THE ACQUISITION OF GERMAN VOWELS BY L₁ SPEAKERS OF ENGLISH

by

SCOTT B. ZINSMEISTER

(Under the Direction of Renate Born)

ABSTRACT

This study in L₂ phonological acquisition recreates the conditions of a previous study on the matter by Ewa Jacewicz in 1999. It reviews the current literature in this field in order to provide the reader with an understanding of current theory and provides a detailed analysis of Jacewicz’ experiment. The experiment is then recreated in order to determine whether perception and production develop in L₂ learning separately or along the same path in beginning language learners. The results of the replication are then compared with Jacewicz’ in order to confirm her findings that perception and production appear to develop along similar line or to indicate that further testing is need.

INDEX WORDS: language acquisition, perception, production, German, English, second language acquisition, second language phonology, phonology, vowel
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by

SCOTT B. ZINSMEISTER
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by

SCOTT B. ZINSMEISTER

Major Professor: Renate Born

Committee: Renate Born
Peter Jorgensen
Don McCreary

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
August 2005
DEDICATION

I would like to dedicate this thesis to friends and family. Especially, to my parents Herman and Suzanne Zinsmeister, my grandmothers Kathleen Zinsmeister and Ophelia Webb, my cousin Beth Hummel, and to Kathryn Haworth for putting up with me during all the research and writing needed for this.
I would like to thank all who have helped me along the way, for I would not be here without their help. And I would like to offer a special thanks to the following people: Dr. Peter Jorgensen, without whose help, this thesis would have never seen the light of day, Dr. Renate Born, for her assistance in writing and fine-tuning this thesis, Dr. Don McCreary, for introducing me to second language analysis, and Dr. Max Reinhart, for helping to make literature understandable, so that I could focus more time on linguistics. I would also like to thank those who voluntarily participated in this experiment, because with their participation, this would have been impossible. Finally, my committee members: Doctors Born, Jorgensen, and McCreary who each lent their expertise to this thesis and helped to further my knowledge.
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CHAPTER 1

INTRODUCTION

The acquisition of a phonological system is one of the most difficult aspects of second language acquisition. This is especially true if the new sounds to be acquired are not found in the learner’s native language, thus leaving the learner without a basis from which to either accurately perceive or produce them immediately.

L\textsubscript{2} acquisition models and theories

In the field of second language acquisition, there is no one overreaching theory or model of acquisition/learning that is universally accepted. However, there are several which are falsifiable scientific methods dealing specifically with the acquisition of L\textsubscript{2} phonology. In this section, some of these competing theories and will be reviewed from the current literature, to help the reader form a general understanding of what processes and factors are at work in acquiring L\textsubscript{2} phonological systems.

One of the most prevalent is the Critical Period Hypothesis which deals with the age of acquisition as its primary factor. The Critical Period Hypothesis consists of two principles. The first is that during the early period of life, a child has the capacity to perceive and produce all sounds. The second is that if this capacity if not exercised during the early period, then the capacity will be lost during puberty.\textsuperscript{1} That is to say, during the early years of life everyone has within him or her the capacity to perceive and produce all sounds of speech. However, a child must be exposed to these sounds for this innate capacity to be activated. Should it not be used,

\textsuperscript{1} Judith Strozer, Language Acquisition after Puberty (Washington: Georgetown UP, 1994) 136.
then it will not become part of the native phonological system. It is only during these early years that this capacity for acquisition may be activated. If one is not exposed during this period, then the sound cannot be mastered natively because of brain modification in the Language Acquisition Device.²

There have been numerous studies into the effect that age of acquisition and/or the age of the learner upon entering a new language area (age of arrival) have on L₂ phonology and perceived foreign accent. One such study on the age of acquisition studied immigrants to the United States and their children.³ It was noted that the children acquired the language with relative ease, especially in the area of phonology achieving either native or near native pronunciation, whereas for the parents it was a life-long process of patchwork to correct their language, i.e. the continuous fixing of problems that are made known to them.

Related to this was Flege’s study on how the age of arrival into a new linguistic area affected learners’ speech.⁴ Flege’s findings indicated that the younger the learners were at the time of their arrival into a new linguistic area, the less foreign was their pronunciation perceived by native speakers. There was a clear decrease in the perceived native-like pronunciation the older the learners were upon arrival in the new area. Therefore, those who arrived as children were perceived as native while those who were older were judged to be less native on a progressive scale. These and other studies lend credence to the idea of a critical age, which, though disputed by some, seems to be around the age of 5 or 6.

² Strozer, 137.
³ Strozer, 143.
On of the most comprehensive models of language acquisition, with particular respect to phonology, is Flege’s Speech Learning Model. The Speech Learning Model seeks to account for age-related limits on the ability to produce L2 vowels and consonants in a native-like fashion. The model is comprised of 4 postulates and 7 hypotheses which are listed in the Appendix under A.2 and selected ones appear below:

H1 Sounds in the L1 and L2 are related perceptually to one another at a position-sensitive allophonic level, rather than at a more abstract phonemic level.

H2 A new phonetic category can be established for an L2 sound that differs phonetically from the closest L1 sound if bilinguals discern at least some of the phonetic differences between the L1 and L2 sounds.

H3 The greater the perceived phonetic dissimilarity between an L2 sound and the closest L1 sound, the more likely it is that phonetic differences between the sounds will be discerned.

H4 The likelihood of phonetic differences between L1 and L2 sounds, and between L2 sounds that are noncontrastive in the L1, being discerned decreases as AOL (age of learning) increases.

The first hypothesis can be paraphrased to state that learners relate allophones in the L2 to the closest positionally defined allophone in the L1. If this hypothesis is true, then one could predict the manner of articulation and production of L2 allophones by defining their L1 counterparts or positional equivalents. But, according to the second hypothesis, if the learner can discern at least some phonetic difference, then a new category can be created in accordance with the seventh hypothesis. Also of particular importance to this paper, are the third and fourth hypotheses. The third being that the greater the perceived difference between a L2 sound and the

5 Flege, 237.
L₁ sound position, the greater the likelihood of a new sound category being created. And finally, in the same vein as the Critical Period Hypothesis, the fourth states that the likelihood of this difference being discerned decreases with the greater the age of arrival. If the learner is in turn unable to discern this difference, then the L₂ sounds will be produced with distinctive L₁-like properties. Thus, the Speech Learning Model offers support to the Critical Period Hypothesis while providing insights into the process of L₂ category formation, or a lack thereof.

Another such model is Best’s Perception Assimilation Model. The basic premise of this model is that “non-native segments tend to be perceived according to their similarities to, and discrepancies from, the native segmental constellations that are in closest proximity to them in a native phonological space.” This model accounts for three methods by which non-native segments may be assimilated: they may be assimilated to a native category, they may be assimilated as an uncategorizable speech sound, or they may be not be assimilated into speech. As an uncategorizable speech sound, the non-native segment is in fact assimilated, but the new segment does not fall within the bounds of any native phoneme. And when the non-native segment is not recognized as a speech sound at all, it will not be assimilated into the native phonological space at all. Thus, just as the Speech Learning Model predicted that if a difference between the native and non-native segment is discerned by the learner, a new category will be created for it in the learner’s phonological system. However, if no difference is heard between the L₂ sound and the native phonology, then the L₂ sound it will be produced with L₁ qualities as it will not have been placed in a new phonological category.

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7 Best, 193.
In dealing with these perceived similarities and differences between the L₁ and the L₂ phonological systems, one must also consider Major’s Similarity Differential Rate Hypothesis. This hypothesis tested the general assumption that similar phenomena are acquired at a faster rate than dissimilar and that markedness is a mitigating factor that can slow rate. In doing so, several previous studies were examined including one by Bohn and Flege which showed that German L₁ speakers learning English acquired the novel phoneme /æl/ with good production values, but had difficulty with the similar phonemes /ɛl/, /ɛl/, and /ɛl/. This contradiction between the data and the initial hypothesis led to the conclusion that according to the Similarity Differential Rate Hypothesis, dissimilar phenomena are actually acquired faster than similar ones due to a lack of interference, or language transfer.

