CONVERGENCE ON THE SEGMENTAL AND SUPRASEGMENTAL LEVEL BETWEEN NATIVE SPEAKERS AND SPANISH L2 LEARNERS OF GERMAN

Christiane Ulbrich

University of Konstanz
christiane.ulbrich@uni-konstanz.de

ABSTRACT

This paper presents an investigation of production data obtained during a collaborative task between Spanish learners and a native speaker of German. The task was designed to target specific words and phrases in the beginning and at the end of the conversation. Derived from contrastive analyses of Spanish and German we analysed segmental and suprasegmental aspects. Main objectives were: (1) to shed light on the question whether there is a decreasing interference of Spanish phonology on L2 German productions depending on learners' proficiency levels, and (2) whether segmental and suprasegmental characteristics are affected by phonetic accommodation to varying degrees. Statistical analysis shows inconsistent accommodation effect. The perceptual relevance was tested in an AXB similarity judgment task. Results suggest that phonetic accommodation can occur cross-linguistically, and that it may be constrained by language proficiency. In line with previous findings the results can best be accounted for by an adaptation of a dynamic system approach.

Keywords: phonetic accommodation, collaborative task, Spanish-German, segmentals, suprasegmentals

1. INTRODUCTION

Accommodation in speech has been of interest in studies of speaker variability since the 1970s. Earlier works focussed on the production and perception of variable converging (and diverging) speech patterns in relation to interlocutors attitudes for instance to discourse-contextual, situational or social factors [12], [5]. Whilst such initial attempts examined the evaluation of speakers' competence and social attributes associated with them by listeners, more recent studies focus on specific acoustic-phonetic properties of speech. Coupland [8] investigated the use of four regional phonological variables (h-dropping, t-flapping, ng-dropping, and simplification of final consonant clusters) in real conversation between a travel agent and clients from Cardiff, England. Putman & Street [27] assessed convergence of temporal characteristics in interview settings (speaking rate, turn durations, and inter-turn-intervals). Babel [1] found that New Zealand English speakers adapted their vowel quality to those of Australian English speakers in a word repetition task. Recent studies use such adaptation effects to assess cognitive status and entrenchment of specific parameters. Following this line of thought, adaptation effects have been used to challenge linguistic theories assuming a system based purely on discrete categories [7], [21], in particular because the adaptations often affect sub-categorical aspects change depending on usage-related factors and can hence be better explained on the basis of a theory allowing flexibility in an emergent dynamic system [29], [33]. Such an approach however, introduces not only theoretical possibilities to model cognitive linguistic representation and practical opportunities for instance through its utilization and application in language learning and teaching [34]. It also introduced new challenges by adding levels of variation, e.g. between and within speakers, between and within the levels of linguistics (syntactic [4], morphological [9], and semantic [19], the relationship between quantifiable acoustic properties and perceptual relevance, [24], and social as well as conversational factors [25], [17].

Two aspects of phonetic accommodation are of specific interest in the study of second language acquisition (SLA):

1. Adaptation effects observed in adults with long before L2 acquisition onset established L1 systems suggest that the linguistic system remains mouldable and flexible over the life span. Short- and long-term effects have been observed in several contexts, most relevant for the present paper, bidirectional influences between an L1 and an L2 e.g. [6], [30], [23], [36], [16]; [11].
2. Such ongoing mutability provides evidence against the assumption of a critical or sensitive period of L2 acquisition [18] and challenges accounts for age-related declines in the attainment of an L2 [3]. It also calls out for consideration of additional, not age-related linguistic and extra-linguistic factors to account for variability and dynamics in phonetic accommodation.

2. EXPERIMENTS

Production data were obtained in the beginning and at the end of a collaborative task carried out by Spanish L1 learners of L2 German with different proficiency levels and their native German interlocutor (36 map pairs averaged 41 min (sd=15.93 min), ranging from 28 to 81 min). The results of an acoustic analysis are reported in the first part of this section. The second part present findings of a subsequently carried out AXB similarity judgment task in which a selection of directly comparable production data was judged by native speakers of German. Three main objectives were pursued in the two experiments:

1. to shed light on the question whether there is a decreasing interference of Spanish phonology on L2 German productions in the utterances produced by speakers of higher proficiency levels
2. whether segmental and suprasegmental characteristics are affected to different degrees
3. and whether such developmental differences are verifiably both acoustically and auditorily.

