

ROADS AND PATHS IN ADAPTATION TO NON-NATIVE SPEECH: IMPLICATIONS
FOR SECOND LANGUAGE ACQUISITION

by

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(Under the Direction of Don R. McCreary)

ABSTRACT

Clarke and Garrett (2004) found that native English-speaking listeners adapted to non-native accented speech in less than one minute. This study replicates Clarke and Garrett's work, but extends it by asking if experience with the same accent will have a priming effect or facilitate in the adaptation of the non-native speech. This experiment included 84 self-reported native speakers of English who listened to novel and contextually ambiguous sentences spoken by native speakers of Korean in the following four conditions: one native speaker (NS condition), one native speaker followed by a non-native speaker (NS/NNS condition), one non-native speaker (NNS condition), and one non-native speaker followed by a second non-native speaker (NNS/NNS condition). The results of this experiment support Clarke and Garrett's finding of rapid adaptation to accented speech, but these results suggest that the adaptation is to individual speakers, and that the situations are so brief that a priming effect does not occur. In other words, the listeners are not retaining features from the previous speaker to use in perceiving the unfamiliar accent of the second non-native speaker that they hear in these very brief instances; however, a look at data from six listeners who had extensive backgrounds with Korean reveal that the extensive experience with Korean is facilitating in the task, which suggests that

phonological adaptation works both rapidly and with a longitudinal retention of exemplars for later use. The findings of this research have implications for theories of phonology, but more importantly for second language acquisition and its applications for the teaching of pronunciation in the language classroom.

INDEX WORDS: adaptation, international teaching assistants, non-native speech, phonology, exemplar theory, second language acquisition.

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DEDICATION

This research is dedicated to my large, loving family and to the many wonderful and diverse people who have participated in my community of learning. I am grateful to all those who continue to learn from and teach me with open hearts, particularly my husband, Robert Jones and our daughter, Alena Leetha Jones-Crabtree. I thank you both for your patience, love, and support through the many hours that this process has taken me away from you.

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TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
CHAPTER	
1 INTRODUCTION	1
Background of this Study	2
Purpose of this Research	4
Research Questions	4
Significance of Research	5
Outline of this Dissertation	6
2 REVIEW OF LITERATURE	8
Exemplar Theory: Concrete Roads and Park Paths?	8
Interaction and Exemplar Theory	15
Interaction Theories in SLA	18
Studies in Adaptation to Accented Speech	21
3 METHODOLOGY	29
Research Design and Hypotheses	30
Tokens	32
Speakers	34

	Token Manipulation and Instruments	35
	Listening Experiment.....	37
	Procedure	38
	Data Analysis.....	40
4	RESULTS	42
	Demographics of Participants	42
	General Description of the Data	45
	Hypotheses Results	50
	Discussion of Hypotheses	56
	Lack of Priming Effect in This Study Compared to Previous Pilot Study	60
	Findings Compared to Other Studies.....	62
	The Human Phonological System, Exemplar Theory, and SLA	64
	Limitations and Future Directions	72
5	CONCLUSIONS--GREAT EXPECTATIONS & MULTIPLE PATHS	76
	REFERENCES	82
	APPENDICES	
	Appendix A: Questionnaire of Language Experience & Interests.....	92
	Appendix B: List of All Token Sentences and Visual Stimuli	95
	Appendix C: Revised Praat Script for Lengthening or Condensing Length of Tokens.....	97
	Appendix D: Summary of Raw Data	102
	Appendix E: Summary of Data After Removal of Outliers.....	103
	Appendix F: RT's & Error Rates After Logarithmic Transformation.....	104

LIST OF TABLES

	Page
Table 1: Experiment Design: Four Conditions by Speaker Group	30
Table 2: Error Rates of Participants with Korean Experience by Condition & Speaker	58

LIST OF FIGURES

	Page
Figure 1: Example Screen of the Visual Stimuli	40
Figure 2: Mean RT's of the Experimental Tokens	46
Figure 3: Differences in RT's between Experimental and Baseline Tokens	49
Figure 4: Comparison of RT's of the Last Four Tokens by Condition.....	50
Figure 5: Scatter Plot of NS/NNS RT'S	53

CHAPTER ONE: INTRODUCTION

The term *globalization* is one used not just in economic markets, but in academic venues, as American universities continue to become diverse demographically. With diversity and globalization come challenges in communication as more and more non-American faculty, students, and assistants choose to work and study in U.S. universities. One challenge has been undergraduate complaints about the quality of education under international instructors, particularly international teaching assistants (ITAs) who are non-native speakers (NNSs) of English (see Thomas & Monoson, 1993). The literature about ITAs is rife with conflict, and the “ITA problem” is a term used throughout the discussions concerning international teaching, particularly concerning ITAs in large university systems. The questions asked about how to make the international student more comprehensible are multitudinous, and much of the literature explores “what it is about ITA discourse that often renders it incomprehensible to the undergraduates to which it is directed” (Williams, 1992, p. 693).

Many scholars discuss language as the first thing undergraduates react to when coming in contact with their ITA, specifically difficulty in undergraduates understanding the accent and pronunciation of ITAs. However, Williams (1992) reports that while undergraduates cite accent and pronunciation as the initial problem with communication, the same students reveal that they seem to adapt to the ITA’s pronunciation and accent as they continue to work together, thus leading her to believe that the problem reported by undergraduates has more to do with other features of the ITAs’ language, such as discourse marking and organization, than with pronunciation.

Williams states that undergraduates in her study reported that the difficulties in pronunciation lessened over time, but is this true? The listeners could feel as if they are getting better at comprehending the speech, but does that prove that they actually are getting better at comprehending the speech? While Williams controls for ITA pronunciation by including planned and unplanned speech read from the same ITA and she additionally notes that rate of speech and phonology need further testing, she does not acknowledge that hearing the speaker twice may further aid in adaptation to the speech because of lexical cues. Perhaps lexical markers or content help the undergraduate students in comprehending the message. Maybe the students really aren't truly adapting to the speech. In the cases in which Williams's interviewed her native English-speaking students, perhaps all of the strategies employed by the international teachers, such as the repetition of words or the use of visuals and text, are actually helping in making the communication more comprehensible. While research that investigates if lexical discourse markers help comprehension of non-native speech is provocative, the assumption that this research design is built upon needs to be tested: Are undergraduates actually adapting to the non-native speech? If the students are able to adapt to the non-native speech, then focus on pronunciation instruction may be less important than teaching discourse organization, as Williams concludes in her research. Nevertheless, very little research has been conducted to test the theory that listeners actually do adapt to non-native speech, yet it is an important premise to establish for the field of second language acquisition (SLA).

Background of This Study

While it is true that some language learners succeed more readily than other learners, it seems equally true that some listeners attend to foreign speech more easily and successfully than other listeners. Why is this so? Second language acquisition scholars have asked comparatively

few questions concerning the listener and the listener's abilities and responsibilities in the communicative process in intercultural and interlingual discourse. These same scholars definitively defend diversity, particularly linguistic diversity, as beneficial to all. At the same time, newspapers are filled with editorials written by students complaining that some of their international instructors and teaching assistants cannot communicate clearly enough, and some of these complaints have even resulted in lawsuits and refunds of tuition (Fiske, 1985). These complaints are overtly expressed in the literature of SLA and language education as negative appraisals of foreign accents (Deen, 1997; Doelman, 1998; Gorsuch, 2003; Lindemann, 2002, 2003, 2005; Plakans, 1997), miscommunication or communication breakdowns because of intercultural diversity (Bailey, 1983; Bloomaert & Verschueren; Gass and Varonis, 1991; Jenkins, 2000; Lippi-Green, 1997; Nahal, 2005; Pickering, 2001), or the "ITA problem" or "lack of receptivity" to internationals (Bresnahan & Cai, 2000; Bresnahan & Kim, 1997; Fitch & Morgan, 2004; Plakans, 1997; Ross and Krider, 1992; Tyler, 1992; Williams, 1992).

However, while scholars promote linguistic diversity, little research has been conducted to show just how experiences with linguistic diversity specifically affects the phonological perceptions of the listener. Second language scholars propose negotiation between language learners and native language speakers as one of the fundamental activities involved in gaining "communicative competence" (Hymes, 1966, 1974) in a language. Yet, these scholars only concentrate on the language learner. Only half of the picture is being examined, because the native-speaking listener also may be gaining benefits from the interaction. Interactionist scholars who look at the negotiations of NSs and NNSs treat the native speaker not as a learner, but as a facilitator to the NNS. By viewing the NS as a static expert, we create the false perception that the NS is an idealized language end product, not a dynamic learner.

Purpose of This Research

One of the purposes of this research is to clarify if NSs of English do adapt to non-native speech in the listening process. Adaptation constitutes reaction times (RT's) and error rates in listening to non-native speech would be similar to RT's and error rates when listening to the same native speech.

A second goal of this research is to discuss the findings' implications for phonology in SLA both theoretically and practically. Therefore, this research also discusses how information from this dissertation might be utilized in training programs for ITAs as well as in the field of second language research and pedagogy.

Finally, this research seeks to inform the field of SLA about future directions that need to be explored, especially as I recognize the importance of contextual factors that affect the success or failure of communication. This dissertation's last chapter addresses avenues for future research concerning adaptation and NS-NNS communication that cannot be answered by laboratory experiments alone.

