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SOCIOLINGUISTIC CONDITIONING OF PHONETIC CATEGORY REALISATION IN NON-NATIVE SPEECH

EWA WANIEK-KLIMCZAK
ewaklim@uni.lodz.pl
University of Łódź

Abstract
The realisation of phonetic categories reflects a complex relationship between individual phonetic parameters and both linguistic and extra-linguistic conditioning of language usage. The present paper investigates the effect of selected socio-linguistic variables, such as the age, the amount of language use and cultural/social distance in English used by Polish immigrants to the U.S. Individual parameters used in the realisation of the category 'voice' have been found to vary in their sensitivity to extra-linguistic factors: while the production of target-like values of all parameters is related to the age, it is the closure duration that is most stable in the correspondence to the age and level of language proficiency. The VOT and vowel duration, on the other hand, prove to be more sensitive to the amount of language use and attitudinal factors.

Key words: second language phonetics, language use, age, acculturation, language attitude, Voice, the VOT, vowel duration, closure duration

1. Introduction

The aim of this paper is to investigate patterns of relationship between socio-psychological factors and phonetic parameters for the purpose of checking the predictive power of socio-psychological factors on successful category implementation in SLA and motivating the level of phonetic parameters for the study of success in SLA. More specifically, the study aims to verify the prediction that socio-psychological factors vary in their predictive power on the target-like production of individual phonetic parameters, which are used in implementation of a linguistic category. The category chosen for investigation is consonantal voice. As the category is implemented either by one or more phonetic parameters, differences in the predictive power of socio-psychological factors on individual parameters, e.g. vowel duration and closure duration in post-vocalic voice implementation, would describe the dynamism of second language acquisition and would help to explain the nature of a foreign accent even in highly proficient early bilinguals. Thus, the study has both theoretical and practical implications. Firstly, by establishing the pattern of relationship we can choose the best predictors of success, and secondly, by checking which factors have significant effect on phonetic parameter values, we can postulate a different degree of independence and control of these parameters. As the level of phonetic detail is claimed to be linguistically relevant (e.g. Docherty 1992, Cho and Ladefoged 1999, Coleman 2002), the degree of correlation

between individual parameters and sociolinguistic factors may shed more light on the interaction between the parameters and their relative ease/difficulty in second language sound system formation. The ease/difficulty question directly leads not only to the applied interpretation in terms of second language learning, but has broader implications for the degree of control / automaticity in speech production.

Dynamic and highly variable, second language speech provides perfect context for the investigation of the relationship between different types of conditioning and their varied effect on language production. As a natural language, non-native speech is characterised by socio-linguistic variability typical for the first language. Numerous studies (e. g. Dickerson 1974, Tarone 1979, 1983, Waniek-Klimczak 2003) have shown that non-native speech exhibits style-sensitivity in the sense of Labov (1972); second-language speakers have been proved to vary systematically in the use of language depending on interlocutors' interaction and their perception of each other (e.g. Beebe and Giles 1984); L2 speech has also been found to contain two levels of social markers suggested for L1 (Dowd, Zuengler, Berkovits 1990, Zuengler 1989). Apart from explaining variability, social and psychological factors have been used in SLA studies as predictors of success in formation of the new L2 system and its use. Combinations of social and psychological factors have been advocated as predictors of success in SLA in Schumann's Acculturation Model (1978, 1986) based on Social Identity Theory (Tajfel 1978). Searching for sources of variable attainment in L2, researchers have investigated such factors as age of first exposure to the language (e.g. Purcell and Suter 1980, Scovel 1988, Thompson 1991, Flege 1992, Flege et. al. 1996), language experience, native speaker input and continued native language use (e.g. Thompson 1991, Flege et. al 1996, Major 1997, Piske et al. 2001).