2.1. Collaborative task for speech production

Fourteen native Spanish learners of L2 German and a native German speaker were recorded via Sennheiser headset-headphones directly onto a Macbook Pro computer at a sampling rate of 44kHz during a collaborative map-task performed by a *just* Spanish or by a *mixed* pair of interlocutors. The map task was designed in a way that specific target words and phrases appeared in the beginning and at the end of the collaborative tasks. Targets were chosen to involve the following segmental and suprasegmental characteristics, derived from contrastive analyses of Spanish and German [20]; [15] and all considered to be the source of pronunciation errors and foreign accentedness:

- *neutralisation of final voicing contrast in plosives*
- *realisation of initial /h/*
- *pitch range* on nuclear accents

2.1.1. Participants

Twelve female participants (n=6 in each a high and low proficiency group henceforth HP and LP) participated three times in a collaborative map-task. They were all native speakers of Spanish from the middle Castilian region with no known speech, language, or hearing disorders. They were exchange students at the University of Marburg aged between 21 and 28 (average 24). Participants were allocated to the HP and LP group according to the results of the placement test administered at the language centre of the University of Marburg. Students with B2.2 level or higher were allocated to the HP group those with B1.1 were allocated to the LP group. The collaborative task was performed with a native speaker of standard German, a 23 years old female student of Speech Science at the University of Marburg. In order to guarantee consistency across the participants we also recruited two additional native Spanish learners of L2 German, one of them meeting the criteria of HP the other of LP, referred to as HPc and LPc in the following.

2.1.2. Procedures

The collaborative task was a map-task (three versions per participant) where one Spanish HP or LP acted as a *tourist*, the interlocutors were G, LPc or HPc and they acted as *guides*. *Tourist* and *guide* sat facing one another but separated by a paper wall in a quite room on a table with a schematic map in front of them, which was not visible to the opposite sitting interlocutor. The two maps consisted of a landscape with about twenty labels. Participants knew that most but not all labels were common to the two maps. The task was for the *tourist* – with a map without a route – to draw one on the basis of discussion with the *guide*, who's map showed a route. Additionally, the *tourist* had to gather certain information 'on her way'; such as *"Which film is currently shown in the cinema?" "What is on the menu of the restaurant?"*. The two maps were designed in a way that specific target words and phrases appeared in the beginning and at the end of the collaborative tasks. The Spanish-Spanish map-tasks were carried out twice, i.e. all participants completed the task with HPc and LPc. Additionally, all Spanish participants completed the task with the female German native speaker (a speaker of the northern standard variety), i.e. We recorded in total 36 conversations with a total duration of 21 hours.

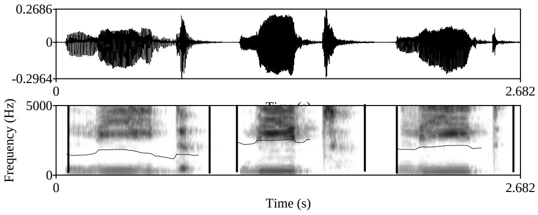
2.1.3. Analyses

Measurements obtained in target words produced by the *tourist* participants (HP1-6 and LP1-6) had to be uttered at least twice (in the beginning and at the end of the collaborative task). Measurements obtained in target words produced by the *guides* (i.e. controls HPc, LPc, G) were averaged across all map tasks and were only used as reference in the figures but not entered in the statistical analysis.

