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The discrimination of Spanish lexical stress contrasts by French-speaking listeners

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Abstract. The goal of the present research is to examine the role of the acoustic parameters involved in the discrimination of Spanish lexical stress contrasts by French-speaking listeners, and to validate the results of a previous study in which we used a stress identification task. The participants of the present experiment were ten French-speaking advanced learners of Spanish and ten French-speaking participants without knowledge of Spanish. They performed an AX discrimination task in which they heard pairs of Spanish trisyllabic words, and had to indicate whether the position of stress in the two stimuli was the same or different. The results support the idea that the perception of an accentual difference depends on the acoustic parameters involved in the manipulation applied to create a stress shift. More specifically, we found that the role of the acoustic parameters varies as a function of the accentual pattern and the competence in L2.

Keywords: lexical stress, stress ‘deafness’, prosodic transfer, L2 speech perception, French L1, Spanish L2

Introduction

It has been frequently noted that French learners of Spanish tend to place the stress on the final syllable of Spanish words (Gil, 2007; Rico, 2012), a fact that is explained as the manifestation of an accentual transfer, since French has been traditionally classified as a fixed-stress language, while Spanish is characterized as a free-stress language (Garde, 1968). In French, primary stress delimits sequences of words (stress groups or rhythmic groups) and appears at the end of such sequences, specifically in reading and in neutral speaking styles (Carton, 1974; Rossi, 1979; Vaissière, 1990). On the contrary, Spanish stress fulfils a distinctive role at the lexical level (Quilis, 1981, 1993), allowing for contrasts such as [ˈbaliðo] (*válido*, ‘valid’), [baˈliðo] (*valido*, ‘I validate’) and [baliˈðo] (*validó*, ‘he/she validated’).

The acoustic phonetic realization of stress also differs in French and in Spanish. Although syllabic prominence is achieved through variations in fundamental frequency (f_0), intensity and duration in both languages, stress in French is realized with an increase in duration and, to a lesser extent, in f_0 (Léon & Martin, 2000; Léon, 2011); in Spanish, stress is usually the result of a combined increase of duration and f_0 values (Quilis, 1981).

Moreover, native speakers differ in the perceptual cues they use to detect accentual prominences. French listeners tend to privilege an increase in f_0 (Rigault, 1962), while changes in f_0 (Enríquez, Casado, & Santos, 1989) combined with changes in either duration or intensity appear to be necessary to identify the position of lexical stress in Spanish isolated words (Llisterrí, Machuca, Mota, Riera, & Ríos, 2005).

These phonological and phonetic differences in the accentual systems might account for the difficulties experienced in production, but also in perception, by speakers of a fixed-stress language such as French when confronted to accentual contrasts in a free-stress language such as Spanish.

The role of the phonological categories of the first language (L1) as mediators in the perception of a second language (L2) was already acknowledged by the early European tradition of the Prague Linguistic Circle. The metaphors of ‘phonological deafness’ (*surdité phonologique*) (Polivanov, 1931) and of the ‘phonological sieve’ (*crible phonologique*) (Troubetzkoy, 1949) tried to capture the perceptual nature of the errors due to transfer from the L1 to an L2. Building on these ideas, the notion of ‘accentual filter’ (*crible accentuel*) has been introduced by several researchers as an

explanation for transfer phenomena in the domain of stress (Billières, 1988; Borrell & Salsignac, 2002; Dolbec & Santi, 1995; Frost, 2010; Muñoz García, 2010; Salsignac, 1998).

In a series of studies on the perception of lexical stress by French speakers, Dupoux and his collaborators (Dupoux, Pallier, Sebastián Gallés, & Mehler, 1997; Dupoux, Peperkamp, & Sebastián Gallés, 2001; Dupoux, Sebastián Gallés, Navarrete, & Peperkamp, 2008; Peperkamp & Dupoux, 2002) have put forward the hypothesis that a stress ‘deafness’ (a particular case of phonological ‘deafness’) might explain the difficulties exhibited by speakers of a language lacking contrastive stress when they are exposed to contrasts in accentual patterns. The results of their experiments indicated that when stimuli with phonetic variability were presented and a cognitively demanding task was used, French listeners, either monolingual or learners of Spanish, had difficulties in perceiving the position of stress which were not found in the native Spanish-speaking participants. This led the authors to conclude that “stress ‘deafness’ is better interpreted as a lasting processing problem resulting from the impossibility for French speakers to encode contrastive stress in their phonological representations” (Dupoux et al., 2008, p. 683).

Using a different approach, Mora, Courtois, and Cavé (1997) have shown that French listeners without knowledge of Spanish were able to correctly identify 87% of the stressed syllables in a sample of spontaneous speech in Spanish, although they did not necessarily rely on the same acoustic cues used by native Spanish listeners. Very similar levels of performance in a stress identification task (around 83%) have been reported by Muñoz García, Panissal, Billières, and Baqué (2009) for French speakers listening to isolated words and to words in a sentence context in Spanish; furthermore, participants with an advanced level of Spanish performed better than those with basic or intermediate knowledge of the language.

The results of all these studies suggest that the effects of the accentual filter might depend, among other factors, on the nature of the task performed by the participants and, in certain cases, on their level of proficiency in the L2. In order to shed some more light on the prosodic transfer that may occur in the perception of lexical stress, we have undertaken a series of experiments in which French listeners were exposed to accentual contrasts in Spanish.

The results of a first experiment showed that, when performing an identification (i.e. phonetic) task, French listeners were able to identify the position of lexical stress in approximately 70% of the cases, although the performance was influenced by the type of stress pattern; moreover, f_0 appeared as the most important parameter in the perception of the stress position and knowledge of Spanish influenced the sensitivity to the acoustic cues which signal the prominence of the stressed syllable (Schwab & Llisterri, 2010, 2011b).

