Some micro-effects of tempo change on Timing in French

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Abstract

A number of factors influence the temporal organization of connected speech. One such factor, tempo change, is an important variable whose effects on segment duration may highlight important language-specific and language universal features of speech timing. When French speakers are asked to read a passage at increasing tempo from slow to normal to fast, they modify their pause behaviour substantially. In addition, consonant and vowel segment durations are compressed, but not to the same degree. Whilst the overall levels of temporal compression are lower for vowels than the levels of compression reported for other languages, they are still somewhat higher than previously reported for French. A probable reason for the former is the smaller degree of vowel reduction that occurs in French under conditions of increased tempo. This factor along with other compression effects such as syllable, consonant and vowel elision are considered in the light of traditional timing typologies.

Introduction

The durational structure of a stretch of connected speech is determined by a number of factors. Speech tempo is one such factor that has received some attention in the experimental phonetics literature. However like the majority of instrumental studies of speech in general, past research has concentrated on a limited sample of languages, most notably English. In addition, the type of corpora analysed have usually been restricted to short controlled utterances. Few researchers have looked at the effects of tempo change over a large stretch of connected speech. Consequently, this study constituted an attempt to examine in detail the effects of tempo change on one feature of timing organization, namely, segment duration in a long stretch of connected speech. These effects can be described as the micro-effects of tempo change. Furthermore, the language under investigation was French. We wished to examine any possible strategies at the segmental level to modify tempo in spoken French, that differed from those reported for other languages.

Micro-effects of tempo change

Previous studies of tempo change have found that the greatest quantitative effect of increasing or reducing tempo is to do with reducing or increasing the amount of pause time relative to articulation time. Smith (1976) and Ducet(1983) found this to be the case in French. However there was also evidence of changes in articulation rate between tempo that can be explained by temporal changes at a micro-level.

A number of authors have investigated the effects of tempo change on the acoustic duration of segments. However, most of these studies have concentrated on corpora composed of isolated sentences and not of larger tracts of connected speech. Whilst the first kind of study provides us with some idea of the effects tempo change on certain categories of acoustic segments, we need to extend these findings to a broader range of speech situations. We are aware of only one controlled study of micro-effects of tempo variation in a passage of spoken French (Smith 1976) Consequently we will report on the findings of some studies of tempo change that have used single utterance-based corpora, in addition to those studies based on larger stretches of read English, Swedish and Dutch.

Gay(1978) and Port(1984) for American English, Lindblom(1963) for Swedish, and Nooteboom and Site(1972) for Dutch, found that overall decreases in syllable duration during rapidly delivered speech were reflected primarily in the durations of the constituent vowels, and only secondarily in the durations of the constituent consonants. Port(1984) for example, provided an explanation for this based on universal mechan- inertia effects of increasingly rapid articulation. Consonant articulations are generally more complex than vowel articulations, in so far as they imply the attainment of a specific constriction, or closure at some point, or points in the vocal tract. An increase in tempo from normal to fast, results in consonant and vowel articulations following each other in quicker succession. Consonant gestures needing more execution time are therefore maintained, or even strengthened at the expense of articulatory gestures associated with vowel production. Consequently vowels tend to reduce in duration and quality, particularly if unstressed.

Although this may be the case for the languages cited above, it is not absolutely certain to what extent this could be classified as a universal of articulatory behaviour. Gay also stressed that the coordination of articulatory movements may be adjusted in some way to preserve the information-bearing elements across changes in tempo. For example, stressed vowel gestures may be maintained at the expense of unstressed vowel gestures. It is also possible that vowel gestures are only weakened if the phonology of the language allows it to happen. Certain languages tend to preserve vowel quality in unaccented or unstressed position to a greater extent than others. As a loss of vowel quality is usually associated with durational shortening (Lindblom 1963), one has to consider to what extent phonology and mechanical inertia of the articulators interact under conditions of rapid articulation rate. Thus it seems likely that we need to put forward
It is generally accepted that vowels in spoken French tend to be perceived as having a greater degree of nasality than in English because French vowels may be modified acoustically and auditorily, approaching more "uncontrolled" qualities in unaccented position. French vowels on the other hand are modified very slightly in comparison. This is often referred to as a reason why spoken French gives the auditory impression of syllable tenseness whereas English vowels are less tensed.