***Neutralisation of final voicing contrast in plosives*:**

The results (based on a total of 213 tokes for /t/ and 197 for /d/) presented here concern the contrast observed in /t/ vs. /d/ in final syllable position. Words that were found in most utterances are: *Tat, Beet, Boot, Not, Rat, Hut, Brot, Kleid, Tod, Lied, Ried, Rad, Sud (act, flower bed, boat, distress, advice, ride, hat, bread, dress, death, song, reed, wheel, brew)*. In order to exclude the influence of the lacking distinction in vowel quality between Spanish and German we excluded targets with short lax vowels preceding the final consonant since they are not part of the Castilian Spanish five-vowel system. Measurements of four intervals were obtained in adaptation of Smith (2007): 1 = vowel duration; 2 = consonant closure duration; 3 = glottal pulsing during consonant closure; 4 = consonant release burst duration (including any ''aspiration''). Duration was normalised in relation to the VC portion of target words to control for within- and between-speaker differences in speech rate. However, burst release duration did not appear to be a meaningful factor but voicing contribution as quantifiable in f0 following the burst release was, as see in the realisation of *Lied* on the right hand side in figure 1.

Figure 1: Illustration of three observed realisations of *Lied* as [liːdə] (left), [liːtʰ] (center), and [liːt] (right)



Statistical analysis was carried out using linear mixed modelling in the R statistical package for the statistical analysis of the data [2]; [28]. We compared a series of models adding independent variables to examine if they improved the fit of the model to the data [2]. Vowel duration and release burst duration were not found to differ significantly in target words recorded at the beginning (henceforth RecT1) and at the end (henceforth RecT2) of the collaborative task.

Figure 2: normalised closure time duration for /t/ and /d/ in the beginning (/t/i and (/d/i) and the end (/t/f and (/d/f) of the collaborative tasks

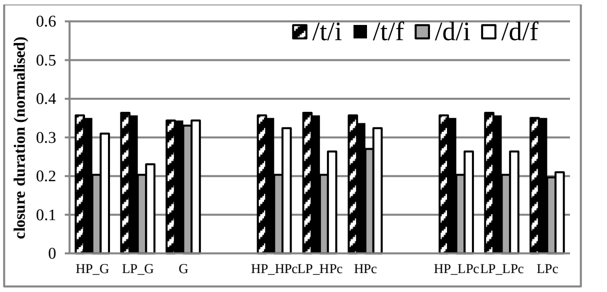


Table 1: Summary of optimal mixed-effects model for CCD

Fixed Factor	Estimate	Std. Error	t value
(Intercept)	7.75	2.078	4.79
PL	0.18	0.006	-2.08*
IL(LPc/G)	0.15	0.001	-1.17
IL(LPc/HPc)	0.12	0.015	1.10
RT	0.21	0.005	2.10*
Con	0.12	0.002	-2.54*
PL:IL(LPc/G)	0.08	0.003	2.31*
PL:IL(LPc/HPc)	0.10	0.002	3.12*
PL:RT	0.03	0.001	2.22
PL:Con	0.21	0.001	1.20
IL(LPc/G):RT	0.05	0.002	1.97
IL(LPc/HPc):RT	0.00	0.003	1.18
IL(LPc/G):Con	0.07	0.002	2.77*
IL(LPc/HPc):Con	0.01	0.007	2.21*
RT:Con	0.13	0.002	2.18*
PL:IL(LPc/G):RT	0.11	0.009	2.03*
PL:IL(LPc/HPc):RT	0.02	0.019	1.99*
PL:IL(LPc/G):Con	0.01	0.006	-3.93*
PL:IL(LPc/HPc):Con	0.07	0.014	4.45*
IL(LPc/G):RT:Con	0.08	0.010	2.11*
IL(LPc/HPc):RT:Con	0.07	0.019	2.99*
PL:IL(LPc/G):RT:Con	0.01	0.002	2.03*
PL:IL(LPc/HPc):RT:Con	0.03	0.019	2.39*

Results of a mixed linear effects analysis of the cononant closure duration data obtained in the experiment.The default levels of the variables are as follows: Profilevel PL (PL)=LP (vs. HP), Consonant (con) =/t/ (vs. /d/), Interloc (IL) = LPc (vs. HPc, vs.G), RecTime (RT)=RecT1 (vs. RecT2). * Denotes $p < 0.05$.

