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Similarity, Cross-linguistic Influence and Preferences in Non-Native Vowel Perception

An experimental cross-language comparison of German vowel
identification by non-native listeners

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Abstract

This dissertation presents an empirical study on German vowel identification by non-native listeners. The central tenet of the study is that the acquisition of second language phonetics and phonology is conditioned by three major forces: (1) *language-specific* phonological and phonetic patterns and *cross-linguistic influence* mainly from the learners' first language L1 on the target language L2, (2) *intra-lingual similarity* of L2 sounds as perceived by L2 learners, and (3) the influence of *universal preferences* and *biases* for particular sound patterns.

Similarity is one of the central concepts in current models of the acquisition of second language phonology. The operationalization of this construct, however, has so far not received sufficient attention. This study aims to integrate contributions from second language acquisition research, empirical studies in acoustic and articulatory phonetics and theoretical approaches from cognitive psychology for a better understanding of the diverse phonetic and cognitive aspects of similarity and its role in non-native vowel perception.

The aim of the experimental part is to investigate the perception of German vowel contrasts by L2 learners from diverse language backgrounds with smaller or larger vowel inventories. Methods of descriptive statistics and higher statistical procedures such as Hierarchical Clustering and Multidimensional Scaling are used to make inferences about inter-category distances and perceived similarity, confusion probability and the direction of perceptual substitutions.

The German vowel system is described in terms of five major classes according to the location of narrowing in the vocal tract (constriction location, cf. Wood 1979): pharyngeal /ɑ α:/, uvular /ɔ o:/, velar /ʊ u:/, mid-palatal /ɛ ε: e: œ ø:/ and pre-palatal /ɪ i: ʏ y:/ vowels are further differentiated by mandibular aperture, rounding, constriction degree and phonemic length. The articulatory description of German vowel categories is supplemented with an acoustic analysis of the input stimuli from the perception experiment.

The empirical basis of the study is a corpus of vowel confusion data collected in an identification experiment performed with 173 non-native listeners from ten L1 sub-samples and 18 German natives (control group). Starting with a contrastive analysis for each of the ten L2 learners' native languages, the empirical material is then evaluated on a language-specific, a vowel-specific and a learner-related level. In a cross-language comparison, typical patterns of wrong identifications (*difficulties*), category confusion and direction of perceptual substitutions (*preferences*) are discussed. Moreover, *perceptual vowel maps*, i.e. spatial

representation of the high-dimensional perceptual vowel space, are derived for each of the ten language sub-samples by means of Multidimensional Scaling (MDS).

Confusion matrices and perceptual vowel maps – spatial MDS representations of the L2 listeners' perceptual vowel space – summarize the results of the identification task for each of the language sub-samples and reveal language-specific as well as more common cross-linguistic patterns of the *difficulties* associated with specific contrasts, typical patterns of *perceptual confusion* and *preferences* for specific response categories. Moreover, the data reveal several *asymmetries* in the direction of perceptual substitution processes (perceptual *bias*). Within a given vowel class, some input categories cause more difficulties than others and some qualities attract more responses than others. While *a*-vowels, /i:/, /u:/, /ɛ/ and /ɔ/ are particularly stable, most difficulties are observed with contrasts of front rounded /y: ʏ ø: œ/ vowels, /e:/ and /ɛ:/. Several sub-samples show a strong tendency of /i:/, /u:/ and /y:/ to attract responses for /e:/-, /o:/- and /ø:/-stimuli, respectively, whereas perceptual substitutions in the opposite direction are rather uncommon. For front rounded qualities, the MDS maps of the listeners' perceptual space reveal language-specific “similarity clusters” with respect to substitutions of front rounded vowels with either back rounded or front non-rounded categories.

The study contributes to the modelling of similarity in second language acquisition in three ways: First, it demonstrates the necessity to distinguish *inter*-language similarity from *intra*-language similarity and phonetic distance and similarity from psychological similarity. Second, it demonstrates empirically the non-linear and language-specific relation between articulatory or acoustic properties of vowel stimuli and the L2 listeners' responses. Finally, it provides empirically grounded ways of operationalizing *perceived similarity* between L2 vowel categories in terms of similarity scores and distances in spatial MDS representations.

