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An Analysis of the Effect of Functional Load on ESL Learners' Perception of Vowel Contrasts

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Abstract: Functional load (FL), which ranks segmental contrasts based on their communicative value in pronunciation, is essential to the development of pronunciation instruction in that it indicates the priority of certain segmental contrasts that may seriously affect the intelligibility and comprehensibility of spoken language for English as a Second Language (ESL) learners. Despite the widespread use of FL in pronunciation pedagogy for ESL learners, there is little evidence on whether FL affects ESL learners' perception of vowel contrasts. In this paper, 20 ESL learners from two Chinese universities are selected to participate in two tasks to observe their performance in discriminating vowel contrasts with different FLs in listening and word pronunciation. The effects of functional load on ESL learners' perception of vowel contrasts are investigated in terms of both input and output dimensions. The overall findings indicate that high FL vowel contrasts are more likely to be captured in listening and more consciously distinguished in pronunciation, a piece of evidence proving the necessity of applying FL principle to English pronunciation teaching.

Keywords: Functional Load, pronunciation teaching, vowel contrasts, second language learning, segmental features

1. Introduction

FL is a practical measure to judge the "importance" of distinguishing segmental contrasts, or the severity of erroneously confusing them. [1]. Motivated by the fact that rare studies have related the ESL (English as a Second Language) learner's perception of vowel contrasts to the impact of FL that different contrasts may carry, this paper investigates ESL learners' ability to differentiate between different FL vowel contrasts through an empirical study with two dimensions of input and output. This investigation is similar to previous studies in that it relies on contrast lists provided by Brown and Catford. The FL of vowel contrasts is divided into two categories: high FL and low FL. In Brown's contrast lists, 1-5 are low FL, while 6-10 are high FL. In Catford's contrast lists, 100%-51% are high FL, while 50%-0% are low FL [2].

Two related tasks are included in the experiment to observe the performance of twenty ESL learners from two universities. In Task 1, forty ESL learners are required to listen to minimal word pairs containing vowel contrasts that have been mentioned in FL lists in previous works and determine whether each pair is homophonic or not. In Task 2, they pronounce samples of words containing different vowel sounds. Their responses on the listening test inspect the effect of FL on the acoustic perception of vowel contrasts, and their performance, including the confusion of vowels that may

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carry varying degrees of FL, will reflect the effect of FL on ESL learners' perception of vowel pronunciation. A more detailed description of the experiment will be presented in the chapter Methodology. Through these tasks, this paper offers a novel perspective on the link between FL and ESL learners' perception of vowel contrasts, shedding light on the use of FL in pronunciation instruction by highlighting several key questions, including the following questions: To what extent do varying levels of FL affect ESL listeners' sound recognition of minimal pairs that contain vowel contrasts? Conversely, to what extent is the confounding of vowel contrasts in ESL learners' pronunciation influenced by the FL carried by these vowel contrasts? And what can be discovered from the potentially unprecedented results?

2. Literature Review

The notion of Functional load, according to Catford, was originally discussed in terms of phonemes. According to King, FL 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. The quantification of FL, in Charles' perspective, should consider three cases which is the phonemic contrasts, allophonic contrasts and componential contrasts [3]. FL was later applied by linguists to rank segmental contrasts according to their importance in English pronunciation, with the hypothesis explaining the likelihood of diachronic sound change that high FL contrasts are more likely to survive in a language, while low FL contrasts are more prone to loss [4]. However, it was not until the 1980s that the broader application of FL in the field of pronunciation teaching was realized. The FL model, constructed by Brown and Catford demonstrates the relative importance of segmentals in terms of how much work phoneme pairs do in communicating meaning differences in a language [1][3]. FL, as a list of segmental contrasts that are developed from minimal pairs in frequently used words, the degree of neutralization among regional English dialects, and the segmental position within a word, are ranked based on their communicative value in order to prioritize more valuable segmental contrasts in time-limited pronunciation instruction. Neither of the two findings had achieved in providing a clear measurement to FL but instead ranked the relative amount of FL segmental contrasts carry. However, it is noted that since 1980s applied linguists have extended the calculation of FL from merely counting the number of minimal pairs to an integrated work which have taken various factors such as phonetic similarity, probability of occurrence, acoustic similarity and lexical sets into account, a more precise measurement of FL is even more difficult to calculate [5].

Despite the controversy, the definition and measurement methods of FL are noteworthy in their application in various studies. Munro and Derwing unearthed initial validation for the "functional load hypothesis," indicating that the comprehensibility and intelligibility of accented speech is largely determined by the degree of FL segmental errors within sentences that the substitutions of high FL segments (such as read is pronounced as rid) led to dramatically lower comprehensibility while the conflation of low FL contrasts (for example, substitute [θ] for [f]) would be less likely to confuse the listeners [6].

