THE MINISTRY OF HIGHER AND SECONDARY SPECIAL EDUCATION OF THE REPUBLIK OF UZBEKISTAN

SAMARKAND STATE INSTITUTE OF FOREIGN LANGUAGES THE FACULTY OF ENGLISH PHILOLOGY

COURSE WORK

THEME:THE RELATIONSHIP BETWEEN THE FREQUENCY OF OCCURANCE OF VOWELS AND CONSONANTS

Student: Qurbonov B.
Group: 304(uzb)
Scientific advisor: Raximov A.

Samarkand – 2015

PLAN:

1. Introduction

Phonological contrast and opposition were central concepts within the Prague School [1], along with the idea that the importance of each specific contrast in a phonological system may differ from one language to another. Such a notion, called Functional Load (FL, henceforth), was further developed by Martinet, who also suggested that FL may play a role in language evolution [2], [3]. According to his hypothesis, phonemes involved in high-FL contrasts would be less prone to change than those involved in low-FL contrasts. Hockett also considered that "The function of a phonemic system is to keep the utterances of a language apart" and observed that "Some contrasts between the phonemes in a system apparently do more of this job than others"

Since then, a few studies have hypothesized or assessed the role of FL in various areas: linguistic typology, description of phonological systems, automatic speech recognition, child language and second-language acquisition, sound change from diachronic and synchronic perspectives, identification of articulatory and perceptual constraints on phonological systems, etc. ([5-9] among others). However, the role of FL is still debated, since several diachronic studies do not support Martinet's hypothesis (e.g.

Following Hockett [4], we consider that FL may be especially useful to shed light on the organization of phonological systems and on the relative weight associated to their components. In this paper, our aim is therefore to evaluate the usefulness of a quantitative approach to FL as a tool to describe and compare phonological systems.

Five languages (Cantonese, English, Japanese, Korean and Mandarin) were compared and analyzed through a quantitative corpus-based approach. These languages were chosen in order to provide some variations in phonology (tonal vs. non-tonal languages) to answer two research questions:

- Are the FL carried by segmental components (vowels and consonants) comparable among languages?
- What is the FL associated with tonal systems?

1. THE RELATIONSHIP BETWEEN THE FREQUENCY OF OCCURANCE OF VOWELS AND CONSONANTS

Analysing vowel and consonant phonemes, we could not always discuss the frequency of their occurance in words. The most wide-spread type of English word is CVC, which is interpreted as a monosyllabic or monomorphemic structure.

According to B. Trnka's statistic analysis, the total number of CVC structures of word is 42%. Therefore, the maximal variety of vowel oppositions appear in positions between consonants. Only seventeen phonemes occur in theinitial position, but /u, is, us/ do not appear in this position. The long vowels and diphthongs usually more often occur in the stressed position. Among the consonants /h/, /n/, /3/ have limited occurance[1]. It is interesting to note that the consonants /kh, ng, j, v/ also show limited frequency of occurance in Uzbek as two of them have been borrowed from Russian (/ac/) and Tadjik (/в/).

If we compare the relationship between the frequency of occurance of vowels and consonants in the languages of different families, Indoeuropean and Ural-altaic, and groups among these families - Germanic (English, German), Romanic (French, Spanish), Slavonic (Russian) and Turkic (Uzbek, Kazakh, Turkmen, Kirghiz) we find they have a typological similarity. This typological similarity is expressed by the relationship of the frequency of occurance between the vowels and consonants, which is equal to 2:3. It shows the stability of the given relationship in many languages, though their structures and grammatical systems differ greatly. The above typological similarity may be illustrated in the following table:

Languages	Frequency of Occurance	
	Vowels	Consonants
m Phonemes. Lang	0,41	0,59
German	0,40	0,60
French	0,44	0,56
Spanish	0,44	0,56
Russian	0,42	0,58
Uzbek	0,42	0,58
Kirghiz	0,43	0,57
Kazakh	0,44	0,56
Turkmen	0,43	0,57

If we apply the table of typological features suggested by V.D. Arakin , including the Uzbek vowels
and by adding the functional load and the power of opposition, it may be outlined in the following
way: (N - number, F.L. - functional load, P.O. -power of opposition.

N	Phonemes,	Languages								
		English			Russian			Uzbek		
		N	F.L	P.O.	N	F.L	P.O.	N	F.L	P.O.
8.	Oppositions on different heights	7	high	strong	6	high	strong	6	high	strong
9.	Oppositions on lip-rounding	0			6	low	strong	6	high	strong
10.	Length	distinctive with quality			0			0		
11.	Distribution	depends on the structure of a word			0			0		

The interdependence of the perceptual boundary between vowels along the spectral and temporal dimensions is of interest because it may shed light on the possible awareness of a listener regarding the spaeker’s production constraints.

2.Vowel-Consonant Distinctions

Speech sounds are divided into two main classes – vowels and consonants. The main articulatory principles according to which speech sounds are classified are as follows:

the presence or absence of obstruction;
the distribution of muscular tension;
the force of the air stream coming from the lungs.

Vowels are speech sounds based on voice which is modified in the supralaryngeal cavities. There is no obstruction in their articulation. The muscular tension is spread evenly throughout the speech organs. The force of the air stream is rather weak.

Consonants are speech sounds in the articulation of which the air stream is obstructed. The removal of this obstruction causes noise, an acoustic effect (plosion or friction) which is perceived as a certain consonant. The muscular tension is concentrated at the place of obstruction. The air stream is strong.

The articulatory boundary between vowels and consonants is not well marked. There exist speech sounds that occupy an intermediate position between vowels and consonants and have common features with both. These are sonants (or sonorous sounds /m, n, ŋ , j, l, w, r/). Like vowels they are based on voice. There is an obstruction in their articulation and the muscular tension is concentrated at the pale of obstruction as in the production of consonants. But the air passage is wide and the force of the air is weak as in the case of vowels. Because of their strong vocalic characteristics some sonants /w, j, r / are referred to as semi-vowels.

From the acoustic point of view vowels are complex periodic vibrations-tones. They are combinations of the main tone and overtones amplified by the supralaryngeal cavities. Consonants are non-periodic vibrations-noises. Voiceless consonants are pure noises. But voiced consonants are actually a combination of noise and tone. And sonants are predominantly sounds of tone with an admixture of noise. Thus, the acoustic boundary between vowels and consonants is not well marked either. V.A. Bogoroditsky pointed out to different groups of muscles which operate in vowel and consonant production and the resulting different articulatory energy in vowels and consonants. The spectrum of a vowel has a sharply defined formant structure and high total energy which are not observed in the spectra of noise consonants. In the spectrum of a consonant there is a formant of noise, which is absent in the spectrum of a vowel. Numerous experiments prove this criterion to be a reliable one in classifying speech sounds into vowels and consonants.

Usually the distinction between a vowel and a consonant is regarded to be not phonetic, but phonemic. From the phonetic point of view the distinction between a vowel and a consonant is based on their articulatory - acoustic characteristics, i.e. a vowel is produced as a pure musical tone without any obstruction of air-stream in the mouth cavity while in the production of a consonant there is an obstruction of air-stream in the speech tract. There are other criteria to distinguish a vowel from a consonant as well.

From the standpoint of information theory vowels are redundant and it is possible to recognize words on the basis of consonants. Perhaps it depends on the number of vowels and consonants. Owing to the latter being usually numerically bigger, it has more information load.

