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Phonological subsystem

English phonetic vowel shortening and lengthening as perceptually active for the Poles

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1. Introduction

Auditory perception is one of the most thriving and active domains of psycholinguistics. Recent years have witnessed manifold attempts to investigate and understand how humans perceive linguistic sounds and what principles govern the process. The major assumption underlying the studies on auditory perception is a simple fact that linguistic sounds are means of conveying meaning, encoded by a speaker, to a hearer. The speaker, via articulatory gestures, transmits a message encoded in acoustic waves. This is the hearer, on the other hand, who, using his perceptual apparatus, reads acoustic signals and decodes them into the meaning. Therefore, in phonetic terms, the whole communicative act can be divided into three stages. Articulatory – the speaker encodes the message by sound production. Acoustic – the message is transmitted to the hearer as acoustic waves. Auditory – the hearer perceives sounds and decodes them into the meaning. Each of the three stages is indispensable for effective communication.

Of the three aforementioned stages of communication, the auditory perception is the least amenable to precise depiction and understanding. While articulation can be X-rayed and acoustic transmission can be visually represented with spectrograms, and hence measured, linguists have no such tools for investigating auditory perception.[1] It probably accounts for the fact that sound

[1] There is, however, some hope in the studies on neurocognition of language (see Brown & Hagoort, 1999 for a review).

perception was for many years neglected and could not find its place in linguistics. The situation has fortunately changed and quickly developing psycholinguistics has paid its attention to the issue. Nowadays, despite obvious drawbacks, new models of perception are being introduced and new empirical data collected. Each day seems to bring new information.

The paper endeavours to look into the phonetic vowel shortening and lengthening before a fortis and lenis plosive as the phonetic process which is functionally present in English and absent in Polish. It strives to ascertain if speakers of Polish, whose phonetic system lacks the vowel length variation, can perceive the shortening and lengthening of a vowel in English. The very process of variation in the vowel length is accompanied by phenomena such as the fortis – lenis dichotomy and partial devoicing thus they are both included in the descriptive part of the paper and contrasted with phonetics of Polish. The research part provides the obtained results and their analysis.

2. Fortis – lenis dichotomy

In English, plosives /p, t, k/ tend to be pronounced with more muscular energy and a stronger breath effort than /b, d, g/; that is why the former are known as relatively strong or fortis whereas the latter as relatively weak or lenis (Gimson, 1994).

Roach (1991: 33) notices that English /p, t, k/ are produced with more force than /b, d, g/ and, as a result, /p, t, k/ are called fortis and /b, d, g/ are called lenis.

According to Jones (1962), English plosives fall into two classes, viz. those uttered with considerable force of exhalation and those in which the force of exhalation is weak.

O'Connor (1973) claims that it happens that the difference between English /p, t, k/ and /b, d, g/ disappears since voice may be lacking in both. Therefore, it leaves the energy difference, fortis – lenis, as a constant. Auditorily this corresponds to strong versus weak sounds, with the addition that the lenis sounds are regularly shorter than the fortis ones. Acoustically the intensity of the burst of the fortis plosives is greater than that of lenis plosives.

Biedrzycki (1978) indicates that a relevant feature, which distinguishes English /p, t, k/ from /b, d, g/ is rather the force of articulation than vocal cord vibration.

In Jassem (1983: 197) one can read that the English fortes are voiceless in all positions whereas the lenis are voiced, partially voiced, or voiceless.

The above review of the books dealing with English phonetics shows clearly that the fortis – lenis opposition is perceptually more informative than the voiced – voiceless distinction in differentiating between /p, t, k/ and /b, d, g/. In other words, the difference between /p, t, k/ and /b, d, g/ is mainly characterised by the force of articulation rather than vocal cord vibration, even though it is customary to refer to the two classes of plosives as 'voiced' and 'voiceless'.

In Polish, on the other hand, the essence of this opposition lies in the presence or absence of voice, that is, vocal cord vibration.

Dłuska (1986) writes that the voiced – voiceless dichotomy is the main one in Polish and the relative difference in strength is minute and hardly observable by the Poles.

