The influence of formal instruction on segmental speech production by German learners of English

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Abstract

This study examines the influence of formal L2 English instruction (FEI) on pronunciation accuracy of similar and new vowels in the framework of Flege's Speech Learning Model (Flege, 1995a, 1999, 2002), focusing on selected segmental pronunciation features produced by native German speakers. A spectral vowel production experiment was carried out with 24 German students who attend sixth, ninth and twelfth grade of a south German secondary school by the time this study was conducted. Spectral characteristics of the similar vowel /ɛ/ and the new vowel /æ/, produced by each subject of the three groups (G6, G9, and G12), were compared to vowel data of native English speakers. In order to test the influence of formal instruction on selected phonetic segments, which are known to cause difficulties for native German learners of English, three native English listeners judged on a three point scale the intelligibility of the segments produced. The results of the vowel experiment showed significant influence of FEI on pronunciation accuracy of some characteristics of the similar vowel /ɛ/ but not of the new vowel /æ/. The listener rating experiment showed that FEI had on average no influence on pronunciation accuracy of the three L2 English learner groups.

Keywords

Segmental speech production, formal instruction, pronunciation accuracy, Speech Learning Model, Similarity, Bark-difference, German

Contents

1. Introduction

The factors which are claimed to affect second language speech learning have been analyzed and discussed thoroughly in second language (L2) phonology literature (Piske et al., 2001). This study focuses on the effect of formal instruction and similarity of the L2 phonology to the first language (L1) phonetic inventory on pronunciation accuracy. The influence of the variable formal language instruction has been subject to research in various studies (Elliot, 1995; Flege & Fletcher, 1992; Flege et al., 1999b; Thompson, 1991; Suter, 1976). The results were ambiguous because some studies detected significant influence of the variable (Elliot, 1995; Flege & Fletcher, 1992; Suter, 1976) and others did not (Thompson, 1991; Flege et al., 1999b). The influence of similarity of L1 and L2 phonemic inventories on pronunciation accuracy has also been examined thoroughly in the phonological literature. An often-discussed model which analyzes similarity effects, is the Speech Learning Model (Flege, 1995a, 1999, 2002). It categorizes L2 sounds into *identical*, *similar* and *new* sounds to the L1 (see 2.3). Bohn & Flege (1992) applied the Speech Learning Model (SLM) to native German learners of English. A commonly known difficulty for native German learners of English is the correct differentiation of the vowels /ɛ/ and /æ/ (Bohn & Flege, 1992; Smith & Swan, 2001; Wode, 1978, 1980, 1981). The vowels /ɛ/ and /æ/ are claimed to be similar and new sounds respectively for native German speakers in the framework of the SLM (Bohn & Flege, 1992). Bohn and Flege (1992) found L2 experience to have a significant effect on learning important phonetic characteristics of new vowel categories.

All subjects of Bohn & Flege's (1992) study have been exposed to an English-speaking environment for at least one year. The SLM has, as to the author's knowledge, not yet been applied to subjects who do not live in the country of the target language and differ in L2 experience because of more or less years of exposure to formal instruction.
In the framework of Flege's SLM one can ask whether the variable formal instruction is significant enough to enable students to produce English vowels which are new and similar to their native language German. Does more experience, respectively more years of English formal instruction, lead to a more accurate, more native-like pronunciation of similar and new vowels? Do learners who only receive general formal instruction in English confuse the respective vowels? And finally, does the variable formal English instruction (FEI) have a significant effect on pronunciation accuracy of selected phonetic segments of native German learners of English?
In order to investigate these questions, this study was conducted with 28 subjects who were, by the time this study was carried out, studying English at different levels of primary and secondary school in the southern German city of Burglengenfeld.

The research questions are the following:

1. Does more experience in form of formal English instruction enable native German learners of L2 English to produce vowels which are either similar or new to the L1 German in a native-like manner?

2. Can learners with more experience in form of formal English instruction distinguish the English vowels /ɛ/ and /æ/?

3. Does FEI influence pronunciation accuracy of phonologically difficult segments for native German students?

2. Literature Review

Factors which are claimed to influence second language speech learning have been researched to a vast extend over the last decades. This study focuses on the variables formal instruction and similarity of the L2 phonology to the L1 phonetic inventory.

2.1 Formal instruction

Studies examining the influence of formal instruction on the degree of L2 pronunciation accuracy, have led to different results. To test the influence of formal instruction variables the researchers used pronunciation accuracy as a dependent variable. The latter was achieved through listener judgments of phonologically difficult segments (Flege et al., 1999b; Flege & Fletcher, 1992; Elliot, 1995). Thompson (1991) and Flege et al., (1999b) did not identify instructional variables as significant predictors of degree of L2 foreign accent. Piske et al. (2001) stated that L2 pronunciation receives little attention in most foreign language classrooms and that this might explain why instructional variables seem to have had so little effect (Piske et al., 2001, p. 200). However, other studies did find instructional variables to be significantly affecting L2 pronunciation. Two instructional variables were found to have a significant effect on L2 pronunciation accuracy by Suter (1976). One of these variables, namely “total amount of formal classroom training in English”, was found to be inversely related to L2 pronunciation accuracy (Suter, 1976). Flege & Fletcher (1992) identified the variable ”number of years of English-language instruction" as a significant predictor of the degree of L2 foreign accent for native Spanish learners of English. Furthermore, Elliot (1995) found the variable measuring the total number of years of formal instruction in Spanish to have a significant positive relationship with pronunciation accuracy. Some studies found formal instruction to have a larger effect on degree of L2 foreign accent if the subjects received special training in L2 pronunciation (Bongaerts et al., 1997; Moyer, 1999). Ellis (1994) has summarized former research regarding formal language instruction and concluded that “there is support for the claim that formal instruction helps learners to develop greater L2 proficiency, particularly if it is linked with opportunities for natural exposure” (Ellis, 1994, p. 616).

2.2 Similarity

A second factor, which is claimed to be affecting second language pronunciation, namely the similarity of the L1 phonology to the L2 phonemic inventory, is of importance for this study. Best & Tyler (2007) claim the L2 Speech Learning Model (Flege, 1995a, 1999, 2002) and the Perceptual Assimilation Model (Best, 1993, 1994a, 1994b, 1995) to be the two most influential theoretical constructs in the field of

nonnative and second language speech perception. The Perceptual Assimilation Model (PAM) and the SLM regard phonetic similarity as key in predicting L2 learners' success in perceptually distinguished contrast. The PAM states that a high degree of similarity between two foreign sounds may lead to poor discrimination. Similarly, Flege's SLM supposes that equivalence classification due to phonetic similarity might prevent second language learners from establishing L2 phonetic categories over time (Bohn & Munro, 2007).

