L3 NORWEGIAN /ʉː/ and /uː/ IN L1 POLISH/L2 ENGLISH LEARNERS: DIFFERENT PATTERNS OF CROSS-LINGUISTIC INTERACTIONS

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ABSTRACT

The spectral properties of Norwegian /ʉː/ and /uː/ were studied in a population of L1 Polish/L2 English speakers acquiring Norwegian as an L3 in an instructed setting in Poland. The vowel /ʉː/ is a rounded high central vowel, displaying a combination of features nominally absent from the speakers' L1 and L2. In addition to descriptive formant measurements, two measures of overlap were used to ascertain if a separate category can be argued to develop for /ʉː/. The results indicate that a distinction is formed against Polish /u/ but not necessarily against English /uː/. Change over time is inconclusive at these early stages of acquisition. Interestingly, /uː/ seems to display influence of L2 acoustics and L1 orthography.

Keywords: Vowel formants; Norwegian; Polish; English; vowel overlap; cross-linguistic influence.

1. INTRODUCTION

1.1. Theoretical background, previous research

Third and additional language acquisition has become recognized as an independent field, based on growing empirical evidence that it is quantitatively and qualitatively different from second language acquisition mainly due to broadened phonetic repertoires, enhanced perceptual sensitivity, higher metalinguistic awareness, language-learning experience and strategies, among others [1, 2]. Systematic enquiries into L3/Ln phonological acquisition have focused on the sources and directionality of cross-linguistic influence (CLI) between the speaker's L1, L2, L3/Ln subsystems, attesting to different types (i.e. progressive, regressive, combined) of multidirectional CLI (L1 ↔ L2, L1 ↔ L3, L2 ↔ L3, etc) modulated by an interplay of factors (see [3] for an overview).

Previous studies on L3 vowel quality acquisition have been rather limited to date [4, 5, 6]. Missaglia [4] demonstrated a bilingual advantage for the acquisition of L3 English vowels in Italian-German bilingual children. Hypothesizing a multilingual system as a 'global entity', Sypiańska [5] showed that multilinguals' vowel space is subject to reshaping in the component languages, consequently becoming less peripheral, and divergent from monolingual baseline data. She also found evidence of combined CLI from L1 Polish and L2 Danish on L3 English vowel production, in line with previous findings. Kopečková et al. [6] investigated the interactions between three vocalic systems in young speakers of L1 German, L2 English and L3 (heritage) Polish. The findings demonstrated high individual variability in vowel production in all three languages, with language status and use as one of the conditioning factors.

The present study aims to contribute further to investigations of the complexities of potential interactions of the speakers' multiple languages while zooming in on selected vowel qualities.

1.2. A basic comparison of the three languages

Polish has a simple six-vowel oral vowel system with three high vowels, /i/, /ɨ/ and /u/. To facilitate transcription-agnostic reference, we will refer to them as BITY, BYTY, BUTY, on the model of the Wellsian keywords for English [7]. Only the latter vowel is rounded, with an F2 in the region of 900 Hz in females [8]. There is no phonological length.

English has a larger set of high vowels comprising FLEECE, KIT, FOOT and GOOSE, traditionally symbolized phonemically as /iː/, /ɪ/, /ʊ/, and /uː/. At first glance, the rounding vs. backness situation may seem similar to that in Polish, with front unrounded and back rounded vowels. However, in many modern English accents, including General British, GOOSE and FOOT have undergone significant fronting in the last 50+ years, and in younger speakers may be regarded as at least central (Deterding [10] citing female F2 values around 1400 Hz, and Bjelaković [18] – around 1800 Hz). This change has been robust enough to be recognized by reference works such as Cruttenden [9] and has seen considerable research from various angles, including its availability to L2 learners [11]. Length is usually taken not to be contrastive, with quality being the chief distinctive factor.

Norwegian has the most complex high vowel system of the three languages, including front unrounded /i(ː)/ (keywords TID, MITT), front (weakly) rounded /y(ː)/ (LYS, NYTT), central rounded /ʉ(ː)/ (GUD, SLUTT) and back rounded /u(ː)/ (BOK, BORT) [12]. Length is phonemic, with only small spectral differences between short and long vowels at each position.

In this paper, we zoom in on the production of Norwegian GUD and BOK, English GOOSE, and Polish BUTY. This is motivated by the combination of height, rounding and backness in Norwegian GUD which is nominally absent from English and Polish. In the light of the fronting of GOOSE, this opens up a number of logical possibilities of cross-linguistic interactions.

Against this background, a few tentative working hypotheses may be formulated:

H1: New categories in L3 Norwegian could form if they are sufficiently dissimilar from L1 Polish and L2 English (cf. Flege [13]).