Research Questions

The purpose of this study was to determine if NSs adapt to non-native speech and if NSs retain information from one non-native speaker in order to prime or facilitate in understanding a second non-native speaker, I devised a laboratory experiment¹ that had four different conditions. This experiment tests reaction times (RT's) and error rates to both native speech and non-native speech to answer the following research questions:

1. Do listeners adapt to non-native accented speech?
2. How long a period does adaptation take, if it occurs at all?

¹ This research design is based on Clarke and Garrett's (2004) first experiment with the addition of a fourth condition. In their original research, Clarke and Garrett found that NSs of English experienced "rapid" adaptation to non-native speech. Their findings will be further discussed in the review of literature.

3. How does exposure to the speaker or speakers from the same language family affect possible adaptation?
4. Are there benefits from previous contact with the same language? For example, if listeners have experience with native-Korean accented English, will they retain that information in future encounters with other Korean speakers of English? Put another way, does experience with one accent prime the listener for hearing a similar accent?
5. If a priming effect does occur, how much experience is needed to benefit from the previous language contact?

Significance of Research

This research is important for the field of SLA because it examines adaptation and learning from the rarely considered role of the native-speaking listeners. Communication is not unilateral, but unfortunately in studies of SLA the focus has tended to fall only on production and mostly on the language learner. Scholars have explored the cognitive side of second language production as well as the production of second language learners, but scholars have almost completely ignored the fact that production is not the only factor in successful communication. Rarely has second language perception by the listeners been considered by linguists, so much so that the onus of communication in the form of production seems to be the sole responsibility of the language producer.

This investigation highlights the role of the native-speaking listener as a responsible part in the process of understanding or comprehending accented speech. It emphasizes the NS listener as an active participant in the process of interlingual communication and as a /theoretically significant part of interaction and SLA (Gass, 1997; Gass & Madden, 1985; Gass

& Varonis, 1994; Long, 1985; Mackey & Gass, 2006; Swain, 1995; Swain & Lapkin, 1995; Swain, 2005). There is as yet very little information on what actually occurs for the listener during negotiation phases in interaction between NS-NNSs, except in cases of production or recasts by the NS. This lack of information about what is happening for the listener is probably due to the difficulty in measuring listening, but it is no less important to investigate. After all, if interaction and input/output theories of SLA argue that negotiation of communication is integral for language learners' growth, then these theorists must also consider and understand the process in terms of what is happening for all parties in the communication, in this case, the native-speaking listener.

This research can have significant implications for pedagogical decisions. Understanding more specifically the processes during listening can inform how and what practitioners in the language classrooms decide to teach. For example, if listeners adapt to non-native pronunciation, then language classrooms can concentrate on other factors that may be causing communication difficulty, such as discourse organization as Williams' study does.

Outline of this Dissertation

Chapter Two begins with a discussion of literature on exemplar theory, a probabilistic theory of how humans store phonological information. In this section, I utilize the metaphors of concrete roads versus paths to explain how I think exemplar theory needs expansion. I review interactionist theories in SLA and discuss why exemplar theory is important to interaction theories. Finally, I review perceptual studies, specifically those that deal with adaptation to accented speech, in order to illustrate why this study is needed.

Chapter Three discusses the methods used in designing the experiment that tested if native-speakers of English adapt to a non-native accent and the hypothesis related to the research

design. This chapter also discusses participants, conditions, instruments & technology, data collection, and analysis tools used in the experiment.

Chapter Four reports the demographics of the participants and the results of the experiment. A discussion of six participants who had extensive experience with Korean language (the accent being tested in this experiment) and their results follows. Next, this chapter explores the findings of the experiment and what they reveal about exemplar theory and SLA. Finally, limitations and future avenues for this kind of research are discussed.

Chapter Five concludes with a discussion of how the limitations of laboratory studies in ascertaining the effects of preconceived attitudes and cultural factors in language used within real contexts. This chapter previews discourse from a pilot study currently in progress that will expand upon the findings in this research in further understanding NS-NNS interaction in the American university. Finally, I discuss future practical applications for U.S. universities that must be explored in conjunction with this dissertation's experimental findings.

CHAPTER TWO: REVIEW OF LITERATURE

This chapter includes a brief overview of exemplar theory, a theory of phonology that explains perception and categorization of phonemes as categorization through experience. After reviewing exemplar theory, I propose that it should be expanded to cover frequent long-term exposure as well as novel or short-term exposure. Secondly, I discuss interaction and exemplar theory or sociophonetics. Thirdly, I discuss interaction theories in SLA, as I argue that theories of interaction need the explanatory power of exemplar theory or a similar phonological theory to clarify negotiations between speakers that are integral to language learning. Finally, I review literature specifically concerning experiments in adaptation to accented speech that informed this study's experimental design.

Exemplar Theory: Concrete Roads and Park Paths?

As noted in Chapter One, Williams' (see also Tyler, 1992) study begins with the assumptions that pronunciation is a peripheral characteristic of language that NSs will adapt to, not a primary characteristic that can establish or confirm the listener's preconceived notions of how successful the communication event will be. Such studies assume that listeners adapt to non-native pronunciation and that organization of spoken discourse impedes communicative success more than pronunciation. However, it has not yet been established that such adaptation does in fact occur. If adaptation does occur, SLA scholars need a theory to explain the phenomenon. Exemplar theory may be such a theory. Exemplar scholars believe that our first language phonology is built upon contact and probabilistic frequency, but is second language phonology also built upon exemplars, or the build up of examples in our experience with

language? In order to broach the topic of why contact between speakers may aid in adaptation or comprehension, in this section I first consider exemplar theory because it addresses experience, what exemplar theorists term a usage-based theory. While SLA scholars might use the term *exposure* to the target language in adaptation of the phonological system, this term fails to capture what happens for the listener during the interaction process. A phonological theory such as exemplar theory can help us theorize the negotiations that occur between NS-NNS during contact.

Exemplar theory originated in the field of psychology but was later introduced to linguistics. Johnson (2005b) explains two major ways that the term “exemplar theory” has been used in phonology: 1.) as a way of constructing grammars from close inspection of phonetic detail of people’s production; and 2.) as a way to situate “languages in a cognitive model of human memory by assuming that people use an exemplar-based memory system to store phonetic details” and “generalizations then are compared by the talker flexibly on-demand over this large store of phonetic exemplars” (p. 293). It is with the second part of this definition that this research is concerned, especially in how some individuals store phonetic details about non-native speech. To test the adaptive nature of the cognitive system, Johnson and Beckman (1997) created a model system based on human cognition to decipher how humans adapt to formants in different vowel spaces. Specifically, using data from speakers representing two different dialects or regional variations of an accent —Alabamans and Californians – they found that while there is a decrease in initial perception, the ability to perceive correctly rises. Johnson and Beckman conclude that “just as real listeners do, it [the model] hones in on the sociolinguistically meaningful variability in the signal” (p. 123). Johnson and Beckman explain that adaptation is not just vocal tract normalization, or having only one underlying prototype, but a creation of new

exemplars, based on classification and categorization. While Johnson and Beckman's study focuses on dialects, the question of whether listeners also increase in their ability to perceive accents as they do for dialects is the focus of this dissertation.

We assume from the ITA literature that listeners have difficulty in comprehending the speech of NNSs, yet researchers such as Williams (1992) observe that native speaking listeners report adapting to pronunciation difficulties. Munro and Derwing (2006) seem to confirm Williams's statement when they state that "in some instances, speech marked with nonnative segmentals and prosody appears to be understood just as well as native-produced speech from a familiar dialect" (p. 112). However, in earlier research, Munro and Derwing (1995b) found that while intelligibility, or the ability to understand lexical items from a speaker, was high for some non-native speakers, reaction times (RT's) also were impacted, which served as an explanation for "irritation" that native speakers reported when coming in contact with a foreign accent. The question becomes, "does adaptation really occur?" If so, does it come at a price of processing; i.e., does the individual who is adapting to the speech have to use more processing power to adapt to and comprehend speech that they perceive as foreign? A rise in RT's would suggest that the processing does take a greater toll on the listener. If RT's lower as the listener hears the foreign accented speech, then it would suggest that some of the characteristics of the accented speech are being adapted to and saved in the phonological system—creating examples which the listener refers back to for faster communication. If exposure to a similar second non-native voice creates no rise in RT's, then this would suggest that the similar accents, as exemplar theory proposes, are close enough to create the beaten path or to have strengthened the pathway to phonological access.

Johnson (1997a, 1997b) and Hume & Johnson (2001) discuss speech styles and speech perception, finding that the speaker always begins with perception of speech from the point of his or her own language background (also see Flege, 1984; Flege & Fletcher, 1992; Flege, Munro, & MacKay, 1995; Schmid & Yeni-Komishian, 1999). As evidence of the human propensity for using one's own speech as a template, Hume and Johnson cite studies in second language acquisition in which listeners are more adept at perceiving sounds of their native language than of those of a second language acquired later in life. Hume and Johnson also cite first language studies that found "babies' perceptual systems become tuned to language specific phonetic patterns" (p. 4), meaning that this pattern is solidified in our early first language acquisition. This may be the beginning of what I call the "concrete road," or stored phonetic details that become the most easily produced and perceived because of the frequency with which they have been encountered. These native language templates may be part of the reason that listeners report difficulty in understanding speech in accents other than their own. Since the native speaker is using his or her own template, then she is unable to shift the template automatically when listening to accented speech. The difficulty in understanding non-native speech may be connected to a lack of any build up of "exemplars"—a term coined by Johnson (1997b).