2.3 Speech Learning Model

A central claim of Flege's (1995a) SLM is that second language speech learning is more difficult as the phonetic space becomes committed to the first language (Walley, 2007). The establishment of perceptual categories of phonemes for the L1 starts already during the first year of life. The more established those categories are when L2 learning starts the more difficult it becomes to acquire new perceptual categories (Piske et al., 2001). By hypothesis, as L1 categories develop, they become more likely to block the formation of new L2 vowel and consonant categories (Tsukada et al., 2005). Flege names this mechanism "equivalence classification" (Flege, 1987). The SLM claims that the greater the perceived phonetic distance between a L2 sound and the closest sound in the first language is, the more likely it is that phonetic differences between the sounds will be detected and a phonetic category established eventually (Guion et al., 2000).
In order to operationalize the distinction between new and similar L2 sounds the SLM employs three criteria for classification. First, the IPA symbols used to represent sounds of the L1 and L2 are considered. Then, acoustic measurements and finally, listener's perceptual judgments of sounds in L1 and L2 are employed. An identical sound is one which has the same IPA symbol in the L1 as well as in the L2. The acoustic measurements of these identical sounds in the L1 and the L2 are not significantly different. The identical sound is usually produced authentically because of a process which is called "positive transfer" (Flege, 1996). A similar sound can have the same IPA symbol but some acoustic differences between the sounds in the L1 and L2 must exist. The similar sounds must be auditorily discriminable in phonetic categories as, for example, formant frequencies or duration. A new L2 sound differs acoustically and perceptually from the L1 sound which resembles the most. Other than the similar sound a new L2 sound has no equivalent IPA symbol in the L1 language (Flege, 1996).

2.4 German and English sounds

According to Bohn & Flege's (1992) literature review, the sounds of English and German have been investigated to a vast extent, but acoustic cross-language comparisons have been rare (Delattre, 1964; House, 1961; Iivonen, 1987; Jørgensen, 1969; Peterson & Barney, 1952). With regards to the vowel sounds /ɛ/ and /æ/, which are the focus of the present study, the vowel /e/ has not been mentioned to be a problem for native German learners of English as previous acoustic research showed that German /ɛ/ is either identical to the English counterpart or just a nuance higher in the acoustic vowel space. Therefore /ɛ/ was considered a similar vowel for native German learners of English (Bohn & Flege, 1992).

Even though /æ/ occurs in some German dialects as for example Swiss German (Boesch, 1957) and Bavarian (Traunmüller, 1982) most German dialects neither have an identifiable counterpart for English /æ/, nor does German use the IPA symbol æ (Bohn & Flege, 1992). To confirm the above stated, Bohn & Flege (1992) measured native English speakers' production of /æ/ and native German speakers' production of the German vowels which are acoustically close to English /æ/, namely /ɛ/, /ɛ:/, and /a/). They compared the vowels spectrally in a Bark-difference scale (see 4.4) and found evidence that /æ/ has no clear counterpart in German and therefore the vowel should be considered as new for native speakers of German (see Figure 1) . The English vowel /ɛ/ was compared to German short /ɛ/ and long /ɛ:/ where the German vowels were found to be significantly higher in the acoustic vowel space than their English counterpart (Bohn & Flege, 1992). German /ɛ:/ was also found to be more anterior in the front-back dimension (see Figure 1 below).

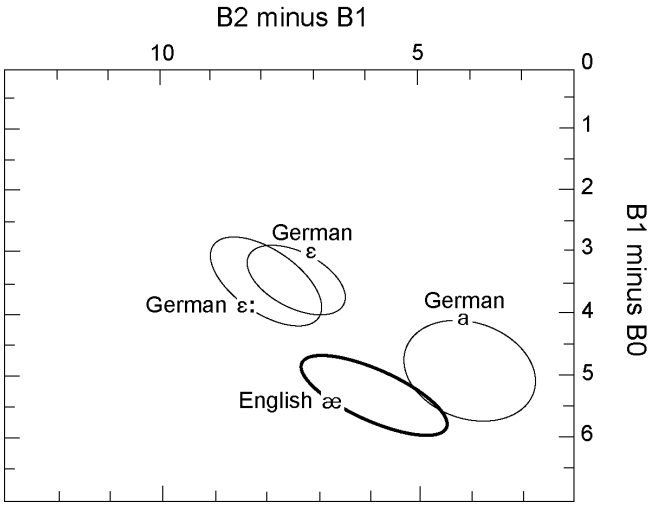

Figure 1 German vowels /ɛ, ɛ:, a/ and the English vowel /æ/ (Bohn & Flege, 1992, p. 139)

Bohn & Flege (1992) also compared vowel durations and found that English and German /ɛ/ did not differ significantly in length and English /æ/ seemed to be longer than German /ɛ/, /a/ and /ɛ:/. The researchers stated that the comparison of absolute vowel lengths is problematic (Bohn & Flege, 1992, p. 137). Due to that reason and the fact that the informants of the present study showed a too high variation in vowel lengths and that no proper comparison data for vowel lengths was found, duration will not be subject to further attention.

Native Germans tend to substitute an /ɛ/-like vowel for the new English vowel /æ/ (Wode, 1978, 1980, 1981; Bohn & Flege, 1992; Smith & Swan, 2001). Bohn & Flege (1992) found that inexperienced native German speakers produced a smaller spectral contrast between English /ɛ/ and /æ/ than the more experienced group. Earlier research found different hierarchies in vowel acquisition (Bohn & Flege, 1990). The researchers indicated that due to the discrepancy between these results, more research on that topic is needed (Bohn & Flege, 1992).

To summarize the most important findings which are relevant for the present study, it can be derived that in order to analyze phonological differences that occur for L2 language learners of English, the L1 is decisive for success or failure in phonological

learning. Flege's SLM categorizes L2 sounds into identical, similar and new sounds. Especially for the L1 German researchers have found out that English /ɛ/ is a similar vowel for native German learners of English while English /æ/ is a completely new vowel that has no equivalent in German. Furthermore, the two vowels are often confused. Several studies have found the variable formal instruction to be having a significant effect on L2 pronunciation accuracy others detected no significant effect. The question whether experience in formal English instruction (FEI) enables L1 German learners of English to produce new and similar vowels (according to Flege's SLM) has, as to the author's knowledge, not yet been researched.

3. Expectations

The research questions as stated in the introduction are expected to find support for the following hypotheses. In accordance with the SLM and the findings of Bohn & Flege's (1992) study it is hypothesized that the amount of L2 experience in form of formal English instruction would not affect L1 German speakers' production of the similar English vowel /ɛ/. This is owed to the fact that category formation is blocked by equivalence classification, whereas English language experience (even through formal instruction) would enable L1 German-speakers to produce the new vowel /æ/ in a native-like manner. Furthermore, it is expected that FEI-experienced native German learners of English would be able to distinguish English /ɛ/ and /æ/ in a native-like manner. Regarding previous research (see 2.1) formal English instruction is expected to have a significant influence on pronunciation accuracy of phonologically difficult segments of native German learners of L2 English.