H2: We hypothesise considerable L1→L3 CLI due to automatized neuro-motor articulatory routines of the native language.

H3: We also expect L2–L3 interactions based on the intrinsic phonetic similarities between English and Norwegian high vowel systems as well as a frequently attested ‘foreign-language effect’ [1].

H4: We predict developmental changes in spectral overlap as a function of time and learning experience (L3→L1).

2. METHODS

2.1. Participants

Ten female students (mean age = 20) majoring in Norwegian at two Polish tertiary education institutions took part in a larger longitudinal study. They were selected from a larger group that also included six male speakers. They had started their programme one month before the first recording session, and were fresh starters without any prior proficiency in Norwegian. All had Polish as their L1, with no language deficits reported in a background questionnaire; and all reported English at the CEFR level B2. Their English proficiency was tested using a placement test as part of the first data collection session.

2.2. Recording sessions

The recording sessions were part of three data collection rounds, abbreviated T1, T2 and T3. T1 took place in November 2021, T2 in March 2022 and T3 in June 2022. Norwegian was collected on the first day of each round, while English and Polish were collected on the second day. Material for other parts of a larger project (including a battery of production and perception tasks, written grammaticality judgements and survey data) was also obtained. The audio recordings accounted for about half of the data collection time.

2.3. Stimuli

Read speech was collected using slides presented on a computer screen at a comfortable pace controlled by the experimenter. We collected all the monophthongs in the three languages, embedded in priming words and target non-words inserted into carrier sentences. These had the general form of *There is the same vowel in ‘bit’ and ‘dit’. The first one is ‘bit’, and the second one is ‘dit’*. In this way, four instances of each vowel (here, English KIT) were collected from each pair of sentences. Additionally, material for other parts of the larger project (e.g. related to plosive aspiration) was collected.

2.4. Recordings, data processing, measurements

The recordings were made in quiet rooms in university offices. Audio was captured using a Shure SM-35 unidirectional cardioid head-worn condenser microphone. It was digitized at 48 kHz, 16 bit using a portable Marantz PMD620 solid state recorder.

The recordings were subsequently forced-aligned using the online interface provided by BAS Munich [14]. The alignments were corrected manually by three trained phoneticians, with target vowel boundaries aligned on the basis of presence of periodic waveform, F2 energy, and amplitude relative to the neighbouring consonants. A Praat [15] script was used to obtain readings of the first three formants of each target vowel, along with the duration. All measurements falling more than a standard deviation from the mean for each vowel were verified manually and corrected.

The statistical analyses were run in R using the *lme4* package for mixed effects regression modelling [16].

3. RESULTS

3.1. General overview

Fig. 1 and Table 1 provide a general overview of the results. From a visual inspection, Norwegian GUD did seem to form a category separate from Polish BUTY and BITY already at T1 but it was less clear what its relation was to English GOOSE. We decided to investigate the overlap between the L2 and L3 vowels.

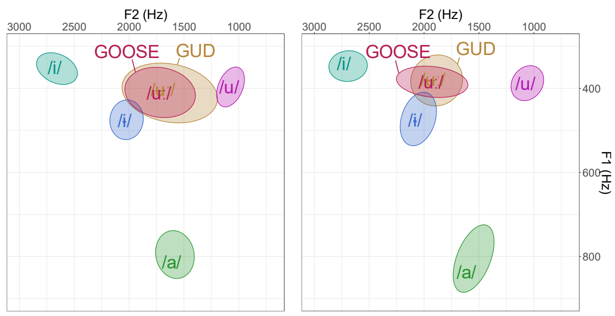

Fig. 1: Aggregate raw Hz data for T1 (left) and T3 (right). Polish /i/, /ɨ/, /u/ and /a/ included as anchors. Ellipses at a 0.5 confidence level.

Vowel	F	T1	T2	T3
BUTY	F1	400	402	388
GOOSE	F1	409	387	384
GUD	F1	406	390	376
BUTY	F2	1068	1053	1059
GOOSE	F2	1727	1769	1926
GUD	F2	1646	1981	1898

Table 1: Raw Hertz group mean formant values for the three data collection times. BOK excluded due to extreme inter-speaker variability.

3.2. Assessing overlap

Two methods were used to assess spectral overlap at the three data collection times: Pillai scores and Mahalanobis distances (as recommended by [17]).

The Pillai score is an output of a MANOVA model that represents the distance between two distributions on a scale from 0 (total overlap) to 1 (complete separation). The Pillai scores for GUD vs. BUTY increased over time, in particular between T1 and T2, indicating improved separation, presumably due to the fronting of GUD/GOOSE visible in Fig. 1; importantly, the scores for most speakers were high at T1, suggesting that even at the very start of their Norwegian course, they had already established a category for the L3 vowel that was separate from their L1.