Differences were found in the consonant closure duration (CCD), as illustrated in figure 2. The model with the best fit included Proficiency Level (HP:LP), Interlocutor (HPc:LPc:G), Recording Time (RecT1:RecT2) and Consonant (/t/:/d/) as fixed effects and a random intercept for Subject and by-subject random slopes for Proficiency Level, Interlocutor and Recording Time. The dependent variable was consonant closure duration. Proficiency Level, Interlocutor and Recording Time were dummy coded with LP, LPc and RecT1 as default levels of these variables, respectively, and Consonant was coded as an ordinal variable (/t/=1, /d/=2). The statistical analyses revealed significant interactions (see table 1): /t/ was produced with a relative stable CCD in all conditions. Note, G produced both /t/ and /d/ with a comparable CCD. The realisation of /d/ varied depending on Proficiency level and RecT. Only HP subjects produced a longer CCD in the end of the collaborative task and only in conversations with HPc and G. Variance of the dependent variable glottal pulsing duration (GPD) was best explained by a model including Proficiency Level, Interlocutor and Consonant. These factors interacted significantly (see table 2); HP showed shorter GPD in conversations with G and generally GPD was significantly longer in realisations of /d/ across all subjects regardless recording time, as illustrated in figure 3.

Table 2: Summary of optimal mixed-effects model for GPD

Fixed Factor	Estimate	Std. Error	t value
(Intercept)	5.58	0.729	3.91
PL	0.082	0.007	2.11*
IL(LPc/G)	0.051	0.002	2.00*
IL(LPc/HPc)	0.024	0.001	2.01*
Con	0.074	0.013	2.05*
PL:IL(LPc/G)	0.008	0.000	-2.07*
PL:IL(LPc/HPc)	0.014	0.003	1.09
PL:Con	0.031	0.003	-2.32*
IL(LPc/G):Con	0.008	0.002	2.33*
IL(LPc/HPc):Con	0.018	0.004	-2.21*
PL:IL(LPc/G):Con	0.023	0.002	1.02
PL:IL(LPc/HPc):Con	0.067	0.001	-2.01*
IL(LPc/G):RT:Con	0.032	0.002	1.96

Results of a mixed linear effects analysis of the cononant closure duration data obtained in the experiment.The default levels of the variables are as follows: Profilevel PL (PL) = LP (vs. HP), Consonant (con) = /t/ (vs. /d/), Interloc (IL) = LPc (vs. HPc, vs.G) *Denotes p < 0.05.

Figure 3: normalised glottal pulsing duration for /t/ and /d/ in the beginning (i) and the end (f) of the collaborative tasks

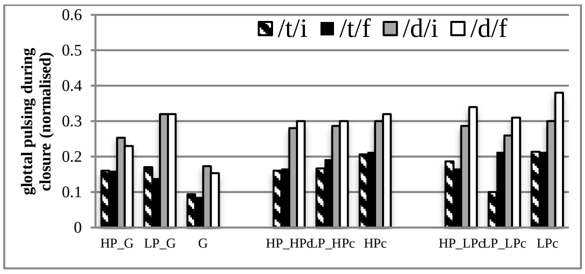
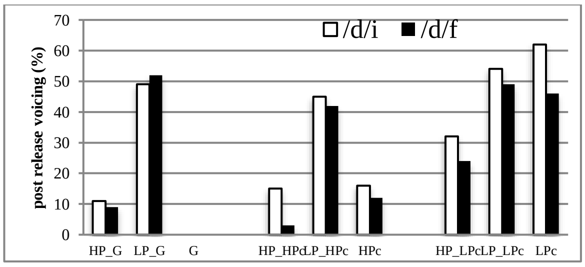


Figure 4: percentage of post release voicing in /d/ at the beginning (/d/i) and at the (/d/f) of the collaborative task



Similarly, post release voicing (PRV) occurred significantly more often in LP compared to HP and HP realisations were found to depend on the interlocutor, as illustrated in figure 4. In task completion with G, HP realised fewer target words with PRV. The interaction between Proficiency Level and Interlocutor was significant, note that the model did not include Consonant since no PRV is expected in /t/, see table 3. Recording Time was excluded from the model to explain variance in PRV since it did not improve its fit.

