Concordia Working Papers in Applied Linguistics

Proceedings of the International Symposium on the Acquisition of Second Language Speech
Concordia Working Papers in Applied Linguistics, 5, 2014 © 2014 COPAL

Intelligibility of English L2: The Effects of Incorrect Word Stress Placement and Incorrect Vowel Reduction in the Speech of French and Italian Learners of English

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Abstract

There is a debate in the literature on whether the intelligibility of English second language (L2) speech is more affected, among other things, by incorrect vowel reduction or by incorrect word stress placement. Identifying which features interfere most with intelligibility will assist in selecting what to prioritize in teaching pronunciation. The focus of this pilot study was to determine how incorrect vowel reduction or incorrect word stress placement, alone or in combination, impacts the intelligibility of Canadian French (CF) and Italian (I) L2 English. A close shadowing test was administered in which native (L1) English speaker/listeners responded to CF- and I-accented English words containing naturally occurring word stress and vowel reduction errors in various combinations. Correct word identification and reaction time results confirm that both incorrect stress and vowel reduction interfere with L2 intelligibility. Results also suggest that even though misplaced word stress is damaging to intelligibility, incorrect vowel reduction is more detrimental.

Arguably, one of the most pressing issues in L2 pronunciation research is the quest to identify the factors that contribute to an L2 English speaker's intelligibility, or lack thereof (Chen, 2011; Field, 2005; Jenkins, 2000, 2002; Pickering, 2006; Zielinski, 2008). Intelligibility refers to the listener's ability to correctly identify or recognize words or utterances (Field, 2005; Hustad, 2012; Jenkins, 2000, 2002; Kent, Weismer, Kent & Rosenbek, 1989; Kirkpatrick, Deterding & Wong, 2008; Smith & Nelson, 1985; Zielinski, 2006). It is influenced by many factors, one of which is the listener's L1. In fact, it is now well-known that when L1 listeners listen to L2 speech they apply their L1's speech processing strategies in order to segment speech and identify words. Thus, when L1 English listeners listen to L2 English speech, some loss of intelligibility may be due to listeners applying their L1 speech processing strategies, to a speech signal that contains features that are non-standard in terms of English phonology (Cutler, Mehler, Norris & Segui 1986; Cutler & Norris, 1988; Cutler & Van Donselaar, 2001; Field, 2005; Munro, 2008; Otake, Hatano, Cutler & Mehler 1993; Strange, 1995; Tyler & Cutler, 2009; Zielinski, 2008).

In English, an important acoustic cue in word recognition and retrieval (i.e., identification) is word stress. This is because word stress (primary stress) in English is not fixed to a given position. In some words the first syllable is stressed, in other words the second syllable is stressed, and so on (e.g. ***par**liament* [ˈ**pɑ̲ɹ**·lə·mənt] versus parlia**men**tary [pɑɹ·lə·ˈ**mɛ̲n**·tɹi]). It is a phonological characteristic (saved in the mental dictionary) and can serve a contrastive function to help distinguish between semantically distinct words (Friederici, Friedrich & Christophe, 2007; Honbolygo & Csépe, 2012; Kijak, 2009; Klein, 1984; Tremblay, 2007, 2008a, 2008b, 2009; Weber, Hahne, Friederich & Friederici, 2004). Word stress also gives rise to phonetic/phonological processes that can affect the phonetic quality of segments in the stressed and/or unstressed syllables (MacKay, 1987). For example, in English, stressing one syllable is accompanied by vowel reduction in one or more surrounding syllables (Ladefoged, 1975; Mackay, 1987) (e.g. **pho**tograph [ˈ**fo**·tə·gɹæph] vs photographer [fə̲·ˈt**ɑ**·gɹə̲·fɚ] vs photographic [fo·tə̲·ˈ**gɹæ**·fə̲k]). [1] As argued by Huart (2002, p. 43), "the reduced form of a vowel in English is not a 'form' in itself but the consequence of lack of stress" ("les formes faibles ne sont pas à proprement parler des « formes », mais la conséquence de la non-accentuation.") Therefore, instead of vowel reduction being viewed as a

[1] A reduced vowel, as used in this paper, refers to the phoneme that is often taken to be a mid-central vowel and is commonly termed schwa.

segmental phenomenon, it should be viewed as a suprasegmental phenomenon (phonological) which influences not only word identification (Braun, Lemhöfer and Mani, 2011; Flemming, 2009; Huart, 2002; Oostendorp, 1998) but also a language's rhythmic properties (Capliez, 2011; Huart, 2002; Préfontaine, 2013). In short, in English, word stress and vowel reduction (prosodic features) have been found to help L1 English listeners identify spoken words (Cooper, Cutler & Wales, 2002; Field, 2005; Fear, Cutler & Butterfield, 1995; Munro, 2008; Tremblay, 2009; Trofimovich & Baker, 2006).

