Frequency Effects upon Perceptual Discrimination of Vowel & Consonant Minimal Pairs

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Frequency Effects upon Perceptual Discrimination of Vowel & Consonant Minimal Pairs

Hirokatsu KAWASHIMA

Abstract

英語の母音と子音のミニマルペアー識別における Frequency Effect（回数効果）の調査を行った。調査対象としたミニマルペアー識別の回数は１回／２回であるが、１）母音のミニマルペアー識別と子音のミニマルペアー識別におけるそれぞれのパフォーマンスの平均点、また、２）それぞれのパフォーマンスと総合的リスニング能力との相関関係、等の観点から収集データの分析を行った。その結果、母音のミニマルペアー識別では回数効果はないが、子音のミニマルペアー識別では回数効果があり、識別のチャンスが２回ある時、パフォーマンスの向上が見られること等が明らかにされている。

Background

Frequency effects are often observable and recognized in language learning and teaching. For instance, English language instructors may face a difficult situation in the classroom when it comes to determining the frequency of asking questions about reading comprehension materials. From a learners' point of view, they may find it hard to adjust themselves to instructor-oriented frequencies in such a situation.

Frequency effects have been addressed in a number of times in the theoretical context of language acquisition/learning. Ellis (1994: p.704) deals with the frequency hypothesis, in which it "states that the order of development in L2 acquisition is determined by the frequency with which different linguistic items occur in the input." Likewise, Ellis (2002: p.144) claims that "frequency is thus a key determinant of acquisition because "rules" of language, at all levels of analysis (from phonology, through syntax, to discourse), are structural regularities that emerge from learners' lifetime analysis of the distributional characteristics of the language input." Furthermore, in Dörnyei (2009), frequency effects are discussed from the perspective of probabilistic learning:

> There is a broadly shared assumption among usage-based linguists that the pattern-finding function of the child's language processor, that is, the abstraction of the regularities from the memorized constructions, is heavily frequency-biased; in other words, frequency underpins regularity effects in the acquisition of linguistic form. (p.119)

Frequency effects have been empirically examined from various angles, such as word recognition and sentence comprehension/production. For example, it is concluded in Diessel (2007: p.123) that

"linguistic expressions that are frequently combined may become automatized, i.e., they may develop into a processing unit in which the boundaries between linguistic elements are blurred and the whole chunk is compressed and reduced."

It must be noted, however, that although frequency effects do not explain everything about language learning/teaching, relatively little attention has been directed at their systematic understanding targeting Japanese learners of English, and that even less is understood about frequency effects upon perceptual discrimination of vowel and consonant minimal pairs, which the author, as an English instructor, has been using quite often in order to familiarize Japanese learners of English with the English sound system. It may be expected that understanding frequency effects upon perceptual discrimination of vowel and consonant minimal pairs will forward research on English minimal pairs, and that such understanding will be beneficial for those who use English minimal pairs in the classroom.

Current Study

The current study presents the results of an investigation which made an attempt to examine frequency effects upon perceptual discrimination of English vowel and consonant minimal pairs. Its research designs are summarized below, and some of the major findings are reported and then discussed.

1 Research Designs

1.1 Research Questions

The current study deals with two types of English minimal pairs [1) vowel minimal pairs consisting of eight sub-types (Nema 1986: /i/−/iː/, /æ/−/ɒ/, /ʌ/−/ɒ/, /æ/−/ʌ/, /ɔː/−/ou/, /e/−/æ/, /əːr/−/ɑːr/, /ʌ/−/əːr/) and 2) consonant minimal pairs consisting of seven sub-types (Nema 1986: /b/−/v/, /f/−/h/, /s/−/θ/, /l/−/r/, /i/−/si/, /dz/−/z/, and /n/−/ŋ/)[1)] and two-stage frequencies for perceptual discrimination of vowel and consonant minimal pairs: one-time and second-time discrimination. The following five main research questions are set:

1) Is there any difference recognized between one-time/second-time discrimination performance regarding vowel minimal pairs?

2) Is there any difference recognized between one-time/second-time discriminative performance regarding consonant minimal pairs?

3) Is there any relationship recognized between general listening proficiency and one-time/second-time discrimination performance regarding vowel minimal pairs?

4) Is there any relationship recognized between general listening proficiency and one-time/second-time discrimination performance regarding consonant minimal pairs?

5) What combination of type of minimal pair and stage of frequency will generate the highest predictability of general listening proficiency?