Dukiewicz & Sawicka (1995) admit the variation in force of articulation in Polish stop consonants, however, they do not perceive it as a relevant opposition. Interestingly enough, they indicate that the difference in force is greatest in Polish and Czech as compared to all Slavic languages.

Wierzchowska (1980) mentions that voicing is not the only feature differentiating /p, t, k/ from /b, d, g/ but also the relative force of articulation. Nonetheless, she does not ascribe it any perceptual importance.

Nagórko (1996) claims that the voiced – voiceless contrast is principal in Polish.

Jassem (1972) considers the force of articulation as relevant in English and redundant in Polish.

The adduced data for Polish plosives bear out the principal role of the voiced-voiceless contrast in perceiving the difference between /p, t, k/ and /b, d, g/ in Polish. If there are any differences in the force of Polish plosives, they result from universal properties of the plosive production (e.g. the absorption of energy to make vocal cords vibrate – see Dłuska (1986)) and are negligible for Polish hearers.

3. Partially devoiced plosives

In English in initial positions, i.e. following silence, /b, d, g/ while remaining lenis, may be only partially voiced or completely voiceless, e.g. in *bill*, *done*, *game*. Vocal cord vibration begins only in the last portion of the compression stage in initial position (Gimson, 1994).

Roach (1991) notices that the release of /b, d, g/ is followed by weak plosion, and this happens at about the same time as, or shortly after, the beginning of voicing. He claims that 'if English speakers hear a fully voiced initial plo-

sive . . . they will notice that it does not sound quite natural' (Roach, 1991: 32).

Kreidler (2001) argues that the onset of a voiced plosive may be voiceless when preceded by a voiceless consonant or when word initial.

Jassem (1972: 25) writes that in a syllable initial position, after a pause, English has partially devoiced plosives. They consist of two segments. The first of which is voiceless, the latter being voiced.

O'Connor (1973) indicates that /b, d, g/ in initial position may have little voicing or none.

In final positions, i.e. preceding silence, /b, d, g/ while remaining lenis, may be only partially voiced or completely voiceless, e.g. *cub*, *lid*, *bag* (Gimson, 1994).

If /b, d, g/ occur before a pause or voiceless element, then they consist of two segments, only the former being voiced (Jassem, 1972: 25).

O'Connor (1973) notices also that, in terms of distinguishing between /b, d, g/ and /p, t, k/ before a pause or a voiceless element, voicing is relatively unimportant since /b, d, g/ may have little or none voicing at all. The weight is therefore put on the fortis – lenis dichotomy word-initially and the preceding vowel duration word-finally.

Roach (1991: 33) argues that final /b, d, g/ normally have little voicing; if there is voicing, it is at the beginning of the hold phase.

The adduced literature indicates clearly that English plosives word-initially and word-finally have voicing in only a fracture of the compression stage. In initial positions it is the last portion of a plosive, immediately followed by a vowel, which is voiced. In final positions only the first portion of a plosive, immediately preceded by a vowel, is voiced.

The waveform and spectrogram in Figure 1 present the stimuli *nab* [næb]. In a word-final position is a partially devoiced /b/. The closure duration occurs within 0.44-0.55 sec. A weak plosion occurs at 0.56.

Polish stops /b, d, g/ word-initially are fully voiced. In their production the entire compression stage is accompanied by the vocal cord vibration (Jassem, 1972). Word-final stops, on the other hand, are only voiceless in Polish (Dukiewicz & Sawicka, 1995; Wierzchowska, 1971, 1980; Rocławski, 1986). In words like *Bug* and *buk* there is no difference between the final plosives – it is voiceless /k/ in both cases in spite of a misleading spelling.