The study demonstrates that perceived similarity between German vowel categories cannot be predicted directly from physical properties of the acoustic signal but is determined by the listener's attentional tuning to specific dimensions of the perceptual vowel space and by language-specific and more general physical and cognitive *biases* associated with stimuli as well as responses.

Perceived similarity s_{ij} between vowel categories of the target language is modelled as the result of the complex interaction of phonetic proximity p_{ij} , stimuli biases b_i and response biases b_j ($s_{ij} = p_{ij} * b_i * b_j$). *Biases* vary according to characteristics of the acoustic signal, the set of stimuli and response categories and the listeners' language experience (in L1, L2, Ln), L2 proficiency and their individual conception of the target language vowel system.

Deutsche Zusammenfassung – German Abstract

Gegenstand dieser Dissertation ist die theoretische und empirische Beschreibung von Faktoren, die die Identifikation von Vokalen und den Erwerb phonetischer und phonologischer Strukturen der Zielsprache bestimmen: (1) sprachspezifische phonologische und phonetische Strukturen und wechselseitiger sprachlicher Einfluss (*cross-linguistic influence*) zwischen der Erstsprache der Lernenden (L1) und der Zielsprache (L2), (2) *intra-linguale Ähnlichkeitsbeziehungen* zwischen L2-Kategorien, wie sie von den Lernenden selbst perzipiert werden, und (3) sprachübergreifende, universale Präferenzen (*biases*) für bestimmte lautliche Strukturen.

„Ähnlichkeit“ ist zentrales Element vieler Modelle der Fremdspracherwerbsforschung. Eine Operationalisierung dieses Konzepts für den Fremdspracherwerb steht aber noch aus. Die vorliegende Studie verbindet Beiträge der artikulatorischen und akustischen Phonetik, der Fremdspracherwerbsforschung und theoretische Ansätze der kognitiven Psychologie, um neue Zugänge zu Konzepten phonetischer und psychologischer Ähnlichkeit und ihrer Rolle im Fremdspracherwerb zu gewinnen.

Im empirischen Teil der Arbeit wird ein Korpus von Konfusionsdaten, d.h. Verwechslungen zwischen L2-Kategorien aus einem Vokal-Identifikationstest mit 173 Deutschlernenden zehn verschiedener Erstsprachen untersucht. Mit Methoden der deskriptiven Statistik und höheren statistischen Verfahren der Hierarchischen Clusteranalyse und der Multidimensionalen Skalierung werden Aussagen zu akustischer und perzeptueller Ähnlichkeit und Distanz, der Fehleranfälligkeit bestimmter Kategorien und der Richtung perzeptueller Substitutionsprozesse abgeleitet.

Grundlage der Datenanalyse ist eine detaillierte artikulatorische Beschreibung deutscher Vokalkategorien nach Konstriktionsort (Region der Verengung im Vokaltrakt, cf. Wood 1979) und weiteren differenzierenden Merkmalen (Kieferwinkelöffnung, Konstriktionsgrad, phonemische Länge, Rundung) sowie eine akustischen Analyse der verwendeten Input-Stimuli. Die 15 deutschen Vollvokale werden in fünf Klassen eingeteilt: pharyngale *a*-Vokale /a: a/, uvulare *o*-Vokale /o: ɔ/, velare *u*-Vokale /u: ʊ/ sowie palatale Vokale, die in prä-palatale /i: ɪ/ und /y: ʏ/ und mittel-palatale Qualitäten /e: ε/ und /ø: œ/ unterteilt werden.

Das empirische Material wird unter sprachspezifischen, vokalspezifischen und lernerspezifischen Aspekten sowie sprachübergreifend analysiert. Mittels deskriptiver Statistik werden Fehlerhäufigkeiten und Präferenzen für bestimmte Response-Kategorien sprachspezifisch und sprachübergreifend beschrieben. Die Identifikationsdaten werden in

Konfusionsmatrizen zusammengefasst und quantitativ wie auch qualitativ analysiert. Aus den Konfusionsdaten werden Werte perzipierter Ähnlichkeit und Distanz zwischen deutschen Vokalkategorien errechnet. Mittels Multidimensionaler Skalierung werden daraus räumliche Repräsentationen des perzeptuellen Vokalraums (*perceptual vowel maps*) abgeleitet, die die sprachspezifisch geprägte Wahrnehmung perzeptueller Ähnlichkeiten und Distanzen zwischen Vokalkategorien durch Lernende verschiedener Erstsprachen visualisieren.