The predictive power of socio-psychological factors has been investigated with reference to specified elements of the sound system at the segmental level (e.g. Flege 1992, 1997, Bohn and Flege 1997, Flege and Liu 2001, Piske et. al 2001) or at the level of global features of foreign accent (e.g. Purcell and Suter 1980, Thompson 1991). At the level of phonetic detail, one parameter, Voice Onset Time, has been particularly well studied in second language context (e.g. Fourakis and Iverson 1985, Nathan et. al 1987, Bohn and Flege 1993, Flege et al. 1996), with researchers investigating the VOT parameter (Lisker and Abramson 1964) from the perspective of category formation. As languages differ with respect to the use of long-lag (above 30ms), short-lag (0-30ms) or lead (pre-voicing), the VOT has been measured in an effort to establish conditions for category formation in the case of speakers whose L1 uses a different VOT category than L2, e.g. the formation of a long-lag category in English by native speakers of Spanish, a short–lag language (e.g. Nathan et. al 1987). Thus, the values of a single phonetic parameter have been used as a variable for the discussion of category implementation. Further development in second language speech phonetics has led to an increased interest in a multi-parameter analysis. In an early study, Fourakis and Iverson (1985) investigated both the VOT and closure duration in stop consonants of English, Arabic and Arabic accented English speakers and found that the two parameters interact in accented speech; more recently, Zampini and Green (2001) reported parameter-dependent success in their Spanish-English subjects, who produced native-like values of VOT but not closure duration. Thus, when predictors of success are approached from the

perspective of the interaction between parameters in category implementation, the predictive power of individual socio-psychological factors may differ.

2. Study Design

The study reported here re-analyses the data reported in Waniek-Klimczak 2005. We investigate the realisation of linguistic category voice in English spoken by Polish immigrants to the U.S in an effort to establish relationship between socio-psychological factors and values of phonetic parameters used in category implementation. The following research questions have been formulated:

1. Do socio-psychological factors predict success in category implementation?
2. More specifically, what is the relationship between individual factors and particular acoustic parameters used in phonetic realization?

Previous research motivates the assumption that socio-psychological factors do affect the degree of target-like value production, and consequently, can be treated as predictors of success. However, the details of this relationship at the level of individual parameters remain to be established. If the relationship between factors and individual parameters proves to be parameter-dependent, we will have shown the applicability of this level of analysis for SLA studies. Additionally, parameter-dependent relationship has practical implications for language learners.

2.1 Socio-psychological factors

Socio-psychological, speaker-related factors present a wide range of variables which may influence the target-like performance in a second language. The factors which have been found relevant to the second language phonetic studies (see e.g. Piske et al. 2001) and which are proposed to be investigated as major sources of variability in the production of phonetic parameters include the age of learning (AOL), language experience and age at the time of recording (AGE), self-assessed language proficiency level, the amount of L1 and L2 use, and finally the acculturation related issue of cultural and social distance and inter-cultural integration.

2.2 Age of learning

Age of learning has been established as the main variable deciding about the emergence of a foreign accent (also referred to as age of arrival in the case of immigrant studies, AOA, sometimes distinguished from the age of first exposure to L2 (AOL, e.g. Flege et al. 1996). Numerous phonetic studies investigated two aspects of the foreign accent problem: on the one hand the earliest age at which foreign accent can be noticed and on the other, the possibility of ultimate attainment in adults. The generally accepted prediction concerns the preference for younger learners and is formulated as ‘the younger, the better’. This generalisation relates to the Critical Period Hypothesis (Lenneberg 1967, Scovel 1988), which assumes that age is a major constraint in the

acquisition of native proficiency in second language. The age factor has been associated with the loss of neural plasticity (Lenneberg 1976), attention-related factors (Jusczyk 1997), related to the diminished ability to establish perceptual representation for new sounds (Flege 1992). Numerous studies tried to find the upper age limit for full attainment: Flege (1991) found that Spanish-English bilinguals were able to establish two separate categories for /t/ in Spanish and English if the age of first exposure to English did not exceed 5 or 6. Flege and Fletcher (1992) provided further support for full attainment of the Flege 1991 study subjects in the accent rating study, which showed the early (AOL 5-6) learners not to have a foreign accent; the same study brought accent ratings in the case of Chinese speakers of English who started learning English at the age of 7.6 on average. A comprehensive study of Italian immigrants to Canada (Flege et al. 1996) proved that the average age at which accent emerges can be established at 7.4 years of age, with the earliest age of 3.1 years at the first exposure to English. The general pattern emerging from this study supports the claim that the age factor functions as the main determinant of success in a second language, with the age of learning accounting for 59% of variance in foreign accent rating. However, the results point to a considerable variability; in effort to explain the differences in success, other factors need to be taken into account, including the amount and quality of second language native input and language experience.

