre- to post-test does not depend on the mere fact of receiving training, but rather on the participant's learning ability during the training session. To examine this hypothesis, we studied the impact of the non-native participants' performance at the end of the training (fifth block) on their responses in the post-test. Figure 4 presents the probability of correct responses in the post-test as a function of the results at the end of the training (in non-natives only). We observe that the probability of correct responses increases when the training performance increases ( $F(1,782) = 7.07, p < .01$ ). It seems thus that the participant's learning capacity (i.e., the training performance) does have an influence on the post-test performance: the more able to learn in the training session, the better in the post-test.

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<sup>4</sup> Two of the 22 non-natives did not answer the questions about musical expertise.



**Figure 4.** Estimated probability of correct responses in the post-test as a function of the percentage of correct responses in the training session (in non-natives only).

## CONCLUSIONS

The first aim of our experiment was to determine whether French-speaking listeners are able to learn to perceive Spanish lexical stress contrasts. Our results have shown that, although their performance does not reach those of native speakers of Spanish, French-speaking listeners have the capacity to integrate and retrieve (at least, temporarily) the accentual information present in a small set of Spanish pseudowords.

Our second aim was to examine whether training can improve French-speaking listeners' performance in identifying the position of lexical stress in Spanish words. For this, we compared the data of French-speaking participants with training (i.e., non-natives) and with no training (i.e., NN controls) in the pre- and post-tests. An unexpected difference between both groups has been found: the French-speaking participants who took part in the training sessions do not show an improvement from the pre- to the post-test, while the controls with no training do improve their scores. Among the several potential explanations, the most convincing one is that the improvement from pre- to post-test does not depend on the mere fact of receiving training, but depends on the participant's learning ability in the training session.

In future work, the issue of stress perception by French-speaking listeners will be addressed with the consideration of the following aspects: (1) phonetic variability will be introduced in the stimuli, as they will be produced by different speakers; (2) similar tasks (implying a lexical processing) will be used both in training and in the pre- and post-test, so that lexical processing will be involved in all phases of the experiment; (3) words and pseudowords will be included in the training as well as in the pre- and post-tests, to make sure that the French speaking-participants, although with no knowledge of Spanish, do not process both types of stimuli in a different way.

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