Another distinction of vowel-consonant dichotomy is made due to the criterion that the vowels have the syllabic function forming its peak while consonants are marginal in the syllable forming its slopes. This criterion is, perhaps, universal as to vowel-consonant distinction. Therefore some linguists use the terms syllabic and non-syllabic phonemes. But the existence of the sonorants or sonants, which may be syllabic, contradicts this criterion. For example, in English *M, III, 1)1,* /w/ oral sonants and /m/, *In/,* /rj/ - nasal sonants may have a syllabic function: **little** /litl/, **hundred** /hAndnd/, parrot /pserat/ etc.

The distinction of the vowel-consonant dichotomy may function differently in various languages. In English, Russian and Uzbek this distinction is more clear than in other languages. But in some languages owing to the vowel harmony which is interpreted as the dilation of the vowel in the stem of the word in its affix, vowels may be more important in recognizing the word than theconsonants[1]

There are also attempts to find an acoustic criterion to distinguish a vowel-consonant dichotomy. Acoustically vowels are characterized by the presence of a strict formant structure, on the contrary consonants have negative formant structure as the vowels have greater intensity than that of consonants. Besides, tone is significant for vowels while noise - for consonants. But this distinction is not clear because of the existence of sounds which are neither vocalic nor consonantal. This type of consonants are sono-rants or sonants which have similiar formant structure like vowels, but tone prevails over noise. In the dichotomic classification of distinctive features sonants are characterized either as vowels or consonants . One of the authors of dichotomic phonology who even suggested twelve binary distinctive features of sounds universal for all the languages of the world G.Fant admitted that the physical criterion for the vocalic and consonantal features have not been rigid and therefore in the classification of Swedish phonemes he proposed a new formulation, retaining the concept of formant reduction in defining the consonant feature, but with intensity associated with the vocalic feature[3]. In fact, the acoustic distinction between vowel and consonant has not been classified yet.

Perhaps, one of the criterion in a vowel-consonant distinction may be found in the perceptual aspect. Though it is easy to distinguish vowels from consonants by ear, there are also some difficulties in classifying them by perceptual features.

In spite of all these contradictions we should use traditional distinction between vocoid-contoid in the phonetic sense and vowel-consonant for the linguistic categories. The phonemic system of the English language consists of vowel phonemes and consonant phonemes. Usually the pronunciation of vowels depends on the neighbouring consonants. Therefore we should begin the description of the phonemic system of English with consonants.

In the description of the phonemic system of English we use articulatory terms in the main, which are more understandable and important for practical use than the

acoustic terms. As to the terminology used in the dichotomic classification of distinctive features, such terms are often called mixed as articulatory, acoustic and even musical terms are used. For example, the terms **vocalic - non-vocalic, oral - nasal, voiceless - voiced, tense** - lax are articulatory terms; **compact - diffuse, grave** - **acute** are acoustic terms; the terms **flat sharp and plain** are borrowed from the theory of music. Besides, some of them, particularly grave - acute are used to distinguish the different types of word stress and the term plain does not mean anything in this case[1]. This type of terminology, which is used in other science as well and has two or more meanings, is not suitable in the phonemic description.

Peutinent to this, analysis of English phonemes is made in the following way:

1) the phonetic (articulatory and acoustic) classification;

2)the phonemic classification which makes clear the distinction between phonemes and their allophonic variations;

3)the distribution of phonemes and some sound clusters. More often we compare the phonemic systems of English and Uzbek.

2.1 THE CLASSIFICATION OF THE PHONOLOGICAL OPPOSITIONS OF VOWELS

Having established the phonematic value of the vowel-length the phonological status of diphthongs and the neutral *hi,* it is convenient to classify all the phonological oppositions in the vowel system of EngUsh. Though some oppositions have been given in certain cases to prove phonematic facts we could not discuss the relation between the phonemes in the entire vowel system of English. As a rale, we should begin with the preliminary phonological analysis, the criterion of which is based on establishing mainly single, as well as double and complex oppositions. According to the horizontal movement of the tongue, it is possible to establish the following single oppositions:

a) fully front - fully back: /i: - **u:/: seen - soon;**
b) front-retracted-back-advanced:/i - u/: **pit-put;**
c) fully front-mixed:/e - 3:/: **ten - turn;**
d) fully front-back-advanced: /a? - a:/: **cap - carp;**
e) back-advanced-fully-back: /a: - 0/: **part - pot.**

The distribution of some members of the given oppositions is limited. For example, /u:/ seldom occurs word-initially; *hi* does not occur word initially; *Id, hi, hi, Istl, IAI* never occur at the end of words; *hi* never occurs word finally. Therefore, the functional load of those oppositions in which *hi, Id, hi* take part are lower than the other oppositions.The oppositions *la:* - 0/ and /A - 0:/ may be regarded as single only on condition that Ax:/ is defined as a back-advanced vowel and *IAI* as a low-narrow vowel. These alternations do not seem to describe more precisely the actual tongue positions in pronouncing *la:/* and *IAI* but make the oppositions more symmetric[1]. The following nine single oppositions are based on the vertical movement of the tongue:All the given oppositions, except /i - e/ and /u - A/ may be regarded double if the vowel-length is regarded as a distinctive feature. In this case the oppositions may be based both on quality and quantity features of vowels.In Uzbek, as in all languages, the height of the tongue is pho-nologically relevant and the following single oppositions may be established.

a)high-narrow - high-broad: *li:* -**1/: beat - bit;**
/u: - u/: fool - full;
b) mid-narrow-mid-broad: *h:*- a/: **foreword -forward;**

c) high-narrow - mid-narrow:
d) high-narrow - low-narrow:
y)high-narrow - low-broad:
f)high-broad - mid-narrow:
h) high-broad - low-narrow
i) high-broad - low-broad:

/o: - o/: **port -pot; /i: - e/: seat - set; /u:..- o:/: boot - bought; *I v.* - ae/: cheap - chap; /u: - o/: shoot** - shot; /i - e/: sit - set; /u - A/: look - luck; /u - a:/ put - part.

The second distinctive feature is lip-rounding. All front vowels are unrounded and all back vowels are rounded in Uzbek, but front-back feature is concomitant. It brings symmetry into the phonological oppositions of the Uzbek vowel phonemes. N.S. Trubetzkoy, citing E.D. Polivanov's classification of the Uzbek vowel phonemes, called it «logically equippolent with two classes of tamber (maximal high and low) quadrangular system» which appears very rarely in languages of the world[1]. Correcting his transcription symbols[2] the system of the Uzbek vowel phonemes may be illustrated in the following way: The timbre (the horizontal movement of the tongue) opposition in the subsystem of the English short vowels is also equippo-lent, as it is shared by three pairs of phonemes /i - u/, *It* - 0/ /i -. u/, /e - o/, *lx* - A/; the same opposition is observed on sonority (the height of the tongue): /1 - e/, *It* - ae/, /1 - as/, /u - 0/, /u - *tJ h*-**A/.**

The neutral vowel phoneme has its own place in the system.In the subsystems of long monophthongs and diphthongs, including two diphthongoids /ii/, Am/ the timbre and sonority oppositions may be outlined as follows: N.S. Trubetzkoy, B. Trnka and some other linguists did not include diphthong *hi/* into this subsystem, regarding it biphone-mic, but they included triphthongs into centring diphthongs[1], which is rather vague. According to the new tendency, /aia/ and /alls/ tend to be smoothed down to a diphthong of the /as/ type (asin fire /faa/, tire /taa/). Some speakers smooth them even further to a pure vpwel /a:/ or /a:/ (as in fire /fa:/ or /fa:/) which is more common in RP[1]. But this type of substitution may be regarded as variphone alternation, (i.e. free variation of the sound structure of a word is called a «variform»)[2].According to the movement and the height of the tongue it is possible to establish double and complex (if long-short feature is distinctive). phonological oppositions between all the monophthongs and diphthongoids[3].

