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DETECTING L2 SPEECH DEVIATIONS BY A COMMUNICATIVE EXPERIMENT PROCEDURE: CANTONESE SPEAKERS' REALIZATIONS OF ENGLISH /r/

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One purpose of connecting L2 speech research and L2 teaching and learning is to help students learn to communicate more effectively in spontaneous speech. However, experiments with L1 and L2 speech production have long used carefully controlled reading procedures. Such procedures may not predict performance in real-time communication. In order to compare reading and self-generated speech, two experiments examined how native English speakers' ratings of native-likeness for Hong Kong English speakers were affected by experimental procedure. Participants were 8 advanced Cantonese speakers of English pronouncing real *r- or -r-* words. In experiment 1, participants read the stimuli carefully in a carrier sentence; in experiment 2, participants were told to make up a story out of the same stimuli used in experiment 1. Results showed that in experiment 2, more errors and types of errors were noticed by native English speakers. Results imply that gearing the procedure to a more functionally-loaded one will more fairly evaluate actual speech performance.

INTRODUCTION

L2 speech acquisition is partly determined by linguistic experience (Flege, Schirru, & MacKay, 2003), and other distributive learning models also support this idea from both L1 (Pierrehumbert, 2003; Saffran, Aslin, & Newport, 1996) and L2 (Best, 1995; Kuhl, 2000) data in speech perception. The types of errors in L2 production can also be attributed to the speakers' language experience. However, other studies have proposed that development errors also exist (Ellis, 1994). They postulate that the sequence in which L2 errors appear echo that of native speakers' speech errors along similar developmental stages. However, most experiments looking at L2 production patterns have been done in strictly controlled settings with participants carefully reading words, sentences or paragraphs. The present study looks at a different experimental paradigm of L2 pronunciation learning, with eight Cantonese speakers (NC) pronouncing the phoneme /r/ in L2 English.

The phonemes which Native English (NE) speakers may find difficult or late in development (in this case, /r/) may also be difficult for NC speakers because more competing cues are present and which cue attracts L2 learners' attention can be highly variable (Davidson, 2006). One representative is the sound /r/ in production because it has both gestures on the tongue tip and tongue body (Browman & Goldstein, 1992). However, according to Speech Learning Model (SLM, see Flege 1987), speech sounds that are very different should be learned more easily by L2 learners whose native language does not include a similar phonemic or allophonic category.

Therefore, testing this sound may help see if the production of /r/ is consistent with the SLM or with a developmental difficulty model.

Towards an alternative method

One purpose of connecting L2 speech research and L2 teaching and learning may be to help improving L2 learners and listeners' intelligibility and facilitate smoother communication (Derwing & Munro, 2003). However, the reliability and validity of experiments of L1 and L2 speech production have long been accredited to the convenience of controlled careful reading procedure of reading single words (Gonzalez-Bueno & Quintana-Lara, 2012), single sentences with the carrier word inside (e.g., Aoyama, Flege, Guion, Akhane-Yamada & Yamada, 2004; Best & Taylor, 2007; Chan, 2006; Flege, 1987, 1995; Hung, 2002, to name just a few), or reading a passage (Lan & Oh, 2012). These studies often discuss the communicative competence of the learners by the results of careful reading. Nevertheless, in a communicative language teaching context, the careful-reading task faces two challenges. First, does careful reading represent the performance in real-time communication? Second, in controlling other elements of linguistic processing (as in reading, not self-generation of language), are we isolating pronunciation as an independent modular language process? Although spontaneous reading has been advocated as a means of pedagogical application, few studies on speech learning have used this approach (Chan, 2010; Sachet, 2013). In Chan's study, the spontaneous speech method was one of the three procedures (sentence reading, paragraph reading, and spontaneous speech) and the results were not analyzed by acoustic measures.

