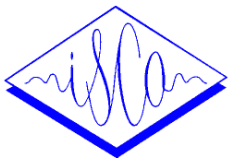

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SYNCHRONIC VARIATIONS, HISTORICAL SOUND CHANGES AND SUPRASEGMENTAL FRAMEWORK

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RESUME

Ce tutoriel concerne l'influence de la structure prosodique sur le sort réservé aux phonèmes au cours des siècles : maintenance, changement ou disparition complète. Par structure prosodique, on entend non seulement les frontières de mots et de syllabes, l'accent de mot, mais également les différentes façons de positionner ses organes vocaux. Dans une première partie, on examinera l'apport évident d'explications prosodiques sur les changements de sons du Latin au Français, et on essayera de dresser, malgré le manque de données, la similitude entre les phénomènes de parole spontanée et ces changements. La deuxième partie, plus hypothétique, rappelle la notion de "base articulatoire", c'est-à-dire une posture générale et une dynamique des mouvements, une notion chère à nos anciens, et toujours aussi difficile à cerner, et qui est cependant une composante nécessaire pour rendre compte de la simultanéité de certains changements. Cette communication, enfin, traite de la nécessité d'intégrer une composante prosodique (positions prosodiques fortes et faibles), une composante acoustique (comme les contraintes aérodynamiques avec la notion de voisement et de dévoisement, actif et passif, et les possibilités de compensation) et une composante auditive pour passer d'une description pure et simple des phénomènes à une modélisation.

1.INTRODUCTION

As well known, most of the historical sound changes are social phenomena, but they are originated by phonetic processes. These processes are rooted in the mechanisms of speech production, speech perception and in the aerodynamic laws. A number of constrains is imposed by the production mechanism itself, such as a different inertia and antagonisticy of the muscles involved in the realization of the bundle of features corresponding to each phoneme. Successive phonemes may also require two conflicting gestures from the same articulator. The physiological constrains play a greater role in spontaneous and rapid speech than in read and slow speech. Many of the articulatory adjustments in spontaneous speech result in an anticipation or persistence of vocal-tract or the glottis configuration. These adjustements can be often interpreted as a manifestation of the Least Effort Principle (Martinet, 1955). See also Rousselot, 1891, Ohala, 1983, Lindblom, 1990, Kohler, 1990, 1991.Some other constrains are imposed by laws of aerodynamics. Obstruency and frication, on one side, and voicing, on the other side, are not highly compatible because of raised oral air pressure. The articulatory adjustments lead to variability in the acoustic realization of the features corresponding to each sound. The listeners may eventually misinterpret the source of some allophonic variations. A redundant feature become primary over the time, leading to a phonological change (Durand, 1956; Ohala, 1981).We also hear phonemes that do not exist, we don't hear phonemes that are present, and we perceive as identical sounds that are not the same acoustically (Sapir, 1921). The phonemic change may eventually disrupt the former phonological system. Many sound changes thus arise from the development of contrastive, phonological status from former phonetically motivated, context-sensitive allophones, through loss of the conditioning environment (a process named phonologization). Velar coarticulation, an apparently universal phenomenon, leads to nasal vowels in about one language out of five; vowel-to-vowel coarticulation, also a universal phenomenon, leads to vowel harmony in languages, such as Hungarian and Turkish. The structure of the former system plays a role in the eventual phonologization of phonetic variations: Sound change is stucture-dependent in an essential way (Jakobson, 1929) and redundant features are likely to be phonologized if the language's phonological representation has a class node to host them (Kiparsky, 1995: 656). Also, transphonologization between voicing feature and tone happened only in already tone languages (see examples in Hagège and Haudricourt, 1978).

Since all speakers share the same type of constrains due to similar speaking conditions, there is a large number of commonalties between both continuous speech phenomena and the sound changes observed in different unrelated languages. The continuous speech phenomena include various degrees of assimilation of voicing, place assimilation, reduction of vowels to

schwa in unaccented words and unstressed syllables, and deletion of vowels and consonants, etc. The changes in different languages also often go in the same direction. For example, t vowels tend to rise; lax vowels tend to lower, back vowels tend to become front vowels, unstressed vowels to be reduced or suppressed, intervocalic unvoiced stops tend to become voiced and a fricative. Note in passing that the three first phenomena, i.e. tenseness-triggered raising, laxness-triggered lowering, and fronting of the back vowels, are not related in an obvious ways to the observed continuous speech phenomena.