The. opposition monophthong - diphthong (absence and presence of glide) may be possible when simple vowels coincide or are regarded to be very close to the nuclei of the diphthongs: *It* -ei/, *Ix - sal, h - oil, 1st* - au/, /a: - au/, /o: - ou/, *IT.* - au/, /i - ia/, /e - ea/, /o - oa/, /o: - oa/, /u - ua/. V.A. Vassilyev found 36 com-mutations illustrating phonological oppositions between two diphthongs[4]. It is also possible to establish oppositions between two diphthongs on the basis of their nuclei as fronting-backing diphthongs: /ei - *oil*, /au - ou (au)/, /ia - ua/, /ea - ua/, /sa - oa/ and also on the basis of their glides as closing-centring diphthongs: /ei - sa/ (when/e/ and *Id* are very close), /oi - oa/. Further development, of the vowel system may result in the appearance of the diphthong Ax:a/ or /aa/ instead of the triphthongs /aia/ and /aua/.

The opposition /ai - aa (aa)/ may also come into being. However it is not real, owing to the existence of words like **tire** /taia/ - **tower** *It&vsl* which sound homophoneous if /aia/ and /aua/ coincide as a result of convergence.

Analysing the permissible variation of the phonemic structure of words from D. Jones' dictionary A.C. Gimson has found 7,5% items of this kind from 5900 monosyllabic and polysyllabic words[5]. The following variphone alternations may also be found in modern English pronunciation .

a) monophthongization of /ei/ —> *Id:* **again /a** 'gen/;

b)reduction of *111* **in /eia/; player** /ple-a/, which is like in
/aig/ and /aua/ —* /a-9, a-9, a9, ag/ but the final element of/eig/ is not omitted;

c) diphthongization of A, e, *xl* —> /i[3], e[3], as[3]/ especially, before the voiced consonants: **bid,** head, **bad;**

d) instability of the glides of closing diphthongs /ei, *ou,* ai, *av,* 01/ in favour of prolonging the prominent first elements in advanced RP in the London region:
/ei/ —* /e[1]/ in day, **made, lay hands, greyer;**
/ou/ —* /gu/ in **row, road, low hurdless, goal;**
/ai/ —* /a [3]/ or **/a:/ in side, society, sigh;**
/au/ —> /a V or **/a: 7** or **/a:/ in sow, allow, half;**
/01/ —* *lo* **V** or ***h'* 7: boy, toy, toil.**

A.C. Gimson also notes the new relationship between the centring, falling /i9, £9, 09, 09/ and /1, e, ae, o:/. For example, the levelling of earlier *Ival, hd* and *h:l* is now common: poor, pore, paw; sure, shore, shaw; the centring diphthongs *lis/* and *hoi* are frequently in opposition: hear-hair, fear-fair, weary-wary[1].

It is possible to classify modern changes in English pronunciation in the inventory of vowels and according to their distribution. For example, the changes in the inventary concern: *Id* became more open *Id; l&l* - more front and long or half-long like /a/; /a:/ - more front; *h:l* - somewhat half-open; /A/ - more front, like central vowel /a/; the nucleous of the diphthong /ei/ has become more open as /si/; the nucleous of the diphthong used in conservative English /ou/ is *hi* and it is indicated as /gu/[2] in most textbooks and dictionaries of today.

Besides, there are the changes in the distribution of vowels, caused by the spelling pronunciation, (consider /kgn'sidg/ -/kon'sidg/ and merely sound substitution in words or by the influence of stress shifting **(regime** /rei'3i:m/ - re(i)' 3i:m/)[3]. These new tendencies in modern English pronunciation are moving towards the monophthongization, diphthongization, changing of the vowel-length, more often appearing as centring diphthongs (/ai/, /au/, /9u/, *h\l* and even triphthongs tend to the direction of cen- tring diphthongs), which have been observed in the historical development of the phonemic system of English vowels.

2.2The classification of English vowel and consonant

In the English consonant system there are 24 consonants. The quality of the consonants depends on several aspects: 1. the work of the vocal cords; 2. what cavity is used as a resonator; 3. the force of the articulation and some other factors. There are four principles of consonant classification: 1. the type of obstruction and the manner of production of noise. We distinguish 2 classes of consonants: a) occlusive c., in the production of which a complete obstruction is formed [t, b,g]; b) constrictive c., in the production of which an incomplete obstruction is formed.[s,z,ʒ] Each of the two classes is subdivided into noise consonants and sonorants. Noise consonants are divided into plosives (or stops) and affricates and constrictive sounds. Sonorants are divided into occlusive and constrictive sounds. Constrictive sonorants may be medial [n] and lateral [l]. 2.Another principle is the place of articulation. Consonants are classed into 1) labial, 2) lingual, 3) glottal. The first class is subdivided into a) bilabial [p]; b) labio- dental [v]; the second class is subdivided into: a) fore lingual or apical, articulated with the tip of the tongue [l, t, n, d], b) mediolingual [j], c)back lingual [k, g,], d) pharingal [h]. 3.The next principle is the presence or absence of voice which depends on the work of the vocal cords. All voiced consonants are weak (lenis) and all voiceless c. are strong (fortis). 4. The next principle is the position of the soft palate. According to this, E. consonants can be oral and nasal.(m,n,n).

In the E. vowel system there are 12 vowel monophthongs and 8 or 9 diphthongs. The quality of a vowel depends, first of all, on its stability, on the tongue position, lip position, character of the vowel end, length, tenseness. 1. According to this principle E. vowels are subdivided into monophthongs, b) diphthongs, c) diphthongoids.[i:], [u:]. According to the position of the tongue vowels are classed from vertical and horizontal planes. From the horizontal plane vowels are divided into : 1. front; 2. front-retracted ; 3.central ; 4. back ; 5. back-advanced. From the vertical plane E. vowels are divided into: 1. close; 2. mid; 3. open. Each class has wide and narrow variations. According to the lip rounding vowels have 3 positions: spread, neutral, rounded. The next point is checkness. All E. short vowels are checked when stressed. The degree of checkness depends on the following consonant. All long vowels are free. According to the length E. vowels are traditionally divided into short and long vowels, it is a historical phenomenon. Besides, there exists the positional length of vowels, depending on the position of a vowel in a word. From the point of view of tenseness all historically long vowels are tense, while short vowels are lax.

13monophthongs consist of a single phoneme:

/æ/, /ə /, /ɜ :/, /ɔ :/, /ɒ /, /a: (ɑ : | ɑː)/, /ʊ /, /u:/, /ʌ /, /ɪ :/, /i/, /ɪ /, /e/

3.Unstressed Vowels in English

As stated above the unstressed vocalism of, English includes all vowel phonemes and the neutral phoneme /ə/ which appears as a result of weakening of the vowels in the unstressed position. The vowel /ə/ articulated by weak articulatory affect, has an indefinite tamber and changes its quality under the influence of neighbouring sounds depending on its position, and in certain positions it may be omitted. Therefore, it may have different variations distinct from each other, especially, by the height of the tongue and duration. The X-ray picture of /ə/ in **a cat** /ə`kæt/ shows that this vowel may be classified as mixed, mid-broad variation, unrounded (either lips are spread or neutral) vowel. Usually linguists distinguish from two to four variations of /ə/.