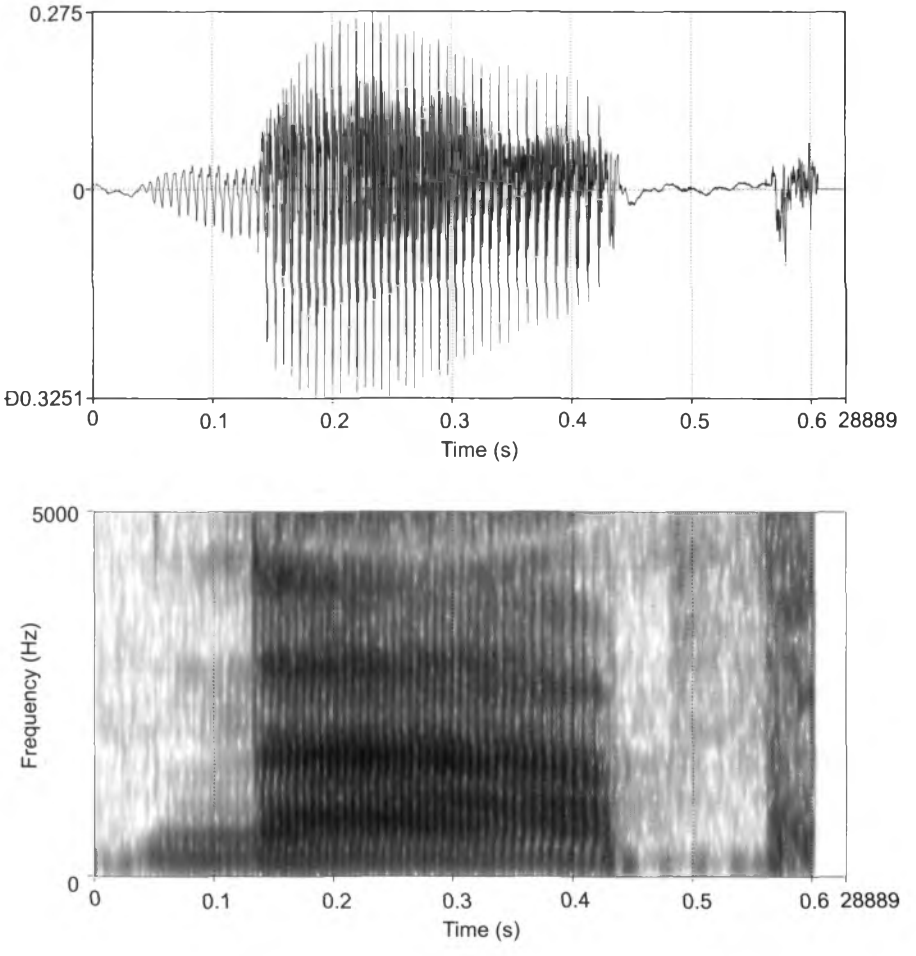


Figure 1. The waveform and spectrogram of the syllable nab /næb/

4. Preceding vowel duration

In English when a plosive occurs finally in a syllable, its value is largely determined by the length of the syllable which it closes. It is due to the fact that the voicing factor is not strongly operative. Thus, syllables closed by voiceless consonants are considerably shorter than those which are closed by a voiced consonant. Therefore, words ending with a stop are not distinguished primarily by a difference of the final consonant but rather by quantitative contrasts of preceding sounds (G i m s o n, 1994).

Roach (1991: 33) indicates that 'the difference between /p, t, k/ and /b, d, g/ is primarily the fact that that vowels preceding /p, t, k/ are much shorter.'

Ladefoged (1975: 44) writes that '[in] pairs, such as "cap, cab; cat, cad; back, bag" the vowel is much shorter before the voiceless consonants /p, t, k/ than it is before the voiced consonants /b, d, g/. The major difference between such pairs of words is in the vowel length, not in the voicing of the final consonants.'

Jassem (1972: 82) mentions that a vowel in a position before a fortis plosive is shorter than before a lenis plosive.

O'Connor (1973) notices, comparing the words *beat* /bi:t/ and *bead* /bi:d/, that whenever a fortis consonant follows in such words, the preceding vowel is shorter than when a lenis follows. Thus, the perceptual difference between these two words lies in the relative lengths of the preceding /i:/. As a result in *beat* the vowel is much shorter than in *bead* and this contributes a great deal to recognition of one word or the other.

The cited literature points to the fact that in English the vowel duration performs a distinctive function in syllables closed by a plosive here, and obstruents generally. Plosive series /p, t, k/ and /b, d, g/ become alike word-finally due to the devoicing process. The fortis – lenis opposition is of little help either since plosives in final positions tend to lose articulatory prominence and strength, and hence the contrast is blurred. The vowel duration appears to shoulder the responsibility of contrasting final plosives by shortening before /p, t, k/ and lengthening before /b, d, g/.