Language transfer in language learning has been described by Selinker as one of three types of transfer from the L₁ to the L₂. The first is positive transfer, which takes place when the L₁ can be used for the L₂ and results in a non-error. In this instance, a phoneme from the L₁ could be used by the learner in the L₂ without it being judged distinctly L₁. The second type of transfer is negative transfer. This is similar in nature to positive transfer; however, the usage of the L₁ system here results in an error. The third is neutral transfer which takes place when the learner makes use of the L₁, but there is no correspondence in the L₂. The result of neutral transfer can, therefore, not be judged as either an error or a non-error.

In a series of eight experiments on language transfer, Selinker found that four of these tests resulted in positive transfer, three of them negatively, and one of them with neutral transfer.

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While, it is impossible from this alone to determine whether positive or negative transfer will take place, Selinker concluded that in general, neutral transfer is rare due to the rigid constraints of language.\textsuperscript{11} Some of the other prevalent theories include, Eckman’s Structural Conformity Hypothesis, which deals with the markedness relationship that exists between languages. It states that less marked structures will be acquired before more marked. For example, in German words that have been changed as a result of the application of inflectional morphology will be acquired later than their base forms. Also, Broselow’s Syllable Structure Transfer Hypothesis observed that L\textsubscript{2} syllables that do not conform to the L\textsubscript{1} will often times be made to conform by learners so that they can be produced. That learners will force a novel sound to conform to their own native phonology in order to produce that sound is a process linked with language transfer and Interlanguage modification.

In the theories reviewed, we have seen that the acquisition of L\textsubscript{2} phonology presents quite a daunting task to the language learner. Once the Critical Period has passed, L\textsubscript{2} phonology can only be partially acquired resulting in a foreign accent. While there may be no universally agreed upon age for the end of this critical period, most linguists agree that one does exist. For adult learners, or any past the critical age, the acquisition of L\textsubscript{2} phonology becomes dependent on whether or not the learner can discern a difference between L\textsubscript{1} phonemes and allophones and those in the L\textsubscript{2}. When such a difference is detected, it can often be produced by means of a new phonemic category in the speaker’s phonological space. When none is detected, language transfer may take place as an L\textsubscript{1} sound is produced because there is no perceived difference between the two. If older listeners are projecting their native language onto the target language while children do not, then that would help to account for phonological discrepancies. And this is

\textsuperscript{11} Selinker, 51.
also why learners who desire correct pronunciation must aim for native-like pronunciation, rather than full native pronunciation.

Analysis of speech

There are many tests that can be performed to determine the level of acquisition of a language (i.e. perception tests, production tests, acceptability judgments, etc.) This thesis is primarily concerned with the perception and production tests. These tests are done to examine the level and rate of acquisition of the L₂. Perception tests, specifically vowel perception, are comprised of two parts. First, the listener must be able to make a categorical differentiation between L₂ vowels; the listener must also, as noted above, be able to make a differentiation between the L₁ and L₂ vowels as well. Second, the listener must be able to identify the same vowel under different circumstances. Although a vowel may be correctly perceived by a listener in isolation, when it is found in a multitude of words, each with their own consonantal environment, their sounds can be altered.

The production test is similar in essence to the perception test, but tests a subject's speaking ability, in this case pronunciation. Here a subject must know the phonological rules of the L₂ and be able to accurately produce them under different contexts and circumstances to achieve native-like results. Knowing this and being able to detect it in both perception and production of the L₂ is what separates phonetic knowledge from functional knowledge.¹² That is, knowing what a sound is versus knowing how to accurately use it within the phonetic structure of a particular language.

Both of these tests, then, can be done in an examination of anything from a single phoneme to sentence prosody and more. But within the aspect of testing for a singular phoneme,

such as a vowel, it can be done with the phoneme in isolation or it can be contained within a word. However, these two forms of testing yield different results even though they are testing for the same phoneme. This is because of the influence of the other sounds in the word upon the one being tested, a phenomenon known as coarticulation. For example, if one wanted to test the production of /ɛ/ in isolation, then the manner of articulation within the mouth and vocal bands would be the sole factor tested. However, if one were to test for it in the word /rɛkən/, for example, then different values would be recorded than the pure form because of the vowel’s consonantal context.

The effect of consonants on surrounding vowels occurs during the transition from one to the other.\(^{13}\) For example, in the word /rɛkən/ the transition in /r–ɛ/ will cause different values to be recorded for /ɛ/ than in isolation. There will also be the additional transition of /ɛ–k/ which will also affect it. Note that this is differentiated from assimilation in that assimilation takes place when sounds become similar to adjacent sounds, whereas coarticulation is a process that occurs during the transition of one phone to the next. This phenomenon is covered in the Dynamic Specification Model which uses temporal information to determine the formant affects of /C–V/ and /V–C/ transitions.

What then is the formant? Vowels are comprised of a fundamental frequency and formant frequencies. The fundamental frequency (F\(_0\)) is the harmonic frequency of the vowel. This is the lowest frequency of the harmonic. The formant frequencies (F\(_1\), F\(_2\), F\(_3\), etc.) reflect the resonance chambers of the vocal tract. The formants are ideally whole multiples of the previous. For example, if the first format were at 250 Hz, then the second would be 500 Hz, the third 1000 Hz, and so forth.

Fundamental frequency and formant frequencies are independent of one another and in this study only the first two formants will be used i.e. F₁ and F₂. These frequencies allow a researcher to examine the quality of a vowel and compare and contrast them with other speech sounds. This is done by plotting the formant data in either a two-dimensional or three-dimensional graph based upon the frequencies for the first two or three formants respectively. The usage of the first two formants for this, with the first formant (F₁) along the X-axis and the second formant (F₂) along the Y-axis is the most widely used for showing the acoustical dispersion of vowels.

These frequencies are most often obtained through a spectrographic analysis of speech. There are several methods for obtaining the formants, however, the preferred method that will be used in this study is the center-clipped auto correlation function (ACC) which has been shown in studies as being consistently reliable across the board and one of the most accurate in predicting and determining frequencies. Using a reliable method of determining frequencies will help to ensure that the data obtained are as accurate as possible and able to withstand repeated testing.

Replication and falsifying data

All scientific data must be falsifiable in order to be accepted as such. If the theory or hypothesis behind an experiment cannot be tested, then it cannot be called a scientific fact. Only data which can be verified can be declared so under the scientific method. Furthermore, even when data are falsifiable, drawing conclusions from a single sample or experiment could prove to be hasty. Even though a hypothesis may be acceptable because it can be verified under the

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scientific method, it is only when that hypothesis can stand up to repeated testing that it can be called a theory. Such is the premise of this thesis.

A study on the acquisition of German vowels by Native speakers of English has been selected to be replicated in order to falsify the data and test their veracity. The study titled “The Perception-Production Relationship in the Acquisition of Second Language Vowel Contrasts”\(^\text{18}\) by Ewa Jacewicz, was selected for this purpose. The methodology, testing procedures, the results, and the conclusions drawn will be analyzed in detail. These same procedures will then be carried out in an attempt to replicate Jacewicz’ experiment as closely as possible. The results will then be analyzed on their own merits. Finally, a comparison of the two studies will be performed in an attempt to verify the data and conclusions set forth by Jacewicz. Should the findings be similar, then the hypotheses originally tested will be strengthened. However, should the findings prove to be dissimilar, then it will be an indication that further testing is required in order to support the validity of the hypotheses. Whatever the results, a better understanding of the relationship between perception and production will be revealed.

CHAPTER 2
THE ORIGINAL STUDY

Purpose

Jacewicz’s study sought to “learn more about links between the perception and production of L2 vowels at the beginning stage of language acquisition.”\(^{19}\) The main question behind this was whether or not perception and production develop initially along separate paths in the performance system or if perception and production are already linked by beginning L2 learners at such an early stage of development, and what, if any, influence the L1 exerts on the L2. From this, two hypotheses were then put forward. First, that the lack of significant context effect between the native L1 phoneme and an L2 phoneme would have a high identification in perception tests and that would indicate an ability to identify it regardless of context. Secondly, however, a significant context effect on the phonemes would lead to a lower level of identification and would indicate an inability to cope with contextual variability.