Die Daten zeigen sprachspezifische wie auch sprachübergreifende Schwierigkeiten und Präferenzen. Während α -Vokale, /i:/, /u:/, /ɛ/ und /ɔ/ generell geringe Fehlerquoten zeigen, ist die perzeptuelle Unterscheidung vorderer gerundeter Vokale /y: ʏ ø: œ/ sowie /e:/ und /ɛ:/ deutlich schwieriger. In den meisten Sprachsamples zeigt sich eine starke Tendenz, /e:/-, /o:/- bzw. /ø:/-stimuli als /i:/, /u:/ bzw. /y:/ zu perzipieren, während umgekehrte Substitutionen deutlich seltener sind. Die MDS-Repräsentationen des perzeptuellen Vokalraums zeigen sprachspezifische Substitutionsmuster für vordere gerundete *ü*- und *ö*-Vokale, die entweder als hintere runde *u*-/o-Qualitäten oder als vordere ungerundete *i*-/e-Qualitäten wahrgenommen werden.

Die Studie leistet einen wesentlichen Beitrag zur Modellierung von *Ähnlichkeit* im Kontext fremdsprachlichen Lernens, indem sie (1) die Notwendigkeit einer grundlegenden Unterscheidung von (a) *inter*-lingualen Ähnlichkeiten zwischen Erst- und Zielsprache und *intra*-lingualen Ähnlichkeiten von Kategorien innerhalb der Zielsprache aufzeigt sowie (b) die Unterscheidung von phonetischer Ähnlichkeit vs. psychologischer Ähnlichkeit verdeutlicht, (2) die non-lineare und sprachspezifische Beziehung artikulatorisch-akustischer Parameter und der Wahrnehmung durch Deutschlernende auf Basis eines großen Samples von 173 Probanden mit zehn verschiedenen Erstsprachen empirisch belegt und (3) Ansätze zur metrischen Operationalisierung perzeptueller Ähnlichkeit und räumlicher Visualisierung des sprachspezifisch geprägten perzeptuellen Vokalraums mittels MDS präsentiert.

Die Untersuchung zeigt, dass perzeptuelle Ähnlichkeiten zwischen Vokalkategorien des Deutschen auf akustischen Eigenschaften des Lautsignals einerseits und sprachspezifischen wie auch allgemeineren physischen und kognitiven Präferenzen (*biases*) andererseits und der relativen Gewichtung (*attentional weight*) von Dimensionen im perzeptuellen Raum beruhen.

Wahrgenommene perzeptuelle Ähnlichkeit s_{ij} zwischen Kategorien i und j wird als Resultat der Interaktion von phonetischer Nähe p_{ij} und der unterschiedlichen Gewichtung von Stimuli-Biases b_i und Response-Biases b_j modelliert ($s_{ij} = p_{ij} * b_i * b_j$). Biases sind von Eigenschaften des Input-Signals, dem Set von Stimuli- und Response-Kategorien und individuellem sprachlichen Wissen, Erfahrungen und Repräsentationen des Zielsprachen-Systems bestimmt.

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Introduction

A crucial component of foreign language learning is the acquisition of the characteristic sound patterns of the target language. At the same time, it is precisely the acquisition of phonetic and phonological patterns of the target language that may lead to considerable difficulties and a traceable “foreign accent” even with very advanced learners. To account for a “foreign” or “non-native accent” in the target language, several explanations have been proposed: phonetic habits due to transfer from the listeners’ native language (L1) into the second language (L2¹) and “reduced neural plasticity” after a so-called “critical period” are among the most widely accepted explanations for the learners’ failure to acquire a native-like accent in L2. Moreover, factors such as inadequate input, social identity or insufficient motivation have been proposed to account for L2 learners’ incomplete or inadequate achievement in L2 sound production and the fact that a native-like accent is rarely achieved by adult or so-called “late learners”. Still of greater importance, however, is the *inadequate perception* of phonetic information in the L2 as already stated by Lado (1957):