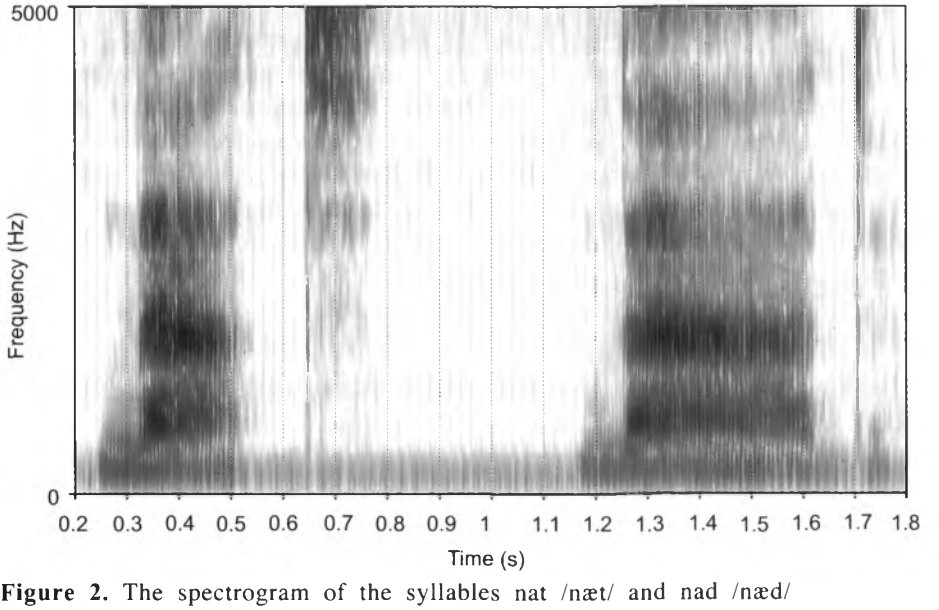


Figure 2. The spectrogram of the syllables nat /næt/ and nad /næd/

Figure 2 presents the spectrograms of the syllables *nat* /næt/ (on the left) and *nad* /næd/ (on the right). One can discern the difference in vowel duration. The vowel duration of *nat* is 0.19 sec. whereas the duration in *nad* is 0.35 sec.

On the contrary, in Polish the preceding vowel duration does not perform any contrasting function. It largely results from the fact that there is no distinction for vowels to mark since obstruents are only voiceless word-finally. Consequently, Polish vowels are rather stable in terms of duration. Nevertheless, some phoneticians, e.g. Dukiewicz & Sawicka (1995), claim that a careful analysis of spectrograms displays traces of the vowel length variation. Still, it is considered to be an effect of general articulatory principles of plosive production, which is typical for all languages, and is not ascribed any distinctive task in Polish.

5. Research objectives and procedures

The research aims at evaluating the perception of the vowel length variation in English by the Poles. In order to achieve it, two locations of plosives are analysed – word-initial and word-final. Word-initial plosives in English are characterised by partial devoicing and the fortis – lenis dichotomy. Word-final plosives, on the other hand, are marked by partial devoicing, the fortis – lenis dichotomy, with the addition of changes in the preceding vowel length. The objective of the research thus consists in the assumption that the perception of word-final English plosives by the Poles should be more effective than word-initial plosives *if the subjects can read the vowel duration as a clue to voicing and voicelessness of a following plosive.*

For the purpose of the study the list of 12 monosyllabic words was drafted, representing the sequence /b, d, g/ both word-finally and word-initially, preceded and followed by a front and back vowel. Not all the words were existing morphemes in English, however, they all belonged to the category of potential words in English, i.e. they did not violate English phonotactics and a syllable structure.