Several studies have evaluated how word stress and vowel reduction impact L2 speakers' intelligibility, but opinion is divided as to the relative contribution made by each. Some studies claim that misplacing word stress most compromises the intelligibility of L2 speech (Anderson-Hsieh, Johnson & Koehler, 1992; Bond, 2005; Bond & Small, 1983; Cutler & Clifton, 1984; Field, 2005; Slowiaczek, 1990; Van Donselaar, Koster & Cutler, 2005; Zielinski, 2008), and that intelligibility is much more impaired when word stress is shifted to the right of its canonical position than when it is shifted to the left (Cutler & Clifton, 1984; Field, 2005). Other studies claim that L2 mis-stressing has little effect on intelligibility as long as stressed vowels retain their quality and unstressed vowels are reduced (Cooper et al., 2002; Cutler, 1986). Conversely, another study found that changes in vowel quality, when stress is shifted, have no effect on word recognition (Small, Simon, & Goldberg, 1988). Research has yet to tease apart the effect that word stress and vowel reduction have on intelligibility, and precisely to determine if it is the isolated effect of each, or the combination of the two errors that impairs intelligibility. Identifying how intelligibility in English L2 speech is affected by these features fills out a gap in the literature. In addition, from a pedagogical perspective, knowing how these specific features of (mis)pronunciation, alone or in combination, contribute to the intelligibility of English L2 speech can provide valuable information to those testing, learning and teaching second languages (Derwing, Munro, & Wiebe, 1998; Derwing & Munro, 2005).

This study sought to determine how incorrect word stress and incorrect vowel reduction, alone or in combination, impact the intelligibility of Canadian French and Italian-accented English. Notable aspects of French and Italian-accented English are incorrect word stress and incorrect vowel reduction; both negatively affect the intelligibility of L2 English speech for native English speakers (Busà 1995; Dupoux, Pallier, Sebastián-Gallés & Mehler, 1997; Dupoux, Pallier, Sebastián-Gallés, Navarete & Peperkamp,

2008; Flege, MacKay, & Meador, 1999; Piske, Flege, MacKay, & Meador, 2002; Tremblay, 2008a, 2008b, 2009; Tyler & Cutler, 2009).

The research addresses these questions:

1) Do both stress and vowel reduction interfere with the intelligibility of L2 speech?
2) Does omission of vowel reduction have a lesser or greater effect on intelligibility than its misplacement?
3) Does rightward misplacement of stress have a greater impact than leftward misplacement?

Based on previous studies (Cutler, Wales, Cooper & Janssen, 2007; Piske, Flege, MacKay & Meador, 2002), the hypothesis is that lack of vowel reduction will have the strongest effect.

THE TEST

The heart of this pilot study is a close shadowing test (perception test) administered to L1 English speaker/listeners.

Participants

The participants consisted of thirty-two L1 English speakers/listeners. The participants (male and female) ranged in age from 20 to 50 years old. Twenty judges took part in the perception test containing the CF-accented English tokens and twelve different judges took part in the perception test containing the I-accented English tokens.

Stimuli

To test the intelligibility of French and Italian accented words containing incorrect word stress and incorrect vowel reduction, English words produced by native French and Italian speakers were collected. The collection of the L2-accented English speech samples took place in Quebec City, Quebec and Padova, Italy. These places were chosen because they are predominantly French and Italian areas, respectively, and, as previously mentioned, incorrect word stress and incorrect vowel reduction are both natural occurring prosodic errors found in their productions of L2 English speech. The speech samples consisted of 184 two-, three- and four-syllable English content (frequency-controlled) words containing at least one reduced vowel.

The words were contained in the carrier sentence "I say 'X' again", 'X' being a different target word. They were read by 20 Canadian French and 20 Italian L2 speakers of English. The recordings were transferred to computer sound files and extracted from the carrier sentences using PRAAT acoustic analysis software (www.praat.org) and categorized according to the prosodic errors found.