A number of data on spontaneous speech phenomena and sound changes are available for Indo-European languages, but we are still missing data on exotic languages before reaching definitive conclusion about the universal character of the synchronic and diachronic observations. In particular, it is not known how far the system of contrasts in a particular language influences the application of the Least Principle Effort (see for example, Basset & Su, 1998, for some preliminary comparative data on Taiwanese Mandarin and French).The present seminar represents an unique occasion for all of us to share data from a wide number of languages: Brazilian Portuguese, Dutch, English (including Singapore English, Finnish, French, Polish, German (including Austrian German), and Taiwanese Mandarin. (See also the proceedings of a seminar organized in Kiel in 1996 on spontaneous speech phenomena, Simpson & al, 1996).

Inside of a particular language, there is a number of slightly different ways in which the phonemes in spontaneous speech may be reduced, or on the contrary, overarticulated. The differences in ways of reducing and of emphasizing (an accented word or a stressed syllable) may be often interpreted as a difference in the weighting of the priorities between the communicative goals of the utterances (cf. Bühler'sSprachtheory, 1934). A speaker may want to express himself essentially clearly and/or rapidly, with or without extra effort. The manner of stressing or destressing what he intends to say depends in part on a number of extra-linguistic factors. These factors include bilingualism, regional habits, imitation of classy prestige speech forms, a sub-group or of a standard, the age and the social origin of the speaker, his level of education, etc. (cf. Labov, 1994 for socio-linguistic influence on speech, and Nolan, 1996 for dialectal variations of English). There are more or less chic ways of speaking sloppily or emphatically. These ways change from one generation of the next. The change with time of manner of emphasis is generally considered as a consequence of the phenomena of " usure " (erosion). The different ways of speaking result in a very large variety of global auditory colorings of the voice of the speakers and in local differences in the pronunciation of some phonemes. As formulated by Sharon Manuel (this seminar), casual speech is a rich source of intriguing puzzles. The differences are not distinctive in the phonological sense, but they are important in communicative situations and may serve as a major vehicle of information about the speaker's social origin, regions, etc. (cf. Labov, 1974, Laver, 1980). And like the more directly biologically rooted variations, these variations may also lead to gradual articulatory shifts and eventually to contribute to phonemic sound changes, if the marked way of speaking become standard. Sound changes cannot be predicted, but they can almost always be given a number of more or less plausible explanations after they have been attested.

This tutorial concerns the particular influence of suprasegmental characteristics on the segments. The first part concerns the influence of the prosodic structure of the words (stress, boundaries, syllables type) on sound changes and on spontaneous reduction. The second part is related to the influence of general articulatory setting.

2.FROM LATIN TO MODERN FRENCH

There is a long tradition, at least in France, pointing on the strong interaction between prosodic changes and sound changes (Rousselot (1981), Roudet (1910), Straka (1979) and Zinc (1986). Riad (1992) has also analyzed major sound changes in North Germanic over the past to millennia as so many stepwise resolutions of inherent conflicts between fixed accent, free quantity, and bimoraic foot structure (cited by Kiparsky, 1995). Välimaa-Blum (this seminar) presents data on the interaction between word stress, vowel harmony and moras in the process of deletion in spontaneous Finnish (Välimaa-Blum, 1998). In contrast with this well-established tradition of prosodic influence, a number of common textbooks on historical linguistics written in English don't even mention the eventuality of such an interaction.

Sound changes, in particular the path from Latin to Modern French and other Romance languages, are well documented, due to tradition of comparative philology in Europe. Prosodic changes are however more difficult to document (Hyman, 1978) and there is obviously no recordings. The mutual interaction between the segmental system and the suprasegmental system is apparent in the passage from Latin to Modern French. The general character of such a strong interaction between sound changes and changes in the prosodic systems needs confirmation however.

2.1. From melodic stress to intensity stress

French is a Romance language, such as Italian, Spanish or Portuguese. After the Roman successful invasion (58-51 AC.), the adoption however of the

language of the conquerors, Latin, by the inhabitants of the Gaul, results in the quasi-complete disappearance of the former Gaelic dialects (Gaelic is a Indo-european, Celtic language) within a few centuries and also in a radical transformation however of Latin.

Classical Latin had two major characteristics. Firstly, on the suprasegmental level, it had a melodic stress. Secondly, quantity was distinctive. These two suprasegmental and segmental characteristics, melodic stress (or pitch accent) and phonological quantity, are compatible, as so far the melodic stress involves maneuvers only at the level of the larynx, without strengthening and lengthening of the melodically stressed vowels (cf. Japanese). The marked syllable, carrying melodic stress was generally the penultimate syllable or the antepenultimate in Latin. It was a heavy syllable, that is either an open syllable ending with a long vowel (VV), or a closed syllable ending with a consonant (VC). The location however of the stress was therefore dependent on the quantity of the vowel and on the syllable type.

