

The Anticipatory Perception Based on Events (APE) Hypothesis

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This abstract summarises sensory-motor timing results obtained by our team on anticipatory phenomena in speech production and perception. The APE Hypothesis proposed here is based on X-ray (see, e.g., Vaxelaire *et al.*, 1999 a,b; Roy *et al.*, 2003), kinematic (see, e.g., Hardcastle *et al.*, 1996; Hecker *et al.*, 2001; Hirsch *et al.*, 2003; Sock & Vaxelaire, 2004; Vaxelaire *et al.*, 2007) and acoustic data. Although data for consonantal anticipatory sensory-motor relations have been studied (see, e.g., Vaxelaire *et al.*, 2003), the focus here will be on anticipatory vocalic gestures, together with their visual and auditory effects. In general, sensory-motor anticipatory relations are examined within Vowel¹-Consonant(s)-Vowel² sequences ($V^1C^{(n)}V^2$), where V^1 is an unrounded vowel, $C^{(n)}$ is one or more consonants and V^2 is always a protruded vowel.

Globally, results show that anticipatory visual identification of the rounded vowel systematically precedes its auditory identification. There is no auditory identification before release of a stop consonant. Such an identification takes place at release, which coincides more or less with peak velocity. However, auditory vowel identification is robust only *after* peak velocity.

The situation is somewhat different when the obstruent interval is one or more fricatives, or a sequence of plosives including one or more fricatives.

Auditory identification takes place at peak acceleration, which coincides more or less with a steep slope in the inferior limit of the fricative noise, in its trajectory towards F3 of the protruded vowel. However, robust identification of the vowel happens only *after* peak acceleration.

Our results show that extension of anticipatory gestures may increase as the obstruent interval increases, thus confirming predictions of some aspects of the Movement Expansion Model (Abry & Lallouache, 1995) but not **any** of the Time-Locked Model (Bell-Berti & Harris, 1981).

The fricative context favours protrusion anticipatory expansion, together with its visual (Roy, 2004) and auditory efficiencies (Hecker *et al.*, 2001). We posit therefore that it is more appropriate to treat plosives separately from fricatives.

Consonantal anticipatory gestures may emerge in the preceding vowel, in a CVC^{+lab} sequence. In such cases, their efficiency would be visual but not auditory.

Data in absolute values are observed, but in the final analysis their exploitation is limited, due mainly to the temporal elasticity of speech signals (Gaitenby, 1965).

Consequently, the procedure adopted in order to analyse anticipatory phenomena is the following: Articulatory, kinematic and acoustic anticipatory events which underlie the perceptual efficiency of the upcoming vowel are detected. Then, the extension of the anticipatory gesture, together with its sensory efficiencies, are quantified by calculating the *percentage of time* taken by the interval which separates the decisive event and the acoustic emergence of the target vowel (onset of a stable formant structure) within the obstruent phase. Such a normalisation procedure allows reasoning in relative terms, thus taking into account potential compressions and expansions of speech signals, which determine the advent of the various articulatory, kinematic and acoustic events.

Constraints elaborated for anticipatory gestures, in a sensory-motor perspective, thus take into account, as a priority, the advent of articulatory, kinematic and acoustic events, which appear on the anticipatory phase of the gesture, hence providing landmarks to rationalise the sensory extension of the anticipatory gesture. The auditory and/or visual efficiencies of specific articulatory, motor and

acoustic anticipatory events allow reinforcing the idea of a tight coupling between the articulatory or motor level, the acoustic level and the sensory level, be it visual or auditory. Indeed, anticipatory perceptual behaviour of subjects seems to be harnessed to these articulatory and acoustic events.