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Cross-Language Perception of German Vowels by Speakers of American English

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CROSS-LANGUAGE PERCEPTION OF GERMAN VOWELS

BY SPEAKERS OF AMERICAN ENGLISH

by

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of a thesis submitted by

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This thesis has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

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ABSTRACT

CROSS-LANGUAGE PERCEPTION OF GERMAN VOWELS

BY SPEAKERS OF AMERICAN ENGLISH

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This study focuses on how the cross-language perception of German vowels by native speakers of North American English differs based on various levels of classroom instruction and experience in a German-speaking country. Of special interest is whether more advanced students and those with target country experience have a different cross-language perception of German vowels from naive or less-experienced listeners. It further examines how English-speaking learners perceive German sounds that are not found in English, namely the front-rounded vowels. Study participants were students at Brigham Young University, divided into four groups: those 1) without knowledge of German; 2) in their 3rd semester of German without stay abroad; 3) in their 5th semester of German or above without stay abroad; and 4) in their 5th semester or above with at least 12 months in a German-speaking country. The subjects performed two tasks. While listening to German words, they first selected the English word with the vowel that most closely matched the German vowel heard from a list of English words on the computer

screen; and secondly, they rated how much alike the German vowel sounded like the English vowel they chose. The results indicate that level of instruction does indeed affect how subjects perceive German vowels. Moreover, perception of the vowels was to some degree affected by the consonant environment. Finally, it was found that all groups rated the similarity of vowels in a similar manner regardless of experience.

ACKNOWLEDGMENTS

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LIST OF ABBREVIATIONS

AE = American English
BYU = Brigham Young University
C = Consonant
IPA = International Phonetic Alphabet
L1 = First language, native language
L2 = Second language, foreign language
LDS = (The Church of Jesus Christ of) Latter-Day Saints
NAE = North American English
PAM = Perceptual Assimilation Model
RQ = Research Question
SLM = Speech Learning Model
V = Vowel
[_] = allophone
/_/ = phoneme
<_> = spelled form
: = lengthening of a vowel

Chapter 1

Introduction

"Then said they unto him, Say now Shibboleth: and he said Sibboleth: for he could not frame to pronounce it right. Then they took him, and slew him at the passages of Jordan: and there fell at that time of the Ephraimites forty and two thousand." --- Judges 12: 6

1.0 Introduction

Previous research has demonstrated the important role played by perception in the acquisition of a second language (Bohn & Flege, 1990; Polka, 1995; Sheldon & Strange, 1982; Wode, 1996). Perception refers to how stimuli are processed, sounds are heard, and how a concept about them is formed in the mind, consciously or not (Ellis, 1994). Not only has speech perception been argued to be a precursor to the production of new speech sounds in a second language (Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997), but poor perception has also been shown to lead to social and professional disadvantages (Cook, 1999; Munro 2003). The relationship between perception and production is, however, not as direct as some have argued (Major, 1994) and production can proceed independently (James, 1996; Smith, 2001). Efforts to understand the acquisition of second language (hereafter L2) perception have focused on the role of the first language (hereafter L1) and the learner's experience with the L2 (cf. Bohn & Flege, 1990; Polka, 1995; Trofimovich, Baker, & Mack, 2001). Though some researchers (Bohn & Flege, 1990; Kingston, 2003; Polka, 1995; Strange, Bohn, Trent, & Nishi, 2004; Strange, Bohn, Nishi, Trent, 2005) have looked at

perception of German vowels by L2 learners, cross-language studies in general are rare (Bohn & Flege, 1992; Strange & Bohn, 1998) and few, if any, studies have examined the impact of L2 experience on cross-language perception, as done in this study, and tested on all German vowels in several phonetic contexts.

The present study provides a comprehensive look at learners' mappings of German vowels to North American English vowels (hereafter NAE) by offering all English vowels as possible answer choices, as well as combining a forced choice task with a goodness rating task for German vowels in four different consonant contexts, namely *b_ne*, *b_re*, *b_sche* and *b_te*.

1.1 Cross-Language Similarity

Some researchers (Ellis, 1994) have demonstrated that an important factor in the acquisition of an L2 is how close or distant the learner's L1 and L2 are from each other. They contend that similarities and differences can either facilitate or hinder the acquisition of the target language. This cross-language similarity or dissimilarity manifests itself in morphology (Robertson, 1987), semantics (Romney, Moore, Batchelder,& Hsia, 2000), syntax (Pfaff, 1979), and also phonetics (acoustics of sounds; Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992), phonology (Flege, 1981; Kawasaki, 1982) and phonotactics (rules governing permissible sequences of sounds; cf. Kawasaki, 1982). Language similarity can be measured by these parameters; but it can also be a psycholinguistic factor as subjects may have a bias towards thinking that the languages they are comparing are either more similar or more different than another person might perceive them to be (Ellis, 1994).

Building on the notion of "similarity", this thesis presents results from a study on cross-language perception. It does not examine whether learners have come to make the distinction between sounds such as /u:/ as in *gute* 'good' and /y:/ as in *Güte* 'quality, graciousness', but rather how they "map" these German vowels to their English vowels. For instance, when they hear the sound /y:/, which English vowel do learners think it sounds most like? And how similar do they think two vowels are to one another?

Vowels are good indicators of the 'accentedness' of a language (Benware, 1986; O'Brien, 2003) because, as Scovel (1995) states, they "provide more phonetic information than consonants." Vowels hence deserve special attention. Of particular interest in this study are the German front rounded vowels, /y:/, /Y/, /ø:/, and /œ/ because they are vowels that do not exist in the English language.

When one acquires an L2, the previous knowledge from the L1 influences perception and production of the L2. This transfer of knowledge can either enhance (positive transfer) or inhibit (interfere; negative transfer) the correct acquisition of the L2 in varying degrees (Carroll, 2004; Gass & Selinker, 2001; Parker & Riley, 2000). Positive transfer occurs when, for example, an Italian speaker learning Spanish uses the same word order to form a question in Spanish as he/she does in Italian because both languages form questions in a similar manner (Gass & Selinker, 2001). "False friends", words that seem similar because they are spelled (homograph) or pronounced (homophone) almost identically, e.g. English *kiss* and German *Kissen* (pillow), but where the semantic meaning is quite different, are examples of negative transfer.

In the case of NAE and German, one can also notice certain similarities in various aspects of language that can facilitate learning, such as morphology, e.g., *warm-wärmer* in German and *warm-warmer* in English (where -*er* is used for comparative), and, e.g., *Apfel* in German corresponding to *apple* in English, and syntax, the neutral word order in both languages being subject-verb-object, for example. This is due primarily because English and German are closely related, both being Germanic languages. They are hence considered closer to each other than, for example, English and Japanese would be. Nevertheless, enough differences exist to both aid and hinder the acquisition, even in perception or production.

Concentrating on the acquisition of the perception of L2 sounds, this study is limited to specifically examining the L2 perception of German vowels by four groups of native speakers of North American English (NAE) at different stages of instruction and experience, namely students without any instruction in German, those in their third semester of college-level German instruction, those in their fifth semester of college-level German instruction or above, and students of German (enrolled in 300- or 400-level courses) with at least 12 months abroad in a German-speaking country, having returned to the United States within the last four years.

1.2 Research Questions

The present study investigates the cross-language perception of German vowels by speakers of North American English. It examines whether this cross-language perception changes with experience. The four groups of subjects were 1) students with no experience, 2) students in their third semester, 3) students in their fifth semester or above without stay

in a target-language country, and 4) those with at least 12 months of experience living abroad and in their fifth semester or above. This study focused on cross-language perception for all German monophthong vowels (except schwa) in four phonetic contexts, namely /n/, /r/, /ʃ/, and /t/. These considerations lead to the following research questions:

1. How do English-speaking learners of German perceive sounds in German in comparison to their North American English vowels?

2. Does cross-language perception/mapping change as learners gain more experience in a language? And concomitantly, Does an extended stay in the target country of at least 12 months make a difference in how learners perceive German vowels in comparison to North American English vowels?

3. How does phonetic context (of a following consonant) affect the cross-language perception of German vowels by English speaking listeners?

1.3 Thesis Overview

This thesis consists of five chapters as follows: First, Chapter 1 has described the background for the present study, including a brief discussion of cross-language similarity, introduced the research questions guiding this study, and presented an overview of the thesis. Chapter 2 consists of a literature review to situate the study into the current context, particularly discussing the German and English vowel systems, perception, phonetic context, and experience. Then, Chapter 3 explains the research methodology, while Chapter 4 describes the results from the study. In Chapter 5, the findings are discussed with regards to the results observed by other researchers, the research questions are answered, and

limitations are listed. Finally, implications are presented and future directions of research suggested.

A literature review to situate the study into the current context, particularly addressing types of perception, the major perception models and the role of phonetic context and experience, now follows in Chapter 2.

Chapter 2

Literature Review

2.0 Introduction

This chapter situates the current study into the larger context of previous research on both the perception of speech sounds and experience in second language learning. This overview provides the background for this study, which examines 1) how learners of a second language perceive L2 vowels, 2) how this perception changes as learners gain more experience, and whether an extended stay in the target country makes a difference in perception, and 3) how phonetic context (of a following consonant) affects this perception. Specifically, this chapter explores differences between categorical and cross-language perception, the major models regarding perception, the effect of phonetic context, and differences between immersion and classroom instruction. Since this study examines specifically the perception of L2 vowels, a discussion of the two types of perception, namely categorical perception and cross-language perception, will lead this review of the literature.

In concentrating on the acquisition of perception of L2 vowels, this study specifically examines the cross-language perception of German vowels by native speakers of North American English (NAE) at different stages of instruction and experience. To start the study, it is important to make a contrasting comparison of the German and NAE vowel systems.

2.1 German and North American English Vowel Systems

As an understanding of the similarities and differences between the German and North American English vowel systems is essential for the analysis of the results from this study, I present a brief description of each system, followed by a comparison of the two. As consonants are not the focus, only the four following consonants used for the study stimuli, namely /n/ /r/ /ʃ/ and /t/, will be described as well.[1]

2.1.1 Definition of Phonetic Descriptors

Before discussing the German and the NAE vowel systems, it is necessary to define the terms used to describe them. Linguists do not always agree on the definition of phonemes (Pisoni & Lively, 1995), but for purposes of this study, I will apply the definition given by Strange (1995:15): phonemes are "distinctive phonetic categories, the smallest segments of spoken language that combine and contrast to make up the words of the lexicon." These phonemes are language-specific and are described in terms of their articulatory features, i.e. where and how they are formed in the mouth, i.e., oral cavity. The space or area where vowels are produced is also called vowel space or acoustic space (Ladefoged, 2001) and commonly illustrated by vowel charts as exemplified by Figure 1.

More specifically, vowels are distinguished by several features. First, vowels are distinguished by the height of the tongue, e.g., mid and low (see Figure 1). An example of an English high vowel is /i/; one of the mid vowels is /o/, and one of the low vowels is the

[1]The symbols written between forward slashes, in this case /n/, /r/, /ʃ/ and /t/ (used hereafter), stand for the phoneme or sound.

vowel sound in *cut* (/ʌ/). For German, the height of the tongue is often described in terms of close, half-close, half-open, and open. (See Pompino-Marschall, 2003, for a description of the equivalences between these two sets of terms, i.e., high-mid-low versus close–half-clos–half-open–open.)

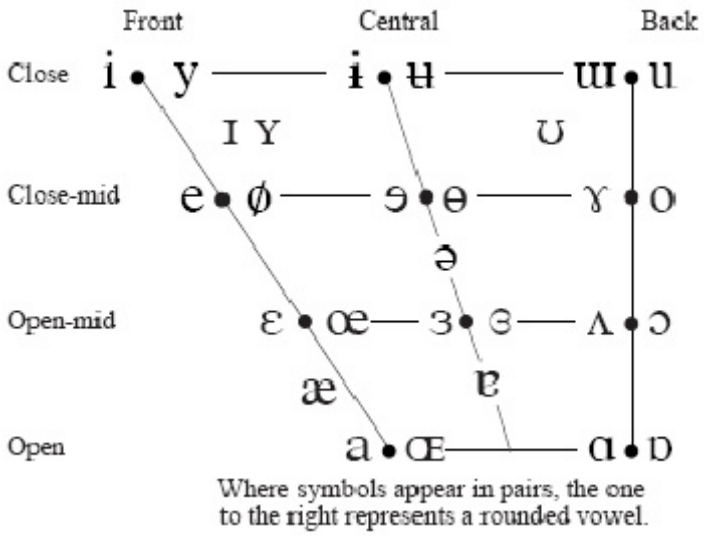

Figure 1. Vowel Chart in the International Phonetic Alphabet (Copyright 2005: International Phonetic Association).

Note. The dimensions of the diagram represent the vowel space possible in the oral cavity, with the left side of the chart corresponding to the front of the mouth, and the top of the chart corresponding to space higher in the mouth.

Close indicates that the tongue is close to the palate (Hall, 2003) and a close vowel can also be described as high (Benware, 1986; Ladefoged, 2001). Open, on the other hand, indicates a low tongue position, with a more "open" space in the vocal tract above the tongue; and half-close and half-open correspond to heights in between. Second, the position of the tongue, referring to how far back or forward the tongue is, in terms of front, central and back, is also used to describe vowels. Front vowels are produced more towards the front of the

mouth and back vowels closer to the back of the mouth. An example of a front vowel is, once again, /i/, one of the central vowels is schwa (/ə/)—like the vowel in *the*; and an example for a back vowel is the /u/ as in *flute*.

Third, vowels differ by lip position, e.g., spread, neutral or round. Examples of rounded vowels are English /o/ as in *coat* and /u/ as in *clue*; whereas English /i/, for example, as in *beat* is produced with unrounded, or spread, lips (Hall, 2003; Ladefoged, 2001; Lindau, 1978; Strange, 1995). Another feature is tenseness and refers to the tongue either being more retracted for tense vowels, or less for so-called lax (or short) vowels (Benware, 1986). Together, these features, tongue height, tongue position, roundedness and tenseness, constitute what is termed the quality of a vowel, or vowel quality. Vowels can also be stressed or unstressed, e.g., *i* in the second syllable of *Kritik* is stressed whereas the vowel *i* in the first syllable of *Kritik* is unstressed. In German and English, stress also contributes to vowel quantity, i.e., vowel length, for tense vowels. For instance, the stressed tense vowel *i* in the second syllable of *Kritik* is a long vowel [i:] (the colon signifies a long vowel), while the unstressed *i* in the first syllable is short, e.g., [i] (lack of the colon indicates a short vowel) (Hall, 2003).

Lastly, vowels can be divided into monophthongs, vowel sounds where the tongue position does not change during the vowel thus giving vowels the same quality throughout (Moulton, 1962), and diphthongs, vowel sounds that change in quality during production of the vowel as the tongue position changes or the sound glides from one vowel to the other, e.g., /ɔ/ to /I/, forming /ɔI/ as in English *boy*. English /I/ as in *fit* and /æ/ as in *cat* are

examples for monophthongs and /au/ as in *cow* is another diphthong.[2]

2.1.2 German Vowel System

The German vowel system, as seen in Figure 2, has 16 monophthongs, namely /i:/, /I/, /e:/, /ɛ/, /ɛ:/, /a:/, /a/, /u:/, /U/, /o:/, /ɔ/, /y:/, /Y/, /ø:/, /œ/, and /ə/.[3] German further includes three diphthongs, /aI/ spelled <ai> or <ei> as in *Mai* or *dein*, for example; /aU/ spelled <au> as in *Haus*, and /ɔY/ spelled <äu> or <eu> as in *Häuser* or *neu*. These vowels differ in quality, determined by where in the vocal tract they are produced; and, for monophthongs, in quantity or length.

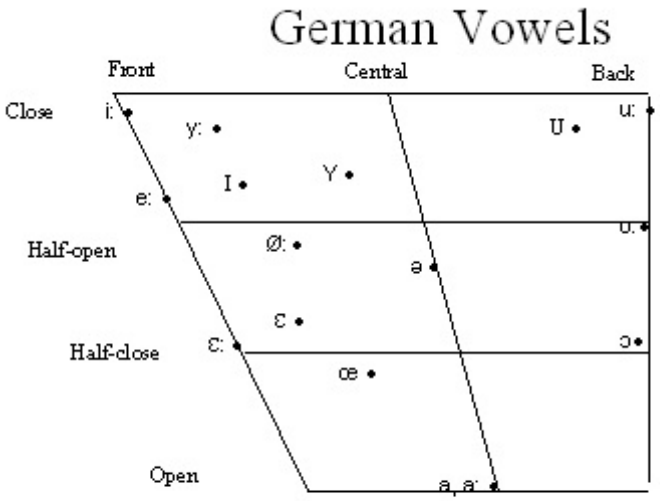

Figure 2. Chart of German Monophthong Vowels (Adapted from IPA, 2005).

[2]Nasality or position of the velum is not relevant to German or English vowels and thus not discussed here.

[3]Since different sources vary in their use of /a/ vs. /ɑ/, for simplicity, I use /a/ as default.

As explained in 2.1.1., German vowels are defined, first, by tongue height, e.g., close /i:/ vs. open or low /a:/(cf. Benware, 1986; Hall, 2003; and Ladefoged, 2001). Second, German vowels are defined by tongue position, divided into front (e.g., /i:/), central (e.g., /a;/) and back (e.g., /u:/). Third, German front vowels contrast in roundedness, e.g., unrounded /i:/ vs. rounded /y:/. All German back vowels are rounded. Fourth, German vowels are differentiated by tenseness, e.g., [i] vs. [I]. Since all vowels tested in this study appeared in stressed syllables, the tense vowels were all long.

2.1.3 North American English Vowel System

In contrast with German, North American English has fewer vowels, namely /i/, /I/, /e/, /ɛ/, /æ/, /ə/ and /ɚ/, /ʌ/, /u/, /U/, /o/ and /ɔ/, and /a/ (see Figure 3): 13 monophthongs (including schwa) and 3 diphthongs (/ai/ as in *bite*, /ɔI/ as in *boy*, and /au/ as in *cow*) underlyingly. It should be noted that long vowels are often diphthongized when stressed in many dialects, and depending on context, e.g., /e/ as in *bait* is actually pronounced as /eI/. In some areas of the United States, however, vowel mergers have occurred that reduce the number of vowels distinguished (for example, *cot* and *caught*, both are pronounced /kat/ in some dialects). Like German, North American English vowels are defined by tongue height, tongue position and tenseness. Rounding is redundant in English and is not a distinguishing feature as it is in German. All English front vowels, e.g., /i/ as in *beat*, are unrounded. All back vowels, e.g., /u/ as in *clue*, are rounded in English.

It should also be noted that some dialects have reversed some vowels in the acoustic space depicted in Figure 3. For instance, /e/, a mid high front vowel (also sometimes noted

as /eI/ since English diphthongizes its long vowels) while /ɛ/ is depicted as a lax mid front vowel.

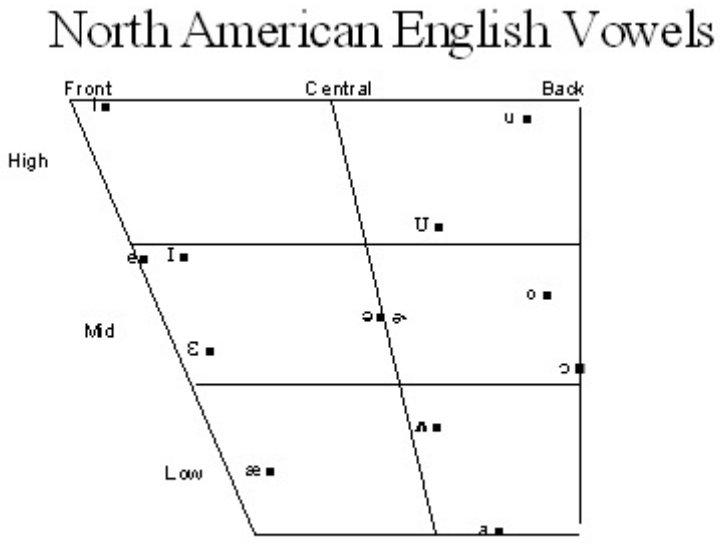

Figure 3. Chart of NAE Monophthong Vowels (Adapted from IPA, 2005).

