1. ABSTRACT

The present work analyses the perception of lexical stress in Spanish by Italian and French native speakers, trying to take into account the differences between Italian, French and Spanish stress systems both in perception and in production.

We have designed two perception experiments using a similar procedure of other works with native subjects (Llisterri et al., 2005; Alfano, 2006) and non-native subjects (Alfano et al., 2007; Alfano et al., 2009). The corpus consisted of couples and triplets of meaningful three syllable words and meaningless three syllable words (pseudo-words), with three different possible stress patterns: proparoxytone (PP), paroxytone (P) and oxytone (O). It was analyzed using the Praat software (Boersma & Weenink, 2003); for each of the three vowels of the words, we measured fundamental frequency (f₀) and vowel duration (D). F₀ and D values of the original words were systematically manipulated and a resynthesis was performed to create the stimuli used in the test, so that the role of these cues in perception could be studied. The test stimuli were created in the following way: in proparoxytone words, f₀ and duration values for each vowel were replaced by the corresponding f₀ and duration values found in the equivalent paroxytone words (PP>P); in the same way, in P words, f₀ and duration values for each vowel were replaced by the corresponding f₀ and duration values found in the equivalent oxytone words (P>O).

Three groups of Italian subjects and two groups of Francophone subjects, divided according to their competence in Spanish, have participated in the experiments performing an identification test.

Italian subjects perceive correctly the stressed syllable in almost 100% of the cases for the original PP and P, but make a mistake in more than 15% of the cases for the original O. The isolated manipulation of D or f₀ does not trigger a change in stress pattern perception. When f₀ and duration values are simultaneously modified, subjects perceive a change in stress location in a high percentage of cases for PP>P (between 56.7% and 90%) but in less than 40% for P>O.

Francophone subjects recognize the stressed syllable in original stimuli in more than 70% of the cases, obtaining the best results in PP perception and the worst performance for O. Such as the previous case with Italian speakers, the isolated manipulation of one of the two acoustic cues does not produce a clear change in stress pattern perception, while the combined manipulation produces a change in stress perception up to 77% of the cases for PP>P and in percentages ranging from 32 to 44% of the cases for P>O.

1 The work is a result of the collaboration among the authors; nevertheless, we owe to Iolanda Alfano the paragraphs 1 and 2, to Sandra Schwab the paragraph 4, to Renata Savy the paragraph 3 and to Joaquim Llisterri the paragraphs 5 and 6.
Our results indicate that native language influence is not sufficient to explain the perception process in a foreign language, suggesting that non-native subjects use not only purely ‘linguistic’ perception strategies, since their choices seem to be also determined by psycholinguistic factors and by acoustic properties of the signal.

2. INTRODUCTION

The study of speech perception in a foreign language has raised many unsolved issues related with several aspects. A large amount of research studies focus on how non-native speakers perceive foreign speech and try to find out the most important factors that influence this process, such as the transfer from the native language, the role played by the level of knowledge in a foreign language or the interdependence between perception and production skills in that language.

Several models, mostly concentrating on segmental feature perception, have been developed in order to predict the stages of the perception process. Moreover, experimental studies on suprasegmental features perception seem to indicate a strong influence of native language too.

2.1 Models of second/foreign language acquisition/learning

In order to predict the stages of acquisition/learning, numerous models have been developed; we will very briefly summarize some of the most frequently discussed in the literature on L2 acquisition.

The Perceptual Assimilation Model (PAM; Best, 1993 and 1994) explains the differential sensitivity to foreign language contrasts by appealing to the notion of phonological perceptual assimilation. According to this model, there are three ways in which a non-native segment may be perceptually assimilated to the native phonological system: (1) mapped onto a native phoneme varying in range from an excellent to a poor exemplar, (2) uncategorized phone falling in between native categories (i.e., roughly equally similar to more than one phoneme) and (3) nonassimilable sound that is very different from any native phoneme and fails to be assimilated within native phonological space. This model suggests a strong influence of the first language on the perception of a second language, but does not seem to give a real prediction of the process stages.

Based on a similar idea of that of the PAM, the Native Language Magnet (NLM; Kuhl, 1991 and 2000) considers a perception space in which prototypic native sounds work as a magnet, since they attract L2 sounds that are perceptually similar. The model predicts that all the cases of similar L2 sounds may be problematic because they are difficult to discriminate.