2.3 The amount of L2 and L1 use

The effect of language use has been investigated in connection with language experience and length of residence. In an early study, Suter (1976) found the length of residence and the native speaker input function as significant predictors of pronunciation accuracy (see also Purcell and Suter 1980); Thompson (1991) reports a high degree of correlation between mean accent rating and the length of residence and the years of education in English - these two factors were found to be more important than the proportion of language use at work, at home and with friends. Studying factors affecting L2 consonant production, Flege et al. (1996) found the length of residence and the use of language most relevant (after the age of learning factor) to consonant production. Other studies of the length of residence and the amount of target language usage point to the relationship between the two aspects of language experience. Flege and Liu (2001) investigated the effect of length of residence on Chinese speakers of English and found that the improvement over time is possible only if the amount of native speaker input is sufficiently high. Another study investigating the effect of the L1 use on the L2 accuracy proved the relationship between the frequency of the L1 use and the degree of a foreign accent in L2 (Flege et al. 1997). Moreover, even very early learners have been found not to establish a new category in L2 as the effect of being exposed to an accented rather than native speech in L2 (Flege and Eefting 1987). Continued usage of L1 has also been found to have an effect on the degree of foreign accent: Piske et al. (2001) report the amount of use of Italian by their subjects to be an independent predictor of their foreign accent in English.

2.4 Cultural/social distance and integration strategy

Cultural and/or social distance and ethnic identity are connected with the affective variables related to empathy and cultural identity (Tarone 1987, Boski 1991); these factors have been studied in connection with the Acculturation Theory claim that it is a set of conditions summarised by acculturation strategy that decide about success in second language acquisition (Schumann 1978, 1986). Schumann (1978) claimed that the smaller the social and cultural distance and the greater the empathy with the native speakers of the target language the more successful the second language learner will be. Further studies into the relative importance of individual factors proved that general integrative orientation seems to be the best predictor within the affective variable group (Purcell and Suter 1980); however, the most successful strategy has been claimed to be correlated with assimilatory integration pattern (Schumann 1986). The view that it is assimilation that is most effective in predicting success in an immigrant situation in general has been challenged by researchers of the Social Identity Theory (Tajfel 1978) and psychology of culture shock and stress coping (critically overviewed and developed in Ward, Bochner and Furnham (2001). The finding that it is a multicultural approach with strong ethnic identity that may be more effective in the case of pronunciation has been reported by Waniek-Klimczak (1993) who found that the inter-cultural acculturation rather than assimilation integration strategy led to a higher degree of accuracy in target sound production.

3. Phonetic parameters

As advocated by Ladefoged (1997), the choice of phonetic parameters for linguistic phonetic analysis needs to be motivated by their contrastive function in a language. Concentrating on the implementation of category voice in stop consonants, we discuss the parameters whose contrastive function has been attested for both English and Polish: Voice Onset Time (VOT) and closure duration, supplemented by vowel duration, which has a contrastive function in English but not in Polish. The two languages differ not only in the choice of parameters, but also their preferred modal values. In the case of VOT, English contrasts long-lag short-lag values, while Polish uses short-lag vs. lead values; closure duration is used more systematically by Polish, with voice corresponding to shorter and lack of voice to longer closure duration. This relationship is different in English, where post-vocalic consonant voicing is implemented by vowel duration and closure duration, with vowel duration functioning as a more reliable cue for voicing than closure duration

3.1 Voice Onset Time

Voice Onset Time, the time span between the release of the stop consonant closure and the onset of regular glottal pulsing (corresponding to glottal vibration) has been found to characterise stop consonant voicing contrast in many languages (Lisker and Abramson, 1964). The VOT duration has been claimed to correspond to three categories in the stop

consonant system (Lisker and Abramson, 1964): prevoiced stops, characterised by the voice lead (negative VOT values); short lag stops, with the onset of voicing simultaneous or lagging behind the release of the closure to a small degree; and finally, the long-lag voiceless stops, characterised by a longer time span between the release of the burst and the onset of voicing. Languages differ with respect to the modal values and, consequently, the range of values used in the implementation of phonetic categories representing voicing. Polish is known to contrast pre-voiced, lead-in stops with the voiceless unaspirated or weakly aspirated, short lag ones; English, on the other hand, contrasts voiceless unaspirated with voiceless aspirated in the initial pre-stressed position and voiceless unaspirated with prevoiced in other positions.

