FLAPPING IN THREE VARIETIES OF ENGLISH

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ABSTRACT: /t/ flapping is a commonly documented feature of American English. Experimental research has shown that numerous factors can inhibit of facilitate flapping. However, most of this research focuses on American English production. The current paper examines the effects of two variables, prosodic pitch accent placement and lexical frequency, on flap production across word boundaries in three varieties of English: American, Australian and Standard British. Acoustic and articulatory parameters are used to describe stop production in the different conditions. Results show that lexical frequency has little effect on stop production across word boundaries. There was, however, a noticeable interaction between dialect type and prosodic pitch accent placement.

INTRODUCTION

The flapping rule states that /t,d/ are flapped intervocalically, where the following vowel is unstressed (e.g. within words such as "ladder" or "latter", or between words such as "get off") (Malecot & Lloyd, 1968). This rule assumes that flaps and stops occur in a categorical distribution, with flaps produced in one phonetic context, and stops produced elsewhere. However, when looking at real speech data this is not necessarily the case.

Flapping can be induced or inhibited by a number of factors apart from phonetic context. Edigo & Cooper (1980) found that flapping was inhibited across word boundaries when the words providing the phonetic context for the flap occurred on either side of a syntactic boundary. Parker & Walsh (1982) suggested that in this data, the prosodic phrase boundary that coincided with the syntactic boundary was the real cause of flap inhibition. Rate of speech is also a factor commonly thought to affect flap production (Parker & Walsh, 1980): the faster the speech, the more likely that flaps will be produced. Social class is yet another influencing force in flap production. Holmes (1997) found that working class women in New Zealand were more likely to produce flapped variants of /t/ than middle or upper class women. Finally, Patterson & Connine (2001) noted that both lexical frequency and morphological complexity had an effect on flap production: low frequency words and morphologically complex words were less likely to be produced with a flap variant than high frequency or morphologically simple words.

Acoustic and articulatory evidence further suggest that the features used to define flaps can vary considerably. Fisher & Hirsch (1976), for example, found that the acoustic features that differentiated /t/ from /d/, such as voicing, preceding vowel duration, and closure duration were "muted" rather than merged when these stops were reduced to flaps, which suggests that flaps can be produced with greater or lesser voicing, vowel durations and closure durations. These findings have been supported in later studies: Fox & Terbeek (1977) noted that /t/ flaps were produced with variable voicing, and durations; and Byrd (1993) noted that some flaps were produced with durations comparable to those for /d/. Despite this variation in flap production, the literature suggests that flaps and /t/ can largely be distinguished by their greater voicing (de Jong, 1998; Fox & Terbeek, 1977); shorter durations (Byrd, 1993); more retracted tongue positions (de Jong, 1998; Connell, 1995); lower jaw positions (Stone & Hamlet, 1982); and the presence of a burst (Byrd, 1993; Fox & Terbeek, 1977).

The above experimental studies, have almost exclusively been carried out on American English. In this paper, we will examine some of the facilitating variables in flap production, and the resulting acoustic and articulatory changes across three dialects of English: American English (AmE), Australian English (AuE) and Standard Southern British English (UKE). The method in this study is largely based on a study by de Jong (1998), in which he documented a link between flap production across word boundaries and prosodic accent placement. His findings showed that in a word pair,

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such as "[put the] tote on [the table]", if either word was produced with a nuclear accent, the stop was unlikely to lenite to a flap production, but when neither word was accented, flap production was highly likely. The current paper aims to expand his findings as follows. Firstly, de Jong's study was based only on AmE. Flapping may be a less common feature in other varieties of English, such as AuE or, more particularly, UKE. Wells (1982) describes flapping in London English as an allophone of /r/, not /t/ or /d/. We examine how far it is possible to generalise the observed effects in de Jong's study to other English dialects. Secondly, de Jong did not control for lexical frequency in his study. Patterson & Connine (2001) showed that high lexical frequency increased the likelihood of /t/ flapping word medially. In this study we will investigate the extent to which lexical frequency affects stop production across a word boundary. Thirdly, de Jong's study used X-ray microbeam data to study jaw and tongue movement. Here, we will use EPG data as well as acoustic data in an attempt to gain a clearer view of lingua-palatal contact in stop and flap productions.

METHOD

Subjects

Data was recorded from six speakers. Two speakers were American, both of whom spoke a Northern dialect of AmE. One of the speakers had been resident in Australia for only a few months at the time of recording, while the other had lived in Australia for several years. Of the remaining speakers, two were English, and two Australian. The English speakers had both been resident in Australia for over a year at the time of recording, and both speakers were judged to be speakers of Standard Southern British English. One of the Australian speakers was judged to be a General- Broad speaker of AuE, while the other was classified as a General-Cultivated speaker. With the exception of one of the UKE speakers, all speakers were female, and all were aged between 22 and 57.

