



# Nasal Place Assimilation and the Perceptibility of Place Contrasts

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## Introduction

Cross-linguistically, nasal consonants are more likely to assimilate in place than oral consonants (Jun, 1995, 2004).

Example from Hindi:

Nasals assimilate:

- (a) phəŋki 'handful'
- (b) gənd 'ball'
- (c) tamba 'copper'

Oral stops do not:

- (d) gətkə 'a type of club'
- (e) gupʈə 'a last name'

This asymmetry arises because the place contrast is less perceptible in nasals than in oral stops (Jun, 1995, 2004).

### Perceptual Distance Map:

[m]-----[n]

[b]-----[d]

[p]-----[t]

Because nasals are perceptually more similar, speakers will be more likely to allow articulatory changes to nasals than to oral consonants.

Previous research disagrees over whether place contrasts are less perceptible in nasals than in oral consonants (Mohr and Wang 1968, Pols 1983, Hura et al. 1992, Winters 2002).

### Objective:

This study settles the discrepancies among previous literature by testing the hypothesis that the place contrasts are less perceptible in nasals than oral stops in four experiments.

## Methods for Experiments I & II

Target stimuli: am, an, aŋ, ab, ad, ag, ap, at and ak.

Stimuli were produced by a native speaker of English and resynthesized with a flat pitch at 250Hz and peak amplitude of 0.7.

Pairs were created by concatenating minimal pairs of sounds differing in place with 500ms ISI. Participants judged similarity on a 5-point scale ranging from 1-Almost identical to 5-Completely different.

Experiment I used tokens with clear releases and Experiment II used tokens with weakened oral stop releases (40dB). 21 native English speaking participants in Experiment I and 19 in Experiment II.

## Experiments I & II: Similarity Judgment

Experiment I Similarity Ratings		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	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
<b>Average</b>		<b>2.59</b>	<b>3.63</b>	<b>4.00</b>

Nasal pairs were rated the most similar (lowest score). Voiceless stops were judged to be the most dissimilar. Voiced stops were in-between.

Nasal contrasts are less perceptually salient than oral stops. The difference found in perceptibility between voiced stops and voiceless stops is not instantiated in any known typological surveys (e.g. Jun 1995).

Experiment II Similarity Ratings		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	Labial vs. Coronal	3.12	3.52	3.72
	Labial vs. Dorsal	2.68	3.45	3.79
	Coronal vs. Dorsal	2.79	3.14	3.78
<b>Average</b>		<b>2.86</b>	<b>3.37</b>	<b>3.76</b>

Despite eliminating the strong releases, the oral stops were still judged to be less similar than the nasals.

**Nasals < Voiced Stops < Voiceless Stops**

## Methods for Experiments III & IV

Stimuli: am, an, aŋ, ab, ad, ag, ap, at, and ak.

The stimuli were covered by cocktail party noise under 3 different noise conditions: -6 dB S/N, -12 dB S/N, and -15 dB S/N where the signal was kept at 60 dB.

Participants saw binary visual cues differing in place and identified which stimulus they heard.

Experiment III presented the stimuli in word-final position and Experiment IV in pre-consonantal position. In Expt. IV, the following syllables consisted of a non-homorganic consonant and a schwa.

23 native English speaking participants in Experiment III and 22 in Experiment IV.

## Experiment III: Identification Expt.

-6dB S/N Average d' Scores		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	Labial vs. Coronal	0.51	0.43	1.93
	Labial vs. Dorsal	0.26	1.21	0.91
	Coronal vs. Dorsal	0.34	1.25	2.37
<b>Average</b>		<b>0.37</b>	<b>0.96</b>	<b>1.73</b>

-12dB S/N Average d' Scores		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	Labial vs. Coronal	0.11	0.24	2.02
	Labial vs. Dorsal	0.21	0.76	0.93
	Coronal vs. Dorsal	0.27	0.77	2.32
<b>Average</b>		<b>0.20</b>	<b>0.59</b>	<b>1.76</b>

-15dB S/N Average d' Scores		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	Labial vs. Coronal	0.24	0.14	1.68
	Labial vs. Dorsal	0.04	0.65	0.63
	Coronal vs. Dorsal	-0.03	0.81	1.98
<b>Average</b>		<b>0.09</b>	<b>0.53</b>	<b>1.43</b>

## Conclusions

Four experiments, two similarity judgment tests and two identification tasks have yielded the same perceptibility hierarchy with nasals having the lowest perceptibility.

This finding supports Jun (1995, 2002) that the place contrast is less perceptible in nasals than oral consonants.

The difference in perceptibility between voiced stops and voiceless stops is not reflected in current phonology. There are two possibilities:

1. Uncover a language that instantiates that pattern
2. Not all phonetic properties such as perceptibility are reflected in phonology (Kochetov and So 2007).

To the extent that the difference in perceptibility underlies the asymmetry in place assimilation, our results generally support the thesis that speakers are more willing to neutralize contrasts of segments that are less perceptually salient (Steriade 2008).

## Experiment IV: Identification Expt. 2

-6dB S/N Pre-C Position Average d' Scores		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	Labial vs. Coronal	0.29	0.12	0.98
	Labial vs. Dorsal	0.08	0.49	0.78
	Coronal vs. Dorsal	0.14	0.55	1.68
<b>Average</b>		<b>0.17</b>	<b>0.39</b>	<b>1.15</b>

-12dB S/N Pre-C Position Average d' Scores		Manner		
		Nasals	Voiced Stops	Voiceless Stops
Place	Labial vs. Coronal	0.00	0.00	0.73
	Labial vs. Dorsal	0.15	0.33	0.45
	Coronal vs. Dorsal	-0.11	0.07	1.63
<b>Average</b>		<b>0.01</b>	<b>0.13</b>	<b>0.93</b>

In both word-final and pre-consonantal positions, nasals have the lowest d' scores in all S/N ratio conditions.

Experiment IV shows that the presence of a following consonant reduces the perceptibility of the place contrasts of the target stimuli.

The hierarchy of perceptibility was consistent in Experiments III and IV:

**Nasals < Voiced Stops < Voiceless Stops**