This model shares his background with the Speech Learning Model (SLM; Flege, 1995). According to the SLM, the greater the perceived phonetic dissimilarity between an

2 The two terms are not usually used with the same meaning. Acquisition (of a second language) is considered a subconscious process of which the individual is not aware; this process is similar to the process that children undergo when learning their native language, since it takes place in a natural life context. Learning a foreign language, on the other hand, is considered a conscious process, that involves some kind of formal instruction, with rules and grammar (Krashen, 1987). As a matter of fact, it is not difficult to imagine how this distinction can be sometimes impossible to apply, since there are so many intermediate cases. For a review on this topic, see Manchón Ruiz (1987).
L2 speech sound and the closest L1 sound is, the more likely learners will be to discern the difference between the L1 and L2 sounds and show measurable progress in production and/or perception. The initial disadvantage of the more dissimilar L2 speech sound will ultimately prove to be an advantage. By hypothesis, a relatively high degree of perceived dissimilarity will eventually result in accurate segmental production and perception because it will promote the formation of a new category.

These models make a connection between the two linguistic systems considered (the one of the L1 and the one of the L2), linguistic perception and phonological acquisition of a new category. Also the Feature Competition Model (Brown, 2000) considers that the most frequent phonological categories influence perception and categorization of new sounds. This model implies the idea of a perceptual assimilation process and proposes an algorithm to determine how a category is prominent in order to predict its influence.

The models we have briefly discussed share some ideas and agree on several factors that may influence speech perception. It is interesting to notice that even if they develop different theoretical frameworks, they all agree on the influence of the L1 phonological structure on L2 sounds perception. Nevertheless, it has to be observed that these models focus only on segmental and not suprasegmental features.

2.2 L2 Lexical stress perception experiments

A large amount of research on non-native speech perception has focused its attention on segmental features (that L1 and L2 do not share), while considerably less attention has been paid to non-native perception of suprasegmentals; that is probably due to the difficulties involved in the analysis of suprasegmental features. Moreover, as far as we know, the studies on the perception of suprasegmental features by non-native subjects often consider typologically different languages (among others, Wang et al., 1999).

Nonetheless, both research on segmental and on suprasegmental features suggest an influence of L1 characteristics on L2 perception (Flege & Hillenbrand, 1986; McAllister et al., 2002; Cutler et al., 1986; Otake et al., 1993).

As regards L2 lexical stress perception, a large amount of research has focussed on free stress vs. fixed stress languages, such as French vs. Spanish, while, as far as we know, less attention has been given to more closely related languages, as it is the case of Italian and Spanish.

Since Francophone speakers seem to be unable to produce some stress patterns, it has been hypothesised that they can be insensitive to stress differences or ‘deaf’ to stress. Many studies focus on how Francophone speakers perceive lexical stress in Spanish. Some of them mitigate the idea of a complete stress deafness (Mora et al., 1997; Muñoz et al., 2008); others indicate that the ability to perceive stress location depends on the degree of the cognitive charge of the task. Dupoux and colleagues, following different experimental procedures, suggest that subjects’ sensibility to stress depends on the possibility to rely on acoustic cues, since Francophone speakers show some problems in difficult tasks with ABX paradigms, but do not result deaf to stress in easier tasks with AX paradigms (Dupoux et al., 1997, 2001 and 2008; Peperkamp et al., 1999).

Finally, others works strongly suggest the need to take into account the acoustic characteristics of the signal, since perception closely depends on them, both in L1 and in L2 (Alfano et al., 2007, 2008, 2009; Wang, 2008).
2.3 Aims and hypothesis

The purpose of this research is to examine thoroughly:
- perceptual strategies assumed by non-native speakers, at least as far as lexical stress in isolated words is concerned;
- the influence of native language on perception;
- the role of the level of L2 knowledge (Spanish, in our case).

It is well known that Italian, Spanish and French share important properties – among them, they show a tendency to isosyllabicity\(^3\) – but, as regards their accentual systems, we have to consider that both Italian and Spanish are free stress languages, while French is a fixed stress language. For this reason, since our initial hypothesis was that perceptual strategy closely depends on the native language, we expected that, listening to Spanish stimuli, native Italian subjects would behave quite differently from native French speakers.

3. EXPERIMENT WITH ITALIAN SUBJECTS

3.1 Subjects

Three groups of ten Italian speakers were tested individually. The first group (group A) had been studying Spanish for several months (6-7 months); the second one (group B) although had never studied Spanish, knew some Spanish thanks to travels to Spain or listening to Spanish music; the third one (group C) had never studied Spanish and had never had any kind of contact with this language.