Word-initially
/b, d, g/ + a front vowel /æ/
ban
dan
gan
/b, d, g/ + a back vowel /ɒ/

bon
don
gone
Word-finally
a front vowel /æ/ + /b, d, g/
nab
nad
nag
a back vowel /ɒ/ + /b, d, g/
nob
nod
nog

The words were subsequently randomly dispersed with words containing voiceless /p, t, k/ in the same positions (e.g. *tan*, *con*, *knack*, *not*) and printed as a list for recording. The list was read and recorded by an educated speaker of British English. Next, the group of 30 subjects without any experience with English was chosen. They were played the recorded words and asked to fill in the initial or final sound they heard in each word on a prepared research sheet. All the subjects were presented with the recorded words played from a cassette. Listening conditions were comparable for all the listeners.

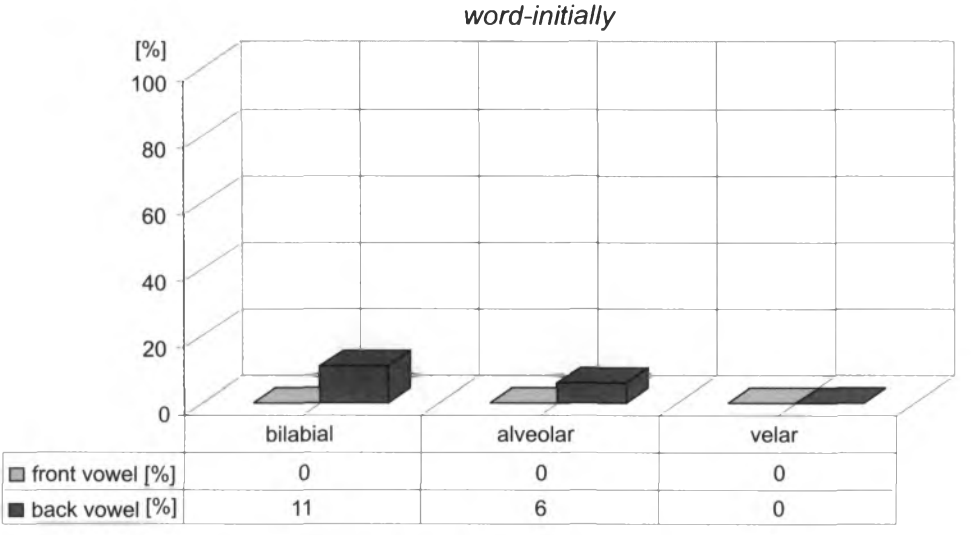
The achieved material was analysed only in terms of the voiced – voiceless distinction. That is, if the element was perceived correctly as, e.g., voiceless but differed as to the place of articulation (e.g. /b/ for /g/, or /d/ for /b/, etc.), still it was classified as a correct response.

6. Research analysis

Figure 3 presents the results for word-initial /b, d, g/ followed by a front and back vowel.

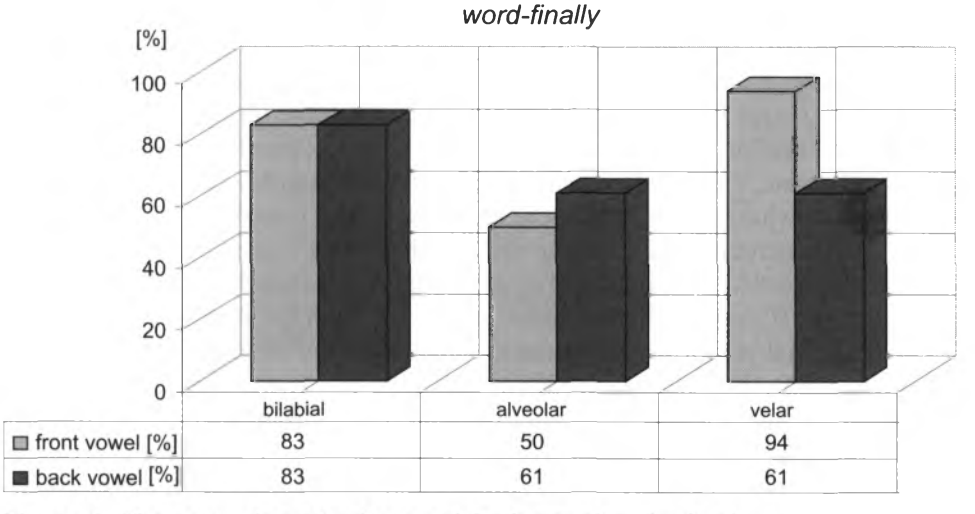
The results show clearly that, word-initially, the Poles erroneously perceive almost all partially devoiced plosives as voiceless. The subjects, led by the rules of Polish phonetics, await the vocal cord vibrations in /b, d, g/. If they hear none they automatically ascribe them voicelessness irrespective of the fact that /b, d, g/ are lenis as opposed to fortis /p, t, k/. The difference in strength does not seem to be an active clue to voicing or voicelessness for the Poles.