The neutral vowel, which appears in final unstressed position, is somewhat close to the tamber of the vowel /ʌ /, perhaps, to the Russian /a/ and the Uzbek /a/, but is shorter than they are: **worker** /wə:kə/ **matter /**mætə/etc.

The next version of /ə/ is used in initial and median unstressed positions except the neighbouring /k/ and /g/. This type of /ə/ is pronounced by a higher position of the tongue than in the first version: **announce** /ə`nauns/, **about** /ə`baut/. These two versions of /ə/ are regarded basic in practical studying of English.

The version of /ə/ used by the neighbouring /k/ and /g/ is regarded to be a very short and back, close-narrow variation: continue /kən`tInju:/, **aggregate** /ə`grIgeIt/.

The fourth version occurs before the consonants /z/ and /d/ which are used as morphemes expressing the plural form of nouns and the tense of verbs: **matters** /mætəz/, **hunters** /hʌ ntəz/, **covered** /kʌ vəd/. It resembles /3:/ though it is pronounced half-long.

All these versions have different degrees of laxity. They are notated by the symbols /ə^{ʌ} , ə^{3}, ə^{u}, ə/.

They all represent the reduced forms of the neutral vowel /ə/, as they all occur in unstressed positions under the influence of reduction. Weakening of the unstressed syllables, as a result of which vowels (sometimes, consonants) change their quality and quantity features, is called **reduction**. The shortening of the vowel-length in unstressed position is known as a **quantity reduction,** while the omission of the clear tamber of a vowel is termed as a **quality reduction**. The most widespread type of quality reduction is neutralization, used in the phonetic but not phonological sense. The vowels of the neutral tamber have features similar to vowels with a certain quality called **“cardinal tambers”** by A.L.Trakhterov. Speaking about /ə/ it is better to describe it as **“neutral tamber”**, than **“neutral position”** of speech organs. Usually “neutral position” is used to describe the configuration of the speech organs just prior to a certain articulation of a speech sound. In **a neutral** position the velum is raised and the air-flow through the nose is shut off. Such a universal neutral position does not exist in the articulation of any speech sound. However, some linguists consider that the sounds /æ/, /3:/, /ʌ /, /e/, /ə/ may be produced by a neutral position. The neutral position stated above is possible in “hesitation vowels”, interpreted also as a “ vocalic filled pause” which

is defined as having a (+vocalic,-consonantal) feature. X-ray pictures of the articulation /ə/ do not show any neutral position of the speech organs. Thus /ə/ is called a neutral vowel not for its articulation by the "neutral position", but owing to the fact that during its articulation it has a neutral, non-distinct tamber or quality which is significant.

Besides the neutral vowel /ə/ there is an unstressed /I/ which is regarded as an unstressed allophone of the English phoneme /I/. The unstressed /I/ is used in unstressed syllables, in prefixes, in medial and final positions: **mischief** /mIstʃi:f/, **abdicate** /ə`bdIkeIt/, **infinite** /In`fInIt/, **discover** /dIs`kʌ və/, **impose** /Im`pəuz/, **enjoy** /In`ʤɔ I/, **credit** /`kredIt/ etc. It should be stated that the neutral vowel /ə/ may often be omitted in colloquial rapid style of speech, but never so in the unstressed /I/: **cotton** /kɔ t(ə)n/, **London** /lʌ nd(ə)n/, **darkness** / dɑ :knIs/, **sausage** /sɔ :sIʤ/ etc. According to their occurance some authors distinguish vowels of: 1) full formation; 2)semi-weak vowels, i.e. those which take an intermediate position between strong vowels and the neutral /ə/ and 3) weak vowels. The idea of the semi-weak vowels have been made clear by G.P. Torsuyev and V.A. Vassilyev: "From the distributional point of view a semi-weak vowel… be defined as a partially reduced vowel which is used in more careful style of pronunciation instead of the neutral vowel used in the rapid colloquial style and instead of the corresponding vowel of full formation used in the full style". All the unstressed vowels of constantly full formation are used in all styles of pronunciation and even in many words of foreign origin, especially Latin and Greek, which have not yet been fully adopted in English: **insect** /Insekt/, **epochs** /i:pɔ ks/, **diagram** /daIəgræm/,**marquee** /mɑ :ki:/ etc.

The vowels of constantly full formation have a relatively stable quality and may preserve their less clear tamber in an unstressed position: **apple-tree** /`æpltri:/, **architect** /`ɑ :kItekt/, **objective** /əb`jektIv/, **artistic** /ɑ :`tIstIk/, **programme** /prəu`ræm/, **ensign** /en`saIn/, **upturn** /ʌ p`t3:n/, **Uganda** /u:gændə/, **obey** /əu`beI/, **idea** /aI`dIə/ etc.`

3.1 *General Principles of Vowel Formation*

The distinction between vowels and consonants is a very old one. The principle of this division, however, is not sufficiently clear up to the present time, the boundary between them being rather uncertain. The old term, "consonants" precludes the idea that consonants cannot be pronounced without vowels. Yet we know that they can and often are; for instance, in the sound that calls for silence: [ʃ:].The fact vowels are usually syllabic, does not mean that consonants are incapable of forming syllables. On the contrary, they may be syllabic too, and we find many instances in the English language of syllabic sonorants forming syllables by themselves.Acoustically, vowels are musical sounds. Nevertheless, in the formation of vowels considerable noise-producing narrowings are sometimes created; on the other hand, some consonants possess musical tone.

According to Prof. D. Jones: "The distinction between vowels and consonants is not an arbitrary physiological distinction. It is in reality a distinction based on acoustic considerations, namely on the **relative sonority or carrying power** of the various sounds." In the opinion of D. Jones, vowels are more sonorous than consonants. This is correct in most cases, but some consonants, especially sonorants, are very sonorous (for example, [l], [m], [n], [ŋ]).D. Jones gives the following definition: "A vowel (in normal speech) is defined as a voiced sound in forming which the air issues in a continuous stream through the pharynx and mouth, there being no obstruction and no narrowing such as would cause audible friction."All other sounds (in normal speech) are called **consonants"**.

I.A. Baudouin de Courtenay has discovered a physiological distinction between vowels and consonants; according to his theory the main principle of their articulation is different: in consonant articulation the muscular tension is concentrated at one point which is the place of articulation in vowel articulation the muscular tension is spread over all the speech organs. Knowing this, we have no difficulty in ascertaining whether one or another particular sound is a vowel or a consonant.Acoustically, a vowel is a musical sound; it is formed by means of periodic vibrations of the vocal cords in the larynx.

The resulting sound waves are transmitted to the supra-laryngeal cavities (the pharynx and the mouth cavity), where vowels receive their characteristic tamber.

We know from acoustics that the quality of a sound depends on the shape and the size of the resonance chamber, the material which it is made of and, also, on the size and shape of the aperture of its outlet. In the case of vowels, the resonance chamber is always the same – the supra-laryngeal cavities. However, the shape and size of the chamber can be made to vary, depending upon the different positions that the tongue occupies in the mouth cavity; and also depending on any slight alterations in the position of the back wall of the pharynx, the position of the

soft palate and of the lips which form the outlet of the resonance chamber. The lips may be neutral or rounded, protruded or not protruded, forming a small or a large aperture, or they may be spread, forming a narrow slit-like opening. When the lips are protruded, the resonance chamber is lengthened; when the lips are spread or neutral, the resonance chamber is shortened, its front boundary being formed practically by the teeth.

