

# AN ACOUSTIC ANALYSIS OF GEMINATE CONSONANTS IN GUINAANG BONTOK

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**1. INTRODUCTION.** In Guinaang Bontok, consonants of all manners of articulation (stops, fricatives, nasals, liquids, and glides) can appear as short and long (Reid 1963, personal communication), which is uncommon among the world's languages. First, contrasts between short and long consonants are not as common as contrasts between short and long vowels (Ladefoged 2001). Second, not all consonants can appear as long even in the languages that have length contrasts in consonants. It was hypothesized that the cross-linguistically less common length contrasts, such as those in glides, were phonetically less clear than the more common ones, such as those in stop and nasal consonants. In order to test this hypothesis, production data of different consonants in Guinaang Bontok were collected experimentally. Following the data collection, an acoustic analysis of short and long consonants was conducted.

**2. METHOD.** A list of 96 words was prepared for this experiment. The list consisted of pairs or triplets of words that contrasted by the length of the word-medial consonant.<sup>1</sup> Three frame sentences were also prepared. When the initial consonant of the target word was a stop or an affricate, the frame (a) *Apedna kinwániyen* (the target word) "He just said (the target word)" was used. When the initial consonant of the target word was a liquid, a nasal, or a fricative, the frame (b) *Nan kinwánina ket* (the target word) "What he said was the target word" was used. For names and some of the made-up words, the frame (c) *Si* (the target word) *nan inayákhana* "The target word is the one he called" was used.

The participants were four native speakers of Guinaang Bontok (two males, two females). Two male participants and one female participant were in their late 40s and early 50s. The other female participant was 15 years old. The data were collected in a participant's house in the village using a DAT recorder with a microphone. The words and frame sentences were written in a notebook in the local orthography, and presented to the participants. The words were randomized so that the words in the pairs or triplets did not appear one after the other. Three tokens (one in isolation and two in the frame sentence) were collected for each target word from each participant. Of the 96 words, 39 were selected and acoustically analyzed. Twenty words included single consonants, and the other nineteen words included geminate consonants. The medial consonants that contrasted in length were voiceless stops (8 words), nasals (8 words), a fricative ([s], 7 words), liquids (8 words), and glides (8 words). The target single or geminate consonants always appeared intervocalically.

The recordings were digitized at 22.05 Hz, and the data were analyzed acoustically using the program Pitchworks. Wide-band spectrograms were produced for each target word, and the durations of single and geminate consonants were measured in milliseconds. For stop consonants, voice onset time (VOT) was included as a part of the consonant for both singleton and geminates. A total of 468 tokens (39 words x 3 repetitions x 4 participants) were analyzed. Of these, 12 tokens were excluded because there was overlapping noise or laughter (6 tokens), or the participant said a different word (6 tokens).

**3. RESULTS.** Table 1 summarizes the results. The duration values of the tokens produced in isolation and in the frame sentences were averaged, because the values of the

<sup>1</sup> Note that they may not *minimally* contrast by the length of the medial consonant.

productions in isolation and in the frame sentences were highly correlated in all four subjects ( $r > .76$ ,  $p < 0.01$ ). As expected, the average durations of geminate consonants were significantly longer than those of singletons in all consonant categories (for /s/,  $t(26) = 11.1$ , for other consonants  $t(47)^2 = 14.0$  to  $17.9$ ,  $p < 0.01$ ). The durational contrast between single and geminate consonants was the largest in nasals. The contrast in stops and liquids was the second largest. It was smaller for fricatives and the smallest for glides. The average duration of short glides was 90 ms., which was about 10 ms. longer than the average durations of short nasals and liquids (78 and 79 ms. respectively). The average duration of geminate glides was also the shortest (139 ms.), compared to the average durations of other geminates.

TABLE 1. The mean duration of each kind of consonant (in milliseconds)

	singleton mean (in ms.) (SD)	geminate mean (in ms.) (SD)	Ratio single: geminate
glide	90 (16)	139 (24)	1.54
liquid	79 (13)	150 (28)	1.90
nasal	78 (16)	162 (28)	2.08
fricative	118 (15)	191 (33)	1.62
stop	94 (23)	176 (34)	1.87

Average durations for geminate fricatives were based on 28 tokens (3 words x 3 repetitions x 4 speakers, -8 missing tokens) for geminates. For all others, each average duration was based on 48 tokens (4 words x 3 repetitions x 4 speakers).

There was also a large overlap in duration values between single and geminate glides. There were 10 tokens of single glides that were longer than the shortest geminate (100 ms.), and there were 23 tokens of geminate glides that were shorter than 136 ms., the duration of the longest single glide. The numbers of geminate tokens that were shorter than the longest singleton token were less than 3 in all the other categories. Similarly, there were more singleton tokens that were longer than the shortest geminate in glides than in other categories.

**4. SUMMARY.** The acoustic analysis of single and geminate consonants in Guinaang Bontok suggests that the contrast in phonological length is phonetically clearer in stops and nasals than in glides. First, it was found that the durational ratios between short and long segments were larger for stops and nasals than for glides. Second, the overlap in absolute duration values was larger for glides than for other categories. It appears that the phonetic properties of contrasts between single and geminate contrasts in Guinaang Bontok match with the cross-linguistic tendency; the results suggest that the length contrasts are phonetically larger in more commonly found length contrasts (stops and nasals) than in those less commonly found (glides) in a language that has length contrasts in consonants of all manners of articulation.

#### REFERENCES

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<sup>2</sup> The degree of freedom and the number of tokens varied slightly due to the missing tokens.