THE FEATURE [FLAT] IN CROSS-LANGUAGE PERCEPTION

MEL GREENLEE  CHARLES A. FERGUSON  DOROTHY HUNTINGTON
Linguistics Department, Stanford University, Stanford, California

JOHN J. OHALA  DEBORAH FEDER
Phonology Laboratory, Linguistics Department, University of California Berkeley, California

ABSTRACT
The legitimacy of [+/- flat] has been repeatedly discussed (Jakobson et al., 1969; McCawley, 1972; J. Ohala, 1985). One argument offered in justification consists of unified acoustic-perceptual correlates in spite of distinctive articular characteristics. Following an earlier suggestion and an empirical test, this paper examines the extent to which [+/- flat] of one language is heard as [+/- flat] in another language when the articular correlates in the two languages are different. Languages chosen were Arabic (pharyngealization) and Bengali (retroflexion); each language has a traditional orthography which indicates the [+/- flat] distinction. Speakers of the two languages listened to both Arabic and Bengali nonce words contrasting [+/- flat] consonants between vowels and transcribed these according to the orthography of their language. Subjects accurately perceived [+/- flat] in their own respective languages, but [+ flat] consonants of one language were rarely heard as [+ flat] in the other. Also, Bengali listeners often identified Arabic [-flat] as the corresponding Bengali [+flat] consonants. Thus, the unity of perceptual correlates for [+/- flat] appears to be questionable.

INTRODUCTION
Among the set of distinctive features proposed in Preliminaries [1], was the distinction flat versus plain: [+flat] segments manifested "a downward shift of all of the formants or even of all of the formants in the spectrum" as compared to plain segments. The proposed feature [+flat] encompassed labialization, pharyngealization, and retroflexion, which were held to be similar in acoustic/auditory effect and never phonologically contrastive in the same language. The utility of the proposed feature has been challenged, both on formal [2], and substantive grounds [3]. McCawley argued against the feature as requiring as many descriptive and interpretive levels as taxonomic phonemics, while other authors noted that all three articulatory manifestations of [+ flat] are not in strict complementary distribution [4]. In Chomsky & Halle's feature set, [+/- flat] was discarded. J. Ohala [5], however, noted several reasons for the usefulness of the feature, including distributional similarities, effects on neighboring segments, and phenomena of borrowing and sound change.

Ferguson [6] proposed an empirical test of the perceptual unity of [+ flat] consonants, investigating the perceptual judgements of Arabic, pharyngealized consonants and South Asian retroflex consonants, since speakers were readily available and the respective orthographies afforded representation for the hypothesized [+/- flat] distinction.

Feder [7] conducted a cross-linguistic perception test of [+/- flat] using Arabic and Hindi words and nine Arab listeners. Stimulus words were recorded by a number of native speakers of each language. In order to reduce the influence of Arabic vowels which co- vari with the [+/- flat] consonant distinction, all CV stimulus words were edited to include only a very short /i/ or /a/. Arab listeners usually responded correctly on Arabic words, but they rarely heard Hindi retroflex stops as [+ flat], although more such identifications occurred when the following vowel was /a/ (16%) than when the syllable contained a high vowel (22%). Feder concluded that a more refined cross-linguistic test of [+/- flat] was needed.

METHODS
The present experiment was designed to further test the perceptual unity of the feature [flat] with speakers and listeners from the same language areas tapped by Feder. However, there were several methodological differences.

First, rather than reducing influence of the vowels surrounding [+/- flat] consonants, we sought to include as much naturally-occurring information as possible. It has often been noted that the auditory effects of retroflexion are more striking on the vowel preceding [+ flat] consonants, while for pharyngealized consonants, although both preceding and following vowels may be affected, the more prominent auditory effects typically occur on the following vowel. In order to give listeners from both language groups equal opportunity to perceive these effects, the [+/- flat] contrast was placed in a medial position between two similar vowels in a CV-CV format.

Duration of the adjacent vowels was not manipulated.

Second, we used only a single, male speaker of each language in recording the stimulus tape, but relied on a number of native speakers of each language as listeners (11 Bengalis and 13 Arabs), who transcribed recorded tokens in their entirety according to the conventions of their respective orthographies. By asking listeners to transcribe the whole "word", we hoped to obtain information about potential vowel effects of the [+/- flat] distinction, as well as data on consonant perception per se. Finally, in the present experiment, all stimulus items were nonce words in both languages. By excluding real words, we intended to avoid potential semantic effects and focus listeners' attention on the phonetic correlates of [+/- flat].

Items contrasting [+/- flat] consonants...
consisted of the following words: Arabic ['kada/—/'rada/ and Bengali
/'kadi/-/radu/]. These were created by digitizing
in a sentence containing the target words, which
was spoken in a frame sentence. Arabic tokens were
recorded on a tape by the author, and the speaker was
a native of Calcutta, India. Each token was repeated
ten times, then randomized onto a stimulus tape containing
items in both languages. Spectrographic analysis of the
stimuli showed that the acoustic correlates of [± flat] were
generally more pronounced in the Arabic than in the Bengali
tones. This was particularly true when Arabic
[flat] consonants occurred between two high vowels.
For example, Arabic ['kada/ showed a peak in the
second formant of both the first and second
instants of /i/, a consequence of pharyngealization
described by earlier acoustic analyses [6, 9].
Bengali ['kadi/- differed from its plain counterpart
less dramatically in the location of vowel formants,
but manifested a rather smaller difference in local
and amplitude of the release burst for /d/ in com-
parison to /l/.

