FUNCTIONAL LOAD AND THE TEACHING OF PRONUNCIATION

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ABSTRACT

The concept of functional load has been used by various writers in various linguistic fields. It has consequently received differing definitions and methods of calculation. It has not, however, been applied to the teaching of pronunciation. In this paper are discussed several aspects of functional load which may be relevant for the assessment of the relative importance of segmental features of learners' speech.

Introduction

'Suppose you are teaching English to foreign students, on a tight schedule, with no special time for pronunciation teaching,' writes Gillian Brown [1] p.53. 'Which of the following problems would you tackle first? Discrimination of /θ/ and /ð/, [etc.].'

Her answer: 'When time is short it is probably not worthwhile spending time on teaching /θ/ and /ð/ if the students find them difficult, but be sure that the sounds substituted by the students are /f/ and /v/ sounds which are acoustically similar to /θ/ and /ð/ and bear a low functional load in English (i.e. don't distinguish many words), and not /s/ and /z/, which are acoustically very different from /θ/ and /ð/ and bear a much higher functional load.'

Many writers have made appeal to the notion of functional load (FL), and for various purposes. However, the precise definition given to the concept has varied from writer to writer [2]. King [3] p.831 writes that 'in its simplest expression, functional load is a measure of the number of minimal pairs which can be found for a given opposition. More generally, in phonology, it is a measure of the work which two phonemes (or a distinctive feature) do in keeping utterances apart - in other words, a gauge of the frequency with which two phonemes contrast in all possible environments.'

It is not clear how much thought has been given to the problem of definition by writers making appeal to the notion. For instance, we could disagree with Brown above, in that phonemes such as /f/ and /v/ do not have FLs in isolation; it is only the contrasts between pairs of phonemes which can carry FLs.

King [4] p.7 proposes a formula for the calculation of FL which 'is the product of two factors: the first measures the global text frequencies of the two phonemes in the opposition; the second measures the degree to which the two phonemes contrast in all possible environments, where environment means, roughly speaking, one phoneme to the left and right'. As Vachek [5] p.65 points out, although environment is of obvious importance, King's definition of this as one phoneme to the left and right should have been stated in finer terms.

The main difference between King's formulation and those of other writers is that it is based on conditional probabilities instead of being an information theory approach. Wang [6] (see also [7]) compares four information theory measures of FL, concluding 'more important than the development of a measure that is internally consistent and which conforms to certain linguistic requirements is the task of providing empirical justification for the measure' (p.50).

The value of the concept of FL has been recognised in other linguistic fields, including general descriptive linguistics [8], diachronic phonology [3], automatic speech synthesis and recognition [9, 10] and spelling reform [11]. It has not, however, been applied to the question of language teaching. In this paper, I therefore wish to explore certain aspects of FL which are of use in the teaching of pronunciation. This discussion owes much to the ideas of Avram [12]. For illustration, I shall deal in particular with the following pairs of (RP) phonemes, which are often conflated by learners: /iː, ɪ; ɪə, eə; e, æ; ɔː, ɔɪ; uː, ʊ; p, b; ð, d; n, ŋ; tʃ, dʒ/.

Cumulative text frequency

In the table below, I give the cumulative frequencies for these pairs of RP phonemes based on the figures for connected speech given by Denes [13]. Thus, for example, the cumulative frequency for the pair /e, æ/ (11.05%) is calculated by adding the individual text frequencies of 7.16% for /e/ and 3.89% for /æ/. On the basis of these calculations, we may then propose that a pair with a high cumulative frequency (e.g. /e, æ/, 11.05%) is of greater importance than one with a low (e.g. /ɪə, eə/, 1.83%). That is, over one in every ten vowels is either /e/ or /æ/, whereas under one in every fifty vowels is either /ɪə/ or /eə/. The risks, as far as loss of intelligibility is concerned, of conflating /e, æ/ may thus be considered greater than those of conflating /ɪə, eə/.

Probability of occurrence

These cumulative frequencies disguise the fact that one member of a conflated pair may occur much more frequently than the other. For example, /iː, ɪ/ have a high cumulative frequency (25.57%); one in four of all vowels in connected speech is either /iː/ or /ɪ/. Given that a learner has produced a vowel of the [i] type, it is, however, four times more likely that this corresponds to /ɪ/ than to /iː/. The basic text frequencies are 21.02% for /ɪ/ and 4.55% for /iː/.

The closer to 0.50, the more equal are the individual frequencies, and the greater is the potential confusion to be caused by the conflation of the pair. (The probability of the more frequent member is one minus the probability of the less frequent). In this way, we may distinguish four extremes:

(i) pairs with a high cumulative frequency and relatively equal probability, e.g. /ð, d/,

(ii) pairs with a high cumulative frequency but unequal probability, e.g. /iː, ɪ/, /n, ŋ/,

(iii) pairs with a low cumulative frequency but relatively equal probability, e.g. /ɪə, eə/, /tʃ, dʒ/, and

(iv) pairs with a low cumulative frequency and unequal probability, e.g. /ɔː, ɔɪ/.

