

Reversibility in vowel systems: When prosody succeeds and when it fails

Omran Allatif & Christian Abry

Institut de la Communication parlée CNRS UMR 5009 INPG-Stendhal
Institut de la Communication Parlée - Université Stendhal - BP 25 - 38040 Grenoble Cédex France
allatif/abry@icp.inpg.fr

Résumé: Les langues ont des exemplaires extrêmes [i a u], intercalant d'autres voyelles sur la périphérie [i e a o u], pas au centre, conformément à notre théorie, la TDF. La variation des trois extrêmes [i a u] a pour effet, soit de remplir la périphérie par un nouveau prototype (le [e] en arabe dialectal); soit de retrouver un extrême disparu (le [i] du kayardild, une des langues d'Australie défectives en voyelles hautes [i u]). Ce sont deux changements —réversible vs. irréversible— qui contribuent pour finir au maintien des voyelles extrêmes.

A lawful variational vowel system paradigm: rate and intonation prosody

Cultural variability and stability is an issue going far beyond the scope of vowel categories in the speech signal. Our rationale for the present quest will be *lawful systemic variability*. *Dispersion-Focalization Theory* (Schwartz *et al.*, 1997) proposes to resolve drawbacks of both *Dispersion* and *Quantal* theories. DFT predicts: (i) the ubiquity of extreme [i a u] exemplars; (ii) the appearance of new prototypes only along the anterior [i a] and posterior [a u] paths of the vowel space (in spite of being rare, as some *focal* colours, our fourth *focal* attractor [y], benefited from recent support from child perception, Schwartz *et al.*, 2005).

Arabic, in spite of its original uncrowded [i a u] system, which for supporters of sufficient contrast distance (against DFT) could predict a general vowel reduction, or on the contrary (DFT) an empty space in-between, offers as a dialectal process both the creation of a new [e] prototype (from short [i]), and a preservation of an extreme exemplar [i] (long [i]). No evidence of a reversibility of [e] towards [i] was found. On the contrary, among Australian languages reputedly defective in high [i u] vowels, Kayardild evidenced recently a come back of [i] exemplars, in a focalized prosodic context, i.e. reversibility. Both this reversibility, in the absence of extreme exemplars, and non-reversibility, say stabilization of a new prototype when the extreme variant has been preserved, can be predicted by our *Perception-for-Action-Control Theory* (Schwartz *et al.*, 2002, aiming at unifying *DFT* with *Motor Theory of Speech Perception*), for which articulatori-acoustic-driven-recoverability of undershot exemplars can succeed or fail depending on lawful variability.

When the plasticity of the Arabic vowels comes to an irreversibility

In the study of the Arabic vowel system, from Mayadin, in the Euphrates area of Eastern Syria (Allatif & Abry, 2004), which operates on both quantity and quality to make distinctive contrasts between vowels, we used the perturbation method, namely the voluntary variation of speech rate (normal vs. fast), combined with qualitative prosodic variations in intonation (declarative vs. interrogative). These perturbations aim at testing adaptability: (i) first robustness, i.e. the capability of a system to resist to constraints in the variable prosodic conditions of linguistic communication; (ii) then, optionally, the capability of this system to restructure itself and thus respond to the disappearance of certain sounds by recovering or not their original prototypes.

The Mayadin system, which does not need to differentiate more than three qualities even though it has a significative and robust quantitative difference for all the three vowels ([i a u] like in classical Arabic) presents however systematically *extreme* exemplars (Fig. 1), in the regions we called *focal points*. So dispersion does not show reduction toward a "sufficient" distinction stance. The short vowel [i] in contrast with long [i:], has ultimately invaded the zone of [e] (a usual phenomena in colloquial Arabic). And it remains in this region whatever the type of perturbation (reduction vs. enhancement), and so does not fuse its quality with that of the long corresponding vowel, neither under the effect of rate nor under melodic height.

Reversibility in a reputedly height-defective Aboriginal vowel space

Australian languages, for which Andrew Butcher and his team have been measuring formants for some years, have systems containing three vowel qualities [e a o], but do not display, like Arabic or Inuit, high point vowels [i u] (and even if we add other languages under description by Butcher, pers. comm., to those already available, this remains true). However, Fletcher & Butcher (2003) recently tested the influence of the prosodic conditions, which could reduce or enhance contrasts. For long as well as for short variants, there were three prosodic contexts: accented syllables [prefix-a],

unaccented [prefix-u], and phrase-final context [prefix-f] (irrespective of accentuation). Data were given for Dalabon, Mayali, and Kayardild (male and female). We converted them from Bark to Hz, in order to get a more classical comparison with our own data. Finally, this is the phrase-final condition that elicited the reappearance of an extreme [i:] exemplar in Kayardild (Fig. 2).