Materials

Dialogues were constructed to elicit accented, unaccented and pre-accented tokens of the target word. In the dialogues below, the accented words are in bold, and the target words are underlined.

Did you say to put the ***hat*** on the table?	
No, I said to put the ***XXXX*** on the table.	Target word accented (acc)
Did you say to ***ge****t* the XXXX on the table?	
No, I said to ***put*** the XXXX on the table.	Target word unaccented (nacc)
Did you say to put the XXXX ***under*** the table?	
No, I said to put the XXXX ***on*** the table.	Target word pre-accented (pre)

The target word (XXXX) was either "note" or "tote". The word “note” had a much high lexical frequency than “tote” , its combined spoken and written logarithmic frequency was 1.89 compared to 0 for “tote” (these lexical frequency values were taken from the Celex Lexical Database (1993)). Therefore we expect there would be an increased likelihood of flapping for note. 21 tokens of "note" and "tote" were elicited from each speaker, 7 accented, 7 unaccented, and 7 preaccented, resulting in a total of 42 tokens per speaker.

Recording and Digitisation

The EPG data was collected using the QMC Electropalatograph system from Laryngograph. The acoustic data was collected using a Senheiser ME80 directional microphone. Both the EPG and acoustic data were digitised simultanenously to a SUN Sparc station. The acoustic data was sampled at 20kHz with a 16 bit quantisation. The EPG data was digitised to the SUN at 200Hz.

Paramaterisation

The acoustic data was labeled using the Emu Speech Database System (Cassidy & Harrington, 1996). The vowel and final /t/ in each target word were manually labelled using features from the waveform and spectrogram. From these labelled segments, the following three acoustic parameters were taken for measurement: the vowel duration in target word; the duration of the final /t/ in target word; averaged probability of voicing throughout the production of the final /t/.

The following three articulatory parameters were taken from the EPG data: centre of gravity of the lingua-palatal contact (COG); the percentage of lingua-palatal contact over entire stop duration; and the duration of maximum lingua-palatal contact. The contact and COG values were all obtained for a 20 ms slice of data centred on the point at which maximum lingua-palatal contact first occurred. The percentage of lingua-palatal contact was measured by dividing the number of lingua-palatal contacts by the total number possible contacts per frame, and averaging the final result over the total number of palate frames.

RESULTS

In this section, we will firstly present the acoustic results, followed by our articulatory findings. The data for each speaker will be considered separately, since between speaker analysis showed that speakers usually differed significantly, notably in the articulatory data. Significance was given at $p < 0.01$. An initial examination of the results revealed that lexical frequency rarely effected consonant production. The results will therefore be presented with collapsed word types, except when a significant difference occurred. In this case, results for the different words will be plotted separately.

Acoustic

Figure 1 presents the durations of the vowels for the words "note" and "tote". Only one speaker (AM1) showed no effect of lexical frequency. Of the other five speakers, all produced "note" with significantly greater vowel duration than "tote". However, these differences are not plotted because it is highly likely that this difference is due to the phonetic context of the preceding consonant (/n/ vs /t/). Speaker AU2 showed a significant interaction between word type and accent, therefore in this case the words have been plotted separately. All speakers, with the exception of AU2 showed a significant effect of prosodic accent placement. Speakers AM1 ,AU1, and UK2 produced their accented vowel tokens with greater duration than their unaccented or preaccented tokens. In addition, UK2 also produced unaccented tokens with significantly greater duration than preaccented tokens. Speaker UK1 showed a slightly different pattern: accented and unaccented tokens were produced with similar durations, both of which were significantly greater than the durations for preaccented tokens. Finally, speaker AM2 produced unaccented words with a shorter vowel duration compared with accented and preaccented words.

Figure 2 shows consonant durations for the final /t/ in the words "note" and "tote" for each speaker. Both the AuE speakers showed a significant effect of lexical frequency, but this effect was not in the expected direction: "note" was produced with a significantly longer consonant duration than "tote". The overall consonant duration showed no notable effect of dialect, with AM2 and AU1 producing on average significantly longer consonant tokens, than the rest of the speakers. Three speakers showed a significant effect of prosodic accent placement. Both the UKE speakers produced the preaccented tokens with a significantly shorter final consonant duration than either the accented or unaccented consonant tokens, while conversely, AU1 produced the unaccented tokens with a significantly shorter consonant duration than either the preaccented or accented tokens.

An analysis of the averaged probability of voicing throughout the consonant showed that speaker UK1 produced consonants in preaccented words with significantly greater voicing than consonants in accented or unaccented words. Furthermore, this speaker also produced consonants from "note" with a higher average degree of voicing that those from "tote".

