

On the perception of English high vowels by Polish learners of English

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The present experiment examined how two pairs of English vowels (/i/-/ɪ/ and /u/-/ʊ/) are perceived by Polish learners of English. The underlying assumption was that non-native vowel perception might be influenced by listeners' L1 vowel system (Flege 1995, Best 1994, Major 2001) or by universal factors (Major 2001). Two research questions were formulated. How much attention do Polish learners of English pay to spectral cues for /i/-/ɪ/ and /u/-/ʊ/ distinctions in English? Are temporal cues equally important for Polish learners of English when they distinguish between /i/-/ɪ/ and /u/-/ʊ/ vowel pairs? Predictions concerned the influence of L1 vowel system (Polish does not use duration differences and has only one vowel in the high back vowel region), the salience of temporal cues and the identification of the vowels in question. 37 Polish subjects and a control group of English native speakers identified stimuli from /hid/-/hrd/ and /hud/-/hud/ continua varying in spectral and durational steps. English subjects strongly relied on spectral cues (typical categorical perception) and almost did not react to temporal cues. Polish subjects relied strongly on temporal cues for both continua, but showed a reversed pattern of identification of /u/-/ʊ/ contrast. Their reliance on spectral cues was weak and had a reversed pattern for /i/-/ɪ/ contrast. The discussion of the results focused on duration as a readily available cue to L2 vowel contrast, assimilation of L2 vowels to the existing vowel system, and the influence of orthography and L1 reading habits on the perception of L2 vowels.

1 PREDICTIONS

Previous studies in L2 speech perception have shown that it can be influenced by listeners' L1 system (Flege 1995, Best 1994, Major 2001) or by universal factors (Major 2001).

In order to discuss the influence of the Polish vowel system on the L2 English system and determine which findings cannot be ascribed to transfer, a comparison of the two is needed. The following will be based on Sobkowiak (2002). The four English vowels in question, /i/, /ɪ/, /u/, and /ʊ/ will be discussed in relation to their closest Polish counterparts. Both English and Polish have an /i/ sound, but the English one is longer, more tense, higher and more fronted. Both languages also have an /ɪ/ sound, produced with a similar tongue position and length, but there is a difference in timber between the two, as the English /ɪ/ is more tense. In the high back vowel region Polish has one vowel /u/, whereas English has two vowels: /u/ and /ʊ/. All three vowels are different. The English /u/ is longer, more tense, with the more extreme high back position of the tongue and more distinct lip rounding in comparison to the Polish counterpart. The English /ʊ/ sound is short, lax and almost mid-central.

2 PROCEDURE

The stimuli were taken from /hid/-/hɪd/ and /hud/-/hʊd/ continua. The method of obtaining them was suggested by Dafydd Gibbon (Bielefeld University, Germany). Being a qualified phonetician he produced the continua. Each continuum was recorded several times and consisted of nine items. The recordings were taken in a sound-treated laboratory.

The choice of the items appropriate for the experiment was based on the first and second formants, as they are mainly responsible for vowel identification. The formants of the stimuli used will be presented below in tables with the results.

The duration of each item was manipulated with Praat. For each spectral step three durational steps were obtained. A long item equalled 250ms, a medium one – 200ms, and a short one – 150ms. There were 18 items in the /hid/-/hɪd/ continuum and 24 in the /hud/-/hʊd/ continuum. The items were presented randomly to the subjects in separate front and back vowel blocks with three repetitions of each item. The interstimulus intervals were considerably long, 150ms, and white noise was present between the stimuli, so as to reduce the role of auditory memory (Repp 1984, pp. 260-264). The stimuli were presented in a reasonably quiet classroom. The stimuli were stored as wav files and played directly from a computer at a comfortable volume. The answers to a few first stimuli were meant to be trials and were not analysed.

37 subjects, native Polish learners of English were tested. The subjects were all high school students preparing for their final exams the following year. They had been studying English for eight years on average. 22 subjects had received private instruction in English in addition to school classes. 10 subjects had spent some weeks in Great Britain or Ireland. All subjects had advanced knowledge of English. Their teacher in high school had been speaking with a British accent and she had been using British books and tapes during instruction. Three native speakers of English identified words in the continua as a control group.

3 RESULTS

To show the effect of duration and spectral changes on the perception of vowel pair by both groups of subjects, native Polish learners of English and native English listeners, the per cent identification scores for both continua by duration steps and by spectral steps will be presented. For the clarity of the analysis first the results of the /hud/-/hʊd/ continuum will be analysed.