Methodology

For this, four lax German vowels were chosen to represent the L2 system while American English would represent the L1. The four vowels used in the study were: the high front rounded vowel /ʁ/, the high front unrounded vowel /i\, the mid front unrounded vowel /ɛ\, and the high back rounded vowel /u/. Of these four German vowels, only the vowels /i\, /ɛ\, and /u/ are also found in the English vocalic system. Therefore, the vowel /ʁ/ was the only new segment for the participants of the study.

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\(^{19}\) Jacewicz 317.
These four vowels were then set up into the lexically contrasting pairs /ɪ/ - /ɛ/ and /ɐ/ - /ʊ/ for analysis. Because lexical vowel contrasts were being examined, real words from the German lexicon were selected in place of arbitrary phonotactic constructions or isolated vowels given without lexical context so that the vowels appeared in their natural state. Moreover, in order to isolate the vowels into minimally contrasting pairs, only words conforming to the pattern //CVCVC/ were chosen where the initial //C)CVC/ pattern contains the vowel in question. The usage of the consonantal environment allowed for a voiced on-set timing and a natural prosodic value for the vowels as they occur in regular speech. One such example from the contrasting pair /ɪ/ - /ɛ/ that was selected is “sticken” – “stecken” where the vowel is the sole variable; see Table 2.1 below for the sixteen tokens used in both the perceptual and production experiments.

<table>
<thead>
<tr>
<th>/ɪ/</th>
<th>/ɛ/</th>
<th>/ɐ/</th>
<th>/ʊ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ˈtɪken/</td>
<td>/ˈdeken/</td>
<td>/ˈtyken/</td>
<td>/ˈdukən/</td>
</tr>
<tr>
<td>ticken</td>
<td>decken</td>
<td>Tücken</td>
<td>ducken</td>
</tr>
<tr>
<td>/ˈʃtɪken/</td>
<td>/ˈʃteken/</td>
<td>/ˈʃtyken/</td>
<td>/ˈʃtukən/</td>
</tr>
<tr>
<td>sticken</td>
<td>stecken</td>
<td>Stücken</td>
<td>Stücken</td>
</tr>
<tr>
<td>/ˈrɪken/</td>
<td>/ˈrɛken/</td>
<td>/ˈrʁken/</td>
<td>/ˈrʊkən/</td>
</tr>
<tr>
<td>Ricken</td>
<td>recken</td>
<td>rücken</td>
<td>Rucken</td>
</tr>
<tr>
<td>/ˈblɪken/</td>
<td>/ˈbleken/</td>
<td>/ˈpflɪken/</td>
<td>/ˈglʊken/</td>
</tr>
<tr>
<td>blicken</td>
<td>blecken</td>
<td>pflücken</td>
<td>glucken</td>
</tr>
</tbody>
</table>

All initial consonants, or clusters in the case of /ʃ, b\l, p\l/, and /gl/, are naturally occurring onsets in the German language. Furthermore, they can occur before a lax vowel in

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20 Jacewicz 320.
disyllabic words where the vowel can be followed by /k/. The lexical category of the words was then chosen as either a verb infinitive or a dative plural in order to add the suffix –en for conformity. For a full listing of the German words used and their glosses, see Appendix A.1.

**Participants**

There were a total of twelve native speakers of American English and one native speaker of German, who was a speaker of Northern German. The English speakers were all students in the second semester German language course at the University of Wisconsin-Madison and had a mean age of twenty years. The subjects were all of the same linguistic/dialectal background, born and raised in Wisconsin, none suffered from speech or hearing impairments, none had any experience with a language that had front rounded vowels, and all had less than one full year of experience with the German language. In addition, only male speakers were selected to eliminate any possible gender speech discrepancies as another variable to the experiment.\(^{21}\) The North German speaker was born in the Hamburg area and had spent most of his life there.

**The Perceptual Experiment**

This portion of the experiment involved the native speakers of English identifying German vowels that were played for them. The tokens found in Table 2.1 were recorded by the native speaker of German for this. These tokens were placed into the carrier sentence “Sag _____ für mich” (“Say _____ for me”) for the native speaker to read. Each token was then edited out of the sentence and digitally stored to be used during the perceptual test.

**The Procedure**

The sixteen tokens were divided into 8 random sequences comprised of 10 repetitions of 4 tokens yielding a total of 40 stimuli per block. These 8 blocks were then broken up into two

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\(^{21}\) Kent and Read 88-89.
groups of 4 blocks each. Blocks 1-4 contained all four vowels, which tested the listeners’ ability to discriminate all four vowels from one another. However, blocks 5-8 contained only a two-vowel contrast of either /ɪ/ - /ɛ/ or /ɪ/ - /ʊ/, which helped to show whether a lower number of contrastive vowels in each set would have any effect on their identification by the listeners. This accounted for a total of 320 testing stimuli in the perceptual test.

The listeners identified the vowels by means of an open-ended identification task. The listeners were asked to choose from the standard German orthographic symbols with which they were already familiar (i, e, a, o, u, ü, ö, and ä) as opposed to choosing from the phonetic symbols, nor were they merely limited to the four vowels being used; the speakers had free choice of any German vowel.

Results

The results of the perceptual identification task were scored according to the number of correct responses and examined for any general tendencies in vowel identification by beginning learners of German. Finally, the effect of consonantal context was then examined for each vowel. Table 2.2 shows the compiled results.

Table 2.2. Identification percentages of /ɪ/, /ɛ/, /ʌ/, and /ʊ/ with correctly identified percentages bolded.\textsuperscript{22}

<table>
<thead>
<tr>
<th>Vowel identified</th>
<th>/ɪ/</th>
<th>/ɛ/</th>
<th>/ʌ/</th>
<th>/ʊ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ɪ/</td>
<td>89</td>
<td>10</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>/ɛ/</td>
<td>7</td>
<td>90</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>/ʌ/</td>
<td>32</td>
<td>54</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>/ʊ/</td>
<td>33</td>
<td>32</td>
<td>26</td>
<td>9</td>
</tr>
</tbody>
</table>

\textsuperscript{22} Jacewicz 322.
Vowel identification in general showed a pattern of regularity. The unrounded vowels /ɪ/ and /ɛ/ showed a low percentage of confusion with few substitutions, whereas the rounded vowels /ɨ/ and /ʊ/ showed a high rate of confusion along with more substantial substitution. One point of interest here is the fact that although /ɨ/ and /ʊ/ served as the main substitution for the other, they were mistaken only for other rounded vowels and not unrounded vowels.

These results were then analyzed by means of a two-way analysis of variance (ANOVA). The factors used in this ANOVA were the syllable onset (i.e. consonantal context) and listening condition (i.e. four- or two- vowel contrast within a block). This analysis showed that there was no main effect on either /ɪ/ or /ɛ/ in terms of consonantal context, regardless of whether the tokens were heard in a four-vowel or two-vowel context with the resultant being (F(3, 136) = .95, p = .419). Therefore, both /ɪ/ and /ɛ/ were readily identifiable by listeners regardless of the consonantal environment.

The rounded vowels /ɨ/ and /ʊ/, however, yielded different results. /ʊ/ was shown to have a significant context effect, (F(3,88) = 60.93, p = .009). Unlike the unrounded vowels discussed above, the consonantal environment created a difference in perception among the listeners. Figure 2.1 below shows the distribution of the four different consonantal onsets in both correct identification of /ʊ/ as well as for its substitutions. This would seem to indicate that /ʊ/ is dependent on its immediate surrounding phonemes for perception, at least among beginning L2 listeners.

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23 Jacewicz 322.
24 Jacewicz 323.
A significant effect of consonantal context was also found for /X/ (F(3,88) = 30.29, p = .055), but at a different level from /U/. Figure 2.2 below illustrates this distribution and it can be seen that while it appears that perception of /X/ is also somewhat dependent on context, the substitution pattern was far more consistent across the board than was the case for /U/.