2.2 Deletion of syllables

The tendency to give the syllable with melodic stress predominance probably started very early in Latin, andwas present in Vulgar Latin, spoken by the soldiers and the merchants, from which French descends. It is believed that this tendency was strongly reinforced by the way the Gaelic speakers spoke Latin: their former prosodic habits persisted. Celtic languages generally have a strong (initial) stress on the word initial syllable. Around the third century, the (penultimate) syllable carrying melodic stress was uttered with more and more effort, to the expense of the surrounding syllables, which become weaker. During the " Préroman " phase (see Table 1), both quantity and differences in timber, on one side, and melodic and intensive stress, seem to have coexist, but vowels timber start to change depending on the length, and the length distinctionbecame not any more distinctive (seen later).

	segmental	suprasegmental
Latin phase	distinctive quantity	melodic stress
Preroman phase	Changes to vowel color	strengthening and lengthening of the marked syllables only
Roman phase	Not distinctive	intensive stress (not distinctive)

Table 1. Different phases (see text)

The slow interaction ends in quite dramatic results in the " Roman " phase: In the frequent words, the syllables which were not carrying primary (penultimate) stress, and which were not word-initial have just disappeared.

Below are some examples:

amantem>	*amant*	[amɑ̃]	'loving'
farina>	*farine* '	[farin]	'flour',
amatus>	*aimé*	[eme]	' loved'
asinus>	asne> âne	[an]	'donkey'
fragilis>	*frêle*	[frel]	'frail'
solidus >	*sou*	[su]	'money'
subtus >	*sous*	[su]	'under'
pediculum >	*pou*	[pu]	'louse'
pulsum >	*pouls*	[pu]	'pulse'

2.3 Prosodic Profile

2.3.1 Historical data

Position in the word: Not all phonemes in the word disappear at the same time. Some phonemes resist longer to deletion, depending on their position relatively to the stressed syllable, and to the word boundaries and their position in the syllables.

If the number of centuries is taken as a measure of their strength, six degrees of relative resistance may be attributed to each vowel in the Latin form of the words (See Vaissière, 1996). Table 2 illustrates the different degrees of strength. The vowel /a/ should be added one more degree of strength, to take into account its greater resistance.

C	V	c	v	C	V	c	v	c	v	(c)
	4		2		5		1		3	

Table 2: Reconstructed strength of the Latin vowels, depending on the number of centuries they have resisted. The stressed syllable is the third syllable.

All the vowels (and syllables) with a degree of strength less than 5 were deleted. The vowel /a/ in final position (estimated degree of strength: 4) resists, and it changed in Modern French into schwa. The strongest syllables were the stressed and the word initial syllable.They never disappeared. Reinforcement of articulatory effort on one syllable was done at the expense of the following vowel. The stronger one syllable, the weakest the following: the final syllable was even weaker than postonic when it was preceded by a postonic (weak) vowel.

Reinforcement of the edge syllables is a general phenomenon and it may explain the longer resistance of the final vowel as compared and to the not-extreme, unstressed vowels (but all the final vowels were also suppressed).

The pretonic syllable was stronger than the postonic syllable. The postonic, non-final syllable appears to be the weakest vowel.In Classical Latin, the graphemes <i> and <u> were used to mark the weak character of the vowel in such a position (apophony).

con + facio > conficio
novos+ tas > novitas

The vowels (including [a]) in these positions disappeared during the Roman Empire:

cal(i)dum >	*caldum*	chaud	[ʃo]	'hot'
sub(i)tanu(m)>	**subtanu*	*soudain*	[sudɛ]	'suddenly'.
masc(u)lu(m) >	**masclu*(later *mâle)*		[mol]	'male'
separare >	*sevrer*	[s vre]		'wean'.

The position of the consonants in the syllable plays a very large role. Word-initial consonants and the second member of the clusters were preserved. All the other positions are weak positions. All consonants in coda position were either deleted, except /r/ and /l/ (the nasal coda nasalized the preceding vowel and then disappear) or vocalized and become part of the vocalic nucleus (/l/ > /u/; /g/ and /k/ > /j/). The consonants in intervocalic position were either deleted (/t/; /d/; /w/, /k/ and /g/ in back context), or weakened (/p/ and /b/ > /v/). Only (/l/, /m/, /n/, /r/) were maintained. As for the vowels, consonants in final position in the words were slightly stronger than the consonants in other weak position (confirmed in Modern French by articulatory data, Straka, 1976: 219).