In many dialects of NAE, however, /e/ and /ɛ/ are reversed (Labov, Ash, & Boberg, 2006), and the same reversal can be found in the German of many speakers.[4]

The low back rounded vowel /ɔ/ has merged with /o/ for many North American English dialects (Labov et al., 2006); whereas Strange et al. (2004, 2005) state that /a/ and /ɔ/ collapse for many speakers of English. For some dialects, it is unclear whether the /ɔ/ merges with /o/ or with /a/, as the vowel in *bore* could be identified with /o/ as in *boat* or /a/

[4]In an analysis of German vowels produced by German speakers of pronunciation stimuli used in German 310, a phonetics and pronunciation course at BYU, Smith (personal communication) has noticed this trend in native speakers, especially younger speakers. Additionally, token recordings made by Jared Löhrmann for his final project in that class showed the same trend.

as in *bought* (Labov et al., 2006). Tense mid-back rounded /o/ is rare in NAE, usually being realized as diphthongized /oU/ (Hall, 2003).

The mid central unrounded vowel /ə/, or schwa, also exists as rhotacized schwa ([ɚ]) before /r/ .[5]

2.1.4 Comparison of the North American English and German Vowel Systems

An important difference between the two languages is that German vowel inventory includes front rounded vowels, namely /y:/, /Y/, /ø:/, and /œ/, which English lacks. Only back vowels are rounded in English. Another important difference is the quantity, or length, of vowel sounds (see Figure 4). In general, German produces longer long vowels, whereas English long vowels are shorter and do not contrast as much with their shorter lax counterpart, e.g., English /i/ and /I/ are not as different as German /i:/ and /I/ are as even the length marker on only the German /i:/ shows (Bohn, 1995; Bohn & Flege, 1992; Hall, 2003; Kufner,1971; Moulton, 1962). The tense-lax distinction is critical in English and not length per se. Nevertheless, Ramers (1988) notes that German vowels are tenser than English ones. This occurs especially before /r/. Long vowels in English are diphthongized, whereas German long vowels are pure monophthongs[6] (Hall, 2003).

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[5]I realize that different sources vary in their use symbols for the 'er' sound. For simplicity, I am using this rhotacized vowel (Pompino-Marshall, 2003).

[6]The transition from the first element to the second element in German diphthongs, namely /aI/, /aU/, /ɔI/, is faster than for English diphthongs (Hall, 2003; Moulton, 1962).

Another difference is that English vowels are generally less differentiated before /r/ than in German (Labov et al., 2006; Kufner, 1971), so that for some speakers of English only five vowels, namely /I/, /ɛ/, /a/, [o], and /U/, are realized before /r/ (Moulton, 1962).

A further difference between English and German vowels is that German vowels are generally higher or more closed (Hall, 2003) than their English equivalents (see Figure 4). One example, the German vowel /i:/ is higher than its English equivalent. Besides being higher, German vowels are also more peripheral or positioned more extreme to the edges of the vowel space, e.g., English /U/ is not only lower (or more open), but also more centralized (as referring to the center of the vowel space) than the German /U/ (Hall, 2003; Ramers, 1988). The differences between the German and NAE vowel systems (cf. Hall, 2003) are summarized in Table 1.

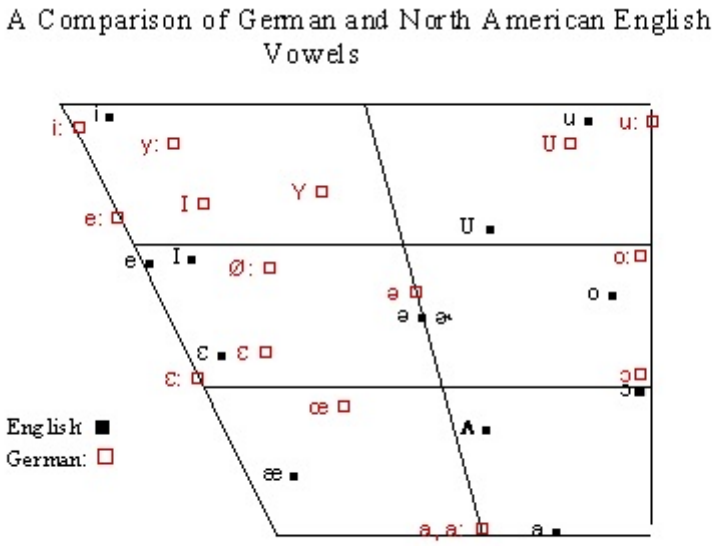

Figure 4. Chart of NAE and German Monophthong Vowels (Adapted from IPA, 2005).

Table 1. Differences in the German and English Vowel Systems

German vowels	are higher in acoustic space	than English vowels.
	are more peripheral	
	show greater long-short contrast	
	show more extreme lip position	

2.1.5 Consonants vs. Vowels

The words subjects heard during the task were in the form *bVCe*, where V stands for vowel and C stands for consonant. The first sound was always /b/; and the other consonant was either /n/, /r/, /ʃ/ or /t/. The /n/ is a nasal consonant, where the air escapes through the nasal cavity. Consonants are described in terms of points of articulation or where the tongue comes in contact with the oral cavity, e.g., bilabial, dental, alveolar, palatal, uvular, and manner of articulation, e.g., as a stop (no air is allowed to pass), nasal, fricative (where the friction is caused by air escaping through a not totally closed oral cavity), approximant (not involving any closure of the vocal tract), or lateral (with a partially closed mouth and air escaping along the sides of the tongue (Hall, 2003). The German /r/ can be pronounced in different ways, but the two speakers in this study used the uvular fricative [ʁ]. The consonant /ʃ/ is a voiceless palato-alveolar fricative.[7] Finally, /t/ is an unvoiced alveolar stop (Hall, 2003). Vowels are influenced by the consonants preceding and following them. In German,

[7]I realize that consonants are best distinguished by fortis and lenis, which often corresponds to patterns of voiceless-voiced, respectively. However, for simplicity I use the voicing descriptor.

as Ramers (1988) states, vowels will be shorter before /n/, /ʃ/, and /t/, but longer before /r/, the four contexts used in this study.

In stressed syllables, English vowels are short before voiceless consonants, especially stops, but are lengthened before voiced consonants (Mack, 1982), e.g., /æ/ is shorter in *bat* than in *bad*. However, any vowel in English can be long in a stressed position (Ramers, 1988). English vowels followed by /r/ are less differentiated, i.e., tenseness is neutralized, and there is no difference between tense and lax vowels, e.g., /i/ and /I/ (Labov et al., 2006; Moulton, 1962). Furthermore, as Kufner (1971) observes, in some North American English varieties, /e/ and /ɛ/ are neutralized, but not /æ/. The vowel pairs /ɔ/ and /o/, /u/ and /U/, and /ɚ/ and /ə/ or /ʌ/ are also neutralized before /r/ thus resulting in the fact that vowels are generally less differentiated before /r/ in English than in German.

In contrast to consonants, whose articulations are more consistent in both German and English (with the exception of /l/ and /r/) and whose places of articulation can be described more specifically, vowels in both German and English show significantly more variation (Benware, 1986; Hall, 2003; Moulton, 1962), and differences in articulation can be perceived in rather small increments (Labov, Ash, & Boberg, 2006). For instance, English /u/ is undergoing extreme fronting approaching [y] in some North American dialects but not others (Labov et al., 2006). Yet all speakers would perceive these as exemplars of /u/ (Strange et al., 2004). Conversely, German [u:] is produced higher and further back in the mouth and with more extreme lip rounding in comparison with its English counterpart (O'Brien & Smith, Under Review). Mastery of vowels, then, will ensure a more native-like pronunciation in the L2 and is thus a good indicator of the 'accentedness' of a language (Scovel, 1995).

Vowel perception is most difficult for English learners of German because sounds that are allophones in English [u] and [y] must be contrasted phonemically when perceiving German. For this reason, vowels were chosen as the focus for this study. Of particular interest are the German front rounded vowels, /y:/, /Y/, /ø:/, and /œ/, as they do not occur in North American English and pose problems for learners in perception and in production (Benware, 1986; Hall, 2003).

2.2 Phonemes, Allophones and Perception

Though phonemes are the smallest contrasting sounds in a language, there can be variation in the way such a phoneme is realized without making a significant difference in that language, e.g., the /l/ in the English word *light* is different from the /l/ in *bull*. These variations in producing the same phoneme are called *allophones* and they are transcribed between square brackets (Benware, 1986; Hall, 2003). Allophones occur in complementary distribution or free variation, where the complementary distribution results from the sound occurring in a different context, i.e., considering which other sounds surround this sound (Hall, 2003). An example for this type of variation is /u:/, which occurs as [u:] in stressed syllables but as [u] in unstressed syllables in German (Benware, 1986). Phonemes and their allophones are language-specific and influence the perception of L2 sounds since subjects will apply their L1 phonemic rules to the mapping of these sounds and certain patterns can be predicted or explained (Flege, 1995). Subjects from different L1 backgrounds will thus also display different mapping patterns for a certain L2 tested (Rochet, 1995; Willerman et al., 1996). A non-native who is not familiar with the L2 may erroneously identify two

contrasting sounds, e.g., [y:]-[u:] as allophones of a single phoneme in their native language, such as /u/ by English speakers learning German (Moulton, 1962). Allophones can also occur in free variation where different allophones are interchangeable without affecting meaning and without being contextually defined. The consonant /r/, for example, can be pronounced as front [r] (apical trill); as back [R] (uvular trill) or even as [ʁ] (uvular fricative) in German, usually depending on where the speaker comes from; but this does not constitute a difference in meaning (Hall, 2003).

2.3 Perception

Apart from examining speech production, researchers have focused their studies of acquisition of L2 sounds very heavily on two dimensions of perception: categorical perception and cross-language perception.

2.3.1 Categorical Perception

Categorical perception examines whether learners correctly or incorrectly identify a given stimulus within the L1 or L2 in terms of categories, e.g., is it [p] or [b]; within-category differences, e.g., [p^h] vs. [p], however, are not considered (Kluender, Lotto, Holt, & Bloedel, 1998). For instance, German contrasts /u:/ in *wurde* versus /y:/ in *würde*. The difference between these two vowels marks a meaningful grammatical distinction between past indicative and present subjunctive (II).[8] Since English does not have the distinction

[8]For example, indicative "Die Frau *wurde* Lehrerin" [The woman became a teacher] contrasts with subjunctive II "Die Frau *würde* Lehrerin, wenn..." [The woman would become a teacher if...].

between /u:/ and /y:/, learners must learn to separate these two sounds so that they can distinguish between these two words both in their perception as well as in their production. Subjects' ability to sense that L2 sounds do not match or are not exactly like an L1 vowel facilitates the development of new categories, and the greater the dissimilarity of the L1 and the L2 sounds the more likely it is that subjects will establish a separate category (Flege, 1995).

A common design to test categorical perception is an identification task. Here, listeners "assign a phonemic label" (Strange & Jenkins, 1978) to an L2 sound they hear. Another common design means of testing perception is the discrimination task. In this type of perception, listeners must discriminate whether two or more sounds are the same or different. One common method of doing so is the ABX procedure where listeners have to determine if the third (X) is identical to the first (A) or second (B) sound heard (Strange & Jenkins, 1978).[9] In categorical perception studies, results are interpreted in terms of whether subjects correctly identify the stimuli presented, i.e., the researchers start with a standard of acceptability in mind. Categorical perception studies further examine where subjects draw the line between what L2 sounds are associated with one phonemic category or another, for example, two L2 sounds as in Levy & Strange (2008). In their study, English speaking listeners discriminated Parisian French vowel contrasts, e.g., /u-y/ and /i-y/, at two different levels of experience, namely subjects without any French instruction vs. subjects who had at least seven years of French instruction, and in two different phonetic contexts, /bVp/ and

[9]The stimuli can also be presented in an AXB format, which can lead to slightly different results since the item in question is equidistant to both other sounds (Best, McRoberts, & Sithole, 1988; Polka & Bohn 1996).

/dVt/. Their results show that inexperienced subjects were more influenced by allophonic variation than the experienced subjects, and therefore had more difficulty discerning the vowel contrasts.

2.3.2 Cross-Language Perception

By contrast, *cross-language perception* studies investigate how a subject's L1 influences how a listener identifies or maps L2 sounds to their L1. Here, it is not about correctly identifying sounds, but rather how similar or dissimilar listeners associate L2 sounds with their L1 sounds, regardless of categories. In Schmidt's (1996) study of adult Korean listeners' perception of English consonants, for instance, subjects had to identify the English consonants they heard with one of 19 Korean consonants given as options. In a second task, these subjects also rated how similar they felt the English and the Korean sound were. Results showed that subjects were more consistent in their responses when the stimuli they heard matched their L1 categories. Not all mapping patterns were completely in agreement with Best's (1995) Perceptual Assimilation Model or Flege's (1995) Speech Learning Model, which will be discussed next.

2.4 Perception Models

Several models, such as Best's (1995) Perceptual Assimilation Model, Flege's (1995) Speech Learning Model, Iverson and Kuhl's (1995) Native Language Magnet Model (NLM), and Juczyk's (1993) Word Recognition and Phonetic Structure Acquisition model (WRAPSA), have been proposed to explain patterns in cross-language perception and

production. Most widely used to describe the development of speech perception are Best's Perceptual Assimilation Model (PAM) and Flege's Speech Learning Model (SLM).

2.4.1 Speech Learning Model (SLM)

Flege's (1995) SLM accounts for changes across all stages and experience levels in L2 speech learning, including advanced learners. According to Flege the acquisition of L2 phonemes hinges on the degree of perceived similarity between the L1 and L2 phonemes. L2 Phonemes can be a) "identical", e.g., German /i:/ and English /i/, b) "similar" to L1 speech sounds, e.g., German /u:/ and English /u/, or c) "new" phonemes that do not have an equivalent in L1,e.g., German /y:/.

For instance, SLM would predict that learners would be more likely to perceive or produce differences between phonemes that are perceptually dissimilar from phonemes in the L1, e.g., the "new" German vowel /y:/ versus English /u/, than they would be able to notice or produce subtle differences between the production of "old", i.e., "similar" sounds. In this way, "new" phonemes would not be identified with any L1 phonemes and learners would thus be expected to eventually establish new categories for these so-called "new" phonemes. The greater the difference between the L1 and the L2 phonemes, the more likely it would be for a listener to establish a new category for the "new" L2 sound (Flege, 1995). Conversely, "old" phonemes would be perceived as equivalent to corresponding L1 phonemes so that learners would be less likely to create a separate category for these "similar" L2 phonemes. For example, it would be expected that English learners of German would have a more difficult time establishing a separate category for German /u:/ which

already has an analog in English (Guion et al., 2000), despite the fact that German /u:/ is produced further back, higher and with more lip rounding than English /u/ (Benware, 1986; Hall, 2003). Consequently, "new" phonemes are actually expected to pose fewer problems long-term in acquisition than are "similar" phonemes already found in the L1 (cf. Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2003; Bohn & Flege, 1990).

In his study on accentedness ratings of English vowels by native Arabic speakers, Munro (1993), however, found that the subjects did not necessarily produce "new" English vowels better than "similar" ones. Further, Rochet (1995) cautions that the distinction between "new" and "similar" is not totally reliable. For instance, just because the same phonetic symbols are used, e.g., /I/ in both English /I/ and German /I/, does not necessarily mean that those two vowels must be similar. Such an assumption is not exact enough, Rochet (1995) states, since certain sounds in different languages, which are noted with the same phonetic symbol, can still differ. One example is English /U/ and German /U/. English /U/ is not only lower, but also more centralized than the German /U/ (Hall, 2003; Ramers, 1988). According to Morrison (2002), however, SLM takes phonetic contexts into account. In response to Rochet's criticism, Flege has dropped using the terms "new" and "similar" and only refers to differing degrees of similarity between sounds (Flege, 1999; O'Brien, 2003) Since SLM considers varying cross-language similarity of L2 sounds and phonetic contexts as well, this perception model lends itself as a prediction tool for the present study.

2.4.1.1 Studies Applying SLM

Support for Flege's SLM has been found in several studies (cf. Guion et al., 2000), including Aoyama, Flege, Guion, Akahane-Yamada, & Yamada's (2004) study on the acquisition of English /r/ and /l/ by native Japanese children and adults. Japanese does not differentiate between /r/ and /l/. For these phonemes, SLM would predict that the more dissimilar L2 phoneme, here English /r/, is easier to learn for the native Japanese speakers than English /l/. The results of Aoyama et al.'s study confirmed this prediction.

In Bohn & Flege's (1990) study, two groups of native German speakers, an inexperienced group with an average of 0.6 years in an English-speaking environment and an experienced group with an average of 7.5 years in an English-speaking environment, were asked to identify four English vowels, namely /i, I, ɛ, æ/ with German vowel categories. They found that the perception of the "similar" vowels, English /i/ and /I/, was not affected by the amount of experience subjects had. The perception of the "new" vowel /æ/, however, was more native-like in experienced subjects, which fits SLM predictions.

2.4.2 Perceptual Assimilation Model (PAM)

Whereas Flege's (1995) SLM accounts for all stages of L2 learning, Best's (1995) Perceptual Assimilation Model was proposed with inexperienced or naive listeners in mind, subjects who are mostly or completely unfamiliar with the L2 sounds (Best & Tyler, 2007). PAM is based on sounds perceived in contrasts (which is not required by Flege's (1995) SLM) and sets up 5 different categories for speech sound contrast identification of pairs of two L2 sounds in a fixed phonetic context: TC-two category, CG-category-goodness, SC-

single-category, UC-uncategorizable vs. categorizable, UU-both uncategorizable. These categories are defined as follows: In the TC assimilation pattern an L2 sound assimilates to an L1 sound category that is different, e.g., a lateral Zulu fricative voicing distinction assimilates to two English categories, namely the consonant clusters <shl> and <zhl> (Best, 1995; Best, McRoberts, & Sithole, 1988). Contrasts in this pattern will be assimilated very easily. For Category Goodness, two L2 sounds assimilate to one L1 sound, where one is accepted as fitting, and the other as different. For instance, in Farsi /g/ and /G/ contrast with one another, but English-speaking listeners perceive both as /g/ and rate Farsi /g/ as a good fit, but Farsi /G/ as not such a good fit with English /g/(Best et al., 1988). Single Category assimilation shows the same assimilation as CG, except that both sounds are "either acceptable or deviant," e.g., the glottalized Thompson stops /k'/ and /q'/ both assimilate to English /k/, but neither are a good fit (Werker & Tees, 2002). In Uncategorizable vs. Categorizable, one L2 sound assimilates to a L1 sound and the other one does not, e.g., in one of Best's (personal communication) studies (some) English listeners perceived the Norwegian "in-rounded" high front vowel (/ʉ̟/) versus /i/; and with some listeners the assimilation of /ʉ̟/ to an English sound category was split between /u/ and /U/, and neither of these were chosen more than 50% of the time.

Best claims that subjects will match sounds to an L1 equivalent whenever possible. When both sounds are uncategorizable (UU), e.g., Zulu click consonants (Best et al., 1988), however, they do not assimilate to an L1 sound, and their discrimination can range from "poor to proficient" (Jacewicz, 1999:26). The assumption is that contrasts are easier to discriminate when the difference in category-goodness is greater (Harnsberger, 2001) and

that between-category differences, or phonemes, are easier to discern than within-category differences or allophones (Best, McRoberts, & Goodell , 2001).

Guion, Flege, Akahane-Yamada, & Pruitt (2000) proposed a modification of PAM to account for poor discrimination in an uncategorized vs. categorized contrast. This modification stemmed from the failure of Japanese /v/ from being assimilated to a native English category.