3.1 Results – ‘who’d’-‘hood’ continuum

Step number	Duration	% of “who’d” identifications	
		Polish subjects	English subjects
1.	250msec	35	65
2.	200msec	45	56
3.	150msec	63	51

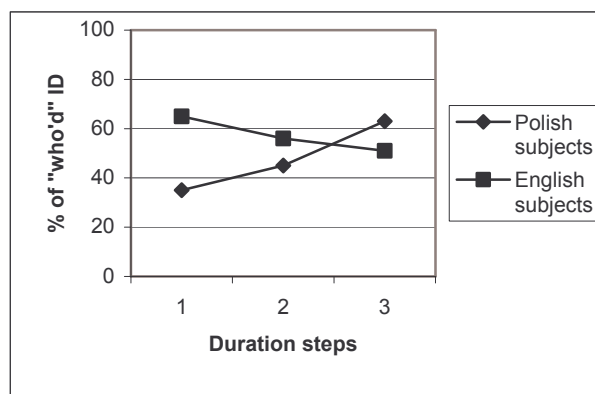


Table 1 & Figure 1. The % of identification scores for ‘who’d’ by duration steps. Answers given by Polish subjects and English subjects.

Both groups reacted to temporal cues for /u/-/ʊ/ contrast. Native Polish subjects, however, showed a reversed pattern.

who'd' - 'hood' continuum			% of 'who'd'		
Step no.	item's F1	item's F2	item's F3	Polish subjects	English subjects
1.	302	808	2464	53	100
2.	318	841	2638	54	96
3.	335	843	2482	45	93
4.	347	937	2611	46	93
5.	358	969	2434	42	63
6.	369	1008	2377	42	7
7.	390	1038	2468	48	7
8.	404	1085	2541	48	4

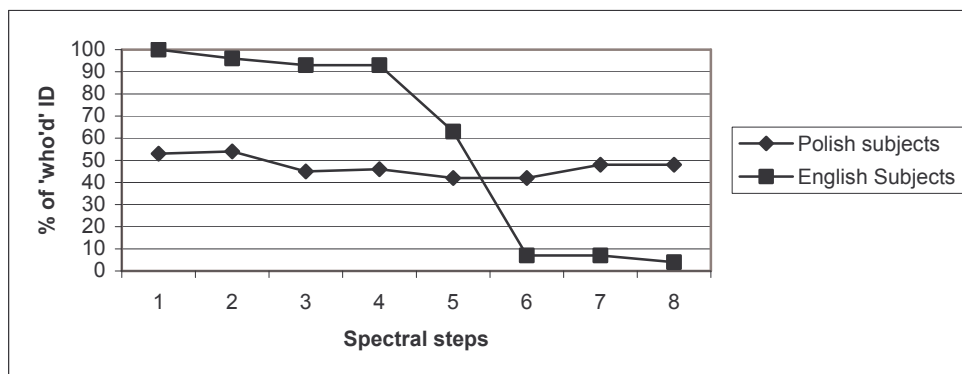


Table 2 & Figure 2. The % of identification scores for 'who'd' by spectral steps. Answers given by Polish subjects and English subjects.

There was a big difference in the reaction to spectral information in the /u/-/ʊ/ continuum. Native English subjects were not hesitant in responding to all but one token and exhibited very strong reliance on spectral cues. They had a typically categorical pattern of perception. Native Polish learners of English showed very weak response to spectral cues. The data suggest that native Polish learners of English and English native subjects differ in the way they divide the acoustic vowel space. For Polish subjects, the whole acoustic vowel space in the region considered represents one category. As far as native English subjects are concerned, the lower and more central the vowel is, the less likely it is to be identified as /u/.

3.2 Discussion of the results for the 'who'd' – 'hood' continuum

The results of the experiment show that temporal cues are more readily available to Polish learners of English than spectral cues. They also show that, unlike to Mandarin subjects from Wang and Munro's (1999) study, temporal cues were important to Polish learners of English in identifying the back vowel continuum.

Both groups moderately responded to temporal cues for the /u/-/ʊ/ distinction. English subjects probably needed information about duration, because spectral steps in the case of the /hud/-/hud/ continuum were considerably smaller, and therefore more ambiguous than in the case of the /hid/-/hid/ continuum. Polish subjects showed a reversed pattern, which is consistent with the debriefing, where 15 subjects claimed that the vowel in 'hood' was longer than in 'who'd', only three subjects claimed that the vowel in 'who'd' was longer

than in ‘hood’ and the rest of the subjects did not know the difference or claimed there was no difference. The confusion was probably caused by orthography, by a double <o> letter in the word ‘hood.’ The reversed pattern of reliance on length can mean that Polish learners of English are able to perceive length differences in vowels, but they have to be explicitly taught which vowels are characterized by longer duration. It is also conceivable that normally the subjects do not perceive any difference between the sounds and when asked to describe it, they made their explanations up and orthography gave them a clue as to what the difference could be.