3.2 Closure duration

At the segmental level, stop consonant production involves two major stages: the occlusion stage and the release of the closure; both of these gestures are temporal in nature. The release stage corresponds to the positive values of the VOT; the occlusion time is measured from the onset of the hold stage to the release and corresponds to the parameter of closure duration. For a stop consonant to be complete both stages need to be produced; however, as stops may be unreleased ("checked"), the parameter of closure duration functions as the major stop consonant characteristics. The duration of an occlusion stage is believed to correspond to voicing of the consonant: voiceless plosives have been found to have longer closure duration than their voiced counterparts (e.g. Lisker 1957, Maddieson 1997), although not in all languages (Ladefoged and Maddieson 1996) and not in all positions (Crystal and House 1988).

3.3 Vowel duration

Vowel duration parameter is conditioned by a number of factors, including inherent duration, position within an utterance and other contextual factors, especially the voicing of the following consonant. It is used as a cue for a number of linguistic functions in English, such as the implementation of tenseness, stress, consonantal voicing. The dynamic usage of vowel duration is predictably difficult for Polish native speakers due to the differences between the systems: the-organisation of temporal organisation of speech requires an acquisition of a new temporal dimension of inherently long/short distinction in the vowel system. Literature on second language perception shows that inexperienced learners of English tend to rely on durational information more than spectral cues for vowel recognition in English, even when their L1 does not use inherent vowel duration distinction (e.g. Spanish, as reported by Flege et al. 1997). Thus, the sensitivity to length distinction needs to be acquired by non-native speakers of English in order to facilitate perception and production of the vowel system.

4. Subjects

The study is based on the analysis of speech samples from 38 speakers of English as a second language. All speakers declare Polish to have been their first language. Apart from the first language background, speakers have been selected on the basis of place of residence in the U.S. and educational background. In order to ensure the similarity in the target variety in English for all speakers, subjects with at least 3 years of residence in Madison, Wisconsin, have been included in the study. Educational background has been controlled by specifying the minimum of the first university degree or enrolment at the university courses at the time of recording; an additional group of teenagers consists of high school students. Adult subjects hold university degrees from Polish universities; student subjects have all been enrolled at University of Wisconsin at Madison or High Schools in Madison, Wisconsin.

As summarised in Table 1, main subject characteristics are as follows: the age at the time of recording varies from 15 to 67, the age of learning ranges from 3 to 46, and the length of residence from 3 to 38; there is an equal proportional of males and females. Self-estimated level of English at the time of recording has been self-assessed on a scale from 1 to 5: an average response (corresponding to the median value) is 4. Eleven subjects rate their language proficiency in English at the level lower than 4, and none lower than 2 (7 subjects declare basic communicative skills (rated 2), 4 subjects say their English is OK (3); 16 subjects assess their English skills as good (4), and 11 as perfect or very good). The proportion of the use of English is generally greater than the use of Polish, and ranges around 63 %.

Table 1. Summarised data for the experimental study subject description; N=38.

	Mean	S.D.	Minimum	Maximum
Age at recording	35.31	14.18	15	67
Age of learning (AOL)	23.6	12.88	3	46
Length of residence (LOR)	11.86	8.01	3	38
Level of English (scale 1-5)	3.8	1.04	2	5
Use of English (%)	63	20.5	25	90
Use of Polish (%)	27	20	10	75

5. Experimental procedure

Speech samples were collected in Madison, Wisconsin, in the form of audio recordings, which were subsequently digitised for a computerised acoustic analysis of speech. Sample collection procedure followed the attention-to-speech paradigm based on Labov (1972), with word-list reading, text reading in English and Polish and a questionnaire aiming at eliciting extemporaneous speech in English.

The word-lists contained test-words randomised with non-test ones; subjects were asked to read the lists at a comfortable rate, and were given a short time to familiarise themselves with the word items. The same procedure was followed in the case of the texts, which were selected on the basis of the topic and were all humorous short pieces,

meant to provoke further discussion: two joke stories, one in Polish (a Jewish joke) and one in English (a Polish joke), and a fragment of a humorous short story. The materials were organised as follows: first, a word-list in Polish and a text in Polish were recorded, then a word-list and two texts in English. The last part of the recording contained a questionnaire which was presented to the subjects in a written form in order to avoid the effect of the interlocutor's speech patterns (the experimenter is a Polish speaker of English). The participants were also encouraged to talk freely in connection with the texts, but only some of them were willing to go beyond short answers to the questions. The present study is based on the recording of the reading material in English only.