In a second experiment, a shape-pseudoword matching task was adopted. We found that French-speaking listeners were able, after a short training, to encode and to retrieve the accentual information present in a small set of Spanish isolated pseudowords, although the responses to the acoustic manipulations performed on the stimuli lead us to hypothesize that the accentual representation acquired and stored by the French speakers was more rigid than the representation encoded by Spanish native speakers (Schwab & Llisterri, 2011a, 2012, 2014).

In the following sections, we will present the methodology and the results of a third experiment, in which a discrimination task has been used.

Method

Participants

Two groups of French speaking participants took part in the experiment: a group with advanced knowledge of Spanish and another one with no knowledge of the language. The advanced group was composed of 10 participants. They were between 21 and 36 years old and were all raised in a monolingual French speaking environment. They had been studying Spanish at the University of Neuchâtel (Switzerland) for 6-11 years. The group without knowledge of Spanish consisted of 10

students of the University of Neuchâtel. They were between 19 and 24 years old and were all raised in a French speaking monolingual environment. None of them reported good knowledge of Italian, which excludes the potential bias of knowing a free-stress Romance language.

Material

The corpus, taken from Llisterra et al. (2005), was composed of 4 triplets of trisyllabic words (CV.CV.CV) and 4 triplets of trisyllabic analogue pseudowords. All words and pseudowords could be proparoxytones (PP; e.g., ['baliðo], *válido*, ‘valid’), paroxytones (P; e.g., [ba'liðo], *valido*, ‘I validate’) or oxytones (O; e.g., [bali'ðo], *validó*, ‘he/she validated’).

The stimuli were divided into *Base* stimuli (i.e. without any manipulation) and *Manipulated* stimuli. For the creation of manipulated stimuli, we proceeded as follows: in proparoxytone words, f_0 , amplitude and duration values for each vowel were replaced by the corresponding f_0 , amplitude and duration values found in the equivalent paroxytone words (PP>P *Manipulated stimuli*); likewise, in paroxytone words, f_0 , amplitude and duration values for each vowel were replaced by the corresponding f_0 , amplitude and duration values found in the equivalent oxytone words (P>O *Manipulated stimuli*). In fact, manipulated stimuli resulted in a shift to the right of the accentual information, as can be observed in Figures 1 and 2.

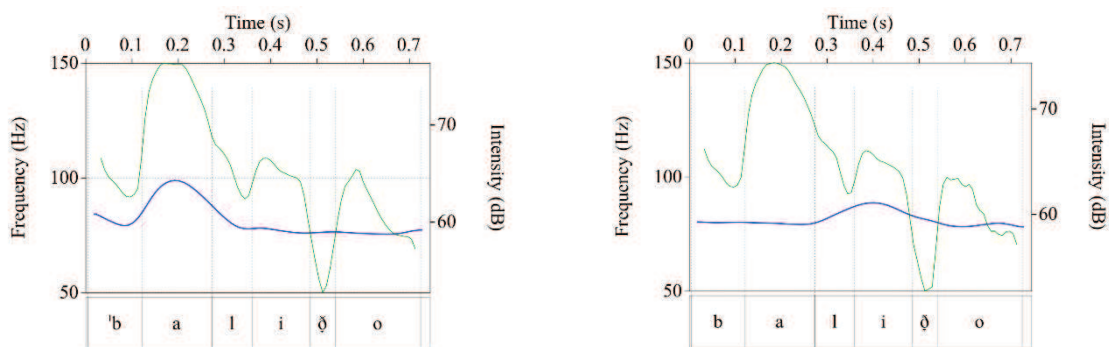


Figure 1. PP>P Manipulated stimulus: base stimulus *válido* (PP) on the left and the result of the manipulation of f_0 (in blue) using the values from *valido* (P) on the right.

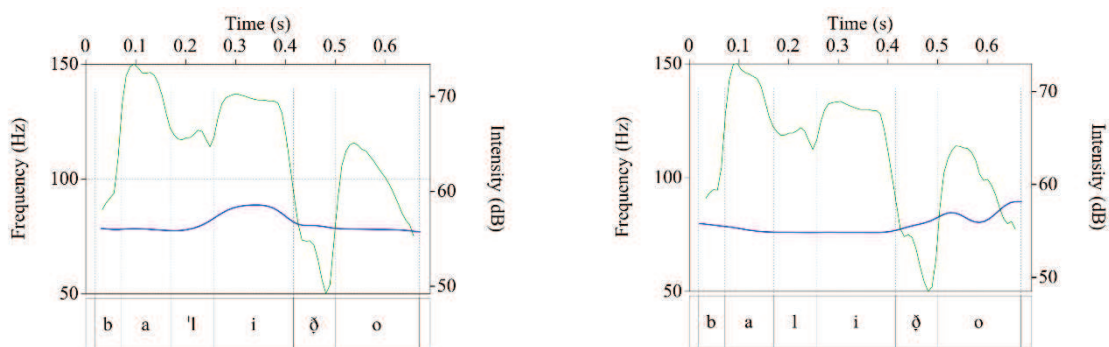


Figure 2. P>O Manipulated stimulus: base stimulus *valido* (P) on the left and the result of the manipulation of f_0 (in blue) using the values from *validó* (O) on the right.

The values were modified not only individually, but also simultaneously, obtaining the seven possible combinations of manipulated parameters: f_0 , amplitude, duration, f_0 +duration, f_0 +amplitude, duration+amplitude, f_0 +duration+amplitude. This strategy allows us to study the effects of each acoustic cue both in isolation and in combination with the others. All the manipulations were

performed by resynthesis, using the PSOLA algorithm implemented in Praat (Boersma & Weenink, 2015).