1.2 Materials

1.2.1 Vowel and Consonant Minimal Pairs

Special care was taken to measure learners' performance in discriminating vowel and consonant minimal pairs (referred to hereinafter as VMP and CMP, respectively) accurately. Firstly, a total of 90 sets of vowel and consonant minimal pairs of different words were prepared (6 sets per each pair). Secondly, four different combinations of three words were made for each set using these words, which were printed on the investigation sheets. Finally, in order to examine learners' sound discrimination ability, a combination of each set was chosen as the "answer", which was recorded onto CD by a native male speaker of English (see Appendix).

1.2.2 General Listening Proficiency

As the materials for measuring general listening proficiency, two sets of listening sections of *STEP* Grade 2 tests were used, which had been originally designed to match the level of high school graduates in general (administered in October 8, 1998 and June 18, 2000). Each set had 20 four-option multiple-choice test items, and 40 test items were used in total.

1.3 Subjects

58 first-year students of the general education course at a university in Japan participated in this investigation.

1.4 Procedures

1.4.1 Vowel and Consonant Minimal Pairs Test

The subjects received general instruction and practice in the target English vowel and consonant minimal pairs from the beginning of April to the middle of June in 2009. About twenty minutes of

discrimination and pronunciation practice of several types of minimal pair was conducted in a ninety-minute lesson held once a week for about two months. From observation of the learning attitude of the subjects, the subjects appeared to have developed high awareness of similar English sounds.

Prior to the investigation, two tests, which also functioned as pre-investigations, were carried out, in which the subjects scored their own tests and understood their discriminative performances objectively. It can be claimed that these two tests served to increase the subjects' consciousness of the target similar English sounds and to make them fully prepared for the investigation and its procedures.

The investigation was conducted in June 2009, at which time the subjects were informed about its purpose of discriminating the target English vowel and consonant minimal pairs after the two-month practice. The investigation took about forty minutes. Its main procedures can be summarized as follows:

1) The subjects were given an investigation sheet and instruction on the purposes and procedures of the investigation.

2) The subjects listened to each set of the three-word combination of the target English vowel and consonant minimal pairs and chose the answer on the investigation sheet.

3) The above 2) process was repeated exactly in the same way, in which the subjects listened again to the same set of the three-word combination of the target English vowel and consonant minimal pairs and chose the answer on the investigation sheet.

1.4.2 General Listening Proficiency Test

General listening proficiency tests were conducted at certain intervals in order to examine learners' general listening proficiency and monitor their progress periodically: in the middle of April, at the beginning of June and at the end of July. The results of the first two tests were used for the present investigation. Its main procedures can be summarized as follows:

1) The subjects listened to sets of twenty English passages on CD and answered multiple-choice comprehension questions on the investigation sheet, which took about 20 minutes.

2) The subjects transcribed the answers on a computer-scored investigation sheet, after which they immediately checked if their answers were correct and understood their general listening proficiency by the totaled score, which took about 10 minutes.

2 Scoring and Processing of the Data

All the investigation sheets were collected, and then the raw data were scored, examined, and processed for analysis.

2.1 Scoring

2.1.1 Scoring the Discrimination Performances of the Vowel and Consonant Minimal Pair Tests

First, the correctness of each of the one-time discrimination items on the investigation sheets was carefully checked with the item scores (0, 1), representing correct and incorrect answers, respectively, and then that of each of the second-time discrimination items on the investigation sheets was checked in exactly the same manner.

2.1.2 Scoring the Performances of General Listening Proficiency Tests

With regard to the GLP tests, the computer-scored investigation sheets were read and processed by an optical mark reader (*SR-3500, Sekonic*) and a mark reader computer software (*SS kun II, Software for Education*), in which the correctness of each comprehension test item was provided with the item scores (0, 1) representing correct and incorrect answers, respectively.