Humans adapt to new voices all of the time. We may come into contact with voices we are unfamiliar with every day, and yet we rarely fail to communicate or to feel that we have understood what most interlocutors have communicated when speaking to us. Many scholars have addressed the ability of human beings to perceive a wide range of different representations of similar sounds (Tatham & Morgan, 2006). Yet, if the sounds are so far from the representations with which we are accustomed, difficulty in comprehending the speech can occur.

This difficulty in comprehension may be due to a lack of build up of exemplars. Pierrehumbert (in Nathan, 2007) discusses exemplar theory as one of probabilistic cognitive process based on a great deal of exposure. Nathan interprets Pierrehumbert's explanation of exemplar theory as follows:

...large numbers of individual instances are all stored, but that similar instances are stored, in some sense, 'on top of' each other, somewhat analogous to tracing a path through a park. As more and more instances in the same place are stored a visible path emerges where the grass is worn away, but all the other paths that do not coincide exactly with the bare earth are still there also, and available to be perceived and produced. However, the more frequent instances are 'stronger' and hence more likely to be produced, and instances that are heard and are similar to the 'beaten path' are likely to be assimilated to it. (Pierrehumbert paraphrased in Nathan 2007, p. 95)

Although Pierrehumbert (2000) cites cross-linguistic examples, she does not apply exemplar theory to second language studies or theories. However, but exemplar theory could explain difficulty in adapting to accented speech because it would mean that the pathways are not yet in the listener's stores for accented speech or that the paths are so seldom trod that they are more difficult to access than the paths for familiar speech. Compare this to our most frequent stored examples which create a sort of "concrete road," or a phonological system which is almost automatically retrievable. Exemplar theory treats the human phonological system as a probabilistic one in which a buildup of examples are stored. As listeners come in contact with other speakers, the listeners use these exemplars to comprehend novel speakers. Listeners are only be able to comprehend speech they come in contact with if it is close enough to the

paradigms that they have stored or as Pierrehumbert explains, if they have created a “beaten path.” I believe, however, that native language phonemes are more like a concrete road, and the examples that differ greatly from these but are encountered frequently are more like the path in a park or garden. I want to introduce the metaphors of the *concrete road* and the ‘*park path*’ because they better explain our adaptation to accented speech which we encounter more frequently and language that we encounter less frequently. Park paths may or may not become paved roads or may become overgrown again and indiscernible if unused. Similarly to Pierrehumbert’s conceptualization of exemplar theory in the above quotation, I believe that exemplars apply to both comprehension and production.

This lack of shift in paradigms because of L1 phonology may also explain why accents occur, but we would also wonder why L2 learners do not shift the template and thus shift to native-like pronunciation after years of exposure. As Pierrehumbert notes, the more frequent the instance is, the more likely it is to be produced. The inability to shift from L1 to L2 production may be a difference in storage in first and second acquisition; a fitting analogy would be the difference between a beaten path and a concrete road. L1 phonology is the concrete road, the most traveled and used, while L2 phonology is a beaten path or a circuit of beaten paths. The concrete road is probably the most likely to be used by the speaker, just as a concrete road becomes Pierrehumbert’s ‘beaten path’ because drivers are likely to use that route. When shifting from the L1 to L2, the travel becomes slower, just as driving on a beaten path would be slower than driving on a concrete road. The listener cannot simply use the L1 phonology to understand L2 production. While the beaten path may someday become the concrete road with enough use, humans need a great deal of exposure for the L2 to have the same automaticity at the phonological level as the L1.

The same difficulty in shifting paradigms may explain listeners' phonological reaction to speech unlike their own. The phonology of listeners' L1 affects their ability to comprehend the accented speech, just as L1 phonology can affect L2 production. It would seem, though, that in order to shift the paradigm, the stored examples that listeners have built up to create the concrete road, there would need to be a great deal of exposure. Exemplar theory proposes that the examples with which listeners come into contact most frequently gets stored on top of one another, or that items that are close in proximity are stored near one another. This network of storage "[strengthens]" (Bybee, 2006 p. 716) the item, or "paves" the road through copious exposure.

To test Bybee's, Johnson's and Pierrehumbert's ideas in terms of exposure, this dissertation asks specifically if the human generative phonological system is adaptive to non-native speech, and if so, how quickly it adapts. Secondly, if it is adaptive, do two similar voices (same accents) in short time spans facilitate the creation of a beaten path? Another case may be that the beaten path and concrete road in phonological systems are analagous to the difference between short-term and long-term memory. In his discussion of exemplar theory, Johnson (2007) outlines the difference between declarative and recognition memory. I, on the other hand, am using the metaphors of park paths and the concrete road, which address how the phonological system stores phonetic detail.

Specifically, the difference between comprehending native and non-native speech may be the difference between the use of a park path and a concrete road. A park path is traveled so that there becomes a barely discernable path. The park path, however, is not yet smooth or quickly traveled. A concrete road, on the other hand, is constructed because of the frequency and speed of use. Native speakers have little difficulty comprehending one another because they may use

their own speech or speech within their frequently used communities as a paradigm for their perceptions, the concrete road that they have established. The park path, on the other hand, is a better analogy for less frequently encountered phonetic characteristics. The park path would be roughly constructed, but unless it were used a great deal, it would not become a concrete road. Through the use of the analogy of Pierrehumbert's park pathway and my construction of the concrete road, I am suggesting that we cognitively perceive language in more than one way, and that exemplar theory needs expansion to include both.

Second language scholars describe the difficulty in perception as a lack of exposure to the target language; that is how SLA scholars have discussed difficulties on the part of the language learner, but not the listener. Exposure is usually discussed in terms of how much of the target language the learner comes into contact with; however, in a global world with interlocutors speaking world Englishes, exposure may come to mean just being experienced in listening to accented speech that differs from the interlocutors'. As the world becomes more global, scholars may eventually discuss accents in English as if they were all dialects.

Interaction and Exemplar Theory

While Pierrehumbert's (2000, 2001, 2006) discussion of exemplar theory works at the sound and frequency level to describe how individuals encounter variation and Johnson's (2005b, 2006, 2007) discussion of exemplar theory tackles variation at the word frequency model, Labov (2006) extends exemplar theory to ask whether it can explain social variation and adaptation to social variation. Labov discusses the connection between exemplar theory and social evaluation as "sociophonetics" and directly links speakers' categorical knowledge of examples in their phonetic environments to social evaluations. Labov differs from Pierrehumbert and Johnson who discuss exemplar theory as probabilistic or frequency based. In Pierrehumbert's, Johnson's,

and Bybee's discussion of exemplar theory, frequency is an explanation for why items, whether they are sounds or full words, are more salient in language. Contrastively, in his discussion of exemplar theory, Labov does not necessarily find frequency to be the overwhelming feature explaining saliency or what gets noticed or produced in language, but he posits social factors affecting what gets produced as well as what gets perceived. Labov argues that linguists, particularly those working in phonetics and phonology, have ignored what may be particularly important for organizing social knowledge. For example, Labov states:

What people note and remember is the use of a particular allophone to instantiate a particular phoneme. What people evaluate is not a sound trace or a word, but something more abstract. It seems that the objects of social evaluation that are remembered and stored undergo a preliminary analysis and the social information is attached to a more abstract object than the remembered exemplars. This abstraction may be retrieved and labeled with a word, because there is no other vocabulary available (p. 513).

Labov argues that more research needs to be conducted to find out what is socially salient and significant for listeners. In other words, frequency may not be the defining feature for what gets remembered, but items that help the listener socially categorize the speaker may be most important for memory.

Labov ignores the fact that "salient" and "significant" may not be the same. While some listeners may be aware of a phonetic feature, such as nasalization of the vowel in the word "bad" (Labov, 2006; p. 513) in a Bostonian dialect, they may or may not be aware that they are attaching a stigma to this sound, and thus stigmatizing the speaker. Listeners may abstractly connect nasalized "bad" to a working class accent, and

thus categorize the speaker as working class, but they may not be aware of this categorization, and listeners may not be aware that it is the nasalization feature that they use in the categorization. In contrast, another example would be listeners' ability to pick out words that have varying voice onset time (VOT) measures. While listeners may understand that the speech is dissimilar to their own, they may not be able to definitively describe the difference or distinction, similar to how naïve raters are unable to describe why one foreign voice is more "accented" than another foreign voice.

Another example of the socially "salient" and "significant" being dissimilar is when members of a group use similar VOT even when they are not part of the same dialect group and are not aware of the similarity, signaling that phonologically the speakers may unconsciously be accommodating for in-group affiliation. Analogous to Labov's concept of salience and social significance in my research is the longer reaction time or increased processing time for NS listeners when they come in contact with accented speech. The listeners may not be aware that processing the accented language takes longer, but it still may be socially significant because the listeners may feel "irritation" (Fayer & Krasinski, 1987) or unease with the communication. Whether the speech is salient and socially significant or not, Labov is arguing for greater discussion and an examination of how both listeners and speakers map these examples to abstract ideas in social evaluations.

This dissertation is an intermediary between the two variants of exemplar theory, since, first, it investigates how perception is affected in terms of word frequency and exposure to the particular accent, and secondly, it addresses the question of variation and speculates how NNSs are affected socially if NSs have increased RT's. Specifically, this

study asks whether listeners adapt in terms of error rates and RT's, and if they do, just how many examples and how much time does it take to facilitate listeners in adapting to non-native speech. However, we cannot neglect the possibility that increased listener RT's may have social significance for the speakers, particularly in the initial phase of contact.