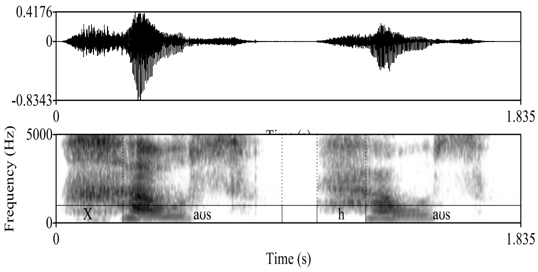
Table 3: Summary of optimal mixed-effects model for PRV

Fixed Factor	Estimate	Std. Error	t value
(Intercept)	97.5	14.3	12.66
PL	28.6	12.2	4.71*
IL(LPc/G)	13.9	6.7	3.21*
IL(LPc/HPc)	19.1	3.8	2.82*
PL:IL(LPc/G)	23 .3	5.8	-3.22*
PL:IL(LPc/HPc)	17.3	3.6	4.24*

Results of a mixed linear effects analysis of the cononant closure duration data obtained in the experiment.The default levels of the variables are as follows: Profilevel PL (PL) = LP (vs. HP), Interloc (IL) = LPc (vs. HPc, vs.G) *Denotes p < 0.05.

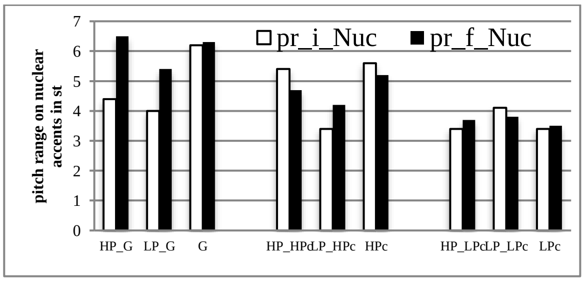
***Initial /h/*:** In German initial /h/ is produced as voiceless glottal fricative. In Spanish, /h/ is not part of the phonemic inventory [15]. Initial /h/ was produced as uvular fricative /X/, as glottal fricative /h/ or dropped Ø. The descriptive statistical analysis was based on the phonetic transcription of relatively few target words (HP RecT1: n=69, average=12; HP RecT2: n=43, average=7; LP RecT1: n=34, average=5; LP RecT2: n=37, average=5) carried out by five trained phoneticians, all students in Phonetics and Speech Science. Only in the data obtained from HP-G map-tasks we found increasing /h/ realisations in initial position. Noteworthy though is the observation that most of realised initial /h/ had a comparably bigger noise component in the signal as found in native realisations of initial /h/ and were hence transcribed as uvular fricative [X] as illustrated in figure 5.

Figure 5: realisation of Haus (house) as [Xaʊs] (left) and [haʊs] (right)



***Pitch range on nuclear accents*:** Spanish rhythm has been assumed to be more syllable-timed as oppose to German rhythm, which is considered to be more stress-timed. This has led Grab-Kempf [14] and Hirschfeld [15] to conclude that articulatory strength and pitch range variation may be reduced in Spanish speakers of L2 German compared to native speakers of German.

Figure 6: pitch range on nuclear accents in semitones at the beginning (i) and at the end (f) of the collaborative task



To our knowledge there is no experimental contrastive analysis for German and Spanish pitch range, however, cross-linguistic analyses of Spanish vs. English and English vs. German have confirmed the above mentioned intuitive assumption that Spanish speakers produce a smaller pitch displacement on accented syllable compared the English speakers [10] and Germans have been shown to produce an even smaller pitch range compared to native speakers of English [22]. In the current production data f0 was measured in monosyllabic and bisyllabic nuclear accents at the end of declarative utterances. Duration was normalised across target words and the f0 interval was converted into semitones. Results are illustrated in figure 6. The statistical analysis was based on 714 pitch range values (HP RecT1: n=262, average=44; HP RecT2: n=178, average=30; LP RecT1: n=135, average=23; LP RecT2: n=139, average=23). Initially, we added syllable number as a factor (mono- vs. bisyllabic) which did not improve the fit of the model. We therefore pooled data points and excluded syllable number as fixed factor from the model. Variance of the dependent variable pitch range was best explained by a model including Interlocutor (HPc:LPc:G) and Recording Time (RecT1:RecT2). These factors interacted significantly; see table 4. Both HP and LP showed larger pitch ranges in conversations with G at RecT2 indicating accommodation. Note that in collaborative tasks with LPc both LP and HP participants produced nuclear accents on declaratives with a relative small pitch range, which may also be the result of convergence towards the interlocutor.