During the test, the stimuli were presented in pairs in which a *Manipulated* stimulus was always presented with a *Base* stimulus. The *Base* stimulus appeared in half of the stimuli with the original stress pattern of the *Manipulated* stimulus (i.e. PP *Base* stimulus for PP>P *Manipulated* stimulus; P *Base* stimulus for P>O *Manipulated* stimulus) and, in the other half of the stimuli, with the intended shifted stress pattern of the *Manipulated* stimulus (i.e. P *Base* stimulus for PP>P *Manipulated* stimulus; O *Base* stimulus for P>O *Manipulated* stimulus). In total, 224 of different stimuli were used: 4 words and 4 pseudowords x 2 patterns x 7 manipulations x 2 pair members. Half the stimuli were presented in the *Base-Manipulated* order and the other half in the *Manipulated-Base* order.

Control pairs with identical stimuli were also included in the test. Among them, 24 were *Base-Base* pairs and 48 were *Manipulated-Manipulated* (4 words and 4 pseudowords x 3 manipulations x 2 patterns). In total, 296 trials were used in this experiment.

Procedure

Participants performed a stress AX discrimination task and were run individually. The experiment was run from a laptop using the DMDX software (Forster, 2012), which recorded the participants' responses. The participants listened to each trial (composed of a pair of stimuli) and had to indicate, as fast as possible, whether the position of the stress in the two members of the pair was "Identical" or "Different", by pressing the *Id* or *Diff* key on a keyboard. The two elements of the trial were separated by 500 ms. The participants had 2 seconds to answer and did not receive any feedback. The experiment began with a few training trials and lasted 20 minutes.

The 296 trials were divided into 4 blocks, each one containing 74 trials with the following conditions: 37 words and 37 pseudowords; 28 *Base-Manipulated* and 28 *Manipulated-Base* pairs; 6 *Base-Base* pairs (2 for each stress pattern: PP, P, O); 8 pairs for each of the 7 modifications; 12 control *Manipulated-Manipulated* pairs (6 PP>P and 6 P>O); 14 pairs for each accentual pattern (PP>P with P; PP with PP>P; P with P>O; P>O with O) The order (*Base-Manipulated* and *Manipulated-Base*) was counterbalanced across lexical status, manipulations, and stress patterns. Within each block, the trials were presented randomly, and the 4 blocks were also randomly distributed. Thus, each participant received a different presentation order.

Data analysis

First, the correct/incorrect responses to the control trials (i.e. identical pairs) were collected in order to ensure that the participants performed correctly the task. Then, we examined the Identical/Different (*Id/Diff*) responses of the test trials, composed of a *Manipulated* stimulus and a *Base* stimulus.

The two accentual patterns (PP>P and P>O) are hardly comparable, because stress is also associated with the prepausal status of the last syllable of the word in the P>O pattern. To that respect, Enríquez et al. (1989) noted that "para explicar la percepción acentual no sólo hay que tener en cuenta el parámetro que interviene, sino, además (y muy especialmente, en la Duración), el esquema acentual de la palabra . . . nos lleva a considerar una oposición entre segmentos interiores de palabra frente al segmento final de palabra, con comportamientos diferentes en cada caso" (p. 267). For that reason, we ran two separate analyses for PP>P and P>O stimuli in the case of pairs containing different stimuli.

Statistical analyses were carried out with the R software (Kuznetsova, Brockhoff, & Christensen, 2014; R Core Team, 2014). We ran the analyses on the Identical/Different responses using mixed-effects logistic regression models (Baayen, Davidson, & Bates, 2008). The dependent variable was the *Id/Diff* response. The predictors were the following: Competence in Spanish (*Advanced, No Knowledge*), Pair member (PP and P for PP>P stimuli; P and O for P>O stimuli), Lexical status (*Words, Pseudowords*) and Manipulation. The control variables were the presentation order of the pair (*Manipulated-Base, Base-Manipulated*) and the presentation blocks.

Participants and trials were entered as random variables. The significance of the main effects and interactions was assessed with likelihood ratio tests that compared the model with the main effect or

interaction to a model without it. For clarity's sake, the results and figures are presented in percentages, although all statistical analyses have been performed on raw data (*Id/Diff* responses).

Considering, for example, the PP>P stimuli, an effect of pair member may be interpreted as follows according to the direction of the effect: 1) The manipulation triggers less “Different” (*Diff*) responses when the manipulated stimulus (PP>P) is paired with a PP stimulus than when paired with a P stimulus, meaning that the manipulation does not induce the perception of a stress shift. For example, the manipulated stimulus *valido* (PP>P) presents 10% of *Diff* responses when it is paired with the PP stimulus *valido* (PP>P paired with PP), whereas the same manipulated stimulus presents 90% of *Diff* responses when it is paired with the P stimulus *valido* (PP>P paired with P). 2) The manipulation triggers more *Diff* responses when the manipulated stimulus (PP>P) is paired with a PP stimulus than when paired with a P stimulus, meaning that the manipulation induces the perception of a stress shift. For example, the manipulated stimulus *valido* (PP>P) presents 90% of *Diff* responses when it is paired with the PP stimulus *valido*, whereas the same manipulated stimulus presents 10% of *Diff* responses when it is paired with the P stimulus *valido*. 3) The manipulation triggers the same number of *Diff* responses when the manipulated stimulus (PP>P) is paired with a PP stimulus than when paired with a P stimulus, meaning that the manipulation “does something, but not enough” for the stress shift to be clearly perceived. For example, the manipulated stimulus *valido* (PP>P) presents 60% of *Diff* responses when it is paired with the PP stimulus *valido*, and the same manipulated stimulus also presents 60% of *Diff* responses when it is paired with the P stimulus *valido*.