As to the examination of the impact of vowel and consonant substitutions with varying FL values, most studies focused on the consonant contrasts. Suzukida and Saito revealed that consonant substitutions notably impaired comprehensibility and concluded that solely high FL consonant substitutions had a detrimental effect on native listeners' comprehension judgments [7].

In 2022, Mutleb Alnafisah tested the impact of functional load and cumulative errors on listeners' judgments of comprehensibility and accentedness. By employing a database of read-aloud sentences with different types and number of FL errors, high FL errors were found being associated with greater loss of comprehensibility and judgments of higher accentedness than low FL errors. For accentedness judgments, higher error frequency affected high FL errors only. The results confirm earlier findings

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for the usefulness of functional load as a metric for L2 pronunciation teaching, but raise questions about whether findings for extremes on the 10- point FL hierarchy reflect error gravity findings for the middle of the hierarchy [8].

To summarize, most of the previous studies have been taken from a empirical perspective, on the basis of the relative rankings given by Brown and Catford since a precise measurement of FL is difficult to calculate and deemed unnecessary. It is true that one can obviously claim that particular contrasts have high or low functional load without mentioning the actual amount, one may need to be more careful when establishing a hierarchy among contrasts and hence the discrepancy in their importance to a language [9]. It is noticeable that vowel contrasts, as a vital segmental contrasts which might bring huge barrier if being conflated, are rarely discussed empirically with the adoption of FL principle. For another, hitherto the application of FL and the examination of its effectiveness are still remained in the level of acoustical input, while whether high and low FL have different impacts on ESL learner's articulation of segmental-contrasted words has not been mentioned. Therefore, the current study conducts an experiment which combines listening and pronouncing to investigate the correlation of FL to ESL learner's perception of vowel contrasts in two dimensions of acoustic recognition and pronunciation.

3. Methodology

3.1. Participants

Twenty ESL learners, varying from different nationalities, mother tongues, cultural backgrounds and prior knowledge of the English phonetic system, are voluntarily recruited from two universities in two provinces of China, all of whom are English major students or interchange students from ESL countries so that their basic knowledge of English is guaranteed. The background information on each individual is collected through a paper-based questionnaire, including all necessary information, which will be strictly protected. In addition, participants who have reached an advanced level of English are specially marked through a 1-to-1 speaking test before the task. The listening materials are provided by a native English speaker who works in the Department of English Major of the university and also acts as a judge listening to the participants' pronunciation transcripts, while the other judges are all experienced English speakers.

3.2. Material for Listening Tests

The material for listening tests is comprised of pairs of words containing vowels that are minimally varied according to the functional load of their contrasts. Additionally, homophonous word pairs are interspersed throughout the material. Each test includes 10 pairs, divided into three categories: high FL vowel contrasted pairs, low FL vowel contrasted pairs and homophonous/same pairs. The pairs are presented in a random order, and examples are provided in Table 1 below. It is evident from the table that the majority of words are monosyllabic, or alternatively, that they are all vocalic nuclei, which serves to prioritize the target vowel contrasts and the ESL learners' familiarity with them.

It is noted that since applied linguists have extended the calculation of FL from merely counting the number of minimal pairs to encompass a more comprehensive approach that considers various factors such as phonetic similarity, probability of occurrence, acoustic similarity and lexical sets [1], a more precise measurement of FL is now even more challenging to calculate. Consequently, the majority of research in this field has been based on the lists developed by Brown and Catford. Therefore, the word selection in this task is consistent with previous studies, which provides a more empirical result.

The words to be pronounced for the speaking test are selected based on the frequency of use to ensure the learners have no difficulty in recognizing them. In total, learners are required to pronounce

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twenty words that correspond to the twenty vowel phonemes of the RP. In fact, the use of RP does not pose a problem, but rather brings some benefits. Brown argues, rightly or wrongly, that RP is widely used around the world as a pronunciation model for foreign learners. Even more compelling is the fact that RP has a relatively large number of vowels, and most ESL learners are educated in the RP model [1].

3.3. Task 1 Description

The listening test is taken separately via online meetings, which feature a series of Yes/No inquiries, each containing a pair of contrasting words (see Table 1). The test-takers should record their response on paper (not online, as it may be modified) by indicating whether the pronunciation of the same pair of words can be recognized (by writing "yes" or ticking the appropriate box) or not (by writing "no" or ticking "x"). At the end of each question, each has five seconds to record their answer and no further corrections are allowed.