2.2 Examining Internal Consistency Reliability of the Tests[2)]

The scored data were then examined in terms of internal consistency reliability using the *Cronbach Alpha* Coefficient. First, the internal consistency reliability coefficients of the two GLP tests (the total number of test items is 40) and those of One-Time Vowel Minimal Pair Discrimination Test, Two-Time Vowel Minimal Pair Discrimination Test, One-Time Consonant Minimal Pair Discrimination Test and Two-Time Consonant Minimal Pair Discrimination Test (referred to hereinafter as VMP1, VMP2, CMP1 and CMP2, respectively) were measured (the total number of each of these test items is 48, 48, 42, and 42, respectively). Table 1 presents their results:

Table 1: Internal Consistency Reliability by *Cronbach Alpha* Coefficient (Original Test Items)

	VMP1	VMP2	CMP1	CMP2	GLP
Number of Test Items	48	48	42	42	40
Cronbach Alpha Coefficient	0.76	0.75	0.57	0.65	0.76

VMP1: One-Time Vowel Minimal Pair Discrimination　VMP2: Two-Time Vowel Minimal Pair Discrimination　CMP1: One-Time Consonant Minimal Pair Discrimination　CMP2: Two-Time Consonant Minimal Pair Discrimination　GLP: General Listening Proficiency

As is obvious from Table 1, the internal consistency reliability of the performances of CMP1 and CMP2 is not high. A number of reasons are deemed to lie behind this, but it must be noted that the small number of subjects and the inappropriateness of some of the CMP discrimination items seem most likely to have caused this kind of poor internal consistency reliability. Higher internal consistency reliability may be obtained with a greater number of subjects, but since the number of subjects is uncontrollable after the investigation, the current study made some attempts to raise the internal consistency reliability of the original results of CMP1 and CMP2 tests by directing careful attention at each of the test items used and reconsidering what should constitute those discrimination tests.

It is generally assumed that *Cronbach Alpha* coefficient should exceed at least 0.7 for reliable analysis, so the current study has expunged a number of "unsuitable" test items from each test item list of the CMP1 and CMP2 tests so that *Cronbach Alpha* coefficients might get as closer to 0.7 as possible. Table 2 presents the results of measuring the internal consistency reliability coefficients of the CMP1 and CMP2 tests whose original test items have been restructured:

Table 2: Internal Consistency Reliability by *Cronbach Alpha* Coefficient (Restructured Test Items)

	VMP1	VMP2	CMP1	CMP2	GLP
Number of Test Items	48	48	42	37	37
Cronbach Alpha Coefficient	0.76	0.75	0.70	0.74	0.76

VMP1: One-Time Vowel Minimal Pair Discrimination VMP2: Two-Time Vowel Minimal Pair Discrimination CMP1: One-Time Consonant Minimal Pair Discrimination CMP2: Two-Time Consonant Minimal Pair Discrimination GLP: General Listening Proficiency

2.3 Examining Normal Distribution

Lastly, the restructured data of the VMP1, VMP2, CMP1, CMP2, and GLP tests was examined in terms of normal distribution, upon which the statistical analyses of the current study are based. *Shapiro-Wiki* tests, whose α value had been set at 0.01, were conducted for this examination. Table 3 presents the results:

Table 3: Normal Distribution of the Restructured Data of the VMP1/VMP2/CMP1/CMP2/GLP Tests

	VMP1	VMP2	CMP1	CMP2	GLP
W	0.97	0.97	0.99	0.97	0.98
p-value	0.24	0.22	0.76	0.21	0.29

VMP1: One-Time Vowel Minimal Pair Discrimination VMP2: Two-Time Vowel Minimal Pair Discrimination CMP1: One-Time Consonant Minimal Pair Discrimination CMP2: Two-Time Consonant Minimal Pair Discrimination GLP: General Listening Proficiency α= 0.01

It is statistically found from Table 3 that all the restructured data is normally distributed, in which each p-value is greater than 0.01 (0.24 for VMP1, 0.22 for VMP2, 0.76 for CMP1, 0.21 for CMP2, and 0.29 for GLP).

3 Data Analysis

The pre-examined data above were then processed for analysis.[3)]

3.1 Descriptive Statistics

First, the mean score, the maximum, the minimum and the standard deviation of the processed data of each of the VMP1/VMP2/CMP1/CMP2/GLP Tests were calculated with a score range from 0 to 1. The results are presented in Table 4:

Table 4: Descriptive Statistics for the VMP1/VMP2/CMP1/CMP2/GLP Tests

	VMP1	VMP2	CMP1	CMP2	GLP
Mean	0.70	0.69	0.59	0.65	0.56
Max.	1.00	1.00	0.89	0.95	0.98
Min.	0.44	0.38	0.24	0.38	0.23
S.D.	0.11	0.11	0.13	0.13	0.14

VMP1: One-Time Vowel Minimal Pair Discrimination VMP2: Two-Time Vowel Minimal Pair Discrimination CMP1: One-Time Consonant Minimal Pair Discrimination CMP2: Two-Time Consonant Minimal Pair Discrimination GLP: General Listening Proficiency

Table 4 shows that there appears almost no difference in discrimination performance between VMP1 and VMP2 (mean: 0.70 and 0.69, respectively), but there may be some difference in discrimination performance between CMP1 and CMP2 (mean: 0.59 and 0.65, respectively).