Consequently any re-organization of the articulatory plan due to increased articulation rate should be more detectable across all syllables, and by extension their constituent segments. Thus the effects of tempo change on accented and unaccented vowels should be similar.

A handful of studies have examined the micro-effects of slowing down tempo in as much detail as speeding up tempo. There is a certain amount of evidence that in the timing limit, that slowing down accentuates up tempo is not the case of all vowels. Port(1981) found that when subjects slowed down their neutral tempo, all accentual and vowel segment durations increased in duration by a constant ratio. Pickert(1980) reported similar findings. Smith(1976) reported a similar result for her French data; remembering also that the fact no differences in the way accentual and vowel segment durations change as a function of tempo increase from normal to fast. Once again, the limitations of her experimental corpus make it necessary to test whether this finding can be replicated in a much larger corpus of French.

Potter and Lehiste(1966) and Port(1969) also investigated the interaction between accent and tempo, and other duration influencing factors such as prosody or absence of accent. Stressed syllables in many languages, including English, Dutch, and Swedish are generally larger than their non-stressed counterparts. Similarly accented syllables are larger than unaccented ones(Lehiste et al., 1965). The greater size was attributed to syllabic size increase and stress carriers. This is not surprising if it is interpreted in a stress-timed language, the size difference is even more marked in a syllable-timed language as it is in French. French is a syllable-timed language, the size difference is even more marked in a syllable-timed language as it is in French.

Table 1: The effect of accent on the duration of segment and vowel segment duration.

<table>
<thead>
<tr>
<th>Accent</th>
<th>Segment Duration</th>
<th>Vowel Segment Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accent</td>
<td>500 ms</td>
<td>250 ms</td>
</tr>
<tr>
<td>No Accent</td>
<td>450 ms</td>
<td>150 ms</td>
</tr>
</tbody>
</table>

The above results could be explained by the comparatively low values of accentuation rate computed for these data. On the other hand Port(1981) gave an explanation of similar results in his data account for our findings. That is, the similar degree of compensation from slow to normal and normal to fast could be explained by an interaction between physiological, mechanical needs of increasing rapidly articulation being offset by the need to maintain more or less invariant temporal relations determined by the phonology, or indeed rhythm, of the language.

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A further analysis of variance and covariance was performed on the vowel duration data to test whether there were any significant differences in the way accented and unaccented vowels were produced. The results showed that the differences in the mean duration of the accented and unaccented vowels were not significant. This was similar to the results of Peterson and Lehiste (1963) for English and Peterson and Lehiste (1972) for Dutch. Temperate changes affected accented vowel duration more than unaccented vowel duration. Moreover, there were significant differences in the degree of duration change between slow and normal tempo and normal and fast tempo. The mean differences for accented vowel duration between slow and normal tempo were of the same magnitude as differences between fast and normal tempo they measured 10%. However, the values for unaccented vowels, 11.5% and 10.5% between slow and normal tempo and fast and normal tempo, were not only a good deal smaller than for accented vowels, but there was no significant difference between slow and normal tempo.

Smith (1978) claims that the only truly “long” segments in French are those in prepausal syllables. But as accent and the possible accentual durational properties were not taken into account in her study, it remains unclear if the difference between prepausal accented syllables interact differently with tempo than prepausal unaccented syllables. On the basis of our finding that the degree of difference in the mean amount of shortening of unaccented and accented vowels was substantially reduced between normal and fast tempo as opposed to slow and normal tempo, we could hypothesize that if prepausal vowels were excluded from the analysis the margin of difference would disappear.

Finally, we did not take into account phenomena such as vowel and syllable allomorphy reported to occur as a result of increasing tempos from normal to fast (Smith 1978). Comparative instrumental studies of the micro-effects of tempo increase in French and English are non-existent. Consequently, we do not know for sure whether French relies more on syllable and segment allomorphy than segment compression to increase tempo. If it is also uncertain whether the number of accented syllables is reduced to counteract overshortening of individual segments. If both of the above possibilities are in fact the case, this could explain why our results differ from those reported for other languages. Although the number of accented syllables in our data did vary, there was some indication that there was some kind of resistance to eliminate too many. A strict syllable- timing hypothesis would predict a reduction in the number of accented syllables. It seems that stressed syllables in English are more resistant to compression under conditions of rapid articulation rate associated with tempo increase. Once again we need to examine the data in more detail before we can make any further assumptions about the differences between the two languages, and whether we can involve the syllable-timing and stress-timing dichotomy.

References