6. Data analysis

The data have been analysed by means of a multi-factorial design and multiple-regression approach, in search for statistically significant relationship between individual socio-psychological factors and phonetic parameters. The independent variables whose predictive value has been checked include age related factors (Age, Age of Learning), language experience (Language Use and self-assessed language proficiency level) and the attitude towards the target speech community as estimated on the basis of the Distance factor (Distance and Strategy variables). The degree to which each of these independent variables accounts for the variability in the data has been checked with the use of multiple regression or ANOVA/MANOVA models, depending on the characteristics of the variable, i.e. the effect of continuous independent variables related to age has been checked with the use of regression models, while the effects of the nominal ones (language experience and the attitudinal ones) have been used as the basis for subject grouping in multivariate analysis of variance.

6.1 The age factor

The relationship between age and target-like production of the parameters has been investigated with the use of a linear regression model in an effort to establish the degree to which the age factor functions as a predictor of success in second language production. The aim of a simple and multiple regressions is to investigate the relationship between one or several independent variables and one dependent variable. Thus, the procedure makes it possible to check the extent to which individual factors contribute in predicting the value of the variable whose values are recorded. The analysis provides information as to the relative importance of individual independent variables, answering the question of how well the model fits the data, or how much of the variability in the data is explained by means of a given independent variable.

The discussion of the result in the following sections will be based on the multiple regression analysis of two age factors: the age at the time of the recording (Age) and the age of learning (AOL), and the effect of each of the variables or a combination of the two variables as an age factor on individual timing parameters. Both variables are continuous, with the mean age at the recording of 35 and the mean age of learning (age at arrival) of 23.6; the basic descriptive statistics for the two variables are the following:

for the Age, the minimum of 14, maximum 67, standard deviation 14, standard error 2.3 and skewness of 0.31, illustrating the tendency in a larger group of older speakers; the Age of Learning has the minimum value of 3, maximum of 46, with standard deviation 13, standard error 2.1 and skewness of -0.13, pointing to a high proportion of participants with the age of learning lower than the mean value. For each parameter, the results will be described with reference to the extent to which each of the factors explains the variability (R-square, which measures the reduction in total variation of the dependent variable due to the independent variables), the relationship between the independent variables in a multiple regression model, (Multiple R, values 0-1) and the relationship between the dependent and independent variables by means of the variation comparison in expected and actual values (F statistic, calculated between regression mean square and residual mean square).

The effect of the Age factor on the VOT

The relationship between the subject-related variables and the variability in the VOT values has been tested for the mean VOT values in the following test words: *paid, cat, personally, candidates, technical, pack, topic, peak, continent, keen.* The model investigates the relationship between two independent variables grouped into the age factor: the age at the time of the recording (AGE), and the age of learning (AOL), understood as the age of exposure to English in a second-language context.

Table 2.The results of single and multiple regression, intercept set to zero for dependent variable VOT, N=38.

Single regression		
Age of Learning	R2: 0.717	standard error of estimate 32.22
Age at Recording	R2: 0.823	standard error of estimate: 25.49
Multiple regression		
Age Factor (AOL, AGE)		
Multiple R:	0.912	F= 89,7
R2:	0.832	df=2.36, p= 0.000
adjusted R2:	0.823	standard error of estimate: 25.13

The regression model has been first applied to the age of learning (AOL) and the age at the recording (AGE) independent variables in a single regression model; the results (Table 2) show that both age-related variables have a strong predictive power for the variability in the VOT values; when used in a multiple regression model, the two variables prove to predict variability in 82% of cases. As age of learning has been found to determine success in second language learning in numerous studies, a high predictive power of this variable is not surprising; what may be unexpected, however, is a high predictive power of the age at the recording. The explanation for this result comes from the analysis of the relationship between the age and AOL variables specific to the participants of the study: the majority of subjects with low AOL were also the youngest participants of the study, as they were mostly children of the older participants in the study. Consequently, as the two variables strongly correlate (correlation 0.83), they are

combined into the Age factor. From the perspective of correlation between the values, negative relationship obtains between the VOT values and AOA (-0.12), i.e. although the correlation is weak, it is the shortening of the VOT that is expected with higher AOL values.

The effect of the Age factor on closure duration

As a dependent variable for the regression model, closure duration parameter has been investigated with reference to the mean value of closure duration for the *hV.d/t* words. When investigated in relation to closure duration, the age factor proves to have an even stronger predictive power than in the case of the VOT values (see Table 3). As in the previous case, it is the age at recording factor that has stronger effect than age of learning. When checked for correlation, the data show an interesting regularity, signalling the lengthening of closure duration with an increased age (0.64 for AGE, 0.68 for AOA).