Table 4: Summary of optimal mixed-effects model for PR

Fixed Factor	Estimate	Std. Error	t value
(Intercept)	53.8	21.9	5.11
IL(LPc/G)	2.4	0.8	-2.09*
IL(LPc/HPc)	1.9	2.65	2.66*
RT	2.1	1.11	1.89
IL(LPc/G):RT	3.0	1.31	2.34*
IL(LPc/HPc):RT	3.6	0.56	2.71*

Results of a mixed linear effects analysis of pitch range data obtained in the experiment.The default levels of the variables are as follows: Interloc (IL) = LPc (vs. HPc, vs.G) , RecTime (RT) = RecT1 (vs. RecT2) *Denotes p < 0.05.

2.2. AXB Similarity Task

Recent studies have shown that different acoustic-phonetic measures exhibited distinct, talker and item-dependent pattern of variation and accommodation [26]. The results of the acoustic analysis above confirm this concern. A perceptual similarity task as first adapted by Goldinger [13] provides a holistic measure of phonetic accommodation effects. Hence, a psychophysical AXB perceptual similarity paradigm was administered to native German listeners.

2.2.1. Stimuli & Procedure

Target words produced by the L2 speakers acting as *tourist* in the collaborative map-task were used as flanking stimuli (A and B) along with the *G guides* target words (X). 53 native listeners of German had to determine whether an early or a late target word produced by a *tourist* was more similar to the *guide's* production of the same word. All listeners (aged between 22 and 58, average 36) were monolinguals with no dialect background. They reported normal hearing and speech. Some of them received course credit for compensation. If phonetic accommodation had occurred, target words produced at the end of the collaborative task should sound more similar to the X-item than those produced in the beginning of the task. AXB perceptual similarity tests were presented to listeners in a quiet room over Sennheiser Pro headphones via Macintosh computers.

2.2.2. Analysis and Results

Regression analysis was carried out comparing a series of models adding independent variables to examine their contribution to the fit of the model. The model we fitted initially to explain variance in the depending variable AXB accuracy included Proficiency Level, Interlocutor, Recording Time and Acoustic-Phonetic-Parameter (neutralisation of voicing in /t/-/d/; /h/ realisation; pitch range) as fixed effects and a random intercept for Subject and by-subject random slopes for Proficiency Level, Interlocutor, RecTime, and Acoustic-Phonetic Parameter. Stepwise removal of Interlocutor, RecTime, and Acoustic-Phonetic Parameter improved the model's fit measured by the difference in deviance ΔD. The statistic results are hence based on a model with Proficiency Level as fixed effect and a random intercept for Subject and by-subject random slopes for Proficiency Level, see table 5.

Table 5: Summary of optimal mixed-effects model for AXB accuracy

Fixed Factor	Estimate	Std. Error	t value
(Intercept)	12.71	3.27	8.12
PL	0.08	0.021	2.02*

Results of a mixed linear effects analysis of AXB Accuracy obtained in the experiment. The default levels of the variables are as follows: Profilevel PL (PL) = LP (vs. HP), *Denotes p < 0.05.

HP target words were more accurately evaluated by the German listeners, LP targets judgments yield chance level performance as illustrated in table 6.

Table 6: AXB accuracy in % for final plosive neutralisation targets (N), /h/-realisation (/h/); pitch range (PR) pooled for HP and LP.