“Much less known, and often not even suspected, may be the fact mentioned above that the speaker of one language listening to another does not actually hear the foreign language sound units – phonemes. He hears his own. Phonemic differences in the foreign language will be consistently missed by him if there is no similar phonemic difference in his native language.” (Lado 1957: 11²)

Numerous studies consider an accurate *perception* of L2 sounds as a central determinant for the development of an appropriate pronunciation in L2. The accurate perception of sounds, contrasts and phonetic details in L2 is considered not only to improve native-like speech production but also to facilitate the development of phonological categories of the target language and to contribute to better word-recognition and ease in speech processing. Several studies on the interaction of perception and production support the argument that the development of L2 sound perception precedes that of production and that – if accuracy in

¹ In studies on foreign language acquisition, the *target language* is frequently referred to as *second language* (L2), which can be the first foreign language that is acquired by a learner in lifetime after his or her *first language* (L1) or any other language acquired after L2 (L3, L4, ..., Ln). L1 is also referred to as *native language*. To simplify, “second language” (L2) will be used in this study as a *cover-term* to refer to any language acquired subsequently to L1, irrespective of the total number of languages that have been acquired by the learner, the attained level of proficiency or the context of acquisition (see chapter 1). Research on *second language acquisition* (SLA) focusses on the learners’ language behaviour and language knowledge and the development of the so-called interlanguage. *Interlanguage* refers to the emergent linguistic system that learners develop in acquiring the target language as manifested in *non-native* language production and perception. This study will investigate the identification of German vowels by adult non-native learners acquiring German as L2.

² emphasis mine.

perception is not given – production can be native-like only by chance. Furthermore, these studies show *language-specific perception patterns* that constrain the development of mental representations for L2 sound categories. Therefore, the study of *perception* in L2 is a crucial issue for an understanding of difficulties in second language acquisition and the development of phonological categories in the target language.

Second language acquisition (SLA) researchers as well as language teachers agree that *inter-lingual differences* between L1 and L2 have a crucial influence on L2 acquisition and performance. More specifically, it is the *learners' perception* of these inter-lingual differences and their implicit and explicit assumptions that have an influence on the emerging interlanguage system. Phonetic structures, which are phonologically distinctive in L2 but not in L1, are often not correctly identified, discriminated and categorized in L2 perception and therefore cannot be adequately acquired. Moreover, sub-phonemic differences (“fine phonetic details”) between L2 sounds and corresponding sounds in L1 may not be recognized sufficiently due to the listeners' perception of L2 sounds as “similar” or even “equivalent” to L1 categories. Inadequate perception due to the influence of the learner's L1 leads to “non-native” pronunciation of L2 sounds.

Experimental studies in SLA provide abundant evidence for the effects of influence from the learners' native language on the perception of the target language. Structures of the learners' native language are commonly assumed to be transferred into the target language. However, *transfer* of linguistic forms from L1 to L2 is not the only strategy of L2 learners to acquire the target language system. Rather, L2 learning does not only involve transfer but also implies a variety of other language-related cognitive processes. Processes of interaction between L1 and L2 such as comparisons of structures between or within language systems, discrimination and categorization, ratings of perceived differences and distances, judgements about similarity and typicality, strategies of preference or avoidance, reaction times, etc. are consciously or subconsciously applied. Cognitive processes involving interactions between the target language and other previously or subsequently acquired languages represented in the learners' mind will be referred to here as *cross-linguistic influence* (following Odlin 1989, 2005; Jarvis & Pavlenko 2008; Jarvis 2012).

The acquisition of a second language's *phonological system* involves the establishment of relations of functional contrast, similarities and differences between linguistic structures together with hypotheses on probability distributions and strategies of preference or avoidance for specific linguistic structures. In other words, it is not only transfer from L1 to L2 that shapes the emergent phonological system of a learner's interlanguage. Rather, the specific

ways that L2 sound structures are perceived, produced and mentally represented are determined by *cross-linguistic influence* of the the native language, the target language and other languages represented in the learner's mind.