Table 3. The results of single and multiple regression, intercept set to zero for dependent variable Closure duration, N=38.

Single regression		
Age of Learning	R2: 0.867	standard error of estimate 37.32
Age at Recording	R2: 0.918	standard error of estimate: 29.33
Multiple regression		
Age Factor (AOL, AGE)		
Multiple R:	0.958	F= 205
R2:	0.919	df=2.36, p= 0.000
adjusted R2:	0.915	standard error of estimate: 29.53

The effect of the Age factor on vowel duration

The effect of the age factor on vowel duration has been first investigated for long and short vowels separately, and then generalised for the vowel duration variable. As in previous cases, the variable is represented by mean values of vowel duration for the *h V d/t* words. The results proved to be very close, suggesting a similar predictive power of the Age factor for all vowel types. The predictive power of the age factor for long vowels is at the level of 79%, and for short ones at 80% level. The results for the generalised vowel duration show 80% level of accounting by the age factor for the variability in the vowel duration data. When correlation for short, long and general vowel duration with AGE and AOL are compared, there is a tendency for the negative correlation to increase more in the long than short vowel series (-16 for long, -11 for short vowel correlation with AGE, -10 for long, and 0.3 with AOL variable).

Table 4. The results of single and multiple regression, intercept set to zero for dependent variable Vowel duration, N=38.

Single regression		
Age of Learning	R2: 0.73	standard error of estimate 84.716
Age at Recording	R2: 0.807	standard error of estimate: 71.96
Multiple regression		
Age Factor (AOL, AGE)		
Multiple R:	0.898	F= 75
R2:	0.808	df=2.36, p= 0.000
adjusted R2:	0.797	standard error of estimate: 72.74

6.2 The effect of Language Use

Three major variables represent the effect of language use: these are the declared proportion of the use of English, the use of Polish and the self-assessed level of English. The data for the use of English and Polish are complementary, as the increased use of Polish corresponds to the decreased use of English by a speaker. The minimum for the use of English is 25%, maximum 90%, with the mean value of 62%, standard deviation of 21 and standard error 3.4; the skewness of –0.24, illustrates the tendency towards a greater than mean use of English in the data. The level of English has been given on a scale 1-5, with the mean value of 3.8, the minimum of 2 and maximum 5 (standard deviation 1.12, standard error 0.17 and skewness of –0.61, pointing to a significant domination of higher level ratings in the data). The predictive power of these variables is checked against the VOT, closure duration and vowel duration data used in the previous section. Unlike in the previous section, however, we will use the parametric and non-parametric ANOVA models to test the predictions. The choice of the methodology in the previous section has been caused by a continuous type of the independent variables whose predictive power has been investigated; as the independent variables to be studied now are discrete, we use them as grouping variables for the subjects. The choice of a parametric or non-parametric test is motivated by the homogeneity of variance as measured by the Levene's tests and problems with normality of distribution in the data.

The effect of Language Use on VOT

The general MANOVA performed on the VOT data detects no significant relationship between the proportion in the use of Polish (p=0.310), the use of English (p=0.31), or the self-assessed level of English (p=0.49). Similar results are computed by the non-parametric, median-sensitive Kruskal-Wallis ANOVA (p=0.65 for the effect of self-assessed level, p=0.33 for the use of English and p=0.33 for the use of Polish). The lack of statistically significant effect may be attributed to the lack of sufficient sensitivity of the data to the language use and level of English as the result of a high degree of homogeneity of the studied population. Interestingly, however, when checked for correlation, the data show a close to significant relationship for the use of Polish and

English and the VOT value (see Table 5), with the same strength of correlation, but reverse direction.

Table 5. Spearman rank order correlation

Pairs of variables		N	Spearman R	p
Level	& VOT	38	0.1912	0.249
E used	& VOT	38	0.317	0.052
P used	& VOT	38	-0.317	0.052

The effect of Language Use on closure duration

When tested for significant effect of language use, closure duration proves not be significantly related to the values of the individual independent variables recognised within this factor. The results of non-parametric ANOVA conducted for each of the independent variables separately yield the probability of non-chance effect at the level 20% for the self-assessed level of English, 33% for the use of Polish and 33% for the use of English. However, when the relationship between the data is checked with respect to correlation, the Level variable proves to be highly significantly correlated with closure duration (see Table 6). The use of Polish and English are in reverse correlation with the closure usage, but the degree of correlation as measured by Spearman coefficient is not significant. Let us notice again the effect of language proficiency on the use of closure duration – a parameter which is repeatedly found to be significant as a predictor of language proficiency in second language speech.