	N	/h/	PR
HP_G	0.67	0.75	0.683
LP_G	0.56	0.54	0.565

3. DISCUSSION

The two experiments confirm general findings on short-term phonetic accommodation in conversational tasks. Adult learners of a second language are hence able to converge towards the speech of an interlocutor. The data also show that these effects depend on the proficiency level of the L2 learner, with more advanced learners showing stronger effects of phonetic accommodation. However, segmental and suprasegmental acoustic-phonetic parameters' convergence appears to vary in that beginners do not show any accommodation effects on the segmental level but in adaptation of pitch range. These findings contradict the findings in [35] where prosodic characteristics (continuation rise in American English L2 speakers of German) appeared to be mastered at relatively advanced stages of L2 acquisition whereas deviant L2 segments (/r/ as [ʀ] in German and [ɹ] in American English) were produced already in groups of beginners. Whilst the then analysed continuation rise is associated with a function related to information structure of an utterance, nuclear accents may be a parameter associated more locally with grammatical units. Additionally it may be the case that such prosodic characteristics that do not involve unknown articulatory patterns can be acquired earlier. Contrary to Pardo et al. [26], variability between individual acoustic-phonetic segmental parameters was considerably small in the current data, which may be due to the fact that data on the different parameters were gathered within the same experimental task.

4. REFERENCES

[1] Babel, M. 2010. Dialect divergence and convergence in New Zealand English. *Language in Society*, 39, 437-456.

[2] Bates, D., Mächler, M., Bolker, B., & Walker, S. 2015. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software, 67*(1), 1 - 48.

[3] Birdsong, D. 1999. Whys and Why Nots of the Critical Period Hypothesis for Second Language Acquisition. In: D. Birdsong (ed.) *Second Language Acquisition and the Critical Period Hypothesis*. Lawrence Erlbaum Publishers. 1-21.

[4] Bock, J. K. 1986. Syntactic persistence in language production. *Cognitive Psychology*, 18, 355–387.

[5] Bourhis, R. Y., Giles, H. 1977. The language of intergroup distinctiveness. In: H. Giles (Ed.), *Language, Ethnicity, & Intergroup Relations,* 119-135. London: Academic Press.

[6] Chang, C. B. 2013. A novelty effect in phonetic drift of the native language. *Journal of Phonetics*, 41(6), 520–533.

[7] Chomsky, N., Halle, M. 1968. *The sound pattern of English*. New York: Harper & Row.

[8] Coupland, N. 1984. Accommodation at work: Some phonological data and their implications. *International Journal of the Sociology of Language,* 46, 49-70.

[9] Dunstan, S. B. 2010. Identities in transition: The use of AAVE grammatical features by Hispanic adolescents in two North Carolina communities. *American Speech*, 85(2), 185–204.

[10] Estebas-Vilaplana, Eva 2014. The evaluation of intonation: pitch range differences in English and in Spanish. In: Geoff Thompson & Laura Alba-Juez. *Evaluation in Context. Pragmatics & Beyond New Series 242,* 179–194.

[11] Fabiano-Smith, L., Viswanathan, N., Olmstead, A. 2010. Short term phonetic and phonological changes during Spanish instruction. *J. Acoust. Soc. Am.* 128, 2486.

[12] Giles, H. 1973. Accent mobility: A model and some data. *Anthropological Linguistics*, 15, 87-109.

[13] Goldinger, S. D. 1998. Echoes of echoes? An episodic theory of lexical access. *Psychological Review*, 105(2), 251–279.

[14] Grab-Kempf, E. 1988. *Kontrastive Phonetik und Phonologie Deutsch-Spanisch*. P. Lang, Frankfurt.

[15] Hirschfeld, U. 1988. Sprachvergleich Spanisch-Deutsch im Bereich der Phonetik/Phonologie. In: Wotjak, Gerd; Regales, Antonio (eds.). *Studien zum Sprachvergleich Deutsch-Spanisch.* Valladolid: Spanischer Deutschlehrerverband, 31-36.