Cantonese L2 perception and production of English /r/

According to Matthews and Yip (1994), /r/ is not in present in the Cantonese consonant inventory. According to Flege (1995), the absence of the /r/ in Cantonese may lead to easier acquisition and thus fewer errors, because a new sound is easier to acquire than the similar sound. L2 sounds similar to L1 ones are more easily assimilated to L1, and thus harder to acquire. Chan (2006), in support of Flege's assertion, pointed out that over 80% of the /r/-initial tokens were pronounced correctly in production tasks. But is this sound really so easy for NC speakers? The complexity of this sound (Chan, 2006) indicate that acquisition of /r/ is not straightforward. Previous studies have shown that /r/ was often pronounced as [w], as depicted by high F3 values, by NC speakers (Hung, 2002). Moreover, in clusters, /r/ tends to be phonologically deleted (Chan, 2006).

Specifically, in previous studies, we found that /r/ is phonetically reduced (not totally substituted to [w]) in reading tasks. According to Lan and Oh (2012) as well as the interview with students prior to the experiment, the error types were not limited to those derived of previous studies. In addition, Cantonese learners in the current study would realize /r/ as [l] or [t]. Since /r/ is perceptually most similar to /w/ (Chan, 2006; Hung, 2002; Lan & Oh 2012), the production of [l] and [t] are phonologically surprising. This is not reported by previous studies using reading procedures. This suggests the necessity of a new way to mine out more error types and approximate the real situation of pronunciation learning problems.

METHOD

The study examines acoustic properties and error types of production of /r/ by experienced Cantonese learners of English in two different procedures. The experiment uses a comparative analysis between careful reading and spontaneous speech.

Participants

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- NC Participants were eight adults working as administrative staff at City University of Hong Kong (4 females, 4 males, mean age=27.5). They all used English as their working language with at least 18 years of English learning experience. None of them had exposure to other foreign languages except English. All participants were right-handed with no reported hearing or motor-control defects. They did not have prior exposure to musical training. Control speakers were two NE speakers (1 female and 1 male, mean age=26.5) from California, U.S.

Materials

Two experiments used the same stimuli set as materials but with different collection procedures. To let their speech contain as many [r] tokens as possible, 18 words in CVC structure were designed to be tested in both experiments. Five words containing /r/-initials varying in five vowel contexts of /i, æ, u, ʌ, and ɔ/, and three words containing [r] clusters were used as /r/-targets. Five /w/-initial words were added as controls because of previously reported /r/-/w/ confusion by NC speakers. Moreover, five other CVC words were inserted to the list as distractors. The wordlist was *root, rob, read, rat, rub, print, train, cream, wok, wear, weak, wide, wake*, *cheap, dark, goat, cop and think*, which are all meaningful and frequent words and were known by the subjects.

Procedure

In experiment 1, we tested the /r/ productions in sentence reading. Carrier sentences of "Now I say ____." were instructed to be read by participants. Randomized stimuli words (18 words excluding fillers) were inserted to the blank and presented to participants. The number of tokens was 13 words × 10 participants (including NC and NE) = 130.