Spectral information for the /u/-/ʊ/ distinction also yielded different responses among the two groups. Native English subjects clearly showed reliance on spectral cues, with a typical categorical perception pattern. Results obtained for English subjects, with a classical categorical perception curve, prove that the method was correct and that stimuli were appropriate for the experiment. Polish learners of English showed very little reliance on spectral cues. The /u/-/ʊ/ identifications by Polish subjects do not have the characteristics of categorical perception. The percentage of ‘who’d’ responses is at the guessing level throughout the whole continuum. Possibly the two sounds, /u/ and /ʊ/, are not normally distinguished by native Polish learners of English, especially that the high back vowel distinction is not functionally very important in English – very few words are distinguished by the /u/-/ʊ/ contrast. Polish learners’ response to the /u/-/ʊ/ contrast could also be accounted for by Bohn’s (1995, p. 294-295) desensitization hypothesis, which states that “whenever spectral differences are insufficient to differentiate vowel contrast because previous linguistic experience did not sensitize listeners to those spectral differences, duration differences will be used to differentiate the non-native vowel contrast.”

3.3 Results – ‘heed’-‘hid’ continuum

Step number	Duration	% identification by duration steps	
		Polish subjects	English subjects
1.	250msec	72	31
2.	200msec	53	31
3.	150msec	37	30

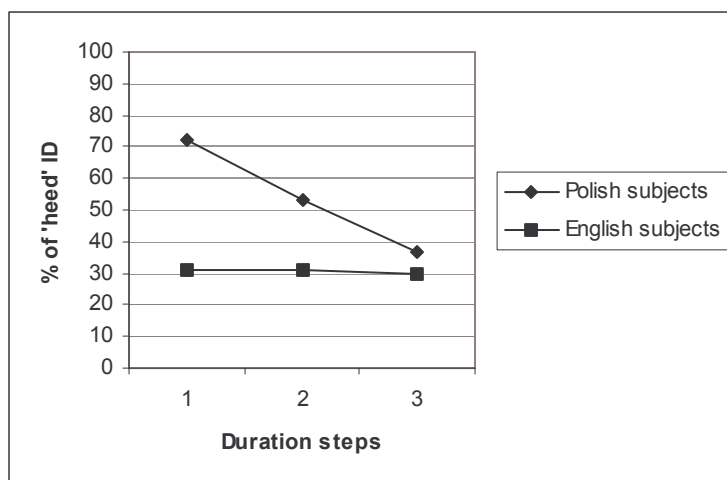


Table 3 & Figure 3. The % identification scores for ‘heed’ by duration steps. Answers given by Polish subjects and English subjects.

It can be seen that native Polish learners of English, in comparison to the control group, responded quite strongly to durational cues. It is noteworthy, however, that both groups gave almost the same percent of ‘heed’ responses in the case of short items. Native English subjects did not rely on temporal cues for the /i/-/ɪ/ contrast.

Step number	Item’s F1	Item’s F2	Item’s F3	% of ‘heed’ identifications	
				Polish subjects	English subjects
1.	278	2455	3208	45	100
2.	304	2313	2947	27	0
3.	319	2278	2797	49	0
4.	336	2240	2593	61	85
5.	348	2217	2715	73	0
6.	362	2156	2664	68	0

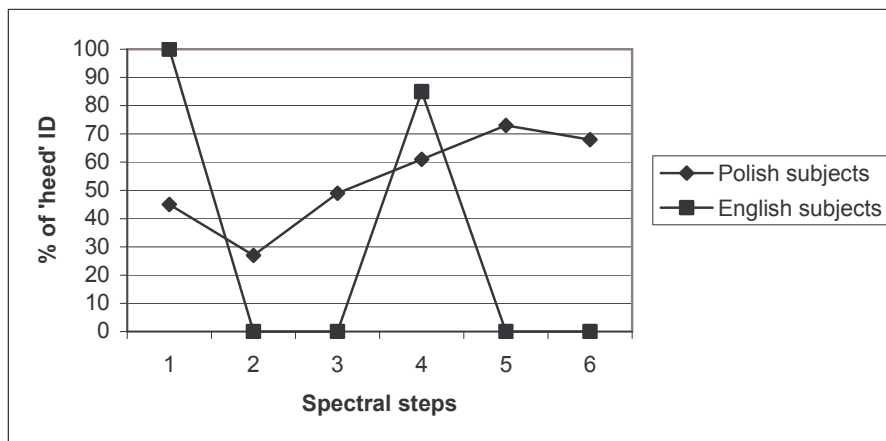


Table 4 and Figure 4. The % identification scores for ‘heed’ by spectral steps. Answers given by Polish subjects and English subjects.