Pierrehumbert's work implies that only over the course of many instances of phonological contact would there be a shift in the perceptual categories. However, laboratory linguists' work (Clarke and Garret, 2004) as well as SLA practitioners' work such as Jessica Williams's (1992) point to a more rapid human adaptive capability. However, if processing rates are longer for non-native speech, it may signal speech characteristics that not only cause processing rates to rise, but also cause irritation in the listener (Fayer and Krasinski, 1987). The listeners may not be aware if RT's rise, but they may still want to avoid foreign-accented speech because processing it is more difficult than processing native speech. This irritation would be an example of Labov's social significance for the listener and the speaker.

Interaction Theories in SLA

While Labov extends exemplar theory to sociophonetics, I would like to extend it to SLA. In the following section, I briefly review theories of interaction in SLA, and then I suggest how exemplar theory should be integrated into SLA, particularly for the input-interaction output model (Gass, 1997; & Gass & Madden, 1985).

SLA scholars need to consider exemplar theory particularly for: 1. the output hypothesis, the interaction hypothesis, and the input-interaction output model. All of these theories posit that language learners learn through interaction, often interaction with native speakers of the target

language. However, while examples of reorganization of learning for the L2 learner are often chronicled through NS-NNS dialogues, SLA scholars have asked few questions concerning how the NS's phonology may be changing in order to provide input in the interactions. Are new categories being established not just for the language learner, but also for the language listener? If so, both parties (the listener and speaker) then become learners in a sense, if phonological adaptation occurs.

There is an almost three-decade history of interaction and negotiation models for SLA; however, SLA scholars have rarely considered phonological adaptation in interaction theories. When they do, it is usually a discussion of the shift for the NNS, not the NS. Swain (1995, 2005) and Swain and Lapkin (1995) developed the comprehensible output hypothesis (sometimes referred to as the output hypothesis) which proposes that communication is what spurs language acquisition. Language input is received by the second-language user, and then production often follows; therefore, interaction, particularly meaningful output, is key to language learning. The use of comprehensible output by the learner does not always, but can, result in learning success. Similar to Swain's theory, Long's (1985) interaction hypothesis postulates that negotiation occurring in communication is fundamental to language learning. Both hypotheses suggest that negotiation for meaning in the actual use of language is what really facilitates language acquisition, and many scholars who advocate these hypotheses argue that learning often takes place during the communicative interaction (Gass & Selinker 2001, pp.294-5).

Finally, Gass (1997) and Gass and Madden (1985) combined ideas from the two hypotheses to develop the input, interaction, output model (IIO model) (see also a discussion by Block, 2003). The IIO model discusses apperceived input, or input that is below the threshold of perception. The IIO model also discusses comprehended input, interaction, integration, and

output; therefore, this model is much more complex than just that of input or interaction, since the negotiation of the interlocutors is implied to be a continual process. While both Swain's and Long's hypotheses recognize interaction and negotiation as learning tools, it is only the IIO model that distinguishes between input that is apperceived and then perhaps integrated into the learners' system, inferring that the activity is a mental process, and not always a conscious mental process. While Swain, Long, and Gass all recognize the role of negotiation in language learning, they all do little to discuss negotiations in terms of the native-speaker interlocutor's adaptation to the listener. Most of the discussion focuses on target-like or failed target-like output of the language learner based on input from the native-speaking interlocutor.

Selinker (1972) developed the term *interlanguage*, which concerns output that is not completely target-like. Selinker's interlanguage probably spawned the input hypothesis, output hypothesis, and the IIO model, but Selinker concentrates on the learner and the production of the learner, not the interlocutor or listener in the communicative space. SLA scholars do discuss the interaction in terms of negotiation or "foreigner talk," but they refrain from asking if a change occurs within the listener, and learning for the NS is never considered. The term "foreigner talk" (Ferguson, 1975) has been used to discuss simplified language for the scaffolding of language that interlocutors use when perceiving that hearers need help in achieving communication. This term seems to assume that the NS listener is a static entity ready to supply pure knowledge, and only the learner is dynamically processing the language. Is there a type of intercommunication happening so that the NS becomes more adept at communicating with someone whose language, particularly whose accent, is divergent from their own language community's accent?

This dissertation remedies the gap in existing research. It asks just how much the target-language native speakers learn and adjust, even if they are not aware of such adjustments or

attenuation while listening to non-native speakers. Many researchers discuss acquisition of language as if it is always the non-native speaker adapting and adjusting, but perhaps the native speaking interlocutor is adapting as well. Gass and Long's theories point to negotiations going on during the communicative phase, but exemplar theory may explain cognitively what is happening phonologically to further flesh out the IIO model, particularly for listeners. In this way, exemplar theory becomes integral to understanding the fine details of the interactions that these two SLA hypotheses and the IIO model posit. If theories of interaction posit that language users and learners learn through negotiating, especially in NS-NNS interaction, then we need to know more about what is happening for the NS listener. Therefore, it is imperative not only to examine the production of the NNS but to ask what is happening for the NS as language receiver. The following section will review specific literature that discusses NS-NNS adaptation, studies that will be helpful in elaborating what is occurring for the listener in interaction theories.

Studies in Adaptation to Accented Speech

This section discusses studies of adaptation to non-native speech by native speakers. Most studies in adaptation to accented speech have the following findings in common: 1. native speakers of a language can be trained to improve in their listening to non-native accented speech, and 2. familiarity with the individual speaker is paramount to intelligibility. Both of these findings suggest that listeners are able to adapt to speech and that they are also able to retain characteristics from the experience or training they receive to use in better comprehension of speech for future similar experiences.

For example, in an early study, Varonis and Gass (1982) found that grammaticality, particularly syntax, influenced judgments of pronunciation. For example, when word order was incorrect in non-native speech, native-speakers ranked the speech less comprehensible. In a

second set of studies, Gass and Varonis (1984) tested the ability of participants to transcribe non-native speech based on domain or topic knowledge. While they found that content knowledge impacted comprehensibility, they also found that familiarity with the same non-native accent and, in particular, with the individual non-native speaker improved the accuracy of the transcriptions. These findings support exemplar theory's probabilistic frequency as key to phonological perception. They point to a need to control for grammar, topic domain, and speaker familiarity in comprehensibility studies. Therefore, based on these findings, constructing a task in which sentences are equally grammatical becomes important. Secondly, Gass and Varonis's (1984) results also suggest a need to control for the listener's topic knowledge when devising a comprehensibility or intelligibility task based on listening to non-native speech pronunciation. Finally, these two studies demonstrate that, since familiarity of the topic and the speaker affect comprehensibility rankings, then both of these need to be controlled for in laboratory studies.

There is a large body of literature discussing listening rater's ability to evaluate speech in terms of accentedness (for a review see Jesney, 2004). While Flege (1984) demonstrated that raters can reliably pick out accented speech in as short a token as a single syllable, he also found that the ability to judge speech as native or nonnative increased when the tokens were increased in length to phrases. This finding leads me to believe that just as findings of familiarity with accent facilitates comprehensibility (Gass & Varonis, 1984), listener experience with recognizing the accent aids in comprehension. Flege (1984) did not test intelligibility or comprehensibility, rather only whether the listeners could judge the speech as native or non-native based on such short instances.

Other studies extended Flege's findings, trying to discern the following three terms when encountering global accents: intelligibility, comprehensibility, and accentedness. Munro and

Derwing (1995a; 1999; 2001; Derwing & Munro, 1997), in their perceptual studies with NSs listening to NNSs, identified what speech is comprehensible, intelligible, and accented. They concluded that *intelligibility* should be defined as the ability to understand the majority of actual words spoken, while *comprehensibility* is the ability to grasp a holistic or global meaning of the utterances. Finally, Munro and Derwing defined *accentedness* as the listener's perception of how different the accent is from the listener's perceived model for a native speaker.

In their studies, Munro and Derwing found that non-native speech that was judged intelligible did not always have lower accentedness ratings, although degree of accent and intelligibility and comprehensibility were correlated. Their work sheds light on terms that may not have been explicitly addressed in SLA literature, and I utilize their term "intelligibility," or the ability to understand individual words from global accented speech. In most of their studies, Munro and Derwing used transcription and/or scalar judgments (excluding Munro and Derwing, 1995b). I utilize reaction time to expand upon their discussion of listening to accented speech as a cause of increased processing time. My research also tests if listeners are actually able to pick the correct word that they heard, rather than responding to a true/false task because of the lack of word-frequency control for a true/false task. To further expand on our understanding of whether experience with one accent may facilitate understanding a second similarly accented speaker, also known as a priming effect, I include a mixed-voice non-native condition.

Even though accent did not necessarily inhibit intelligibility or comprehensibility in their studies, Munro and Derwing (1995b) also found RT's were affected when listening to non-native speech and completing their true-false task. Munro and Derwing suggest that the increased processing time, or "working harder," when judging particularly accented speech may also lead listeners to rate intelligibility and comprehensibility as lower (Munro and Derwing, 1995b; p.

303). Munro and Derwing further infer that the increased processing time may be behind the “irritation” found in such studies as Fayer and Krasinski (1987). For example, in their work, Derwing and Munro (1997) found that while listeners may be able to understand a speaker perfectly well, they may rate the comprehensibility low because of the increased time it took to process the speech. This lag in time, they found, often had to do with the degree of accentedness, but not always. When listeners judged speech as heavily accented, Derwing and Munro found that the comprehensibility and intelligibility ratings were often lower, but not always. The finding that heavy accent does not necessarily correlate with intelligibility and comprehensibility ratings led them to conclude that accent is not always a factor that affects listening comprehension.