Listeners were not told that they would be hear-
ing two languages, but were instructed to write as
closely as possible, in their own language, the
speech on tape. They were told that they
would hear possible but nonoccurring words in their
own language, and that the recorded words had been pro-
cessed by a computer.

RESULTS

Table 1 shows each group of listeners' responses
to flat and plain (dental) stops in either language.
In tallying responses, only the value of the fea-
ture [± flat] was considered, disregarding other
miscues (e.g., of consonant voicing). For
both [± flat] and [−flat] consonants, listeners
were much more accurate when judging their
own language. Each group correctly perceived [± flat]
consonants in their own language over 80% of the
time. Yet only rarely were [± flat] stops of one
language identified as the corresponding [± flat]
stops in the other. Arabic heard Bengali retroflex
stops as pharyngealized /f/ or /v/ when the
Bengali plain stops were presented between
low vowels ([t=3.27 (df 25), p<0.001, 2-tailed]).
Since in Arabic, /f/ is [flat] to /v/ in the con-
text of [± flat] stops, Arabic listeners, bearing a
[− flat] consonant surrounded by low back vowels,
transcribed the consonant as [± flat].

Bengali listeners, on the other hand, made more
errors in judging Arabic [− flat] stops when these were
surrounded by high vowels ([t=1.74 (df 10), p>0.05, 2-tailed]).
Thus, Arabic [± flat] stops must have been
drawn as retroflex when in the context of /i/.
This pattern of errors is somewhat surprising,
given the more pronounced acoustic effect of ret-
roflexion on the high second formant of /i/ rather
than on the already low formant structure of /a/.
At present, we have no explanation for this para-
doxal result.

DISCUSSION

Our findings have demonstrated that while both
Arabic and Bengali speakers accurately perceive
the phonological feature [± flat] in their native
languages, they rarely identify [± flat] in the
other language. This result argues against
the proposed universal acoustic/perceptual correlates of
[± flat] as a phonological feature. In
particular, the large percentage of false-
positive responses by Bengali listeners would seem
to challenge the distinctiveness of the proposed
acoustic correlates of [± flat]. Since Bengali
listeners most often heard Arabic plain stops as
retroflexes when in the context of a high vowel,
one might infer that for a Bengali listener, the pro-
posed acoustic correlate of lowering formant structure
is not a necessary cue for judging a
consonant as [± flat] [10].

One possible source of the Bengali listeners'
bias for hearing plain stops as retroflex might
lie in the pronunciation of Arabic by the speaker
we recorded. It may be that he sometimes
pronounced the Arabic plain stops with an alveolar
place of articulation, since no distinction between
dental and alveolar stops exists in Arabic, allow-
ing for free-variation. If our speaker pronounced
the Arabic plain stops as alveolar, then Bengali listen-
ners' frequent misidentification of these stops
retroflexes in the Hindustani language, and
speakers perceive American English alveolars as retro-
flexion on the high second formant of /i/ rather
than on the already low formant structure of /a/.
At present, we have no explanation for this para-
doxal result.

REFERENCES

Prefatory notes to speech analysis: The distinctive
features and their correlates. Cambridge: MA.
Harvard University Press.

logical feature system in a theory of language. In
Y.B. Naskar (Ed.) Phonological theory. Evolution
and current practices. IL—6. Lake Bluff, IL:
Jupiter Press.


Frumkin (Ed.) Phonetic linguistics, 23—41.

as behavioral theory. In R.C. Gardner (Ed.)

flexion, and the distinctive feature flat. A
perceptual experiment. Paper presented at the
California-Berkeley Phonology Laboratory.

second formant on the perception of variation

acoustical and physiological investigation. The
Hague: Mouton.

for the direction of sound change. PDDA Reports,
Series 2, no. 16. U. California-Berkeley
Phonology Laboratory.

Table 1: Perceptual Confusions According to
Native Language of Listeners

<table>
<thead>
<tr>
<th>Arabic—speaking listeners</th>
<th>Bengali—speaking listeners</th>
</tr>
</thead>
<tbody>
<tr>
<td>[± flat]</td>
<td>[± flat]</td>
</tr>
<tr>
<td>90.2%</td>
<td>7.9%</td>
</tr>
</tbody>
</table>

Table 2: Percent Listener Errors in Identification of [±—flat] Consonants

<table>
<thead>
<tr>
<th>Arabic</th>
<th>Bengali</th>
<th>Arabic</th>
<th>Bengali</th>
</tr>
</thead>
<tbody>
<tr>
<td>[± flat]</td>
<td>[± flat]</td>
<td>[− flat]</td>
<td>[− flat]</td>
</tr>
<tr>
<td>0.0%</td>
<td>92.0%</td>
<td>47.3%</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

Footnote:

*One Bengali subject consistently added an extra syllable for 3/4 of the Arabic [± flat] stimuli. These unscorable responses are omitted from the table.