Beside a number of empirical studies that describe the phenomenon of cross-linguistic influence and language-specific perception of sounds in L2 acquisition, several theoretical models and hypotheses have been proposed to describe constraints on L2 perception as influenced by the L1 phonological system. A number of models of L2 speech perception and acquisition have been proposed such as Kuhl's Native Language Magnet Model (Kuhl 1995; Kuhl & Iverson 1995), Flege's Speech Learning Model (Flege 1995) or Best's Perceptual Assimilation Model (Best 1995; Best/Tyler 2007). These models posit cognitive processes such as "perceptual assimilation", "equivalence classification" or "category goodness" to account for the influence of L1 on the learners' success to perceive L2 sounds correctly and to develop adequate mental representations for L2 categories. The primary aim of research within these theoretical accounts is to predict the relative *difficulty* of non-native contrasts in L2 perception, production and mental representation. To account for difficulties in L2 acquisition, SLA research largely focusses on contrastive analyses comparing L1 and L2 structures and on experimental testing. Difficulties are assumed to result from inter-lingual *differences* and *similarities* between structures of L1 and L2.

"Similarity" is one of the central concepts in many studies on second language acquisition. The assumption that *similarity* between sounds in L1 and L2 limits perceptual accuracy and that perceptual accuracy limits production and mental representations of L2 sounds is a common notion in models and theories on the acquisition of second language phonology. It is, however, surprising that the operationalization of the construct "similarity" itself has, so far, not received sufficient attention in second language acquisition research.

One of the central aims of this study is the operationalization of "similarity" as a central factor in non-native vowel identification. A further aim is to demonstrate the interacting effects of similarity and cross-linguistic influence in L2 vowel perception in an experimental cross-language comparison.

The study shall provide a comprehensive approach to L2 perception by integrating contributions from *second language acquisition* research, empirical studies in articulatory and acoustic *phonetics* and theoretical concepts from *cognitive psychology* for a better understanding of the diverse phonetic and cognitive aspects of similarity and its role in non-native vowel perception.

Similarity between vowel categories will be discussed under two aspects: (1) in terms of an analysis of *articulatory* and *acoustic* characteristics of vowel signals (objectively measurable similarity) and (2) in terms of *perceived* similarity of vowel categories within the L2 system (subjective similarity as perceived by L2 learners).

In theoretical accounts, similarity commonly refers to inter-lingual relations between L1 and L2 structures, whereas *intra*-lingual relations of similarity between items *within* the L2 system are commonly disregarded. Both types of similarity relations may even hinder the development of adequate L2 categories. A central tenet of the study is that not only inter-lingual relations between L1 and L2 sounds, but also *intra-lingual similarity* relations of categories within the target language have a crucial role in the development of mental representations for L2 sound categories. Both, cross-linguistic influence in general and intra-lingual similarity relations established by the learners are considered to determine the learners' success in developing adequate L2 sound categories.

The effects of cross-linguistic influence and intra-lingual similarity of categories within the target language will be exemplified by a specific sub-set of the phonological system – the vowel inventory. The aim of the experimental part is to investigate the perception of German vowel contrasts by L2 learners from diverse language backgrounds with smaller or larger vowel inventories. German has a comparatively rich and complex system of vowel contrasts that may cause considerable difficulties in L2 acquisition particularly for learners from native languages with a smaller, less complex vowel inventory. This study will show how the perceptual identification and categorization of German vowel sounds and the learners' difficulties as well as their strategies of preference or avoidance in an experimental task are influenced not only by language-specific factors but also by learner-related and more universal aspects of human speech perception and cognition.

The experimental design of this study is largely motivated by the author's experience in teaching German as a foreign language in groups with learners from diverse language backgrounds. For many German learners, problems in perception and categorization of German vowel phonemes do not only have an effect on "foreign accent" in L2 but appear also to cause severe problems in the acquisition of orthography, lexical items and morphological forms (cf. Kerschhofer-Puhalo 2010b, 2012, in press a).

The major purpose of an empirical investigation of German vowel perception by L2 learners from diverse language backgrounds is to describe possible language-specific and/or universal patterns of *difficulties*, *category confusion* and systematic perceptual vowel *substitutions*. Integrating theoretical approaches and empirical data on L2 German vowel perception, the

study's results will contribute not only to *phonological and typological theory*, but will also serve *pedagogical purposes*, by providing controlled empirical evidence for difficulties and perceptual confusion of German vowel categories which were observed among L2 learners from ten different languages. The ten languages under investigation are Albanian, Arabic, English, Farsi, Hungarian, Mandarin, Polish, Romanian, SerBoCroatian, and Turkish. The language choice was motivated by statistics on the most common native languages of students in the Austrian educational system.