English subjects responded very strongly and unanimously to spectral cues in the /hid/-/hɪd/ vowel continuum, the pattern, however, was quite unexpected. Polish subjects showed a reversed pattern of ‘heed’ and ‘hid’ identification.

3.4 Discussion of the results for the ‘heed’-‘hid’ continuum

The pattern of identification in the ‘heed’ – ‘hid’ continuum was quite unexpected, especially in the case of reaction to spectral cues by native English subjects. Strong and unanimous responses to spectral information in the ‘heed’ – ‘hid’ continuum by native English subjects form a categorical perception pattern typical for more than two categories. The vowel in the fourth item was produced with higher pitch and higher pitch is characteristic for /i/. To accept this possibility would also mean to claim that only item one is perceived as ‘heed’ and, except for the problematic token number 4, all the other items with intermediate formant values belong to the ‘hid’ category. The second explanation of the unexpected pattern is that perhaps more than two categories are involved in the continuum. This hypothesis would require detailed oddity discrimination tests, which would show how many discrimination peaks, related to category boundaries, are present in this continuum.

Polish learners of English strongly relied on temporal cues for the /i/-/ɪ/ distinction. Such results are consistent with what subjects wrote in the debriefing. 23 out of 37 subjects

claimed that the sound in 'heed' is longer than the sound in 'hid.' Native English subjects did not rely on temporal cues for the /i/-/ɪ/ distinction, probably because the spectral steps were big enough, and therefore unambiguous. Noteworthy, the Polish subjects' response to temporal cues for the /i/-/ɪ/ distinction in the case of short tokens is almost at the same level as the native subjects' response. This may mean that Polish learners of English are more sensitive to longer vowel duration.

There was a considerable difference in reaction to spectral cues for the /i/-/ɪ/ distinction between the two groups of subjects. Native English subjects perceived the continuum categorically, which is probably due to the large spectral step-size (Repp 1984, pp. 272-275). Native Polish subjects showed much less reliance on spectral steps, no categorical perception of the items from the continuum and surprisingly, a reversed pattern, or tendency of identification. Orthographic confusion is probably responsible for such a result. The subjects responded to the stimuli as if they interpreted, according to Polish orthographic habits, a vowel in 'hid' as /i/. Such an explanation would be consistent with the debriefing, in which only 5 subjects claimed that the vowel in 'hid' is an /ɪ/ sound. Polish learners of English seem to have interpreted 'hid' as having an /i/ sound, because of Polish orthography interference and 'heed' as having a long vowel because of a double <e> letter.

4 CONCLUSIONS

In both continua orthographic labeling caused confusion among Polish learners of English. Maybe it would have been better to select more popular words for the /i/-/ɪ/ continuum, like 'beat' and 'bit,' for example, and hope that learners are more familiar with them. 'Beat' and 'bit' were not chosen, however, because parallel front and back vowel continua were needed (vowels followed by voiced stops are considerably longer than those followed by voiceless ones) and there is no similar minimal pair for the back vowels. Moreover, more popular as 'beat' and 'bit' probably are, the word 'bit' actually exists in the Polish language and is pronounced with /i/, which could have caused even more confusion. Other possible minimal pairs would be 'peel,' 'pill,' 'pool,' and 'pull' but then the dark /ɪ/ would interfere. Perhaps, pictures should have been used, instead of words, as labels to be identified. Then, it would, however, be difficult to determine whether a potential reversed pattern of discrimination could be ascribed to previous orthographic confusion or not. Maybe two parallel studies among two similar groups of subjects, one with labels in the form of words and the other in the form of pictures should be conducted to compare the results. Another issue would be the choice of pictures to represent the words, the choice by no means easy, taking into account abstract character of most of the tokens appearing in suitable minimal pairs.