In other research, Derwing et al. (2004) found that task type – specifically, ratings of dialogues with a NS versus a monologue introduction with thirty seconds preparation versus a picture description with previous practice -- also influenced the listeners’ judgments of fluency (see also Munro & Derwing, 1994). From these studies, similar to the Gass and Varonis’s studies above, the following items become clear: if researchers want to test language only, then 1. they must use tokens or stimuli that are content neutral, and 2. they must choose speakers with whom listeners are not familiar. A final consideration gathered from Derwing et al’s and Gass and Varonis’s research is that task type as well as listeners’ backgrounds, attitudes, contexts, and roles are also important for the success or failure of NS-NNS communication.

Derwing and Munro’s definition of intelligibility for ratings of global accent (1995b; 1997; 2005) and their findings that speed of speech (1998) may also have an effect on intelligibility and comprehensibility ratings are integral to perception research. While Derwing and Munro (with the exception of the 1995b research) as well as Gass and Varonis used

transcription and ratings, their studies did not test speed of adaptability of the native listening speaker. If judgments of intelligibility and comprehensibility are made quickly, then it becomes important to understand *how* quickly, and to capture the speed of RT's of intelligibility judgments accurately. The quick and accurate capture of adaptation also becomes integral to understanding if cognitive strain is one of the reasons why native speakers rate non-native speech as more difficult to comprehend, as Munro and Derwing posit. An increase in RT that is significantly different than RT to native-English speech would indicate increased processing time used on the part of the listener, which is why a baseline for comparison is integral to this type of experimental research.

Other researchers who consider native speakers' adaptation to non-native speech with experience listening to the similar accent as the major test variable include Weil (2001a, 2001b), Clarke (2000, 2003), Bradlow and Bent (2002, 2008), and Clarke and Garrett (2004).

Weil (2001) found that listeners exposed to Marathi speakers over four days of experimental sessions via intelligibility tests were able to extend their knowledge to other Marathi speakers on the fifth day. Thus, after training, listeners found the speech of talkers who shared a similar accent more intelligible. Weil found that length of utterance affected the listeners' ability to extend their phonological knowledge, and that the perception of word-length utterances did not improve for listeners.

Clarke (2000) trained listeners to adapt to accent over several days, and then tested the training with a transcription task. However, Clarke did not find that the listeners were able to generalize what they had learned in training to new voices, even when several voices from the same accent group were used in training.

Similarly, in a transcription exercise, Bradlow and Bent (2002, 2008) found listeners adapted to Chinese-accented English after exposure, but, unlike Clarke's 2000 study, the listeners could then extend their learning to perceiving speech produced "by a novel Chinese-accented talker" (707). Bradlow and Bent's "results showed that, if exposed to multiple talkers of Chinese-accented English during training, native English listeners could achieve talker-independent adaptation to Chinese-accented English" (707), meaning that they are able to take the features from one speaker and apply these in perceiving a similarly accented speaker. Bradlow and Bent's work, while not longitudinal, provides the NS listener with a great deal of exposure which they label as "training" to aid in transcription tasks.

However, there are problems with using transcription tasks to measure processing. Transcription tasks carry with them many more problems in simulating NS-NNS real-time processing because they may involve a great deal of memory, depending on the length of the utterances tested. As with Munro and Derwing's findings, the transcription task does not constitute the immediate adaptation to speech that would be similar in real-time conversations because during writing, the speech gets reinterpreted by the writer. A final difficulty connected to a transcription task is determining how to score the task. Bradlow and Bent scored the task by counting correct words written in comparison to the actual words said. One problem with this is that listeners often deduce or infer words based on context, even though Bradlow and Bent used novel sentences from a listening test. Another problem with transcription is that listeners often summarize units and reword in their own language. A third problem with transcription tasks is how to normalize adaptation for the speed of writing. Some writers may be able to quickly write the sentences after hearing them, while other listeners who are slow writers may not be able to transcribe in the short amount of time provided, which could also affect adaptation scores.

Based on these conclusions about transcription task difficulties, I surmised that utilizing a quicker form of intake would be a better design to measure listener adaptation.

Other studies that effectively measured adaptation were Clarke's (2003) and Clarke and Garrett's (2004) study. They were able to better measure adaptation by simulating real-time listening through a cross-modal word verification task in their experiments concerning rapid adaptation to foreign-accented English. Clarke and Garrett (2004) tested how long it took English-speaking listeners to adapt to a foreign accent, specifically Spanish and Chinese-accented speech. They found that it required less than one minute of prior exposure to the accent and in some cases only exposure to two to four sentences in order to for the native English speakers to adapt to foreign-accented speech. Their study included three different experiments. Experiment One utilized adaptation to a Spanish-accented speaker. Experiment Two used the same tokens as Experiment One but with pink noise (also known as background noise) added to the final token. Experiment Three had the same design as Experiments One and Two but with a Chinese-accented speaker which was a less familiar accent for the listening participants. In all of the experiments, Clarke and Garrett found rapid adaptation to the accented speech occurred by the native English listeners.

This dissertation's goal is to replicate and extend Clarke and Garrett's experiment with a different non-native speaking accent (Korean) and the addition of a condition in which the native-English speaking listeners hear first one Korean speaker and then a second Korean speaker to test if the exposure to the first accent will aid in comprehending the second similar accent. Finally, Clarke and Garrett discuss their results in terms of phonology, but I will discuss these results in terms of their implications for SLA as well as phonology, particularly implications for negotiation/interaction theories and second-language classrooms.

To summarize, the first section of this chapter has been an exploration of exemplar theory and what it posits about how humans acquire phonological systems. I conjecture that for second language acquisition, humans may develop different exemplars, those from their most frequent encounters, usually their first language or languages that are acquired. I use the metaphor of the concrete road to describe phonological access to the sounds frequently stored. For those that are less frequently encountered, I use the metaphor of the park path, which I have borrowed from Pierrehumbert (cited in Nathan 2007). With this metaphor, I am arguing that exemplar theory needs expansion to reflect L1 and L2 acquisition for both production and comprehension.

In the second section of this chapter, I discussed Labov and his extension of exemplar theory to the field of sociophonetics. I argue that this dissertation's research is an intermediary between how exemplar theory is conceived in phonology and in sociophonetics because it considers the cognition of the listener as well as the social significance of the listener's perceptions for the speaker.

In the third section of this chapter, I argued that interaction-based theories in SLA need exemplar theory to explain what the listener or hearer in the communication process is doing, especially if SLA scholars argue that negotiation is integral to language learning. Here, I add that the listener may also be a learner, acquiring a more diverse phonological system (i.e. more park paths) with more frequent encounters with accented speech.

In the final section of this chapter, I discussed adaptation to non-native speech studies and reviewed how my study differs from those in that I am testing a "priming effect" or whether experience with one speaker will aid in faster RT's and lower error rates when encountering a second speaker with a similar accent.

CHAPTER THREE: METHODOLOGY

Since I wanted to test adaptation to accented speech, or the ability of listeners to improve in reaction times (RT's) and error rates when listening to non-native speech, I decided to develop an experiment with Clarke and Garrett's (2004) design as a model. I was particularly interested in whether the improvement in RT's and error rates occurs within a short period of time as might happen in brief real-life conversations between NSs and NNSs or for listeners who assess language proficiency in standardized tests, such as the TOEFL® iBT, in which less than one minute of speaking is evaluated in each of the six sections that comprise the speaking portion of the test. My specific research questions from Chapter One were:

1. Do listeners adapt to non-native accented speech?
2. How long a period does adaptation take, if it occurs at all?
3. How does exposure to the speaker or speakers from the same language affect possible adaptation?
4. Are there benefits from previous contact with the same accented language?
5. If this priming effect does occur, how much experience is needed to have benefits from the previous language contact?

The following chapter is a description of the research design, the tokens, the participants, the instruments, the procedures, and data analysis used for the adaptation to non-native accented speech that were used to answer the above questions.

Research Design and Hypotheses

Token sentences (usually referred to as tokens) read by NSs and NNSs were arranged in the following four conditions in this experiment: all one native speaker (NS Condition), one native speaker followed by one non-native speaker (NS/NNS Condition), all one non-native speaker (NNS Condition), and non-native speaker followed by a second non-native speaker (NNS/NNS Condition). Table 1 below lists the number of token sentences the listeners in each condition heard. It is important to note that the ordering of this design is similar to Clarke and Garrett's (2004) original experiments, with the exception of the NNS/NNS Condition.

Table 1: Experiment Design: Four Conditions by Speaker Group

Condition/ Speaker	NS Condition	NS/NNS Condition	NNS Condition	NNS/NNS Condition
Practice 8 tokens	NS 1	NS 1	NS 1	NS 1
Experimental 12 tokens	NS 2	NS 2	NNS 1	NNS 1
Experimental 4 Tokens	NS 2	NNS 2	NNS 1	NNS 2
Baseline 8 tokens	NS 3	NS 3	NS 3	NS 3

The research design outlined in Table 1 was developed to test the following hypotheses:

1. The NS condition will have the fewest errors and fastest RT's.
2. The NS/NNS condition will have higher RT's with the introduction of the NNS speaker (token 13) but RT's will diminish by the end of the experiment (16th token) as the listeners adapt.
3. The NNS condition will begin with higher RT's than the NS condition, but these RT's will decrease by the end of the experimental section (16th token).
4. The NNS/NNS condition will have a spike in RT's with the introduction of the second non-native speaker similar to the NS/NNS condition, but these RT's will not be as high as

the NS/NNS condition because the previous experience with a similar accent will facilitate the comprehension of the second NNS, thus creating a priming effect.