4. Method

In order to test spectral differences and similarities in the English vowels of native German speakers, a speech production experiment was carried out. The first part of the experiment focused on the production of /ɛ/ and /æ/. Sample words, produced by the subjects, were recorded and the spectral characteristics of the vowel sounds were extracted and analyzed (see 5.1-5.3). The second part of the experiment was an analysis of segmental features which are known to cause difficulties especially for native German learners of English (Smith & Swan, 2001). The recordings were judged by three native English listeners who had not received special phonological training (see 5.4).

4.1 Subjects

Three groups of eight students with four female and four male subjects each participated in the speech production experiment as volunteers. All 24 informants were native German speakers who grew up in the city Burglengenfeld in the south east of Germany. At the time this study was conducted they all attended the Burglengenfelder Gymnasium which offers primary and secondary education leading to a high school diploma. All subjects were asked to fill in a short questionnaire and state their age, gender and years of FEI experience. The first group (G6) consisted of four female and four male sixth grade students whose average age was 11.5 years. They stated that they had an average number of formal English instruction of 4.3 years. The second group (G9) included students with an average age of 15 years. They went to ninth grade and had 6.7 years of formal English instruction on average. The subjects of the last group (G12) were in their last year of Gymnasium, twelfth grade. They were on average 17.5 years old and had 8.7 years of formal English instruction (FEI).

4.2 Native Speaker Data

The data for comparison of the English vowels produced by native English speakers was used from Peterson & Barney's study (1952). They collected spectral vowel data of 76 speakers (33 men, 28 women and 15 children). The data states the fundamental frequency and the first three formant frequency values of ten American-English monophthongal vowels as spoken in a /h_d/ context and repeated two times by each speaker. In order to have the same sample number, every ninth double sample was picked and the respective speech production data of the two vowels /ɛ/ and /æ/ was extracted to serve as the native group (NAT). The data set was chosen because previous studies had used it as suitable comparison values (Syrdal & Gopal, 1985; Turner & Patterson, 2003) and the status of the data was reevaluated by Watrous (1991). "Peterson and Barney (1952) made careful checks of their measurements for accuracy and precision, and it is unlikely that large measurement errors were committed" (Syrdal & Gopel, 1985, p. 1098).

4.3 Stimuli & Acoustic Measurements

The 24 students were individually recorded with a Roland R-09HR audio recorder in a separate, quiet but not acoustically isolated room at the school. The first word pair that included the vowels /ɛ/ and /æ/ was *bet* and *bat* which was presented in the carrier sentence *I bet you like Batman and Superman* in order to ensure that the students knew the words. The other stimuli consisted of the words *edge* and *catch*. They were simply presented as a word pair because the probability that the students would know the lexemes was estimated to be higher than for the first word pair.
The recordings were imported into the speech analysis software Praat 5.2.21. From the waveforms spectrograms were obtained and analyzed. The fundamental frequency (F0) and the frequency of the first two formants (F1, F2) were measured for the vowel in each test word.
In order to test the influence of FEI on pronunciation accuracy of phonologically difficult segments, sentences and word pairs were created (see Appendix A) which according to Smith and Swan (2001) include typical different pronunciation features. The tested features were the vowel distinction between /ɛ/ and /æ/, production of the liquid allophone [ɬ] also named "dark l", distinction between the labio-dental fricative /v/ and the velar glide /w/, distinction between the voiceless palate-alveolar affricate /tʒ/ and the voiced palate-alveolar affricate /dʒ/, the final voicing of consonants g, z, b, v, and finally, the distinction between the sibilants /s/ and /z/. The stimuli were marked on a three-points-scale by three native English speakers who received no prior phonetic training. If the stimulus was not at all intelligible or comparable to a native pronunciation it was marked with one point. If the feature was pronounced intelligibly but not native-like, the listeners graded it with two points and if it was pronounced native-like three points were given. The total number of stimuli was six, accordingly, the subjects could reach 18 points in case of native-like pronunciation and the whole group (eight subjects) could reach 108 points. Six points for each subject and 36 for the whole group with eight subjects would demonstrate very poor pronunciation.

4.4 Statistical Analyses

The produced vowel sounds were normalized according to Syrdal and Gopal's (1986) Bark conversion method. In this context, normalized means that the variations among tokens (gender, age) of the same intended and perceived vowel were minimized and differences between perceptually distinct vowels were maximized. The primary purpose of a normalization procedure is to model the human speech perception in order to explain how listeners categorize vowel sounds (Adank, 2004). Several authors selected the Bark scale to represent perceived formant frequencies in their normalization procedures (Syrdal and Gopal, 1986; Bohn & Flege, 1992; Most et al., 2000). The human auditory system can be described as several series of overlapping bandpass filters which can also be named critical bands. The latter refers to the effective range of frequencies to which each place on the basiliar membrane, a part of the inner ear, responds (Adank et al., 2003). Zwicker (1961) proposed that the empirically defined critical band scale can be adopted as a standard tonality scale. His proposed scale divides the human auditory range, below 16 kHz, into 24 critical units which are

defined as Bark (named after Barkhausen, who introduced the unit of loudness). Two formulae for transforming Hertz values into Bark values exist.

$B_i = 13 \arctan x (0{,}00076\ F_i) + 3{,}5 \arctan x (F_i /7500)^2$ (A)

Zwicker & Terhardt (1980) introduced the first one (A), which was used in Syrdal & Gopal's original Bark-difference model (1986) and later enhanced Traunmüller (1990) the formula with the claim that his formula is more accurate (B):

$B_i = 26.81/(1+1960/F_i) - 0.53$ (B)

In the present study, Traunmüller's version (1990) was applied on the acoustic data in an attempt to characterize the two English vowel /ɛ/ and /æ/ vowels produced by the L2 learners and the native English comparison group with the data of Peterson & Barney´s study (1952). After transforming the Hertz values of the formants F0, F1 and F2 into the Bark (B) values B0, B1 and B2, the difference for each vowel of B1 and B0, and B2 and B1 was calculated. It has been shown that the dimension B1 minus B0 optimally separates vowel heights and the B2-B1 dimension shows differences in vowel frontedness and backness (Syrdal & Gopal, 1986; Bohn & Flege, 1992). The Bark-difference vowel normalization has been evaluated by several researchers as an appropriate method to normalize gender and age differences in vowel speech analysis (Syrdal & Gopal, 1986; Bohn & Flege, 1992; Most et al., 2000).
The differences between groups are visualized in diagrams where the B1-B0 values are plotted against the B2-B1 values. To verify the visual differences, independent two-sample t-tests were applied to find out whether the means of two groups are statistically different from each other.