Another suggestion for the improvement of the experiment is that the level of pitch should be controlled in order to avoid such confusion as with the token number 4 in the /hid/-/hɪd/ continuum. Nevertheless, some conclusions can be drawn from this experiment.

The fact that native English subjects only turned to temporal cues in the /hud/-/hʊd/ continuum, where spectral cues were small enough to be unambiguous, can be taken as a proof that spectral cues are more important to English native speakers than temporal cues are. Temporal cues played only a secondary role in the identification of vowels. This also shows that reliance on one cue or another and categorical perception are to some extent a matter of a task (Repp 1984, p. 259).

Unlike Mandarin listeners in Wang and Munro's (1999) study, Polish learners of English relied on temporal cues for distinctions in both continua. Also debriefing, unlike in Wang and Munro's (1999) study, showed that many Polish learners of English thought that only length distinguishes the vowels in both continua. Such heavy reliance on durational

information in perceiving English vowels by Polish learners may prove that, as Bohn (1995, pp. 294-298) and Flege (1995, p. 244) claimed, duration is a more readily available cue to foreign vowel contrast. In terms of Major's (2001) Ontogeny Phylogeny Model, heavy reliance on duration could be understood as being universal. Heavy reliance stems neither from L1 transfer, because Polish does not use vowel duration contrastively, nor from L2 component as duration contrast, although present in English, is not so salient. Since reliance on duration cues is also found among English learners of other language backgrounds, it can therefore be a universal feature of second language acquisition.

Reversed patterns of identification in the case spectral cues for the /i/-/ɪ/ distinction and temporal cues for the /u/-/ʊ/ distinction make it difficult to draw conclusions as to the nature of English vowel perception by native Polish learners. Nevertheless, under some assumptions speculations about how English /i/, /ɪ/, /u/ and /ʊ/ vowels are perceived can be made.

Under the assumption that orthographic confusion is responsible for the reversed pattern of 'heed' and 'hid' identifications, it can be speculated that native Polish learners of English identified English /i/ and /ɪ/ vowels as Polish /i/ and /ɪ/. It could then mean that the vowels are assimilated as Two Categories according to Perceptual Assimilation Model. The reliance on spectral steps, however, was not very strong, which suggests that the sounds are perhaps assimilated as a Category Goodness type. A Polish /i/ category could be the category to which the two English vowels were assimilated, as most of the tokens were identified as 'heed.' Perhaps, only the length difference is perceived by Polish learners of English, and the sensitivity to spectral differences in this part of acoustic vowel space is under slight influence of the two Polish categories. According to the Speech Learning Model (Flege 1995) predictions, the two English vowels are certainly too similar to (a) Polish category(ies) for Polish learners of English to establish clear-cut new categories. If differences are noticed, they are durational. So even if the category formation began, it would be based on different features or different weights than an English native speaker's category (SLM, Hypothesis 6). Since durational differences are exaggerated by Polish learners of English in the /i/- /ɪ/ contrast, the perception of the two vowels can be probably better explained by the Ontogeny Phylogeny Model (Major 2001). Spectral information reliance for the /i/-/ɪ/ contrast would probably come from L1 in the case of Polish inexperienced learners of English, whereas heavy reliance on temporal cues as a sign of overgeneralization would be attributed to universal characteristics of the interlanguage.

The /u/-/ʊ/ distinction is even more problematic, as it is doubtful whether Polish subjects normally distinguish the sounds at all. When they were asked to do so in the experiment, they relied on temporal cues and reversed the pattern of identification according to orthographic cues. They did not rely on spectral cues at all. In terms of the Speech Learning Model (Flege 1995), they did not notice enough differences to form a new category and equivalence classification made them perceive both English vowels as one category. Since English has two categories in the high back vowel space and Polish has only one, it could be expected that at least the differences between the Polish /u/ and the English /ʊ/ would be noticed, but as there was no considerable difference in the response to spectral cues for this continuum, Polish learners of English probably assimilated both English /u/ and /ʊ/ into a single native /u/ category (Single Category type according to the Perceptual Assimilation Model). Again, strong reliance on temporal cues seems to be a universal interlanguage feature according to the Ontogeny Phylogeny Model (Major 2001).

The perception of the second language speech sounds is a complex phenomenon based on a few factors: the acoustic structure of the sounds in L1 and L2, their perceptual similarity or dissimilarity, orthography of the two languages and subjects' reading habits, subjects' proficiency in the second language and the importance of a given contrast in

thesecond language. There is a need for further research and analysis aiming also at constructing a phonological theory explaining complexities of the second language speech perception.

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