Figure 2.1. Consonantal context distribution in the identification of /U/ in perception test.\textsuperscript{25}

\textsuperscript{25} Jacewicz 323.
These data show that both /ɪ/ and /ɛ/ were identified in equal accuracy at 89% and 90% correct respectively. And although both /ɛ/ and /ʊ/ were poorly identified, they did show a remarkable similarity in the rates at which they were identified, or misidentified, at 32% correct for each. Jacewicz concluded from this that the vowels /ɪ/ and /ɛ/ had a stable mental representation, whereas the significant context effect on /ɛ/ and /ʊ/ showed a clear lack of such stability. Therefore, L₂ vowels are represented by their relationship to the surrounding phonemes. Finally, it was concluded after the perceptual experiment that because the /ɪ/ - /ɛ/ contrast existed in the L₁, the listeners were able to readily distinguish between them. However, because /ɛ/ was not present in their native language, the listeners were not able to use their L₁ representations in distinguishing between the /ɛ/ - /ʊ/ contrast.

Figure 2.2. Consonantal context distribution in the identification of /ɛ/ in perception test.²⁶

²⁶ Jacewicz 324.
The Production Experiment

Since the perceptual experiment found that the listeners identified a distinction between /ɪ/ and /ɛ/, but not /ɹ/ and /ʊ/, it was hypothesized that “in the production study one could reasonably expect the subjects to produce a measurable distinction in /ɪ/ and /ɛ/, but not in /ɹ/ and /ʊ/ as there would likely be an acoustical overlap.”\textsuperscript{27} From this, it was also hypothesized that because of the perceptual results that there would be no overlap in the production of /ɪ/ and /ɹ/ in the speech of the subjects. This information was found by means of a spectral analysis of the subjects’ speech which is discussed in detail in the section below. Finally, three questions were posed: does L\textsubscript{2} German vowel spacing in production mirror perception, to what extent could the L\textsubscript{1} acoustic locations affect their L\textsubscript{2} variants, and how does the acoustic spacing of native German speakers compare with that of L\textsubscript{2} speakers?\textsuperscript{28}

Methodology

The same subjects from the perceptual experiment participated in the production experiment using the same 16 tokens and the carrier sentence “Sag _____ für mich” (“Say _____ for me”). The sentences were repeated six times in random order, after which, the subjects were tested for their English articulation. This was done in the same manner as with German. A carrier sentence “Say _____ for me” was used with the tokens “hid”, “head”, and “hood” which represent the lax vowels /ɪ/, /ɛ/, and /ʊ/ in English respectively and were also read six times each in random order. The vowels were then measured using CSpeechSP software, which uses the center-clipped autocorrelation function (ACC) method of analysis. ACC is an algorithm designed to determine the pitch and frequency of sound data. In a comparison of high precision

\textsuperscript{27} Jacewicz 324.
\textsuperscript{28} Jacewicz 325.
algorithms, Vijay Parsa and Donald Jamieson concluded that this method was one of the most accurate and reliable.\textsuperscript{29}

The tokens were rendered as both digital waveforms and spectrograms so that they could be measured for overall duration, duration of the segments in the onset of the first syllable, Voiced-Onset-Time (the delay before speaking) and duration of the target vowel, and the duration of the second syllable.\textsuperscript{30} The fundamental and formant frequencies were then determined.

\textbf{Results}

The results of the L\textsubscript{2} German vowels /\textipa{I}/, /\textipa{E}/, /\textipa{Y}/, and /\textipa{U}/ clearly show that, as expected, the unrounded vowel contrast of /\textipa{I}/ - /\textipa{E}/ is well separated as in the perception test. Furthermore, the rounded vowel contrast /\textipa{Y}/ - /\textipa{U}/ overlaps, mirroring the results of the perception test as listeners were unable to distinguish between them as Figure 2.3 illustrates.


\textsuperscript{30} Jacewicz 320.
The subjects’ L₁ speech was then tested for the American English vowels /ɪ/, /ɛ/, and /u/.

This was necessary to observe any possible influences or similarities between their L₁ and their L₂ articulation. Figure 2.4 shows their dispersion pattern and proximity to the L₂ vowels. It is of interest to note that for all three English vowels, their German counterpart is in close proximity.

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31 Jacewicz 326.
Figure 2.4. Acoustic dispersion of L2 German and American English vowels preceded by the neutral /h/-onset.\textsuperscript{32}

Finally, the native speaker data were plotted for the German vowels /ɛ/, /ε/, /χ/, and /u/ which were the same classified by the listeners in the perception test. These native vowels were then plotted against the L2 data given earlier in Figure 2.3, the results of which can be seen in Figure 2.5.

\textsuperscript{32} Jacewicz 327.
Figure 2.5. Acoustic dispersion of native German vowels and L₂ German vowels in five consonantal contexts.\(^3^3\)

These data are especially revealing because they show that all of the native German vowels are well separated from one another, whereas there is close proximity, and near overlap, between the L₂ vowels /ɛ/ and /ʊ/. As seen in Figure 2.4, for the vowels L₂ vowels /ɛ/, /ɛ/, and /ʊ/ it can be seen that they mirror the placement of their English counterparts in the L₁. For instance, although the L₂ /ʊ/ is fairly close to the native along the F₁ axis, it is of a greater frequency along the F₂ axis than the native production. It can also be seen that L₂ /ɛ/ overlaps with native German /ɛ/. This is because the L₂ production mirrors that of the English L₁ and is of a significant distance from the native German production in both the F₁ and F₂ frequencies. Equally distinguishable is the fact that L₂ /ɛ/ is being produced in the same manner and as a result is the furthest of the four vowels from the native production.

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\(^3^3\) Jacewicz 327.
However, the most revealing aspect here is the fact that the novel vowel /\gamma/ was produced at virtually the same frequency range by both the L2 speakers and the native speaker. Thus, the only vowel not found in the English phonetic system was produced by the test subjects at the closest level as the native speaker. Some possible reasons could be L1 interference on the L2, or as Wode found in a similar study, the L1 could simply be serving as a point of articulatory reference for the L2 sounds with which it has a counterpart, which Wode concluded was not necessarily a simple case of interference of the L1 speech patterns on the L2.\textsuperscript{34} This means that the sound being produced by the learner falls somewhere between the L1 and the L2 pronunciation. Regardless, the three questions posed prior to the production experiment were answered. The L2 acoustic spacing did mirror the perceptual experiments results in that /ɪ/ and /ɛ/ were perceived as distinct sounds, though not at the same frequency values as the native speaker, while there was overlap in /\gamma/ and /ʊ/. The acoustic location of the English vowels did seem to have some type of influence, whatever the cause, on the L2 variants. And finally, /\gamma/ and /ʊ/ were produced quite similarly by the L2 speakers in contrast to the native speaker data, which showed a clear separation.

Perception-production relationship

In establishing a relationship between perception and production, the main question of this study must be considered; do perception and production develop initially along separate paths or do L2 learners link them already at an early stage of acquisition?\textsuperscript{35} The subjects were able to perceive a distinction between /ɪ/ and /ɛ/ even with contextual variation. And they were equally able to disperse them in production, albeit at different frequencies primarily along the F1


\textsuperscript{35} Jacewicz 328.
axis. Thus, the lexical contrast of /ɪ/ and /ɛ/ was realized in both perception and production mentally but not entirely phonetically. Moreover, the /ɻ/ - /ʊ/ contrast also displayed a close relationship between perception and production. Neither vowel was perceived as being distinct from the other, refer back to Table 2.2, nor was there any significant distinction made during production, though there was a slight differentiation. From this, it was determined that “the link between perception and production was most likely guided by the acquisition of lexical contrasts.”\(^{36}\)

In the end, Jacewicz concluded that this constituted a Lexical Contrast Hypothesis which postulated that

\[
\text{…the acquisition of segmental contrast at the lexical level occurs through the physics of speech at the phonetic level, and the performance system determines the way the L}_2\text{ sounds are heard or said. The L}_1\text{ background, all sources of variability in speech, experience with the L}_2\text{, and individual differences among L}_2\text{ learners have an immediate impact on the way the lexical contrast is mentally constructed. The basic tenet of the hypothesis is that in the acquisition of L}_2\text{ phonology, L}_2\text{ learners focus on detecting and expressing lexical contrasts in the L}_2\text{ and not on detecting the phonetic similarities and differences between the L}_1\text{ and L}_2\text{ sounds.}^{37}\]