The recording will be played once, and the answers will be collected as soon as it is finished. Due to the simplicity of this test, the impact of FL on their acoustic perception of vowel contrasts may be less pronounced, but the result can serve as a contrast indicator of how differently they perform when listening to and pronouncing words with different levels of FL.

Table 1: Word Pairs for Task 1 Examples

Word Pairs	Vowel contrasts contained	Level of functional load
pit, pet	/ɪ,e/	High
bit, bat	/ɪ,æ/	High
bought,boat	/ɔː,əʊ/	High
bit,beet	/ɪ,iː/	High
bet.bat	/e,æ/	High
her,hair	/ɜː,eə/	Low
fire,fare	/aɪ,eə/	Low
pull,pole	/ʊ,əʊ/	Low
kennel,colonel	/e,ɜː/	Low
coarse,course	/ɔː/	Homophonous
bet,bet	/e/	Same
dear,deer	/ɪ/	Homophonous
air, heir	/eə/	Homophonous

3.4. Task 2 Description

The speaking test provides twenty words for participants to pronounce, each containing one vowel phoneme of RP. Test results are collected primarily through an online survey where participants can record themselves on their cell phones. The recording results are automatically saved online, which can be easily read and viewed by the collector. Once the results are collected, the judges will first transcribe the results to test whether different FL segmental errors may have different effects on ESL learners' oral intelligibility in order to demonstrate consistency. Similar to the results of previous studies focusing on the effect of functional load on listeners' intelligibility judgments, this result will ensure that the task setting and word choice are adequate, otherwise the results and implications may not be sufficient to account for this intangible relationship between vowel segments and their nature [9].

To find the general FL effect on ESL learners' pronunciation, the data is decoded by listing and classifying the occurrence of vowel conflations. The decoding process will consider the FL level (high or low), RO (Rate of occurrence) and Comprehensibility. For example, in five answers to the

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survey the word bet which contains one vowel phoneme /e/ is found to be pronounced as /ægg/. The vowel contrast /e/ and /æ/ can be found in the FL list and is of low FL. Another word with /æ/ in this task is bat, in which six more answers pronounced /æ/ as /e/, so a total of 11 occurrences of this vowel confusion are found in all the samples containing either /e/ or /æ/. Thus, the calculated RO can be strong evidence for discovering the impact of FL on the production of ESL learners' segmental errors in pronunciation. The comprehensibility of a vowel contrast is calculated as the accuracy rate of judges' transcriptions, as shown in Table 2.

Table 2: Calculation Results

FL category	Vowel contrasts	RO
Low	/e/,/æ/	0.306

4. Results

4.1. Results of Task1

To reveal the impact of FL on ESL learners' acoustic perception of vowel contrasts and serve as a contrast indicators comparing with the results of pronunciation test (Task 2), twenty effective sample answers to the listening task (Task 1) are collected, as shown in Table 3.

Table 3: Result of Task 1

Category	Accuracy Rate
High FL	0.895
Low FL	0.785
Homophonous	0.925

From the result, it appears that most ESL learners were able to recognize all the homophonous word pairs, thereby validating the efficacy of this task. The overall accuracy of identifying high FL vowel contrasts is much higher than that of identifying low FL contrasts.

4.2. Results of Task 2 and Discussion

In the pronunciation test, eighteen effective answers were collected, with two answers found invalid due to poor sound quality. The general comprehensibility of pronunciations with high FL vowel conflations is 0.210 (calculated by dividing the number of correct transcriptions by the total number of segmental errors), and a much lower number can be found when it comes to low FL vowel conflations (0.448). This number is consistent with the findings of previous research, reflecting that high FL errors are associated with greater loss of comprehensibility than low FL errors [8].

Table 4: Results of Task 2

FL category	Vowel contrasts	RO
High	/ɪ/,/iː/	0.222
	/ɪ/,/eɪ/	0.083
	/əʊ/,/ɒ/	0.075
	/ɔː/,/əʊ/	0.056
	/e/,/eɪ/	0.056
	/uː/,/əʊ/	0.028

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Table 4: (continued)

Low	/e/,/æ/	0.306
	/u:/,/ʊ/	0.250
	/ɒ/,/ɔ:/	0.194
	/ʌ/,/ɑ:/	0.167
	/ɪə/,/eə/	0.111
	/aʊ/,/əʊ/	0.056
	/ɑ:/, /ɜ:/	0.056

High and low FL segmental substitution errors occurring in the sample recordings were coded based on the FL principle. Table 4 lists all the vowel conflations that occurred in the participants' performances into high or low FL category and ranks them in order of occurrence. It is obviously to see that in general, low FL vowel conflations are more likely to occur than high FL conflations in ESL learners' pronunciation, while the high FL conflation /ɪ,i:/, low FL conflations /e,æ/ and /u:,ʊ/ appeared most frequently. These three pairs, compared with other vowel conflations, share mutual segmental features as they are all more phonetically similar and serve to distinguish more minimal pairs [10].