Results and discussion

Control trials

The participants' performance was between 95.24% and 100% of *Identical* responses for the trials composed of identical elements, which indicates that they performed the task properly.

PP>P Manipulated stimuli

As far as the *Id/Diff* responses are concerned, since the control variables (i.e., presentation order and blocks) showed no effect, they were removed from the model. The lexical status was also removed from the model, since it showed no effect and did not interact with other variables. Given the presence of the three-way interaction Competence x Pair member x Manipulation, we ran separate analysis for each manipulation, in order to determine whether the manipulation induces the perception of a stress shift (i.e., presence of an effect of pair member), and in order to examine the difference between the advanced participants and the participants with no knowledge of Spanish.

Manipulation of duration

Regarding the isolated manipulation of duration (see Figure 3), we observe an effect of Pair member, with more *Diff* responses when the manipulated stimulus was paired with P (90.23%) than when it was paired with PP (16.04%) ($\chi^2(1) = 23.01$, $p < .001$), which indicates that the manipulation of duration does not seem to induce the perception of a stress shift. Then, the results show an effect of Competence (Advanced = 50.38% and No Knowledge = 55.89%; $\chi^2(1) = 4.37$, $p < .05$), but no interaction Pair Member x Competence ($\chi^2(1) = 2.64$, *ns*).

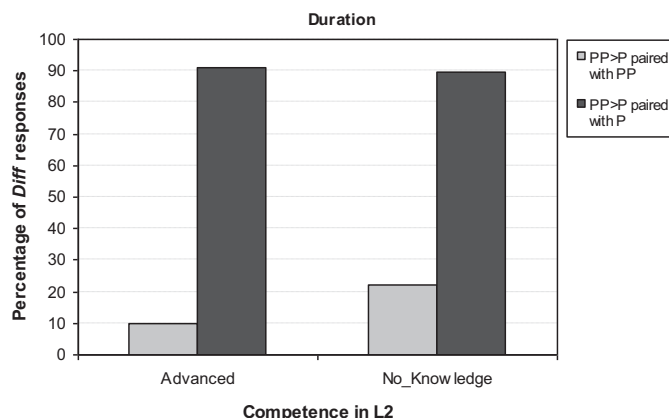


Figure 3. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the isolated manipulation of duration.

Manipulation of f_0

As far as the isolated manipulation of f_0 is concerned, we observe no effect of Pair member ($\chi^2(1) = 0.01$, *ns*), no effect of Competence ($\chi^2(1) = 0.19$, *ns*), and no interaction between both variables ($\chi^2(1) = 1.59$, *ns*). As can be seen in Figure 2, the manipulation of f_0 alone does not clearly induce the perception of a stress shift (67.66% of *Diff* responses for “PP>P paired with PP”) and 61.62% for “PP>P paired with P”). Nevertheless, it “does something”, although not sufficiently to clear-cut the perception between the PP and P stimuli.

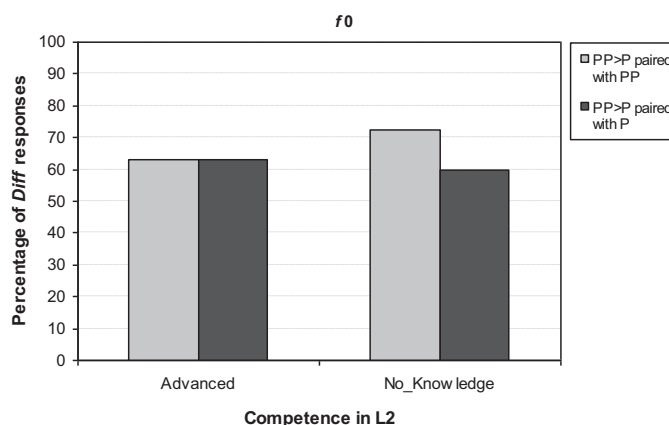


Figure 4. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the isolated manipulation of f_0 .

Manipulation of intensity

With regard to the isolated manipulation of intensity (see Figure 5), a clear effect of the Pair member is observed, with more *Diff* responses for “PP>P paired with P” (95.28%) than for “PP>P paired with PP” (0.65%) ($\chi^2(1) = 41.81$, $p < .001$), which indicates that the manipulation of intensity alone does not induce the perception of a stress shift. Moreover, no effect of Competence ($\chi^2(1) = 1.29$, *ns*) and no interaction between both variables ($\chi^2(1) = 2.36$, *ns*) are noted.

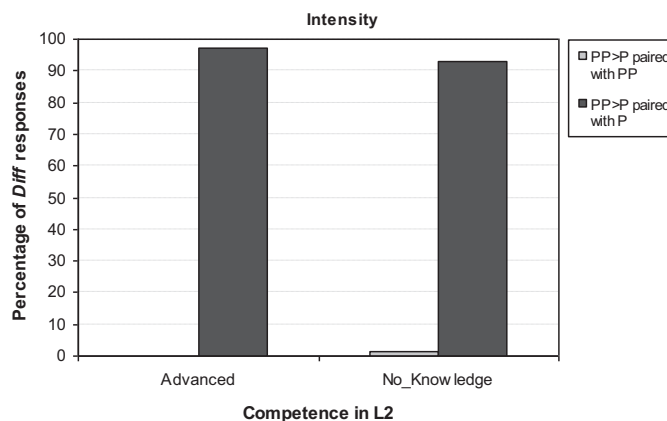


Figure 5. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the isolated manipulation of intensity.