In the world's languages, substantial variation in number and quality of vowel contrasts across phonological systems is observed. This *variation* concerns not only the number and type of phonemic contrasts but also sub-phonemic phonetic variation along articulatory and acoustic parameters, i.e. phonetic details in the realization of a given vowel category. While phonetic variation is considered to vary continuously along specific articulatory or acoustic parameters, vowel perception is commonly regarded as categorical. However, *categorical perception* is language-specific. In other words, no linear relationships between gradual variation along phonetic parameters and categorical perception can be assumed. Rather, category boundaries vary language-specifically and language users from diverse language backgrounds exploit different phonetic parameters to differing extent according to the structure of their native language vowel system.

Even though typological studies and cross-linguistic comparisons reveal enormous variation in number and types of vowel contrasts, system constellations and phonetic parameters for phonemic contrasts, there are some distributional patterns that are particularly common in the vowel systems of the world's languages. *Common patterns* in vowel inventories and the frequent occurrence of specific vowel qualities, e.g. a preference for /i/, /u/ and /a/ in the languages of the world, have been argued to be "*universal*" and motivated by human speech capacity in general and by characteristics of the human vocal tract and the peripheral auditory system in particular. Sounds that are "easier" in articulation and perception are expected to occur "universally" more frequently and are also referred to as less "marked" than more complex, more marked structures that universally occur less frequently.

A large number of studies from diverse theoretical backgrounds have argued that phonetically grounded universal preferences and markedness conditions determine the distributional patterns of vowel systems in the languages of the world as well as the organization of individual vowel systems. However, a question of intense scientific debate is whether these universal forces are merely phonetic or cognitive in nature.

Universal preferences and *markedness constraints* have also been an issue in second language acquisition research. Studies in SLA show that structures and developmental sequences in learners' interlanguages largely correspond to patterns observed in natural language systems. Universal factors resulting from major characteristics of human speech capacity are assumed to determine vowel inventories in natural languages as well as L2 learners' difficulties and their strategies in L2 language acquisition. These universal forces may even "overrule" language-specific characteristics of the learners' L1 explaining the occurrence of common patterns of difficulties and preferences in interlanguages independently of the learners' native language. More specifically, less difficulties with universally more common "unmarked" sound structures are observed in interlanguages with L2 learners from diverse language backgrounds.

Asking for the phonetic and/or cognitive bases of these universal preferences and constraints in language systems and interlanguages, however, also addresses the issue of the relation between *phonetic form* and *phonological function*. For native but particularly for non-native perception, it is important to emphasize that no linear relation can be assumed between articulatory constellations and the resulting acoustic characteristics of the speech signal on the one side and the listeners' perception of this signal on the other side. Rather, the matching of acoustic signal (form) and phonemic category (function) must be considered to vary according to the listeners' native language and his/her linguistic knowledge and experience in the target language.

A fundamental differentiation in the present study refers to the human articulatory and acoustic vowel space as distinct from the language-specific perceptual vowel space. The *perceptual vowel space* refers to the cognitive organization of a particular vowel system and the listeners' selective attention to specific phonetic parameters. The perceptual vowel space in a language user's mind may be compared to a language-specifically tuned *cognitive map*.

The current study will present a method to visualize L2 learners' cognitive maps for the L2 vowel system by the statistical procedure of Multidimensional Scaling (MDS) based on category confusion data from an identification task.

The cognitive vowel map, i.e. the psychological structure of a vowel system, may vary according to the listeners' native language, their awareness of particular phonemic contrasts in the language under consideration and their perceptual sensitivity and selective attention to specific phonetic details in the signal.

In the course of the L2 acquisition process, the cognitive map of the L2 vowel system may be reorganized by increased awareness of particular phonemic contrasts and phonetic

characteristics that the learner has not been aware of before. The mental representation of the L2 vowel system may also be further refined by increased perceptual sensitivity and perceptual re-allocation to specific phonetic details that the listener has previously not been aware of. It is expected here that the listener's knowledge and experience will not only determine the extent to which L2 vowel sounds are identified correctly, but also influences his/her strategies in cases where correct identification seems at risk.