The thirty Italian subjects, aged 17 to 54 years, were born in the Italian region of Campania and had been living there for many years. Moreover, subjects were selected by means of a preceding test: they were asked to perform a previous identification task, in order to be sure that there were able to correctly identify the stress location.

3.2 Corpus

As Table 1 shows, the corpus consisted of six couples of meaningful three syllable words (\textit{words}) and six couples of meaningless three syllable words (\textit{pseudo-words}).

<table>
<thead>
<tr>
<th>words</th>
<th>pseudo-words</th>
</tr>
</thead>
<tbody>
<tr>
<td>['baskula'] - [bas'kula]</td>
<td>[der'rišlo] - [derri'šlo]</td>
</tr>
<tr>
<td>'Scales'-'He/she/it swings'</td>
<td>'I pull down'-'He/she/it pulled down'</td>
</tr>
<tr>
<td>['kantara'] - [kan'tara]</td>
<td>[re'traso] - [retra'so]</td>
</tr>
<tr>
<td>'large pitcher (or a liquid measure)’-'He/she sang'</td>
<td>‘delay’-'He/she/it was late’</td>
</tr>
<tr>
<td>['lastima'] - [las'tima]</td>
<td>[bor'raša] - [borra'ra]</td>
</tr>
<tr>
<td>‘pity’-'He/she/it hurts’</td>
<td>‘He/she/it deleted’-'He/she/it will delete’</td>
</tr>
<tr>
<td>\textit{Table 1: Corpus used with Italian subjects (proparoxytone, paroxytone and oxytone words and pseudo-words)}</td>
<td></td>
</tr>
</tbody>
</table>

\(^3\) The division between syllable-timed languages and stress-timed languages constitutes a vexed question (see, among others, Bertinetto, 1989 and 1990; Bertinetto & Magno Caldognetto, 1993; Almeida, 1997; Cantin & Rios A., 1991; Ramus \textit{et al}., 1999; Russo & Barry, 2008).
3.3 Method
The experimental procedure we have adopted had been designed for a study with native Spanish subjects (Llisterrri et al., 2005) and already followed in other works with native Italian subjects (Alfano, 2006) and non-native subjects (Alfano et al., 2007; Alfano et al., 2009).

The corpus was read 10 times by a native Spanish speaker; for each of the three vowels of the stimuli, we measured:

- $f_0$ at the beginning, at the centre and at the end of the vowel;
- vowel duration.

The corpus was analyzed and resynthesized using the Praat software (Boersma & Weenink, 2003).

The test stimuli were created in the following way: the original values of both $f_0$ and duration were replaced in each vowel of each stimulus by the mean values of each parameter, using Praat PSOLA algorithm (hereafter, Original stimuli). Moreover, in proparoxytone words, $f_0$ and duration values for each vowel were replaced by the corresponding $f_0$ and duration values found in the equivalent paroxytone words (PP>P Manipulated stimuli); in the same way, in P words, $f_0$ and duration values for each vowel were replaced by the corresponding $f_0$ and duration values found in the equivalent oxytone words (P>O Manipulated stimuli).

Each word was resynthesised with the replaced values using PSOLA as implemented in Praat; Figure 1 shows an example of a manipulated stimulus.

The values have been modified not only individually, but also simultaneously, obtaining the three possible combinations of Manipulated stimuli: $f_0$, D, $f_0$+D. This strategy has allowed the study of the effects of each acoustic cue both in isolation and in combination with the other.

Figure 1: ['navilo] with the original $f_0$ contour (top) and after superimposing the $f_0$ contour of [na’vilo] (bottom)

3.4 Procedure
The tests were administered using a specifically designed data-collection software. Subjects were told they were going to listen to Spanish words and pseudo-words; each participant received instructions about the task and did a brief training.

---

4 The speaker did not receive particular instructions, he was asked to read following the indicated stress pattern.
The experiment consisted of an identification test of the stressed syllable: subjects had to click on the key 1 if they perceived stress location on the first syllable, on the key 2 if they thought the stressed syllable was the second one and on key 3 if they perceived stress location on the last syllable (see Figure 2).

Figure 2: Screen of the identification test with Italian speakers

We proposed 57 stimuli (21 original stimuli plus 12 x 3 items with manipulated values-D; D₁0; D₁+D₀). The stimuli were given in random order; a total of 1710 answers was obtained.