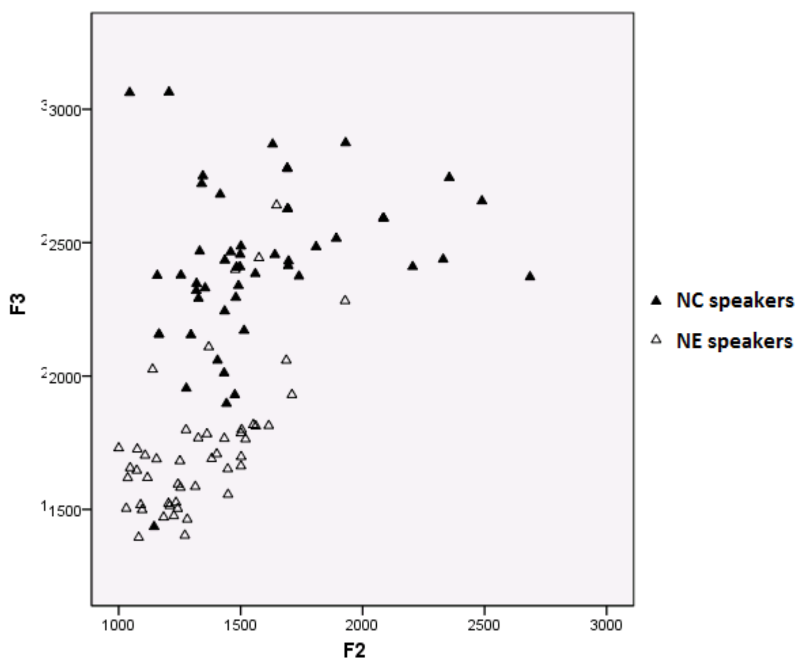
The procedure in experiment 2 was not strictly controlled and took the form of free speech in a laboratory setting. In a pilot study, we let participants make up two stories after five minutes of preparation, with both stories including all the words printed on a word-list containing the randomized stimuli words as in experiment 1. However, two pilot subjects thought the task was too difficult to complete. So we broke the randomized word-list down into four smaller word sets. At the start of the second experiment, participants were told we were testing fluency in spoken English.

In experiment 2, altogether 101 usable tokens (including /r/-initials, /w/-initials and /r/-cluster initials) were collected from five Cantonese participants' productions and 48 tokens from the native English participant's productions (101+48=149 tokens). Stimuli tokens for each participant differed with some overlap. Only five of eight NC participants successfully recorded in Experiment 2 in the sound booth because other three promised to make a spontaneous speech prior to the experiment but refused to do so on spot.

The productions of target words (including /r/-initials, /r/-clusters and /w/-initials as control) in both experiment 1 and 2 were extracted from the sentences and segmented as phonemes within those words. The /r/ parts of the productions, defined as the section from the beginning of voicing to the steady state of vowel, were examined for its second formant (F2), third formant (F3) and general audible perception judgment by NE speakers. Another two Native English listeners with standard American English accent who were not involved in the production experiment and a phonetically trained Chinese speaker worked together to rate the productions in its nativeness and denote the types of mis-pronunciations by Cantonese participants' English productions in both experiments.

RESULTS

Figure 1 exhibits two scatter plots with the upper one displaying the F2 and F3 formant space in /r/ produced by NE and NC speakers in the reading task and the lower one displaying the same space of the spontaneous task.. From both figures we can see that as expected, NE speakers show smaller F2 and F3 values in distribution, which is an acoustic property of /r/. Regardless of task, we see a general tendency of Cantonese speakers to mispronounce /r/ by increasing the F3.