5. Analysis & Results

5.1 Spectral comparison of the vowel /ɛ/

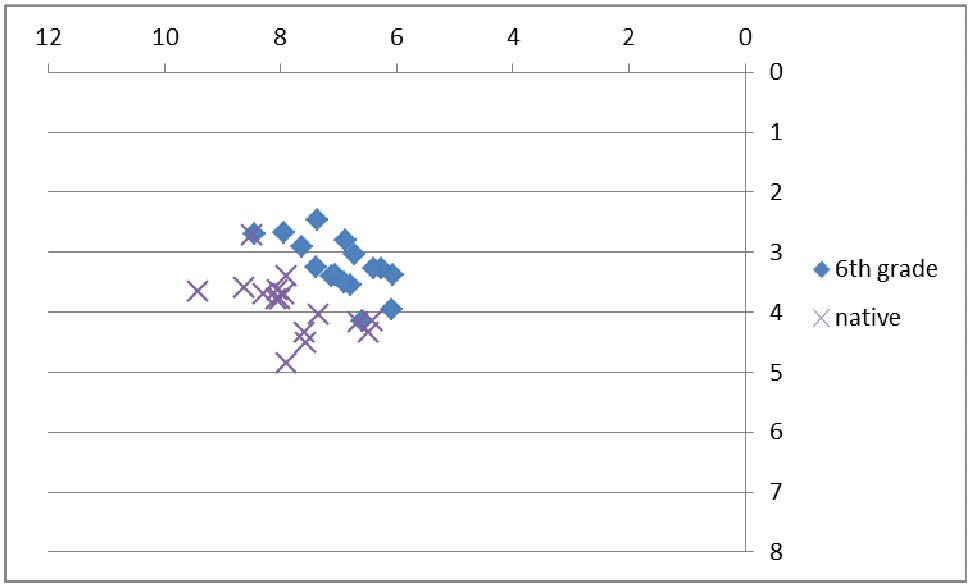

Figure 2 /ɛ/ produced by G6 and NAT

Figure 2 visualizes the range of /ɛ/ produced by group G6 and the native English speakers NAT. The diagram shows that G6 produced an overall higher vowel and also a more anterior vowel /e/ in comparison to the native group NAT. The t-test revealed a statistically significant difference between the two groups in the height dimension B1-B0 with a p-value < 0.001 (alpha < 0.5) as well as in the front-back dimension B2-B1 (p-value < 0.004; alpha < 0.5).

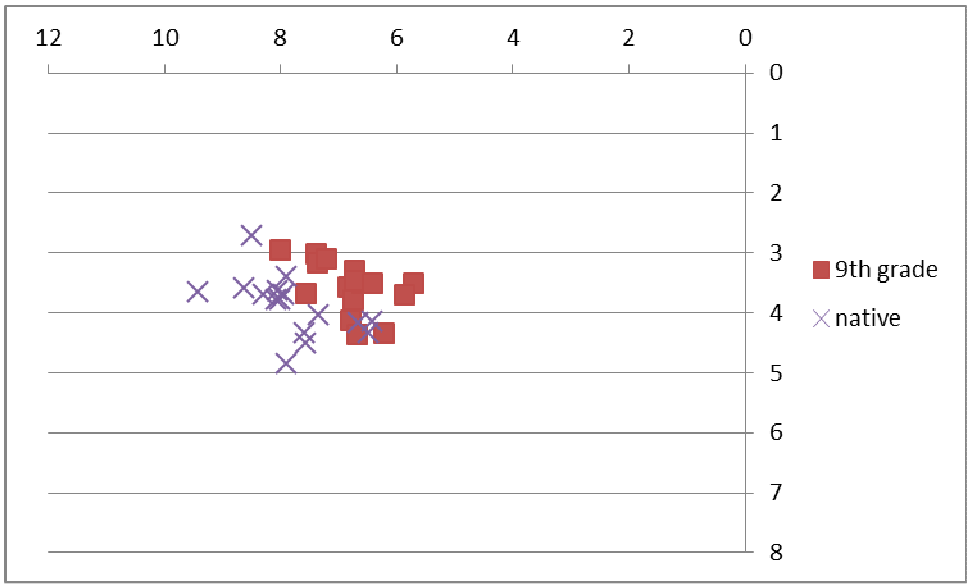

Figure 3 /ɛ/ produced by G9 and NAT

Figure 3 shows a similar effect for the more experienced group G9 in comparison to the native speakers. However, the t-test for the height dimension calculated a p-value > 0.05 which implies that /ɛ/ produced by G9 is not significantly higher than /ɛ/ produced by the native group. This result does not support the hypothesis that more experience has no effect on similar vowels. With regards to the spectral front-back dimension, though, the diagram shows that the vowel of G9 is further back than /ɛ/ of NAT which could be proven statistically as the t-test stated a significant difference with a p-value of 0.013.

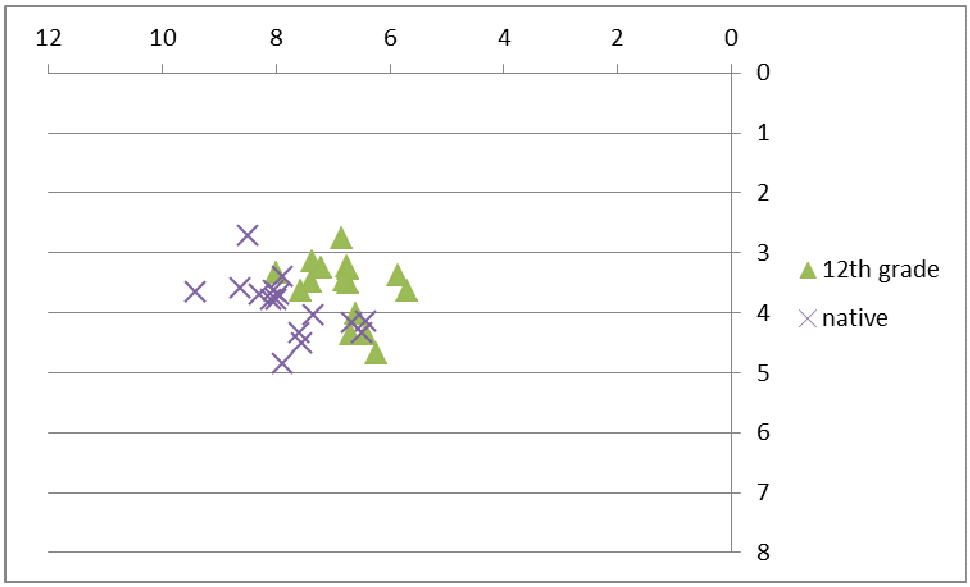

Figure 4 /ɛ/ produced by G12 and NAT

G12 also shows native-like segmental production of /ɛ/ as the vowel height dimension is statistically not significantly different from NAT (p-value > 0.089). Figure 4 shows an overlap of the data produced by G12 and NAT. Compared to the less experienced group G9, no statistic difference could be found with respect to vowel height. The mean B1-B0 value is closer to the native value but the difference from G9 was not significant. This result implies that already in grade nine, students have developed a native-like vowel /ɛ/ with respect to the height dimension. With a p-value of 0.001 the group G12 still differs significantly in the front-back dimension from the native vowel. Even with their greater FEI experience G12 did not produce "more accurate" /ɛ/ with respect to the front-back dimension than the less experienced groups G6 and G9. In conclusion, no significant development between G9 and G12 could be found. Between G6 and G9, whose students differed in approximately three years of formal instruction, students of G6 produced a significantly higher /ɛ/ (p-value = 0.04) than the native group. G12 and G9 produced significantly more native-like vowels with respect to vowel height than G6. The above mentioned results do not support the hypothesis that more formal English instruction experience has no effect on the production of the similar vowel /ɛ/ with regards to vowel height. The analysis of the front-back dimension did not lead to significant differences within the learner groups. However, the values differed significantly for each learner group from the native speaker group. The results for the front-back dimension do support the hypothesis and imply that in general native

German students of English produce the English vowel /ɛ/ more anterior in the spectral vowel space than native English speakers.