It has already been mentioned that in producing vowels, the muscular tension is spread equally over all the speech organs, yet the tension may be stronger or weaker. If the muscular tension in the walls of the resonance chambers is weaker, the vowel has a less distinct quality; it may sometimes be quite obscure. If the muscular tension is stronger, the vowel has a well defined quality. In the first case, the vowels are called lax, in the second-tense.

It is difficult, however, if not next to impossible, to classify vowels correctly from the point of view of tenseness. The degree of tenseness may be ascertained chiefly by comparison, while the result of comparison depends largely upon the articulation basis of the mother-tongue of the person who makes the comparison. To a Russian, for instance, all vowels seem tense, because Russian vowels are lax.

We can now formulate the general principles of vowel articulation.

1.Vowels are based on voice which is modified in the supralaryngeal cavities.

2.The muscular tension is spread over all the speech organs.

3.The air-stream passes through the supra-laryngeal cavities freely, no narrowings being expressly formed on its way.

4.The breath force is rather weak for, it is expended when the air stream passes through the larynx and causes the vocal cords to vibrate.

Thus, vowels have no special place of articulation; - the whole of the speech apparatus takes part in producing them. The classification of vowels, as well as the description of their articulation, is therefore based upon the work of all the speech organs.

3.2 Consonants Vs. Vowels

On the basis of theoretical considerations and the results of experiments with synthetic consonant-vowel syllables, it has been hypothesized that the short-time spectrum sampled at the onset of a stop consonant should exhibit gross properties that uniquely specify the consonantal place of articulation independent of the following vowel. The aim of this paper is to test this hypothesis by measuring the spectrum sampled at the onsets and offsets of a large number of consonant-vowel (CV) and vowel-consonant (VC) syllables containing both voiced and voiceless stops produced by several speakers. Templates were devised in an attempt to capture three classes of spectral shapes: diffuse-rising, diffuse-falling, and compact, corresponding to alveolar, labial, and velar consonants, respectively. Spectra were derived from the utterances by sampling at the consonantal release of CV syllables and at the implosion and burst release of VC syllables, and these spectra (smoothed by a linear prediction algorithm) were matched against the templates. It was found that about 85% of the spectra at initial consonant release and at final burst release were correctly classified by the templates, although there was some variability across vowel contexts. The spectra sampled at the implosion were not consistently classified. A preliminary examination of spectra sampled at the release of nasal consonants in CV syllables showed a somewhat lower accuracy of classification by the same templates. Overall, the results support an hypothesis that, in natural speech, the acoustic characteristics of stop consonants, specified in terms of the gross spectral shape sampled at the discontinuity in the acoustic signal, show invariant properties independent of the adjacent vowel or of the voicing characteristics of the consonant. The implication is that the auditory system is endowed with detectors that are sensitive to these kinds of gross spectral shapes, and that the existence of these detectors helps the infant to organize the sounds of speech into their natural classes.

4.The Articulatory Classification of English Vowels

Various qualities (timbres) of English vowels are determined by the oral resonator – its size, volume and shape. The resonator is modified by the most movable speech organs – the tongue and the lips. Moreover, the quality of a vowel depends on whether the speech organs are tense or lax and whether the force of articulation weakens or is stable throughout articulation.The position of the speech organs in the articulation of vowels may be kept for a variable period of time. All these factors predetermine the principles according to which vowels are classified:

according to the horizontal movement of the tongue;
according to the vertical movement of the tongue;
according to the position of the lips;
according to the degree of the muscular tension of the articulatory organs;
according to the force of articulation at the end of a vowel;
according to the stability of articulation;
according to the length of a vowel.

1. According to the first principle English vowels are classified into front /i:, e, æ/ and the nuclei of the diphthongs /eI, ɛə, aI/, front-retracted /I/ and the nucleus of the diphthong /Iə/, mixed /ɜ:, ə/, back-advanced /ʊ, ʌ, ɑ:/ and the nuclei of the diphthongs /oʊ, ʊə/ and back /u:, ɔ:, ɔ/.

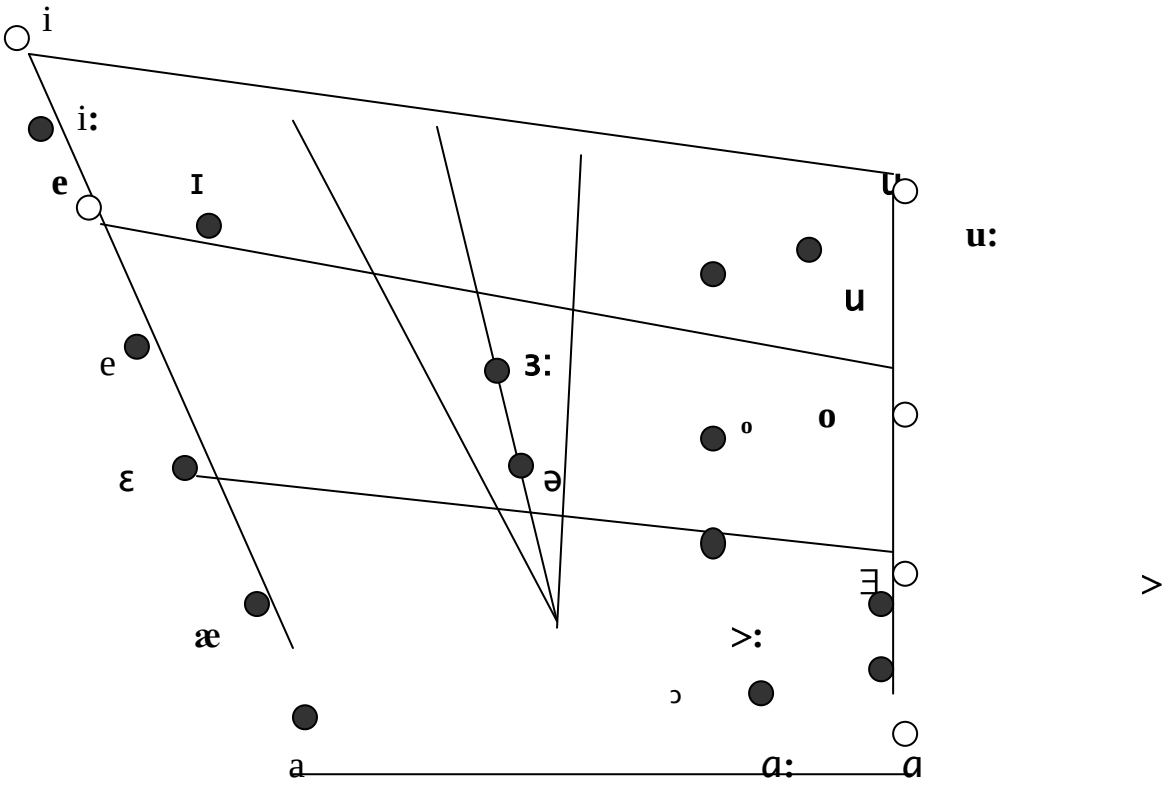
2. According to the vertical movement of the tongue, English vowels have been traditionally subdivided into close (high), mid and open (low). It is insufficient, however, to define the articulatory features of vowels in terms of the 3 degrees of the opening of the mouth cavity, since functionally different vowels, such as /i: - I/, /u: - ʊ/, /ɔ: - ɔ/ are not described from the point of view of their articulatory destinations.