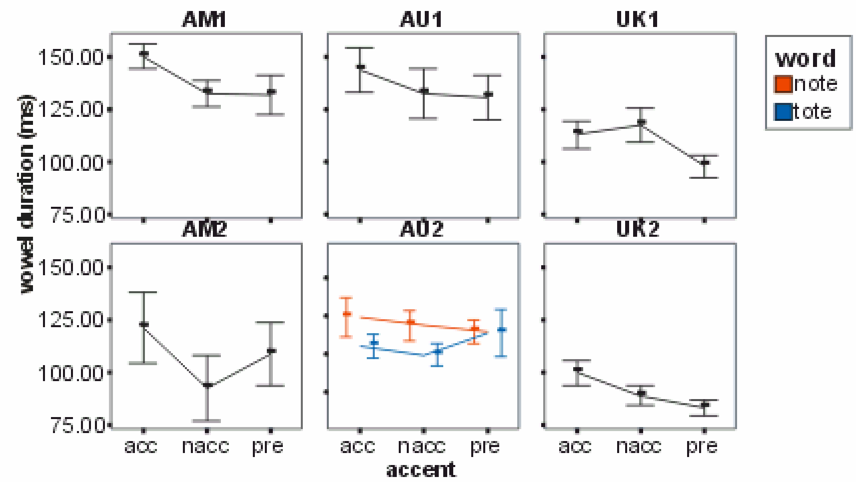

Figure 1. Vowel duration for AmE (left), AuE (middle)and UKE (right) speakers. The dots and vertical lines represent the means and standard deviations of the accented, deaccented and pre-accented tokens for each speaker.

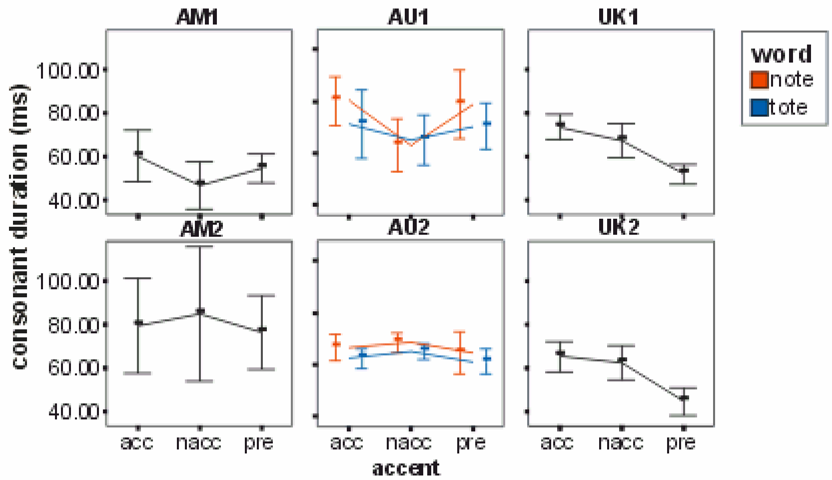

Figure 2. Consonant duration for AmE (left), AuE (middle)and UKE (right) speakers. The dots and vertical lines represent the means and standard deviations of the accented, deaccented and pre-accented tokens for each speaker.

Articulation

Figure 3 shows the COG values for all speakers calculated from a 20ms slice centred on the point at which maximum lingua-palatal contact first occurred. Lexical frequency had no significant effects on the COG values for any of the speakers. There was a significant effect of prosodic accent for three speakers: both AuE speakers and UK2 produced the preaccented tokens with significantly higher COG values than the accented tokens, in addition AU2 and UK2 also produced preaccented tokens with greater COG values than unaccented tokens.

Figure 4 shows the percentage of lingua-palatal contact which occurred at the point of maximum contact. As with the COG values, lexical frequency had no effect on amount of tongue/palate contact, but prosodic accent did. Three speakers, AU1, AU2, and UK2, all produced preaccented tokens with significantly greater lingua-palatal contact than unaccented tokens. Both AuE speakers also produced preaccented tokens with significantly greater tongue/palate contact than accented tokens. Finally, the duration of maximum lingua-palatal contact was also measured, but no significant differences were found for either lexical frequency or word effect.

