Nasal place assimilation and the perceptibility of place contrasts

keywords: nasal place assimilation, perceptibility, experimental phonology

SYNOPSIS A typological study of place assimilation shows that nasals are more likely to assimilate in place than oral consonants (Jun, 1995). Jun argues that this typological asymmetry derives from a difference in perceptibility of [place] in nasals and in oral stops. Since the place contrasts in nasals are perceptually weaker than the place contrasts in oral stops, speakers are more willing to neutralize the former. However, evidence for the weaker perceptibility of the place contrasts in nasal consonants in the previous phonetic and psycholinguistic research is mixed (Hura et al. 1992; Mohr & Wang 1968; Pols 1983; Winter 2002). To settle this debate, this paper reports a similarity judgment experiment and an identification experiment in noise, which both support the lower perceptibility of [place] in nasals. The results support Jun's idea that the asymmetry in place assimilation may result from a difference in the perceptibility of [place].

EXPERIMENT I: METHOD The first experiment was a similarity judgment study. The three conditions were nasals, voiced stops, and voiceless stops. Our stimuli consisted of [am-an], [am-aŋ], [an-aŋ], [ab-ad], [ab-ag], [ad-ag], [ap-at], [ap-ak], and [at-ak]. Two native speakers of English pronounced four tokens of each sound, which were re-synthesized with a flat pitch contour at 250Hz and the peak amplitude was adjusted to 0.7 by Praat. Pairs of sounds were concatenated with 500 ms ISI. The participants were asked to judge the similarity of each pair using a 5-point-scale. Nineteen native speakers of English participated.

EXPERIMENT I: RESULTS

Table 1: The average similarity rating scores.

	Nasals	Voiced stops	Voiceless stops
Labial vs. coronal	2.69	3.64	3.98
Labial vs. dorsal	2.49	3.67	4.00
Coronal vs. dorsal	2.57	3.60	4.02

Table 1 shows the average similarity ratings (in which lower numbers mean higher similarity judgments). A general mixed-model shows that nasal pairs were judged to be more similar than voiced stop pairs ($t = 12.62, p < .001$), and voiced stop pairs were judged to be more similar than voiceless stop pairs ($t = 4.42, p < .001$).

EXPERIMENT II: METHOD The next experiment was an identification task under noise. The stimuli consist of [am, an, aŋ, ab, ad, ag, ap, at, ak]. To mimic the real communicative situations, we used cocktail party noise. The current experiment used three S/N ratios: -6dB, -12dB, and -15dB where the signal dB was kept at the average of 60dB. 24 native speakers of English participated in this study. We calculated d' as a measure of a perceptual distance between two sounds.

EXPERIMENT II: RESULTS AND DISCUSSION

Table 2 shows the average d' values for each comparison in each S/N ratio condition (where higher d' values correspond to the higher perceptibility between two sounds). A general mixed model

Table 2: The average d' values.

-6dB	Nasals	Voiced stops	Voiceless stops
Labial vs. coronal	0.62	0.55	1.99
Labial vs. dorsal	0.39	1.29	1.01
Coronal vs. dorsal	0.47	1.33	2.41
-12dB	Nasals	Voiced stops	Voiceless stops
Labial vs. coronal	0.24	0.36	2.07
Labial vs. dorsal	0.34	0.86	1.03
Coronal vs. dorsal	0.39	0.87	2.37
-15dB	Nasals	Voiced stops	Voiceless stops
Labial vs. coronal	0.23	0.13	1.61
Labial vs. dorsal	0.04	0.62	0.60
Coronal vs. dorsal	-0.03	0.78	1.90

comparing nasals and voiced stops shows that their d' values are different ($t = 5.87, p < .001$). The difference between voiced stops and voiceless stops was also significant ($t = 10.29, p < .001$). A follow-up experiment in which we placed the stimuli in a pre-consonantal position shows the same hierarchy.

GENERAL DISCUSSION Both of our experiments support the following perceptibility hierarchy: nasal $<$ voiced stop $<$ voiceless stop. Our results thus support Jun's (1995) hypothesis that nasal place contrasts are perceptually weaker than oral stop place contrasts. However, we also find other perceptual asymmetries which are not necessarily reflected in phonological patterns. For example, we consistently find that voiceless stop place contrasts are more salient than voiced stop place contrasts, but this difference does not seem to be reflected in phonology. Taken together, our experiments show that perceptibility differences in nasal vs. oral consonants do underlie the asymmetrical phonological patterns (Jun, 1995; Steriade, 2001), but that not all perceptibility differences can be reflected in phonology (Kochetov & So, 2007).

Word count: 706

References

Jun, Jongho (1995) *Perceptual and Articulatory Factors in Place Assimilation: An Optimality Theoretic Approach*. Doctoral dissertation, University of California, Los Angeles.

Kochetov, Alexei & Connie K. So (2007) Place assimilation and phonetic grounding: A cross-linguistic study. *Phonology* **24**: 397–432.

Steriade, Donca (2001) Directional asymmetries in place assimilation: A perceptual account. In *The Role of Speech Perception in Phonology*, Elizabeth Hume & Keith Johnson, eds., New York: Academic Press, 219–250.