

# TENDENTIAL STRATEGIES IN CONSONANTAL INVENTORIES ACROSS LANGUAGES ACCORDING TO THE THEORY OF PHONOLOGY AS HUMAN BEHAVIOR

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## ABSTRACT

The theory of Phonology as Human Behavior combines aspects of the “communication factor” and the “human factor” of Prague School and Martinet’s diachronic phonology which view language as a tool of communication that ecologically reflects the characteristics of its users. PHB provides a “motivation” for the distribution of sounds: i.e. why we produce the phonemes we do and why their distribution within language is non-random.

We examine the phonemic systems of a wide range of diverse languages according to the following parameters:

- (1) The number of phonemes in the system.
- (2) The ratio of “easier” versus “more difficult” phonemes in the system.
- (3) The number and kinds of articulators we use in phonetic gestures and processes used to produce the more difficult phonemes.

Our results demonstrate that the phonemic inventories and the phonotactic distribution of phonemes across languages reflect a compromise between the striving for maximum communication and minimal effort.

**Keywords:** phonemic inventories, phonology as human behavior, maximal communication, minimal effort

## 1. INTRODUCTION

The theory of Phonology as Human Behavior (PHB) (e.g. [3, 14] of the Columbia School (CS) of linguistics (e.g. [13]) combines and expands the Saussurean notion of sign and system in general (e.g. [11]) and aspects of the “communication factor” and the “human factor” of the Prague School and André Martinet’s diachronic phonology in particular (e.g. [12]). All of the above theories basically adhere to the functional semiotic definition of language as a sign system used by human beings to communicate: i.e. as a

tool of communication that ecologically reflects the characteristics of its users. Thus, PHB/CS provides a “motivation” for the distribution of sounds: i.e. why we produce the phonemes we do and why their distribution within language is non-random.

## 2. THE MINI-MAX PRINCIPLE UNDERLYING PBS/CS

This motivation for the non-random distribution within the sound systems of language is based on the fundamental axiom underlying PHB/CS: i.e. language represents a compromise resulting from the constant struggle between the communication factor (our striving for maximal communication) and the human factor (our propensity to exert minimal effort) (e.g., [15, 16]). With regard to the phonemic inventories of languages: (1) the communication factor implies striving for maximal diversity and differentiation within the phonemic inventory and (2) the human factor implies striving for efficiency: i.e. favoring the easiest and most convenient phonemes. Thus, every language may be analyzed synchronically and compared and contrasted diachronically regarding its dynamic development in the process to resolve this constant struggle between the communication and human factors in its attempt to achieve maximal communication with minimal effort.

## 3. VOWELS VERSUS CONSONANTS

The implications and ramifications of this mini-max principle on vowels and consonants are based on our viewing phonetics and phonology from the point of view of the history of the air stream in the phonation and perception of sounds. Consonants interrupt, hinder and impede the airflow by the systematic control of the musculature of different active and passive articulators in diverse manners and by altering the position and movement of the vocal folds among other acquired processes in order to create communicative distinctions.

Vowels, on the other hand, maintain a free flow of the airstream and systematically alter and control the size and shape of the vocal tract in order to create communicative distinctions. Therefore vowels are generally easier to produce than consonants. Thus, by virtue of the human factor, we would expect languages to have more vowels than consonants. However, consonants generally provide more clear-cut communicative distinctions than vowels. The result is that the communication factor overrides the human factor and languages usually have more consonants than vowels: i.e. more effort is exerted and invested to create and maintain more clear-cut communicative distinctions. Furthermore, from the point of view of phonotactics, this communicative difference between consonants and vowels also can serve to explain why the "unmarked universal" syllable is CV(C) as well. Further evidence for the relative difficulty of consonants is found in developmental and clinical phonology where most errors appear in consonants (e.g. [14, 15, 16]). Therefore, in this study we will concentrate on consonants.

#### 4. METHODS AND PREDICTIONS

We will examine the phonemic systems of the following 16 languages: Italian, Greek, Lithuanian, Russian, English, Swahili, Guarani, Navajo, Maori, Chinese, Japanese, Hebrew, Arabic, Georgian, Hungarian and Turkish (e.g. [1, 2, 4, 5, 6, 9, 10, 17]). This paper represents only the first phase of this research and based on the initial findings presented here we intend to broaden our data base.