5.2 Spectral comparison of the vowel /æ/

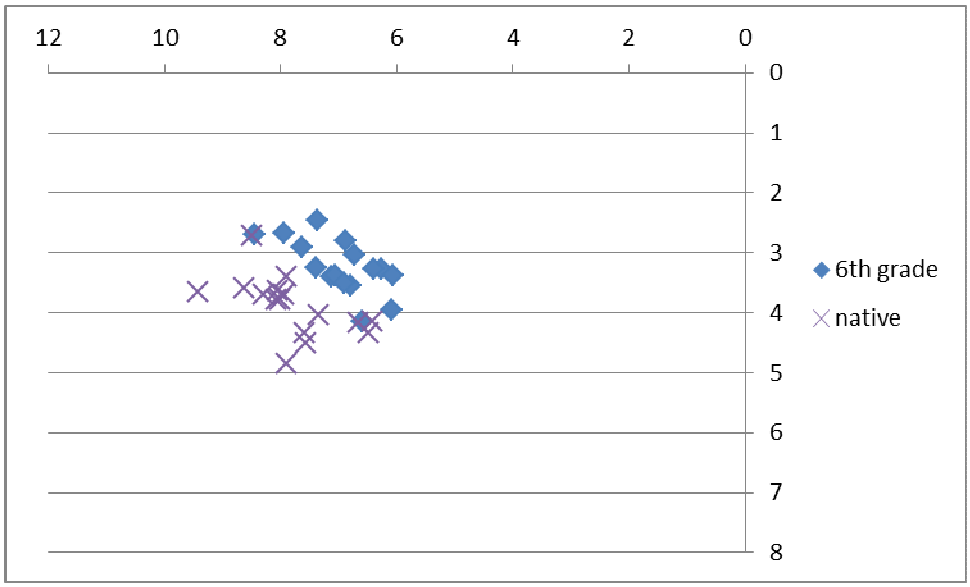

Figure 5 /æ/ produced by G6 and NAT

Figure 5 visualizes the vowel /æ/ produced by group G6 and the native speakers' vowel productions in the spectral Bark-difference dimension. Very little overlap between the data can be observed. The results of the t-test show that the vowel /æ/ produced by the native German group differs significantly from the native values in both Bark-difference dimensions B1-B0 and B2-B1.

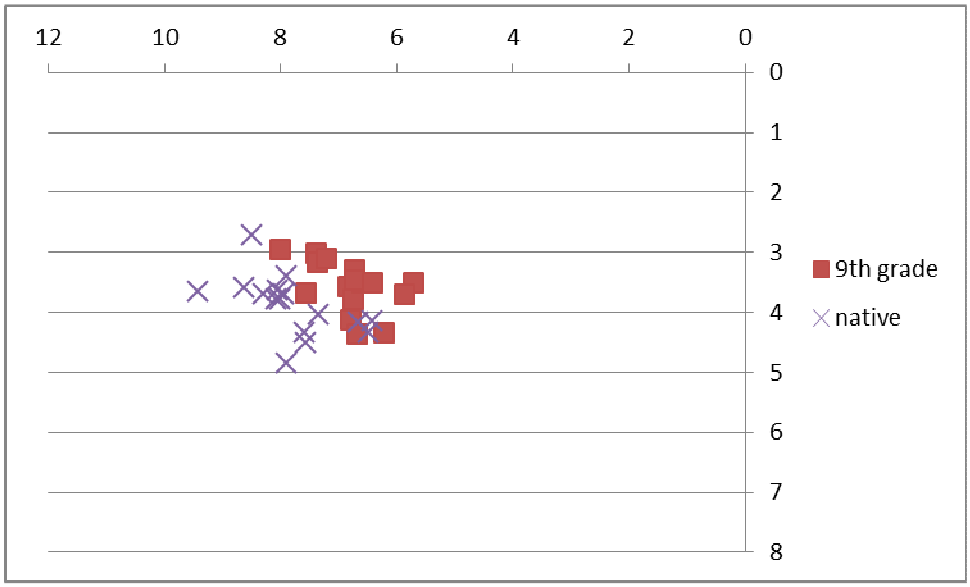

Figure 6 /æ/ produced by G9 and NAT

In Figure 6, the data of group G9 seems to overlap slightly more with the native data, but no statistical evidence could be found. The /æ/ produced by the German ninth grade students is spectrally higher and more anterior in the Bark-difference vowel space than the native vowel. Figure 7 below shows the same effect for G12 whose mean vowel production is significantly different from the native mean data.

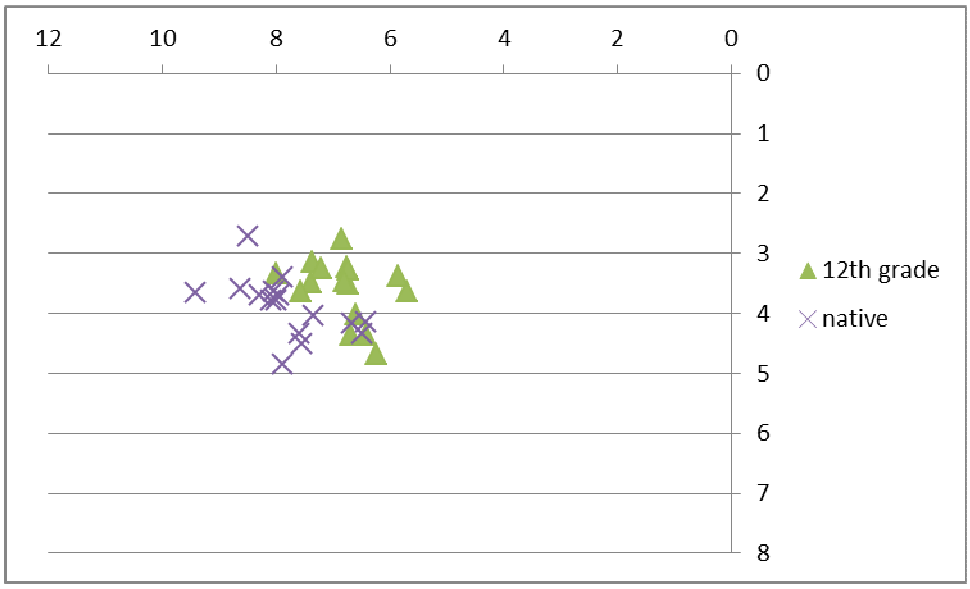

Figure 7 /æ/ produced by G12 and NAT

The result that the vowel /æ/ was higher and more fronted than the /æ/ produced by the native speakers does not support the hypothesis that more experience in FEI leads to category formation of a new vowel which enables the learners to produce the new vowel /æ/ in a native-like manner.