Manipulation of duration and intensity

As for the combined manipulation of duration and intensity (see Figure 4), the results show an effect of the Pair member, with more *Diff* responses for “PP>P paired with P” (84.27%) than for “PP>P paired with PP” (17.21%) ($\chi^2(1) = 22.60, p < .001$). Thus, the manipulation of duration and intensity does not induce the perception of a stress shift. An effect of Competence is observed (Advanced = 48.76% and No Knowledge = 52.73%; $\chi^2(1) = 10.05, p < .01$), as well as an interaction between the Pair member and the Competence is present ($\chi^2(1) = 12.12, p < .001$): the participants with no knowledge of Spanish give more *Diff* responses than the advanced participants when the stimulus is paired with PP stimuli. In that sense, the former are more sensitive to the combined manipulation of duration and intensity than the latter.

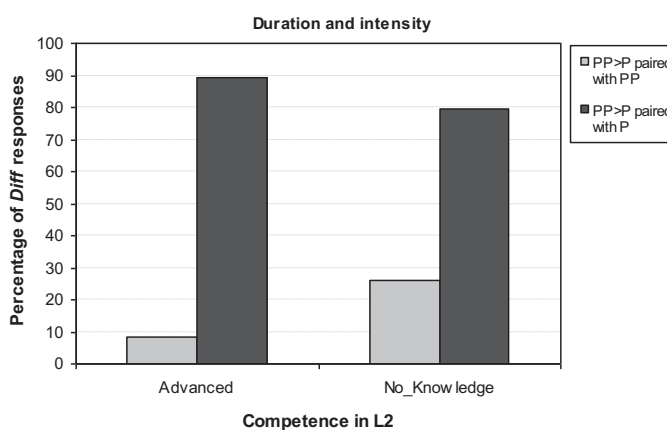


Figure 6. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of duration and intensity.

Manipulation of f_0 and duration

As for the combined manipulation of f_0 and duration (see Figure 7), the results show an effect of Pair member, with more responses *Diff* for “PP>P paired with PP” (91.81%) than for “PP>P paired with P” (34.21%) ($\chi^2(1) = 22.21, p < .0001$). Therefore, the combined manipulation of f_0 and duration does induce the perception of a stress shift. No significant effect of Competence is observed ($\chi^2(1) = 0.97, ns$), although there are more *Diff* responses for the participants with no knowledge of Spanish (70.16%) than for the advanced participants (55.86%). Despite the smaller difference between “PP>P

paired with PP” and “PP>P paired with P” in participants without knowledge than in advanced participants, no significant interaction is observed ($\chi^2(1) = 0.66, ns$).

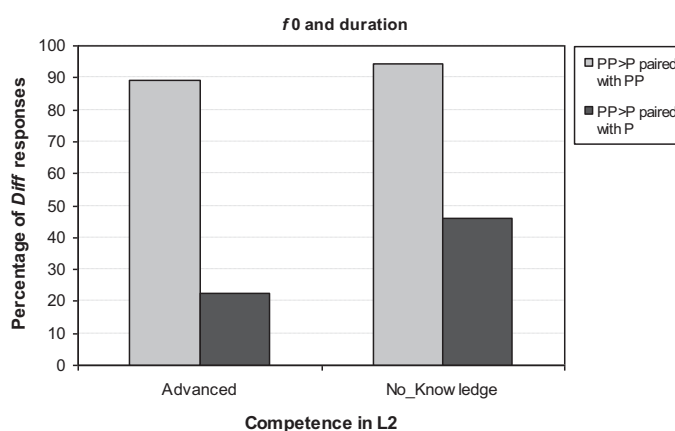


Figure 7. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of f_0 and duration.

Manipulation of f_0 and intensity

Regarding the combined manipulation of f_0 and intensity, no effect of Pair member is observed ($\chi^2(1) = 1.00, ns$), in spite of the difference that can be noted in Figure 8 (77.87% of *Diff* response for the “PP>P paired with PP” and 59.87% for “PP>P paired with P”). Like in the case of the isolated manipulation of f_0 , it seems, thus, that the combined manipulation of f_0 , and intensity “does something”, but not sufficiently to clear-cut the perception between the PP and P stimuli. Moreover, results show no effect of Competence ($\chi^2(1) = 1.21, ns$) and no interaction Pair Member x Competence ($\chi^2(1) = 0.24, ns$).

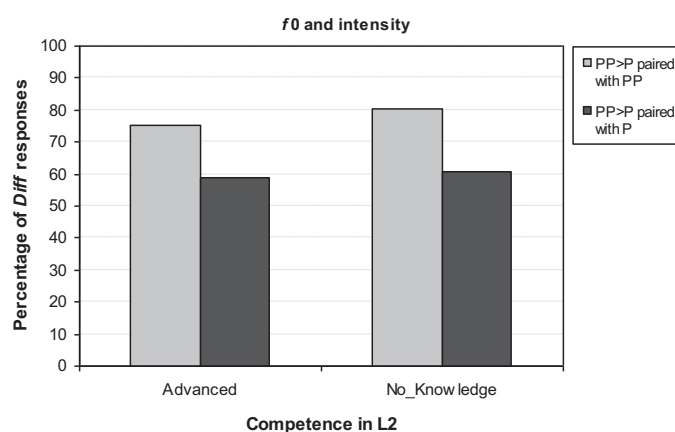


Figure 8. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of f_0 and intensity.