Figure 4 presents the results for word-final /b, d, g/ preceded by a front and back vowel.



	bilabial	alveolar	velar
front vowel [%]	0	0	0
back vowel [%]	11	6	0

Figure 3. The perception of /b, d, g/ + a front and back vowel



	bilabial	alveolar	velar
front vowel [%]	83	50	94
back vowel [%]	83	61	61

Figure 4. The perception of a front and back vowel + /b, d, g/

The correct perception of partially devoiced /b, d, g/ increases substantially in final position. As in the case of initial position, the voicing factor is not operative here, hence the subjects could not utilise it in differentiating between /b, d, g/ from /p, t, k/.

Figure 5 shows the juxtaposed results for the perception of /b, d, g/ word-initially and word-finally.

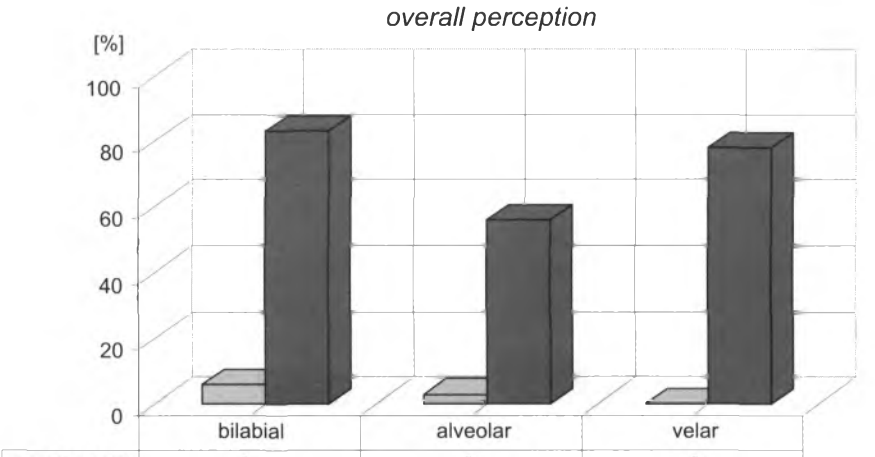


Figure 5. The overall perception of /b, d, g/ word-initially and word-finally

Word-finally, the correct perception rises by 77%, 53%, and 78% for /b/, /d/, and /g/, respectively. Regardless of the fact that both initial and final /b, d, g/ are partially devoiced, i.e. the vocal cord vibration does not perform its contrasting function, its is the final sequence /b, d, g/ that is perceived much more effectively. What seems to underlie the increase in the correct perception is the duration of the preceding vowel. It allows one to draw two following conclusions, the first of which emphasises the interplay between the vowel and plosive whereas the latter concentrates on the vowel itself.

1. When perceiving a string: a vowel followed by voiced plosive, the Poles expects to hear the vocal cord vibration throughout the whole compression stage of a plosive. If they hear none or little voicing, as it is the case with English /b, d, g/ in final positions, they resort to quantitative differences in the preceding vowel. In other words, the Poles can read the vowel duration as a clue to voicing or voicelessness of a following plosive when the plosive itself is largely devoid of such information. It is a rather daring hypothesis if one assumes that the vowel duration is not functional in Polish. Further research is imperative to prove that the subjects can freely resort to the vowel duration when the voiced-voiceless distinction in the following plosive is lacking.