What is the interest of these two types of evidence for our purpose? In fact they reveal that we are justified to distinguish two types of adaptive perturbations: 1) Reversible perturbations: like the one we found for [i:] in the Mayadin dialect, with reduction or enhancement according to the condition, an [i:] staying however basically the same in quality; and for [e] returning to [i] in phrase-final condition for women subjects of the Kayardild language. 2) Non reversible perturbations: like the short [i] in Mayadin, produced as [e], and never coming back to the [i] zone, i.e. to the extreme area of the vocalic space. This non-reversibility is the expression of a phonetic change that is now fully completed. So it seems that such an obvious violation of the universal [i a u] triangle (otherwise formulated as: "all languages tend to realise extreme exemplars", according to DFT) as encountered in these Australian languages has to be considered as just a recent local achievement of the trend of this *Sprachbund* (see Troubetzkoy). In other words, as just a stage of an oncoming evolution toward the universal pattern... provided socio-ethnological circumstances allow the local preservation of these languages, as for our dialect.

References

- Allatif, O. & Abry, C. (2004). Adaptabilité des paramètres temporels et spectraux dans l'opposition de quantité vocalique de l'arabe de Mayadin (Syrie). *Actes des XXVes Journées d'Étude sur la Parole*, Fès, 13-16.
- Fletcher, J. & Butcher, A. (2003). Local and global influences on vowel formants in three Australian languages. *15th International Congress of Phonetic Sciences*, Barcelona, 905-908.
- Schwartz, J.-L., Abry, C., Boë, L.-J. & Cathiard, M.-A. (2002). Phonology in a Theory of Perception-for-Action-Control, in J. Durand & B. Laks (eds.). *Phonetics, Phonology, and Cognition*. Oxford: Oxford University Press, 254-280.
- Schwartz, J.-L., Abry, C., Boë, L.-J., Ménard, L. & Vallée, N. (2005). Asymmetries in vowel perception, in the context of the Dispersion-Focalization Theory. *Speech Communication*, 45, 425-434.
- Schwartz, J.-L., Boë, L.-J., Vallée, N. & Abry, C. (1997). The Dispersion-Focalization Theory of vowel systems. *Journal of Phonetics*, 25, 255-286.

Arabic dialect of Mayadin (Syria)
3 subjects, 6 vowels (12 repetitions), 2 rates and 2 intonations

Figure 1:
Dispersion of I vowels ([i]-[i:], squares), U ([u]-[u:], dots), A ([a]-[a:], triangles). Circled symbols are placed as on a schematic chart.
1) Extreme (*focal*) vowels are not all reduced toward the center of the vocalic space.
2) Irreversibility of the change of short [i] to [e] is evidenced by its distinctiveness against [i:] whatever the context.

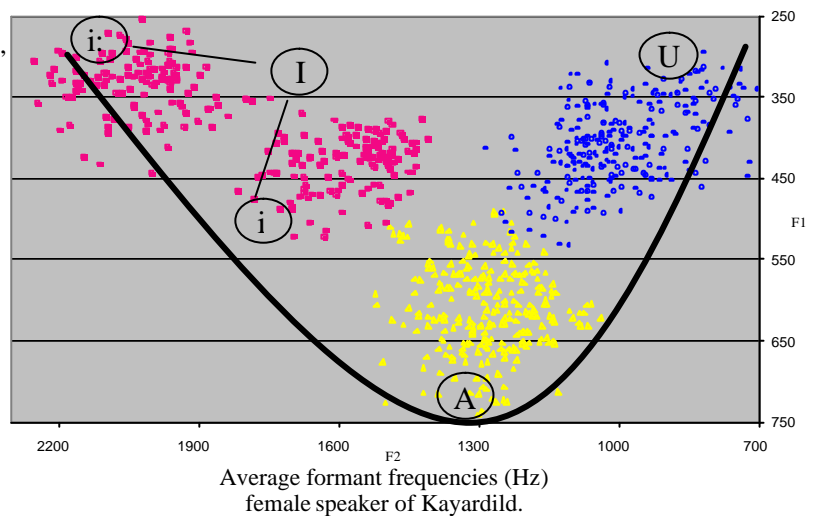


Figure 2:
Data for a Kayardild female speaker, under 3 prosodic contexts: accented syllables [prefix-a], unaccented [prefix-u], and phrase-final [prefix-f]. In bold, evidence of a come back of the high vowel [i:], in the final [prefix-f] context.
(from Butcher *et al.*, 2003)