The stimuli used in this study include 50 two-, three-, and four-syllable English words pronounced by CF and 38 two-, three-, and four-syllable English words pronounced by I L2 speakers, containing naturally-occurring word stress placement and vowel reduction errors in various combinations. The perceptual stimuli were selected based on the prosodic error categories found. The error categories for the CF L2 speakers of English are shown in Table 1 and for the I L2 speakers of English in Table 2.

Table 1. Natural word stress and vowel reduction errors found in CF-accented English

Category 1	Category 2	Category 3	Category 4	Category 5	Category 6
Correct stress placement Correct obligatory vowel reduction *competence* [ˈkɑmpətənse]	Correct stress placement Absence of obligatory vowel reduction *magnificent* *[mægˈnifisɛnt]	Incorrect leftward stress placement Absence or misplacement of obligatory vowel reduction *endurance* *[ˈɛndʒuɹɛns]	Incorrect rightward stress placement Correct obligatory vowel reduction *conscious* *[kʌnˈʃəsli]	Incorrect rightward stress placement Incorrect placement of vowel reduction *vegetable* *[vəˈdʒɛtəbəl]	Incorrect rightward stress placement Absence of obligatory vowel reduction *academy* *[ækæˈdɛmi]

All the categories found have been attested by previous literature on French-accented English speech (e.g., Cutler & Clifton, 1984; Cutler, Mehler, Norris & Segui, 1986; Field, 2005; Frost, 2011; Tremblay & Owens 2010). All categories were balanced (had 9 tokens) with the exception of category 3 (which had 5 tokens).

Table 2. Natural word stress and vowel reduction errors found in I-accented English

Category 1	Category 2	Category 3	Category 4	Category 5
Correct stress placement	Correct stress placement	Correct stress placement	Incorrect leftward stress placement	Incorrect rightward stress placement
Correct obligatory vowel reduction *sacrifice* ['sækɪəˌfa‿ɪs]	Absence of obligatory vowel reduction *magnificent* *[mægˈnifisɛnt]	Incorrect obligatory vowel reduction *legitimate* *[ləˈdʒitiˌmet]	Incorrect obligatory vowel reduction *detergent* *[ˈdɛtə-dʒənt]	Incorrect or absence of vowel reduction *catalogue* *[kəˈtæləg]

As for CF, all I categories were balanced (had 8 tokens) with the exception of category 5 (which had 6 tokens). These are preliminary results; we hope to find more occurrences of incorrect errors combinations when we go through more of our data.

Task

The administered perception test was a close shadowing task (Marslen-Wilson & Welsh, 1978). This is an on-line task, relatively unaffected by post-perceptual processing in which higher cognitive skills come into play (Marslen-Wilson, 1985). In the test, L1 English judges listened to the accented words and repeated each token, immediately after hearing it, as it 'should be' pronounced by a L1 English speaker. If they did not recognize a word they were instructed to respond 'NO'. The judges proceeded on to the next token by clicking on a button on the computer screen. Stimuli were presented to the judges in randomized order, so error types were randomly interspersed.

ANALYSIS

The judges' responses were analyzed qualitatively and quantitatively. Qualitative analysis determined which types of errors contribute to loss of intelligibility. To this end, each judge's response was analyzed to determine if he/she corrected the pronunciation, indicating that the stimulus was intelligible. The stimulus was deemed to be unintelligible if the judge 1) simply repeated the mispronounced token, 2) misidentified

the token, 3) responded 'NO', as instructed to do if he/she did not recognize the accented word stimulus.

Quantitative analysis determined which errors slow down word identification, based on the measurements of the judges' reaction times. Percentages of correct and incorrect responses for each error category were computed and reaction times from the offset of stimulus output to onset of response were measured.

RESULTS

Initially, judges' responses for each category were categorized as either positive (identified) or negative (un-identified or misidentified) and the percentage of correct identification for each error category was tabulated (qualitative analysis). The results are illustrated in Figure 1.