2.3.2 Modern French

In carefully articulated speech, all phonemes are articulated, open syllabication tendency prevails and there are cases of schwa insertion in certain clusters:

Madame est une aimable amie:> **ma-da-me-ty-nɛ-ma-bla-mi**
'Madam is a nice friend'

avril:>av^{ə}ril 'april'

The reduction in French " sloppy" spontaneous speech indicates a resistance of the word-initial consonant and the word final syllable. All consonants and vowels in different position may be strongly reduced may eventually disappear in frequently spoken words. High vowels and schwa are also more likely to disappear than open vowels.

Madame est une aimable amie:>> **mdam-e-tyn-e-mabl-a-mi**
B(on)jou(r), m(a)dam(e), m(er)ci, m(on)sieu, p(a)pa, m(a)man >>
bju, mdam, psi, psjǫ, ppa,mmɑ̃ 'hello, Madam, thanks, Sir, Daddy, Mummy'

All vowels in function words may disappear, leading to a large number of three consonant sequences. The two consonants flanking the deleted vowels become adjacent:

j(e) t(e) l'ai dit, s(i) tu r(e)trouv(e)s c(e) truc ..>>
ʃtle di si ty rtruv stryk

The successive consonants represent illegal clusters in French phonology. Since there are illegal in the phonological system, the missing schwa can be easily restituted by the listener (CCC > CəCəC) (see a similar type of explanations for the deletion of schwa in French by Henriette Walter, 1976: 284-285).

Vowels in absolute word-initial position may also be deleted (Basset & Su, 1998).

(A)lors, (en)fin(then, finally)

Two facts are worth to be noticed, concerning the way of speaking of the new generation.

a) As seen before, a large number of final consonants have been deleted (but they are present in the written form). They are not uttered by my own generation. The final consonant of a number of frequent words tend to be restored by the new generation in words such as:

exact, but (‘goal), fait (‘fact’), o(‘one’), jadis (‘one upon the time’), hélas (‘alas), gentil (‘nice’), fusil (‘gun’), outil (‘tool’).

A student of mine is currently getting statistics about this new trend.

b) An epenthetic schwa is often added at the very end of a number of very frequent words, when emphasized, and followed by a pause. The words may end by a consonant (‘bonjour’) or by a vowel (‘merci’). It is often added to other words as well (examples will be heard during the seminar). The adding of an unstressed epenthetic syllable may be a strategy for giving prominence and to the word final syllable. Languages have often a mechanism whose function if to remote stress form final position and there is preference in languages for stressing the penultimate position. (Hyman, 1971). The adding of a postonic vowel may help to emphasize the preceding (formerly) final syllable. It may be also a way of adding extra length to the prosodic group final syllable. It sounded very strange to me some years ago, but I used too, and I think, I also have started to produce it occasionally.

2.4. Vowels change

2.4.1. Historical data

Stress plays a well-known role in vowel changes. The stressed vowels lengthen and become a diphthong

stressed	**Classical Latin**	i:	i	e:	ɛ	a:	a	ɔ	o:	u	u:	**10**
	Vulgar Latin	i		e	ɛ	a		ɔ	o		u	**7**
unstressed	**Classical Latin**	i:	i	e:	ɛ	a:	a	ɔ	o:	u	u:	**10**
	Vulgar Latin			e	ɛ	a		ɔ	o			**5**

Table 3: Vocalic system in Classical Latin and in Vulgar Latin. The number on the right indicates the total number of vowels.

Latin had 5 long and 5 short syllables, with similar timber. The functional load of the length distinction was very high. The five short stressed vowels and the ten unstressed vowels lower. While 10 vowels in both stressed and unstressed positions were attested in Classical Latin, 7 vowels were attested in stressed vowel and only 5 in unstressed vowels (see Table 3).

The reduction of a number of vocalic contrasts in unstressed syllables is a general phenomenon. The phonetic implementation of stress and accent crucially involve the enhancement of segmental distinctiveness. Jaw tends to lower. in stressed vowels (Stone, 1981), and in emphatic stress (Fujimura, 1991). When jaw lowers, the supraglottic cavity is wider. More space allows the tongue to make more precise and more extreme movements (Maeda, personal communication) and more contrasts can be realized.