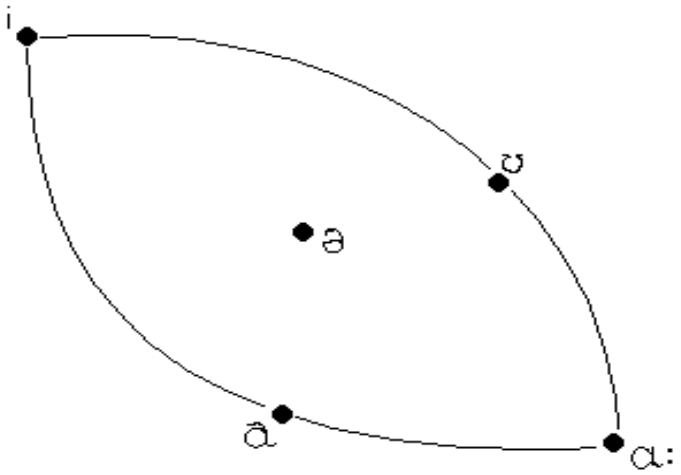
Russian phoneticians G.P. Torsuyev, A.L. Trakhterov, V.A. Vassilyev have made the classification more precise by subdividing each class (close, mid, open) into two subclasses – vowels of narrow and broad variation. Thus, according to the height of the tongue, vowels can be classified as high-narrow /i:, u:/, high-broad /I, ʊ/, mid-narrow /e, 3:, o (ʊ)/, mid-broad /ə, ɛ(ə)/, low-narrow /ʌ, ɔ:/, low-broad /æ, a (I, ʊ), ɑ:, ɔ/.

This more exact classification reflects the distinctive differences in the quality of the historically long and historically short vowels.

The terms used to describe English vowels are applicable to other languages as well. For instance in Russian., German and French, front and back vowels are distinguished. Some of them are close, others more open. But they seldom correspond exactly to the English vowels which, though apparently similar sounds,

are not identical. Thus both Russian and English /u/ and /i: / sounds are close and fronted, but /u/ is closer than the English /i:/. To enable a linguist or a language-learner to give the exact position of the tongue for a certain vowel of any language, a system of standard or cardinal vowels was devised by D. Jones and is presented in the following quadrilateral. This is a simplication of the real positions of the tongue for various vowels. The high point of the tongue describes an area of the shape shown next to the quadrilateral.





The four corners of this quadrilateral and the lines connecting them indicate the limit of possible tongue position for vowels.

Other vowels of whatever language have their tongue position within this figure. In relation to the cardinal vowels English vowels occupy the positions

marked by larder dots. The cardinal vowels are not the vowels of any particular language. They present an absolute standard in relation to which the vowel sounds of individual languages can be described and placed in the quadrilateral. In order to use them one must have them recorded of learn from a teacher who knows them.

The Cardinal Vowel system is used mainly in purely scientific linguistic work, where no comparison with one's mother-tongue is possible, e.g. in description and classifications of the vowel system of individual languages to be read by linguists of different nationalities.

In language-teaching it can be used only when one has the recording at one's disposal or can get oral instruction from a teacher familiar with the cardinal vowels.

3. According to the position of the lips, i.e. whether they are rounded, spread or neutral, English vowels are divided into rounded /ɔ:, ɔ, u:, ʊ/ and unrounded /i:, I, e, æ, ʌ, ɑ:, 3:, ə/. Subdivision of vowel into lip-spread and lip-neutral is unnecessary for phonological analysis, but may be useful in describing concrete realizations of the phonemes.

4. According to the degree of muscular tension English vowels are classified into tense and lax. Thus, for instance, English /i:/ and /u:/ are characterized as tense, because the speech organs that participate in their formation – the tongue and the lips, are considerably tensed. In the articulation of short /I/ and /ʊ/ these organs are relatively relaxed, so these vowels are characterized as lax.

All the long vowels are believed to be tense, while short vowels are lax (Torsuyev G.P.). This is due to the time for which the speech organs are kept is a certain position, and this requires greater muscular tension of the speech organs. Not all phoneticians share this opinion. According to D. Jones only the long /i:/ and /u:/ may be considered a tense. D. Jones applies the terms "tense" and "lax" only to close vowels, because in the case of open vowels it is difficult to define whether there is any tenseness or not. This point can be clarified with the help of special electromyographic investigations.

5. According to the force of articulation at the end of the vowel (the character of the end) English vowels are divided into free and checked. Free vowels are pronounced in an open syllable with a weakening in the force of articulation towards their end, i.e. they have a fading character. These are all the English long monophthongs and diphthongs and unstressed short vowels. Checked vowels are those in the articulation of which there is no weakening of the force of articulation. They are pronounced abruptly at the end, immediately followed by a consonant that checks them. These are historically short vowels under stress. They occur in closed syllables.

6. According to the stability of articulation English vowels are divided into monophthongs /i:, I, e, æ, ɑ:, ʌ, ɔ:, ɔ, u:, ʊ/, diphthongs /e I, a I, ɔI, aʊ, oʊ, Iə, ɛə, oə, ʊə/ and diphthongoids, or diphthongized vowels /i:, u:/.

The stability of articulation (as in the case of monophthongs or its instability (as in the case of the diphthongs and diphthongoids) is, actually, the stability (or instability) of the shape of the oral resonator. When the position of the tongue and the lips during the pronunciation of a vowel is altered to some extent, a new vowel quality is produced. In diphthongs two vowel elements are distinguished – a nucleus and a glide. The nucleus is stronger, longer, more definite in timbre, more prominent and syllabic. In different languages the nucleus of a diphthong may be either the first or the second element. Diphthongs that consist of a nucleus followed by a glide are falling diphthongs because the total amount of articulatory energy falls towards the second element. Those consisting of a glide followed by a nucleus are rising diphthongs, since the articulatory energy rises towards the second element. English diphthongs are falling. Rising diphthongs are common in Italian. In some phonetic contexts English diphthongs /Iə, ʊə/ may be pronounced with the second element stronger and more prominent than the first, and are, consequently, rising.When the diphthong /oʊ/ is pronounced as an exclamation with the high rising tone, the /ʊ/ element in it is as strong and prominent as /o/. So /oʊ/ can be called a level diphthong.

D. Jones points out that in unstressed syllables the /I/ and /ʊ/ elements in /Iə/, /ʊə/ may be weaker than the second element /ə/. E.g. /ˈsIərIəs/ “serious”, /ˈpIərIəd/ “period”; /ˈInfʊəns/ “influence”; /ˈkɔŋgeˋʊənt/ “congruent”.

7. Closely connected with the quality of vowels is their quantity, or length. Any speech sound must have certain duration to display its quality, to be perceived as such. According to their length English vowels are divided into long /i:, a:, ɔ:, u:, ɜ:/ and short /I, e, æ, ʌ, ʊ, ə/. This length is historical. It differs from the positional length of the same vowels. In connected speech historically long vowels may be of the same length as historically short ones and even shorter. Cf, /bi:t/ -/bId/, /si:t/-/sId/.