The situation is far less clear for L3 GUD vs. L2 GOOSE. There was evident overlap between the two vowels at all three Ts, and they both increased in F2 (thus improving separation from BUTY). There was considerable inter-speaker variability. For several speakers, the scores were very low at T1 (indicating substantial overlap), but even the top scores were lower than for GUD vs. BUTY. At T2 and T3, the variability remained, with the Pillai scores increasing for some speakers but decreasing for others. (See Fig. 2.)

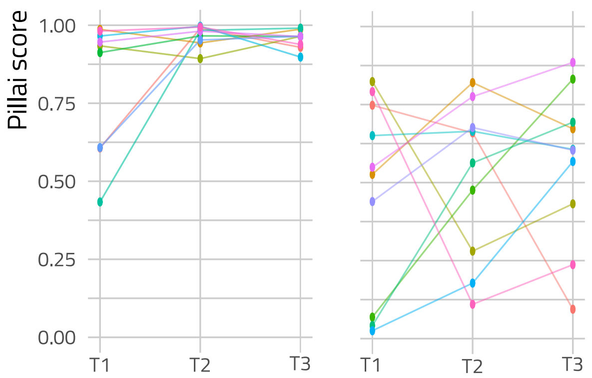

Fig. 2: Pillai scores for GUD–BUTY (left) and GUD–GOOSE (right) at T1, T2 and T3. Each line is one speaker.

A similar picture emerges from the second analysis using Mahalanobis distances. The Mahalanobis distance is the distance between a point and a distribution; in vowel merger studies, it is the distance between a token of one category and the distribution of another category. The greater the score, the greater the distance (thus less overlap).

We calculated distances for each vowel pair in both directions for each speaker. The mean distances between GUD and BUTY increased over time for all but two speakers, even though the main change occurred between T1 and T2, with some apparent reversal between T2 and T3 (see Fig. 3). The picture for BUTY vs. GUD was similar, but with less inter-speaker variation – presumably due to lower variability within the L1 category.

The patterns of developmental change in the mean distances between L3 GUD and L2 GOOSE were again far less clear. At least for some speakers, the mean distance seemed to decrease over time, in particular in the GUD–GOOSE direction, suggesting decreased separation. The apparent anomaly at T2, especially for GOOSE–GUD, may be due to the forward 'leap' of GUD visible from the means in Table 1, which increased distance from GOOSE; at T3, GOOSE seems to have caught up, resulting in a 'reversal'. Fig. 3 summarizes the analyses.

The developmental changes were assessed using mixed-effects regression models fitted to each vowel pair, with Mahalanobis distance as the response variable, *time* as the treatment-coded categorical fixed predictor of interest (levels: 't1', 't2', 't3', reference: 't2') and a by-speaker random intercept. Statistical significance was assessed with likelihood ratio tests. They retuned time as a significant factor in all models, i.e. there were significant differences between the three data collection points.

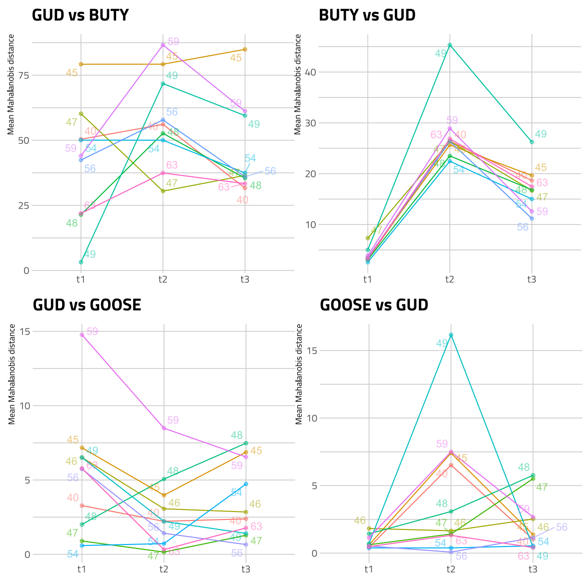

Fig. 3: Mahalanobis distances for T1, T2, and T3. Each line represents one speaker.

3.3. Inter-speaker variability and spelling

We found considerable inter- and intra-speaker variability in the treatment of BOK. In a subgroup of our speakers, BOK was mapped onto Polish BUTY, as expected on the basis of its phonology/phonetics. This may be seen as corroborating our H2 (of the facilitative effect of automated L1 articulatory routines). However, most speakers showed two other patterns.