Lowering of the short stressed vowels is not easily explained. Three "prosodic" explanations may be proposed. Firstly, it may be an indirect consequence of jaw lowering. If there is no compensatory tongue movement, the first formant raises and the vowel is perceived as lower because of a higher first formant. But such an explanation does not account for the fact that long stressed vowels remain stable and for the fact that unstressed vowels also lower (short i>e; short u > o; short e>ɛ, short o> ɔ, etc.). The second type of explanation is of the auditory type. The lowering will the consequence of a voluntarily equalization of the auditory energy for the vowels in the same prosodic position (stressed or unstressed). There is an integration of intensity over time by the ear, so those vowels with the same timber will appear more energetic if longer (up to certain duration). The short vowels, in stressed and unstressed, lower (F1 raises) to become as intense as the corresponding long vowels in the same position. Vowels in closed syllable are also generally shorter than vowels in open syllable. They also tend to lower and the same reason may be advocated: they lower to become as energetic as (longer) vowels in open syllables (cf. the alternations between /Ce/ and /CɛC/, /Co/ and /CɔC/ in Modern French. The third explanation comes from auditory facts: shorter excepts of /i/, /u/, /o/ and /e/ tends to be perceived as /e/, /o/, /ɛ/ and /ɔ/.

Stressed vowels were lengthened and there were periods in the passage from Vulgar Latin to French where they become diphthongized, and later monophthongized. The way of realizing prominence on stressed syllables plays again a large role in the vowel changes. At the beginning of the twelfth century, all diphthongs were stressed on their first element. There was a stress shift, and stress becomes associated with their second element, and the first element became a semi vowel. If the second element was more close than the first element (i.e. less intense), the second element disappeared. Such a phenomenon exemplified the interdependence between the segmental line and the suprasegmental one.

2.4.2. Modern French

There is a lack of data concerning variations in perceived timber of the vowels in spontaneous speech. The perception tests are a time consuming task. Duez's acoustic data for two French speakers suggest that the amount of contextual assimilation, as measured by the 'locus equation' (Lindblom, 1963), may be higher than in English (Duez, 1989).

2.5. Consonants change

2.5.1. Historical change

As mentioned in2.3.1, consonants are maintained, weakened or suppressed, depending on their position relative to word boundaries and word stress.
Word initial position and preconsonantal positions are strong positions. The other positions are weak positions.

#CVCV>	CVV	CV
CVCCV>	CVCV	

Table 4: Strength of the Latin consonants. Initial (top) and postconsonantal consonants (bottom) are stronger than the other types of consonants.

Initial consonants persisted, and remained the same, except /k/ and /g/. The velars changed to /s/ when located before front vowels. They change to /ʃ/ in front of the central vowel /a/:

cattu>chat [ʃa]('cat')

All the observed changes in the passage from Latin to Modern French are conform to the well-studied lenition process (there is no clear case of fortition). For a clear view on lenition, and fortition processes, see Lass, (1984, I don't agree with Lass, however, when he classifies aspiration and fricatization as uniquely lenition processes).
The weakening process involved both the stricture (openness) and glottal state (sonority) of the consonants, although rarely the place of articulation. The scheme is the very general scheme observed in sound changes:

(a) Stop>fricative>approximant>zero
(b) Voiceless> voiced

Each step increases the permeability of the vocal tract to airflow (less resistance). Intervocalic stops changed to fricative, and eventually disappear.

Latin b > Italian, French v > Spanish β
Latin d > Italian d > Spanish, French zero
Latin g > Italian dʒ > Spanish, French zero

ripa >	*rive*	'border'
credere >	*croire*	'to believe'
legere >	*lire*	'to read'

The problem of intervocalic voicing will be dealt with later in this paper.