First, all listeners began with a practice section to familiarize them with the task. In all four conditions, the same native speaker read sentences for these practice trials, denoted by NS 1 in the above table. All of the baseline token sentences for every condition were the same sentences and spoken by the same native speaker of English, noted by NS 3 for all conditions. The speaker the listeners heard in the practice section was not the same native speaker as in the experimental or baseline sections, noted as NS 2 in the above chart. The baseline tokens were the last section in every condition so that the students had familiarity with the task, but since the experiment lasted less than five minutes, the participants were not fatigued by the time they reached the baseline tokens.

The baseline tokens serve an important purpose in perception experiments. Unlike the practice trials, which were expected to have high reaction time rates because of the unfamiliarity with the task, the baseline tokens' purpose is to give a general idea of what the normal level of RT's are; in essence, the best RT's for each listener. The baseline section served as a barometer for RT's. The baselines should have the lowest RT averages overall for each condition. Since there were only forty trials at maximum of four seconds each before the baseline trials, it was assumed that the listening participants would not be fatigued by the time they reach the baselines, but that they would also be familiar with the task by the time they reached the baseline section. Baseline RT's are vital in understanding whether listening participants are within the averages or if they should be excluded as outliers. The baseline averages should be similar among conditions; otherwise, the results would indicate that something was wrong with the

experimental design, technology, or listening participants. Hypothetically, all conditions should have similar baselines.

As noted in Table 1, the first three conditions (NS, NS/NNS, & NNS conditions) were exactly the same arrangement as Clarke and Garrett's (2004) original design. However, their original research question was concerned with how quickly listeners adapt to foreign-accented speech, specifically Chinese and Spanish. My research design was also concerned with adaptation to one foreign-accented voice, Korean-accented; however, my other main research question was concerned with whether there was a priming effect from exposure to a speaker of the same language. Therefore, in the NNS/NNS condition, two non-native speakers were used in the experimental section, one speaking the first twelve tokens, as denoted by NNS 1, and then a second speaker for the last four tokens, as denoted by NNS 2 in Table 1. The NNS/NNS condition was very similar to the NS/NNS. In the NS/NNS condition the listeners hear a native speaker for the first twelve experimental trials and then a non-native speaker voice introduced at trial 13 and continuing to the end at token 16 (the same non-native speaker as in the last four trials for the NNS/NNS condition). The NNS/NNS condition was specifically used to test if there is a difference in RT's of the last four trials when compared to the last four trials of the NS/NNS condition, which would indicate a difference in the listeners' cognitive processing. Put another way, these conditions were arranged as noted in Table 1 to test if listeners reacted more quickly when a non-native speaker followed a non-native speaker or when the non-native speaker followed the native speaker.

Tokens

In order to create a cross-modal stimuli-presentation experiment in which NS-English listeners would hear sentences spoken by NSs of English and Korean NNSs of English and then

choose a correct visual stimulus word, token sentences needed to be considered. Tokens, or contextually ambiguous sentences, were taken from Clarke and Garrett's (2004) original experiments and were arranged into the following order: 8 practice tokens, 16 experimental tokens, and 8 baseline tokens. Clarke and Garrett originally used tokens from the Revised SPIN Test, a test which is designed to test speech perception in noise for contextually dependent and independent sentences (Bilger, 1984, as cited in Clarke and Garrett, 2004; Kalikow et al., 1977). These sentences were considered contextually ambiguous because listeners are unable to deduce the final word from any of the prior words in the sentence. Examples of contextually ambiguous sentences used are "The man spoke about the clue" and "Tom is considering the clock." A complete list of tokens used is included in Appendix B.

These sentences were particularly important because they are what Clarke and Garrett refer to as "low probability" sentences, meaning that the final word was not predictable based on the content of the whole sentence, and the final words had been tested for frequency. Word frequency and, hence, familiarity with the words were important factors in this design. Clarke and Garrett's original tokens were "familiar, monosyllabic nouns with a mean frequency of 22 per million" (Kučera and Francis, 1967, as cited in Clarke and Garrett, pp. 3649-50). Frequency and word length were important as the sentences needed to be as uniform as possible and yet familiar to a general listening audience. This research was not intended to test memory or vocabulary, nor was it intended to skew results because of misplaced stress on syllables. Therefore, the sentences were approximately the same length, the same general subject-verb form, and the final word a monosyllable. This resulted in sentences that were uniform as possible and meant that the listeners could concentrate on listening without taxing their memory.

The token sentences averaged 5.625 words. Half of the tokens had final words that matched the visual stimulus. Therefore, “yes” would be the correct response, and half of the tokens had final words that did not match the spoken word and the visual stimuli, so “no” would be the correct response. In the tokens with the mismatches, the visual stimuli were minimal pairs and differed in only one sound, sometimes an internal or final vowel sound, such as in “cook” and “kick” or “clue” and “clay,” but sometimes in a consonant sound, as in “phone” and “foam.”

Speakers

For the experimental task, five speakers in total were recruited, three native speakers of English and two non-native speakers of English. The following sub-sections describe the two groups of speakers and the procedure in recording them.

Native Speakers

The three native speakers were all female, having resided in the southeastern region of the United States for more than five years. Three speakers were recruited because the baseline and practice sections required native speakers, but the speakers in the baseline and practice sections could not be reheard in the experimental sections in order to get accurate RT’s for novel speakers. The native speakers had backgrounds in education and teaching experience at American universities, similar to the non-native speaking participants

Non-Native Speakers

The non-native speakers were two female international teaching assistants (ITAs), native speakers of Korean, who had both been in the United States more than five years. These two speakers were chosen from the recruited volunteers because they shared the same language backgrounds, were the same sex (female), and as teachers of record for their classes, had had similar scores on a standardized test (SPEAK) to be eligible to teach at their university. The

Korean speakers of English where both second language learners of American English, having studied English for more than ten years and having resided in the southeastern U.S. for more than five years.

Recording the Speakers

The speakers were all recorded with the program Audacity[®], a free audio editor and recorder, using a Venus unidirectional microphone. Each read thirty-two sentences, recorded at 44100 hz. The speakers read each set of thirty-two sentences at least four times. They had time to read over the sentences before recording. They were given time to ask any questions about the vocabulary or pronunciation of words in the sentences before recording. Many of the participants asked about volume or speed. The speakers were asked to read as naturally as they could, with the same volume and speed they would use for teaching. Because these tokens or sentences needed to initially be similar in length even before editing, some of the speakers were asked to read again at a later date so that their pitch rates would not be unnatural after manipulation for uniformity.

Token Manipulation and Instruments

Using Praat[®], a free computer software program utilized in the analysis of speech, all files were equalized for amplitude at 73 decibels (db) with the application for normalizing amplitude. Tokens were then individually edited into WAV files, making sure that the endings and beginnings were edited to the 0 crossing, so that no popping would disturb or distract the listeners. Praat[®] scripts were then reviewed, but none manipulated the tokens by condensing and lengthening at the same time, so one of the scripts in Praat[®] was rewritten and manipulated by Robert Jones, a computer programmer and systems administrator. The WAV files were then either condensed or lengthened with the manipulated script (see Appendix C). This manipulation

ensured that all sentences would be approximately the same length, and that within the conditions, the tokens would be exactly the same lengths. Praat[®] was used to run the scripts to manipulate the tokens.

Unlike Clarke and Garrett's original experiment, in which the researcher only manipulated the final word of the tokens, the whole sentence in this case was either condensed or lengthened to ensure uniformity of length. A revised script (see Appendix C) from Praat[®] for taking the mean length of sound files was used to condense and lengthen the sentences to their mean for that condition. These tokens ended up being 1.791 milliseconds in the NS condition, 1.81 milliseconds in the NS/NNS condition, 1.907 in the NNS condition, and 1.883 in the NNS/NNS condition. The tokens were scaled to be uniform within every condition, but care was taken not to clip the tokens and create unnatural sounding data. In some cases, the readers were asked to read again if clipping occurred during the scaling process.

It was important to keep all the sentences the same length within the condition. There were valid reasons to edit the whole token. First, I wanted to test language as it naturally occurs—as naturally as it could be tested in a systematic way—even in a laboratory situation. Editing the last word in the sentence, as Clarke and Garrett did, would manipulate the speaker's prosody in a way that differs from normal classroom speech. I wanted to test speech with as natural a prosody as possible while at the same time having uniform tokens. By condensing or lengthening the whole sentence, the natural prosody of speech was kept intact, although rate of speech is slightly manipulated. Second, it was believed the whole construction more closely resembled classroom discourse. Several researchers listened to all of the tokens again to ensure natural-sounding data. Finally, having the tokens in the same condition be uniform in length was extremely important, since the program they were entered into is measuring RT's. In order to

measure these RT's accurately, all tokens within each condition needed to be uniform as well as presented uniformly.

The tokens were then put into the stimulus-presentation program Superlab[®] 4.0, which was used to present the token sentences to the listeners. Superlab[®] 4.0 is a cross-modal stimulus-presentation program developed and marketed by Cedrus Corporation. It was necessary in order to ensure that the aural stimuli were immediately followed by the visual stimuli that the students responded to. The use of a stimuli-presentation program was integral to presenting the stimulus at equivalent speeds and then getting a data file in which RT's and error rates were recorded. Superlab[®] was loaded onto personal computers in a small, quiet language lab. The students used the Cedrus RB-730 response pad, which has two colored tiles (red and blue) on the farthest left-end button and the farthest right-end button. This ensured that the students would have a clear visual connection to the color-coded button they were supposed to push. A red "yes" and a blue "no" appeared on the screen, matching the colored tiles on the response pad (see Figure 1 below).