In some speakers, BOK was mapped onto Polish /ɔ/ (BOTY). We think that the obvious explanation of interference from L1 orthography is sufficient in view of the fact that the data in the present study come exclusively from a reading task.

Very interestingly, other speakers realized BOK with qualities similar to their GUD/GOOSE. We would be inclined to name this a ‘foreign /u/ effect’ (cf. the ‘foreign language effect’ in [1]): the fronter qualities shown in GUD/GOOSE may be seen as ‘allophonic’ ‘foreign’ realizations of an underlying /u/ category, and once a phone is assigned to this category, the realization applies even if it is not required by the phonetics of the Ln phone; in other words, ‘BOK is /u/, but foreign, and foreign /u/ is [ʉ]’. This effect may be seen to also confirm our H3: the ‘foreign language effect’ means that the phonetic realization of an L3 phone is guided by an L2 phone (GOOSE in our case), resulting in an apparent merger whose phonetic quality derives from the L2 rather than L1. Additional evidence for this pattern is provided by a perception study from this same project, in which GUD and BOK were, somewhat surprisingly, perceptually assimilated to Polish /u/ at similar rates by Polish listeners.

Finally, in some speakers, two or three realizations were in evidence. This is summarized in Fig. 5.

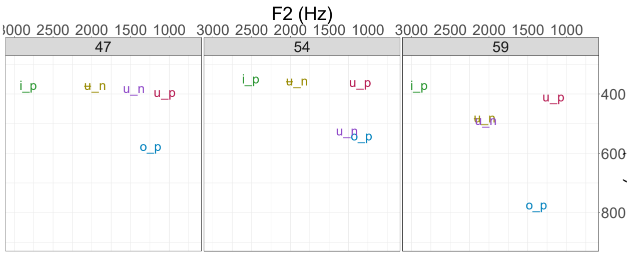

Fig. 4: Inter-speaker differences for BOK (u_n). Polish /i/, /u/, /ɔ/ shown as i_p, u_p, o_p; GUD as ʉ_n. Each panel is one speaker. Separate high back (Speaker 47); merged with /ɔ/ (54); merged with GUD (59).

4. DISCUSSION

Overall, GUD and GOOSE were well differentiated from BUTY. This seems to partially confirm our H1 in that there must be sufficient acoustic separation between the native and foreign languages to warrant formation of a new category in the L2/L3.

We do not have English production data from our speakers that would predate their Norwegian course. Consequently, we cannot state with any certainty that these speakers had acquired appropriately ‘modern’ central qualities of GOOSE first (i.e. before starting their Norwegian). However, existing literature, e.g. Šimačková & Podlipský [11], seems to suggest that this is indeed a possibility. In any case, what *can* be stated with relative confidence is that that the speakers were sensitive to the spectral similarity between GUD and GOOSE. Also, the two vowels seemed to drift towards higher F2 vowels jointly over time. Overall, this seems to, at least partially, confirm our H3.

Interestingly, the acoustic characteristics of the vowels seemed to override any putative phonological assignment of GOOSE as back, and the combination of non-backness with rounding was not a complicating factor. This is despite the unanimous assignment of English GOOSE borrowings in Polish to Polish /u/ (and despite the <u> spelling in Norwegian GUD). Thus, L1 articulatory routines did not play a major role for these two vowels, contra our H2.

However, we do have evidence that the spectral characteristics are only one possible source of cross-linguistic influence. Given the spectral similarity between Polish BUTY and Norwegian BOK, one would be inclined to predict that the acquisition of the latter should pose no problems for Polish learners. This is, in fact, *not* the case in our data (see 3.3 above).

The extremely varied developmental paths visible in both the raw data and the Pillai and Mahalanobis results for the individual speakers serve as confirmation of our H4 (of substantial developmental changes). They point to considerable inter-speaker differences in the attested patterns of development, to the extent that straightforward interpretation of the direction of change is difficult. In particular, the apparent reversal of some trends in some speakers between T2 and T3 requires more analysis.

5. CONCLUSION AND OUTLOOK

We have observed a complex pattern of cross-linguistic interactions and developmental changes in trilingual acquisition of typologically untypical vowels. However, several important avenues remain open for further research.

Currently, we are investigating naturalistic acquirers in the same configuration of languages. In addition to their realizations of GUD (where its dissimilation from GOOSE will be the focus), we are also looking at BOK in spontaneous speech, where the influence of spelling is less strong., We are also collecting relevant data from Norwegian English and Polish English to apply a subtractive L1–L2 design on the model of Westergaard et al. [19].

6. ACKNOWLEDGEMENTS

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