2.5.2. Modern French

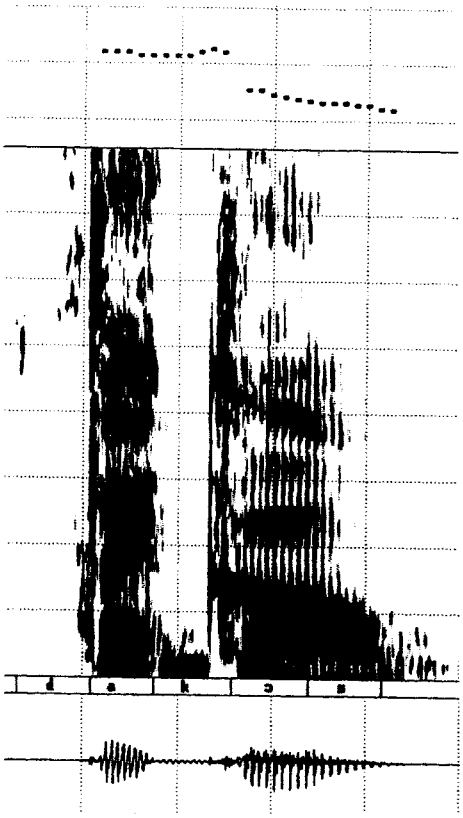

Figure 1: Spectrogram of the word 'd'accord'. Initial /d/ is perceived as /t/, and intervocalic /k/ is still perceived as intended, despite the voice bar.

Similar changes of sonority and openness are observed in Modern French (Duez, 1995; Basset & Su, 1998).
A voice bar in intervocalic short consonants is often observed. There is a delay of voicing or even trace of aspiration in word initial consonants. Figure 1 illustrates a spectrogram corresponding to the word '*d'accord*' ('ok') in spontaneous speech. There is no visible voicing in initial /d/ and no cessation of voicing in intervocalic /k/. The first consonant is perceived, as a voiceless consonant (at least by French listeners and it may not be the case for native of English), but the second one is perceived as intended.
In her work on spontaneous speech, Duez (1995) observed that the place of articulation of /b/, /d/ and /g/ is maintained in assimilated and reduced consonants (80% of the intervocalic voiced stops were well identified by a panel of listeners).

2.6: Adding aerodynamic constrains and prosodic features to the description

Intervocalic short voiceless consonants tend to be voiced. Intervocalic long voiceless consonants remain voiceless. Intervocalic long voiced (geminate) consonants tend to be devoiced. Intervocalic short voiced consonants remain voiced.
These phenomena can be explained in a rather straightforward manner. When the vocal-tract is completely closed, supraglottal air pressure raises rapidly (See Stevens, 1977). Voicing is inhibited when the supraglottal air pressure becomes equal to the subglottal air pressure. Voicing should stop in a natural way within a few milliseconds through a process that may be called "passive devoicing", if there is neither an extension of the volume between glottis and the constriction and an active slackening of the vocal folds. Because of the compliance of the vocal-tract walls, there is a passive extension of the volume, so that voicing is maintained for awhile, without active movements of the speaker ("passive voicing"). Ohala and Riordan (1979) estimated that voicing could be maintained for /b/, /d/ and /g/, 80, 60 and 50 ms, respectively, due to passive expansion of the volume of the cavity between the glottis and the place of constriction.

As a consequence of passive voicing, unvoiced short /p/ tends to be «naturally" voiced, and as a consequence of passive devoicing (due to heightening supraglottal air pressure, long, geminate voiced stops tend to be devoiced. So the following tendency are common both to sound changes and in spontaneous speech (Table 5).. ("p" and "b" represents any voiceless and voiced stops, respectively; 'pp' and "bb', long, geminate consonants or clusters):

pp>p	passive devoicing sufficient and shortening
bb>p	passive devoicing counteracting and shortening
b>b	passive voicing sufficient
p>b	passive voicing counteracting

Table 5: Natural tendencies of voicing and devoicing observed on single stops and geminates; best explained by aerodynamic constrains

Such aerodynamic characteristics and prosodic strength of the consonants should be part of the description to draw the link between phonetic realization and sound changes. Prosodic position has two effects. First, initial position and prestressed positions are associated with a general tensening of all

articulators. Such a tensening leads to a delay of voicing (and aspiration) through a tensening of the vocal folds, and to a lesser nasalization (tensening of the levator palatini). See, for example, Straka, 1979b, Vaissière, 1986, for data on the velum in continuous speech in English, and also Vaissière, 1988, Fougeron, 1998). Second, prosodically weak position favors passive tendencies: all clusters will tend to be voiceless, and short consonants to be voiced. Voicing could be interpreted as the "marked" feature for stops in strong position (such as initial) an clusters, It will "unmarked" in weak position ('pava' or 'paba' as more natural than 'papa'). A large number of called "context-free" changes have been most likely originated by prosodic context, and then extended (or not) to all sounds.