Listening Experiment

The listening participants were recruited from a large southeastern university comprising approximately 36,000 students. Eighty-four undergraduate participants from either first-year composition courses, first-year linguistics courses, or first-year Spanish courses were recruited to be listeners in the research in Spring 2008 and given the opportunity to participate in the experiment as one option for partial credit or extra credit in their classes. If the students wished to volunteer for the experiment, they came to a small lab where the experiment was set up during designated hours, where the researcher gave directions, monitored their activity, and answered any questions concerning the experiment. The students also filled out a questionnaire about language background and attitudes as they waited outside the computer lab before taking part in

the experiment. All listening participants self-reported as native-speakers of American English (although the demographic questionnaire information points to more diversity than originally assumed), and all participants reported normal hearing.

Procedure

The listening participants filled out questionnaire/intake forms and signed waivers (See Appendix A). They were then given a code number, and the code number was written on their intake form. The subjects were given a code number to ensure that their identities would be confidential.

The subjects entered the computer lab in groups of four at a time because of limited computer lab space and computer resources. Each of the computers had a different condition (one of the four) loaded onto it. The participants were not told which condition they would be taking part in, and they were not explicitly put into a condition. In other words, the four participants sat randomly at a computer of their choosing, but this seating ensured that the conditions would have equal numbers of participants. Participants were then given their code number to log into the program and begin the experiment. Participants were given both oral and written instructions to work as quickly as possible. They were explicitly told that RT's and error rates were being recorded. Each section (the practice, the experimental, and the baseline) also had the following written instructions preceding the activity:

Please listen to each sentence carefully. After you hear each sentence, you will see a word. If the word matches the last word of the sentence that you heard, please select "Yes." If the word does not match the last word in the sentence, please select "No." **Please respond as quickly as possible.** Failure to respond within four seconds will move you on to the next sentence. We will stop after

these eight (sixteen for the experimental and eight for the baseline) sentences so that you may ask any questions that you have.

Students listened to the tokens through noise-reduction headphones, and used an RB-730 response pad with color coded chips covering the farthest right and left buttons, denoting red for “yes” and blue for “no.” The researcher was nearby to be able to answer any questions.

The token sentences were immediately followed by probe words (for a complete list of tokens and probe words, see Appendix B) that either matched the final word in the token sentence or did not match the word. For example, students heard the sentence “They knew about the fur.” Subjects would then see on a screen the word “firm” with a red “yes” and blue “no” on the screen. They would then press the red or blue button on the response pad that corresponded to the color and placement of the “yes” or “no.” In this example, “no” would be the correct response because the word that they saw on the screen, “firm,” and the final word in the sentence that they heard, “fur,” did not match. The program recorded the listeners’ error rates and time in milliseconds (ms) for each token response. If the listener did not respond within four seconds, the program proceeded to the next trial, and recorded a *no response*. The picture below is an example of the screen displayed immediately after hearing the token sentence “They knew about the fur.”

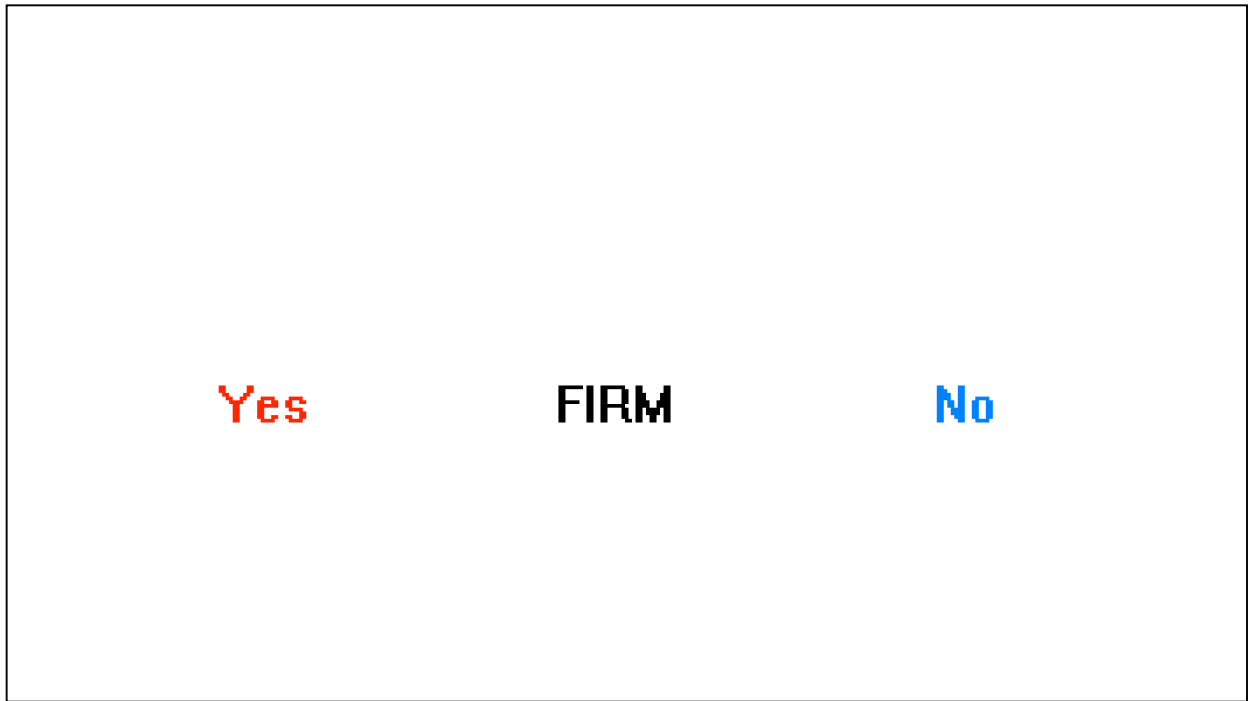


Figure 1: Example Screen of the Visual Stimuli

For the above example, since the aural stimulus was “They knew about the fur,” the listener should have pushed the blue button on the farthest right side of the response box, since it corresponded to the blue “No” on the example screen shown in Figure 1. The correct answer was “no,” since “firm” was the visual stimulus which did not match the aural stimulus “fur.”

Data Analysis

Superlab[®] automatically created a raw data file of the participants’ RT’s and their errors. These files were separated by condition and put into Excel files where means, medians, and modes for RT’s and the error rates were calculated. The standard deviations were also calculated, so that individuals whose averages fell outside of the range could be eliminated as outliers. A histogram of the data was made to see if the data had a normal distribution. This will be further discussed in Chapter Four.

The averages were then put into Excel charts using a line graph to plot each token’s average time in milliseconds. The charts were then analyzed to discern if they followed the

hypothesis for each condition. Finally, a t-test was calculated to see if the difference in milliseconds between the groups was statistically significant. Then the slope of the line of the tokens 12 to 16 in the NNS, NS/NNS, NNS/NNS condition was calculated. This was done to see if the slope was negative or positive. The slopes of these lines were then compared. Finally, the means of the RT's in each of these conditions were calculated to see if there was a significant difference between them. ANOVA and the linear mixed-effect model (LMM) were also used to determine statistical significance between groups for the four hypotheses. These two methods, the main statistical models used in the data analysis, will be further discussed in Chapter Four.

CHAPTER FOUR: RESULTS

This chapter presents the results from the experiment outlined in Chapter Three. First, this chapter discusses the listening participants and their demographic information, results culled from the questionnaire (see Appendix A) that they filled out before taking part in the experiment. Second, this chapter discusses the general data and the statistical analysis used to examine the data to compare the baseline tokens in each condition and test whether the four hypotheses outlined in Chapter Three were confirmed or denied. Third, this chapter will discuss the results of the hypotheses in further detail, particularly hypothesis four. I examine information concerning long-term experience with Korean and how the longitudinal experience may be affecting six of the participants who reported Korean language experience. Fourth, I will discuss these findings in comparison to a pilot study, with a discussion of methodological changes that should be made for future studies. Fifth, I conclude this chapter by comparing my results to other adaptation studies and propose two ways that the human phonological system is utilizing information that it encounters in short-term and long-term exposure, utilizing the metaphors from Chapter Two—the park path and the concrete road. I also discuss how this information should be considered and integrated into exemplar theory as well as how this information can be interpreted for SLA. Finally, I conclude with limitations of this study, and suggestions for what studies need to be conducted to supplement this dissertation’s findings for the field of SLA.

Demographics of the Participants

The sample of listening participants consisted of 24 males (28%) and 61 females (72%). One individual was excluded because she failed to finish the task. The mean age of the listening

participants in this study was 20.52 (range = 18, 35). While filling out the questionnaire, participants gave information about their language contact experiences. For family language use, all but 19 of the participants reported using only English at home. However, this population of second language users is surprisingly high, in that the university's statistics claim only a 6% international population, but they define this as students from other countries (<http://www.uga.edu/profile/facts.html>). This means that approximately 22% of the participants in this sample report using a language other than English at home. Additionally, four reported using two languages other than English in the home, which constitutes almost 5% of the sample population. The languages reported as spoken in the home were as follows: Hindi, German, Bosnian, Spanish, Gujarati, Urdu, Filipino, Italian, Mandarin, Thai, and Romanian.