5.3 Comparison of /ɛ/ and /æ/

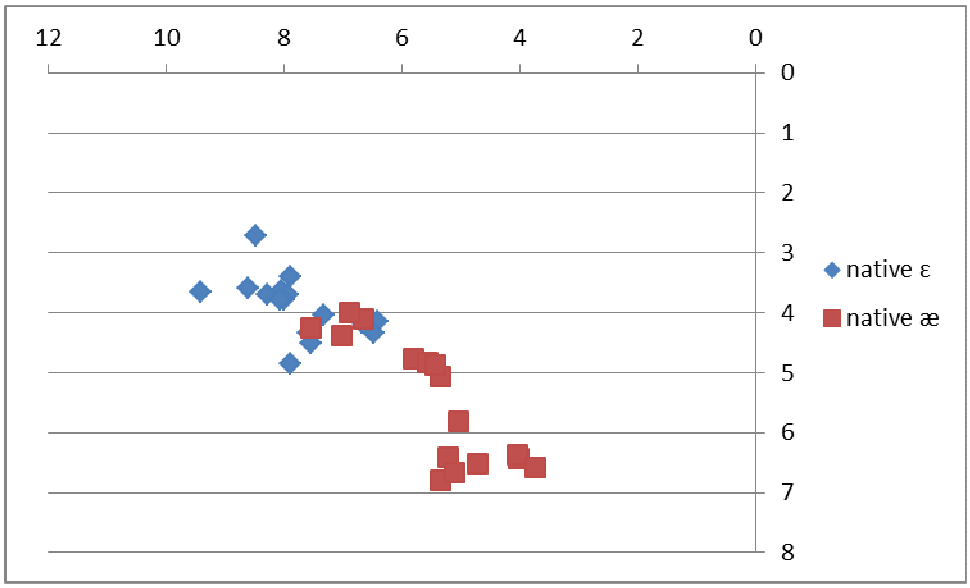

Figure 8 /ɛ/ and /æ/ produced by NAT

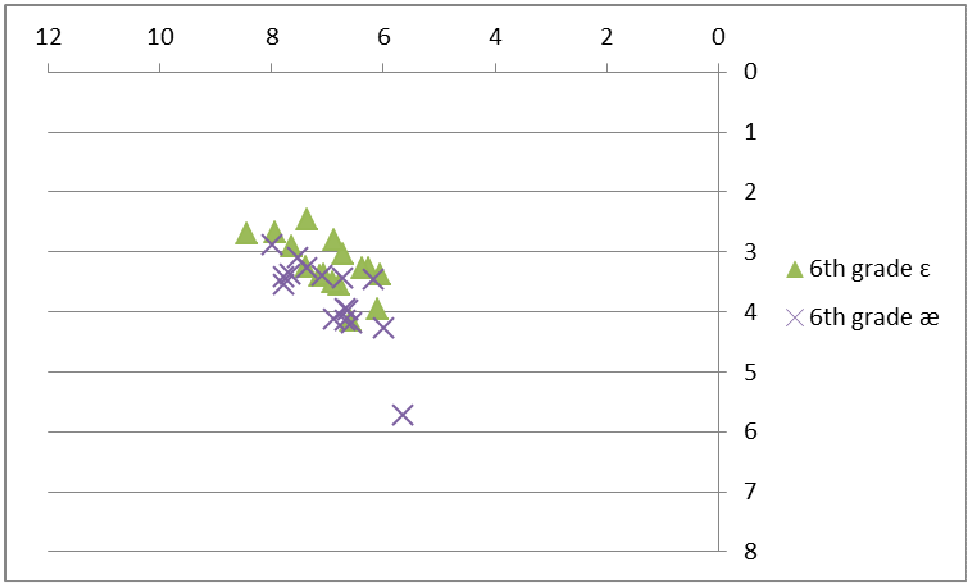

Figure 9 /ɛ/ and /æ/ produced by G6

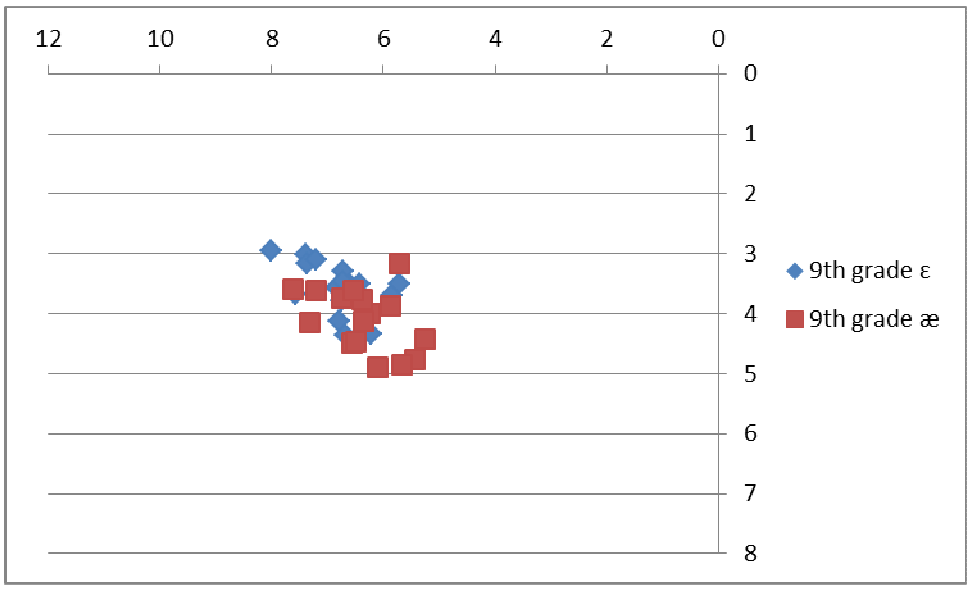

Figure 10 /ε/ and /æ/ produced by G9

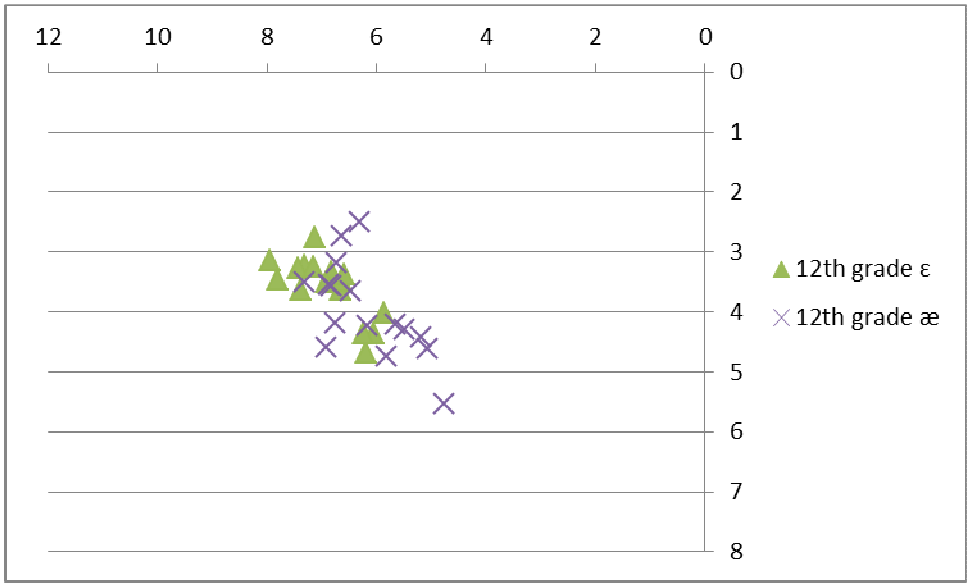

Figure 11 /ε/ and /æ/ produced by G12

Figures 8-11 show the ranges of English /ε/ and /æ/ as produced by the native speakers group (Figure 8), G6 (Figure 9), G9 (Figure 10) and G12 (Figure 11). In Figure 8 we can see the distinction between the vowels /ε/ and /æ/ by the native English speaker group. Figures 9-11, however, show an almost complete overlap for both vowel productions in all German groups. The two English vowels as produced by the native speakers differ to the largest extent in the height dimension. To analyze between-group differences in the separation of /ε/ and /æ/ the differences of the B1-B0 values for /æ/ and the B1-B0 values for /ε/ were calculated for each subject. T-tests were applied to compare the means of each group. Significantly different values in comparison to the native vowel height differences were obtained for all learner groups (G6, G9 and G12). The vowel height difference for group G6 was M=0.54, for G9 M=0.53 and for G12 M=0.38. Compared to the mean difference of the native group Nat M=1.6 all learners groups produced a significantly smaller height difference between /ε/ and /æ/. The

hypothesis that more experience in FEI leads to a native-like differentiation between /ɛ/ and /æ/ could not be supported. Further analysis of the values showed that the learner groups did not just substitute the vowels in the sense that they produced /ɛ/ for /æ/ or vice versa. The t-tests showed that the vowels differed often in the two dimensions from each other. However, substitution could be found for G6, whose subjects produced the same vowel in the front-back dimension (p-value > 0.9) and the most experienced group G12, which produced the same vowel for /ɛ/ and /æ/ with regards to the height dimension (p-value > 0.11).

5.4 Pronunciation accuracy of selected features

An overview of the average grading points which the three native English listeners estimated for each stimulus produced by each subject can be found in Appendix B. The average number of points of the least experienced group G6 (8 points) shows that typically difficult phonological features were not mastered in general. The student group G6 with an average amount of 4.3 years of FEI scored a total of 67 points (Average= 8). The more experienced group G9 managed a total score of 78 (Average=9.75) and G12 with an average of 8.7 years of FEI scored 87 points (Average=10.88). The total scores show that the groups with more experience scored higher points, but statistical analyses which compared mean values of the groups in form of t-tests did not support the hypothesis that FEI influences general pronunciation. Neither did the t-tests show significant differences in between groups G6 and G9 with a p-value > 0.06 nor did it between G9 and G12 (p-value > 0.88). Not even between G6 and G12 who differ in 4.4 years of FEI a significant difference could be calculated (p-value > 0.15).

6. Conclusion & Discussion