[16] Jiang, H., 2010. Effect of L2 phonetic learning on the production of L1 vowels: A study of Mandarin-English bilinguals in Canada. In: K. Dziubalska-Ko laczyk, M. Wrembel, and M. Kul (eds.), *New Sounds 2010: Proc. of the 6th International Symposium on the Acquisition of Second Language Speech*, Poznan, Poland, 227–232.

[17] Kim, M., Horton, W. S., Bradlow, A. R. 2011. Phonetic convergence in spontaneous conversations as a function of interlocutor language distance. *Laboratory Phonology,* 2(1), 125-156.

[18] Lenneberg, E. H. 1967. *Biological foundations of language.* New York: Wiley.

[19] Liberman, K. 2012. Semantic drift in conversations. *Human Studies*, 35, 263–277.

[20] Lleó, C., Kuchenbrandt, I., Kehoe, M., Trujillo, C. 2003. Syllable final consonants in Spanish and German monolingual and bilingual acquisition. In: Müller, Natascha (ed.). *(In)vulnerable domains in multilingualism.* Amsterdam: Benjamins, 191-220.

[21] McCarthy, J. J. 2003. *OT constraints are categorical. Phonology*, 20, 75–138.

[22] Mennen, I., Schaeffler, F., Docherty, G. 2012. Cross-language differences in fundamental frequency range: A comparison of English and German. *Journal of the Acoustical Society of America*, 131, 2249–2260.

[23] Mennen, I. 2004. Bi-directional Interference in the Intonation of Dutch Speakers of Greek. *Journal of Phonetics* 32(4), 543-563.

[24] Pardo, J. S. 2013. Phonetic convergence in college roommates. *Journal of Phonetics*, 40, 190–197.

[25] Pardo, J. S. 2010. Expressing oneself in conversational interaction. In: E. Morsella (Ed.), *Expressing oneself/expressing one's self: communication, cognition, and identity,* 183–196. Hove, England: Psychology Press/Taylor & Francis.

[26] Pardo, J. S., Urmanche, A., Wilman, S., & Wiener, J. 2017. Phonetic convergence across multiple measures and model talkers. *Attention, Perception, & Psychophysics,* 79, 637-659.

[27] Putman, W. B., & Street, R. L. 1984. The conception and perception of noncontent speech performance: Implications for speech-accommodation theory. *International Journal of the Sociology of Language,* 46, 97-114.

[28] R Core Development Team. 2016. *R: A language and environment for stat istical computing,* version 3.3.2. Retrieved from http://www.R-project.org

[29] Roon, K. D., & Gafos, A. I. 2015. Perceptuo-motor effects of response-distractor compatibility in speech: beyond phonemic identity. *Psychonomic Bulletin and Review,* 22, 242–250

[30] Sancier, M. L., Fowler, C. A., 1997. Gestural drift in a bilingual speaker of Brazilian Portuguese and English. *Journal of Phonetics*, 25(4), 421-436.

[31] Smith, B.L., Hayes-Harb, R. Bruss, M., Harker, A. 2009. Production and perception of voicing and devoicing in similar German and English word pairs by native speakers of German. *Journal of Phonetics* 37, 257–275.

[32]Tobin, S. 2015. A dynamic approach to phonetic change. *ICPhS* (M. Wolters, J. Livingstone, B. Beattie, R. Smith, M. MacMahon, J. Stuart-Smith & J. Scobbie, Eds.). London: IPA.

[33] Tobin S.J., Nam, H. Fowler, C. A. 2017. Phonetic drift in Spanish-English bilinguals: Experiment and a self-organizing model. *Journal of Phonetics* 65 45–59

[34] Trofimovich, P. 2016 Interactive alignment: A teaching-friendly view of second language pronunciation learning. *Language Teaching*, 49.3, 411–422.

[35] Ulbrich, C. 2015: Developmental stages and variability in the acquisition of second language segments and prosody. In *The Scottish Consortium for ICPhS 2015 (Ed.), Proceedings of the 18th ICPhS.* Glasgow, UK: Paper number 0549 .

[36] Ulbrich, C. & Ordin, M. (2014): Can L2-English influence L1-German? The case of post-vocalic /r/. *Journal of Phonetics* 45C, 26-42.