2.4.2.2 Studies for German Testing PAM

Strange, Bohn, Trent, & Nishi (2004), for example, examined how English speakers mapped North German vowel contrasts to American English vowels and how they rated the vowels' similarity. They compared these perceptual findings to predictions made by them based on spectral similarities between North German vowels and American English vowels and PAM principles and found that L2 vowels that are acoustically similar to L1 vowels were not always also perceived as similar. For instance, German [e:], which is acoustically similar to NAE [eI], was most frequently mapped to AE [i:] instead. In a follow-up study Strange, Bohn, Nishi, & Trent (2005) examined how phonetic context affected the perception of North German vowels by AE listeners and found slightly different results, i.e., here, "spectral similarity predicted the perceptual assimilation of front-rounded" (p. 1760) vowels, which were mapped to AE back vowels, regardless of context.

Another example of applying PAM's predictions is Polka's (1995) study. She examined English listeners' perception of German vowel contrasts /y/-/u/ and /Y/-/U/ in a discrimination task, as well as a keyword identification and goodness rating task. These four

vowels were mapped primarily to high back rounded English vowels. For the results of Polka's study, she observed "a category goodness assimilation, and that the difference in category goodness was more pronounced for the tense vowel pair (i.e., /y-u/) than for the lax vowel pair (i.e., /Y-U/)" (p. 1286), thus fitting PAM's predictions. Subjects had more difficulty mapping the lax vowels than the tense vowels, e.g., they performed like natives within one language for /u/ vs. /y/, but failed in /U/ vs. /Y/. But, as Polka states, more detailed differentiation between non-native vowel contrasts based on acoustic differences would possibly play a part in her study, which is better addressed by Flege's (1995) Speech Learning Model.

2.4.3 Critique of PAM and SLM

Kingston (2003) provides a study on training speakers of American English in the perception of non-low German vowels that puts Best's (1995) PAM as well as Flege's (1995) SLM predictions to a test. Kingston (2003) claims that no predictions are possible beforehand of how "listeners will behave by comparing the two languages' contrasts and the systematic variation in their pronunciation" (p. 299). Some of the results from his study were as predicted by PAM, and also SLM. For instance, the vowel pairs contrasting in height and roundness, e.g., /I:ɛ/ and /Y:œ/, were both equally discriminated by subjects in the study. But other results, for example, that subjects were less successful in distinguishing tense than lax vowels for height (e.g., /Y:œ/ > /y:ø/) did not fit the predictions made by either theory "that all instances of the same contrast (for height, roundedness, etc.) should assimilate equally" (Kingston, 2003:323).

Levy & Strange (2008) claim that neither PAM nor SLM, directly address the role of phonetic contexts in the perception or production of L2 sounds. Best & Tyler (2007) had already disputed this, however. As O'Brien (2003) points out, the PAM and SLM models are not complete and should be used together to interpret findings in speech perception. Even Best & Tyler (2007) aim at reconciling these two models by 'officially' extending PAM beyond naive L2 learners and pointing out commonalities with Flege's (1995) Speech Learning Model (SLM). Best & Tyler clarify that PAM, like SLM, has taken phonetic differences into account from the outset. They further note that the two models have often wrongly been used or cited in combination or for groups of learners for which the theories' predictions were not originally intended. They explain that, according to PAM, "the phonological level is central to the perception of L2 speech by [L2] learners ... in a way that it cannot be for L2-naïve listeners perceiving unfamiliar nonnative speech" (p. 23) because these listeners have not learned the phonological system for that language yet. Best & Tyler further suggest that, in certain contexts, when additional detail is needed, perception is carried out on a phonetic level.

Best's PAM (1995) and Flege's SLM (1995) are intended to account for the reasons why some L2 sounds are more difficult for learners to acquire than other L2 sounds during the course of mastering the L2 phonological system. These accounts rely heavily on the notion of "perceived similarity", however, the question arises as to what it means for sounds to be "perceptually similar". To this end, cross-language perceptual tests serve as a means of establishing perceptual similarity "independent of identification or discrimination performance in order to predict L2 learning difficulties more accurately" (Strange et al.,

2004). More studies are also needed to continue finding explanations for acquisition patterns (cf. Best & Tyler, 2007; Long, 1990).

2.5 L2 Perception of German by native English speakers

Prior to the present study, other researchers have examined the perception of German vowels by speakers of English. Kingston et al. (1996) studied the effects of training on the categorical perception of front rounded German vowels by speakers of American English. The listeners were trained on these vowels in different phonetic contexts, CVC(e)n environments (where the first C was /b, d, g, p, t, k/ and the second C was /p, t, k/). Training tokens were spoken by 5 different native speakers. Their results show that training did improve the identification of the vowels and that the training effect varied according to which speaker the subjects heard, as well as to whether the vowel was tense or not. From these results, Kingston et al. conclude that Best's (1995) strong version of PAM, i.e., all instances of a phonological contrast should be assimilated equally well, is not accurate.

In Polka & Bohn (1996), the native German and non-native (English speakers') perception of the German /u/ - /y/ contrast (and English /ɛ/- /æ/ contrast) was tested in an ABX format, i.e., three sounds are presented and subjects have to determine if the third (X) is identical to the first (A) or second (B) sound heard (Strange & Jenkins, 1978). Both German and English speaking listeners were highly successful in discriminating all the contrasts, i.e., the German subjects identified stimuli containing /u/ with one of two response choices, namely /dut/, written as *duht*, and stimuli containing /y/ with the response choice /dyt/, written as *düht*. And the English subjects identified German /u/ more often than /y/.

English subjects' goodness ratings of the stimuli confirmed their categorical discrimination abilities between the /u/-/y/ contrast by rating German /u/ as a better match for American English /u/ than German /y/ was a match for /u/. Differences in goodness rating may also indicate which L1 sounds subjects perceive as similar to the L2 sound in a cross-language perception task. In my study, I also looked at differences in the perception of vowels that may pose a challenge to listeners, like the /u/ and the /y/.

In Strange et al.'s (2004) cross-language study they determined the cross-language spectral similarity of North German and American English vowels and used their findings to predict results for the mapping experiment of their study, namely for English listeners to map German vowels to American English vowels. Some of their results did not fit the predictions. For instance, German /U/ was not mapped most frequently to English /U/, but rather to /oU/; and German /ɔ/ was not mapped most frequently to English /ɔ/, but rather to /oU/. On the other hand, German /o:/ was mapped most frequently to its American English counterpart /oU/ and German /e:/ to American English /eI/, both American English diphthongs. This can be attributed to the fact that in English long vowels are diphthongized[10] (Hall, 2003). As my study offered all NAE vowels as response options, subjects would also be able to select diphthongs as subjects in Strange et al.'s (2004) study did.

As the second part of the same experiment, Strange et al.'s (2004) subjects performed a goodness rating for each vowel. Three of the front rounded vowels received

[10]Some German dialects, e.g., Swiss German, use Umlaut where modern standard German uses diphthongs, e.g., Swiss German *Schwyzerdütsch* vs. standard German *Schweizerdeutsch* (cf. König, 2005; Stedje, 2001).

poor ratings on a 7-point Likert scale, where 1 = “very foreign-sounding” and 7 = “very English-sounding”, namely /y/ at 2, /Y/ at 1, and /ø/ at 3, compared to /œ/ at 5 when presented in syllables. However, when heard in sentence context, these same vowels received goodness-of-fit ratings of 2, 3, 2, and 4 respectively. High and mid back rounded vowels, namely [u] and [o], were also mapped to American English back rounded vowels and received slightly higher goodness ratings, i.e., Strange et al. concluded from the difference in goodness ratings that subjects were able to distinguish the German vowels depending on the context. From their results, they further concluded that spectral similarities were not necessarily good predictors of how the vowels were associated by the subjects, e.g., German front rounded vowels that are spectrally closer to German front unrounded vowels were mapped between front unrounded and back rounded American English vowels, and that duration did not affect the mapping patterns. Because subjects in my study likewise performed a goodness rating task, the results from these previous studies need to be considered in the analysis and discussion of the present study.

In their follow-up study Strange et al. (2005) examined the perception of North German vowels to their English equivalents by speakers of American English without any experience in German. They noted that the front rounded “vowels were spectrally more similar to front-unrounded [English] vowels than back-rounded North German vowels” (p. 1753). They observed that the German front rounded vowels were consistently mapped to American English back vowels, but that the response selection among these American English back vowels varied for the different German front vowels, except for [y], which was mapped to American English [u], regardless of phonetic context. Particularly, the modal

choice for German [Y] was American English [U] (74% of the time), and the secondary choices were [ʌ] (13%) and [u] (11%). German [ø] mapped onto American English [u] (43%), [U] (33%) and [oU] (21% of the time) and was not mostly associated with any one particular English vowel in all contexts tested. Therefore, Strange et al. state that this vowel fits the uncategorizable pattern according to Best's (1995) PAM. German [œ], however, was mapped more consistently onto American English [ʌ] (74%) and [U] (19% of the time).

Furthermore, Strange et al.'s (2005) analysis revealed no significant difference across the phonetic contexts in the mapping nor in the goodness rating for the German front rounded vowels. In fact, median ratings of 4-5 indicated that the front rounded vowels were perceived as neither too foreign nor too native sounding. The consistency in mapping German [I], [ɛ] and [ɔ], however, differed more across phonetic contexts so that for each of these vowels the modal choice changed, depending on the context. When American English [a] and [ɔ] were collapsed, however, "categorization consistency did not differ markedly across contexts" (p. 1759).

Next, results for German [e] and [U] fit predictions that these vowels would be the least consistent in mapping to their American English counterparts. When collapsing across contexts, German [e] was mapped onto American English [I] 31% of the time, and German [U] was mapped onto American English [oU] 32% and [ʌ] 12% of the trials. Mapping for German [U] also varied depending on context, and Strange et al. again considered German [U] "uncategorizable as any one AE vowel"(p. 1759) as in their 2004 study. It furthermore "received the poorest goodness ratings" (p. 1759). German [e] received a good rating and was mapped to AE [I] and [eI]. In my study subjects also performed a mapping and goodness

rating task, and in the analysis I present not only the modal choice, but secondary choices as well; therefore, it is important to take into Strange et al.'s results into account.

2.6 Phonetic Context

Although phonetic context in which L2 sounds occur did not consistently affect cross-language perception in Strange et al. (2005), it has been shown to play a role in both the choice of similar L1 phone and the likeness rating in other cross-language perception studies. Particularly, Hillenbrand et al. (2001) in their study of the effects of phonetic context on vowel identity and spectral change observed that differences in place of articulation had a greater influence with phonetic context than did voicing or manner of articulation; and that vowel perception was less influenced by following consonant contexts than preceding ones. Furthermore, open syllables (CV), as tested in this thesis, are less influenced by the following phonetic context than closed syllables (VC) (Kawasaki, 1982).

In her study of cross-language identification of English consonants by Korean learners, Schmidt (1996:3207) noted that "English consonants received slightly different similarity ratings when followed by different vowels." In testing vowels in five contexts, namely /h_d/, /b_d/, /b_t/, /l_C/ and /n_C/, Trofimovich et al. (2001:175) also noted that "the mapping frequency for each English vowel in the five phonetic contexts revealed a significant effect of phonetic context for six (/i/, /I/, /u/, /U/, /a/, and /ʌ/) of the eight vowels" tested in their study with Korean speakers of different experience levels. They observed, however, that context did not always play a role in the similarity rating of these L1 and L2 sounds. The results from Jacewicz's (1999) study, likewise, show that phonetic context (of

preceding consonants, namely /bl/, /d/, /gl/, /pfl/, /r/, /ʃt/ and /t/) only affected the mapping of rounded, but not unrounded German vowels by English listeners. Therefore, the role of the phonetic context must also be taken into account when examining the cross-language perception of L2 sounds, for identification tasks as well as for goodness rating tasks.

The present study used /n/, /r/,[11] /ʃ/, and /t/ as phonetic contexts after the vowels tested to investigate how these would affect the subjects' perception of German vowels. The place of articulation for these consonants is alveolar for /n/ and /t/, uvular for [ʁ], and palato-alveolar for /ʃ/ (Hall, 2003; Ladefoged, 2001). In this manner, the phonetic contexts in the present study varied only slightly in place of articulation, relatively speaking. The consonants further differ in manner of articulation: /n/ is a nasal consonant, [ʁ] (as presented in this study) and /ʃ/ are fricatives, and /t/ is a stop consonant (Hall, 2003; Ladefoged, 2001). Since this study also examines the role of experience in cross-language perception, I now turn to a discussion of research on the effects of L2 experience on perception.

2.7 Experience

How students spend their time during a study abroad will also influence their speech acquisition. A learner can acquire an L2 without receiving formal instruction. On the other hand, students can study the L2 in a classroom without ever being exposed to or practicing the L2 with natives. Yet, another way to gain experience is to have both types of experience: living in the environment where the learner uses the language daily and also receives

[11]Duden uses /r/ as the default symbol for the consonantal "r" in German, but the two speakers producing stimuli for the present study both used [ʁ], a uvular fricative.

instruction (Kaplan, 1989). As O'Brien (2003:137) states, for example, learners staying in a country where an L2 is spoken, often receive corrective feedback from natives, and, therefore, even when the experience is supposedly naturalistic, such correction can "resemble classroom interactions." Flege & Liu (2001) showed that type of experience (student vs. non-student) was more important than the amount of experience in their study of Chinese speakers living the United States.

Some studies have suggested that immersion in a German-speaking country appears to positively affect learners' acquisition of German. O'Brien (2003) observed that, in the target environment, native speakers of American English usually received a great amount of varied native input. Polka (1995) observed a difference in improvement according to which vowels were concerned: monolingual English-speaking adults achieved proficiency in perceiving the German tense (or long) vowel pair /u/ versus /y/, but failed to differentiate the lax pair /U/ versus /Y/ in her study of English speakers learning German. Jacewicz (1999) found similar results for the /U/-/Y/ pair.

Bohn & Flege (1990) also saw a distinction between how L2 experience affected the learning of different sounds--newly acquired L2 sounds and those that are in the L2 as well as in the L1. They state that "experience does not affect perception of /i/ and /I/ in English by Germans, but experience affects /ɛ/ and /æ/ perception" (p. 322), a finding that fits with SLMs predictions regarding the perception of "new" vs. "similar" vowels. Bohn & Flege also caution that other variables besides experience, e.g., using duration as a cue in vowel perception, have to be considered since some learners are able to quickly learn new L2 sounds while others do not learn them at all.

In their "investigation of current models of L2 speech perception," Guion et al. (2000), likewise, concluded that experience leads to better perception for certain sounds, but not as much for others. In their study, three groups of Japanese listeners with different amounts of experience identified seven different English-Japanese consonant contrasts and rated their similarity. For three contrasts, increased accuracy was found for more experienced subjects, whereas for four other contrasts, no significant difference was obtained between the two experience groups. Aoyama et al. (2004) also found little improvement for Japanese adults over a one-year period staying in the United States (cf. Bohn & Flege, 1992).

The amount of time a learner has spent acquiring or learning a language without necessarily being in an immersion environment also plays an important role in the success of learning an L2. Best & Tyler (2007:21) state an early cut-off for labeling learners 'experienced' since "significant L2 perceptual learning has been observed in late learners after as little as 6-12 months of [L2] immersion, as compared to those with 0-6 months of experience" and that there is little perceptual gain for stays that last much beyond one year (Flege & Liu, 2001). In this light, it is perhaps not surprising that Fox et al. (1995), state that experienced and inexperienced Spanish speaking immigrants to the Birmingham, Alabama area did not differ significantly in their perception abilities of American English and/or Spanish vowel pairs in their study (average age 30 vs. 38 years; time in country 4.1 vs. 3.7 years (not too different); age upon arrival 23 vs. 31 year; and studying English in school 9.3 vs. 6.6 years). Bohn & Flege (1997:69) state that, though continuous contact with an L2 aids learners in their perception, it may take "several years of L2 experience" for learners to accomplish the proper contrast between certain L1 and L2 sounds. The terms experienced

and inexperienced are used, but Best & Tyler caution that often the levels are not well defined. The differentiation between inexperienced and experienced groups of subjects thus remains to be investigated further.

2.8 Experience and Phonetic Context as Tested in Current Study

To test how experience affects cross-language perception, the present study involved subjects in four different groups according to experience with German, namely 1) students with no experience with the L2; 2) students in their third semester of college-level German instruction; 3) students in their fifth semester of college-level German instruction or above who had not stayed abroad; and 4) students in their fifth semester or above with at least 12 months abroad in a German-speaking country, having returned to the United States within the last four years.

The present study's design follows Trofimovich et al. (2001) who tested the cross-language perception of English vowels by Korean learners of English by means of a forced-choice identification task and likeness rating task. They found that advanced learners processed allophones of English vowels differently than beginning learners of English (namely more experienced learners perceived allophones as belonging to the same phoneme mapped to L1). The present study examined the cross-language perception of German vowels at different stages of L2 instruction and experience.

Subjects in the present study who had experience living in a country where the target language is spoken were mostly spending time there on LDS missions. Every day spent in the country, they would communicate with native speakers of German in natural situations.

Such a stay in a foreign country can be compared to a work internship experience or an extended work stay, without receiving formal language instruction besides their interaction with natives in informal or work settings. Internships and work stays are a major part of the professional world and the mastery of a foreign language in an international setting is of great importance (Sherry, 1988). Bohn & Flege (1990) caution, though, that other variables besides experience, e.g., using vowel duration as a cue, have to be considered.

The factors of context and experience also need to be considered in combination, as Trofimovich et al. (2001) observed in their study, described above, that less experienced subjects were more affected by the phonetic context than the more experienced subjects were who had learned to ignore unimportant, or non-phonemic, differences in the vowels they heard. They further observed that less experienced subjects perceived the English vowels, in some contexts, as more similar to their Korean equivalents than more experienced subjects did.

Besides a mapping task, the present study also included a goodness rating task where subjects were asked to determine how similar or dissimilar they thought the German vowel they heard was with regards to the English vowel they selected as equivalent. Trofimovich et al. (2001) observed in their study of Korean speakers learning English vowels that subjects gave significantly different ratings for several of the tested vowels in different contexts, while not for a few others. Further Trofimovich et al. observed that "the more experienced L2 learners perceived the English vowels, at least when they occurred in certain phonetic contexts, as being more similar to the corresponding Korean vowels than did the less experienced L2 learners" (p. 181). They caution, though, that "similarity ratings may not

always reveal context-based differences" (p. 181).

2.9 Need for the Present Study

As part of the research on mapping of L2 sounds to the L1, more studies regarding phonetic contexts and examining a wide selection of possible responses for L1 equivalents are clearly needed in order to determine cross-language similarity and examine predictions made by current perception models. Other research offering the whole range of L1 response options for a whole range of L2 stimuli is rare. Furthermore, studies have only tested a few phonetic contexts, and the present study offers a new combination of contexts to compare. Besides contexts, previous studies have usually compared only two or three levels of experience in subjects. Thus, the present study was undertaken with four groups of a total of 118 subjects differing in their experience with the L2, here German, as well as testing all German monophthongs (except schwa) in four phonetic contexts, and by offering all American English vowels as response options.

2.10 Prediction of Results

2.10.1 Predictions for the Perception of German Vowels in General

Based on similarities and differences in the phonological systems of North American English and German, as well as considering results from previous studies on the perception of German vowels, I would predict the following results to obtain for my study.

1) "Similar" German vowels, i.e., /i:/, /I/, /e:/, /ɛ/, /ɛ:/, /a:/, /a/, /u:/, /U/, /o:/ and /ɔ/, will be

most frequently mapped to their English equivalents (according to Flege's (1995) SLM).

2) "New" German vowels, i.e., /y:/, /Y/, /ø:/ and /œ/, will be mapped to either their front unrounded or their back rounded English counterparts, though their mapping might show less of a single modal choice, but /y:/ and /Y/ will be most frequently mapped to English /u/ and /U/ respectively (Strange et al., 2004). "New" vowels will receive relatively low goodness ratings as they will not be good matches for English vowels, and "similar" vowels will receive relatively good ratings (according to Best's (1995) PAM and Flege's (1995) SLM).