One purpose of this study was to examine whether the production of the vowels /ɛ/ and /æ/ by native German students was influenced by the amount of FEI. Does more experience in form of formal English instruction enable native German learners of L2 English to produce similar and new English vowels (in accordance with Flege's SLM) in a native-like manner? The results, with regards to the production of the English vowel /ɛ/, show that G6, the group with the least experience in FEI (4.3 years) did not produce a native-like /ɛ/. It was higher and more anterior in the Bark-difference vowel space. However, G9 produced a native-like /ɛ/ with respect to vowel height but it was significantly more anterior in the spectral vowel space (just like the German /ɛ:/ according to Bohn & Flege, 1992). The same result could be accounted for G12.
It can be concluded that more experience in FEI (6.7 and 8.7 years) did enable the groups G9 and G12 to produce a native-like /ɛ/ in vowel height, but not in the front-back dimension. No development could be observed in the latter dimension. The hypothesis of the SLM that category formation is blocked by equivalence classification for similar vowels could not be supported as the more experienced groups G9 and G12 were able to produce /ɛ/ in a native-like manner in the height dimension. With regards to the front-back dimension, no group was able to achieve the native values.
The question is whether a new category for English /ɛ/ was formed or not? The SLM does not define how many spectral characteristics have to be native-like until one can name it a new category for a vowel. To draw a final conclusion, more research would be necessary and more acoustic vowel properties would have to be examined (e.g. formant dynamics, third formant, vowel duration, etc.).
However, the present results do not confirm the hypothesis that more experience does not influence category formation for similar vowels. Whether or not a new category was formed remains unclear and needs further investigation. The variable FEI did influence vowel pronunciation of learners with 6.7 and 8.7 years of FEI experience. The results suggest that native-likeness with respect to one characteristic of acoustic vowel description was achieved after 6.7 years of FEI. The possibility that it was coincidence can be excluded because the sample size of eight subjects in each group seems big enough. However, the likelihood that individual ability might have influenced the results cannot be excluded but due to the comparison of means it is very low.

The findings for the production of the new vowel /æ/ were surprising. None of the three learner groups, not even the ones with FEI experience of 7.5 years were able to produce a native-like vowel in either vowel dimension. In Flege & Bohn's (1992) study, experienced adult learners of English who had the same amount of FEI were able to produce English /æ/ close enough to the English acoustic norm at least in some important characteristics (Bohn & Flege, 1992, p. 156). The difference between the subjects of the latter study and the subjects of the present study is that Bohn & Flege's participants had lived in an English-speaking country for 7.5 years. It is very unlikely that the present result could cast doubt on the hypothesis of the SLM which implies more experience would lead to the production of a new vowel category. Furthermore, the results of the tested vowel /æ/ indicate that FEI alone does not enable native German