In the experimental part of this study, a category identification task is used to reveal L2 listeners' difficulties in identifying German vowel categories correctly. Wrong identifications are considered to reflect the learners' difficulties in differentiating specific vowel contrasts. The results are subject to a quantitative as well as a qualitative analysis, revealing difficulties in correct identification, category confusion and perceptual substitutions, and the learners' tendencies to prefer or neglect specific response options.

The purpose of the empirical investigation is to exemplify the interaction of language-specific and universal factors based on empirical evidence for difficulties that L2 learners of German may encounter upon perceiving phonemes of a phonological system, which is more complex than their native phonemic system. The data analysis provides a language-specific description for each of the L1 sub-samples and a cross-language comparison of patterns of perceptual confusion and perceived similarity between L2 categories.

This kind of large-scaled overview and cross-language comparison of German vowel perception by learners from diverse language systems may reveal the influence that universal phonetic and cognitive factors may have in second language vowel perception better than studies focussing only on one single language. The data analysis will not only provide evidence for phonological or typological theory but will also serve pedagogical purposes.

Unlike many other studies, which investigate only a subset of L2 phonemes, the full repertoire of German vowel phonemes is investigated in the present study. The decision to include the whole vowel inventory in the study is motivated by three arguments: (1) the dynamic relationships between all members of the target system have to be considered in order to understand the process of system organization and category formation of new or similar L2 sounds, (2) in a cross-language comparison of vowel perception the possible candidates for perceptual substitutions may vary language-specifically, e.g. for front rounded vowels both front unrounded or back rounded vowels are possible substitutes, (3) for pedagogical purposes, an empirical investigation of the complete vowel inventory is more relevant and useful than studies of single vowel qualities or a sub-set (e.g. only front vowels) of vowels.

The current study will ask for the phonetic and cognitive factors that determine (1) the listeners' *difficulties* in identifying German vowels correctly, (2) patterns of perceptual *confusion* between L2 categories, and (3) the listeners' *preferences* for specific categories as response options.

Referring to the notions of similarity and cross-linguistic influence, the study will ask for those factors that influence *perceived similarity* of vowel categories between and within language systems and for the impact of cross-linguistic influence interacting with universal preferences and constraints that determine the listeners' performance in an identification task in L2. The theoretical concepts of *markedness* and *universals* will be applied here to extend the scope and descriptive power of traditional contrastive analysis of the systems of L1, L2 and IL.

To conclude, the central tenet of this dissertation is that cross-language speech perception is conditioned by three major factors:

- (1) *cross-linguistic influence* between the learners' first language L1 and the target language L2 (and other languages acquired),
- (2) relationships of *intra-lingual perceived similarity* between vowel categories of L1 and L2 and between categories within L2 as established by the learner at a given stage of L2 acquisition, and
- (3) cross-linguistically, by the influence of universal phonetic and phonological *preferences and markedness* conditions that determine or constrain the acquisition process and the listeners' difficulties and choices of specific response categories in an identification task.

An integrated view of these three major factors shaping interlanguage phonology enables a comprehensive account of perceptual learning in second language acquisition.

Organization of the dissertation

Chapter 1 will resume basic theoretical notions and concepts of SLA research that have been claimed to play a role in the acquisition of phonetic and phonological patterns in L2 acquisition. Moreover, the chapter will review concepts of markedness and universals and their status within second language acquisition theory.

Chapter 2 discusses fundamental aspects of human speech perception and language processing and the development of speech perception in L1 and L2, i.e. the mechanisms by which sounds are processed, acquired, internalized, and used in L1 or L2. Moreover,

experimental methods in L2 perception are reviewed. The last section of chapter 2 discusses current theories of L2 perception.

Chapter 3 discusses different aspects of “similarity” in phonetics and SLA research. The chapter reviews aspects of phonetic similarity in articulatory, acoustic and perceptual terms and relates the diverse notions of similarity with the learners’ ease or success in identifying L2 sound patterns correctly. The impact of acoustic-phonetic structures on the language-specific perception and mental representation of L2 sounds is discussed in the last section of this chapter.