Table 6. Spearman rank order correlation

Pairs of variables		N	Spearman R	p
Level	& closure	38	-0.426	0.007
E used	& closure	38	-0.117	0.48
P used	& closure	38	0.117	0.48

The effect of language use on vowel duration

Vowel duration parameter proves to be the least sensitive one to the effect of either of the language use variables in the study: no significant effect has been found for the inter-relation between the dependent variable of vowel duration and the independent ones of English used, Polish used or Level, either in the analysis of variance or correlation analysis. The effect on vowels has been checked for long, short and overall vowel duration; the results of a Kruskal-Wallis ANOVA for long vowels are at p=0.19 level, for short vowels at p=0.58, and for generalised vowel duration at p=0.25 level for the Level variable; the use of English variable yields the results at the p=0.15 level for long, p=0.36 for short, and p=0.85 for all vowels; the use of Polish variable results in the same relationship as for the use of English (reversed values). Correlation results find no

significant relationship between the data, with the highest correlation result for the proportion in the use of English and long vowels (Spearman R= 0. 267, p=0.10).

6.3 The effect of Distance and Strategy

The distance factor is investigated with reference to two variables: Distance and Strategy. The values for each variable have been entered on the basis of a generalisation from the answers elicited in the questionnaire. The Distance variable has been converted into a scale of one to three, and the Strategy has been coded as either assimilation (A), integration (I) or separation (S). The distance factor is assumed to be represented by a combination of the two variables, with assimilation strategy corresponding to the minimal distance, integration to the mid-distance and separation to the highest distance value. As the independent variables contain ordinal data, the data are analysed by a non-parametric test for median values with the independent variables as the grouping ones (Kruskal-Wallis ANOVA).

When tested for significant effect with the use of the median-based analysis of variance, although the VOT and vowel duration show a relatively stronger effect of the distance, none of the dependent variables prove to be significantly related to the Distance factor (Table 7). Interestingly, however, when the data are converted into ranks, the results prove to reach the level of statistical significance, with the Kendall coefficient of concordance equal 0.93, pointing to a high degree of correlation between the dependent parameter values and the Distance factor.

Table 7. Significance levels for the results of Kruskal-Wallis ANOVA for the independent variable of Distance and Strategy and the dependent variables of VOT, closure duration and vowel duration; N=38.

	Distance	Strategy
VOT	0.097	0.51
Closure	0.51	0.19
Vowel	0.097	0.51

In view of those results, further analysis has been performed with the use of parametric analysis of variance, repeated measure design, for individual test word values. The ANOVA performed for the VOT parameter in the test words *paid, cat, personally, candidates, technical, pack, topic, peak, continent, keen* shows the statistically significant effect for the VOT, but the interaction between Distance and VOT only approximates the assumed significance level, with the p-level of 0.056. The interaction between distance and closure duration in *h V d/t* test words is insignificant at p=0.99 level, and for vowel duration as measured in *h V d/t* tests words at p=0.14 level. In all cases, the differences between the individual values in a regression approach prove to be highly significant, suggesting that parameter values in the test words differ significantly, but not in relation to the distance parameter. Consequently, we conclude that while the VOT parameter may be the most sensitive one to the distance factor, the effect is not regular enough to reach the level of statistical significance.

7. Discussion

Generalising from the regression results for the Age factor, we can safely assume that this factor has a strong determining effect on a target-like use of durational values; the effect is the strongest in the case of closure duration, and the weakest for vowel duration, with VOT between the two. The age factor accounts for 91% of variability in closure duration, 82% in the VOT and 80% in the vowel duration data. Notice that a high predictability value for closure duration suggests a strong relationship between this parameter and the influence of the first language on timing organisation of speech.

The results of language use effect on the three durational parameters do not provide strong evidence for the facilitating effect of greater degree of language use; however, while group homogeneity may be responsible for the lack of significant results, certain weak tendencies can be observed. The main tendency concerns the closure duration parameter, which is significantly correlated with the self-assessed level of language proficiency; secondly, the VOT parameter is weakly positively correlated with the degree of English use (and negatively with the use of Polish); finally, long vowels also tend to be weakly correlated with the proportion of target language use.