Manipulation of f_0 , duration and intensity

Finally, as for the combined manipulation of the three parameters (Figure 9), an effect of Pair member is observed ($\chi^2(1) = 31.53, p < .001$), with more responses *Diff* for “PP>P paired with PP” (95.80%) than for “PP>P paired with P” (32.72%). Therefore, as expected, this manipulation induces the perception of a stress shift. Moreover, no effect of Competence is noted ($\chi^2(1) = 0.01, ns$), although

we observe more *Diff* responses for the participants without knowledge (70.44%) than for the advanced participants (58.09%). Moreover, the participants with no knowledge, in comparison with advanced participants, present a smaller difference between “PP>P paired with PP” and “PP>P paired with P” ($\chi^2(1) = 1.71, p < .01$).

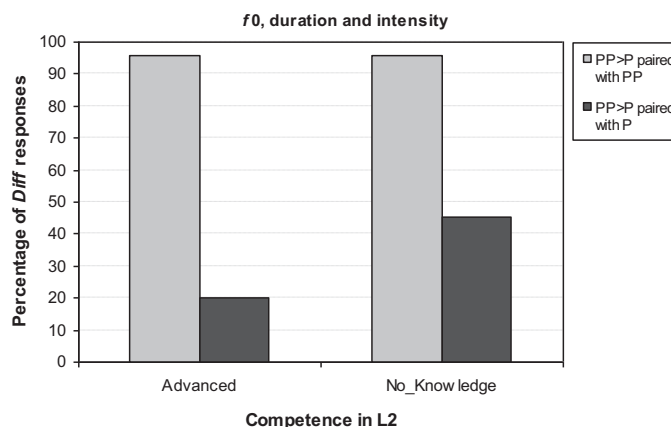


Figure 9. Percentage of *Different* responses as a function of the pair member (PP>P paired with PP, PP>P paired with P) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of f_0 , duration and intensity.

Summary

In summary, the manipulation of duration and intensity, in isolation or in combination, does not trigger the perception of a stress shift in the case of PP>P stimuli. The manipulation of f_0 , alone or with intensity, seems to “do something”, but not sufficiently to clear-cut the perception of the stimulus as being different from the stimulus with the original or the shifted stress pattern. The role of the intensity seems minor, since it does not “help” f_0 . On the other hand, the combined manipulation of f_0 and duration triggers the perception of the stress shift, with or without intensity. The differences between the advanced participants and the participants with no knowledge of Spanish are mainly observed when the manipulation involves duration. It seems that the participants with no knowledge are more sensitive to the manipulation of this parameter than the advanced participants.

P>O Manipulated stimuli

Given the presence of the three-way interaction Pair member x Manipulation x Competence, we ran separate analysis for each manipulation, in order to determine whether the manipulation induces the perception of a stress shift (i.e., presence of the effect of the Pair member), and in order to examine the difference between the advanced participants and the participants with no knowledge in Spanish. Since lexical status was not involved in the three-way interaction with competence, it was not included in further analyses. Regarding the control variables, whereas Block showed no effect and was removed from the analyses, the presentation order within the pair has a significant effect (i.e. more *Diff* responses for the *Base-Manipulated* than for *Manipulated-Base*) and was included in further analyses, although it will not be discussed in this paper.

Manipulation of duration

Regarding the isolated manipulation of duration (see Figure 10), we observe an effect of Pair member, with more *Diff* responses for “P>O paired with O” (79.49%) than for “P>O paired with P” (37.17%) ($\chi^2(1) = 6.71, p < .01$), which indicates that the manipulation of duration does not seem to induce the perception of a stress shift. Then, the results show no effect of Competence ($\chi^2(1) = 0.01, ns$) and no interaction Pair Member x Competence ($\chi^2(1) = 1.60, ns$).

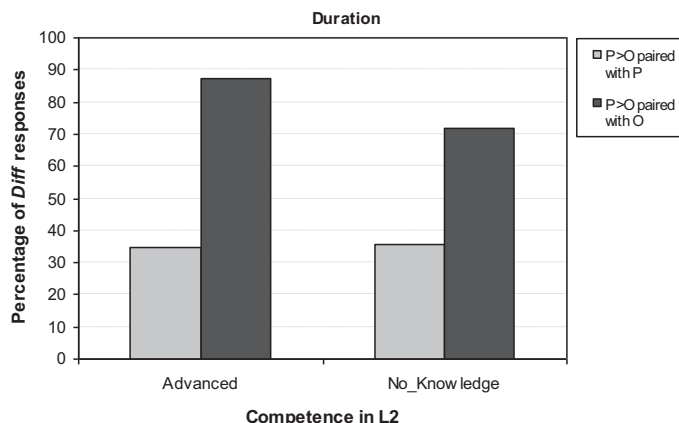


Figure 10. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the isolated manipulation of duration.

Manipulation of f₀

As far as the isolated manipulation of *f₀* is concerned (see Figure 11), we observe an effect of Pair member ($\chi^2(1) = 9.22, p < .01$) with more *Diff* responses for “P>O paired with O” (70.31%) than for “P>O paired with P” (39.63%). Moreover, no effect of Competence ($\chi^2(1) = 0.00, ns$) and no interaction between both variables ($\chi^2(1) = 2.76, ns$) were observed. These results indicate that the manipulation of *f₀* alone does not trigger the perception of a stress shift.

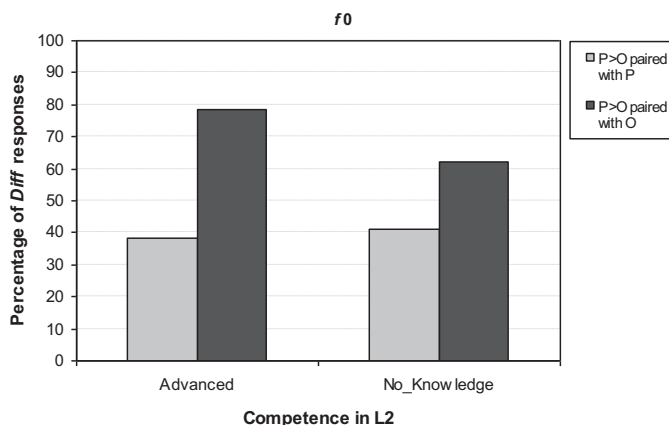


Figure 11. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the isolated manipulation of *f₀*.