3) Lax German vowels will be more difficult to map for subjects than tense German vowels, e.g., German /u:/ will be easier to map than /U/, as seen in less clear modal choices in Polka's (1995) study on the perception of German vowel contrasts by English listeners.

4) German mid and mid-low vowels, namely /e:/, /o:/, /ɛ/ and /ɔ/, may be inconsistently mapped to their English counterparts and receive poor goodness ratings since they are slightly higher than the English equivalents (Strange et al., 2004).

5) Front unrounded and rounded high lax vowels may be identified as mid unrounded and rounded vowels respectively (Hall, 2003; Strange et al., 2005).

6) As vowel mergers have occurred in some North American English dialects, subjects might be split in their mapping of German vowels to English /a/ and /ɔ/ or /o/ and /ɔ/ (Labov et al., 2006; Strange et al., 2004, 2005).

7) Tense German vowels may be mapped to English diphthongs as tense (long) vowels in

English are always diphthongized (Hall, 2003; Strange et al., 2004, 2005).

2.10.2 Predictions for Perception Based on Experience and Context

Generally speaking, if higher levels of instruction or exposure impact perception, I would predict that more consistent selections of L1 vowel categories (modal choice) will be obtained for the more experienced subject groups and poorer likeness ratings for vowels that are dissimilar (Trofimovich et al., 2001). But, with regards to a stay abroad, it is not clear if a stay of one year or more in the target country will have been sufficiently long to have affected the subjects' perception of German vowels to the degree that they differ from subjects who merely studied German in the United States. The effect of experience may also differ according to the vowel in question (Bohn & Flege, 1992; Guion et al., 2000; Polka, 1995; Trofimovich et al., 2001), e.g., subjects in all groups, regardless of experience level, may perceive German /i:/ and /I/ similarly because these vowels have an English equivalent and are very difficult for learners to discern as predicted by PAM (Best, 1995) and SLM (Flege, 1995), and it may take a very long time for learners to acquire the difference (Bohn & Flege, 1997). Whereas more experienced subjects might be better able to perceive the differences in "dissimilar" vowels, e.g., German /y:/(Flege, 1995). Nevertheless, goodness ratings for "new" German vowels will not change with experience as Trofimovich et al. found in their 2001 study.

Phonetic context may have an influence on the mapping of German vowels to English vowels. I predict that subjects with more experience in L2 will be able to ignore contextual differences and recognize the allophonic occurrence of a particular German vowel as one and

the same phoneme and map it in a manner that is less affected by phonetic context (Trofimovich et al., 2001). The /r/ context will affect the subjects' mapping of German vowels (Labov et al., 2006; Kufner, 1971; Moulton, 1962; Ramers, 1988). Table 2 summarizes the most important predictions for the results of the present study ordered by research question.

Table 2. Summary of Predictions.

Research Question		Prediction
1	1	"Similar" vowels are mapped to English equivalents, good rating
	2	"New" vowels mapped to front unrounded or back unrounded vowels, lower goodness rating
	3	Lax vowels more difficult to map
	4	Mid and mid-low vowels mapped inconsistently to counterparts Receive lower goodness ratings
	5	Front high lax vowels mapped to mid vowels
	6	Mapping may be split between English /a/, /o/ and /ɔ/
	7	Tense vowels mapped to English diphthongs
2	8	More consistent modal choice with increased experience
	9	Experience affects goodness rating
3	10	Context affects perception

In this chapter, I have discussed some of the theoretical models and several research studies regarding the perception of L2 sounds, and in particular German vowels, as well as the place this particular study fills. I now turn to a description of the research methodology in Chapter 3.

Chapter 3

Research Methodology

3.0 Introduction

As stated in the previous chapter, the main focus of this study was the cross-language perception of German vowels by native speakers of North American English (NAE). The tests administered in the present study were performed to discover how cross-language perception differs for various levels of instruction (including lack of instruction) and for those with substantial experience living in a German-speaking country. Of special interest was the question of whether more advanced students as well as those with experience in a German-speaking country show a change in how they perceive non-native German vowels in relation to their NAE vowels. In particular I examined whether they notice fine-tuned differences between NAE and German, and whether their mapping of the German vowels onto the NAE vowels changes with more experience, either in terms of length of study or time in a German-speaking country. This study addressed these questions through a cross-language vowel category identification task and a category-likeness rating task using a 7-point Likert scale. In this chapter I outline the procedure used to collect the data before turning to a discussion of the results in Chapter 4.

3.1 Methods

3.1.1 Subjects

The subjects in this study were all students at Brigham Young University (BYU). All were native speakers of North American English with at least fourteen subjects in each of the following four groups:

Group 1: Students with no experience in German (naive listeners, recruited from Psychology 545 class).

Group 2: Students in their third semester of college-level German instruction (German 201; no time spent abroad in L2 environment).

Group 3: Students in their fifth semester or above of college-level German instruction (no time spent abroad in L2 environment).

Group 4: Students in their fifth semester or above of college-level German courses with at least 12 months abroad in a German-speaking country, having returned to the United States within the last four years.

In order to reduce confounding variables, subjects with knowledge of Chinese, Dutch, French, Scandinavian languages and Turkish were excluded since these languages also have front-rounded vowels.[12] It should be noted, however, that completely naive monolingual subjects were nearly impossible to find due to the university's language requirement for students.[13]

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[12] Knowledge of front-rounded vowels in other languages would indicate an increased familiarity with the rounded vowels, and therefore, could affect the subjects' perception of these sounds in the study stimuli.

[13] General Education requirements at BYU include at least 4 semesters of college-level foreign language courses or equivalents.

Subjects in groups 3 and 4 were recruited from those currently enrolled in either 300- and 400-level German courses at BYU. Students with some experience staying in the L2 environment, but for less than 12 months, were excluded from the study; the minimum of one year was determined necessary to allow for enough experience to off-set classroom instruction (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004)[14]. Students' names were replaced with subject numbers in data processing to ensure confidentiality.

A total of 205 subjects took part in the present study. The data, however, from 73 subjects were not analyzed since they did not fit into one of the four groups because they were either bilingual or had knowledge of languages with front rounded vowels; in addition, one subject opted to not finish the experiment. An additional 14 subjects were excluded after their data were lost due to software problems. Thus, the number of subjects included in the data analysis was 118 total (58 female and 60 male) between 18 and 52 years of age (see Table 3). The break-down for the four groups is as follows: Group 1 – 44 subjects (26 female, 18 male); Group 2 – 16 subjects (12 female, 4 male); Group 3 – 15 subjects (10 female, 5 male); Group 4 – 43 subjects (10 female, 33 male). The unusual high male to female ratio in Group 4 can be attributed to the fact that many of these subjects have served missions for the Church of Jesus Christ of Latter-Day Saints (LDS), and higher numbers of men serve missions than women. Of the 10 female subjects in Group 4, 7 had lived in a German-speaking country during their high school years. The questionnaire, however, did

[14]Aoyama et al. administered a categorical discrimination task to native Japanese adults and children (the latter began English schooling after Time 1) living in the US, at Time 1, and again, one year later, at Time 2. They found no significant differences in scores from Time 1 and Time 2 for either group.

not inquire about the school they attended or whether they had daily contact with native German speakers. The other 3 female subjects in Group 4 served LDS missions.

Table 3. Number, Gender, Age, Age of First Exposure to German, and How Long German has been Studied by Subjects Included in the Analysis

Group	Number of Subjects	Age	Age at first exposure to G.	Years of German studied
1	44	20.1	N/A	N/A
	(26F, 18M)	(Range 19-52)		
2	16	20.6	13.8	3.2
	(12F, 4M)	(Range 19-24)	(Range 5-21)	(Range 1-7)
3	15	21.5	13.5	5
	(10F, 5M)	(Range 19-27)	(Range 12-19)	(Range 1.5-9)
4	43	22.5	14	5
	(10F, 33M)	(Range 18-30)	(Range 6-19)	(Range 2-11)
All	118	21.2	13.7	4.4
	(58F, 60M)	(Range 18-52)	(Range 5-21)	(Range 1-11)

Though four subjects were exposed to German before the age of 12 because their family lived, for a time, in a German-speaking country, this exposure was assumed not enough to exclude these subjects from the study as they were not bilingual or exposed to German steadily from that early age on until the present; neither did they receive instruction until a later age, similar to the rest of the subjects in their group. Subjects further differed greatly in the number of years spent studying German formally (in high school or college), ranging from 1 to 11 years of instruction. The subjects came from different L1 dialect areas. However, L1 dialect seemed not to play an important role in this study since most subjects

came from the western dialect area and indicated that *bought* and *pot* sounded the same to them, so that the options [bɔt] vs. [bat] were not required.[15]

3.1.2 Stimuli

The stimuli used in the perceptual task were audio-recordings of 60 different German words. These words consisted of real and non-sense words of the form *b_Ce*, where the vowel was inserted in the first syllable between the <b> ([b]) as the first consonant, and either <n> <r> <sch> or <t> as the second consonant, followed by schwa, e.g., *bute, bohne*, etc.. All 15 German monophthong vowels were represented in this manner, e.g., *Biene, bitte, Bure, Botte* (see Appendix B for the complete list of stimuli). Since the vowels were all in stressed position, the tense vowels were all long. These tokens were recorded by one male and one female native German speaker from Northern Germany (Osnabrück and Hanover respectively) to ensure a standard German pronunciation. The recordings took place in a sound-proof booth using Peak 4.14 software and Sennheiser MKH 40P48 microphones. Tokens were recorded in the carrier phrase: *Ich habe ___ gesagt* "I said ____". The stimulus words were extracted from the phrase using GoldWave 5.10 software and stored as individual wave sound files on a computer (in mono, 44,100 samples per second, 16 bits).

[15]Further information from the biographical questionnaire regarding dialect background of subjects can be found in Appendix A.

3.1.3 Procedures

The experiment itself consisted of one task with two steps, a forced choice similarity task and a goodness rating task.

Subjects first heard a German word played twice via headphones. On the screen, while focusing on a priming screen which consisted of a blank screen with a plus sign (+) in the middle. After they heard the word, a new screen appeared. On this new screen, they saw the following table:

A = beat	B = fit	C = bait	D = set
E = cat	F = paw	G = bored	H = coat
I = put	J = clue	K = cut	L = bird
M = kite	N = Boyd	O = cloud	P = the

Figure 5. Words Representing NAE Vowels to Choose From as Responses

Subjects were asked to choose which of these English words (seen in Figure 5) contained a vowel most resembling the vowel they thought they heard in German. Table 4 shows which NAE vowel the words represented. All NAE vowels were available as response options.

Table 4. Words Corresponding to NAE Vowels.

Vowel				
front unrounded	beat - /i/	fit - /I/	bait - /e/	set - /ɛ/
low central/back	cat - /æ/	paw - /a/	bored - /ɔ/	coat - /o/
<u> and /ɚ/	put - /U/	clue - /u/	cut - /ʌ/	bird - /ɚ/
diphthongs, schwa	kite - /ai/	Boyd - /ɔI/	cloud - /au/	the - /ə/

These English words were chosen because they are monosyllabic and mostly higher frequency words. Furthermore, most of them had the phonetic contexts tested, namely /t/; and whenever possible, the phonetic context was kept alveolar. Subjects then indicated their choice by pressing the corresponding letter on the computer keyboard.

After selecting in Step 1 the word which contained the vowel they thought most resembled the vowel in the German word, a new screen appeared for the goodness rating task. On this screen (shown in Figure 6), subjects were asked to rate how well the German vowel matched the NAE vowel they selected on a 7-point Likert scale where 1 = 'not at all alike' and 7 = 'an absolute match'.

1 2 3 4 5 6 7

<--->

not at all alike an absolute match

Figure 6. Likert Scale for Goodness Rating Task.

Once they entered their rating by pressing a number key on the keyboard, a new priming screen appeared and a new token was presented, starting the identification and rating sequence again. All tokens were presented in random order, and the next token was presented as soon as the subject had submitted the selection for the likeness rating. E-Prime was used to administer the test to the subjects with the researcher present during the administration of the tests. Each token was presented twice spoken by the female voice and twice by the male

voice, thus subjects heard a total of 240 stimuli (60 tokens x 2 speakers x 2 repetitions). (See Appendix C for the complete text of the instructions.)

At the beginning of the test, subjects heard a recording of instructions for the tasks and audio samples of the English words they needed to choose from (see Appendix D). The task started with ten practice questions to familiarize them with the procedure. This also permitted subjects to adjust the volume setting for the earphones and to ensure the equipment was working before the results were recorded.

3.1.3.1 Questionnaire

In order to collect participant demographics for relevant analysis and grouping, a questionnaire was administered prior to the perception tasks (see Appendix E for the complete questionnaire). Besides noting name and gender, this questionnaire asked the subjects about their level of instruction in German, purpose for studying German, dates, locations, and length of time spent in a German-speaking country, knowledge of other foreign languages and of linguistics, usage of German in their daily lives, rating of their own German abilities, purpose and motivation for learning German, and information regarding places where the student grew up and lived. Not all of this information was used in the analysis for this study.

3.2 Data Analysis

Data from 118 subjects were analyzed. The data were subjected to statistical tests to show significance of results. Namely, frequencies of responses were tabulated for the forced

choice task, and averages were calculated for the goodness rating task. Since subjects heard each token 4 times (2 speakers x 2 repetitions) in each phonetic context, they could have chosen the same response for that token, i.e., the German vowel in that context, four times, or subjects could also have selected a different response each time, e.g., as response to hearing the German word *Biene*, a subject may have selected NAE /i/ all four times this stimulus appeared, whereas for *Börre*, for example, the subject could have selected NAE /ɚ/ one time, and /ʌ/, /U/ or any other response for the other times this stimulus appeared. The frequencies for each response option were determined by adding up how many times subjects selected it, i.e.,in a certain context for the particular German vowel (e.g., NAE /U/ for German /U/ as in *Bunne* vs. *Burre* vs. *Busche* vs. *Butte*) and also in all four contexts overall. These frequencies were either broken down according to subject group or given for all subjects combined. Frequency counts were then converted into percentages of total responses possible for that vowel in each context, or in all contexts combined. (Each vowel for 118 subjects x 4 contexts x 2 speakers x 2 repetitions = 1888 possible responses.)

Averages for the goodness rating task were determined for each subject since they could have given a different rating to the same token each time they heard it (4 times, i.e., 2 speakers x 2 repetitions, in each context for a total of 16 stimuli for each German vowel). In order to compare subject groups, the individual subject's average ratings for each token were added within their group and then divided by the number of subjects in that group to provide a group average rating. This was done by context and for all four contexts combined as well.

One-way ANOVAs, two-way ANOVAs and Tukey HSD Tests, with Bonferroni adjustment, were performed to determine statistically significant differences for the subject groups and also the phonetic contexts, e.g., *bVte, bVne*. Due to the high level of comparisons, the alpha level (probability value) was set at 1% (.01), instead of the customary 5% (.05). Therefore, the confidence interval was also 99%. Furthermore, I collapsed NAE /ɔ/ and /o/ in the analysis because most American speakers do. A discussion of the results now follows in Chapter 4.

Chapter 4

Results

4.0 Introduction

The results for this study are discussed in the following order. To begin with, data for the forced choice similarity task are presented first for each tested German vowel for all subjects overall, then by comparing the results for groups. Choice trends for this task are addressed and the influence of phonetic context is discussed as well. Next, the results for the goodness rating task are presented; once again, first for all subjects, then by groups. The chapter closes with a summary of the findings.

4.1 Forced Choice Similarity Task-overall

As the reader will recall, subjects were first asked to choose an English vowel that best matched the German vowel in the word they heard. The results for the top four responses selected overall in the forced choice similarity task are shown in Table 5. For the mapping scores of the most frequently selected responses , i.e., the modal choice, a two-way (group x vowel) ANOVA revealed a significant group ($F=33.83$, $p<.0001$), vowel ($F=128.14$, $p<.0001$) and group x vowel interaction ($F=5.68$, $p<.0001$). Because significance was found at this level, a series of one-way ANOVAs were run for each vowel to determine how the groups differed from each other on each of the vowels examined. The results according to group will be discussed in more detail later in this chapter.

Table 5. Top Four English Choices for German Vowels for All Phonetic Contexts and All Subjects Collapsed.

German	Response Rank			
Vowel	1st	2nd	3rd	4th
/i:/	/i/ (86.4)	/ɚ/ (4.7)	/I/ (3.5)	/ə/ (1.8)
/I/	/I/ (68.1)	/ɚ/ (12.6)	/ɛ/ (7.6)	i (1.9)
/e:/	/e/ (61.4)	/i/ (16.9)	/ɛ/ (12.7)	/ɚ/ (3.5)
/ɛ/	/ɛ/ (82.2)	/e/ (7.0)	/i/ (3.4)	/ɚ/ (1.7)
/ɛ:/	/ɛ/ (59.6)	/e/ (18.4)	/æ/ (8.7)	i (4.0)
/a:/	/a/ (84.6)	/æ/ (7.5)	/e/ (2.2)	/ə/ (1.2)
/a/	/a/ (68.4)	/æ/ (11.5)	/ʌ/ (8.7)	/ə/ (4.5)
/u:/	/u/ (61.6)	/U/ (22.6)	[o] (8.3)	/ɔI/ (4.1)
/U/	/U/ (49.8)	[o] (21.6)	/u/ (11.3)	/ɔI/ (6.0)
/o:/	[o] (77.0)	/ɔI/ (16.5)	/U/ (2.1)	/a/ (1.2)
/ɔ/	/a/ (38.3)	[o] (32.3)	/ʌ/ (13.6)	/ɔI/ (5.4)
/y:/	/u/ (66.1)	/U/ (19.9)	/ɚ/ (5.5)	[o] (1.9)
/Y/	/U/ (45.4)	/u/ (16.8)	/ɚ/ (13.5)	/I/ (7.6)
/ø:/	/U/ (45.4)	/ɚ/ (31.4)	/u/ (18.6)	[o] (4.5)
/œ/	/U/ (21.8)	/ɚ/ (20.1)	/ʌ/ (19.1)	/ɛ/ (14.0)

Note. The English choices /ɔ/ and /o/ are listed together as [o]. Numbers in brackets are percentages of times the response was selected.

For the "similar" vowels, namely /i:/, /I/, /e:/, /ɛ/, /ɛ:/, /a:/, /a/, /u:/, /U/, /o:/ and /ɔ/, subjects consistently selected the NAE counterpart for the German vowels with the greatest frequency, as shown in Figure 7. When subjects selected a NAE vowel other than the equivalent vowel, these secondary choices (indicated as dotted lines in Figure 7) were

relatively close phonemically; and with the exception of /o/ and /a/, subjects selected English vowels that matched the German vowels in rounding. Moreover, with the exception of both German /a:/ and /a/ (central vowels; neither front nor back), German back vowels were generally associated with English back vowels, while German (unrounded) front vowels were associated with English front vowels.