Interestingly, the effect of distance and acculturation strategy has not reached the assumed significance level for any parameter. There are many possible reasons for the lack of significant regularity in the data: the investigated group has been selected from a fairly homogeneous population, sharing numerous characteristics, and possibly not divergent enough for the study to detect regular effects. Moreover, the elicitation of distance and strategy values differed, with distance questions more direct than the strategy ones, based on attitudinal judgements (see Waniek-Klimczak 2005 for questionnaire details). In fact, the difference in the results between distance and strategy supports this suggestion, as it is the more directly elicited Distance factor that approximates significant relationship more closely. Generalising, we can say that although they do not reach the assumed significance level, the results suggest a greater degree of impact of the distance factor than strategy, and the effect is larger for vowel duration and the VOT than closure duration, supporting different factor effect on individual parameters.

Thus, the predictions with respect to the effect of socio-psychological factors have been only partially supported by the analysis. The strongest effect has been found in the case of the Age factor, whose predictive power on the value of all three durational parameters has been verified. Although the predictions as to the facilitating effect of other factors have not been supported, the analysis points to an interesting relationship between the type of a socio-psychological factor and the individual parameter sensitivity. Closure duration has been found to be most significantly correlated with the age factor, and also the level of proficiency variable; the VOT variable, on the other hand, proves to be related to the proportion of English use and the distance factor; vowel duration tends to be closer to the VOT than closure duration in the type of socio-psychological conditioning.

When considered from the perspective of category implementation, the results point to variable success with respect to individual parameters. The need to incorporate a multi-parameter approach is particularly well illustrated by the implementation of voicing in post-vocalic, word final position, where two parameters are used in English:

vowel duration and closure duration. As vowel duration tends to be affected by such factors as the amount of language use and distance to the target speech community to a greater extent than closure duration, which is mostly conditioned by age and language proficiency, individual speakers may vary as to the implementation strategy and success in the use of a particular parameter.

Varied relationship between subject-related factors and the value of phonetic parameters proves the relevance of sociolinguistic approach to phonetic implementation studies. The predictive power of some independent variables was verified by the data analysis, while the relevance of others proved to be smaller; in all the cases, however, we observed differences in the relationship between the socio-psychological factor and values of a particular phonetic parameter. Predictably, the effect of the Age factor proves to be most significant; interestingly, however, the significance is the highest in the case of closure duration parameter. On the other hand, Language use and Distance factors have a stronger effect on the VOT and vowel duration. Generalised with respect to phonetic parameter control, the results support a higher degree of control in the case of the latter two (VOT and vowel duration) than the former (closure duration), which is most resistant to positive influence of target language use and positive values of socio-psychological factors. In terms of category implementation, the difference between individual parameters points to the need to recognise the level of phonetic detail in second language study. Inherently variable, second language system exhibits socio-psychological factor sensitivity at the implementation level; differences in this sensitivity make it possible to recognise not only varied predictive power of these factors, but also a subtle relationship between socio-psychological factors and individual phonetic parameters used in implementation.

8. Conclusion

The study has demonstrated a varied predictive power of socio-psychological factors on successful category implementation in SLA. The data show that socio-psychological factors predict success in the production of individual parameters and provide information as to the strategy of linguistic category implementation. Let us illustrate this point with respect to category voice in word-final plosive consonants: in this position, both vowel duration and closure duration are used as cues for voicing. The present study shows that vowel duration and closure duration are conditioned by different factors, with the former more sensitive to language use and distance from the target community, and the latter to age, language proficiency and overall strategy. Thus, the level of phonetic detail offers interesting insights into system formation in SLA, with varied effect of individual factors on particular parameters.

The results have both theoretical and practical implications. The relationship between individual factors and particular acoustic parameters used in phonetic realization points to a different degree of control between parameters, with closure duration proving to be the most difficult one. The results support earlier findings (e.g. Zampini and Green 2001) suggesting a higher level of difficulty in closure duration than the VOT. In terms of SLA success, closure duration proves to be most resistant to other factors than age and language proficiency, while the VOT seems to be most sensitive to language use and the

attitudinal Distance factor; interestingly, while vowel duration tends to resemble VOT in the type of conditioning, there is a difference in the relationship between long and short vowels and language use, with long vowels showing a more regular effect. While more research is needed before firm conclusions can be drawn, we hope to have demonstrated the relevance of a multi-parameter approach to the study of socio-psychological predictors of success in SLA.

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