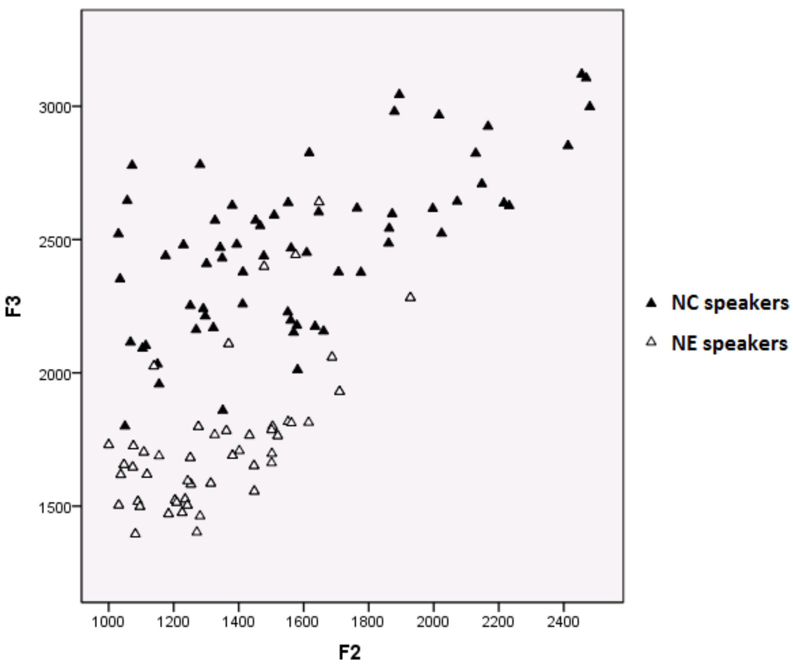


Figure 1. Above: Scatter plot of NC and NE speakers' F2 (horizontal axis) and F3 values (vertical axis) in the reading task. Below: Same F2 and F3 in the spontaneous speech task. NC speakers showed higher F3 in both tasks.

Formant values for words with /r/ in two experiments

The data for NE speakers' spontaneous speech were used in both experiments because there was not much difference for the NE speaker's productions in different settings. For NE speakers, the mean formant values were F2=1314 and F3=1702 (N=46, analyzable tokens). A t-test showed that the difference between NC and NE participants in experiment 1 was significant (F2: $t=4.204$, $df=92$, $p<.0001$; F3: $t=13.256$, $df=92$, $p<.00001$).

On average, the formant values in the careful reading task (experiment 1) for /r/ initial and /r/ cluster words by NC speakers were F2=1573 and F3=2410 (N=48, analyzable tokens). Inter-subject difference was not significant (F2: $F(2, 45)=1.300$, $p=.283$; F3: $F(2, 45)=.293$; $p=.747$). The difference of /r/ in word-initial or in cluster was not significant as well (F2: $t=-.586$, $df=46$, $p=.560$; F3: $t=-.600$, $df=46$, $p=.551$).

For the spontaneous speech task in experiment 2, the mean formant values for NC speakers were F2=1492 and F3=2232 (N=84). NC participants did not show a significant inter-subject difference for F2 ($F(2, 81)=2.528$, $p=.087$). However, the inter-subject difference for F3 was significant ($F(2, 81)=8.671$, $p<.001$). The difference of /r/ in two word types was not significant in F2 ($t=-2.243$, $df=82$, $p=.28$). However, the difference of /r/ in initial or cluster positions was significant for F3 ($t=-5.589$, $df=82$, $p<.001$). Again, a t-test showed that the difference between NC and NE was significant (F2: $t=2.884$, $df=126$, $p<.05$; F3: $t=7.530$, $df=126$, $p<.0001$).

The comparison between two experiments was insignificant for F2 ($t=1.232$, $df=130$, $p=.220$), but significant for F3 with the production in experiment 1 having a higher F3 ($t=2.637$, $df=130$, p<.01). A pictorial representation of the results was depicted in Figure 2 below (error bars at 95% Cl).

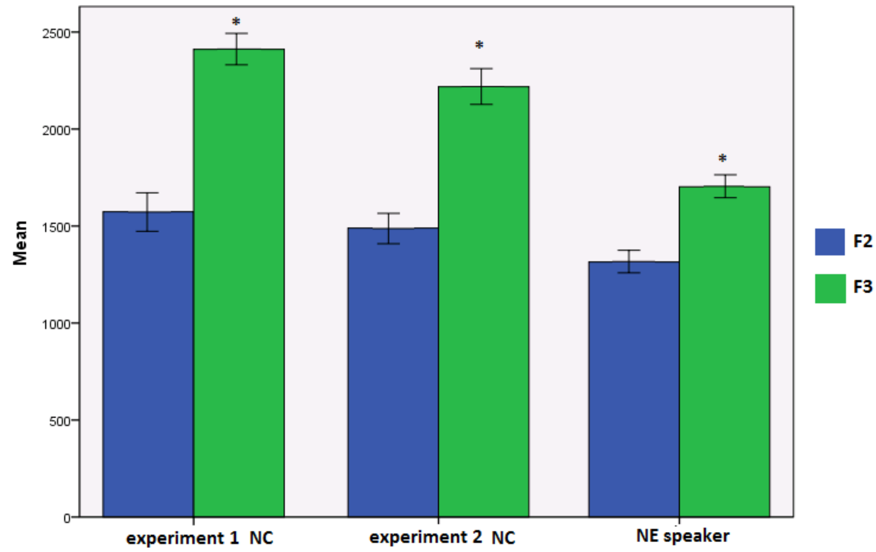


Figure 2. Comparison of F2 and F3 values of NC speakers' (separately in two experiments) and NE speaker's production (in experiment 2).