students to develop new categories for new vowels. This confirms the result of Flege and Bohn's study in which the inexperienced group was not able to produce a native-like /æ/ even though they have had an average of 6.6 years of FEI and have been living in the United States for 0.6 years. As mentioned earlier (see 2.1), Ellis (1994) concluded that "there is support for the claim that formal instruction helps learners to develop greater L2 proficiency, particularly if it is linked to opportunities for natural exposure" (Ellis, 1994, p. 616). Flege and Bohn found out that "adults may need L2 exposure for a considerable period of time before they show evidence of phonetic learning for a new L2 vowel" (Bohn & Flege, 1992, p. 155). The present study claims that even extended formal instruction in the L2 English does not influence native German speakers sufficiently enough in order to form a new vowel category for English /æ/. The suggestion that "adults may need L2 exposure for a considerable period of time before they show evidence of phonetic learning for a new L2 vowel" (Bohn & Flege, 1992, p. 155) might be the explanation for the poor production of /æ/. Regarding the fact that students of group G6 with an average age of 11.5 and G9 with an average age of 15 years might still be considered children, Bohn & Flege's suggestion might be extended to a degree that also children need a longer period of exposure to the native language in order to produce new vowels. The results of this study show that FEI has no influence on the production of new vowels and only partly on similar vowels for German learners of English. With the implications of former studies and the present results it can be suggested that native German students of L2 English might need either more extended and specialized phonetic instruction or/and a considerable time of exposure to the target language in the respective country.

In order to test the second research question which regarded the distinction of /ɛ/ and /æ/ mean differences of the respective Bark-difference dimensions B1-B0 (that show vowel height) of each vowel for each group were compared to the mean native values. The hypothesis that learners with extended experience in FEI could make a native-like distinction between the vowels could not be supported. All learner groups (G6, G9 and G12) differed significantly from the native group values. This result was anticipated after the findings of the vowel comparisons, because the learner groups were only partly able to produce the similar vowels with more experience of FEI - while categories for the new vowel /æ/ were not formed at all. Accordingly, an accurate distinction between the two vowels was not expected. The "popular stereotype" (Flege & Bohn, 1992, p. 155), that native Germans tend to substitute an /ɛ/-like vowel for the new English vowel /æ/ (see 2.4) could be partly confirmed. In order to classify the "/ɛ/-like" vowel, whether it was closer to the German /ɛ/ or a vowel between the latter and the English /ɛ/, would need further investigation which would go beyond the scope of this work. It can be concluded that some FEI inexperienced as well as FEI experienced subjects substituted the vowels /ɛ/ and /æ/ in some phonetic characteristics.
Regarding the analysis of the vowels measurement errors cannot be excluded, but as the formant frequencies were not uncommon for subjects of the respective age groups the probability of measurement errors is rather small.
Another purpose of this study was to examine the influence of formal English instruction (FEI) on pronunciation accuracy of phonologically difficult segments of English. The results were established by testing well-known phonetic difficulties for

native German learners of L2 English (Smith & Swan, 2001). The subjects were recorded and evaluated by three native English speakers, who graded them on a 3-point-scale. The findings turned out conflicting relatively to the constituted expectations. Statistical tests of mean comparisons showed that FEI had no significant influence on pronunciation accuracy of selected segmental features when comparing the groups G6 (4.3 years of FEI), G9 (6.7 years of FEI) and G12 (8.7 FEI). The results appear shocking, because the fact that students of twelfth grade with an average of 4.4 years more experience in FEI are not able to pronounce phonetic segments more intelligibly than students of sixth grade shows the huge lack of English pronunciation instruction at German schools. One of the English teachers of sixth and ninth grade stated that one reason might be that the German school curriculum does not regard phonetic training after grade six as important and teachers do probably not correct students' pronunciation in higher grades, because they have to focus on other parts of English language teaching. Another reason for the result can be subjectivity in the listeners' judgment, but since the scale only included three points and the stimuli (see Appendix B) were mostly easily identifiable, it is very unlikely that subjectivity in evaluation influenced the results significantly. The quality of the recordings was clear enough to identify intelligibility of the phonetic segments. German and English language are both of Germanic origin and therefore German accented English is, even if it is strongly accented, still pretty comprehensible for most native English speakers. Furthermore, English is as a lingua franca used by many different nationalities which speak English with a foreign accent. These facts might account for a diminishing importance of speaking English "accent-free".

This study provided evidence that formal English instruction (FEI) does partly influence native German learners of L2 English production of the similar vowel /ɛ/ with respect to some acoustic vowel characteristics. This is against the prediction of Flege's SLM that "extended L2 experience would not lead to the establishment of phonetic categories for similar L2 sounds because category formation is blocked by equivalence classification" (Bohn & Flege, 1992, p. 156). The same variable did not influence the category formation of the new vowel /æ/. The results of the vowel /æ/ are not likely to contradict the hypothesis of the SLM but rather show that the variable FEI does not influence the learning process of new vowels. In accordance with Bongaerts' (1995), Moyer's (1999) and Ellis' (1994) findings (see 2.1) the suggestion of specialized phonetic instruction and/or a considerable time of exposure to the target language in the respective country might help native German learners of English in order to create a new vowel category. The suggestion for more phonetic training and exposure to the target language was also supported by the results for the phonological difficulties test, because the variable FEI was found to have no significant influence on pronunciation accuracy of selected phonetic features which are difficult for native German learners of English.

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Appendix A

Stimuli for the pronunciation accuracy test

1. I bet you like Batman and Superman.
2. The red house looks bad.
3. The pool was full with cool white wine.
4. Jane has a very warm jacket in the van.
5. edge - catch
6. What kind of dog does Bob have?
7. eyes - ice
8. plays - place

Appendix B

Average points for each subject assigned by the native English listeners

Table 1 Listener judgements

Grade	No.	Age	FEI	/e/ vs. /x/	dark [ł]	w/v	edge / catch	final voicing	voiced /voice-less	Total	Group TOT
6	1	11	4	1	2	1	1	1	1	7	
6	3	12	4	1	3	1	1	1	1	8	
6	4	12	4	1	2	2	1	1	2	9	
6	5	11	4	2	1	2	1	1	1	8	
6	6	12	4	1	3	1	1	1	1	8	
6	7	11	4	1	1	1	1	1	1	6	
6	8	12	6	2	3	2	1	1	1	10	
6	9	11	4	2	2	1	1	1	1	8	64
9	1	15	7	3	2	2	1	1	2	11	
9	2	15	7	3	3	1	2	1	1	11	
9	4	15	7	2	2	1	1	1	1	8	
9	5	15	7	1	1	1	1	2	1	7	
9	6	14	7	2	2	3	1	1	1	10	
9	7	15	6	1	2	2	1	2	2	10	
9	8	15	6	2	2	2	1	1	1	9	
9	9	15	6,5	3	2	1	3	2	1	12	78
12	1	17	9	1	3	2	2	2	1	11	
12	3	18	7,5	3	2	1	1	1	2	10	
12	4	18	8	3	3	2	1	1	3	13	
12	5	17	10	2	2	3	1	1	1	10	
12	6	17	8	1	2	2	1	1	2	9	
12	7	17	8	3	2	2	1	1	3	12	
12	8	17	10	1	2	1	1	1	2	8	
12	9	19	9	3	3	2	2	1	3	14	87

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