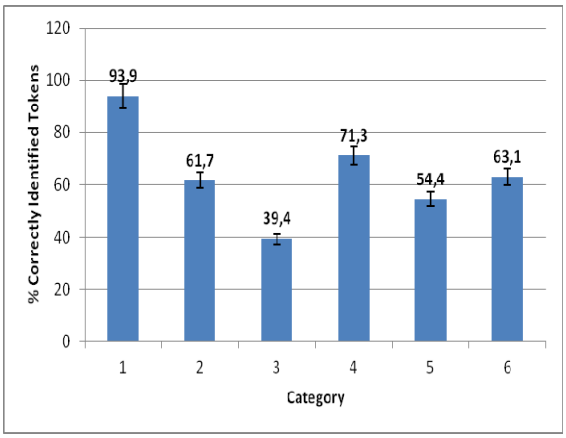

Figure 1. Percentages of correctly identified CF-accented English tokens

The results indicated a significant difference between Category 1, where tokens contained correct word stress and vowel reduction, and all the other categories ($p \geq 0.001$). These results suggest that both prosodic errors, alone or combined, have an impact on L2 intelligibility.

Additionally, results also showed that not all error types have an equally negative impact on intelligibility. For example, there was a significantly smaller amount of tokens positively identified for Category 3, where tokens contained incorrect leftward stress placement and incorrect vowel reduction, than all other prosodic error categories ($p \leq 0.001$), with the exception of Category 5, where the amount was still significant but to a lesser degree ($p \leq 0.05$). It is important to note these two categories contain both prosodic errors but in different combinations. There was also

a significant difference among the categories that contained incorrect rightward stress placement (Categories 4, 5 and 6). For example, Category 4, where vowel reduction was correctly placed, had a significantly greater amount of correctly identified tokens than Category 5, where vowel reduction was incorrectly placed ($p \geq 0.05$) but had no significant difference with Category 6, where there was omission of vowel reduction. Interestingly enough, when comparing the categories that contained only one prosodic error there was a greater amount, although not significant, of tokens correctly identified for Category 4, which contains incorrect rightward stress placement but correct vowel reduction, than Categories 2, which contains correct stress placement but no vowel reduction.

All these results suggest several things. Firstly, misplaced leftward stress (Category 3) impairs intelligibility significantly more than misplaced rightward stress (Categories 4, 5 and 6). Secondly, while our previous results identify both incorrect vowel reduction and incorrect stress placement as separately impairing intelligibility, the present results show that when put together, as in the case of Categories 3, 5 and 6, they have a more detrimental effect on word identification. Thirdly, correct vowel reduction (Category 4) seems to aid in the identification of words more than correct word placement (Category 2). Lastly, misplacement of vowel reduction, as in the case of Categories 3 and 5, impairs intelligibility to a greater extent than absence of vowel reduction, such as in Categories 2 and 6.

What was surprising was that incorrect leftward stress placement had a more negative impact on intelligibility than incorrect rightward stress placement, because the usual metrical stress rules in English allow leftward stress movement (Hogg & McCully, 1987). Thus, the present results could have theoretical implications, which call for further investigation.

Further support for the results of the preliminary qualitative analysis comes from the analysis of the reaction times (RT) of the correctly identified CF-accented English tokens (quantitative analysis). Reaction times were measured manually, using PRAAT software, from the end of the token word output to the initiation of speech (hesitation noises excluded) for the response. The mean RT for each category is illustrated in Fig. 2.

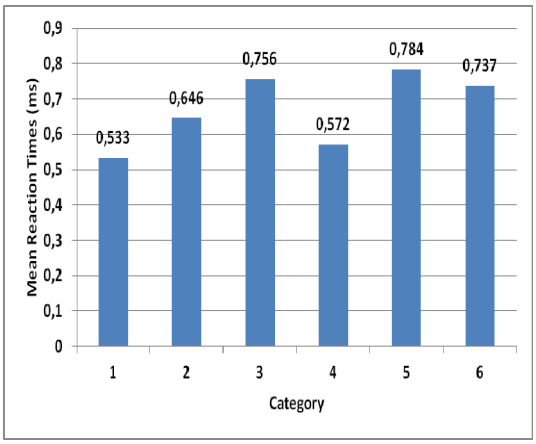

Figure 2. Mean RTs of judges' responses to the CF-accented English tokens per category

Results were consistent with the previous results in that they show that RTs were slower for the categories that contained the combination of both prosodic errors (Category 3, 5 and 6) and faster for the categories that contained only one of the two prosodic errors (Category 2 and 4) or no prosodic errors (Category 1).