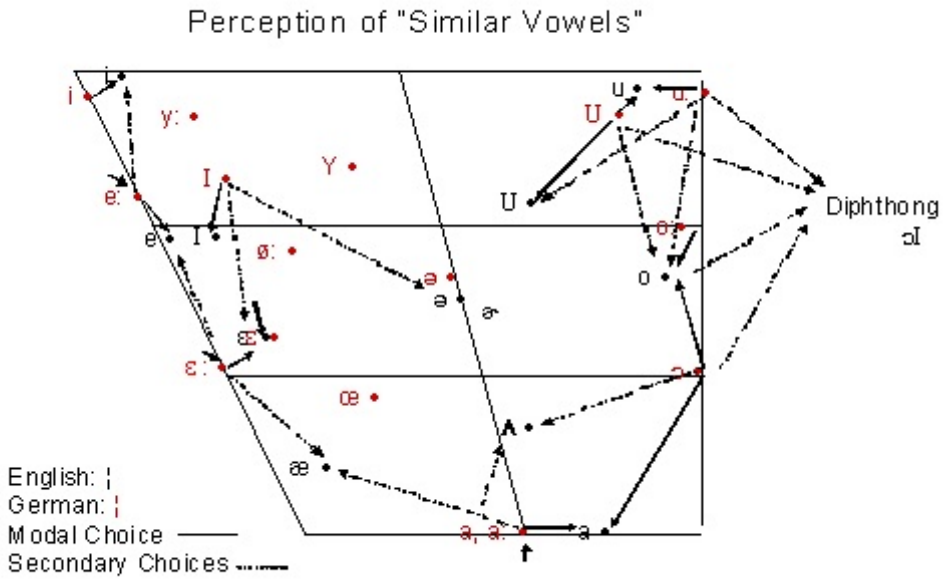

Figure 7. Mapping of "similar" German vowels to their English equivalents.
Note. The diphthong /ɔI/ is placed outside the vowel space in order to avoid overlapping with other arrows in the graph.

There is one exception to the trend of choosing a close acoustic neighbor, namely for the German /ɔ/, where subjects selected English /a/ as in *paw* most frequently followed by English /ɔ/ as in *bored* as the second choice. One surprising observation should also be noted, namely that for the back round vowels, subjects selected the diphthong /ɔI/ as in *boy* as a secondary choice. In fact, this diphthong was consistently in the top four choices for all the

back round vowels, though German vowels in each case are pure vowels, i.e., monophthongs, not diphthongs like their English counterparts. Moreover, all of these German vowels have North American English equivalents.

In contrast to "similar" vowels, the "new" German front rounded vowels did not follow the same pattern. Instead, as seen in Figure 8, it was found that all front rounded vowels, except for /y:/, were associated most frequently with English /U/ (as indicated by the solid lines) and that rhotacized schwa (/ɚ/) as in *bird* (as indicated by the dotted lines) was the other vowel consistently selected as a frequent choice for all front rounded vowels.

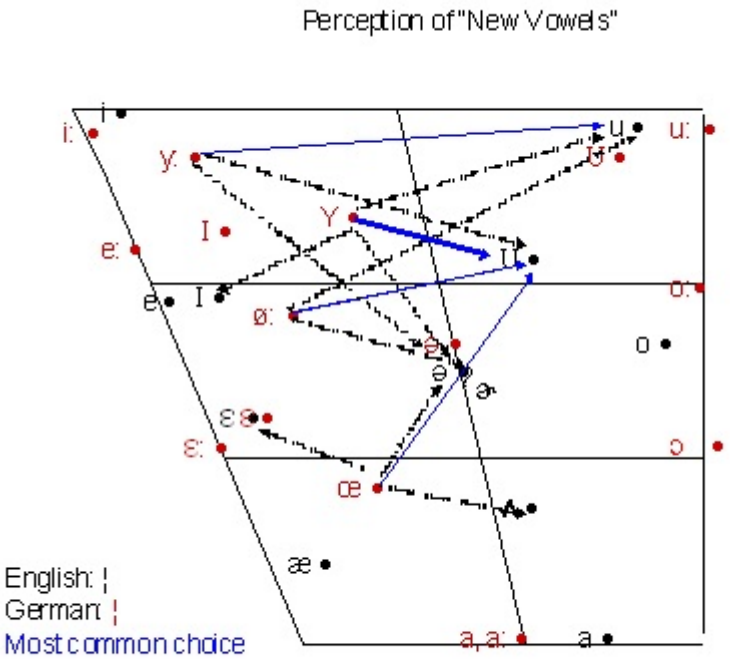

Figure 8. Mapping of "New" German Vowels to NAE vowels.

In the case of the two *ü* vowels /Y/ and /y:/, they are both heard in English to correspond to their back rounded counterparts, namely /U/ and /u/. The same, however, does not hold true for the two *ö* vowels. Rather than being associated with their "back vowel" equivalents in North American English, namely /ɔ/ or /o:/, they are perceived most frequently as being like English /U/. And, for /œ/, English /ɚ/ and then also /ʌ/ are almost evenly distributed choices along with North American English /U/.

For the front rounded vowels, subjects selected an English back or central vowel. For the lax vowels, however, some subjects associated the German front rounded vowels with a front vowel, German /œ/ with English /ɛ/ (14%), German /Y/ with English /I/ (7.6%), thus listening for the front-back distinction rather than the rounded-unrounded distinction. For example, both German /Y/ and /y:/ can be heard as either English lax /U/ or tense /u/. The tense-lax distinction does, however, plays a role in one trend found, where only the lax vowels /Y/ and /œ/ were associated with their unrounded counterparts, /I/ and /ɛ/ respectively. In the case of /œ/, however, this response was less frequent than the English /ʌ/, which is a neighboring vowel. Unlike where the subjects tended to associate "similar" German vowels with their English equivalents within a proximate acoustic space, acoustic proximity was not a clear factor in the English vowel choice for "new" German vowels, and the tense front rounded vowels were not perceived as being equivalent to the front unrounded vowels in North American English. Even with tense German vowels, subjects generally associated them with English vowels that tended to be lax.

Overall response trends were analyzed in order to answer Research Question 1, "How do English-speaking learners of German perceive sounds in German not found in North

American English?" According to the results from the two-way ANOVA, three general trends were noted (see frequency percentage chart for all responses in Appendix F):

1. For the vowels /a:/, /ɛ:/, /i:/, /o:/, /u:/, one primary choice, known as a clear modal choice, was found.

2. For other vowels (e.g., /ø:/ and /œ/), the choices were more distributed, i.e., subjects tended less towards choosing one single English vowel as similar to the German vowel.

3. Finally, for the vowels /a/, /ɛ/, /e:/, /I/, /ɔ/, /U/, /Y/, /y:/, the phonetic context played a role as to which English vowel was more likely to be selected.

These results show that there is not one clear response or way of mapping all the German vowels to the subjects' L1 vowels.

4.1.1 Trend 1: Clear Modal Choice Overall

Looking at Figure 9 for the German vowel /a:/, we see the two English vowels selected most frequently as equivalents, namely /æ/ and /a/. Data are listed according to the phonetic context, namely before <n> <r> <sch> and <t>, which are shown across the X-axis on the bottom of the chart and indicating the proportion of overall responses for that vowel according to group.

What becomes immediately apparent is that the majority of subjects selected the English vowel /a/ as in *paw*, which is close in acoustic space and slightly further back than the German equivalent, as the vowel most like the German /a:/ sound (84.6 % of the time, combining data from all the groups). The second most frequently selected vowel, i.e., English

/æ/ as in *cat*, was selected just 7.5 % of the time. Although it is also a low vowel like German /a:/, but more fronted, participants clearly associated German /a:/ with one primary English vowel, namely its English equivalent /a/. This will be referred to as the single modal choice for this German vowel.

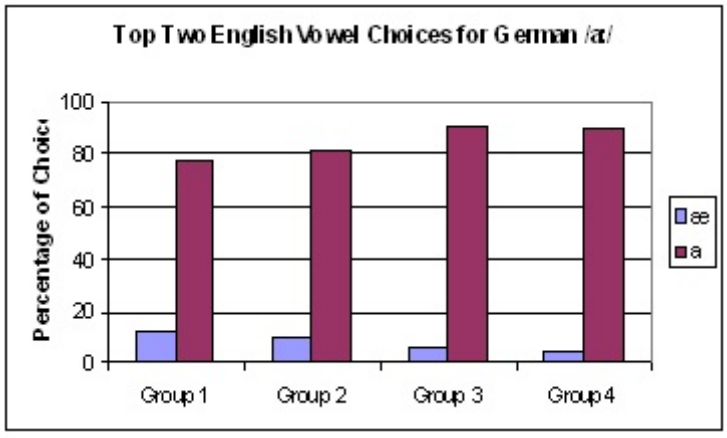

Figure 9. Top Two English Vowel Choices for the German Vowel /a:/: /a/ and /æ/.

Another vowel with a clear preference for one English choice was German /ɛ:/. Here all subjects regardless of group selected English /ɛ/ as in *set*, a very close equivalent to the German vowel, 59.6 % of the time, followed by English /e/ as in *bait,* which is also a front vowel, but higher than the German vowel /ɛ:/, (18.4 %) and /æ/, another front, but lower vowel than its German equivalent /ɛ:/, (8.7 %).

For the German vowel /i:/, subjects selected English /i/ 86.4 % of the time. The second most frequent choice was English rhotacized schwa (/ɚ/) as in the "er" sound in *bird*, but only selected 4.7 % of the time (ninety responses) and mainly in the /r/ context, not surprisingly since that is what colors the schwa.

German /o:/, was most frequently associated with English [o] (77%), namely /ɔ/ (53%) and /o/ (24 %). For many speakers, NAE /ɔ/ only occurs before /r/ and, therefore, appears to be an allophone of /o/. /ɔ/ has been lost in most dialects of North American English (Labov, Ash, & Boberg, 2006), and is, therefore, collapsed with /o/ into [o] in the analysis. (The separate choices for *bored* and *coat* were offered in this experiment because subjects in the piloting stage of this study expressed the desire for an /r/ context for the /o/.) Having collapsed the responses for /o/ and /ɔ/ as the single modal choice, the English diphthong /ɔI/ as in *Boyd* occurred as the second most frequent choice (16.5 %) for German /o:/. Recall from Chapter 2 that American tense vowels are not only long vowels but they are generally produced as diphthongs. Thus, the two choices from English, [ow] and [ɔj], are both diphthongs, leaving some room for English listeners to also map the long German /o:/ to the phonemic diphthong /ɔj/. [ɔ], however, is not a diphthong. The next frequent choice, English /U/, occurred only 2.1 % of the time (41 responses). For the rounded back vowels, namely German /ɔ/, /o:/, /U/ and /u:/, English /ɔI/ was chosen from 4.1% to 16.5% of the time and for the rounded front vowels, i.e., German /Y/, /y:/, /œ/ and /ø:/, between 1.3% and 3.1%; whereas /ɔI/ was selected only between 0% and 0.4% for the unrounded German vowels, namely /i:/, /I/, /e:/, /ɛ/, /ɛ:/, /a:/ and /a/ (see Appendix F).

Lastly, German /u:/ had as its single modal choice English /u/ with 61.6 % of the responses. Subjects then chose English /U/ as the second choice 22.6 % of the time, followed by /ɔ/ and /o/ with a combined 8.3% of the responses. All vowels selected were back vowels.

4.1.2 Trend 2: Less Clear Modal Choice

The second trend noted was where the subjects' choices were more diversified, i.e., there was a less clear modal choice of one single English vowel being selected as response. For instance, as seen in Figure 10, subjects associated the German /ø:/ with a number of different English vowels, namely /U/ as in *put* (32.5 % of the responses), /ɚ/ likely is the "er" sound in *bird* (31.4 %)[16], and /u/ as in *clue* (18.7 %). one of these choices are close acoustic neighbors of German /ø:/.

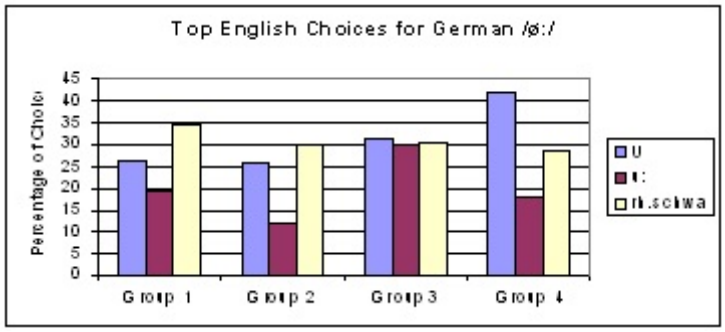

Figure 10. Top English Vowel Choices, /U/, /ɚ/ and /u/, for the German Vowel /ø:/.

For German /œ/, the subjects' responses again did not show a clear modal choice either. Figure 11 shows the four most frequent choices associated with German /œ/, namely /U/ (21.8%) as in *put*, /ɚ/ (20.1%) as in *bird*, /ʌ/ (19.1%) as in *cut*, and /ɛ/ (14%) as in *set*. Besides /ɛ/, /U/, /ʌ/, and /ɚ/, two other English vowels were chosen more than 100 times for German /œ/, namely /ə/ (schwa) as in *the* (6.6 %) and /ɔ/ (6 %), both mid-high vowels.

[16]Many instructors teach /ø:/ using English [ɚ], having students then try to stop short of /ɹ/, which is very similar auditorally.

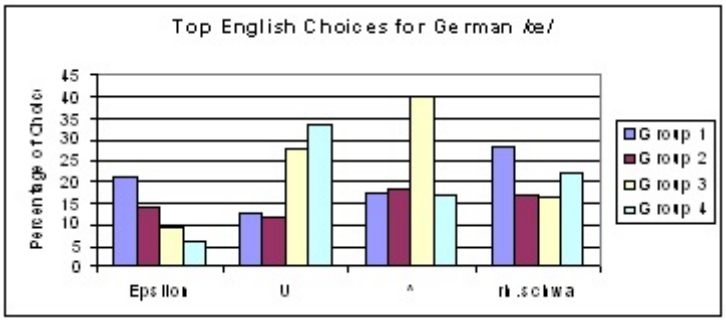

Figure 11. Top English Vowel Choices, /ɛ/, /U/, /ʌ/ and /ɚ/, for the German Vowel /œ/.

4.1.3 Trend 3: Modal Choice Dependent on Phonetic Context

The third and final trend highlights the importance of the phonetic context, i.e., the influence of adjacent consonants on the cross-language perception of German vowels. In these cases, the phonetic context clearly influenced which English vowel subjects tended to select as the equivalent for the German vowel. This trend seemed to occur mainly with the lax vowels, as well as with the high tense front rounded vowel /y:/.

German /a/, for example, has the English equivalent /a/ as a clear modal response (63.4 % overall). However, the consonantal contexts of /r/ and /t/ influenced the subjects' choice. The second most frequent choice (11.5 %), English /æ/, was selected less often in the /r/ context (1.0%) than in the /n/, /ʃ/ and /t/ contexts (an average of 3.3%); whereas /ʌ/ (8.7 % of the responses) was selected more often in the /t/ context (5.1%) than in the /n/, /r/ and /ʃ/ contexts (an average of 0.6%) by all subjects. The /r/ context influenced subjects' choices in many instances, regardless of the group subjects belonged to, but will be discussed further when looking at the results according to groups.[17]

[17] The /r/ context creates a variety of problems (cf. Hall, 2003; Kufner, 1971; Labov et al., 2006; Moulton, 1962).

German /ɛ/ provides another example of the influence that consonantal context can have on the cross-language perception of German vowels. As illustrated in Figure 12, the English vowel /ɛ/ was selected 82.2 % of the time (for all groups collapsed). These vowels are not only phonemic equivalents, but they also share similar acoustic space in both German and North American English. However, the second choice (only 7 % of all responses), English /e/, was really only selected in the context of /r/ (5.3% with /r/ vs 0.7% for /n/, /ʃ/, /t/).

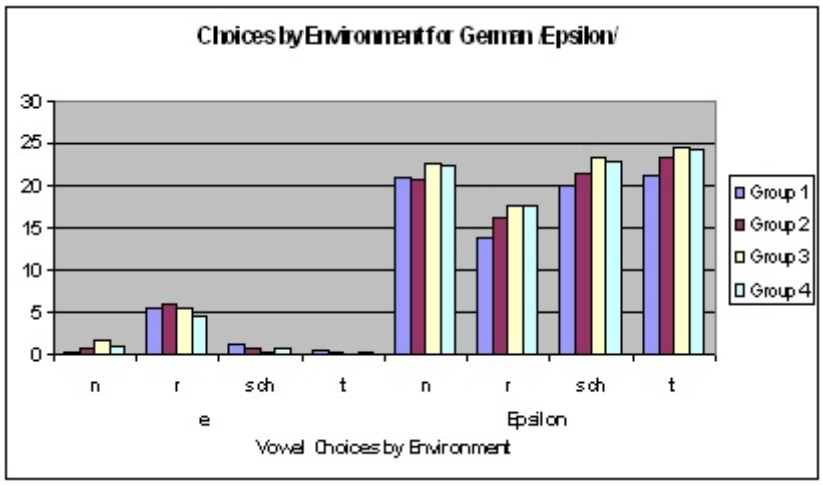

Figure 12. Top Two English Vowel Choices, /ɛ/ and /e/, for the German Vowel /ɛ/.

The German vowel /e:/ also showed the influence of the /r/ context in the choices of English equivalents. Besides the modal choice of English /e/ (61.4%), the second most common choice was determined by the /r/ context. For this phonetic context, subjects from all groups selected English /e/ 11.1% of the time, followed by English /ɛ/ at 8.0% of the time and lastly English /i/ was selected 2.7% of the time. This is particularly interesting since /ɛ/ was otherwise selected 12.7% of the time, regardless of the phonetic context, while /i/ was the second most commonly selected English vowel at 16.9%. However, the choice of English

/i/, while not seemingly influenced by the /r/ context, was more likely to be selected in the /n/ context than any other context. German /e:/ is higher than English /e/, thus closer to English /i/. But many speakers invert /e/ and /ɛ/, so this does not necessarily hold true (Labov et al., 2006). It can be said, however, that subjects listened for tenseness (Strange et al., 2004).

Looking next at the results illustrated in Figure 13 for German /I/, the difference in the /r/ context is strikingly obvious. Though, English /I/ was chosen for more than 80% of all responses given for German /I/ in all contexts, it was selected just 4.3% for /r/. However, in the /n/, /ʃ/ and /t/ contexts, English /I/ was selected 21.8%, 16.7% and 22.7% respectively. On the other hand, /ɚ/ is the English vowel of choice for German /I/ before /r/, being selected 9.4% of the time, followed by /I/ at 4.3% and then /ɛ/ at 3.7% of the time. This is particularly interesting in the light of the fact that in all other contexts, /ɚ/ is selected less than 1.0% of the time, while /ɛ/ is chosen in all other contexts less than 0.95% of the time.

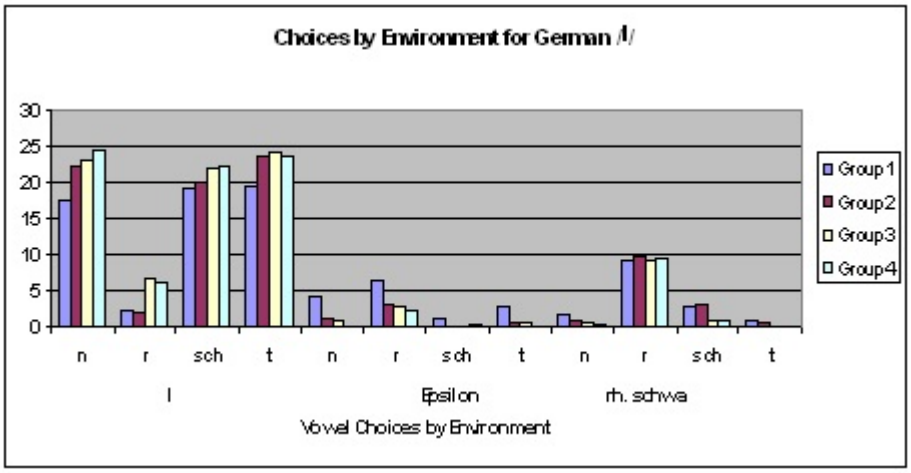

Figure 13. Top English Vowel Choices for the German Vowel /I/.

German /ɔ/ shows a slightly different pattern of influence. Here, English /a/ (38.3% overall), was the highest choice for /n/ (12.3%) and /ʃ/ (15.6%), but not for /r/ (4.0%) or /t/ (7.3%). For /r/, [o] , the overall secondary choice at 32.3% , is the most common choice at 17.7% (versus 2.4%-7.1% for /n/, /ʃ/ and /t/). For /t/, the most common choice is /ʌ/, receiving 10.6% of selections for all groups, vs. 7.3% for /a/ and 2.4% for [o].