3.2 Performance Differences

3.2.1 Performance Difference between VMP1 and VMP2

In order to verify the above tentative results with statistic significance, the current study examined the data employing a paired t-test. According to the results, there is no statistically significant difference in discrimination performance between VMP1 and VMP2 [$t(57) = 0.47$, $p = 0.64$], which means that there are no frequency effects in discriminating vowel minimal pairs.

3.2.2 Performance Difference between CMP1 and CMP2

Likewise, the data was analyzed employing a paired t-test in order to examine frequency effects upon discriminating consonant minimal pairs. The results show 1) that there is a statistically significant difference in discrimination performance between CMP1 and CMP2 [$t(57) = 6.45$, $p = 0.00$], 2) that the performance of CMP2 exceeds that of CMP1, and 3) that frequency effects are certainly found when discriminating consonant minimal pairs.

3.3 Relationships between VMP1/VMP2/CMP1/CMP2 and GLP

In order to explore relationships between VMP1/VMP2/CMP1/CMP2 and GLP, their simple linear correlation coefficients were computed.

3.3.1 Relationships between VMP1/VMP2 and GLP

First, relationships between VMP1/VMP2 and GLP were examined. Table 5 presents the results:

Table 5: Simple Correlation between VMP1/VMP2 and GLP

	VMP1	VMP2
GLP	0.39**	0.45**

VMP1: One-Time Vowel Minimal Pair Discrimination VMP2: Two-Time Vowel Minimal Pair Discrimination ** < 0.01

Table 5 shows that there is a statistically significant relationship both between VMP1 and GLP ($r = 0.39$, $p < 0.01$) and between VMP2 and GLP ($r = 0.45$, $p < 0.01$). These two relationships of statistic significance, however, provide no information about whether frequencies in discriminating vowel minimal pairs are connected with relationships between discriminating vowel minimal pairs and general listening proficiency. The current study therefore examined the difference in strength between these two statistically significant relationships (correlation coefficients). The results of this examination show 1) that the difference is not significant statistically [$t(57) = 1.02$, $p = 0.31$], and thus 2) that frequencies in discriminating vowel minimal pairs do not have much to do with relationships between discriminating vowel minimal pairs and general listening proficiency.

3.3.2 Relationships between CMP1/CMP2 and GLP

Next, relationships between CMP1/CMP2 and GLP were likewise examined. Table 6 presents the results:

Table 6: Simple Correlation between CMP1/CMP2 and GLP

	CMP1	CMP2
GLP	0.25	0.32*

VMP1: One-Time Vowel Minimal Pair Discrimination VMP2: Two-Time Vowel Minimal Pair Discrimination * < 0.05

Table 6 shows 1) that although there is no statistically significant relationship between CMP1 and GLP ($r = 0.25$, $p > 0.05$), a statistically significant relationship is found between VMP2 and GLP ($r = 0.32$, $p < 0.05$), and 2) that frequencies in discriminating consonant minimal pairs do have much to do with relationships between discriminating consonant minimal pairs and general listening proficiency.

3.4 Relationships between VMP1/VMP2/CMP1/CMP2 and GLP Based upon Multi-Regression Analysis

The two tables above show one aspect of relationships between VMP1/VMP2/CMP1/CMP2 and GLP. The current study has also investigated them in a comprehensive manner by conducting multi-regression analysis, in which the predictive power of each combination of two of VMP1/VMP2/CMP1/CMP2 with GLP was examined. The results are shown in Table 7:

Table 7: Predictive Power of VMP1/VMP2/CMP1/CMP2 with GLP Based upon Multi-Regression Analysis

		VMP1& CMP1	VMP1& CMP2	VMP2 & CMP1	VMP2 & CMP2
GLP	R'	0.35	0.37	0.41	0.42
	$R^{2'}$	0.15	0.17	0.20	0.21
	p-value	0.01	0.01	0.06	0.00

VMP1: One-Time Vowel Minimal Pair Discrimination　VMP2: Two-Time Vowel Minimal Pair Discrimination　CMP1: One-Time Consonant Minimal Pair Discrimination　CMP2: Two-Time Consonant Minimal Pair Discrimination　GLP: General Listening Proficiency　R': multiple coefficient adjusted for the degree of freedom　$R^{2'}$: coefficient of determination adjusted for the degree of freedom

Table 7 shows 1) that the combination of two of VMP1/VMP2/CMP1/CMP2, which generates the lowest predictive power with GLP, is VMP1 & CMP1, and 2) that this combination can account for 15% of the variance of general listening proficiency ($p = 0.01$). It can also be seen 1) that the best combination of two of VMP1/VMP2/CMP1/CMP2, which generates the highest predictive power with GLP, is VMP2 & CMP2, and 2) that this combination can account for 21% of the variance of general listening proficiency ($p = 0.00$).

