# ARTICULATION OF PROSODIC CONTRASTS IN FRENCH

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## ABSTRACT

The current study examines the influences of intonation and syllable structure on accentuation and final lengthening in a corpus of articulatory data. While consistent kinematic patterning across speakers was not observed for intonation differences, it is apparent that different articulatory manoeuvres are employed to bring about accent-related duration change in open and closed syllables.

## 1. INTRODUCTION

Many studies of the acoustic correlates of accentuation in French have examined this phenomenon in syllables at the edge of major prosodic phrases or sentences (e.g. Delattre [1]; O'Shaughnessy [2]). More recent investigations ( e.g. Touati [3]) separate the two classes of accented syllable (accented final and accented non-final), and note that accent-related duration differences are somewhat reduced in the phrase-internal context.

In a recent paper (Fletcher and Bateson [4]), we propose that accentuation and phrase-final lengthening are associated with different underlying articulatory manoeuvres. As suggested by Edwards et al. [5] for English, final lengthening in French involves a specific lengthening at the phrase-edge. Accentuation, by contrast is a change in linguistic prominence and not essentially a duration contrast. The two linguistic phenomena should not be confused in experimental designs.

In the current study, we re-examine the phrase-internal accented/unaccented contrast in a corpus of articulatory data, based on natural as opposed to reiterant speech. An extra "level" of accent is also examined by comparing pretonic accented syllables with tonic accented syllables (syllables associated with a melodic peak). We also look at the influence of tone and syllable structure on the articulatory timing of phrase-final syllables. In an early acoustic timing study of accent in French, Benguerel [6] claims that accentual lengthening is greater when intonation is falling rather than rising. He also claims that the lengthening effect is strongest in open as opposed to closed syllables. It is of interest to see how these effects manifest themselves in the underlying articulation of syllables.

## 2. METHOD

Two speakers of French produced ten repetitions of the sentences shown in Table I at two self-selected tempi, conversational normal and fast. The sentences were devised in such a way that the test tokens (indicated in uppercase) represent different prosodic categories. Set A places the tokens (chosen to contrast open and closed syllables) in unaccented (PAPA) pretonic, accented (PAPE), and tonic accented contexts. Set B places the tokens in sentence-final declarative and sentence-final interrogative contexts. In all instances, the token in the sentence B (i) was recited with a low, slightly falling tone.



Table I. Carrier sentences containing the test tokens (in upper case)

| | |
|---|---|
| Set A | |
| (i) | Le PAPE a patté Miné. |
| | Le PAPA pattait Miné. |
| (ii) | Le PAPE Aballe pattait Miné. |
| | Le PAPA Bahl pattait Miné. |
| Set B | |
| (i) | Miné lechait le PAPE. |
| | Miné lechait le PAPA. |
| (ii) | Miné lechait le PAPE? |
| | Miné lechait le PAPA? |

The token in sentence B (ii) was recited with a rising tone, commonly associated with a yes/no question.

Vertical movements of the lower lip, upper lip and jaw were recorded using the modified SELSPOT opto-electronic articulator tracking device at Haskins Laboratories. The digitized and low-pass-filtered position signals were corrected for any head movement and were numerically differentiated to produce instantaneous velocity. Vertical position of the lower lip was subtracted from that of the upper lip to obtain lip aperture. Peaks in the movement trace (Fig. 1) correspond to points of maximum closure associated with the production of the bilabial consonant and valleys correspond to maximum opening associated with the production of the low back vowel.

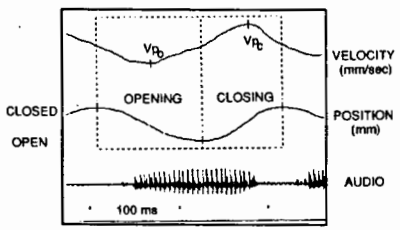


**Figure 1**
Kinematic Measures

Measurements of gesture duration, displacement, and associated peak velocity using automatic peak picking were noted for opening gestures in the case of /pa/ syllables, and for both opening and closing gestures for /pap/ syllables. The time course of gesture velocity was also examined. We are calling the time period from the onset of the gesture (defined as the last point of zero velocity before the opening or closing gesture) to the time were peak velocity is registered in the gesture, the acceleration phase, and the time period from the peak moment to the offset of the gesture, the deceleration phase, in accordance with earlier work by Nelson [7] among others.