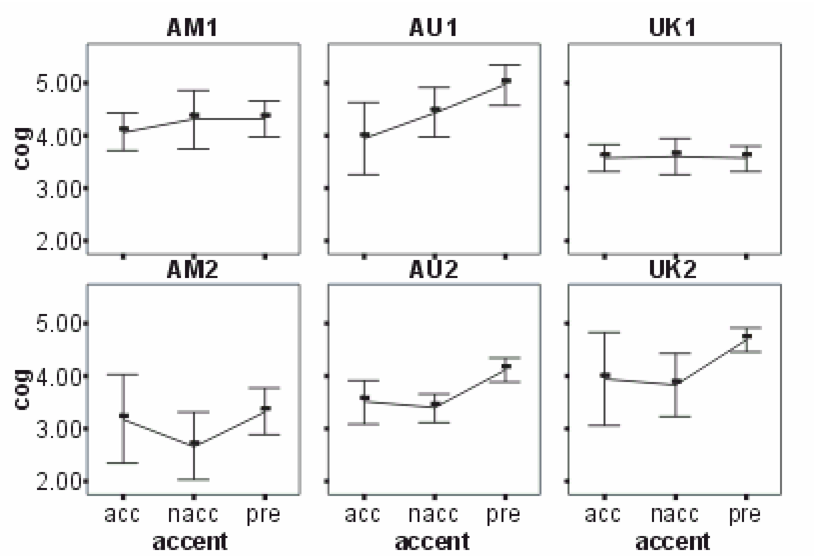

Figure 3. Centre of Gravity (COG) for AmE (left), AuE (middle)and UKE (right) speakers. The dots and vertical lines represent the means and standard deviations of the accented, deaccented and pre-accented tokens for each speaker

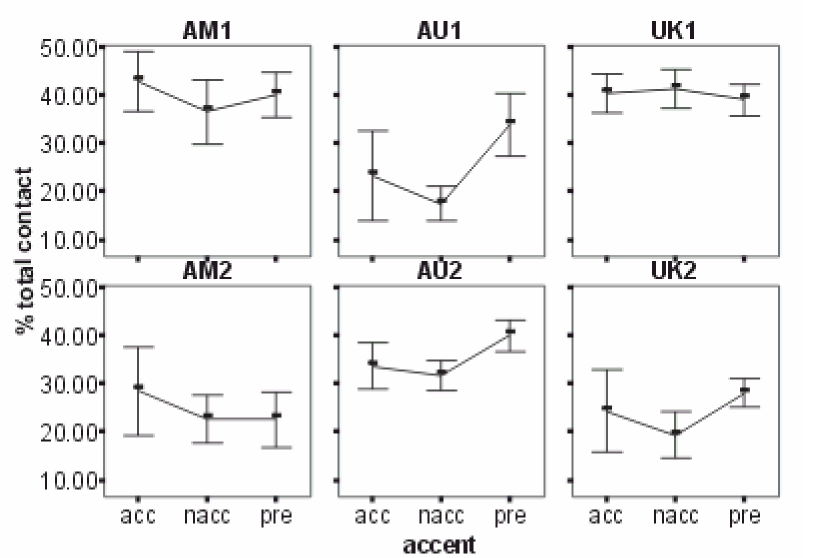

Figure 4. Percentage of total lingua-palatal contact, measured at 20ms slice centred on the point at which maximum lingua-palatal contact first occurs for AmE (left), AuE (middle)and UKE (right) speakers. The dots and vertical lines represent the means and standard deviations of the accented, deaccented and pre-accented tokens for each speaker

DISCUSSION

From the above results, we can see firstly, that lexical frequency does not appear to facilitate flap production. In the few cases where lexical frequency did have an effect, the resulting changes were frequently not as predicted (i.e. lower frequency words should be produced with greater consonant duration, greater degree of lingua-palatal contact, more fronted contact, greater duration). These findings suggest that when the phonetic environment that permits flap production occurs over a word boundary, the effects of lexical frequency are substantially diminished, or are removed altogether.

Secondly, our results show that dialect-specific variation occurs in the production of word final /t/. This production is most apparent in the acoustic data. Both the UKE speakers produced the stops in the preaccented words with shorter consonant durations and shorter vowel durations. Further, UK1 produced preaccented stops with greater voicing. This is highly suggestive of some form of consonant reduction occurring in the preaccented condition. However, a post hoc perceptual analysis showed that neither UKE speakers produced flaps. A more detailed analysis of the acoustic and articulatory data will be needed to ascertain the nature of the UKE consonant reduction. This pattern was not seen for either AuE or AmE speakers, and suggests that prosodic structure affects stop production differently in UKE versus AuE and AmE.

Finally, in comparison with de Jong's data, our results show little evidence of flap production in the unaccented prosodic condition versus stop production in the preaccented and accented conditions. Surprisingly, the AmE speakers in particular show little stop variation over the three prosodic contexts. These findings are perhaps the result of unnatural nature of the experiment (laboratory environment and contrived sentences). In a follow-up experiment, we will analyse consonant production in high frequency phrases, such as cliches, and anticipate a substantially greater instance of flap production in both AmE and AuE speakers. This pattern would confirm dialect-specific patterns of flap production.

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