It may be claimed that the difference between the predictive power generated by the combination of VMP1 & CMP1 (15%) and that generated by the combination of VMP2 & CMP2 (21%) shows that frequencies in discriminating vowel and consonant minimal pairs as a whole have something to do with relationships between discriminating vowel and consonant minimal pairs and general listening proficiency.

4 Summary & Discussion

The above analyses have made clear several points with regard to frequency effects upon perceptual discrimination of English vowel and consonant minimal pairs.

4.1 Performance Differences

It has been found from the analyses of performance mean score above that although there are no frequency effects recognized upon discriminating vowel minimal pairs, frequencies certainly have much to do with the performance of discriminating consonant minimal pairs. With the limited data, it is hard to correctly and comprehensively interpret this finding, but its essence may be summarized:

1) Learners may find it more difficult to discriminate consonant minimal pairs than vowel minimal pairs.

2) Therefore, frequency effects may be more observable in discrimination of consonant minimal pairs than in that of vowel minimal pairs.

3) Learners may show the same performance in discriminating vowel minimal pairs whether they listen to them once or twice (once is sufficient).

4) Learners may perform better when listening to and discriminating consonant minimal pairs twice (once is insufficient).

4.2 Relationships with General Listening Proficiency

It has been found from the analyses of correlation/multi-regression above 1) that although frequencies in discriminating vowel minimal pairs do not have much to do with relationships between discriminating vowel minimal pairs and general listening proficiency, those in discriminating consonant minimal pairs do have much to do with relationships between discriminating consonant minimal pairs and general listening proficiency, and 2) that frequencies in discriminating vowel and consonant minimal pairs as a whole have something to do with relationships between discriminating vowel and consonant minimal pairs and general listening proficiency. It is likewise hard to correctly and comprehensively interpret this finding with the limited data, but its essence may be addressed:

5) There may be no difference between one-time and second-time discrimination of vowel minimal pairs in their relationships with general listening proficiency.

6) Two-time discrimination of consonant minimal pairs may be related to general listening proficiency, but one-time discrimination of consonant minimal pairs may not be.

It can be claimed from all the above that the discrimination of minimal pairs embraces frequency effects, and that the discrimination of consonant minimal pairs and the combination of discrimination of both vowel and consonant minimal pairs in the same research context may be the key to understanding the nature of frequency effects upon the discrimination of minimal pairs.

Concluding Remarks

The results of the current study may have some implications for classroom teaching and research. For example, knowing that there is little difference in performance between one-time and

second-time discrimination of vowel minimal pairs may save time when checking learners' discriminating ability of minimal pairs, and the use of second-time discrimination of consonant minimal pairs may enhance research on the nature of relationships between listening sub-skills and general listening proficiency.

It must be noted, however, that the results reported and discussed in the current study are still tentative and inconclusive in a number of points, such as the control of the frequency of discriminating minimal pairs (three-time discrimination, e.g.), of the use of different types of minimal pairs, of construct validity of research materials, and of various types of "noise" in collecting data. Future studies, taking these points into account, will take us closer to a complete map of the nature of frequency effects upon perceptual discrimination of English vowel and consonant minimal pairs.

Notes

1) These types of minimal pairs were chosen, because each of them includes more than six minimal pairs of words which are actually used, and therefore because they can be compared with each other under the same conditions.
2) XLSTAT-PRO (Version 2009: Addinsoft Inc.) was used for this examination.
3) EXCEL STATISTICS (Version 5.0: Esumi Inc.) and TAHENRYOU-KAISEKI (Version 5.0: Esumi Inc.) were used for the analyses.

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Appendix (partial example)

CD から聞こえてくる単語の組み合わせを選び，該当するものに○をつけなさい。

best best vest（ ）

best vest best（ ）

vest vest best（ ）

vest best vest（ ）

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