The overall impact of this hypothesis is that it attempts to explain how “L}_2\text{ listeners classify L}_2\text{ vowels perceptually as a system of contrasts created by the vowels themselves and not as single categories of contrast between the L}_1\text{ and the L}_2\text{.”}^{38}\]

\(^{36}\) Jacewicz 329.
\(^{37}\) Jacewicz 329.
\(^{38}\) Jacewicz 330.
In this experiment, then the context within which the vowels appear will have no role in their identification. But in the case of /ʌ/ - /ø/, as was shown in Figures 2.1 and 2.2, both /ʌ/ and /ø/ depended on their immediate contextual surrounding for perception by the listeners, though this was true of /ʌ/ to a lesser extent than for /ø/. Together, this would seem to have confirmed the Lexical Contrast Hypothesis in that listeners were readily able to produce a distinction that they could perceive in the case of /ɪ/ - /ɛ/, whereas they were unable to produce and significant distinction in the case of /ʌ/ - /ø/, which they were equally unable to perceive.
CHAPTER 3

THE CURRENT STUDY

Purpose

The purpose of the current study, as mentioned in chapter one, is to replicate the study reviewed in chapter two. This is done to in order to confirm the data and conclusions obtained in the original or to dispute them and show that further experimentation is needed. Therefore, the current study will try to preserve as much as possible the conditions of the original. Through this replication, Jacewicz’ conclusions can be supported or it can be demonstrate that further experimentation is needed. This chapter will present the findings of the replication with an analysis of the results. Chapter 4 will deal with the actual comparison of the two studies and the conclusions drawn therefrom.

Methodology

See Chapter 2 Section 2 for a description and Table 2.1 for a list of tokens used.

Participants

As in the original study, 12 native speakers of American English were test subjects along with 1 native speaker of Northern German. All speakers of English were of the same dialect group, having been born in and spent most of their lives in Georgia, and were all students enrolled in the second semester German class (GRMN 1002) at the University of Georgia. None had any speech or hearing impairments, nor had any ever studied a language with front rounded vowels other than German. Only male speakers were used with a mean age of 21. The male
A speaker of Northern German was born and raised in Rostock. All subjects participated voluntarily and were not compensated.

The Perceptual Experiment

The carrier sentence “Sag _____ für mich.” was used for the German tokens (see Table 2.1). These carrier sentences were digitally recorded with a digital voice recorder at 8,000 Hz with a bit-rate of 16. The necessary tokens were edited out of the sentence by using Sony’s Sound Forge 7.0 software. Each token was then stored as a separate file to be played during the perceptual test for the 12 subjects. The native German tokens were then analyzed for fundamental frequency, formant frequencies (F1, F2, and F3), and duration with TF32 software. TF32 is an updated version of the DOS program CSpeechSP that is designed to take advantage of the 32-bit environment of Microsoft Windows, which allows for better spectrographic analysis. TF32 still uses the ACC method of analysis previously discussed in Chapter 1, so the results can be viewed as having a fairly high degree of accuracy.

The Procedure

The same procedures described in Chapter 2 Section 5 were used here.

Results

The results of the perception test were analyzed for the correct number of responses and what substitutions, if any, were used for the intended vowel. The results of this are shown below in Table 3.1.
Table 3.1. Identification percentages of /ɪ/, /ɛ/, /ɤ/, and /ʊ/ with correctly identified percentages bolded.

<table>
<thead>
<tr>
<th>Vowel intended</th>
<th>/ɪ/</th>
<th>/ɛ/</th>
<th>/ɤ/</th>
<th>/ʊ/</th>
<th>/ɔ/</th>
<th>/œ/</th>
<th>/ə/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ɪ/</td>
<td>67.7</td>
<td>23.6</td>
<td>1.3</td>
<td>5.9</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ɛ/</td>
<td>5</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ɤ/</td>
<td>6.9</td>
<td></td>
<td>18</td>
<td>56.9</td>
<td>9.72</td>
<td>8.33</td>
<td></td>
</tr>
<tr>
<td>/ʊ/</td>
<td>8.75</td>
<td></td>
<td>15</td>
<td>35</td>
<td>28.75</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

From this table, a few generalizations can be made concerning the subjects’ perception of the vowels. The two unrounded vowels /ɪ/ and /ɛ/ were perceived rather well with very few errors for /ɛ/. Also, when taking into account the fact that these vowels were set up as contrasts, a clear distinction was made by the listeners in the case of the /ɪ/ - /ɛ/ contrast. And although /ɪ/ was misidentified far more than /ɛ/, its main substitution was /ɛ/, which shows that most listeners could distinguish an unrounded vowel, with only a few instances of a rounded vowel being selected.

By contrast, the rounded vowels /ɤ/ and /ʊ/ were identified with considerably less accuracy. The rounded front vowel /ɤ/ was overwhelmingly mistaken for /ʊ/, while /ʊ/ itself was commonly mistaken for another rounded back vowel /ɔ/. Both were misidentified as an unrounded vowel in less than 9% of cases, and interestingly both /ɤ/ and /ʊ/ were only mistaken for /ɪ/ with regard to the substitution of an unrounded vowel. In terms of the /ɤ/ - /ʊ/ contrast, little distinction seems to have been made between the rounded vowels with neither showing a clear majority, or even greater than 35%, of correct perception with /ɤ/ barely being correctly identified at all. These data were then analyzed with a two-way ANOVA as in the previous chapter.
Figure 3.1. Consonantal context distribution in the identification of /u/ in perception test.

From the ANOVA, it was observed that there was significant context effect on the vowel /u/. Figure 3.1 confirms this effect as well. For example, the consonantal onsets st- and gl- were identified correctly about half the time or greater, while d- and r- were identified more often as /o/. Therefore, there must be some relationship here in the transitional period that influences the perception of the same vowel in different contexts.
Figure 3.2. Consonantal context distribution in the identification of /ɪ/ in perception test.

Here too it is obvious that there is a consonantal effect of the identification of the vowel. However, the effect is not as great as it was on /u/. This is borne out in the ANOVA results as well as the graphical results in Figure 3.2. There does appear to be some degree of conformity, but the identifications of /œ/ and /ɹ/ show that consonantal context is still exerting an effect on the vowel’s perceptibility. Compare these results with Figure 3.3 below which shows the effect on /ɹ/. Although there was no main effect proven, there is still some small discrepancy. However, when compared to the effect in Figures 3.1 and 3.2, there can be little doubt that there exists a sizable difference among the two rounded vowels.
The question then becomes, why? Why was the contrast /ɪ/ - /ɛ/ identified at a little more than twice the rate of /γ/ - /ʊ/? One possible explanation is that, like in Chapter 2, because the former contrast exists in the L₁, the listener is able to more readily distinguish between them. The latter contrast’s problems with identification are then due to the fact that /γ/ is not to be found in the L₁, therefore making it harder for it to be discerned from /ʊ/. However, it remains to be seen as to whether this auditory overlap in /γ/ - /ʊ/ will translate into an articulatory one.

**The Production Experiment**

In conducting the production tests, the three questions raised by Jacewicz before the production experiment were considered: does L₂ German vowel spacing in production mirror perception, to what extent could the L₁ acoustic locations affect their L₂ variants, and how does

![Figure 3.3. Consonantal context distribution in the identification of /ɪ/ in perception test.](image-url)
the acoustic spacing of native German speakers compare with that of L2 speakers? If the production of the subjects mirrors their perception, then one would expect the same degree of overlap mentioned in the previous section. An analysis of the formant frequencies should be sufficient to reveal a transfer of L1 phonology onto the L2 words and to what extent the L2 productions differ from that of the native speaker.

