

# A corpus analysis of Japanese vowel devoicing

Marco Fonseca<sup>1</sup> & Gustavo Augusto Mendonça<sup>2</sup>

<sup>1</sup>University of Tokyo, <sup>2</sup>University of São Paulo

marcosilvafonseca@gmail.com, gustavoama@gmail.com

This paper aims at evaluating the influence of gestural magnitude timing in Japanese vowel devoicing (Goldstein and Fowler, 2003; Beckman, 1996) through a corpus-based approach. We hypothesize that vowel devoicing encompasses a gradient nature and also that duration plays a significant role in its conditioning. The Corpus of Spontaneous Japanese (CSJ, National Institute for Japanese Language and Linguistics, 2004) was employed in the analysis. It consists of a large-scale speech database containing about 7.5 million of words of Standard Japanese from spontaneous monologues. It is a richly annotated corpus, including segmental duration and vowel devoicing information.

It is known that Standard Japanese has five short vowels (/a, e, i, o, u/) and their long counter parts (/a:, e:, i:, o:, u:/) (Labrune, 2012). Vowel devoicing in Japanese is usually observed in high short vowels between two voiceless obstruents (Maekawa, 2005). For instance, the word /kiken/ “danger” may be realized as [k<sub>i</sub>k<sub>i</sub>en], with a short devoiced [i]. It has been argued that Japanese vowel devoicing might be considered a gradual phenomenon related to gesture timing organization and overlapping (Beckman, 1996). That is, vowel devoicing might occur because of the overlap between the supralaryngeal gestures controlling vowel quality and the laryngeal gestures controlling phonation. The phenomenon might be considered gradient, to the extent that many degrees of devoicing might be observed. In this paper, we provide corpus evidence for the gestural timing organization nature of vowel devoicing in Japanese.

It has already been tested in an experimental corpus (Kondo, 2005) that Japanese non-devoiced vowels are shorter than their devoiced counterparts, but no corpus-based analysis concerning duration values has been provided so far. Figure 1 illustrates a boxplot of the log transformation of the duration values (originally in milliseconds) of vowel segments in the CSJ vs. devoicing. The box on the left represents the duration of non-devoiced vowels while the box on the right represents the duration of the devoiced vowels. Figure 1 shows that the quartiles of the non-devoiced vowels present higher duration values when compared to the duration of the devoiced ones and their medians do not overlap. A t-test was conducted in order to evaluate duration values in a sample of 819,439 vowels and statistical significance was found ( $p < 0.001$ ) between non-devoiced vowels (mean=-2.73, SD=0.53)<sup>1</sup> and devoiced ones (mean=-3.24, SD= 0.48). Therefore, the results indicate that Japanese devoiced vowels are shorter than non-devoiced ones. This might be considered evidence that Japanese vowel devoicing consists of a phenomenon which involves, besides different phonation quality, also the reduction of gesture magnitude (Beckman, 1996).

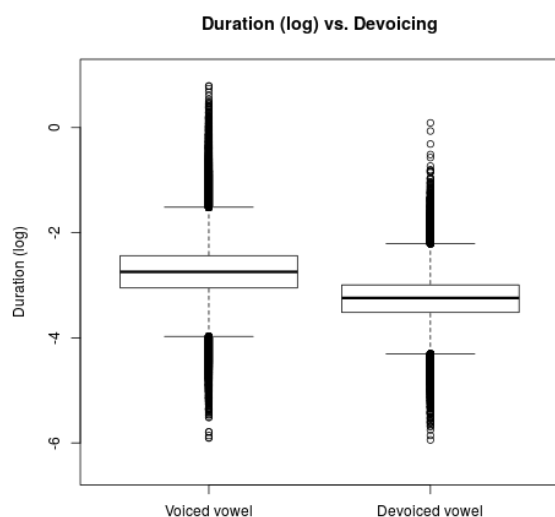
It is also known that in Japanese high vowels are longer than non-high vowels (Beckman, 1996). We extracted the duration measurements of devoiced high and non-high vowels from the CSJ. Figure 2 illustrates a boxplot containing the log transformation of the duration values of devoiced vowel segments in the CSJ vs. vowel height. The box on the left represents the duration of the non-high devoiced vowels and the box on the right represents the duration of devoiced high vowels. In Figure 2, although the duration of the non-high devoiced vowels seems to be longer than the duration of their high-counterparts, their medians do not seem to overlap. Results gathered from a t-test conducted in a sample of 62,706 devoiced vowels indicate no statistical significance ( $p=0.54$ ) between the duration of devoiced high vowels (mean=-3.24, SD=0.45) and devoiced non-high vowels (mean=-3.25, SD=0.68). Our data seems to indicate that different patterns are observed for non-devoiced and devoiced vowels. That is, although high vowels are shorter than non-high vowels, this duration difference seems to be lost in the devoicing environment. We argue that this might be the case given the gestural timing organization of the phenomenon. In a devoiced environment, the supralaryngeal gestures and the laryngeal ones overlap and the outcome is a segment with a reduced duration.

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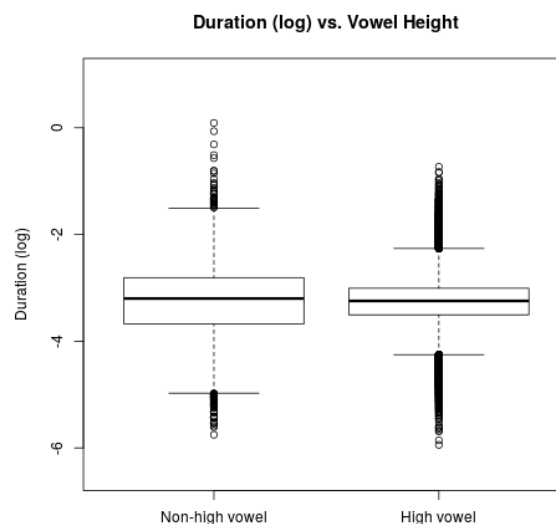
<sup>1</sup>For convenience, we report the duration values in a logarithmic scale, Therefore -1 corresponds to  $10^{-1}$  s.

In conclusion, the CSJ data seem to indicate that vowel devoicing in Japanese is a gradual phenomenon related to gesture timing organization. Furthermore, the duration distinction of high and low vowels is not observed in devoicing environment. By presenting the duration values regarding this phenomenon, we hope to have shown that Japanese vowel devoicing is related to gesture magnitude reduction and the importance of corpora in linguistic analysis.

**Figure 1: Boxplot of duration (log) vs devoicing**



**Figure 2: Boxplot of duration (log) vs vowel height**



## References

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