

DEGREE OF VOICING IN INITIAL STOPS
IN EDUCATED POLISH AND AMERICAN ENGLISH

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In some studies the degree of voicing is measured in terms of 'the duration of the time interval by which the onset of periodic pulsing either precedes or follows the release of a stop' (Lisker and Abramson 1964: 387). If one assumes the release of the stop closure to be the zero point, the onset of voicing may be represented in (-) or (+) values depending on whether it precedes (lead) or follows (lag) the release (terminology from Lisker and Abramson 1964).

I. In accordance with the above assumptions, we have obtained the lead and lag times for Educated Polish and American English stops followed by a stressed vowel. We have devised this experiment guided by two hypotheses:

1. that the degree of voicing in the Polish initial voiced and voiceless stops should appear to be considerably greater than in their American counterparts. This assumption has been based on the fact that
 - (a) the Polish voiceless /p t k/ are said to be unaspirated (but cf. Jassem 1964b : 364) while the AE /p t k/ are defined as aspirated. Aspiration has also been linked with the onset of voicing of the following vowel so that the greater the delay of the voice onset the greater the degree of aspiration. One might go one step further and say that the greater the delay of the voice onset the greater the degree of aspiration and the lesser the degree of voicing of a stop.
 - (b) the initial AE /b d g/ are described as partially devoiced after a pause while the EP /b d g/ are said not to be subject to devoicing in this position.
2. that there might possibly be areas of overlapping in the degree of voicing between the Polish voiceless and American English voiced cognates i.e. between the EP voiceless /p/ and the AE /b/, the EP /t/ and AE /d/, the EP /k/ and AE /g/. This would allow us to state that the substitution of the EP [p] for the AE [p^h] by a Polish student learning American English in words like /pul/ might be perceived by speakers of American English as /bul/, owing to the fact that the degree of voicing in the EP /p/ is very close to that of the AE /b/. By the same token

/ten/ might be perceived as /den/

/kuwł/ „ „ „ „ /guwł/.

Conversely, /bul/ and /den/, as pronounced by speakers of American English, may be perceived as /pul/ and /ten/ by Polish students, /duwł/ and /guwł/ as /tuwł/ and /kuwł/, etc.

Description

The measurements were obtained from oscillographic representations of words pronounced in isolation. The instruments used in the experiment were: Siemens Oscillomink, Greer Photoelectric Manometer, Sony condenser throat microphone C-17B with a frequency response — 2 db at 30 cycles, upper response — 700 cps.

A plastic catheter was introduced into the oral cavity via the nose for oral pressure representation, and words were pronounced in isolation by a single speaker of Educated Polish and American English. The microphone was held tightly against the larynx¹.

The sample words used:

Educated Polish		No. of tokens	American English		No. of tokens
pop	pól	5+5=10	pop	pull	5+5=10
bak	ból	5+5=10	bock	bull	5+5=10
tak	tank	5+5=10	talk	tank	5+5=10
dok	dandys	5+5=10	dock	dandy	5+5=10
kap	kup	5+5=10	cop	coop	5+5=10
gaz		5	gas		5

Results

EP AE Phoneme	Educated Polish		American English	
	Onset of voicing in msec	Range in msec	Onset of voicing in msec	Range in msec
p	+37.5	+18 : + 57	+82.5	+69 : + 92
b	-78	-62 : -109	+18	+11 : + 30
t	+33	+28 : + 41	+84	+55 : +110
d	-72	-40 : -109	+14	+11 : + 17
k	+49	+37 : + 72	+71	+50 : +102
g	-61	-35 : -106	+31	+27 : + 37

Table 1. The mean values for the onset of voicing

¹ The experiment was carried out in the Department of Linguistics, University of California at Los Angeles. I wish to thank Professor Peter Ladefoged for his permission to use the instruments in the phonetic laboratory under his direction. I am especially indebted to Mr. John Ohala, a member of the laboratory staff, for suggesting the method for carrying out this experiment and many other valuable remarks. I wish to add that the statements made in this article are my sole responsibility.

Table 1 clearly shows that the degree of voicing in the EP /p t k b d g/ is considerably greater than in AE, the differences being 45, 51, 22, 96, 86, and 92 msec., respectively.