Methodology

The same procedures outlined in Chapter 2 Section 8 were used with the three English tokens “hid”, “head”, and “hood” in the carrier sentence “Say _____ for me” along with the same German carrier sentence used by the native speaker in the recording of the perception test tokens. The productions were then analyzed using the TF32 software.

Results

The first of the three questions can be answered by referring back to Table 3.1 and comparing that with the L2 production data results in Figure 3.4 below. The perception test revealed that only /ɛ/ was being distinctly perceived with /ɪ/ being fairly perceived and the others almost not at all. If production develops along with perception, one would expect to find a mirror of that in Figure 3.4 and that is exactly what the data show. There is considerable overlap among /ɪ/, /ʏ/, and /ʊ/, while /ɛ/ remains clearly distinct from the other three. And although there is overlap among the remaining three, /ʏ/ and /ʊ/ are produced with only a small degree of difference. Thus, it would appear from the data here that the learners’ production is proceeding along the same path of acquisition as their perception.

39 Jacewicz, 325.
Figure 3.4 Acoustic dispersion of L2 German /ɪ/, /ɛ/, /ʏ/, and /ʊ/ in four consonantal contexts.

The second research question was whether or not the L1 could be having an influence on the subjects’ L2 production and if so to what extent. Figure 3.5 plots the learners’ native production of /ɪ/, /ɛ/, and /ʊ/ against their L2 production of /ɪ/, /ɛ/, /ʏ/, and /ʊ/. It can be seen here that the learners’ L1 does seem to affect the L2 production considerably. Along the x-axis, the F1 seems virtually identical in the L1 and its L2 counterpart with the only major difference coming in the y-axis in the F2. It should also be noted the novel L2 sound /ʏ/ is closely articulated with the L1 /ʊ/, its closest counterpart here.
Figure 3.5. Acoustic dispersion of L₁ and L₂ vowels.

However, though the L₁ and L₂ production of /ɪ/ are similar along the F₁ axis, there is a considerable difference along the F₂ axis that was not present in the learners’ speech productions in the original experiment. This can likely be attributed to the dialect of the learners. The learners of German in the original were from Wisconsin, whereas the learners in the current experiment were from Georgia. This group of Southern dialect speakers produced /ɪ/ in a laxer manner than the standard English pronunciation. For example, the simple past tense of the verb “to do”; did. The Southerners pronounce this word as /dɪd/, while the standard pronunciation is /dɪd/. Here the native language of the southern speakers seems to have an influence along the F₁ axis of the L₂, but not along the F₂ axis. This could be because of the fact that German vowels are far tenser in their production than are English vowels. The students are likely able to discern this difference and attempt to produce /ɪ/ in a manner more consistent with the standard German pronunciation.
These differences in the subjects’ dialects and how speech production and perception were affected by these differences are covered in the analysis of the two experiments in Chapter 4.40

Finally, the third question associated with this production test was if the L2 German productions differ from the native speaker. The answer to that question must be yes. Though the L2 speech data are not far from the native speaker data, there is a consistent pattern of the L2 speech having a higher F1 and F2 than the native speaker. Moreover, these L2 values are closer to their English counterparts than they are to the native speaker’s productions. Therefore, a definite correlation between the L1 and the L2 can be seen as language transfer which prevents the L2 speech from matching the native speaker with the possible exception of /ɛ/. Though it was produced near /u/, there was no direct correspondence in the L1 and it is likely that a new category was created.

The perception-production relationship

The data from Figures 3.4 and 3.5 are used below in Figure 3.6 to map the speech of the native speaker of German against the speech productions of the L2 learners. This figure demonstrates that there is a fairly high degree of influence or transfer from the L1 to the L2. The L2 productions are extremely close in the cases of /ɪ/, /ʊ/, and /ɛ/, which were also the vowels classified at low rates in the perception test. Therefore, it seems reasonable to conclude from this data series that the subjects’ perception and production were developing along the same path. Sounds that the listeners were unable to successfully differentiate perceptually, were also produced in a confused manner inconsistent with native speech but were close to L1 speech patterns.

40 See Chapter 4, Production, pages 44-45.
Figure 3.6. Acoustic dispersion of native and L₂ German words in four consonantal contexts.
CHAPTER 4

OBSERVATIONS AND CONCLUSIONS

Perception

Jacewicz’ perception results (Table 2.2 below) and the current study’s perception results (Table 3.1 below) reflect a pattern, albeit with some differences.

Table 2.2. Identification percentages of /ɪ/, /ɛ/, /ɜ/, and /u/ with correctly identified percentages bolded.41

<table>
<thead>
<tr>
<th>Vowel identified</th>
<th>/ɪ/</th>
<th>/ɛ/</th>
<th>/ɜ/</th>
<th>/ʊ/</th>
<th>/o/</th>
<th>/æ/</th>
<th>/a/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ɪ/</td>
<td>89</td>
<td>10</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ɛ/</td>
<td>7</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ɜ/</td>
<td></td>
<td></td>
<td>32</td>
<td>54</td>
<td>10</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>/u/</td>
<td></td>
<td></td>
<td>33</td>
<td>32</td>
<td>26</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1. Identification percentages of /ɪ/, /ɛ/, /ɜ/, and /u/ with correctly identified percentages bolded.

<table>
<thead>
<tr>
<th>Vowel identified</th>
<th>/ɪ/</th>
<th>/ɛ/</th>
<th>/ɜ/</th>
<th>/ʊ/</th>
<th>/o/</th>
<th>/æ/</th>
<th>/a/</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ɪ/</td>
<td>67.7</td>
<td>23.6</td>
<td>1.3</td>
<td>5.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ɛ/</td>
<td>5</td>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ɜ/</td>
<td>6.9</td>
<td>18</td>
<td>56.9</td>
<td>9.72</td>
<td>8.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/u/</td>
<td>8.75</td>
<td>15</td>
<td>35</td>
<td>28.75</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From these results, there seems to be a pattern of correct identification. Remarkably, /ɛ/ was identified at exactly 90% in both tests. The substitution pattern also reflected a similarity as /ɪ/ was the main substitution in the original test and one of the two found in the replication. The

41 Jacewicz 322.
perception of /ε/ seems consistent across the tests. Furthermore, both /ʌ/ and /ʊ/ were shown in both tests to have poor identification. /ʊ/ was identified at almost the same rate, but listeners had far more difficulty with /ʌ/ in the replication.

One pattern of Jacewicz’ test was that /ʌ/ and /ʊ/ were both the main substitutions for one another. However, this remained true in the replication only for /ʌ/ with a majority of listeners substituting /ɔ/ for /ʊ/, though the pattern of choosing other round vowels holds for the main substitution. Other substitutions for /ʌ/ and /ʊ/ remained at near the same levels except that the replication introduced the unrounded substitution /ɪ/.

The original study showed that listeners would only substitute a rounded vowel for a rounded vowel. Upon replication, however, it was found that unrounded vowels were also substituted, though at small percentages compared to rounded vowels. Overall, the identification rates for /ʌ/ and /ʊ/ were fairly similar, validating this data.

The only glaring discrepancy upon replication was the identification of /ɪ/ which had a far lower rate of correct identification than in the original test. While /ε/ remained the primary substitution in the replication test, the unrounded vowel was also mistaken for rounded ones. While the /ɪ/ - /ɛ/ contrast remains far stronger among beginning listeners than does /ʌ/ - /ʊ/, listeners in the replication seemed to have greater difficulty discerning /ɪ/.

Therefore, we must then consider the effect of the consonantal onset in each vowel case. Figures 2.1 and 3.1 below show the consonantal effects upon the vowel /ʊ/ in the perception tests. In both tests, a significant context effect was found for this vowel. This demonstrates that
although /u/ is to be found in the L1, that the listeners’ mental representation of the L2 sound /u/ is dependent upon its immediate environment.

Figure 2.1. Consonantal context distribution in the identification of /u/ in perception.42

Figure 3.1. Consonantal context distribution in the identification of /u/ in perception.