Manipulation of intensity

With regard to the isolated manipulation of intensity (see Figure 12), an effect of the Pair member is observed ($\chi^2(1) = 14.18, p < .001$), with more *Diff* responses for “P>O paired with O” (91.42%) than for “P>O paired with P” (22.50%), which indicates that the manipulation of intensity alone does not induce the perception of a stress shift. Moreover, no effect of Competence ($\chi^2(1) = 1.25, ns$) and no interaction between both variables ($\chi^2(1) = 0.25, ns$) are noted.

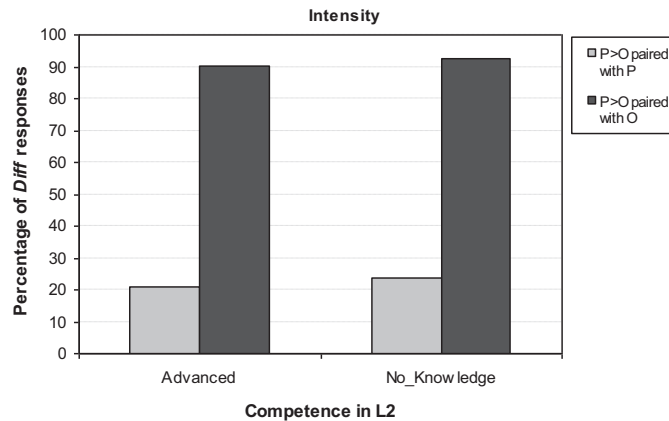


Figure 12. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the isolated manipulation of intensity.

Manipulation of duration and intensity

As for the combined manipulation of duration and intensity (see Figure 13), the results show an effect of the Pair member, with more *Diff* responses for “P>O paired with O” (71.35%) than for “P>O paired with P” (36.98%) ($\chi^2(1) = 8.32, p < .01$). Thus, the manipulation of duration and intensity does not induce the perception of a stress shift. No effect of Competence is observed ($\chi^2(1) = 1.33, ns$), but a marginal interaction between the Pair member and the Competence ($\chi^2(1) = 3.17, p = .08$) has been found. The participants with no knowledge gave less *Diff* responses (44.6%) than the advanced participants (63.73%), especially when the manipulated stimulus was paired with an O stimulus. Participants without knowledge seem thus to be less sensitive to this manipulation than the advanced participants.

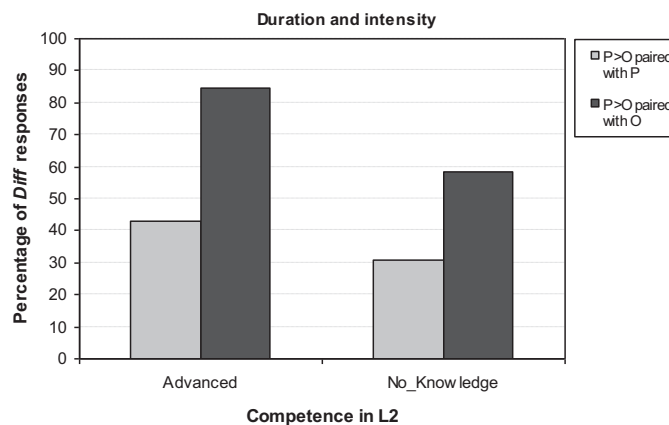


Figure 13. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of duration and intensity.

Manipulation of f_0 and duration

As far as the combined manipulation of f_0 and duration is concerned, the results show an effect of Pair member, with more *Diff* responses for “P>O paired with P” (64.91%) than for “P>O paired with O” (40.57%) ($\chi^2(1) = 6.35, p < .05$). Therefore, the combined manipulation of f_0 and duration induces the perception of a stress shift. An effect of Competence is observed ($\chi^2(1) = 6.09, p < .05$), as well as an interaction Pair Member x Competence ($\chi^2(1) = 7.60, p < .01$). As can be seen in Figure 14, the

advanced participants present a greater difference between “P>O paired with P” and “P>O paired with O” stimuli than the participants with no knowledge.

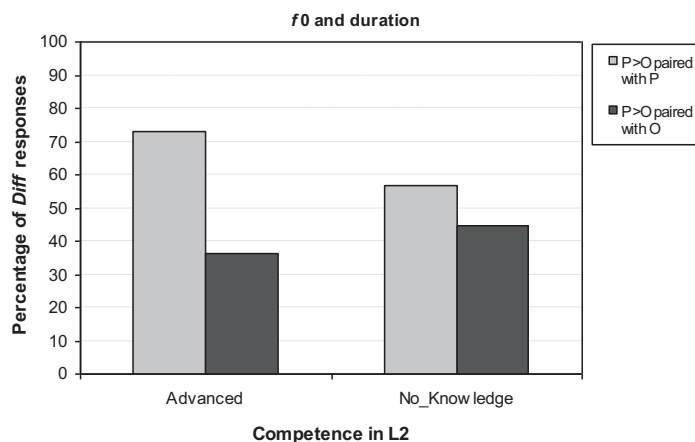


Figure 14. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of f_0 and duration.