3. GENERAL ARTICULATORY SETTINGS

3.1.Definition

The notion of articulatory baseline of setting is difficult to defined (Straka, 1989). It is a cumulative abstraction and an association of motor tendencies:
"Les sujets qui parlent leur langue maternelle obéissent inconsciemment à certaines tendances, héritées ou acquises qui se manifestent dans tous les mouvements des organes de la parole. Ces tendances sont relatives à la forme de la langue et à la direction de ses mouvements, à l'activité des lèvres, de la mâchoire, du voile du palais, des cordes vocales "
(Roudet, 1910:37).
A number of allophones and sound changes such as diphthongization of the vowels, affrication of the stops, simplification of the geminates, elimination of the weak elements seems to be all related to a general "relâchement d'articulation" –relaxation- (Dauzat, 1930:42). Many concomitant changes would be therefore related to a single, general change in speaking habits. Following this line of thinking, Hagège and Haudricourt proposed to set up an "ethnology of the articulatory gestures" (Hagège & Haudricourt, 1978). It should be verified, however whether contradictory habits, which would result in sound changes in different directions, do not exist in a given language.
The notion of general articulatory setting is both related to the average position or quasi-permanent position of the speech organs, as well as their dynamics. These two factors are very difficult to quantify.

3.2.Average position of the articulators

The averaged position of articulators and the mean deviation of their displacement may vary. These general settings may characterize the way of speaking of individuals (Laver, 1980), as well as dialects or languages. The notion is related to the term "voice quality", which refers, according to Abercrombie, to "those characteristics which are present more or less all the time that a person is talking: it is a quasi-permanent quality running through all the sound that issues from his mouth" (Abercrombie, 1967: 91). Laver (1980) calculated the average formant frequencies of the vowels in his own performance of different settings on the first paragraph of the Rainbow Passage: neutral settings, lowered larynx, raised larynx, close rounding, retroflex, dentalized, palatalized, velarized and pharyngalized. Rounding, for example, leads to the reduction of the first three formants; palatalization raises F2 and F3, and lowers F1. Pharyngalization raises F1, but lowers F2 and F4.The mean position of the articulators may also contribute to the characterization of a language or a particular style. For example, the articulation seems more fronted in French than in English (Delattre, 1953, 1965). Young people in the suburbs of Paris speak in a more fronted manner. By contrast, speech in the chic quarters of Paris are characterized by a more back setting. Note that speakers have a number of different forms in their repertoire and they alter, often unconsciously, their way of speaking to fit the occasion. The setting concerns both the supraglottic articulators and the larynx. The general setting of the glottis is more similar between French and Japanese, than between French, and English and German, as exemplified by the difficulties encountered by natives of both languages for speaking French.

3.3. Dynamic settings

The speech organs movement must also be highly coordinated. The way of coordinating the different speech organs is the result of a long acquisition process and it is specific to each language (Grammont, 1933:22).
Some phonemes require more complex coordination than others do, because they involve more articulators or more complex movements. At the supraglottic level, /p/ is less complex than /m/. /p/ is realized with a simple lip movement, while /m/ requires a coordination of both lip and velum movements. Rounding is more easily performed in high vowels, but it is more difficult and requires more effort in open vowels. Acoustically effective cpensation may differ: the tongue height and the lips may compensate for jaw lowering in front vowels, and in back vowels, respectively (Maeda, 1990).
The differences in coordination not only concern the realization of each phoneme separately, but also the sequence of phonemes. Different dynamic habits characterize the languages. In French, the position of the articulators required for a vowel seems to be more

anticipated during the preceding consonant than in English. Lips are already protruded when the following consonant is round. The anticipation seems to be less in English (Delattre, 1965). Anticipatory movements contribute to the acoustic stability of the vocalic timber in French. In French, assimilation of voicing affects the sonority of the consonant but not its articulatory force, while in Russian, it seems to affect both.

3.4. Syllabification

The way of syllabification is very important and may vary (Maddieson, 1985). Generally, two general tendencies are considered. The first general trend is toward open syllabification. The coda consonant of the closed syllables tends to disappear, to become vocalic or to be linked with the next syllable. The syllable ends with high intensity. Open syllabification characterizes the Slavic languages. This tendency also dominates the passage from Old French to Middle French.

Close syllabification tendency, on the contrary an earlier center of effort in the syllable. There is initial strengthening and the coda consonants remain. It characterizes the passage from Middle English to Modern English (Hagège and Haudricourt, 1978:25).

3.5. Influence of phonological contrasts

The choice of a particular way of coordinating the speech organs is only partly arbitrary. There is also an influence of phonological systems on coarticulation differences (cf. Clumseck's study on the soft palate movements in six languages; Clumseck, 1976; and the study by Manuel (1990) on cross-languages differences in spatiotemporal organization). Phonetic implementation of the features is a very complex problem (see for example, Fujimura, 1995, C/D model for a prediction of prosodic organization based on syllables). The tight link between a vowel and the following coda is language dependent.