42 Jacewicz 323.
The same effect can be noted in both tests in the perception of /\textgamma/ as shown in Figures 2.2 and 3.2. In fact not only did both tests find that there was a consonantal effect on the perception of /\textgamma/, but that there was far more conformity than found in /\textupsilon/. This is interesting given the fact that /\textupsilon/ is present in the L₁ speech of the listeners while /\textgamma/ is not. In both tests, /\textgamma/ was identified at the same rate as lower than /\textupsilon/, but with less influence from the consonantal environment. This could possibly indicate the formation of a new vowel category in the listeners’ phonological system. As far as perception, /\textgamma/ seems to be developing away from a dependency on L₁ knowledge of /\textupsilon/. This should be either confirmed or rejected by the results of the production tests. If L₂ German /\textupsilon/ and /\textgamma/ are articulated in the same manner and they coincide with L₁ English /\textupsilon/, then this hypothesis would be rejected as the perception and production of /\textgamma/ is dependent on that of L₁ and L₂ /\textupsilon/.

![Figure 2.2. Consonantal context distribution in the identification of /\textgamma/ in perception test.](image-url)

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43 Jacewicz 324.
Finally, the replication found a small discrepancy in the perception of /\textipa{\texth}/ that was not noted in the original test. Jacewicz found no evidence of a consonantal effect on /\textipa{\texth}/ in her study, but upon replication a slight one was revealed as shown in Figure 3.3 below. Therefore, it could be that this effect exerted enough influence on the perception of /\textipa{\texth}/ to render identification lower than in the original test. It should also be noted that the decrease in the perception of /\textipa{\texth}/ corresponds to a proportional increase in the consonantal effect versus the original study. From this, it can be preliminarily concluded that the mental representation of /\textipa{\texth}/ is not as stable as /\textipa{\epsilon}/, nor as stable in the listeners of the replication as it was in those of the original study. What remains to be seen is what effect, if any, this will have on production and whether or not it will mirror perception.
Figure 3.3. Consonantal context distribution in the identification of /ɪ/ in perception test.

For now, however, Jacewicz’ hypotheses on the perceptual test can be definitively addressed here. Jacewicz hypothesized that a lack of significant consonantal context would translate as a high rate of identification, while a significant context effect would lead to a low rate of identification in the perception test. This was found to be true here and by Jacewicz. In both studies, /ʃ/ and /ʊ/ had a significant context effect from their immediate environment which shared an inversely proportional relationship with identification. This even held true for /ɪ/ in the present test as a small context effect resulted in a slightly lower rate of identification, also sharing the same inversely proportional relationship. The relationship is further evidenced by the high rate of intelligibility of /ɪ/ and /ɛ/ in Jacewicz’ tests and /ɛ/ in the present test. None of these had any significant context effect exerted on them by their immediate environment with the result being a very high identification rate for all three of nearly 90%. Therefore, though the data
of the present test differ to a degree from that of Jacewicz, the results and hypotheses can be verified in so far as perception of L2 German vowels is concerned.

Production

As with the perception test, Jacewicz posed three questions earlier: does acoustic spacing mirror the perceptual patterns, to what extent could the L1 be exerting influence on the L2, and how does the L2 German data compare with that of the native speaker? In addition, Jacewicz proposed that since the /ɪ/ - /ɛ/ contrast was differentiated, but not /ʏ/ - /ʊ/, then it should be the same for their production. Furthermore, because of their perception, /ɪ/ and /ʏ/ were not expected to overlap in their production.

In answer to the first question, does acoustic spacing mirror the perceptual patterns, Figures 2.3 and 3.4 show that it does. Jacewicz’ results showed that, like the perceptual test, /ɪ/ and /ɛ/ were well separated while /ʏ/ and /ʊ/ had some overlap. Moreover, there was no overlap between /ɪ/ and /ʏ/ as predicted from the perceptual results. And even though the present study produced different results, they help to confirm Jacewicz’ hypotheses. In the perception results of this replication, /ʏ/ and /ʊ/ were shown to have a low rate of identification which should translate into overlap in production as in Jacewicz’ findings. However, /ɪ/ was also perceived with some difficulties as discussed in the previous section. This should also result in some overlap if production does in fact consistently mirror perception, which is exactly what is to be found in Figure 3.4. The only clearly separated vowel produced here is /ɛ/ mirroring the perception. Therefore, the overlap between /ɪ/ and /ʏ/ in the present test is entirely consistent even though it was predicted not to occur and, in fact, did not in the original test.
Figure 2.3. Acoustic dispersion of L2 German vowels in four consonantal contexts.\(^{44}\)

Figure 3.4 Acoustic dispersion of L2 German /ɪ/, /ɛ/, /ɨ/, and /ʊ/ in four consonantal contexts.

The second question raised was what influence the L₁ would have on L₂ production.

Jacewicz found that the L₂ production of /ɪ/, /ɛ/, and /ʊ/ were in close proximity to their L₁.

\(^{44}\) Jacewicz 326.
counterparts. Figure 2.4 shows the comparison of the original’s data with L1 data clearly
influencing L2 articulation, assuming that the L2 productions diverge from that of native speakers.
Similar results are also found for the present study in Figure 3.5. These data also show the
tendency of the L1 to influence L2 production, however, the discrepancy of /ɪ/ in L1 English
between the two studies immediately becomes apparent.

First, it should be noted that the L2 production of German /ɪ/ falls in a similar frequency
range. Therefore, the difference must lie in the speakers’ L1 only. As the subjects of both studies
were all native speakers of American English, the only difference between them seems to be the
dialect regions from which they hail. The subjects in Jacewicz’ study were all from Wisconsin,
whereas the subjects of the present study were all from Georgia.

The fact that both English and German contain the vowel contrast of /ɪ/ and /ɛ/ should
mean that the native speakers of English can make this distinction. Moreover, it could be
assumed that if both groups of American students were from the same native language that the
results would be similar; however, this is not exactly the case. Though both the Wisconsin and
Georgia groups natively speak American English, they are from two varying dialect groups. One
difference between these two dialect groups is in the perception and production of /ɪ/ and /ɛ/.

This contrast is less distinct in southern dialects than in the north. For example, the difference in
production in the south of /pɪn/ and /pɛn/ is non-existent with the individual vowels being
produced similarly.\(^{45}\) Also, refer back to the example given in Chapter 3 of /dɪd/ vs. /dɛd/.\(^{46}\)

This dialectical relationship is evidenced in Tables 2.2 and 3.1. Here /ɪ/ was identified
correctly at a considerably lower rate by southern speakers than by northern speakers. In addition,

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\(^{46}\) See Chapter 3 page 33.
it was misidentified far more by southern speakers as /ɛ/ than by northern speakers. However, the identification of /ɛ/ was found to be at virtually the same rate. This indicates that /ɛ/ was a sound which the southern speakers were familiar in detecting while /ɪ/ presented a problem in terms of differentiating between /ɪ/ and /ɛ/. Figures 2.4 and 3.5 below show this as well. The L₂ production of /ɪ/ by both groups is similar, but the L₁ production of /ɪ/ is considerably different. The southern students are pronouncing the German vowels similar to the northern students, most likely, because German vowels are tenser than their English counterparts. This is resulting in similarly produced L₂ vowels while the L₁ remains separated. Furthermore, both the northern and southern speakers have roughly the same dispersion, or degree of separation, between /ɪ/ and /ɛ/ in both the L₁ and L₂ along the F₁ axis. The real distinction comes along the F₂ axis and is quite substantial for /ɪ/.

That /ɪ/ and /ɛ/ are separate sounds for both groups in the L₂ seems clear from these data; most likely as a result of the tenser German vowels. However, with /ɪ/ being produced by the southern speakers so differently, it would account for the discrepancy between the two groups in perception of /ɪ/ as well as production. Further testing is required to determine if this is in fact the case. Nevertheless, both studies did indeed find that there was an influence of the L₁ onto the L₂.
Figure 2.4. Acoustic dispersion of L$_2$ German and American English vowels preceded by the neutral /h/ -onset.$^{47}$

Figure 3.5. Acoustic dispersion of L$_1$ and L$_2$ vowels.