## 3. RESULTS

The results of the kinematic analysis are presented in Tables II and III. All results of within group comparisons (Kirk [8]) cited in the following paragraphs, are significant at $p<0.01$. For subject AS, tonic accented /pa/ syllables have significantly longer opening gestures and bigger lip apertures than unaccented /pa/ syllables (F's 61.5, 15.19), with no significant differences in peak velocity. Both acceleration and deceleration duration are longer in the opening gestures of accented compared to unaccented syllables(F's 48.25, 11.13). By contrast, speaker BA, shows no overall duration contrast, but unaccented /pa/ opening gestures are significantly bigger and faster than tonic accented gestures (F's 8.78, 28.69).

For the tonic/pretonic contrast in /pap/ syllables, there are no significant duration differences in opening gestures for either speaker. Conversely, closing gestures in tonic accented syllables are consistently longer than pretonic gestures (AS:F, 10.59; BA:F, 9.44). This difference is localised to the deceleration portion of gestures for both speakers (AS:F 6.58; BA:F, 5.44). Tonic syllables also have bigger opening

and closing lip apertures in BA's data (F's 14.44,16.79) coupled with higher peak velocities (F's 13.71, 7.96). AS shows no significant lip aperture differences, but peak velocities are lower in closing gestures of tonic syllables (F 3.63).

TABLE II - Mean and standard deviation values (in parentheses) of opening gesture duration (ms), lip aperture (mm), peak velocity (mm/s), acceleration and deceleration durations (ms) in /pa/ syllables (token - PAPA).

| | | Unacc. | Tonic | Final(LOW) | Final(RIS) |
|---|---|---|---|---|---|
| D. | AS | 101(8) | 169(11) | 168(6) | 182(14) |
| | BA | 73(5) | 72(2) | 131(11) | 135(12) |
| LA. | AS | 7.62(.69) | 9.9(1.2) | 9.2(1.6) | 10.05(.7) |
| | BA | 5.41(.88) | 8.31(.83) | 9.8(.78) | 12.04(1.5) |
| Vp. | AS | 149(13) | 152(16) | 125(25) | 114(20) |
| | BA | 169(30) | 134((24) | 119(21) | 153(35) |
| Acc. | AS | 63(13) | 103(8) | 84(11) | 80(14) |
| | BA | 43(6) | 42(4) | 75(9) | 72(7) |
| Decel. | AS | 39(6) | 67(10) | 84(15) | 103(11) |
| | BA | 30(2) | 30(4) | 55(6) | 64(10) |

Table III - Mean and standard deviation values (in parentheses) of opening and closing gesture durations (ms), lip aperture (mm), peak velocities (mm/s), acceleration and deceleration durations (ms) in /pap/ syllables (token - PAPE)

| | | Opening gesture | | | |
|---|---|---|---|---|---|
| | | Pretonic | Tonic | Final(LOW) | Final(RIS) |
| D. | AS | 121(8) | 136(13) | 127(9) | 107(4) |
| | BA | 69(4) | 76(5) | 93(4) | 114(5) |
| LA. | AS | 9.6(.6) | 9.9(.6) | 9.6(.7) | 8.7(.7) |
| | BA | 7.8(.9) | 10.3(.9) | 10(1.2) | 11(1.1) |
| Vp. | AS | 155(22) | 148(13) | 161(8) | 151(13) |
| | BA | 173(26) | 225(10) | 187(19) | 166(17) |
| Accel. | AS | 62(9) | 69(14) | 69(8) | 54(4) |
| | BA | 39(3) | 43(5) | 60(7) | 68(3) |
| Decel. | AS | 59(7) | 67(5) | 58(7) | 59(2) |
| | BA | 30(1.5) | 33(4) | 32(3) | 46(1.2) |
| | | Closing gesture | | | |
| D. | AS | 138(8) | 163(11) | 156(12) | 180(10) |
| | BA | 63(4) | 71(3) | 97(4) | 108(3) |
| LA. | AS | 11.9(1.5) | 11(.8) | 10.5(.9) | 9.8(.6) |
| | BA | 7.5(.8) | 10.4(.8) | 11.4(1.3) | 11.8(1.2) |
| Vp. | AS | 183(25) | 161(13) | 172(16) | 132(12) |
| | BA | 211(17) | 267(29) | 265(35) | 225(35) |
| Accel. | AS | 53(5) | 59(3) | 54(3) | 64(3.5) |
| | BA | 26(3) | 29(2) | 33(3) | 46(4) |
| Decel. | AS | 85(8) | 105(11) | 103(13) | 116(12) |
| | BA | 37(2) | 42(3) | 64(3) | 61(2) |