It would seem reasonable to rank them as above in decreasing order of importance for learners and teachers.

Occurrence and stigmatisation in native accents

Whilst RP has been used as the reference accent in this paper, certain of the learners' conflations are to be found in other native accents. /uː, ʊ/ conflation is widespread in Scotland; /ɪə, eə/ conflation is an increasingly common phenomenon in New Zealand, the West Indies and East Anglia; and /ð, d/ conflation is found, if only sporadically, in the Republic of Ireland, although it is heavily stigmatised. We may conclude that listeners are accustomed to making the perceptual adjustment necessary for intelligibility of these conflations, but not for the others.

Acoustic similarity

As Brown quoted above notes, acoustic similarity between sounds is a relevant factor. That is, /θ, f/ and /ð, v/ are more acoustically similar than /θ, s/ and /ð, z/. For example, /θ, f/ may be difficult to distinguish in bad transmission conditions, as on a telephone line; listeners are therefore already familiar with recognising the intended sound from context. On the other hand, /θ, s/ are more distinct, even on noisy telephone lines; listeners are therefore unaccustomed to realising that a misinterpretation or conflation may have taken place. Comparable acoustic similarity is found between the nasal consonants /m, n, ŋ/.

The structural distribution of phonemes

It is a phenomenon of English syllable structure that /ŋ/ only occurs in syllables containing short vowel phonemes (/ɪ, æ, ʌ, ɒ/). /n/, on the other hand, occurs in syllables with either long or short vowel phonemes. Thus, a learner who conflates /n, ŋ/ will not be open to misunderstanding all the time; his conflation may only lead to confusion where it occurs after a short vowel phoneme, since any occurrence after a long vowel must be /n/ not /ŋ/.

In similar vein, it is a feature of English that stressed word-final syllables do not contain short vowel phonemes unless they also contain a final consonant. Thus, /bɪt/ is permissible (bit), but not */bɪ/. Long vowel phonemes are not subject to this constraint, e.g. /bɪː/, bee. Thus, any vowel in a stressed word-final syllable without a final consonant cannot be a short vowel phoneme.

Syllable structure constraints therefore limit the potential confusion of conflated pairs (/n, ŋ/, /iː, ɪ/) in particular environments.

Lexical sets

We must not lose sight of the fact that phonemes combine to create the actual words of the English lexicon. There are some phonemes which are not contained in many words. For instance, Wells [14] p.133 notes that the lexical set for the phoneme /u/ is relatively small - around 40 words. The frequency of this phoneme is a mere 1.95%, and would be even lower were it not for the fact that this lexical set includes a number of words of very frequent occurrence, such as put, good, look, would.

The number of minimal pairs

The simplest expression of the FL of a phonemic contrast is the number of minimal pairs which this contrast serves to distinguish. For some English phonemic contrasts, there are plenty of minimal pairs; for others, there are relatively few. For /uː, ʊ/, the only minimal pairs involving common modern words are pool, pull; fool, full; who'd, hood; suit (if pronounced /suːt/), soot. Minimal pairs are similarly scarce for /ʃ, ʒ/ and /θ, ð/. Misunderstanding is therefore very unlikely to occur for these contrasts and on this basis, we may consider them to be relatively unimportant. The following table shows the relative importance of all the vowel and consonant contrasts introduced earlier, in terms of the number of minimal pairs exemplifying the contrasts. The criterion has been set, somewhat arbitrarily, at 20 minimal pairs. Fewer than 20 pairs can be found for those contrasts marked -, while over 20 pairs can be found for those marked +. Minimal pairs for consonants in word-initial position and in word-final position have been calculated separately.

The number of minimal pairs belonging to the same part of speech

Following on from the previous section, we may note that although there are certain contrasts for which there are several minimal pairs, sometimes these minimal pairs involve few words from the same part of speech. These pairs are therefore unlikely to cause confusion in the context of a sentence. For example, there are several minimal pairs for initial /ð, d/. However, it is a phenomenon of English that words beginning with /ð/ are grammatical words, such as the, those, they, then, though. They are thus unlikely to be confused in context with the corresponding /d/ words, which are virtually all lexical words, such as doze, day,

	1	2	3	4
/ɪ:, ɪ/	25.57%	0.18	+	-
/ɪə, eə/	1.83%	0.40	-	+
/e, æ/	11.05%	0.35	+	-
/ɔ:, ɔɪ/	3.28%	0.07	-	-
/u:, ʊ/	5.57%	0.35	-	+
/p, b/	6.34%	0.46	+ +	-
/ð, d/	11.81%	0.42	- -	+
/n, ŋ/	13.72%	0.15	* -	-
/tʃ, dʒ/	1.46%	0.42	- -	-

Column 1 = cumulative text frequency, expressed as a percentage of the occurrence of all vowels, or of all consonants.
Column 2 = probability of the less frequent member of the pair.
Column 3 = whether 20 minimal pairs can be found. For consonants, this is given for word-initial and word-final positions. * indicates that /ŋ/ does not occur initially in English words.
Column 4 = occurrence in native accents.