$^{47}$ Jacewicz 327.
Finally, the third question was how the students’ L₂ German productions compared with that of a native speaker. Figure 2.5 shows Jacewicz’ findings. Here, as expected from the perception data, the native speaker data confirmed that there was definite transfer from the subjects’ L₁ phonology to their L₂ productions. For example, the subjects produced L₂ /ɪ/ in the same frequency range as the native speaker’s production of /ɛ/. Also present is the fact that both /ʌ/’s occurred with the same frequency range. This lends support to the earlier argument that new phonetic categories are created by L₂ learners for novel phonemes not found in the L₁. In fact, /ʌ/ was the only vowel in Jacewicz’ findings produced in accordance with the native speaker data.

The present study, however, shows a marked difference. Though the native speaker data were often of a higher frequency along the F1 axis than that of the original study’s, as illustrated in Figure 3.6, an interesting phenomenon developed between the native speaker productions and the L₂ productions that were not found in Jacewicz’ data. Namely, that the L₂ productions, with the exception of /ʊ/, were produced within the frequency range of the native speaker. But as predicted, /ʌ/ and /ʊ/ were produced by the subjects in close proximity to one another, while /ɪ/ and /ɛ/ were clearly separated at almost the same level as the native speaker.

This portion of the test is dependent upon the data of the native speaker. With only one speaker to compare results with, any conclusions would seem to be suspect. One can only observe here that more native speaker input is required in order for more accurate mean results of L₁ German production frequencies. Therefore, this portion of the production test could not be confirmed in replication and further testing with a larger pool of native speakers is recommended.
Figure 2.5. Acoustic dispersion of native German vowels and L2 German vowels in five consonantal contexts.48

Figure 3.6. Acoustic dispersion of native and L2 German words in four consonantal contexts.

48 Jacewicz 327.
The findings of this and the previous study can then be compared to the acquisition theories discussed in Chapter 1. With regard to the Critical Period Hypothesis, only a partial conclusion can be drawn. While it is true that the L1 learners of both studies were unable to match the native speaker in pronunciation, neither children nor those who began the acquisition as children during the critical period were tested for a comparison. Also, a number of other factors, such as the learners’ instructors and their pronunciation whether native or non-native help to preclude any conclusive statements on the CPH or the Language Acquisition Device.

The first three hypotheses of Flege’s Speech Learning Model discussed in Chapter 1 are proven by the data here. The second hypothesis, for instance, is a new category can be established if the learner can discern some of the differences between the L1 sound and similar L1 sounds. In both studies the learners were able to produce the novel sound /ʁ/ at an acoustical position close to that of the native speaker, whereas familiar sounds were closer to their L1 productions. More importantly, the dialectical differences between the northern and southern learners also demonstrates this. Though southerners produce /ɛ/ and /ɨ/ the same in their speech, when they produced the German /ɨ/ it was produced in a manner far more consistent with both the northern students and the native speakers of German. This is likely because they were able to more readily discern the tenser /ɨ/ of German and therefore produce it. The same L1 phone was far enough from the L1 for learners who normally do not differentiate between /ɨ/ and /ɛ/ to make a distinction.

Best’s Perception Assimilation Model shows that the unrecognizable sound of /ʁ/ was assimilated into the learners’ phonological systems. A new category was created for this sound as there was no correspondent in the native language of the learners. Also, the recognizable
sound /ɪ/ was heard by the southern speakers, yet produced in a manner inconsistent with the native phonology. The Similarity Differential Rate Hypothesis likewise theorizes that dissimilar phenomena are acquired at a faster rate than similar due to a lack of interference. This complements the Perception Assimilation Model in that the novel sound /ɛ/ was acquired by the learners in a manner more consistent with native speech than were the already existing sounds of /ɛ/, /ɪ/, and /ʊ/.

Language transfer was found to be a direct influence on the learner’s perception and production. Selinker’s theory was substantiated here when the learners’ L₁ productions were in close proximity to their native L₁ productions for /ɛ/, /ɪ/ (with exception of southern dialect), and /ʊ/ than they were to the native German productions. And this same transfer was also observed and discussed in terms of their perception.

Conclusions

Do perception and production develop initially along separate paths or do beginning learners link the two aspects already at such an early stage of acquisition? Such was the main question behind Jacewicz’ study. From a detailed analysis of Jacewicz’ study, it has been shown that she concluded perception and production were indeed linked even at such an early stage. The main effect on both perception and production then was the consonantal environment surrounding the vowel. The replication of Jacewicz’ study also found that perception and production were related, note the influence of southern English on the perception of L₂ German sounds. Though the actual data differed from that of the original, the same patterns were found in terms of the perception-production relationship.

The sole point where this study diverged from Jacewicz’ was that of the comparison between the L₁ German speech production and L₂ speech. This study demonstrated that the
subjects’ speech patterns were in line with those of the native speaker. The solution of a larger native speaker sampling in further testing and research was offered as a possible remedy. In order to support a hypothesis, the data must be falsifiable to be valid, and as such, Jacewicz’ procedures have been replicated here. In the end, the sole conclusion that can be reached after recreating the testing procedures is that Jacewicz’ results and conclusions withstand repeated testing and should remain valid until substantiated evidence is offered to the contrary.
APPENDIX

A.1. The following four series of German words served as stimuli in the perception test.

- single onset: sonorant
  - /ɪ/ Ricken ‘roe deer’ (dat. pl.)
  - /ɛ/ recken ‘to stretch’
  - /γ/ rücken ‘to move’
  - /ʊ/ Rucken ‘jerk’ (dat. pl)
- complex onset: obstruent + obstruent
  - /ɪ/ sticken ‘to embroider’
  - /ɛ/ stecken ‘to stick’
  - /γ/ Stücken ‘piece’ (dat. pl.)
  - /ʊ/ Stucken ‘a sort of plaster’ (dat. pl., added)
- single onset: obstruent (stop consonant)
  - /ɪ/ ticken ‘to tick’
  - /ɛ/ decken ‘to cover’
  - /γ/ Tücken ‘malice’ (dat. pl.)
  - /ʊ/ ducken ‘to duck’
- complex onset: obstruent + sonorant
  - /ɪ/ blicken ‘to glance at’
  - /ɛ/ blecken ‘to uncover’
  - /γ/ pflücken ‘to pluck’
  - /ʊ/ glucken ‘to cluck’
A.2.

- P1 The mechanisms and processes used in learning the L₁ sound system, including category formation, remain intact over the life span, and can be applied to L₂ learning.

- P2 Language-specific aspects of speech sounds are specified in long-term memory representations called phonetic categories.

- P3 Phonetic categories established in childhood for L₁ sounds evolve over the life span to reflect the properties of all L₁ or L₂ phones identified as a realization of each category.

- P4 Bilinguals strive to maintain contrast between L₁ and L₂ phonetic categories, which exist in a common phonological space.

- H1 Sounds in the L₁ and L₂ are related perceptually to one another at a position-sensitive allophonic level, rather than at a more abstract phonemic level.

- H2 A new phonetic category can be established for an L₂ sound that differs phonetically from the closest L₁ sound if bilinguals discern at least some of the phonetic differences between the L₁ and L₂ sounds.

- H3 The greater the perceived phonetic dissimilarity between an L₂ sound and the closest L₁ sound, the more likely it is that phonetic differences between the sounds will be discerned.

- H4 The likelihood of phonetic differences between L₁ and L₂ sounds, and between L₂ sounds that are noncontrastive in the L₁, being discerned decreases as AOL (age of learning) increases.

- H5 Category formation for an L₂ sound may be blocked by the mechanism of equivalence classification. When this happens, a single phonetic category will be used
to process perceptually linked L₁ and L₂ sounds (diaphones). Eventually, the
diaphones will resemble one another in production.

- H6 The phonetic category established for L₂ sounds by a bilingual may differ from a monolingual’s if: 1) the bilingual’s category is “deflected” away from an L₁ category to maintain phonetic contrast between categories in a common L₁-L₂ phonological space; or 2) the bilingual’s representation is based on different features, or feature weights, than a monolingual’s.

- H7 The production of a sound eventually corresponds to the properties represented in its phonetic category representation.
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