Only speaker BA shows significant kinematic differences according to tone. In /pap/ syllables, opening and closing gestures are longer when tone is rising (F's 59.36, 17.37) than when tone is low. This duration difference is reflected in both the acceleration and deceleration portions of opening gestures of /pap/ syllables (F's 6.28, 35.99) and the acceleration portion of /pap/ closing gestures (F,47.99). There are no tone-related lip aperture differences or significant peak velocity differences in /pap/ opening gestures, although closing gestures are slower when tone is rising (F,3.99). No significant duration differences are observed in /pa/ gestures although lip aperture is bigger and peak velocities higher in syllables with rising tone (F's 8.88, 4.17).

## 4. DISCUSSION AND SUMMARY

Clearly, more data are needed to supplement this initial analysis, especially in view of the degree of inter-speaker variability. Some generalizations can be made, however. As in our earlier study, these data suggest that more than one type of articulatory manoeuvre underlies these prosodic contrasts. Conventional accent or stress effects -longer, bigger gestures - are evident in /pa/ syllables for speaker AS, and /pap/ syllables for BA. It can also be argued that the observed bigger apertures in word initial /pa/ syllables for AS are also an accent effect, given the increased predominance of word initial accent in spoken French. Speaker BA consistently accented the first syllable of "Papa" in sentences A (i) and (ii).

The localisation of the duration contrast to the tailend of closing /pap/ gestures suggests that pretonic closing gestures may be cut short by the opening gesture associated with the upcoming syllable in the sequence. In other words, gestural sliding, resulting in truncation of closing gestures may explain shorter gesture durations in pretonic syllables (Saltzman and Munhall[9]). In addition, changes in underlying amplitude of both opening and closing gestures may determine observed kinematic patterning in BA's tonic accented productions and AS' /pa/ data.

In AS' /pap/ data, on the other hand, the lack of a lip aperture difference, coupled with slower peak velocities suggest alteration of another underlying control variable - i.e. gesture stiffness, or force (Saltzman and Munhall [9], Edwards et al. [5]) without a change in underlying gesture amplitude. This latter pattern does not suggest a typical stress or prominence contrast for this syllable. It is more like the pattern for final lengthening noted by Edwards et al. for English.

While results for the tone contrast are not consistent across speakers, they suggest that syllables associated with rising tone are as long or longer than syllables associated with falling tone, contrary to Benguerel's claims. Duration effects are clearest in closed as opposed to open syllables. The lack of lip aperture differences and slower peak velocities in rising tone /pap/ syllables again suggest a similar articulatory manoeuvre to that noted for final lengthening in English by Edwards et al. By contrast, the bigger lip apertures and higher velocities in rising tone /pa/ syllables without an accompanying duration difference suggest an articulatory manoeuvre not unlike that attributed to a stress contrast.

## 5. REFERENCES


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Acknowledgments:

Parts of this research were supported by the National Science Foundation (USA) under grants no. IRI-8858109, IRI-861785 to Mary Beckman, the Ohio State University and by the National Institutes of Health (USA) under grant no. NS-13617 to Haskins Laboratories.