3.5 Results
3.5.1 Original stimuli
Figure 3 shows the results obtained for original stimuli, that is to say those items with no manipulation of the acoustic cues.

Figure 3: Results in % from identification test for original words (left) and pseudo-words (right); A, B, C = subject groups; PP = proparoxytones, P = paroxytone, O = oxytone

For original PP and P stimuli, the average of correct identification and discrimination reaches very high values, without relevant differences among the three groups and between words and pseudo-words. However, listening to original O subjects behave in a different way: group A does not correctly perceive the stress in 26.7% (words) and in 13.3% of the cases (pseudo-words); group B fails in 13.3% of the cases (words and pseudo-words) and group C in 16.7% (words) and in 10% of the cases (pseudo-words).

The software has been designed by Dr. P. Riccardi (University of Naples).
3.5.2 Manipulation of $f_0$

Analysing the results of $f_0$ manipulation in words, it can be seen that PP>P stimuli are identified as paroxytone in percentages reaching the 33% of the cases for group A, the 10% for group B and the 26.7% for group C; looking at the answers concerning pseudo-words, it is possible to see that PP>P stimuli are perceived with a change in stress location (as P) in percentages ranging from 46.7% (group C) to 70% (groups A and B); words and pseudo-words answers do not show the same trend.

On the contrary, P>O stimuli are perceived as paroxytone, that is to say with the original stress pattern, in very high percentages, both in words and in pseudo-words (see Figure 4).

![Figure 4](image)

3.5.3 Manipulation of duration

Looking at the answers concerning stimuli with modified duration (see Figure 5), it can be seen that subjects clearly perceive P>O stimuli as paroxytone, that is to say with the original stress pattern, both in words (83.3%, 94%, 86.7%, group A, B and C respectively) and in pseudo-words (93.4%, 90%, 96.7%, group A, B and C respectively).

As regards PP>P stimuli too, the manipulation of duration does not trigger a clear change in stress pattern perception, but it should be noted that group A behaves in a different way in the case of pseudo-words: it identifies PP>P pseudowords as paroxytone in 66.7% of the cases, while groups B and C identify pseudowords PP>P as paroxytone in only 3.3% and 16.7% of the cases (see Figure 5).
3.5.4 Simultaneous manipulation of f0 and duration

When f0 and duration values are simultaneously modified, subjects perceive a change in stress location in a higher percentage of cases, both in words and pseudo-words, but it is interesting to notice that the manipulation has a stronger effect in the case of PP>P stimuli in comparison with P>O items (67.8% of the cases in favour of P words, but only 28.9% in favour of O words, respectively on the left and on the right side of each graphic of Figure 6).

3.5.5 Remarks

It is evident that Italian subjects show some problems when they listen to Spanish stimuli - even in the case of original items - depending on the stress pattern: they correctly perceive PP and P patterns, but make mistakes in identifying the oxytone pattern, both in words and pseudo-words (see Figure 3).
When $f_0$ values are modified, subjects seem to be indifferent to the manipulation in the case of P>O stimuli, but tend to perceive some change in stress pattern in PP>P, especially for pseudo-words (see Figure 4): Italian subjects do not react in the same way they do in their native language, since exposed to Italian items they never perceive the manipulation of $f_0$ (Alfano, 2006).

On the other hand, Italian subjects did perceive changes in stress location in the case of Italian stimuli with manipulation of duration, while they do not seem to be aware of duration differences in Spanish stimuli (except the case of the group A for pseudo-words, see Figure 5). Compared to Spanish stimuli with manipulated duration, Italian subjects do not behave in the same way they do with stimuli in their own language but, at the same time, do not rely on the acoustic cues used by native Spanish speakers (Llistérri et al., 2005).

In the case of the simultaneous manipulation of both acoustic cues, the percentages of answers that indicate a change in stress perception are the 67.8% for PP>P, but only the 28.9% for P>O, where in Italian L1 they were respectively the 90.8% and the 71.7% (Alfano, 2006).

First of all, to interpret the results, it is important to consider that the higher frequency of paroxytone words in Spanish and Italian may bias the processing of oxytone words towards the most common pattern: in the case of PP>P stimuli, subjects may be more sensitive to the manipulation in comparison with P>O items, since it goes in the direction of paroxytone pattern. However, problems with oxytones have been also detected in the case of original items.