In some dialect areas of North American English, the /a/ and /ɔ/ have merged (Strange, Bohn, Trent, & Nishi 2004; Strange, Bohn, Nishi, & Trent, 2005); therefore, subjects may have perceived the German /ɔ/ as an equivalent to either. Interestingly, the third most frequent choice (13.6 % for all phonetic contexts), North American English /ʌ/ (which doesn't really exist in English before /r/, but exists before /t/), was also less likely to be selected in the /r/ context, but much more likely in the /t/ context. The English diphthong /ɔI/ as in *Boyd* was selected 5.4 % of the time for German /ɔ/.

The influence that phonetic context plays can be seen in the choices subjects made for the German /U/ as well. For example, when /r/ followed the German vowel, subjects tended to select the English vowel /ɔ/ as in *bored* 21.0% of the time. (In many dialects /ɔ/ only exists before /r/ and may be an allophone of /o/ before /r/, hence, in the analysis these two choices were collapsed; see Appendix F for frequency percentages for each separately.) But when the vowel /U/ was followed by /n/, /ʃ/ or /t/, subjects tended to select the English vowel /U/ most frequently (15.9%), regardless of group. English /U/, though slightly more fronted, but less rounded, is the equivalent to German /U/ as a high back vowel.

Responses for the high front rounded German vowels /Y/ and /y:/ were influenced by the /r/ context as well. The lax vowel /Y/ was most often associated with the lax English back

rounded vowel /U/ (45.4 % of the time). The second most frequently selected vowel, the tense back counterpart /u/ was selected only 16.8 % overall, but in the /n/ context /u/ accounted for 8.9% of subject's choices, compared to 2.4% for /r/, /ʃ/ and /t/. Several other responses followed, namely rhotacized schwa (/ɚ/) (13.5 %), North American English /I/ (7.6 %), the unrounded equivalent for /Y/, and English /ʌ/ (5.7 %), a rounded mid-central vowel.

Finally, the tense high front rounded vowel /y:/ was also associated with its back rounded English counterparts, i.e., the tense English /u/ (66.1 %) and lax /U/ (19.9 %). Rhotacized schwa (/ɚ/), once again, followed as third most frequent response (5.5 %) for all contexts collapsed. English /u/ was the modal choice in all four contexts, ranging from 13.0% to 19.4% for the individual contexts, 13.0% in the /r/ context being the lowest. The secondary choice, English /U/ ranged from 3.9% to 5.4% in the individual contexts, but here, the percentage of responses was actually highest for /r/ at 5.4%, but still lower than for /U/. English /ɚ/ was chosen less than 1.3% for /n/, /ʃ/ and /t/, but 2.9% in the /r/ context.

In order to look at the results in somewhat more detail, the responses for the forced choice similarity task will now be discussed with regards to the different subject groups.

4.2 Forced Choice Similarity Task by Group

To determine if groups differed in their mapping of German vowels to their English counterparts, data for the modal responses for each German vowel were analyzed using a one-way ANOVA ($p < 0.01$) with a Bonferroni adjustment from the usual p-value of .05 down to .01, due to the number of multiple comparisons. Subsequent post hoc Tukey HSD tests were also done to determine which of the 4 groups differed from each other, including adjustments

for different sample sizes. In order to answer Research Questions 2, “Does cross-language perception/mapping change as learners gain more experience in the language?”, and “Does an extended stay in the target country of at least 12 months make a difference in the perception of German vowels?” the forced choice similarity task were analyzed by groups.

As the reader will recall, the four groups of subjects were 1) students with no knowledge of German, 2) those in their third semester, 3) those in their 5th semester or above who did not spend time in a German-speaking country, and 4) those in their 5th semester or above who had stayed abroad for at least 12 months.

Four patterns emerge when examining the modal choices (the most frequent choice, not secondary or third most frequent choices) made by each of the groups:

1. There was no difference between groups for /i:/, /ɛ/, /ɛ:/, /a:/, /y:/, /U/, /u:/
2. Group 1 was less consistent in the modal choice than Groups 2, 3, and 4 for /e:/
3. Groups 3 and 4 were less consistent than Groups 1 and 2 for /ɔ/
4. Groups 1 and 2 were less consistent than Groups 3 and 4 for all other vowels. (/I/, /a/, /o:/, /Y/, /œ/, /ø:/)

4.2.1 No Group Difference in Modal Choices

The groups did not differ significantly in their modal choices for German /i:/, /ɛ/, /ɛ:/, /a:/, /y:/, /U/, and /u:/ (all $F(3,11) < 9.67$, $0.01 < p < .09$). The results are shown in Table 6.

Table 6. Modal English Choice for German /i:, ɛ, ɛ:, a:, U, u:, y:/ by Subject Group.

German Vowel	Modal Response	Group			
		1	2	3	4
/i:/	/i:/	83.4	84.8	91.3	88.5
/ɛ/	/ɛ/	76.3	81.6	87.9	86.9
/ɛ:/	/ɛ/	50	57.4	64.2	70.1
/a:/	/a/	77.4	81.3	91.3	90.7
/U/	/U/	45.5	44.9	58.8	52.6
/u:/	/u/	55.5	55.5	74.6	67
/y:/	/u/	59.8	53.5	86.3	70.6

Note. Numbers are percentages representing the proportion of times these responses were selected compared to other responses by each group.

For example, English /i:/ was the modal response for German /I:/ in all subject groups, and it was, chosen between 83.4% (by Group 1) and 91.3 % (by Group 3). Since groups differed in size, the statistics program adjusted for these differences. However, as a result, what may appear to the reader to be a large difference between vowels selected, e.g., 53.5% for English /u/ as modal choice for German /y:/ by Group 2 versus 86.3% by Group 3, was nevertheless not statistically significant.

4.2.2 Group Differences For the German Vowel /e:/

Group 1 was more varied in the modal choice for German /e:/, namely English /e/ (30.8%), whereas Group 2 (73.1%), 3 (80.4), and 4 (77.9%) were not significantly different ($F(3, 117) = 45.89$, $p < .01$). The second most frequent choice, English /i/ (Group 1: 39.9%, Group 2: 10.2%, Group 3: 2.5%, Group 4: 5.4%), became less frequent with increased experience. German /e:/ is slightly more fronted and higher than English /e/ and has a more

extreme lip position, but is closer in acoustic vowel space than the English /i/ would be. The less experienced subjects may have heard this as the English /i/ which is higher in acoustic space. The third most frequent response seemed to be selected similarly by the different groups (Group 1: 13.2%, Group 2: 10.2%, Group 3: 12.1%, Group 4: 13.8%).

4.2.3 Group Differences For the German Vowel /ɔ/

In the third pattern, shown in Table 7, the more experienced subjects actually were less consistent in their selection of the modal choice of English /a/ for German /ɔ/ ($F(3,117) = 10.81$, $p < .0001$).The second most frequently selected response, [o], is more consistent in Groups 2, 3, and 4 than in Group 1, which fits with the pattern seen with German /e:/. The third most frequent response, /ʌ/, showed no significant difference by experience.

Table 7. Modal English Choice for German /ɔ/ by Subject Group.

	Group			
Response	1	2	3	4
/a/	50.3	44.1	37.1	22.4
[o]	17.3	32.4	34.6	47.7
/ʌ/	13.2	9.4	19.8	12.5

Note. Numbers are percentages representing the proportion of times these responses were selected compared to other responses by each group.

4.2.4 Inexperienced Subjects (Groups 1 and 2) as Less Consistent Than More Experienced Groups 3 and 4

The less experienced subjects, Groups 1 and 2, were less consistent in their selection of the modal English equivalent for the German vowels /I/, /a/, /o:/, /Y/, /œ/, /ø:/(all $F(3,117) <$

50.92, $p < .0001$). Table 8 shows the modal choices for these vowels by subject group.

Table 8. Modal English Choice for German /I, a, o:, Y, œ, ø:/ by Subject Group.

German Vowel	Modal Response	Group			
		1	2	3	4
/I/	/I/	56.4	67.6	75.8	76.6
/a/	/a/	58.2	68	78	74.4
/o:/	/ɔ/	65.8	80.5	93.3	81.3
/Y/	/U/	42.8	38.3	50.8	49.4
/œ/	/U/	12.6	11.3	28	33.7
/ø:/	/U/	26.4	25.8	31.7	42.2

Note. Numbers are percentages representing the proportion of times these responses were selected compared to other responses by each group.

4.2.5 Group Differences for "New" Vowels

In terms of "new" vowels, it was noted that experience played no role in how subjects treated the vowel /y:/. By contrast, the mapping of all other "new" German vowels was shown to be affected by experience where Groups 1 and 2 differed from the more advanced Groups 3 and 4. In these cases, the front rounded counterparts do not exist as allophones of English vowels.

4.2.6 Role of Phonetic Context for Modal Choice by Group

As the discussion this far has suggested, the results from a two-way (group x context) ANOVA show that the context that has the greatest impact on how subjects heard the German vowels was /r/. In other words, if /r/ followed the German vowel /U/, e.g., in *burre*, or /I/ in

birre, it was most likely to affect how subjects mapped the German vowel to their English vowel system, leading them to select a vowel other than the modal vowel they select for other contexts (See 4.2.3). However, this context did not affect all vowels, nor all groups. Table 9 shows how the various phonetic contexts affected the modal choice for each German vowel according to subject group. For German /ɛ/, only Groups 1 ($F(3,43) = 9.53$, $p < .000$) and 4 ($F(3,42) = 11.96$, $p < .000$) were less likely to select the modal choice in the /r/ context, while for German /y:/, Groups 3 ($F(3,14) = 4.87$, $p < .004$) and 4 ($F(3,42) = 17.24$, $p < .000$) were similarly affected. And for German /u:/ and /ø:/, only Group 4 ($F(3,42) = 3.83$, $p < .011$) was less likely to select the modal choice in the /r/ context.

The two-way ANOVA and post hoc Tukey HSD tests further showed that, for some vowels, the other contexts impacted the subjects in their selection of the modal choices as well, e.g., /n/ following the vowels /i:/, /e:/, /a/, /u:/ and /ø:/, /ʃ/ following /a/ and /œ/, and /t/ after the vowel /a/, /ɔ/ and /œ/. In these contexts, subjects were less likely to select the modal choice (see Table 9). And where /r/ followed German /a/, the modal choice was actually ***more*** likely to be selected.

Post hoc Tukey HSD tests showed further that three German vowels did not show any significant influence of consonant context on the subjects' selections in any of the groups, i.e., German /ɛ:/, /a:/, and /o:/ (all F's < 2.60, $p > 1.53$); whereas other ones, namely /i:/, /I/, /e:/, /ɔ/, /U/, /Y/ and /œ/, were affected by /r/ in each group of subjects (all F's < 185.91, $p < .000$). For /ɔ/, all groups were also less likely to select the modal choice after /t/. For /e:/, all subjects were also less likely to select the modal choice in the /n/ context than in the /ʃ/ and /t/ contexts. Finally, for /U/ and /Y/, all subjects were also less likely to select the modal choice after /n/

than before /ʃ/, and less in the /ʃ/ context than before /t/.

Table 9. Role of Phonetic Context for Modal Choice by Group.

German vowel	Group 1	2	3	4
i:	r < n, ʃ, t	r < n, ʃ, t	r < n, ʃ, t	r < n, ʃ, t
I	r < n, ʃ, t	r < n, ʃ, t	r < n, ʃ, t	r < n, ʃ, t
e:	n, r < ʃ, t	n, r < ʃ, t	n, r < ʃ, t	n, r < ʃ, t
ɛ	r < n, ʃ, t	no	no	r < n, ʃ, t
ɛ:	no	no	no	no
a:	no	no	no	no
a	t < n, ʃ < r	t < n, ʃ < r	t < n, ʃ < r	t < n, ʃ < r
ɔ	r, t < n, ʃ	r, t < n, ʃ	r, t < n, ʃ	r, t < n, ʃ
o:	no	no	no	no
U	r < n < ʃ < t	r < n < ʃ < t	r < n < ʃ < t	r < n < ʃ < t
u:	no	no	no	r, n < ʃ, t
Y	r < n < ʃ < t	r < n < ʃ < t	r < n < ʃ < t	r < n < ʃ < t
y:	no	r < n, ʃ, t	no	r < n, ʃ, t
œ	r < ʃ < t < n	r < ʃ < t < n	r < ʃ < t < n	r < ʃ < t < n
ø:	no	no	no	r, n < ʃ, t

Note. Contexts statistically significant at alpha .05, $p < .05$. No stands for: no difference for context. Contexts on the left side of the unequal-sign (<) caused subjects to select the modal choice less frequently.

4.3 Goodness Rating Task

Finally, examining the scores for the second part of the task, namely rating the likeness of the German vowel with the selected English vowel on a 7-point Likert scale, a two-way (group x vowel) ANOVA was run on the data. This analysis revealed no group ($F = 1.23$, $p >$

.05), vowel ($F = 1.45$, $p > .05$) nor group x vowel interaction ($F = .567$, $p > .05$). Because no significance was found at this level, no further statistical analyses were run. Yet, the more frequently the response was selected overall (modal choice), the higher, generally, its goodness rating was compared to the secondary choices. This higher rating simply indicates the subjects' confidence in their selection of one response, as a closer equivalent to the German vowel, over another one, which they perceived as less similar. Table 10 shows the average goodness ratings for the modal choices for each German vowel tested.

German /ɛ/, for example, was most frequently associated with its English counterpart /ɛ/, as was German /ɛ:/. English /ɛ/ was given a higher goodness rating by all groups for German /ɛ/ than for /ɛ:/, but the differences in ratings of modal choices for different German vowels were not statistically analyzed. For the "new" German vowels /Y/, /y:/, and /ø:/ the goodness rating for the most frequently selected response did not differ significantly across groups either.

As with the Forced Choice Similarity Task (cf. Figure 9), German /œ/ follows a somewhat different pattern, as seen in Figure 14. Groups 1 and 2 rated the modal choice, English /U/, lower than the next three most frequently selected responses; whereas Group 4 rated /U/ highest of all choices. Groups 1 and 2 thus gave English /ɛ/ a higher likeness rating than /U/, whereas Groups 3 and 4 did the opposite, giving English /U/ a higher rating than /ɛ/. No statistics were run, however, as to the significance in difference.

Table 10. Average Goodness Ratings for the Modal Choice for all German Vowels Tested for All Phonetic Contexts Collapsed.

German	Modal	Group			
Vowel	Response	1	2	3	4
/i:/	/i/	5.3 (83.4%)	5.2 (84.8%)	5.3 (91.3%)	5.0 (88.4%)
/I/	/I/	3.9 (58.4%)	4.3 (67.6%)	4.6 (75.8%)	4.4 (76.6%)
/e:/	/e/	2.8 (30.8%)	4.6 (73.1%)	4.7 (80.4%)	4.8 (77.9%)
/ɛ/	/ɛ/	4.6 (76.3%)	4.5 (81.6%)	4.9 (87.9%)	4.9 (86.9%)
/ɛ:/	/ɛ/	3.5 (50.0%)	3.6 (57.4%)	3.7 (64.2%)	3.9 (70.1%)
/a:/	/a/	5.0 (77.4%)	4.6 (81.3%)	4.9 (91.3%)	4.7 (90.7%)
/a/	/a/	4.2 (58.2%)	4.1 (68.0%)	4.6 (77.9%)	4.3 (74.4%)
/ɔ/	/a/	3.7 (50.3%)	3.1 (44.1%)	2.6 (37.1%)	2.3 (22.4%)
/o:/	[o]	4.9 (65.8%)	4.8 (80.5%)	5.1 (93.3%)	4.8 (87.3%)
/U/	/U/	3.6 (45.5%)	3.4 (44.9%)	3.7 (58.8%)	3.7 (52.6%)
/u:/	/u/	4.2 (55.5%)	3.8 (55.5%)	4.4 (74.6%)	4.5 (67.0%)
/Y/	/U/	3.4 (42.8%)	3.2 (38.3%)	3.7 (50.8%)	3.6 (49.4%)
/y:/	/u/	4.1 (59.8%)	3.5 (53.5%)	4.4 (86.3%)	4.2 (70.6%)
/œ/	/U/	1.5 (12.6%)	1.2 (11.3%)	2.4 (27.9%)	3.1 (33.7%)
/ø:/	/U/	2.9 (26.4%)	2.3 (25.8%)	2.5 (31.7%)	3.0 (42.2%)

Note. Numbers represent scores given on a 7-point Likert scale, where 1 = 'not at all alike' and 7 = 'an absolute match'. Percentages in brackets show frequency of the modal choice among all responses within each group.

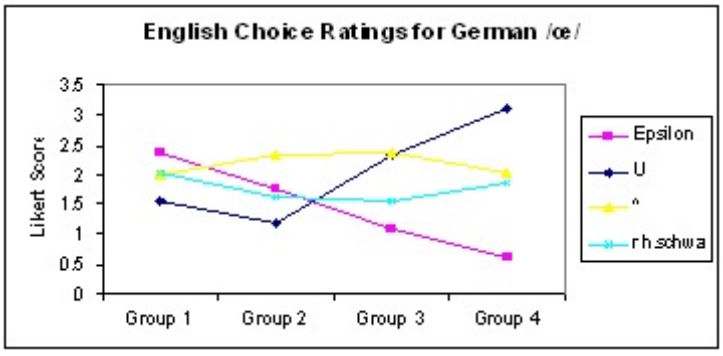

Figure 14. Goodness Ratings for Top Choices, English /U/, /ɚ/, /ʌ/ and /ɛ/, for German /œ/.

How the findings of this study answer the research questions and relate to theories and other studies in the area of cross-language perception of vowels will be discussed next in Chapter 5.

Chapter 5

Discussion of Results

5.0 Introduction

In this chapter, I answer the research questions by discussing the results in light of what other researchers have found, followed by conclusions to be drawn from this study. As the reader will recall, this study examines cross-language perception of German vowels by learners who are native speakers of North American English, at four different levels of experience or instruction in German. The subjects in this study performed a forced choice similarity task and a goodness rating task to answer the following three research questions: 1) How do English-speaking learners of German perceive sounds in German in comparison to their North American English vowels? 2) Does cross-language perception/mapping change as learners gain more experience in the language, and does an extended stay in the target country of at least 12 months make a difference in the perception of German vowels? and 3) How does phonetic context (of a following consonant) affect the cross-language perception of German vowels by English speaking listeners? The chapter begins with a brief summarizing overview of the results in Table 11, which lists the main predictions from Chapter 2, ordered by research question, along with a brief statement regarding whether the prediction was confirmed or not. Next, the research questions that guided this study are answered, followed by implications that can be drawn. Finally, I report limitations to this study and suggest future directions for further research.

Table 11. Overview of Predictions and their Results by Research Question.

RQ		Prediction	Result
1	1	"Similar" vowels are mapped to English equivalents, good rating	Mostly mapped to equivalents, good rating
	2	"New" vowels mapped to front unrounded or back unrounded vowels, lower goodness rating	All front rounded vowels (except /y:/) most frequently mapped to /U/, also /ɚ/; front unrounded secondary choice only for /Y, œ/; slightly lower rating for /œ, ø:/
	3	Lax vowels more difficult to map	Yes, inferred by less clear modal choice
	4	Mid and mid-low vowels mapped inconsistently to counterparts Receive lower goodness ratings	Mid and mid-low vowels were mapped to their counterparts Goodness ratings varied
	5	Front high lax vowels mapped to mid vowels	True for /I/; true for /Y/, but only as secondary choice
	6	Mapping may be split between English /a/, /o/ and /ɔ/	Top choices were /a, o, ɔ/ for /ɔ/, and /o/ and /ɔ/ for /o:, U, u:/
	7	Tense vowels mapped to English diphthongs	Only true for /u:/ and /o:/ with the secondary choice of /ɔI/, other diphthong responses negligible
2	8	More consistent modal choice with increased experience	Depends on vowel, as well as context
	9	Experience affects goodness rating	No, all groups performed similarly
3	10	Context affects perception	Yes, but depends on vowel and group

The results for this study partially affirmed the predicted outcomes and partially were contrary to expectations. The results for each research question from this study will now be discussed in relation to previous studies and prevalent theories informing this area of research.