It is also noticeable that other factors, such as English proficiency, may severely influence the manifestation of FL in ESL learners' pronunciation. Of the 18 participants, 6 have been learning English for more than 10 years, while the rest are under 10 years-learning-age. For the more advanced ESL learners, the number of high FL substitutions found in their pronunciation (RO=0.069) was very limited compared to the number of low FL substitutions (RO=0.143), with a ratio of 1:2.4 for high FL to low FL vowel confusions, while beginner ESL learners performed more similarly, with a ratio of 1:1.87 for high to low FL vowel confusions.

Correlating the result with those of Task 1, it can be observed that although ESL learners have slightly different levels of proficiency in perceptual recognition and pronouncing awareness of vowel contrasts, the high FL vowel errors are less likely to occur in both dimensions of input and output. This may support the idea that the FL principle is universally applicable to the teaching of English listening and speaking.

5. Conclusion

This paper investigated the impact of FL on ESL learners' perception of vowel contrasts in both dimensions of input and output, and the results showed a general correlation between language proficiency in vowel contrasts and ESL learners' vowel recognition scores. Similar to the previous findings concerning the impact of FL on segmental contrasts, the general result of the current experiment supports that high FL vowel contrasts are more likely to be captured from input and consciously distinguished in output, while low FL vowel contrasts are prone to be neglected in listening and conflated in word pronouncing. The findings also suggest that merely distinguishing high or low FL is not enough for effective pronunciation instruction, and that several parameters measuring FL are especially of great importance, such as acoustic similarity, numbers of minimal pairs and phonetic similarity, since vowel substitutions like /ɪ /, /i:/, which have a particularly high FL, may occur frequently in ESL learners' pronunciation. Besides, the development of English proficiency may balance the impact of FL that higher-level English learners perform better in vowel recognition and may make fewer FL errors in pronunciation in particular, compared to lower-level English learners. These findings provide strong evidence that the impact of FL on ESL learners' perception of vowel contrasts varies with FL level, both in terms of acoustic recognition and pronunciation, and creatively combine observations with listening and speaking performance to

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emphasize the overall great potential of the FL principle (especially the classification of high and low FL) in prioritizing the teaching of important vowel contrasts, while some segmental features or individual discrepancy should be concerned when setting such priorities.

References

[1] *Brown A (1988) Functional Load and the teaching of pronunciation. TESOL Quarterly 22: 593-606.*

[2] *Sewell, Andrew. (2021). Functional Load and the Teaching-Learning Relationship in L2 Pronunciation. Frontiers in Communication. 6. 627378. 10.3389/fcomm.2021.627378.*

[3] *Catford, J. C. (1988). Functional load and diachronic phonology. In Y. Tobin (Ed.), The prague school and its legacy (pp. 3–19). John Benjamins.*

[4] *King, Robert D. (1967). "Functional load and sound change", Language 43(4):831-52.*

[5] *Hockett, C. (1967). The Quantification of Functional Load. Word 23, 320–339. doi:10.1080/00437956.1967.11435484*

[6] *Munro, M. J., & Derwing, T. M. (2006). The functional load principle in ESL pronunciation instruction: An exploratory study. System, 34(4), 520–531. https://doi.org/ 10.1016/j.system.2006.09.004*

[7] *Suzukida, Y., & Saito, K. (2019). Which segmental features matter for successful L2 comprehensibility? Revisiting and generalizing the pedagogical value of the functional load principle. Language Teaching Research, 25(3), 431–450. https://doi.org/10.1177/1362168819858246*

[8] *Alnafisah, M., Goodale, E.D., Rehman, I., Levis, J.M., & Kochem, T. (2022). The impact of functional load and cumulative errors on listeners' judgments of comprehensibility and accentedness. System.*

[9] *Munro, M. J., & Derwing, T. M. (1995). Foreign accent, comprehensibility, and intelligibility in the speech of second language learners. Language Learning,45(1),73–97.https://doi.org/10.1111/j.1467-1770.1995.tb00963.x*

[10] *Catford, J.C., 1987. Phonetics and the teaching of pronunciation: a systemic description of English phonology. In: Morley, J. (Ed.), Current Perspectives on Pronunciation: Practices Anchored in Theory. TESOL, Washington, DC, pp. 87–100.*