Secondly, we think that differences of acoustic duration between Spanish and Italian stressed vowels could be considered as one of the reasons of this behaviour, especially with oxytone words. The acoustic analysis of the stimuli shows that in internal word position Italian stressed vowels are 35.8% longer than Spanish ones, but in oxytone words they are 12% shorter. Moreover, prepausal stressed vowels are, in Spanish, 42.3% longer than word internal ones, while in Italian they are 7.8% shorter than word internal ones (Alfano et al., 2009). For this reason, Italian subjects seem to be somehow unable to solve a sort of conflict between the acoustic stimuli (that is to say long final stressed vowels) and their L1 expectations (short final stressed vowels).

Comparing pseudo-words with words results, further investigation is needed not only to understand better the difference observed between words and pseudowords in PP>P $f_0$ manipulated stimuli, but also to explore more deeply the differences between the three groups in PP>P pseudowords manipulated in duration.

We have carried out the experiment on three different groups of subjects in order to point out possible differences depending on the level of Spanish knowledge. The analysis of each group does not reveal a clear trend: it can be observed that, in some cases, group A seems to behave in a quite different way from the other ones. Nevertheless, we need to stress the fact that lexical knowledge does not seem to constitute a very important factor, since group A knew the meaning of the items in the only the 25% of the cases and group B

---

6 Average percentages of the three groups, concerning words stimuli (§ 3.5.4).
7 For a comparison between Italian and Spanish systems, concerning the distribution of the different stress patterns, see Alfano (2008).
did not reach the 10%.

In any case, we must go carefully and consider that the three groups did not have a very different level of Spanish knowledge (§ 3.1).

In sum, we can conclude that the performance of non-native Italian subjects appears to be influenced by their native language but, at the same time and in a strong way, by the acoustic features of the signal too.

4. EXPERIMENT WITH FRENCH SPEAKERS

4.1 Subjects

Two groups of French speaking subjects took part in this experiment: one French speaking group with advanced knowledge in Spanish and one French speaking group with no knowledge in Spanish. The advanced group in Spanish (hereafter, group A) was composed of 10 subjects. They were between 21 and 36 years old and were all raised in a French speaking environment with only one language, French. They had been studying Spanish at University of Neuchâtel (Switzerland) during 6-11 years.

As far as the French speaking group with no knowledge in Spanish (hereafter, group B) is concerned, it was composed of 10 students of the University of Neuchâtel. They were between 19 and 24 years old and were all raised in a French speaking environment with only one language, French. Although some of these subjects indicated good knowledge in German and/or English (learning these two languages is obligatory in the Swiss educational system), none of them reported good knowledge in Italian (which excludes the eventual bias of knowing a free stress Romance language).

4.2 Corpus

The corpus we used was taken from Llisterri et al. (2005). It was composed of 4 triplets of trisyllabic words (CVCVCV) and 4 triplets of trisyllabic pseudo-words (see Table 2). All words and pseudo-words could be proparoxytones, (e.g. número), paroxytones (e.g. numero) and oxytones (e.g. numeró).

<table>
<thead>
<tr>
<th>words</th>
<th>pseudo-words</th>
</tr>
</thead>
<tbody>
<tr>
<td>['limite'] - ['limitte'] - ['limi'te']</td>
<td>['malede'] - ['male'do'] - ['male'do']</td>
</tr>
<tr>
<td>‘limit’ - ‘I limit’ - ‘I limited’</td>
<td>['laede'] - ['laede'] - ['laede']</td>
</tr>
<tr>
<td>['meño'] - ['meño'] - ['meño']</td>
<td>['nu'li'] - ['nu'li'] - ['nu'li']</td>
</tr>
<tr>
<td>‘doctor’ - ‘I medicate’ - ‘He/she medicated’</td>
<td>['luvi'] - ['luvi'] - ['luvi']</td>
</tr>
<tr>
<td>['numero'] - ['numero'] - ['numero']</td>
<td>['bali'] - ['bali'] - ['bali']</td>
</tr>
<tr>
<td>‘number’ - ‘I number’ - ‘He/she numbered’</td>
<td>['nu'] - ['nu'] - ['nu']</td>
</tr>
<tr>
<td>['bali'] - ['bali'] - ['bali']</td>
<td>['malede'] - ['malede'] - ['malede']</td>
</tr>
<tr>
<td>‘valid’ - ‘I validate - ‘He/she validated’</td>
<td>['nu'] - ['nu'] - ['nu']</td>
</tr>
</tbody>
</table>

Table 2: Corpus used with Francophone subjects (proparoxytone, paroxytone and oxytone words and pseudo-words)

8 After taking the test, we asked the subjects to tell if they knew the meaning of the stimuli.
4.3 Method

The experimental procedure, which is described in detail in Listerri et al. (2005), was similar to the one we used with Italian speakers (§ 3.3). In total, 24 Original stimuli and 48 Manipulated stimuli (16 x 3; D; f₀; D+f₀) were presented in this experiment.