5.1 Research Question 1: How do English-speaking learners of German perceive sounds in German in comparison to their North American English vowels?

English speakers learning German associated "similar" German vowels with their English equivalents in the forced choice similarity task, though not all of them with clear modal choices as predicted. This was not possible for "new" vowels since they do not have a corresponding English vowel. Subjects associated the front rounded vowels primarily with English /U/ or /ɚ/, or even /u/. Subjects did not simply associate these German vowels based on either lip rounding or the front-back continuum. In other words, when hearing /ø:/, subjects in this study did not associate this vowel with its unrounded front counterpart /e/, nor did they associate it with its back-rounded counterpart [o]. Instead, subjects tended to hear the front rounded vowels in terms of the more central vowels /U/ and /ɚ/, both of which are weakly rounded, and listened more for the rounded-unrounded distinction than for the frontness of the vowel. Strange, Bohn, Trent, & Nishi (2004) observed comparable results for German /ø:/, with English /U/ being the modal choice, whereas, in a later study, Strange, Bohn, Nishi, & Trent (2005) observed English /u/ as the modal choice for German /ø:/, both of these English equivalents being back rounded vowels. Strange et al. (2004, 2005) did not, however, list the secondary response choices.

Nevertheless, in my study ***all*** front rounded vowels were mapped to rhotacized schwa (/ɚ/) as in *bird*, this being a consistently selected secondary choice. This fits with Moulton's (1962:102) observation that "the one phonetic substitution commonly made is the use of English "er" (/ɚ/) for German o-umlaut" (cf. also Benware, 1986; Hall, 2003). It was further noted that experience (see Section 5.2) played no role in how subjects treated the vowel /y:/. This can be attributed to the fact that for many speakers of North American English, [y] is

an allophone of the English vowel /u/, as heard in words like *dude* (Fridland, 2006; Labov et al., 2006; Sledd, 1966). For these speakers, German /y/ would then be automatically assimilated to their English underlying phonemic category /u/.

Although it cannot definitively be predicted if these new vowels are confused by subjects in their categorical perception, it would suggest that these new vowels could pose problems by being perceptually similar to one another, i.e., to other new vowels, according to the notion of "perceptual similarity" posed by Flege (1995) and others (cf. Baker, Trofimovich, Mack, & Flege, 2001; Best, 1995). The German vowel /œ/ (and also /ø:/) showed varied responses by subjects in the present study and no clear modal choice as English equivalent. Consequently, it is classified as an uncategorizable assimilation according to PAM (Best, 1995).

Though not presenting a clear picture, such distributions can point to the differences in cross-language associations and their difficulties according to the categories in Best's (1995) PAM and Flege's (1995) SLM. For example, as predicted and observed by other researchers, some "similar" German vowels in this study were clearly associated with their English equivalents, namely /i:/ with /i/ (which can be perceived as "identical" as the modal choice accounted for 86.4% of responses for this vowel), /a:/ with /a/, /o:/ with [o, ɔ] and /u:/ with /u/, showing a definite modal response. This constitutes a Single-Category assimilation in categorical perception terms as predicted by PAM, similar to SLM's prediction that L2 phonemes assimilate to a single coinciding L1 category. The responses for the other "similar"

German vowels, i.e., /a/, /ɛ/, /e:/, /I/, ɔ/ and /U/, on the other hand, depended on phonetic context and thus were not predicted by PAM or SLM principles.[18]

One surprising observation was that for the back round vowels subjects chose the diphthong /ɔI/ as in *boy* as one of their choices. This diphthong was consistently in the top four choices for the back round vowels. This is perhaps most intriguing since the German vowels in each case are ***pure*** vowels, i.e., monophthongs, not diphthongs like their English counterparts. As I have not found this phenomenon documented anywhere else[19] I can merely speculate about possible reasons for subjects choosing /ɔI/: For the four German back rounded vowels, /ɔI/ represented between 4.1 % (for /u:/) and 16.5 % (for /o:/) of the responses; and for the front rounded vowels, the percentages were between 1.3 % (for /y:/) and 3.1 % (for ø:/). Perhaps subjects were trying to account for the roundedness by choosing the diphthong /ɔI/. In Swiss German, for example, a standard German /ɔI/ as in *Deutsch* (/dɔItʃ/), is said as /y/ as in *Dütsch* (/dytʃ/) (König, 2005; Stedje, 2001).

5.1.1 Vowel Length Influencing Choice

The tense-lax distinction did not seem to affect the choice of the English vowel the subjects selected as equivalent, with one exception. Only lax German vowels were associated with their unrounded counterparts, e.g., German /Y/ with English /U/, and /œ/ with /ə/ as in *the*, /ɚ/ as in *bird*, and /ɛ/ as in *set*. Though tense vowels in German are long underlyingly,

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[18]Strange et al. (2005), on the other hand, obtained results that led them to label German /U/ and /ø/ as uncategorizable according to PAM and not assimilated to an L1 category according to SLM, thus predicting that L2 learners of these German vowels would acquire them relatively easily.

[19]A results chart in the appendix of Felty's (2007) dissertation shows a slight confusion with <oy>, but he does not discuss it.

length did not impact which vowels subjects were choosing as equivalent. In general, subjects tended to select short vowels in English as equivalent to the German vowels, even when the German vowel was long. This may be due to the lesser differentiation in vowel length in English than in German, as noted by Bohn (1995) and others.

The finding that some lax German vowels apparently obtained no clear modal choice in this cross-language perception study, as predicted in Chapter 2, points to confusion in the subjects' perception. It then becomes unclear what they are listening for and indicates that subjects may also have difficulty distinguishing such vowels in a categorical perception task, which would affirm Strange & Bohn's (1998) results from their study investigating native listeners' identification of electronically manipulated syllables. They found that German mid and low tense vowels in electronically manipulated syllables were more easily identified when they were long. Similarly, Polka (1995) observed that English speaking listeners performed native-like in their discrimination of the tense German /y/-/u/ contrast, whereas they failed in the lax pair /Y/-/U/. (The latter was also obtained by Jacewicz (1999) in her study for English learners of German.) This would indicate difficulties in both, cross-language and categorical, perception tasks. Such findings contradict Kingston (2003), however, who observed a poorer performance for the discrimination by English listeners of tense German vowels than of lax vowels.

5.2 Research Question 2: Does cross-language perception/mapping change as learners gain more experience? and Does an extended stay in the target country of at least 12 months make a difference in the perception of German vowels?

The answer to this research question depends on the vowels and in some cases the phonetic context. As seen, for some vowels, experience played no role in how subjects mapped the German vowels to their English vowel system, e.g., German /i:/ was mapped most frequently to English /i/ by subjects in all four groups. For other vowels, though, including three of the four "new" vowels, i.e., /Y/, /œ/ and /ø:/, but not /y:/, experience did affect how subjects viewed the German vowels in comparison with their English system. In these cases, subjects tended to choose a single modal vowel as they became more experienced.

More experienced learners, regardless of time in a German-speaking country, viewed German vowels differently than the less experienced subjects. They were generally more consistent, with some exceptions, in the choice of English vowels they mapped the German vowels onto. Specifically those in their fifth semester of German or above (Group 3) performed in a similar manner to those (Group 4) who had spent at least 12 months in a German-speaking country, and the two less experienced groups, namely subjects without knowledge of German (Group 1) and those who were in their third semester of German (Group 2), also performed in a similar manner.

As subjects became more advanced, their cross-language perception changed depending on the vowels and in some cases the phonetic context. For some vowels, experience played no role in how subjects mapped the German vowels to their English vowel system. However, for other vowels, including three of the four "new" vowels, namely /Y/,

/œ/ and /ø:/, experience did affect how subjects viewed the German vowels in comparison with their English system. In these cases, subjects tended to choose a single modal vowel more consistently as they became more experienced.

Time abroad, on the other hand, did not seem to make a significant difference between the more experienced groups, namely 3 and 4, in terms of how they viewed the German vowels in comparison to their English vowels. Those in their fifth semester of German or above (Group 3) mapped the German vowels to their English vowels in a similar manner to those who had spent at least 12 months (Group 4) in a German-speaking country. This appears to indicate that more experienced learners, regardless of time in country, view the German vowels differently than the less experienced subjects. In particular, they are generally more consistent in their modal choice than the less experienced subjects, with some contextual exceptions, in how they view German vowels. Secondly, groups did not differ significantly in the way they performed in the goodness rating task (see Section 5.4).

The present results confirm what Bohn & Flege (1990) observed in the perception of English vowels by German listeners and Guion, Flege, Akahane-Yamada, & Pruitt (2000) for the perception of English vowels by Japanese listeners, that for some vowels, inexperienced subjects and experienced subjects performed alike in the perception of German vowels (Pattern 1). If one can compare perception results with production results and reverse L1 and L2, the results for German /I/, /i/, and /ɛ/ fit with Bohn & Flege's (1992) results who observed that German learners of English at two different experience levels did not differ in their unnative-like production of the English vowels /I/, /i/, and /ɛ/, which have German equivalents.

Bohn & Flege (1990) also saw a distinction between newly acquired L2 sounds and those that are in both the L2 and L1. They state that "experience does not affect perception of /I/ and /i/ in English by Germans, but experience affects /ɛ/ and /æ/ perception" (p. 322). They caution further that other variables besides experience must be considered since there are some learners who quickly learn a new L2 sound and others who do not learn it at all. Conversely, in their examination of current models proposed for L2 speech perception Guion et al. (2000) conclude that experience does indeed lead to better, or more accurate, perception. Similarly, Levy & Strange (2008) observed that experienced English speaking subjects performed better on a categorical discrimination task of Parisian French vowels. Though cross-language perception studies, like the present study, do not consider whether a subject's perception of an L2 sound is right or wrong, a more consistent selection of the modal choice in this study for more advanced groups can be paralleled to an understanding or perception of sounds in L2 that is closer to the target and less influenced by the subject's L1, as indicated by Guion et al. (2000), and that they created a category.

Regarding the lack of difference found between those subjects who are advanced but had never stayed in the target country and those who had stayed a minimum of 12 months, one can refer to Aoyama, Flege, Guion, Akahane-Yamada, & Yamada's (2004) study in which they also saw little improvement for Japanese adults over a one-year period staying in the United States, and to DeKeyser's (1990) results who obtained no difference in proficiency between students spending a semester in Spain and students who remained at their home university in the United States. It is possible that different pairings of L1 and L2 will create different problems and perhaps different time frames for acquiring the L2 sounds.

How students spend their time during a study abroad will also influence their speech acquisition. O'Brien (2003) found that, as time went on, some of the English-speaking students in Germany limited their use of the L2 more and more out of frustration and being tired of being corrected by native Germans. She also indicated that those students going abroad at a higher proficiency level do not make as much progress. It is also possible though, that a difference in perception between subjects who spent time in the L2 country and those who did not obtains only after a much longer stay, several years as Bohn & Flege (1997) remark.

5.3 Research Question 3: How does phonetic context (of a following consonant) affect the cross-language perception of German vowels by English speaking listeners?

As predicted, the subjects' overall selection of the modal choice for the majority of German vowels tested in this study, namely /a/, /ɛ/, /e:/, /I/, /ɔ/, /U/, /Y/, and /y:/, was affected by the phonetic context. These findings match results in other studies such as Schmidt (1996) and Trofimovich et. al. (2001), who have likewise shown that phonetic context influenced cross-language perception in Korean learners of English.

For the vowels in the present study in which phonetic context played a role, /r/ had the most impact, followed by /n/. As Hillenbrand, Clark, & Neary (2001) observed, the place of articulation in contexts plays an important role in vowel identification. It is not surprising then that in this study, the /r/ context (recall that NAE /ɹ/ and German /r/ differ greatly) affected the perception of German vowels in a significant manner, also because in English many vowels are neutralized before /ɹ/. As the reader will recall, rhotacized schwa (/ə˞/), in which learners add an /r/-quality to the schwa vowel, as it occurs in L1 words like English

occur, *stir*, and *her*, was a common secondary choice for the high front rounded and unrounded vowels, as well as for the *ö* vowels, and occured mostly in the /r/ context. This accounts for why so many students say /ø:/ with an extra /r/ quality (Moulton, 1962) because that is indeed how many subjects are hearing that vowel.

For other vowels in the present study, context did not have a significant effect on the overall mapping of German vowels to English vowels. While the overall selection of the modal choice for some rounded vowels, namely /ɔ/, /U/, /Y/, and /y:/, as well as /ɛ/ and /e:/, was affected by phonetic context, this was not the case for other rounded vowels, namely /o:/, /u:/, /œ/ and /ø:/. These results contradict Jacewicz (1999) who observed that context affected the perception of rounded, but not of unrounded vowels of German vowels by English listeners in her study. The present findings further contradict Strange et al. (2005) who observed no context effect on the categorization consistency of English speaking subjects listening to North German vowels. This contradiction may be due to differences between phonetic contexts being used in the various studies. Additionally, in the present study, phonetic context did not affect each subject group equally at all times. This seems to further confirm the findings of Trofimovich et. al.(2001) who found that, depending on the vowel, advanced learners put aside unimportant differences in their cross-language mapping of sounds and did not see L2 allophones as separate L1 sounds.

5.4 Results for Likeness Rating

No significant difference among the groups was found for the likeness rating for any of the vowels. The present study's findings confirms Trofimovich et al.'s (2001) results who, likewise, observed no difference in likeness ratings according to experience.

Phonetic contexts did play a role in the goodness ratings, where, for example, matches were given a lesser score in the /r/ context, demonstrating the subjects did not find the English vowels a good match for the German vowels, however, no statistics were run on phonetic context affecting goodness ratings for this study. Such results, if they were statistically significant, are in line with Schmidt (1996) whose mean goodness ratings of English vowels by Korean subjects varied according to phonetic context. Strange et al. (2005), likewise, obtained median goodness ratings of North German vowels by English listeners varying according to context. Furthermore, Trofimovich et al. (2001) observed that Korean learners of English were affected by phonetic contexts in their similarity ratings.

Likewise, in the current study, when subjects selected the modal choice, they also usually gave a higher goodness rating to this English equivalent for the German vowel in question than for a secondary choice. Lower goodness rating scores would seem to indicate a support for Flege's (1995) SLM where new L2 sounds, e.g., /œ/, are not identified with any L1 category because there is no "good" match. In such cases, subjects notice a distinction between the two sounds.This ability to sense that the L1 vowel is not a good match could then facilitate them being able to develop a new category in categorical perception.

In the present study, the average goodness ratings scores by all subjects overall for the *ü* sounds were 3.5 for /Y/ and 4.1 for /y:/. These were somewhat different from those for

the "similar" German sounds (between 2.9 for /ɔ/ and 5.2 for /i:/). On a 7-point Likert scale these somewhat intermediate medium ratings between roughly 3 and 5, i.e., neither "poor" nor "native-like" ratings, indicate that subjects did not perceive these German vowels as being too poor or too native sounding (Strange et al., 2005). Polka & Bohn (1996) obtained comparable results for goodness ratings in their categorical discrimination study on the German /u/-/y/ contrast. German /u/ and /y/, as equivalents for English /u/, received a mean rating of 3.89 and 2.8 (on a 7-point scale) respectively. Polka & Bohn differentiate the ratings for the /U/-/Y/ contrast, however, as significant and call this a Category Goodness assimilation according to PAM (Best, 1995), with German /U/ being rated as a better match than German /Y/ for the English equivalent /U/. In the present study, even /ø:/ received an average overall rating of 2.8; but German /œ/ obtained average overall goodness ratings for its top four choices between only 1.5 for English /ɛ/ and 2.2 for /ʌ/. Furthermore, as the reader will recall, ratings for the top responses for German /œ/ changed with the experience level of the subjects. The present findings differ from Strange et al. (2004) who observed high median ratings by English listeners for German /œ/ in syllable stimuli (5 out of 7) and lower ratings for /y/, /Y/ and /ø/ at 2, 1, and 3 respectively. For citation-form stimuli (which is more similar to the current study) the median ratings Strange et al. obtained were 4 for /œ/ and 2, 3, and 2 for /y/, /Y/ and /ø/ respectively.

Another difference between the current study and Strange et al. (2004) is found in the goodness rating for German /ɔ/, at 2.9 in this study, but in Strange et al. at 5. However, Strange et al. collapsed English /a:/ and /o:/ in their results, whereas I collapsed English /ɔ/ and /o/. For other vowels, results from the present study are comparable to Strange et al.'s

(2004) findings. For instance, for German /u:/, I observed an average goodness rating of 4.2 for its English equivalent /u/ which is similar to Strange et al.'s (2004) median rating of 4 for the same vowel. Likewise, German [i] and [a] obtained similarly high ratings in both studies. Furthermore, Strange et al. (2005) obtained high median goodness ratings (from 4, for /Y/, /œ/, /U/, and /ɔ/, to 7 out of 7 for /i/) for all German vowels rated by English listeners. (For this study, however, the statistical significance for the goodness rating results compared by vowels was not analyzed.)

5.5 Implications

The study has a number of implications. *First*, the study points out the potential difficulties that L2 learners will have with German vowels, and in particular which English vowels may cause interference in acquiring L2 perception. If, for instance, subjects select one English response option most frequently for a certain German vowel and also give a very good rating, it leads to show that subjects would have little difficulty in developing an L2 category for that sound, which is necessary for successful L2 acquisition, e.g., German /i:/. If, however, subjects are confused and there is no single modal choice for a certain vowel, and the English vowels they associate with the German vowels receive low goodness ratings, this can imply a lack or difficulty in categorical perception, i.e., German /Y/, /œ/, and /ø:/. These insights could help improve perceptual and production training so that potential trouble areas can be better and more directly addressed (cf. Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997; Derwing, 2003; Leather, 1997). Particularly, L2 learners need to become aware of the differences and similarities between L1 and L2 sounds so they can

start to develop separate categories for new vowels in perception and production (cf. Guion & Pederson, 2007).

Second, the study provides evidence that, although subjects mapped "similar" vowels to their L1 equivalents most frequently, as SLM (Flege, 1995) and PAM (Best, 1995) would predict, these theories still do not provide a complete account for why some "similar" vowels would be assimilated to L1 sounds that are not obvious equivalents, e.g., English /ə/ for German /I/ or English /ɔI/ for German /U/.

Third, results from the study affirm that context affects vowel perception and needs to be investigated more thoroughly and considered in perception models, e.g., PAM (Best, 1995), PAM-L2 (Best & Tyler, 2007) and SLM (Flege, 1995), which still do not address these adequately.

Fourth, as different patterns obtained for the various vowels tested, the study results affirm that some sounds are more clearly defined and more easily perceived than others, as seen in clearer modal choices (even in different phonetic contexts) and higher goodness ratings.

5.6 Limitations

In retrospect, this study could have been improved in several ways. For instance, this study examined a whole range of German monophthong vowels and offered the whole range of English vowels as possible equivalent choices, which may have been somewhat overwhelming for some subjects. Furthermore, the tokens differed only by the vowel in the first syllable, rendering the listening task somewhat monotone. Therefore, a limited list of English choices, a smaller subset of German vowels, and possibly variations in the beginning

consonant of each German word might provide for a less tiring testing situation. Another challenge was the short duration of each token, which was hopefully partially compensated for by playing each word twice in succession.

Due to the small sample size in some groups, variables like age, gender, non-sense vs. real words, knowledge of linguistics, etc. were not analyzed. Furthermore, I did not control for differences in study abroad vs. church mission, e.g., exposure to different L2 dialects and how much English was spoken during the stay abroad, etc. Besides this, not all subjects were from the same dialect area and, therefore, may have differences in their L1 vowel inventories.