4.1 The Phonological Status of Diphthongs

There are two basic approaches to the phonological status of English diphthongs, which are known as the "unit theory" and "analytic treatment". The unit theory suggested by the Prague phonologists (N.S.Trubetzkoy, B.Trnka, J.Vachek) is based on the certain rules for the determination of the mono- and biphonematic realizations of the combinations of two phonemes. The criteria used in the unit theory are as follows: 1) diphthongs may be produced by unit articulatory movements and their length is almost equal to that of simple vowels (monophthongs); 2) diphthongs are monosyllabic combinations, i.e. their two elements – a nucleus and a glide – do not belong to different syllables of a word; 3) according to the functional criterion the distinctive function of a diphthong may be established by two rules: a) the combination is biphonemic if its components may function as distinctively different elements, i.e. if it can be substituted. If the combinations may fulfill its distinctive function, it is monophonematic; b) if the combination has its correlation pair among the simple phonemes, then it is monophonematic.

According to the above criteria long vowels and diphthongs can be defined as single vowel phonemes, since both categories with the exception of /a:/ and /3:/ are free vowels with a variable degree of opening. In this case /i:/ and /u:/ are interpreted as /ii/ and /uu/ (but not as /ij/ and /uw/ in which the second elements appear as semi-vowels or consonants). According to the articulatory direction of the second elements, the diphthongs /eI, aI, aʊ, əʊ, ɔI/ are parallel to those of the high, long vowels. They are opposed to the remaining diphthongs, whose second elements move towards the central neutral vowel /ə/. Usually these two groups of diphthongs are called closing and centring diphthongs. J.Vachek classifies them as "movement diphthongs" which are constituted by a direct articulatory movement and cannot be divided into two vowels /eI, aI, aʊ, əʊ/ and therefore, they are regarded as single phonemes and "positional diphthongs" which preserve the individual articulatory nature of these two elements /Iə, ɛə, ʊə, ɔə/.

N.S.Trubetzkoy's first functional criterion, which may function as single phonemes, it is a biphonematic combination, is entirely useless. By using this principle the diphthongs /eI/ and /ou/ become biphonematic, though Trubetzkoy regarded them as single phonemes, i.e. he admitted their monophonematic value. In this case he takes into consideration the stability of diphthongs in morphological changes. This approach is formal and cannot explain the phonological status of diphthongs.

The morphological criterion which works in favour of a morphemic boundary between the two elements of a diphthong leads to its interpretation as a biphonematic combination. For example, **loyal** /lɔ:jəl/, **lower** /lɔ: - ʊə/, **sawing /s ʊə-uIŋ/, poet** /pəʊ-It/ etc. In such words they occur at morphemic junctures in native words, or in two contiguous syllables of the same morpheme in distinctively foreign words. In words like **seer** /si:ə/, **fewer** /fju:ə/. B.Trnka notices the combinations of two phonemes in which the first element preserves the tendency of length.

The analytic treatment suggested by some American and Copenhagen linguists regards diphthongs to be biphonematic combinations. The criterion used by American linguists is based on the method of complimentary distribution. As complex segments (diphthongs) consist of two components. The first components of the diphthongs /eI, αI, əʊ, aʊ/ are in complementary distribution with the simple vowels /ɛ/ and /a/ used in such words as **let, sun.** The second elements are also in complementary distribution with the semi-vowels or glides /j/ and /w/. The diphthongoids /i:/ and /u:/ are also treated as /ij/ and /uw/. According to this approach English diphthongs are regarded as the combinations of two phonemes, because their first and second elements can function as single phonemes.

On the paradigmatic axis the English diphthongs may form phonological oppositions both with simple phonemes and with each other. They have constitutive, distinctive and recognitive functions in the structure of English.

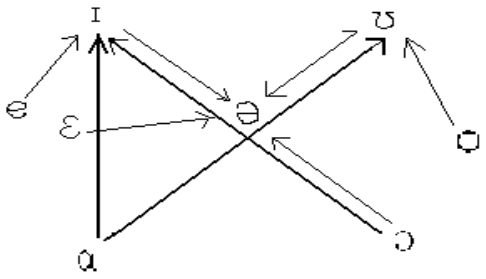
On the syntagmatic axis the structure of a diphthong is represented by three properties: a) the first component, called its nucleus; b) the second element, called its glide; c) its monosyllabic character, i.e. forming the crest of the syllable as in the word **time** /taIm/.

The length of the diphthong, which is equal to that of the simple vowel, also proves its monophonematic character.

D. Jones defined diphthongs from the phonetic point of view. He also regarded diphthongs as monosyllabic units pronounced by one expiration. He distinguished “rising” /Iə, ʊə/ and “falling” (all other diphthongs) diphthongs. The endings of the rising diphthongs have greater prominence than their beginnings, while in falling diphthongs their beginnings have greater prominence than their endings.

D. Jones’ treatment is based on the articulatory indivisibility of English diphthongs and their monosyllabic character. Besides he represented positional variants of the diphthongs /ɔI, eə, ɔə/ in his dictionary. But /uI/ can not function as a diphthong owing to its articulatory divisibility and disyllabic character.

The substitution of diphthongs by monophthongs takes place in morphological alternations: **devine** /dəˈvaIn/ - **devinity** /dəˈvInItI/, **chubby** /tʃʌbI/ - **chubbier** /tʃʌbIə/ etc. The gliding of English diphthongs may be represented in the following form:



Speaking about diphthongs we should mention two triphthongs: /aIə/ and /aʊə/. The first two elements of these combinations may be regarded as diphthongs /aI/ and /ʊə/ while the third element represents the neutral vowel /ə/. There is no stable articulatory and syllabic indivisibility among the elements of these combinations. Usually they are divided into two syllables: **tire** /taI-ə/, **fire** /faI-ə/, **cower** /kaʊ−ə/, **shower** /ʃaʊ−ə/. The element /ə/ cannot be omitted in the pronunciation, otherwise words like **high** /haI/ - **higher**/ haIə/ , **tie** /taI/ - **tire** /taIə/ may be mixed.The combinations /eIə/, /ouə/ and /ɔjə/ occur in word-forms as **player** /pleIə/ **rower** /rouə/ **destroyer** /dIstrɔjə/ and they are also considered to be combinations of vowel phonemes or groups of vowel phonemes

The monophthongs are divided into *front*, *central*, *back* and at the same time *close*, *mid* and *open* types according to the place where they occur in the oral cavity:

	Front		**Central**		**Back**	
	long	**short**	**long**	**short**	**long**	**short**
Close	ɪ :	ɪ			u:	ʊ
Mid		e	ɜ :	ə	ɔ :	
Open		æ		ʌ	ɑ :	ɒ

8 diphthongs consist of two phonemes:
/eɪ /, /aɪ /, /ɔ ɪ /, /ɛə (eə)/, /ɪ ə /, /ə ʊ /, /aʊ /, /ʊ ə /

5 triphthongs consist of three phonemes:
/aʊ ə /, /aɪ ə /, /eɪ ə /, /ɔ ɪ ə /, /ə ʊ ə (oʊ ə)/

4.2The clarifications vowel and consonant sound

There are ***24 consonant***sounds in the English language. The following classification gives you general information about them.

Occlusives (Explosives): /p/, /b/, /t/, /d/, /k/, /ɡ /, /m/, /n/, /ŋ/ ;

Constructives (Slippery): /f/, /v/, /s/, /z/, /θ/, /ð/, /ʃ /, /ʒ /, /h/, /w/, /l/, /j/ ;

Occlusive-constructive (affricates): /ʧ /, /ʤ/ .