2. The Poles can read fairly effectively the vowel length not as compensation for the loss of the voiced-voiceless distinction of the following plosive but simply because it varies considerably as compared to Polish. To put it differently, it has nothing to do with plosives but is solely restricted to the vowel duration. Spectrograms of Polish display traces of variation in vowel quantity, even though vowels in Polish are exempted from marking the voicing or voice-

lessness of a following plosive. It would indicate that, when faced with substantial alternation in the vowel duration, the Poles are in a position to perceive it. This hypothesis is not fully explanatory either – it does not lucidly account for the increase in the correct perception of final /b, d, g/. The problem that calls for clarification is how the subjects know that the lengthening and shortening of a vowel signals the voicing and voicelessness of a following plosive if such a process is absent in Polish.

7. Concluding remarks

The research clearly shows that English partially devoiced plosives are perceived more effectively word-finally than word-initially by the Poles. What seems to be responsible for the fact is the preceding vowel length duration. That inevitably leads to the conclusion that the Poles, whose phonetic system does not functionally employ the vowel length variation, can somehow read it as a meaningful clue to the voicing or voicelessness of a following plosive. Nonetheless, the rationale for this phenomenon is far from lucid. Whether the subjects can perceive the vowel duration as compensation for the missing voicing factor of a plosive that follows, or they merely sense the quantitative differences when exposed to greater variation in the vowel length, is still a matter of speculation. Further research is needful to fish out the factors accountable for this tendency.

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Arkadiusz Rojczyk

Fonetyczne różnice w iloczasie samogłosek angielskich i ich wartość percepcyjna dla Polaków

Streszczenie

Artykuł porusza problem iloczasu samogłoski w języku angielskim w sygnalizowaniu opozycji dźwięczna – bezdźwięczna w wygłosowych spółgłoskach zwarto-wybuchowych. Angielskie spółgłoski właściwe w pozycji wygłosowej ulegają częściowemu, a nawet całkowitemu ubezdźwięcznieniu. W tej sytuacji ciężar utrzymania percepcyjnego kontrastu między parami minimalnymi – takimi jak *cat, cab* zostaje przeniesiony na iloczas samogłoski, która jest dłuższa przed spółgłoską dźwięczną i krótsza przed bezdźwięczną. W języku polskim samogłoska jest zwolniona z zadań dystynktywnych na poziomie temporalnym, jako że polskie spółgłoski właściwe są fonologicznie tylko bezdźwięczne w wygłosie. Badanie empiryczne zaprezentowane w artykule wskazuje, iż Polacy, którzy nie mieli kontaktu z językiem angielskim, potrafią w pewnym stopniu korzystać z iloczasu samogłoski w angielskim, by rozróżniać między ubezdźwięcznionymi i bezdźwięcznymi wygłosowymi spółgłoskami zwarto-wybuchowymi. Wyniki te mogą wskazywać, iż badani byli w stanie wykorzystać kontrast iloczasowy niewystępujący w ich języku ojczystym.

Arkadiusz Rojczyk

Phonetische Unterschiede in der Länge der englischen Vokale und deren perzeptorischer Wert für Polen

Zusammenfassung

Der vorliegende Artikel betrifft das Problem der Vokalenlänge im Englischen bei der signalisierten Opposition: stimmhaft – stimmlaut in explosiven Auslautkonsonanten. Typische englische Konsonanten werden im Auslaut teilweise oder sogar völlig stimmlos, so dass die Länge des Vokals (längerer Vokal vor einem stimmhaften Konsonanten und kürzerer Vokal vor einem stimmlosen Konsonanten) die Aufgabe hat, den perzeptorischen Kontrast zwischen solchen minimalen Paaren, wie *cat*, *cab* zu bewahren. In der polnischen Sprache braucht der Vokal solche distinktive Funktionen auf temporaler Ebene nicht zu erfüllen, denn typische polnische Konsonanten sind im Auslaut nur phonologisch stimmlos. Die in dem Artikel dargestellte empirische Untersuchung zeigt, dass die Polen, welche mit der englischen Sprache nie in Berührung gekommen sind, sind gewissermaßen im Stande, die Vokallänge im Englischen zu benutzen, um zwischen den stimmlos machenden und den stimmlosen explosiven Auslautkonsonanten unterscheiden zu können. Das kann heißen, dass die Untersuchungsteilnehmer den, in ihrer Muttersprache nicht erscheinenden Längekontrast sich zu Nutze machen konnten.