Manipulation of f_0 and intensity

Regarding the combined manipulation of f_0 and intensity, no effect of Pair member ($\chi^2(1) = 0.84, ns$) and no effect of Competence ($\chi^2(1) = 0.32, ns$) are observed. An interaction between Pair Member and Competence is however present ($\chi^2(1) = 5.51, p < .05$). As can be seen in Figure 15, the Pair member effect goes in different direction in the advanced participants and in the participants with no knowledge. The former tend to perceive more differences when the manipulated stimulus is paired with the stimulus with the original pattern (“P>O paired with P”), while the participants without knowledge perceive more differences when the manipulated stimulus is paired with the stimulus with the shifted pattern (“P>O paired with O”).

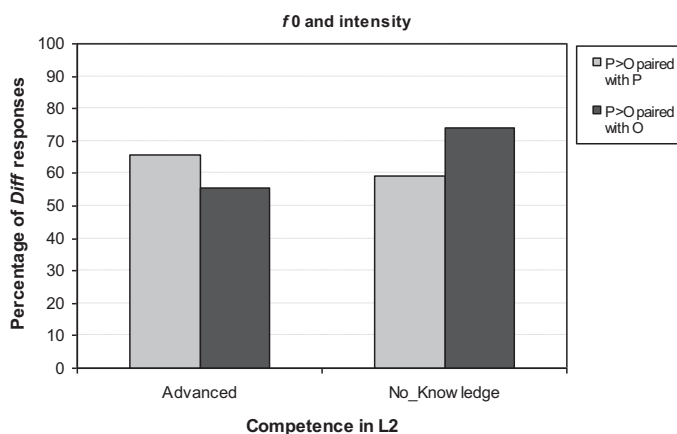


Figure 15. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of f_0 and intensity.

Manipulation of f_0 , duration and intensity

Finally, as for the combined manipulation of the three parameters, an effect of Pair member is observed ($\chi^2(1) = 8.32, p < .001$), with more *Diff* responses for “P>O paired with P” (74.97%) than for

“P>O paired with O” (26.90%). Therefore, as expected, this manipulation induces the perception of a stress shift. An effect of Competence is noted ($\chi^2(1) = 1.33$, $p < .001$), as well as a marginal interaction between the Pair Member and the Competence ($\chi^2(1) = 3.17$, $p = .08$). As can be seen in Figure 14, the difference between “P>O paired with P” and “P>O paired with O” is smaller in the participants with no knowledge than in the advanced participants, which might suggest that the participants without knowledge are less sensitive to this manipulation than the advanced participants.

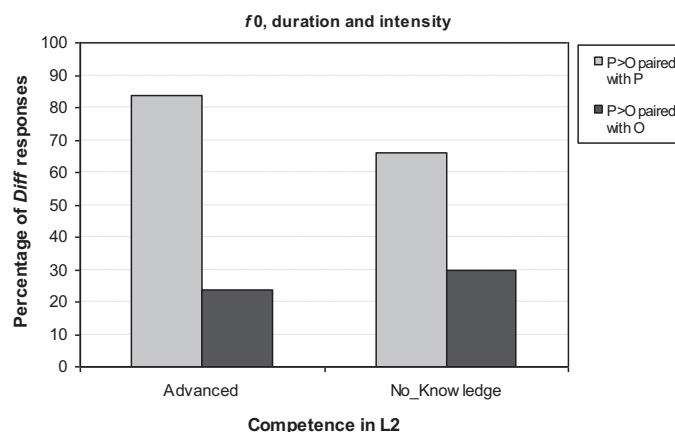


Figure 16. Percentage of *Different* responses as a function of the pair member (P>O paired with P, P>O paired with O) and the competence in L2 (Advanced, No Knowledge) for the combined manipulation of f_0 , duration and intensity.

Summary

In summary, the combined manipulation of f_0 and duration, with or without intensity, clearly triggers the perception of a stress shift in P>O stimuli. The isolated manipulation of f_0 , duration or intensity, as well as the combined manipulation of duration and intensity do not cause the perception of a stress shift. The combined manipulation of f_0 and intensity seems to “do something”, but not sufficiently to clear-cut the perception of the stimulus as being different from the stimulus with the original or the shifted stress pattern.

Conclusion

In PP>P (e.g., *válido* manipulated using the values from *valido*) and in P>O (e.g., *valido* manipulated using the values from *validó*), f_0 seems to play the most important role in the perception of a stress shift, especially when combined with duration, whereas intensity plays a minor role. The main difference between the two accentual patterns resides in the isolated manipulation of f_0 . While f_0 alone does not induce the perception of a stress shift in PP>P stimuli, it seems to “do something” in P>O stimuli, but not enough to clear-cut the perception of a stress shift. On the overall, the results from the discrimination test confirm the findings of a previous experiment in which an identification task was used (Schwab & Llisterri, 2010, 2011b).

The differences between the advanced participants and the participants without knowledge of Spanish mainly concern the role of duration, but they present an opposite trend in PP>P and P>O. Whereas it seems that the participants with no knowledge tend to be more sensitive to duration than advanced participants in PP>P stimuli, they are less sensitive in the case of P>O. This might be explained by the expectations that the participants with no knowledge might have from the French accentuation. As French stress is realized on the final syllable with an important lengthening (Léon, 2011), the participants without knowledge, not used to the phonetic realization of stress in Spanish, might have been less sensitive to duration in P>O than the advanced participants, because the lengthening of the final syllable in the Spanish stimuli was not as important as it would be in French.

To summarize, this investigation supports the idea that the perception of an accentual difference depends on the acoustic parameters used in the realization of the stress shift. More specifically, it has been shown that the role of the acoustic parameters varies as a function of the accentual patterns (PP>P and P>O) and the competence in L2. However, further work is needed to assess the effects of increasing the phonetic variability of the stimuli with the introduction of more voices and to explore the perception of lexical stress in words in context.

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