4.4 Procedure

Subjects performed an identification task and were run individually. The stimuli were presented online from a laptop using DMDX software,9 which also recorded the subjects' responses. Subjects were instructed to listen to each stimulus (e.g. médico), to make a selection among the three possible choices that appeared in a row on the computer screen (see Figure 7), and to press the corresponding button in a response box.

![Figure 7: Screen of the identification test with French speakers](image)

The left-to-right order of the three choices was always the same across trials: Position 1 corresponded to the stimulus with stress on the first syllable, position 2 to the stimulus with stress on the second syllable, and position 3 to the stimulus with stress on the third syllable. Thus, subjects pressed button 1 when they perceived stress on the first syllable, button 2, for stress on the second syllable, and button 3 for stress on the third syllable. Each subject received a different randomization of the stimuli.

4.5 Results

4.5.1 Original stimuli

Figure 8 shows the results obtained for original stimuli, that is to say those stimuli with no manipulation of the acoustic cues. First of all, we observe that French speakers are able to correctly identify the location of stress in 71.5% of the cases (mean across patterns (PP, P and O), and across lexical status (words and pseudo-words)). Secondly, it appears that group A (advanced in Spanish) achieves a better performance than group B (with no knowledge in Spanish), whatever the pattern and the lexical status of the stimuli may be (mean correct identification (across patterns and lexical status) for group A = 82.2%; for group B = 60.8%).

9 The software has been developed by K. Forster, Psychology Department (University of Arizona).
Thirdly, we notice that stress on the first syllable (PP) is better perceived (mean across groups and lexical status) = 86.7%) than stress on the second syllable (P; mean across groups and lexical status) = 71.5%), that is in turn better identified than stress on the third syllable (O; mean across groups and lexical status = 56.2%).

4.5.2 Manipulation of $f_0$

Figure 9 shows the results obtained for stimuli with a manipulation of $f_0$ values. When $f_0$ is manipulated, French speakers perceive the change in stress pattern in 26.9% of the cases. As far as PP$>$P words are concerned, there are identified as paroxytone in percentages reaching the 34.2% of the cases for group A and the 27.5% for group B, while the difference between both groups increases with PP$>$P pseudo-words (group A = 37.5%; group B = 17.5%).

Regarding P$>$O words, they are identified as oxytone in percentages reaching the 34.2% of the cases for group A, the 21.7% for group B, whereas the difference between both groups goes in the reverse direction with P$>$O pseudo-words (group A = 16.7%; group B = 25.8%). When we compare stress perception in PP$>$P and P$>$O stimuli, it appears that
4.5.3 Manipulation of duration

Figure 10 shows the results obtained for stimuli with a manipulation of duration values. French speakers perceive the change in stress pattern in only 13.1% of the cases. It is interesting to note that group B is more sensitive to the manipulation of duration than group A, whatever the pattern and the lexical status may be. Indeed, group B perceives the change in stress pattern in 18.5%, while group A perceives it in only 7.5% (means across patterns and lexical status). Moreover, the comparison of stress perception in PP>P and P>O stimuli shows that the manipulation of duration has a similar effect on both patterns (PP>P = 12.7%; P>O = 13.5%).

![Figure 10: Results in % for words (left) and pseudo-words (right) with a manipulation of duration values; A, B = subject groups; PP = proparoxytones, P = paroxytone, O = oxytone; PP>P = proparoxytones with paroxytone duration values; P>O = paroxytone with oxytone duration values](image)

4.5.4 Simultaneous manipulation of $f_0$ and duration

Figure 11 shows the results obtained for stimuli with a manipulation of $f_0$ and duration values. The simultaneous manipulation of $f_0$ and duration triggers the perception of a change in stress pattern in 47.7% of the cases. Words and pseudo-words show the same trends. Firstly, the difference between group A and group B is similar whether it be words (means across patterns; group A = 60.8%; group B = 53.3%) or pseudo-words (means across patterns; group A = 41.7%; group B = 35.0%). Secondly, the simultaneous manipulation of $f_0$ and duration has a stronger effect on the perception of the accentual change in PP>P stimuli (57.5% across groups and lexical status) in comparison with P>O stimuli (37.9% across groups and lexical status).
4.5.5 Remarks