In chapter 4, phonetic and phonological definitions of vowels are reviewed. The discussion will focus on aspects of system size and contrast types and on the phonetic correlates of phonemic oppositions. The chapter discusses phonetic, phonological and typological aspects of vowel inventories and presents evidence for specific patterns that cross-linguistically seem to be preferred in the vowel inventories of the world’s languages. Theories on vowel inventory typology that have been proposed to account for these universal patterns and preferences such as Markedness Theory, Natural Phonology, Quantal Theory and articulatory-oriented approaches are discussed in the last section.

Chapter 5 presents a phonetic and phonological description of the German vowel system. German vowel categories will be classified in terms of articulatory regions of the vocal tract and will be described in terms of articulatory and acoustic properties. The acoustic-phonetic data presented here is based on a detailed analysis of the input stimuli from the experimental part of this study. A description of the German vowel system that is based on articulatory and acoustic characteristics offers insights into *phonetic similarities* between German vowel categories. The last section of this chapter presents an analysis of phonetic similarity of German vowels in terms of acoustic-phonetic properties and deduces predictions for difficulty and category confusion between German vowels by means of Hierarchical Clustering.

The experimental design, the input material and the test procedure of the current study are presented in chapter 6.

Chapter 7 provides a detailed discussion of procedures of data analysis and crucial aspects of data interpretation. The goals, scope and limitations of data analysis and data interpretation are described for each of the type of quantitative or qualitative analysis procedure (for an overview of all types of analyses performed in this study, see Table 7.8).

A detailed discussion of the study’s experimental results focussing on language-specific, learner-related and category-specific aspects is presented in chapter 8, 9, 10 and 11.

Chapter 8 describes individual factors and their influence on the L2 learners' differential success in the perception experiment.

Chapter 9 provides a first overview of the major results for the full sample of 173 non-native listeners and presents a cross-language comparison on language-specific differences and commonalities in difficulties, perceptual substitution processes and category preferences. A general analysis of results for the full L2 sample will include the following aspects: (1) a quantitative analysis of (a) L2 listeners' *difficulties*, i.e. the ratio of wrong and correct identifications, and (b) the listeners' *preferences* for specific response categories in a cross-language comparison and a vowel-specific comparison, followed by (2) a qualitative analysis of (a) *confusion patterns* and perceptual substitution processes, (b) *similarity scores* for the full L2-sample, and (c) *cognitive maps* of the *perceptual vowel space* for each of the ten sub-samples of L2 listeners derived from a Multidimensional Scaling Analysis (MDS).

Chapter 10 discusses the results for each of the language sub-samples separately. For each of the participants' native languages, the analysis will offer (1) a description of *general characteristics* of the language under discussion, (2) a *phonological and phonetic description* of the vowel system, (3) a brief *contrastive outline* describing previous research and possible areas of difficulty with L2 German vowel perception, and (4) a detailed analysis of the quantitative and qualitative results of the perception experiment (as outlined above).

Chapter 11 provides a cross-language comparison of vowel-specific difficulties, preferences and directions of perceptual substitution patterns for each of the German vowel categories. The vowel-related focus of this chapter allows for a *cross-language comparison* for German vowel classes and single categories and reveals common patterns observed in several language sub-samples. Moreover, it provides insights into category-specific patterns *within* a given vowel class. These common patterns within a given vowel class refer not only to comparisons of error rates (difficulties) but also to the occurrence of perceptual substitutions (confusion patterns) and the listeners' bias to select specific response patterns (preferences and asymmetries).

Chapter 12 will take up the diverse strings of argumentation and resume the experimental results focussing on the issues of "similarity" and "bias" to account for the differential results in terms of error rate (difficulties), category confusion due to similarity, and category preferences (biases) and asymmetries in perceptual substitutions. The major aim of this last chapter is to relate the phonetic facts and empirical results with theoretical contributions from research in cognitive psychology and findings on speech perception and language learning to

identify those elements that are essential to a model of *intra-lingual similarity* of L2 categories and *perceptual bias* in second language acquisition.

General conclusions, pedagogical implications and an outlook for further research are given in the final section of this study.