In our cross language examination of consonant inventories we will classify the relative difficulty of consonants by the number of sets of articulators and the control of the musculature employed in the diverse gestures and processes needed to produce them. Generally speaking the larger the amount of active articulators the more difficult the consonant may be. Moreover, among the active articulators there is a hierarchy of preferences for: (a) oral articulators, i.e. lips-apex-posterodorsum preferred over (b) anterodorsum and uvula which in turn are preferred over (c) non-oral laryngeal which is preferred over (d) pharyngeal articulators. In creating new sounds speakers can either choose non-preferred oral articulators or less preferred non-oral articulators or exploit the preferred oral articulators in new combinations or manners of articulation.

Our methodology entails: (1) Quantitatively examining the frequency of consonants across languages of diverse language families. Using the PHB principles we predict that the more frequent consonants are the easier ones to produce. (2) Qualitatively examining the more difficult consonants (i.e. the less frequent consonants) within languages. The PHB principles predict that all languages will have both relatively easier and more difficult consonants with a ratio favoring the easier to produce consonants. However, our basic working prediction is that: (3) When languages enhance their consonant inventories by using consonants that are more difficult (less frequently found in the consonant inventories across languages), they will do so in the most efficient manner possible by choosing what we call a dominant *Tendential Strategy*.

#### 5. TENDENTIAL STRATEGIES

The human factor dictates that even the more difficult consonants should be produced and exploited in the most efficient way. Therefore when a language adopts more difficult consonants it will strive to consistently use "more of the same": i.e. exploiting similar phonetic gestures and processes used by the easier to control active articulators. Although some studies have investigated phonetic tendencies in vowel and consonant systems (e.g. [7, 8]), the phenomenon of tendential strategies has never been dealt with. Therefore, this paper which shows patterns of tendential strategies across languages constitutes a novel research direction, one which opens up many future research possibilities, as will be further discussed in section 14.

#### 6. FINDINGS: QUANTITATIVE DATA

Our initial findings reveal: (1) The number of consonants across languages ranges from 10-42. (2) The average number of consonants is: 25. (3) The most frequent consonants are /m,n/. This is not surprising because even though these nasals are complex (involve the use of 3 sets of articulators, vocal folds+uvula+oral articulators) they are the most natural sounds to produce [14]. (4) The second most frequent consonants are the voiceless stops /p,t,k/. This is also not surprising because: (a) consonants are "phonemes of constriction" and maximum constriction is favored and (b) voiceless consonants are easier to produce than voiced consonants: their production involves only one set

of articulators rather than two as for voiced sounds [14]. (5) The most frequent tendential strategy (although not always the main strategy) is the merging of two phonemes which are already part of the acquired inventory into a new single phonemic unit ( $a + b = ab$ ) (what is referred to elsewhere as (phonological) Integrality (e.g. [13]): e.g. affrication (primarily) as well as secondarily palatalization and/or labialization. This, too, is not surprising because it neither involves exploiting new articulators nor learning new gestures or processes, but rather exemplifies "more of the same". (6) The second most frequent tendential strategy is prenasalization. This, too, is not surprising because it involves employing a natural process for the most frequently used consonants.

### 7. TENDENTIAL STRATEGIES: THE CASE OF ITALIAN

The less frequent consonant phonemes of Italian include: /tʃ,ts,dz,dʒ,kʷ,gʷ,ɲ,ʎ/ [1, 2]. The main tendential strategy is Affrication (4/8) that exploits the merging of two voiceless and/or voiced basically homorganic apical obstruents: i.e. combining together two already existing consonants to create a new one – 4 affricates – among the highest in all languages. Secondary strategies: Palatalization (2/8)/ Labialization (2/8) that also basically combine two consonants in two related processes involving at least two or three active articulators. As previously stated: i.e. the merging of two phonemes which are already part of the acquired inventory into a new integral single phonemic unit ( $a + b = ab$ ).

### 8. TENDENTIAL STRATEGIES: PALATALIZATION: RUSSIAN/LITHUANIAN

The less frequent consonant phonemes of Russian/Lithuanian include: /ts,tʃ,dz,dʒ,ɣ,ʎ,ʒ,ʒʲ,kʲ,gʲ,mʲ,nʲ,pʲ,bʲ,tʲ,dʲ,fʲ,vʲ,sʲ,zʲ,ʒʲ,tʃʲ,dʒʲ,tsʲ,rʲ,lʲ/ [1, 10]. The main tendential strategy (18/22, 19/26) is also integral Palatalization ( $a+b=ab$ ). Disregarding the palatalized consonants results in 25 consonants and a ratio of 3/4 relatively easier consonants vs. 1/4 more difficult consonants. Once again, affrication and palatalization belong to the most frequent tendential strategy because it entails the merging two phonemes which are already part of the acquired inventory into a new integral single phonemic unit ( $a + b = ab$ ).