Comparison between /r/ and /w/ in two experiments

A comparison of initial /r/, cluster /r/ and /w/ production was done for NC speakers in both experiments 1 and 2 to see how the difference between /r/ and /w/ was realized in production. Surprisingly, in experiment 1, the difference between the three entries was not significant for both F2 and F3 [F(2, 51)=.886, p=.427; F3: F(2, 51)=2.103, p=.133]. Speakers did not distinguish between /r/ and /w/ in production. However, in experiment 2, the difference was not significant for F2 [F(2, 91)=2.601, p=.08] but was for F3 [F(2, 91)=14.537, p<.001]. Tukey's post-hoc tests revealed that the significance lay in the difference between cluster /r/, which has an even higher F3 than the average of /w/ [md=-490.481, Std.E=91.053, p<.001]. A pictorial representation of the results was depicted in the figure below (error bars at 95% Cl).

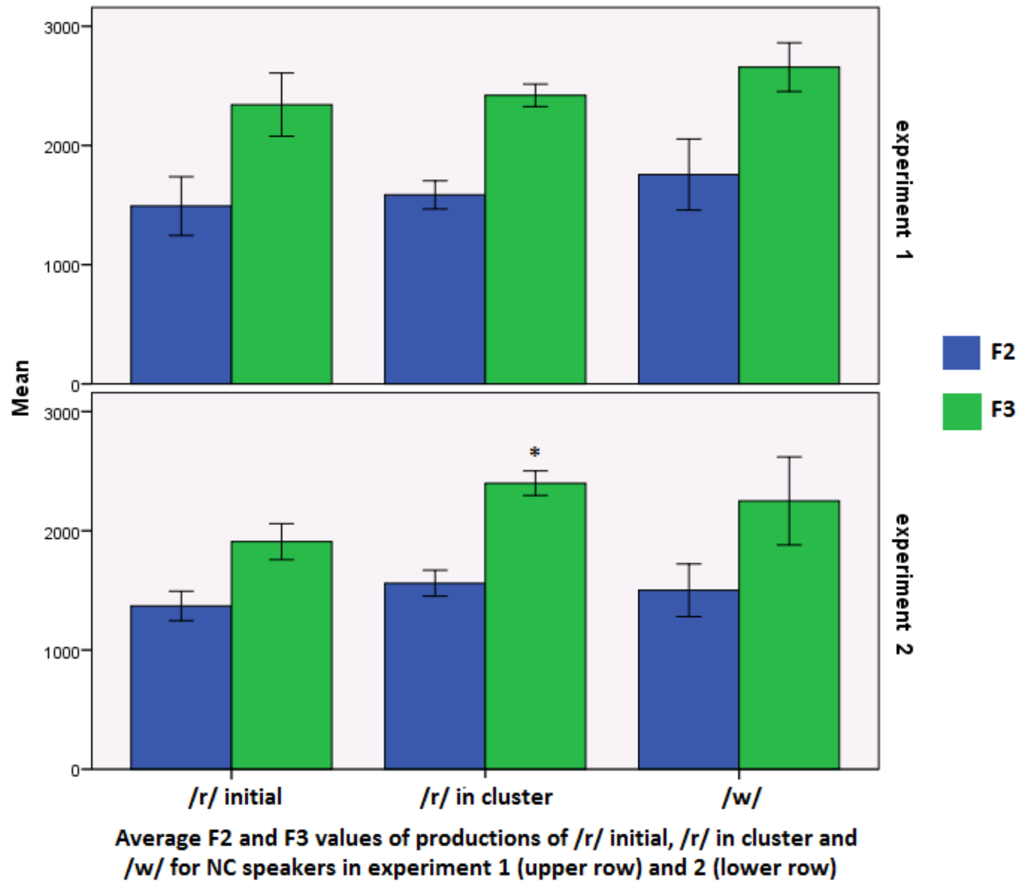


Figure 3. Comparison of F2 and F3 word type for NC speakers' production in two experiments.