Rolled consonants: /r/,

	Occlusive	**Constructive**	**Affricate**
Voiced	/b/, /d/, /ɡ / ;	/v/, /z/, /ð/, /ʒ / ;	/ʤ/
Voiceless	/p/, /t/, /k/ ;	/f/, /s/, /θ/, /ʃ /, /h/ ;	/ʧ /
Sonorant	/m/, /n/, /ŋ/ ;	/w/, /r/, /l/, /j/ ;	

Here some more information about consonants:

	Bilabial	**Labio-dental**	**Dental**	**Alveolar**	**Post alveolar**	**Palatal**	**Velar**	**Glottal**
Nasal	m			n			ŋ	
Plosive	p, b			t, d			k, ɡ	
Affricate					ʧ , ʤ			
Fricative		f, v	θ, ð	s, z	ʃ , ʒ			h
Approximant				r		j	w	
Lateral				l				

5. Conclusion

In this paper, we investigated the way five languages rely on their phonological components to distinguish among their words, with the notion of FL. Our main goal was to answer two questions: 1. Are the FL carried by segmental components (vowels and consonants) comparable among languages? 2. What is the FL associated with tonal systems?

The first result was that a large diversity was visible among the languages, and also within each phonological system. A few contrasts played a major role in each language, as shown in Figure 2 for vowels. No cross-language preference was however demonstrated in favor of maximal perceptual contrasts or specific articulations – except that obstruents seem to be more important than sonorants, and that the FL associated with consonants is higher than with vowels, as far as high-FL segments are concerned. These results are fully compatible with general trends observed in the composition of phonological systems, with more consonants than vowels, more obstruents than sonorants [22]. This result is confirmed at the level of the subsystems, with *FLC* values much larger than *FLV* values in the 5 languages. The group of Asian languages (Cantonese, Japanese, Korean, and Mandarin) furthermore displayed a remarkably similar pattern, despite their differences in terms of lexical prosody, morphology, and syntax (agglutinative SOV languages for Japanese and Korean vs. mainly mono- or disyllabic SVO languages for Cantonese and Mandarin). Leaving English out, one can positively answer the first question (but see below).

The answer to the second question was provided by Figure 3: *FLT* is similar to *FLV* for Cantonese and Mandarin, and the importance of the tonal system is not balanced by a lower role of the consonant or the vowel system.

This study exposed nevertheless that the situation is not straightforward, since English behaved quite differently, with much higher FLs associated with its consonantal and vocalic subsystems. It can reflect either methodological choices (see for instance or different strategies in the way languages convey information. It definitively points toward several directions for future research. First, it underlines the need for a larger typological sample, in order to evaluate the range of variation observed in subsystem FLs in the world languages. Second, it suggests to relate the segmental and tonal levels to the syllable structure, and beyond, to the other levels of the language grammar. Several typological studies have shed light on correlations between these levels of linguistic coding and the approach presented in this paper can also be applied to syllable structures or to their positions in the words. In a typological perspective, this quantitative method will renew our understanding of the relative weight of each linguistic subsystem in the world languages. Finally, estimating FL with *conditional* entropy would offer a way to take context into account. It would improve the evaluation of the impact of phoneme coalescence by focusing on word pairs that remain confusable once their context of occurrence is considered. Similarly, the relevance of grammatical words in FL computation could be examin.

6. References

1. Cercle Linguistique de Prague, "Thèses présentées au premier congrès de philologues slaves", Travaux du cercle linguistique de Prague 1: 5-29, Online: http://www2.unil.ch/slav/ling/textes/theses29.html, accessed on 10 Mar 2013.
[2] Martinet, A., Économie des changements phonétiques. Traité de phonologie diachronique, Francke: Berne, 1955.
[3] Martinet, A., “Some basic principles of functional linguistics”, La Linguistique, 13(1): 7-14, 1977.
[4] Hockett, C. F., "The quantification of functional load: A linguistic problem", Report Number RM-5168-PR, Rand Corp., Santa Monica, 1966.
[5] King, R. D., "Functional load and sound change", Language, 43(4): 831–852, 1967.
[6] Surendran, D. and Niyogi, P., "Measuring the usefulness (functional load) of phonological contrasts", Technical report TR-2003-12, Department of computer science, University of Chicago, 2003.
[7] Surendran, D. and Levow, G. -A., "The functional load of tone in Mandarin is as high as that of vowels", In Proc. of speech prosody 2004, Nara, Japan, 99-102, 2004.
[8] Van Severen, L., Gillis, J. J., Molemans, I., van den Berg, R., De Maeyer, S., and Gillis, S., "The relation between order of acquisition, segmental frequency and function: the case of word-initial consonants in Dutch", J Child Lang, 1(1): 1-38, 2012.
[9] Pellegrino, F., Marsico, E. and Coupé, C., "La typologie des systèmes vocaliques revisitée sous l'angle de la charge fonctionnelle", Proc. of the Joint Conference JEP-TALN-RECITAL 2012, 1:JEP, Grenoble, 4-8 June, ATALA/AFCP, 617-624.
[10] Research Centre on Linguistics and Language Information Sciences, The Hong Kong Institute of Education, A linguistic corpus of mid-20th century Hong Kong Cantonese, retrieved on 1 Mars 2013 from http://hkcc.livac.org.
[11] Max Planck Institute for Psycholinguistics, WebCelex, retrieved on 18 Mars 2013 from http://celex.mpi.nl.
[12] National Institute for Japanese Language and Linguistics and National Institute of Information and Communications Technology, The corpus of spontaneous Japanese (CSJ), Third printing, 2011.
[13] Universität Leipzig, Leipzig corpora collection (LCC), http:// corpora.informatik.uni-leipzig.de.
[14] Sharoff, S., "Creating general-purpose corpora using automated search engine queries", In Baroni, M. and Bernardini, S. (Eds.) WaCky! Working papers on the web as corpus, Gedit, Bologna, http://corpus.leeds.ac.uk/query-zh.html, 2006.
[15] CC-CEDICT Dictionary, downloaded on 30 Nov 2012 from http://cc-cedict.org/wiki/.
[16] NJStar Chinese Word Processor v.5.30, downloaded from http://www.njstar.com/cms/njstar-chinese-word-processor/.

[17] Sheik, A., CantoDict, http://www.cantonese.sheik.co.uk/.
[18] Learner, Z., JyutDict, downloaded on 3 Mars 2013 from http://www.zhongwenlearner.com/downloads/jyutdict/.
[19] Kim, S., Yi, H., Yu, C. and Han'guk Pangsong Kongsa, y o un Han gug par m taesa n A orean pronunciation dictionary, S ul kpy lsi mun gak, .
[20] Shannon, C. E., "A mathematical theory of communication", Bell system technical journal, 27: 379-432 & 623-656, July and October, 1948.
[21] Carter, D. M., "An information-theoretic analysis of phonetic dictionary access", Computer Speech Lang, 2(1): 1–11, 1987.
[22] Maddieson, I. Pattern of Sounds. Cambridge, UK: Cambridge University Press, 1984.
[24] Plank, F. “The co-variation of phonology with morphology and syntax: a hopeful history”. Linguistic Typology 2:2.195-230, 1998.
[25] Pellegrino F., Coupé C., and Marsico E. “Across-language perspective on speech information rate”. Language 87, 539–558. 2011.