5.7 Future Directions

In the future, this study could be expanded to include the following areas of research:

First, the results presented in this study examine only the modal choice(s) for the German vowels. Examining the significance of all vowel choices made by the subjects will provide a more complete picture. Of special interest in this regard is the selection of English /ɔI/ for the rounded (front and back) German vowels.

Second, Group 2, or L2 learners at the end of their third semester of learning the language, deserve further attention as subjects in this group seem to be in a period of transition–sometimes behaving like the naive group (Group 1), while in other cases behaving more like Groups 3 and 4. It is possible that a teacher effect has to be taken into account with this group as well because subjects from Group 2 were recruited from two intact classes taught by the same instructor; whereas subjects from Groups 3 and 4 came from a variety of

classes and instructors.

Third, vowel mergers in a subjects' L1 dialect (cf. Beddor & Gottfried, 1995; Smith, Gardner, Whitlock, & Fitzner, 2007) may also impact their vowel choices. Some of the subjects were native Utahns whose dialect has a number of mergers in words, such as where *pin* and *pen* are produced in a similar fashion. It would be interesting to examine what role the L1 dialect plays (Best & Tyler, 2007) in the cross-language perception tasks of this study, e.g., confusion between /i:/ and /e/.

Fourth, future research could also consider the question of how a subject's cross-language perception correlates to his/her categorical perception. If subjects, for example, map their front-rounded vowels onto one single English vowel, could that be an insight into whether they hear these vowels in German as one single vowel or whether they have been able to create separate categories for each of these vowels, both perceptually and productively? In sum, how does a subject's cross-language perception correlate with his/her categorical perception?

Fifth, to examine if results would vary for different speakers of the German words, more than two speakers would have to be recorded for the stimuli. Neary (1989), for example, found that subjects in a vowel task made fewer mistakes when stimuli were heard in a blocked fashion, i.e., as a set produced by the same speaker and then as another set by a different speaker, than when they heard stimuli in a random order, mixed for the different speakers. Consequently, testing the same sets of stimuli in a blocked instead of random order might deliver different results.

Sixth, future studies would be needed to examine further what influences subjects more in their perception of new versus similar vowels, vowel quality (spectral features) or

duration; and whether one is playing a role over the other as found by Bohn (1995), Bohn & Flege (1997), Escuerdo & Boersma (2005) and Morrison (2002) and others for different levels of experience. This could be tested by presenting manipulated tokens.

5.8 Conclusion

Even though not all of the results in this experiment were significant, the results do provide valuable insights, including the affirmation of previous studies' findings that phonetic context affects cross-language perception, that certain patterns in the identification of German vowels by non-native listeners obtain, and that experience can affect their perception as well. In addition to these insights, this experiment discovered data, e.g., the /ɔI/confusion, that also merit further examination. With this study and its results, I hope to have provided added incentive for other researchers to explore more phonetic contexts in cross-language vowel perception, as well as to take a fresh look at goodness ratings and to further investigate the effect of different types of experience on perception.

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Appendix A

Subjects' Dialect Background Information

Since the biographical questionnaire also asked subjects to state where they had lived in the United States, their dialect (according to Labov et al., 2006; see Table 12) was determined by most time spent in one area between ages 8-13. If subjects spent time in various areas, the dialect is listed as *Other*. Speakers from Utah were furthermore distinguished from the other speakers of the Western dialect. No subjects came from New England, New York, North Central, The North, or Western Pennsylvania.

Table 12. Dialect Areas in Which Subjects Grew Up.

Group	Inland North	Mid Atlantic	Midland	The South	Utah	The West	Other
1	1	-	1	1	10	19	12
2	-	-	1	-	3	6	6
3	-	-	1	3	3	3	5
4	1	5	1	4	8	12	12
All	2	5	4	8	24	40	35

Subjects further stated (see Table 13) whether they thought the words *bought* and *pot*, as well as *merry*, *Mary* and *marry* sound the same. Most of them answered yes to this question. Subjects were also asked to express their perception of the cross-language similarity between English and German. Here, Group 1 (without any experience learning German) and Group 4 (those who had lived in a German-speaking country) gave a lower

rating than Groups 2 and 3, where a score of zero meant the subjects thought the two languages to not be similar at all, and a score of 3 meant that subjects thought English and German to be very similar.

Table 13. Subjects perception of *bought* and *pot* or *merry*, *Mary* and *marry* sounding the same expressed as frequencies; as well as subjects' average rating scores of the cross-language similarity between English and German.

	bought/pot same		*merry, Mary, marry* same			Cross-language similarity
Group	yes	no	yes	no	no answer	Average score (Range 0-3)
1 (44)	44	0	28	16	0	0.5 (0-2)
2 (16)	13	3	9	7	0	2.8 (1-3)
3 (15)	15	0	12	3	0	2.5 (1-3)
4 (43)	39	4	34	6	3	1.8 (0-3)
All (118)	111	7	83	32	3	1.9 (0-3)

Note. Numbers in parentheses and for *bought/pot* and *merry, Mary, marry* indicate numbers of subjects.

Appendix B

Complete listing of stimuli that were presented to the subjects: Lists 1 through 4 contain a total of 60 words. As all of these were recorded by two speakers, the number of different tokens is 120, each appearing twice in the study, providing 240 stimuli.

List 1	List 2	List 3	List 4
Baate	Bahre	bahne	Bahschem
bäte	Barren	banne	Basche
Batte	Bären	bähne	bähsche
bete	Beere	Behne	behsche
Bette	Berren	Bennen	besche
Biete	Biere	Biene	biesche
Bitte	Birre	binnen	bischel
Bote	bohre	Bohne	bohsche
böte	Borren	Bonne	Bosche
Botte	Böhre	Böhne	böhsche
Bötte	Börre	bönne	Bösche
buhte	Buren	Buhne	buhsche
Büte	Burren	bunne	Busche
Butte	Bühren	Bühne	Bühsche
Bütte	bürren	bünnen	Büsche

Appendix C

Script for Study Tasks

To begin the experiment, you will hear a number of German words. You will be asked to identify the vowel in the first syllable of each word by associating it with the best matching vowel from a list of word of English words presented to you on the computer screen, each with a corresponding number. Each word will be presented once. After hearing the word, press the number on the keyboard which corresponds to the number of the English word whose vowel sounds closest to the one in the German word you heard. You may take your time, but once you have selected a response, you may not change it.

Next, a new screen will appear asking you to rate how much the vowel in the first syllable of this German word sounds like the vowel in the English word you selected on a scale from 1 to 7, 1 stands for "not similar at all" and 7 stands for "a total match."

After you have entered your response, the sequence will start over and you will hear the next German word and, once again, will be asked to identify the vowel in the first syllable with the best matching vowel in an English word from the list on-screen and then rate how much alike these vowels are.

There will be 10 practice questions to familiarize yourself with the task before we begin recording your responses.

[At the end:]

Thank you for your participation in this study. If you are interested in hearing the results of the study, I will be happy to contact you.

Appendix D

Oral Explanation of Instructions

The following text was heard spoken by a female voice as the screen with English word options appeared:

The list of options for English words that represent the vowels which you can choose from:

Remember: You are going to match the German vowels that you will hear by choosing the closest English vowels represented by these words. Please focus only on the vowels and not how the words begin or end.

Option A: beat
Option B: fit
Option C: bait
Option D: set
Option E: cat
Option F: paw
Option G: bored
Option H: coat
Option I: put
Option J: clue
Option K: cut
Option L: bird
Option M: kite
Option N: Boyd
Option O: cloud
Option P: the

Very important: This experiment is not looking for right–or wrong–answers. Therefore, go by your first impression of the German vowel and match it with an English vowel.
The estimated test time is 45-60 minutes, working through each item swiftly, in the manner mentioned above.
Once you have selected your answer, you may not change it.

Stimulus: Go by your first impression.

Appendix E

Name: _____
Meeting time: _____
For your appointment, please come to B013 JFSB
If you can't make your appointment, please e-mail laurasmith@byu.edu or lore@mstar2.net

BIOGRAPHICAL QUESTIONNAIRE

This questionnaire concerns your language experiences over the course of your lifetime. Feel free to elaborate where you think it would be helpful to the study. All responses are confidential.
Thank you again for your participation.

Name: _____ Gender: M ____ F ____

Home telephone: _____ email: _____

1. a. Where were you born? _____
   b. Do you feel you speak Standard North American English? Yes No
   c. Do the words bought and pot rhyme for you? Yes No
   d. Are the words Mary, Merry and Marry the same for you? Yes No
      If not, describe which ones are different, which are the same: _____
      _____

2. Are you a native speaker of German? Yes No
   If not, please continue with question 3.
   If so, how long have you been living in the United States? _____
   What percentage of each day do you spend speaking German? _____
   Please continue with question 3.

3. If you answered >no= to the above, how long have you been speaking German? _____
   What is your native language? _____
   How would you rate your overall ability in German?
   beginner intermediate advanced near-native
   How would you rate your ability to speak German?
   beginner intermediate advanced near-native
   How would you rate your ability to read German?
   beginner intermediate advanced near-native
   How would you rate your ability to understand spoken German?
   beginner intermediate advanced near-native
   How would you rate your German writing ability?
   beginner intermediate advanced near-native

4. How often do you read German?

never____ sometimes ____ often _____ very often _____

Which types of texts do you read in German?

letters_____ newspapers / magazines ____books ____ other _____

How many books do you read in German every year? _____

5. In which languages other than English and German do you have proficiency?

6. At what age(s) did you start learning each of your foreign languages? ('Start learning' = first exposure of 6 months or more, or first study of one semester or more)

7. On a scale of 1 (least native-like) to 10 (most native-like), rate your oral proficiency in each of your languages, including your native language.

8. On a scale of 1 (least native-like) to 10 (most native-like), rate your command of grammar in each of your languages, including your native language.

9. On a scale of 1 (least native-like) to 10 (most native-like), rate your command of vocabulary in each of your languages, including your native language.

10. On a scale of 1 (least important) to 10 (most important), rate the importance to you of the languages you know, including your native language.

11. On a scale of 1 (least important) to 10 (most important), rate the importance to you of:

_____Native-like pronunciation in German
_____Grammatical accuracy in German
_____Knowledge of German vocabulary
_____Knowledge of social aspects of German language use
_____General fluency in German
_____Being able to use German with ease in routine interactions with strangers
_____Being able to use German with ease on the job
_____Being able to use German with ease with friends and family
_____Being treated as an equal by native German speakers
_____Being mistaken for a native speaker of German

12. In the boxes below, indicate the use of German and other languages during the past 6 months.

Check the percentages that apply to your personal experience. The numbers should total 100%.

At Home	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
German											
English											
Other											

Check the percentages that apply to your personal experience. The numbers should total 100%.

At School	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
German											
English											
Other											

Check the percentages that apply to your personal experience. The numbers should total 100%.

With Friends	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
German											
English											
Other											

Check the percentages that apply to your personal experience. The numbers should total 100%.

Elsewhere	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
German											
English											
Other											

Check the percentages that apply in your personal experience. The numbers should total 100%.

Overall	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
German											
English											
Other											

13. Do you identify more closely with the German culture or the American culture?

14. Where have you lived? (six months' stay minimum) Indicate the cities and periods below.
ENGLISH-SPEAKING (Use back of sheet if necessary to list more places)

I lived in _____ from _____ to _____

I lived in _____ from _____ to _____

I lived in _____ from _____ to _____

14. (continued) Where have you lived? (six months' stay minimum) Indicate the cities and periods
below. (Use back of sheet if necessary to list more places)
GERMAN-SPEAKING

I lived in _____ from _____ to _____

I lived in _____ from _____ to _____

I lived in _____ from _____ to _____

15. At what age were you first exposed to your non-native language in school or college?

16. Please indicate the approximate periods in which you studied German. Circle "school" or "college" as appropriate.

In school / college, I studied German from _____ until _____

In school / college, I studied German from _____ until _____

In school / college, I studied German from _____ until _____

17. All told, for how many years did you study German? _____

18. On a scale of 1 (not at all motivated) to 10 (highly motivated), rate your motivation to learn German. _____

19. At what age were you first exposed to the German language on a daily basis? _____

20. At what age did you begin to use German on a daily basis? _____

21. At what age did you begin to speak German with ease? _____

22. Do you feel that you have a special talent for learning languages? Please elaborate.

23. What aspects of your mental makeup helped you learn German?
Use a scale of 1 (least helpful) to 10 (most helpful).

_____Memory for vocabulary
_____Memory for grammatical features
_____An ability to imitate language sounds
_____An ability to analyze language structures
_____An "ear" for language sounds
_____Desire to learn English / German

24. Did you learn German by "ear" or by "eye"? That is, did you rely more on reading or on listening? Please try to quantify this relationship by estimating the relative contributions of:

Reading: _____ % Listening: _____ %.

25. a. How often do you write (personal or business correspondence) in German?

On a daily basis Quite often Sometimes Not often Almost never

b. How many hours do you spend each day writing emails in German? _____ hours

c.How many hours a day do you spend writing emails in English? _____ hours

26. How is your German spelling? Excellent Very good Average Not very good Poor

27. a. How similar do you feel that German and English are to one another?

b. Do you feel this similarity or dissimilarity has helped or hinder your learning of German?

c. Or if you have not learned German, do you think this similarity or dissimilarity would help or hinder your ability to learn German?

28. a. Have you taken any linguistics courses? Yes No
b. If so, which ones? Please provide course names rather than numbers:

29. I would appreciate any comments or other information you feel would be useful:

Appendix F

Percentages for subjects' choices of English equivalents for German vowels heard.

Percentages for	German Vowels														
English choices	i:	I	e:	ɛ	ɛ:	a:	a	ɔ	o:	U	u:	Y	y:	œ	ø:
a) beat /i/	**86.42**	1.86	**16.94**	3.41	3.98	0.98	0.52	0.21	0.05	0.05	0	0.26	1.24	0.83	0.67
b) fit /I/	3.46	**68.08**	2.22	1.34	0.52	0	0	0.05	0.1	0.21	0	**7.59**	0.41	0.57	0.67
c) bait /e/	0.93	1.24	**61.36**	**6.97**	**18.44**	2.17	2.89	0.62	0.1	0.05	0	0.21	0.05	1.34	0.36
d) set /ɛ/	1.08	**7.59**	**12.71**	**82.18**	**59.61**	0.36	0.62	0.15	0.05	0.21	0.1	1.76	0.36	**14**	1.76
e) cat /æ/	0	0.1	0.67	1.24	**8.73**	**7.49**	**11.52**	0.72	0	0.1	0.1	0	0	0.46	0
f) paw /a/	0.05	0.67	0.46	0.77	1.34	**84.56**	**63.39**	**38.33**	1.19	1.19	0.36	0.26	0.15	1.91	0.36
g) bored /ɔ/	0.21	1.08	0.26	0.31	0.52	0.72	0.62	**24.43**	**53.05**	**17.61**	**5.32**	3.51	1.55	5.99	4.18
h) coat /o/	0	0.1	0	0.05	0.1	0.26	0.15	**7.9**	**23.97**	3.98	2.94	0.21	0.36	0.83	0.36
i) put /U/	0.41	2.94	0.05	0.1	0.05	0.1	0.72	2.32	2.12	**49.8**	**22.62**	**45.35**	**19.89**	**21.8**	**32.49**
j) clue /u/	0.88	1.03	0.05	0.21	0.05	0.1	0.1	0.21	0.77	**11.26**	**61.57**	**16.79**	**66.06**	3.82	**18.65**
k) cut /ʌ/	0	0.46	0.05	0.1	0.1	0.31	**8.73**	**13.64**	0.62	4.65	0.83	5.73	1.81	**19.11**	3.51
l) bird /ɚ/	**4.65**	**12.55**	3.51	1.7	3.41	0.46	0.21	0.26	0.36	1.91	1.14	**13.48**	**5.53**	**20.14**	**31.4**
m) kite /ai/	0.05	0.52	0.05	0.1	0.05	0.05	0.1	0.05	0	0.1	0.05	0.15	0	0	0.05
n) Boyd /ɔI/	0	0.21	0.05	0.05	0.1	0.41	0.31	5.37	**16.53**	6.04	4.13	1.96	1.29	1.91	3.05
o) cloud /au/	0.1	0.1	0.05	0	0	0.83	0.57	2.07	0.88	1.34	0.57	0.62	0.77	0.67	1.03
p) the /ə/	1.76	1.5	1.03	1.45	3	1.19	4.55	3.67	0.21	1.5	0.26	2.12	0.52	6.56	1.44

Subjects in the piloting stage of this test expressed the desire for an /r/ environment for the /o/, hence it was included as a choice.
The /o/ in 'bored' and 'coat' are the same vowel, though, and are collapsed in the group analysis.
Frequencies in bold are examined in the analysis by group and environment.
The frequencies for 'coat' are added to those for 'bored'.

Appendix G

Consent Form

Consent to be a Research Subject

Introduction

This study is conducted under the direction of Dr. Laura Catharine Smith and Lore Schultheiss, a graduate student in Second Language Acquisition at Brigham Young University to study the perception of German vowels by native speakers of American English. You were selected to participate because you are a native speaker of Utah English (or more generally North American English) and fit one of the following criteria: 1) you have no knowledge of German, 2) you are taking a third or fifth semester German course without experience living in a German-speaking environment or 3) you are a current student of German who has spent at least one year in a German speaking country within the last five years.

Procedures

You will report to B013 JFSB to meet the researchers. Your participation in the study involves a single meeting with the researchers lasting approximately 45-60 minutes during which you will be asked to perform one task with two steps. First you will hear a German word by means of headphones. On the computer screen, you will see a list of English words and you will be asked to match the vowel in the first syllable of the German word with the English word containing the vowel most similar to the German vowel. After matching the German word to the English word, you will be asked to rate how closely the German vowel you identified resembles the vowel in the English word you selected on the computer screen. The first and second steps will be performed alternately for each German word you hear. You will also be asked to fill out a biographical questionnaire. The above-outlined procedures are commonly used by the scientific community to study speech perception. The researchers are not looking for a specific "correct" response. You are thus asked to respond as you normally would.

Risks/Discomforts

The study involves minimal risks or discomfort to you. You may feel self-conscious about how you identify or rate a German vowel or because you may not recognize some words you are asked to hear. The researchers will be sensitive to those who may become uncomfortable. Moreover, your participation will have no effect on the grade you receive in any German course this semester or in the future and your individual results will not be reported to non-research personnel.

Benefits

There are no direct benefits to subjects from participation in this study. However, such knowledge will help us understand the how English learners of German hear German vowels and thereby help us train students in their understanding of German vowels. Knowledge gained by this research will guide foreign language teachers in the design of listening exercises for German vowels.

Confidentiality

All information provided, including questionnaires and response data, will remain confidential. Individuals will never be identified other than by descriptors such as gender, age, and prior learning experiences. Otherwise data will only be presented in transcripts. Questionnaires and data files will be stored in a locked storage cabinet and only those directly involved in the research will have access to them. As a subject, you will have access to your data. All questionnaires and response data will be destroyed after 10 years. The data will primarily be used for this study; however, the

data will also be used in future research for comparison with future studies.

Compensation

As compensation for your participation in this study, you will receive an edible treat.

Participation

Participation in this research study is voluntary. You have the right to withdraw at anytime or refuse to participate entirely without jeopardy to your class status, grade or standing with the university. If you do withdraw you will still receive compensation for your participation. You may also refuse to answer any questions you do not feel comfortable with.

Questions about the Research

If you have questions regarding this study, you may contact Dr. Laura Catharine Smith at 422-3513, laurasmith@byu.edu. or Lore Schultheiss at 426-5207, lore@mstar2.net.

Questions about your Rights as Research Participants

If you have questions you do not feel comfortable asking the researchers, you may contact Dr. Christopher Dromey, IRB Chair, 422-6461, 133 TLRB, dromey@byu.edu.

I have read, understood, and received a copy of the above consent form and desire of my own free will and volition to participate in this study.

Signature:_____ Date: _____