Native speaker perception

Three listeners, including two NE speakers and one Chinese phonetician, were asked to pick which productions were more accented, similar to the way Flege et al. (2003) assessed accentedness. Words pronounced as strongly accented were labeled "1" and mildly or unaccented sounds were labeled "0". Due to technical problems with the computer when the listeners were doing the perception test, only the data for experiment 2 were collected. The inter-rater difference is not significant. A correlation between formant values and native speaker's perception was done. Spearman's correlation test showed that F2 was not significantly correlated with NE perception (r=.03, p=.324). However, F3 was correlated with NE perception in near-significance (r=-.15, p=.078). Such a correlation was negative, indicating that the lower the F3 was, the better chance it could be perceived as a good token for /r/. This suggests that using F3 as an indicator for native-like English /r/ production has some perceptual basis.

Error patterns

Only r-deletion and [w]-substitution were found in the first experiment. However, three more error patterns were found in experiment 2. Firstly, bidirectional confusion of /r/ and /l/ as well as /r/ and /w/ was found. Secondly, hypercorrection of inserting /r/ and /l/ in non-cluster words, such as *pay* as *play*, or *big* as *brig*, was found. Finally, affrication of /r/ in the /r/-initial was present as well.

The most common mistake was the complete omission of [r] in the production of *tree*. The second type of error is the substitution of [w] in *Troy*. Spectrograms of these two words are shown below in Figure 4. In *tree* on the left panel, the vowel part is followed right after the noise part with no visible F3 variation (Please refer to the arrow in on the left panel). In *troy* on the right panel, a signature F1-F2 nearing which indicates [w], instead of F2-F3 nearing indicating [r] is represented (shown by the arrow in on the right panel).

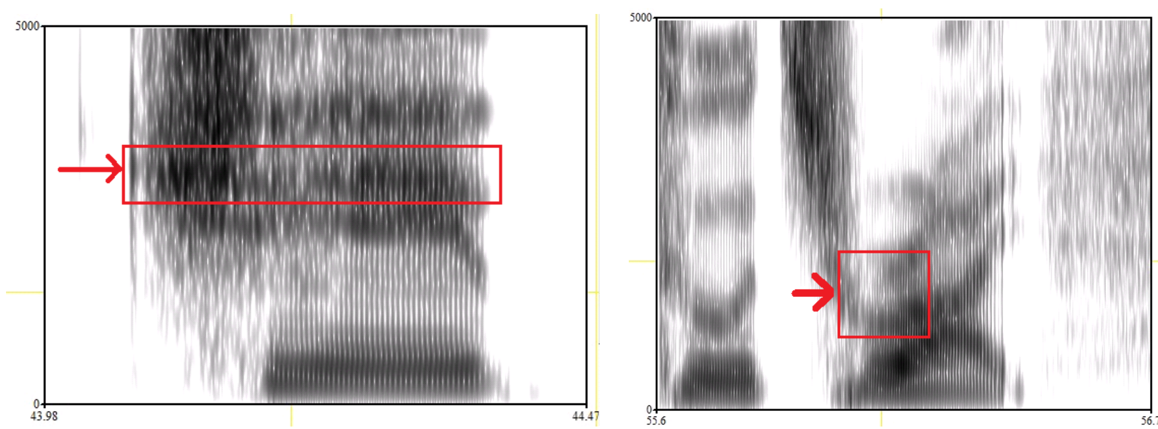


Figure 4. Spectrogram examples of error types 1 and 2: deletion (left) and substitution (right).