In this experiment, French speakers had to identify the location of stress in stimuli with no acoustic manipulation (original stimuli) and in stimuli with separate and combined manipulation of f0 and duration (manipulated stimuli). Results with original stimuli show first that French speakers are able to correctly perceive stress in 71% of the cases. This agrees with the results of Muñoz et al. (2008), who found a correct identification of 83% in a similar task, and indicates that French speakers might not be so deaf to stress as it was thought (at least in an identification task). Secondly, results suggest that the exposition to L2 makes French speakers more sensitive to stress, as the advanced group in Spanish identified stress more accurately than the group with no knowledge. Thirdly, it seems that it is harder for French speakers to perceive stress on oxytone stimuli (in original stimuli and in P>O stimuli). This observation, which was also highlighted in Muñoz et al. (2008), is quite surprising given the fact that French stress is mainly oxytone. It might be due to the different acoustic realization of stress in final syllables in French and Spanish. Nevertheless, more studies are needed to understand better the difficulty of French speakers to identify oxytone stress in L2.

As far as manipulated stimuli are concerned, results reveal first, as observed with Italian speakers, that the combined manipulation of f0 and duration leads to a better perception of the accentual change than the separate manipulation of each acoustic parameter. It appears thus that stress is perceptually not defined by only one parameter, but by the combination of all parameters.

Secondly, results suggest that f0 is a more important cue than duration for a syllable to be perceived as stressed by French speakers. Indeed, researches in French (Rigault, 1962; Dahan & Bernard, 1996) have shown that f0 is the decisive parameter in the perception of prominences in French L1. It seems thus that French speakers have transferred this knowledge from L1 (French) to L2 (Spanish).

Thirdly, and more interestingly, both groups of French speakers (Advanced and With no knowledge) don’t behave in the same way according to the different acoustic manipulations. On one hand, the advanced group perceives better the accentual change when both parameters (f0 and duration) are jointly manipulated. On the other hand, while both groups
are equally sensitive to the isolated manipulation of $f_0$, the group with no knowledge in Spanish is more sensitive to the isolated manipulation of duration. It appears thus that French speakers with no knowledge in L2 process stress in a more acoustic way. Indeed, whereas the advanced French speakers in Spanish can process stress using their linguistic knowledge of Spanish, those with no knowledge rely more on all available acoustic cues, even less salient. Consequently, the knowledge in L2 seems to modify the perceptual strategies used in identifying stress in L2.

In sum, this experiment shows that French speakers’ stress perception in L2 is affected not only by the native language, but also by the knowledge in L2, the accentual pattern of the stimuli and the acoustic parameters used in the realization of stress.

5. DISCUSSION

Native Italian subjects exposed to Spanish stimuli do not behave in the same way they do in their L1 - they do not react to the manipulation of duration (§ 3.5.3) and they perceive, in some cases, a change in stress pattern in the stimuli with $f_0$ modification (§ 3.5.2) – but, at the same time, they do not come to rely on the same acoustic cues used by native Spanish subjects (Listerri et al., 2005).

Looking at the different patterns, it is quite interesting to notice the particular reaction to oxytone stimuli: as far as original items are concerned, the correct identification rate is lower in comparison with other patterns (§ 3.5.1); moreover, no manipulation is sufficient to trigger a change in stress pattern perception in the case of $P>O$ stimuli, that is to say that nothing seems to succeed in obtaining an item perceived as oxytone.

We suggest to take into account the following aspects: on one hand, as we have already discussed (§ 3.5.5), a typical oxytone Italian item is different from an oxytone Spanish stimulus and, on the other hand, the oxytone pattern is not very frequent in Spanish and absolutely uncommon in Italian, so, in the case of $PP>P$ stimuli, subjects may be more sensitive to the manipulation in comparison with $P>O$ items, since it goes in the direction of the unmarked paroxytone pattern.

We believe that differences of acoustic duration between Spanish and Italian stressed vowels can help to understand the results, especially with oxytone words. The acoustic analysis of the stimuli shows that in internal word position Italian stressed vowels are 35.8% longer than Spanish ones, but in oxytone words they are 12% shorter. Moreover, prepausal stressed vowels are, in Spanish, 42.3% longer than word internal ones, while in Italian they are 7.8% shorter than word internal ones (Alfano et al., 2009). For this reason, we think Italian subjects are somehow unable to solve a sort of conflict between the acoustic stimuli (long final stressed vowels) and their L1 expectations (short final stressed vowels).