### 9. TENDENTIAL STRATEGIES: ASPIRATION. THE CASE OF CHINESE

The less frequent consonants of Chinese include: /ts,dz,w,ɣ,ɲ,z,tʰ,kʰ,pʰ,tsʰ,tʃʰ/[4]. The main tendential strategy is Aspiration (5/11). Aspiration requires investing additional effort in order to produce an explosion of air in the same consonant. Disregarding the aspirated consonants results in 15 consonants and a ratio of 2/3 relatively easy consonants vs. 1/3 more difficult consonants.

### 10. TENDENTIAL STRATEGIES: EXPLOITING NASAL PATHWAYS: GREEK, SWAHILI, GUARANI

The less frequent consonants found in these languages include: /ts,dz,ɣ,ʎ,θ,ð,ɲ,ɲ,ɱ,mb,nd,ng,ʎ/ [1, 9, 10]. Tendential strategy: Greek (6/13) 5 nasals plus prenasalization. Swahili: (9/12) 3 nasals, plus prenasalization. Guarani: (5/8) 5 nasals, plus prenasalization. Exploiting nasal pathways is the most frequent main tendential strategy across languages. This, too, is not surprising for the same reason that the most frequent consonants across languages were nasals because even though nasals are complex (involve the use of 3 sets of articulators, vocal folds+uvula+oral articulators in full constriction) they are the most natural of consonants [14]. Once again, prenasalization belongs to the most frequent tendential strategy because it entails the merging two phonemes which are already part of the acquired inventory into a new integral single phonemic unit ( $a + b = ab$ ).

### 11. LOW NUMBER OF CONSONANTS: MAORI AND JAPANESE

The number of consonants in Maori and Japanese is low (10/15 respectively). The less frequent consonants include: for Maori: w,ɲ; for Japanese: w,ɲ,t [1, 5, 10]. This resulted in the "Make-up" strategies: vowel length, and diphthongs. Thus, there is a compromise between consonants and vowels - when the communication factor requires more distinctions, the vowels compensate for the low number of consonants. Diphthongs – like Affrication, Palatalization, Labialization and (Pre)Nasalization belong to the most frequent tendential strategy because it entails the merging of two phonemes which are already part of the acquired inventory into a new integral single phonemic unit ( $a + b = ab$ ).

## 12. HIGH NUMBER OF STRATEGIES: THE CASE OF NAVAJO

The less frequent consonants of Navajo include: /ts,tʃ,w,ɣ,ʒ,ʔ,tʰ,kʰ,tsʰ,tʃʰ,t',tʃ',ts',tʃ',k',t,tl/ [1, 10]. The tendential strategies of Navajo include: Aspiration, Ejectiveness, Affrication, and Lateralization. The Navajo consonant inventory includes 8 basic consonants: /m,n,p,t,k,l,s,j/ which turn into 30 through the use of tendential strategies. Therefore, instead of having many basic consonants, Navajo employs more strategies on fewer consonants.

## 13. SUMMARY

Affrication as well as all the other integral (a+b =ab) tendential strategies exist in most languages (14/16) whether it is the main tendential strategy in each language or not. These integral tendential strategies comprise the easiest phonemic process – combining two already existing phonemes to create a new one (the human factor). The reason that they are not always be used as a main strategy in most languages may be due to the fact that they do not always create the most clear-cut and blatant or salient communicative distinctions (the communication factor).

Palatalization - like affrication, combines already existing phonemes with the anterodorsum (aka palate) as an additional articulator. When used, palatalization exhibits one of the highest degrees of dominance within the language's consonantal inventory.

(Pre)Nasalization – exploiting the most frequent and natural articulators (nasals exist in all languages) plus an extra homorganic articulator – is a highly frequent and dominant tendential strategy across languages for the reasons we have previously discussed.

The less frequent tendential strategies include: aspiration, ejectiveness (2/16). This might be explained by the fact that these strategies involve the use of additional processes and gestures to the same individual consonant phoneme.

The least frequent tendential strategies include: lateralization and implosion (1/16). The reason for their relatively limited use is that they involve the changing of the direction of the airflow from an easier or more natural one to a more difficult and less natural one necessitating the exertion of more effort for less than optimal communication distinctions.

## 14. FURTHER RESEARCH

This paper represents only an initial stage of our research. We further intend to: (i) expand the number of languages to be examined, (ii) examine the vowel inventories across languages and the relation between vowels and consonants within languages, (iii) examine whether similar tendential strategies apply to vowels as well as consonants (such as the integral Tendential Strategies of diphthongization and nasalization, (iv) examine differences in acquisition data across languages according to our findings.

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