Error types 3 and 4 were not found previously in studies of careful reading. The third type is the substitution of /l/ in this type of error: *pray* is pronounced as *play* twice in the third speaker's pronunciation. Similarly, *clean* was pronounced as /krin/. The spectrogram in Figure 5 on the left is the production of *play* . The visible rising F3 indicates the presence of /r/ (shown by the arrow in on the left panel). Moreover, /r/ and /w/ were also found to be acoustically similar . This resulted, in some cases, that the F3 value in /w/ tokens were lower than that of /r/ ones because some productions with low F3 value in /r/ were realized with higher F3 value as in /w/, and vice versa. This might be related to the high variation of F3 in the second experiment, though it may not be a direct cause of it.

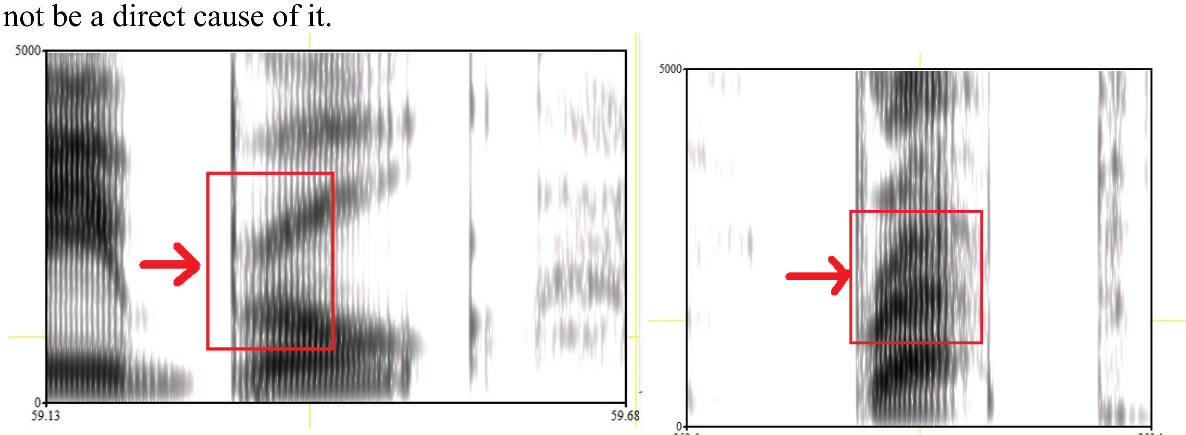


Figure 5. Spectrogram examples of Error types 3 and 4: /l/-substitution (left) and hypercorrection (right)

The fourth type of error was a hypercorrection from non-/r/ CVC sounds to clustered CrVC sounds. The above spectrogram on the right shows *big* with /r/ inserted between the consonant and vowel because of the apparent F3 rise. This was not a slip of tongue because /r/ insertion occurred seven times in the five speakers' productions, while native speakers of English did not depict any of such insertion in non-/r/ words.

DISCUSSION

Differences between two procedures and its implications

NE speaker perception results, with ratings of nativeness and the F3 value being negatively correlated, has allowed us to use F3 as the perceptual factor that could be used to examine nativeness of production of /r/. In both experiments, although both /r/-deletion and [w]-substitution were found in the production data , not all tokens had had their /r/ phonologically deleted or substituted. Phonological substitution of /r/ by [w] should entail the acoustic realization of /r/ to have a similar distinctive feature of [w]. However, the actual production results did not show a universal high F3 as in /w/ produced by the same group of speakers. Therefore, it is proposed that the category of /r/ is not phonologically mapped by L1 categories, but a new category established on the basis of both L1 and L2.

In the comparison of formant values between F2 and F3, the results showed, quite unexpectedly, that in the performance of /r/ production in terms of F3 was even more non-native-like in the reading task than in spontaneous speech, although the discrepancy was not significant. This indicates that the *degree* of pronunciation deviations, demonstrated by the F3 values in production and proven with its connection by NE perception, did not vary much even when NC participants were faced with a cognitive load to produce sounds or with reading.