French speaking subjects are able to correctly perceive stress in 71% of the cases in stimuli with no acoustic manipulation: it means that French speakers might not be so deaf to stress as it was thought (at least in an identification task). As far as manipulated stimuli

---

10 As far stress patterns distribution is concerned, Spanish and Italian do not show the same distributions: Spanish presents more oxytone words than Italian and in Italian we find more proparoxytones than in Spanish, but it is interesting to take into account the higher frequency of paroxytone words in both languages (see Alfano, 2008).
are concerned, the manipulation of f0 seems to be necessary, but not sufficient, to determine a change in stress pattern perception.

Analysing the different patterns, it is unexpected that, as observed with Italian speakers, also French speaking subjects obtain the worst performance exposed to oxytone stimuli and P>O items. In the first place, we consider it might be due to the different acoustic realization of stress in final syllables in French and Spanish. However, further investigation is required to understand better the consequences of these differences on the perception in L2: a contrastive acoustic analysis between French and Spanish oxytones will probably allow to formulate a more solid hypothesis. In the second place, it is quite interesting to notice that the difficulty of French speakers with oxytone stress pattern in L2 is documented in other studies (Muñoz et al., 2008), in which the authors suggest to take into account the so-called ‘law of the grasp of consciousness’. This Clapa rède’s law is based on the idea that the more often a sort of behavior or judgment has been used automatically or by habit, the harder it is to become aware of it. Also this factor could help to explain the reason why French speakers obtain the worst performance exposed to oxytone stimuli, since, as it is well known, French almost consistently stresses the last syllable. On one hand, therefore, French speakers could not be well aware of their native-language stress pattern and so they could not be able to easily recognize it and, on the other hand, it is possible that they do not pay enough attention when they are asked to identify oxytone stimuli. Finally, we can hypothesize that French speakers could be somehow aware of the differences between French and Spanish lexical stress and that this sort of awareness could give place to a form of ‘perceptive hypercorrection’, thwarting the identification of oxytone pattern. With no doubt the special status of oxytone pattern constitutes a crucial point and deserves a detailed analysis from each point of view we have only briefly discussed.

In both experiments we have considered different groups of subjects depending on their level of foreign language knowledge. While in the first experiment, with three groups of Italian speakers, the analysis of each group does not reveal a clear trend – even if it can be observed that, in some cases, group A (the most advanced subjects in Spanish) seems to behave in a quite different way from the other ones -, in the second experiment, with one group of French speaking subjects with advanced knowledge in Spanish (group A) and one French speaking group with no knowledge in Spanish (group B), we can see that group B seems to process stress in a more acoustic way in comparison with group A. It can be seen, therefore, that in the second experiment the knowledge in L2 seems to modify the perceptual strategies used in identifying stress in L2. Nevertheless, we have to take into account the fact that the three Italian groups did not have a very different level of Spanish knowledge (§ 3.1) and it is probably for this reason that we cannot evaluate in a deep way the role played by L2 knowledge.

6. CONCLUSIONS

In conclusion, our results clearly indicate that the perception of lexical stress in L2 is not an easy task - even in the case of a free stress language speakers - and confirm that it does not depend on only one acoustic parameter, but, such as in L1, it always depends on
the co-variation of both parameters (f0 and duration). Moreover, the obtained data indicate that lexical stress perception in L2 is affected not only by the native language, but also by the level of L2 knowledge, the stress pattern of the proposed items and the acoustic features of the signal.

It seems to be crucial, indeed, to consider the acoustic parameters used in the realization of stress in L1 and L2, since, as we have seen, the differences in the temporal organization contribute to create the expectations biased by the speakers’ L1, and, therefore, have an influence on the perception in L2.

Nevertheless, further research is needed: it will be necessary to investigate better the factor of the level of L2 knowledge and to perform new acoustic analyses in the three languages in order to evaluate in a deeper way the importance of the acoustic features of the signal.

7. BIBLIOGRAPHY


11 In this study we have examined the effects of f0 and duration manipulation, but, as it is well known, the perception of lexical stress depends on the co-variation of three acoustic parameters: fundamental frequency, duration and also intensity.