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den, dough).

Consideration ought also to be given to the fact that the frequency of occurrence of members of the closed set of grammatical words is higher than for lexical words.

The number of inflections of minimal pairs

One problem in counting the number of minimal pairs relying on particular phonemic contrasts is the use which English makes of inflections such as the suffixes for plural, past tense, -ing forms. Thus, for example, for the /ɪə, eə/ contrast, several pairs take /z/, /d/ and /ɪŋ/ endings, e.g. fear, fare; spear, spare; steer, stare. Whether these should be counted as separate minimal pairs or not in the calculation of FL is a somewhat arbitrary methodological consideration.

The frequency of members of minimal pairs

Minimal pairs for the English contrast /u:, ʊ/ are scarce. A few examples exist, further to those quoted above, but in which one member is of such infrequent occurrence that the minimal pair can hardly be said to have any importance. Thus, while the /ʊ/ words would, could, should, look may be considered frequent, the corresponding /u:/ words wooed, cooed, shoed/shooed, Luke are so infrequent as to be almost contrived.

The number of common contexts in which the members of minimal pairs occur

It is also worthwhile to consider whether the members of minimal pairs belong to the same semantic field or not, i.e. whether contexts can be easily supplied in which both members of a minimal pair are plausible alternatives, both grammatically and semantically. Such contexts are easily supplied for English pairs such as fate, faith; trek, track; sherry, cherry; shin, chin; cheer, jeer, but this is not possible for the majority of minimal pairs in English.

Conclusion

In summary, it should be clear that more advanced analysis than a counting of the number of minimal pairs is involved in the calculation of FL. Avram [12] summarises this point succinctly: 'if we suppose that one opposition is illustrated by ten minimal pairs and another by twenty, it does not necessarily mean that the second opposition is twice as important as the first. Starting from minimal pairs, the successive application of certain correctives is essential if we wish to establish the actual value of an opposition more clearly' (p.42).

On the basis of the above observations on FL, we may propose that the relative importance of the phonemic RP contrasts discussed in this paper can be ranked as follows, most important first: /p, b; e, æ; i:, ɪ; ð, d; n, ŋ; tʃ, dʒ; u:, ʊ; ɪə, eə; ɔ:, ɔɪ/.

References

[1] Brown, G. (1974) 'Practical phonetics and phonology' in J.P.B. Allen & S. Pit Corder (eds.) The Edinburgh Course in Applied Linguistics (vol.3: Techniques in Applied Linguistics). Oxford University Press, pp.24-58.
[2] Meyerstein, R.S. (1970) Functional Load. Janua Linguarum Series Minor no.99, Mouton, The Hague.
[3] King, R.D. (1967) 'Functional load and sound change' Language 43:831-852.
[4] King, R.D. (1967) 'A measure for functional load' Studia Linguistica 21:1-14.
[5] Vachek, J. (1969) 'On the explanatory power of the functional load of phonemes' Slavica Pragensia 11:63-71.
[6] Wang, W.S.-Y. (1967) 'The measurement of functional load' Phonetica 16:36-54.
[7] Wang, W.S.-Y. & Thatcher, J.W. (1962) 'The measurement of functional load' Report no.8, Communication Sciences Laboratory, University of Michigan, Ann Arbor.
[8] Hockett, C.F. (1955) A Manual of Phonology. Memoir no.11, International Journal of American Linguistics, Baltimore.
[9] Fry, D.B. & Denes, P.B. (1957) 'On presenting the output of a mechanical speech recogniser' Journal of the Acoustical Society of America 29:364-367.
[10] Fry, D.B. & Denes, P.B. (1958) 'The solution of some fundamental problems in mechanical speech recognition' Language & Speech 1:35-58.
[11] Wells, J.C. (1986) 'English accents and their implications for spelling reform' Simplified Spelling Society Newsletter no.2:5-13.
[12] Avram, A. (1964) 'Some thoughts on the functional yield of phonemic oppositions' Linguistics 5:40-47.
[13] Denes, P.B. (1963) 'On the statistics of spoken English' Journal of the Acoustical Society of America 35:892-904.
[14] Wells, J.C. (1982) Accents of English (3 vols.) Cambridge University Press.