An additional Mann-Whitney analysis was run on the judges' RTs to evaluate if there were any significant differences between prosodic error categories. Results corroborate some of the previous findings. Mean RT for Category 1 is significantly faster than all other categories ($p \geq 0.001$) and, mean RT for Category 3, which contains tokens with incorrect leftward stress placement coupled with incorrect vowel reduction, is significantly slower than all other prosodic error categories ($p \leq 0.001$). Interestingly enough, as noted previously, there is a difference between Category 2 and Category 4 which each contain only one prosodic error. However this time it is significant. The mean RT for Category 2, which contains tokens with correct stress placement and no vowel reduction, is significantly slower than the mean RT for Category 4, which contains tokens with incorrect rightward stress placement and correct vowel reduction ($p \leq 0.05$). The last results supports the suggestion that correct vowel reduction aides more in the identification of CF-accented words than does the correct placement of word stress. Significant results found are shown in Table 3 below.

Table 3. RTs (ms) of CF-accented English tokens

Category	Category description	Significance	Category %
1	Correct stress placement, correct vowel reduction; e.g. *consent* [kən ˈsɛnt]	p ≥ 0.001***	All
2	Correct stress placement, no vowel reduction; e.g. *collector* *[kɑ ˈlɛk tɚ]	p ≤ 0.05*	Cat 4
3	Incorrect leftward stress placement, absence/misplacement of vowel reduction; e.g. *endurance* *[ˈɛn ʤu ɹɛns]	p ≤ 0.001***	All
4	Incorrect rightward stress placement, correct vowel reduction; e.g. *catalogue* *[kæ ɾə ˈlɑg]		
5	Incorrect rightward stress placement, incorrect vowel reduction; e.g. *label* *[lə ˈbʌl]		
6	Incorrect rightward stress, absence of vowel reduction; e.g. *chemistry* *[kɛ ˈmi stɹi]		

These results also support the previous observations that intelligibility is significantly better when stress and vowel reduction are correct and that leftward misplacement of stress has a greater impact on intelligibility than rightward misplacement.

As for the I-accented English tokens, so far a preliminary analysis has been done of the percentages of correct/incorrectly identified tokens. The results are similar to those found for the CF data in that there is a notable difference between the categories that contained only one Italian prosodic error (*I*-Categories 1, 2, and 3) as opposed to those that contained both (*I*-Categories 4 and 5), as illustrated in Figure 3. This supports previous results that suggest that when both prosodic errors are combined the impact on L2 intelligibility is more detrimental.

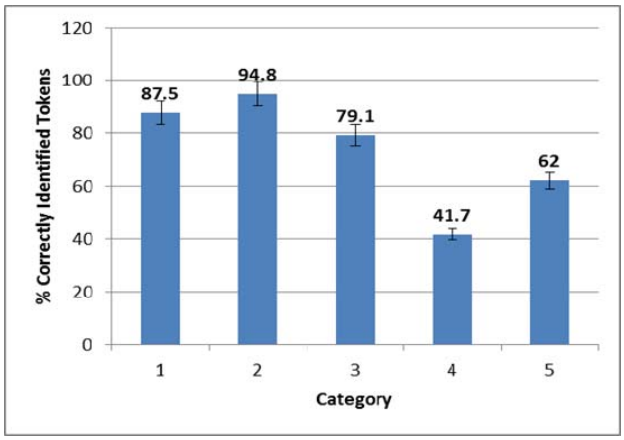

Figure 3. Percentages of correctly identified I-accented English tokens

Results also show a much lesser amount of tokens positively identified for Category 4, which contains tokens with incorrect leftward stress placement and incorrect obligatory vowel reduction, than all other categories. These results, in agreement with those from the CF data, show that incorrect leftward stress placement has a more negative impact on intelligibility than incorrect rightward stress placement.

DISCUSSION AND CONCLUSION

Preliminary results of the percentages of correct word identification for the CF and I-accented English words, in addition to the longer reaction times of the CF-accented English words, confirm that both incorrect stress and vowel reduction interfere with L2 intelligibility. Results show that both rightward and leftward misplacement of stress impair intelligibility, but intelligibility seems to be more impaired by leftward misplacement. As for vowel reduction, its misplacing has a greater negative effect on intelligibility than its omission. In addition to the questions sought, results from CF data also suggest that even though misplacement word stress is damaging to intelligibility, it is incorrect vowel reduction that is more detrimental. Hence, one might conclude that word stress and vowel reduction should be an area of concern for pronunciation teachers.

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