3.6. Cross-languages, and dialectal differences

Courtenay (1890) make the hypothesis of a general transfer of the laryngeal activity to supralaryngal activity, with the progressive disappearance of the glottal consonants.

The Celtic substratum is often considered as the main factor responsible for the fact that Vulgar Latin spoken by Celtic "mouth" underwent much more changes than the other Romance languages. When indigenous population learns the language of the conquers they carry over features of their original language into the adopted one.

The differences between English and German may be due in part to the Celtic influences (English = German vocabulary + Celtic pronunciation; French = Vulgar Latin + Celtic pronunciation).

Similarly, South French accent is believed to be due to the fact that the substratum was the more conservative "langue d'Oc" (in the South of Gaul) which have received less influenced from the Germanic invasions than the "langue d'Oïl" (in the North).More word reduction on the north (because of a stronger stress) characterizes French spoken in the North.

3.7.Sound changes due to articulatory timing

Differences in relative timing of crucial events among different articulators may results in allophones and eventually sound changes due to articulatory timing. Rousselot considered sound changes as "un défaut de coordination ou de précision dans les mouvements" (Rousselot, 1891: 5).

The movement of the lips has prevailed over the tongue movement in the change from Latin [w] to French [v].In contrast, the tongue movement in German [w] prevailed. [w] changed to French [g].

wadja > wage in English
wadja > gage in French

If the articulatory organs separate less rapidly for a stop, an audible glide is created, and all the stops may tend to become an affricate. Delayed opening of the vowel or strengthening of the closure for the consonants leads to the insertion of glides (cf., the so-called Roman diphthongization, which results in the insertion of an element more close than the second between the consonant and the vowels: pe>pje, po> pwo:

Petra > pietra > pierre ('stone')
Novum > nuovum > nuef > neuf ('new')

3.8. Auditory weighting

There may be also different habits in the weighting of the different acoustic corresponding to a given feature. The place of articulation for a stop and a fricative is cued by the spectral characteristics of the burst or frication, and the following formant transitions into the vowels. An abrupt change in amplitude is sufficient to signal the presence of an underlying /t/ in the cluster /st/.Both the spectral slope and the transitions into the vowel cue the place of articulation of /s/. If a fricative is not strident, the frication noise amplitude is weak, and the spectral slope is not sufficient to identify the consonant.Transitions become more important for the correct identification of the place of constriction.The transitions effects or burst may become maximized to become perceptually more salient, and this trend may extend to all consonants; leading the change in manner of articulation of a

whole set of consonants.

CONCLUSION

More data are needed to investigate the relationship between spontaneous speech phenomena and sound changes, on one side, and both (synchronic and diachronic) types of variations and prosodic structuring, on the other side. The task is not a very easy one. Prosodic changes in the history of languages are more difficult to investigate than sound changes. The transcription of spontaneous speech phenomena is also rather problematic and terribly time-consuming. Some of the sounds produced resemble none of the sounds proposed by IPA. Allophonic variations are not discrete but continuous. The transcription should include acoustic as well as auditory aspects. First, it should be done with the help of spectrograms. The errors done by Victor Zue in spectrograms reading experiments (Cole & al, 1990) mirror sound changes. Second, perception tests are necessary. There is difference between speech as measured on spectrograms and its auditory representation, since the latter is constrainted by the properties used to classify the sounds in the auditory system. on the properties used to classify the sounds (Stevens, 1981). Articulatory data and aerodynamic data on spontaneous speech would be most useful for interpreting the puzzling spontaneous speech phenomena. Reducting articulatory effort on the part of the speaker in spontaneous speech leads to the disappearance of articulatory movement(s) and to a gestural reorganization (Kohler, 1991:145; Lindblom, 1990, Moon & Lindblom, 1994). The gestures are difficult to infer from the acoustic data. To obtain physiological data when the speakers speak spontaneously represents however a real challenge.
We may conclude by citing Nolan: "Segmental Continuous Speech Phenomena's are not independent of prosodic CPS's ... and ultimately may turn out to be treated best in conjunction to prosodic changes" (Nolan, 1996).An appropriate methology to deal with spontaneous speech is still to be found, and data on sound changes may be essential for a better understanding of the observed phenomena, since sound changes are the ultimate offsprings of spontaneous speech phenomena.

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