However, the individual differences were significant in the second experiment, leaving the impression that in spontaneous speech, the quality of the sound is more unstable within the /r/ sounds. Compared with /r/ and /w/, the cluster /r/ was utilized as a sound with different acoustic distinction to differentiate from /w/, although we were not sure if the difference was perceptual as well. Since the gestures for C-/r/ clusters involved both tongue tip, tongue dorsum and lip, and arranged in short time with considerable overlapping, the C-/r/ clusters can be seen as complex in gesture (Browman & Goldstein, 1992; Lan & Oh, 2012). When processing these clusters, if the learners were in cognitively more loaded situations such as spontaneous speech when they do not have enough cognitive resources to focus on pronunciation, the variation of F3 may be higher in such a condition.

Implications for L2 teaching and research

Morley (1994) pointed out that heavy cognitive loads in independent speech tasks will lead to more pronunciation errors and hence it is necessary to incorporate guided practice and spontaneous speech together in an integrated curriculum. In her curriculum guidelines for instructional planning of pronunciation courses, a practice mode that moves from dependent practice through guided practice to independent practice was introduced. The last one is

represented by extemporaneous speech. The study takes one step further to urge for an update of methods in pedagogy-oriented research as well.
Larsen-Freeman (1997) referred to chaos theory to explain SLA in general, that one simple rule of difference may generate various unpredictable patterns of production. In the aspect of speech production, we could also see that the very limited feature components in one phoneme can result in various perception and production errors either due to lack of attention of one or a combination of more of the features, by interventions of the L1 category directly, or by other non-phonological habit-formation such as sociolinguistic hypercorrection (Chan, 2006), insertion due to lexical influence (Setter, 2008), and lack of motor control (Browman and Goldstein 1992; Davidson, 2006).

Therefore, in looking at L2 speech production, both linguistic factors such as the influence of L1 phonology on L2, and learners' affective factors should be both considered. The latter component is discussed in the following section. Since the factors that were neglected in traditional studies regard the L2 system as merely a mixture of L1 factors and L2 factors as well as phonological transfer rules, we need to introduce procedures with less control but more inclusion of the learner variables, even at the expense of controlling variables exhaustively.

Learner variables

One difficulty to carry out the study was the affective factors of participants as learners, especially the attitudes of learners towards their accentedness of pronunciation. Just as Derwing (2003) reveals, L2 learners are aware of their general pronunciation deficiency and appear shy and unwilling to have their voice recorded, especially in spontaneous tasks, where only five out of eight participants successfully finished the task. Even in one participant's recording (he went through the tasks successfully, of course), whisperings, in Cantonese, of "this is too difficult to me, tell me how to do it" were found. However, this attitude in turn led to more pronunciation problems because genuine production tasks (facing a recorder or communicating with a native speaker) may witness more pronunciation errors because of lack of self-monitoring and stutter/hyper-caution/avoidance. One piece of evidence in the production is the hypercorrection errors, such as pronouncing *pay* as *play*, or *big* as *brig*. The fear to mis-pronunce "Cr-" clusters has led to the adding of "-r" color productions even in cases "r" is not presented. This is similar to other parts of grammar in Cantonese English interlanguage: in Cantonese English, the plural marker (-s) and past tense marker (-ed) are often misused in English sentences to avoid mistakes (Chan, 2006).

As for motivation, these experienced learners in Hong Kong were very keen on acculturating to the English language community from the perspective of pronunciation. In an interview after the experiments, they confessed that they never resisted changing their pronunciation and never wanted to keep the Cantonese identity in spoken English. However, this view of acculturation has a disadvantage – they fear speak and being discovered to have imperfect pronunciation.

The study examined the effect of experimental procedure on production test results and proposed a novel way of examining L2 speech production. Results partly agreed to the prediction that multiple error types would occur in experiment 2, but the quality of sounds in experiment 2 were more native-like in terms of formant values, though they were more variable than that of experiment 1.

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