Educated Polish		American English		EP and AE	
Phoneme	Range in msec	Phoneme	Range in msec	Overlap range	No. of tokens within overlap range
p	+18 : +57	b	+11 : +30	+18 : +30	EP 3 AE 5
t	+28 : +41	d	+11 : +17	—	—
k	+37 : +72	g	+27 : +37	+37	EP 1 AE 1

Table 2. Cross-language overlap ranges; voiceless : voiced opposition

It will be noticed that only the EP /t/ and the AE /d/ did not show overlap ranges, the closest tokens of the two sounds being no more than 11 msec apart.

II. To further determine whether there would be a consistent perception confusion between the voiceless vs. voiced stops across the languages, the following experiment was devised and carried out:

1. A list of 120 Polish words was prepared, each beginning with an initial voiced or voiceless obstruent /p b t d k g tʃ dʒ s z f v ʃ/. The list included 10 tokens of /p t k/ each, dispersed at random among the 120 words;
2. Each word was read twice by a speaker of Educated Polish to a group of 17 speakers of American English. The subjects were asked to identify the initial sound of each word and write it down in what would be the ordinary spelling of the heard sound.

The results did not show any consistency in the confusion of the EP /p/ for the AE /b/, the EP /t/ for the AE /d/, the EP /k/ for the AE /g/. Out of a population of 170 tokens each, (10×17=170) only the EP /p/ was identified as the AE /b/ once. There were no instances of confusion with regard to the EP /t k/.

Conclusions

If we assume that the experiment was devised and carried out correctly we are forced to conclude:

1. that the single parameter of voicing is evidently not the only factor in the perception of voiced vs. voiceless stops by the speakers of American English;
2. that other signals might determine the separation of the prevocalic voiced from voiceless stops by speakers of American English e.g. the force of explosion: generally stronger after voiceless stops.

III. We have devised a similar experiment with eight Polish students. Among 130 words recorded by a speaker of American English there were randomly

dispersed:

14 tokens of AE initial /b/
 12 „ „ AE initial /d/
 12 „ „ AE initial /g/

The subjects were asked to identify the initial sound of the heard word.

We have assumed that due to the closeness in the degree of voicing the AE initial /b d g/ were subject to confusion with the EP /p t k/. The total number of tokens of each sound subject to confusion was:

AE/b/ $14 \times 8 = 112$
 AE/d/ $12 \times 8 = 96$
 AE/g/ $12 \times 8 = 96$

Results

AE	EP						total
	p	b	t	d	k	g	
b	76	36	—	—	—	—	112
d	—	—	51	45	—	—	96
g	—	—	—	—	45	51	96

Table 3. Cross-language identifications. Number of tokens

AE	EP						total
	p	b	t	d	k	g	
b	68%	32%	—	—	—	—	100%
d	—	—	53%	47%	—	—	100%
g	—	—	—	—	47%	53%	100%

Table 4. Cross-language identifications. Percentages (rounded off)

Discussion

1. The percentage of identifications of the partially devoiced AE /b d g/ with the EP voiceless /p t k/ is quite amazing. It is even greater than with the EP /b d g/.
2. It will be noticed that the percentage of identifications of the AE /d/ with the EP /t/ is bigger than that of the AE /g/ with the EP /k/ and, as it follows from Table 2, only the AE /d/ and the EP /t/ did not show overlap ranges in the degree of voicing. The discrepancy may be due to the individual differences of the speaker of American English who recorded the words and the Polish hearers. It may also be indicative of the fact that the differences in the degree of voicing of 11 msec are not significant in the process of perception.

Conclusions

1. There is a strong possibility of confusion of the AE initial /b d g/ with the EP /p t k/.

2. In Polish the parameter of voicing plays a decisive part in the process of perceptual differentiation of /b d g/ from /p t k/ i.e. the distinctive status of the voiced vs. voiceless opposition is unquestionable.

The conclusions that emerge from all the three experiments are the following:

- I. The degree of voicing in the Polish /b d g p t k/ is considerably greater than in the American English.
- II. The feature voiced vs. voiceless in the Polish stops has a distinctive status while in American English it is less important in the process of perceptual differentiation of these phonemes. A number of phonologists (Gimson 1966, Jakobson et al. 1956, Jassem 1964a, Reszkiewicz 1961, Trager and Smith 1951) posit fortis vs. lenis as distinctive in English and the results of our experiments would tend to support this view. The problem with the features fortis vs. lenis is that they are not very clearly defined — fortes are said to be produced with a greater tension of muscles, greater force of exhalation, stronger explosion, more deviation from neutral position and longer duration as opposed to lenes. It is thus a complex of parameters out of which it is difficult to choose one as dominant.

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