As for language study, only one participant had never studied a language other than English, although another respondent reported having studied American Sign Language and no other foreign or second language study. Of the other 83 respondents who reported having studied a language other than English, the length of time varied greatly. Some reported as little as one semester of foreign-language study whereas one respondent reported as many as 16 years of foreign language study. Students self-reported having studied the following 12 languages: Latin, Spanish, German, French, Arabic, Korean, "Hatia(?)," Hebrew, Italian, Chinese, American Sign Language, and Japanese. "Hatia" is questionable; this is what the respondent wrote, but there is no known language named Hatia, so it is speculated that the respondent meant "Haitian" [Creole] here.

Forty-seven (55%) of the participants reported having an international instructor in the current semester. Of that number, four of the participants were unsure as to what language or languages the international instructor spoke. Others reported that their instructors spoke the

following: Japanese, Chinese, Spanish, Russian, French, Taiwanese, Mandarin, German, Jamaican, Arabic, Indian, French-Ghanan, Portuguese, Vietnamese, and several African languages.

As for contact with speakers of other languages outside of the classroom, 68 (82%) of the students reported having friends or acquaintances who spoke a language other than English. The respondents listed 29 different languages used by friends and acquaintances in their social networks: French, Spanish, Vietnamese, Bulgarian, Gujarati, Urdu, Patwa, Korean, Dutch, German, French Creole, Chinese, Bangladeshi, Filipino, Hindi, Arabic, Savinien French, Larisa, Jarjeta, Indian, Jamaican, Japanese, Igbo, Afrikaans, Thai, Nigerian, Thai, and Ukrainian. Six of the participants reported that while they had acquaintances who spoke a language other than English, they were unsure what the language was.

As for attitudes toward learning a language, nine (11%) of the participants reported having no interest in learning a language other than English. One participant responded as not sure, and the rest of the participants conveyed an interest in learning a language other than English. The 75 (88%) of the participants who were interested in learning a language listed the following languages that they wished to study: Spanish, American Sign Language, Italian, Greek, Arabic, German and Germanic Languages, French, Portuguese, Farsi, Latin, Vietnamese, Chinese, Mandarin, Japanese, Gaelic Irish, Danish, Nigerian, Bulgarian, Tagalog, Quiche [Quechua], Taiwanese, Hebrew, and Hindi. One participant responded “all” to the question item of being interested in learning a language other than English.

As for travel abroad, 15 (18%) of the participants responded that they had never been out of the country, but 18 (21%) of the participants responded that they had lived abroad. The rest (61%) had traveled out of the country although this did not guarantee that they had spent time in

a second language environment as some participants listed places such as Canada, Britain, and other English-speaking nations as their destinations.

In summary, this section has been about the demographic information of the listening participants. The demographic findings from the questionnaire illustrate that the participants have wide-ranging experience in language contact and use, one that is particularly diverse in terms of languages spoken in their homes and social networks. Also interesting in the demographic data are the participants' language attitudes, since all of the participants except one reported language-learning interests with many of the respondents having an interest in learning multiple languages. These findings convey positive attitudes toward language learning and language diversity.

General Description of the Data

The following section is a general description of the data from the experiment to test if native-English speakers adapted to Korean-accented speech, and if exposure to one Korean-accented speaker facilitated in lower RT's when listening to a second Korean-accented speaker. First, I examine the raw data to determine if there were participants outside of the mean RT's and error rates and if the experiment data were normally distributed (see Appendix E). Next, in this section, I will look at the data after statistical analysis, specifically utilizing ANOVA and linear mixed-effect model (LMM). Then, I consider the baseline tokens to determine if the RT's and error rates are similar for all conditions.

After looking at the error rates for the individual participants and also calculating the reaction time (RT) means and medians for the individual tokens, I determined that two of the participants (participant 20 and 43) were outliers because they exhibited much higher error rates (RT's) than the other listeners. Participant 20's mean accuracy was 40% correct in the NS

condition in which the other participants had a mean accuracy rate of 92% correct. Participant 43's accuracy was 0% in the NNS condition in which the other participants had a mean accuracy rate of 88% correct. Participants 20 and 43 were removed from the data set and the RT's and error rates were recalculated for all of the tokens (see Appendix F).

To determine if the experiment data were normally distributed, all of the conditions' reactions were combined, and it was found that the distribution was skewed to the right and the error rates did not have a constant variance. That the experiment data were skewed to the right makes sense as the mean RT was less than 1,000 milliseconds, or under one second, so we would expect the data to cluster below the 1,000 millisecond mark. A general visual depiction of the raw data of the means of the RT's of the 16 experimental tokens with the two outliers removed can be seen below in Figure 2 which contains a line chart illustrating all means of the listeners' RT's by token according to condition.

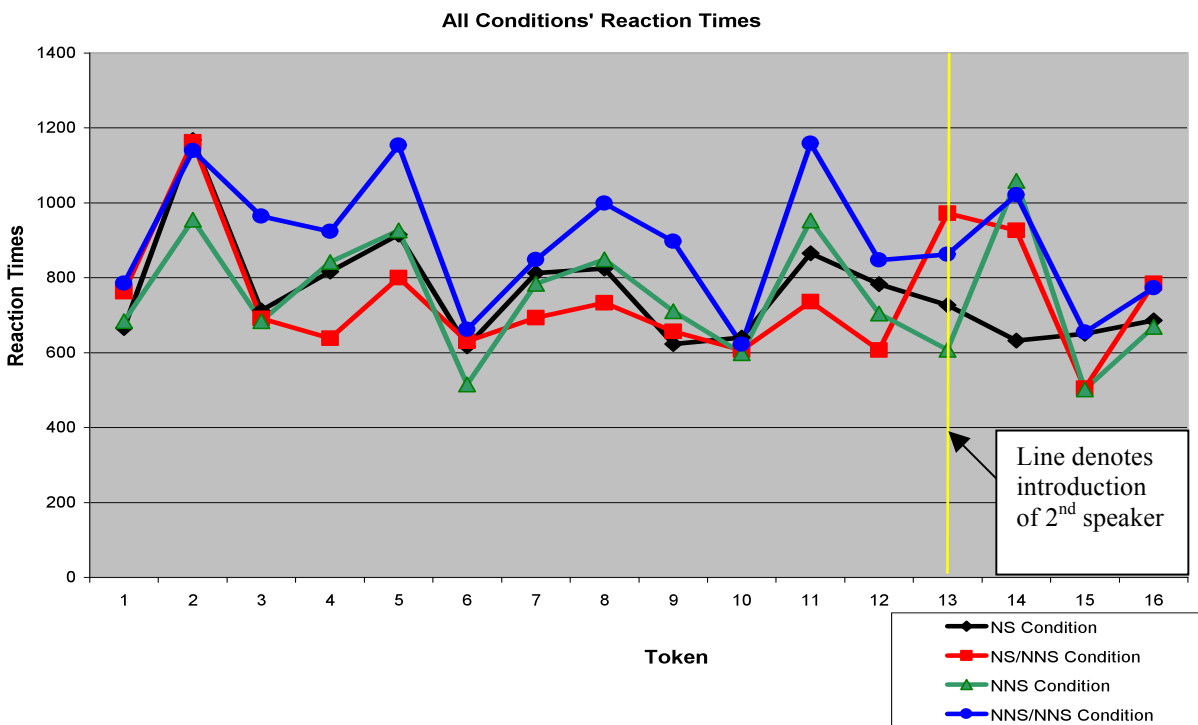


Figure 2: Mean RT's of Experimental Tokens by Condition

As can be seen in Figure 2 above, the RT's of all of the conditions cluster together or follow similar patterns in terms of listeners' means throughout all of the conditions. At token 13, as noted by the yellow line, a significant rise occurs for the NS/NNS and NNS/NNS conditions. This rise is expected because it is the introduction of the new or novel speaker for the NS/NNS and NNS/NNS conditions. However, if we look at the mean RT's by token 15 and 16, we see that the means are almost in line with the NS condition, suggesting adaptation to the novel speaker, since the 15th and 16th token points in all of the conditions cluster together by the end of the experiment as pictured in Figure 2.

The RT's were also examined to determine if there was a normal distribution of data. After univariate analysis, it was found that the RT's skewed to the right and did not have a normal distribution. In order to use a method or model that requires the assumption of normal distribution, a natural logarithm transformation was performed on the variable of reaction time (see Appendix G). This transformation ensured that the data would have a roughly normal distribution and constant error variance so that the data could be analyzed by ANOVA and LMM, which are models that assume normal distribution.

After the logarithmic transformation, it was found that the RT's for the first twelve experimental tokens of NS, NS/NNS, and NNS conditions are similar in terms of mean and median RT's ($M = 6.48, 6.51, 6.53$; $Mdn = 6.44, 6.44, 6.49$ respectively). The NNS/NNS condition had the highest mean and median reaction time ($M = 6.72$; $Mdn = 6.72$). For the last four tokens, as expected, the NS and NNS conditions ($NS\ M=6.40$; $NNS\ M = 6.41$) were similar to each other in terms of mean RT, while the NS/NNS and NNS/NNS conditions were similar to each other in mean and median RT's ($NS/NNS\ M = 6.56$; $NNS/NNS\ M = 6.62$). However, the conditions differed in error rates, and the NNS/NNS condition clearly had the highest error rate

(see Appendix F). This will be further discussed under hypothesis one and in the discussion section.

Baseline Comparisons

The first step in certifying that the results of this experiment were valid is to establish that the baselines are similar for all groups. As discussed in the methodology section, the baselines were established as a reference to see what the best times for the participants would be ideally and also to compare these RT's for each condition against each other to be sure that all groups are similar. Two models were used to analyze the difference between the RT's and error rates of the four conditions, ANOVA and LMM. The LMM yielded no statistically significant difference between conditions in term of RT's, $F(3, 567) = .41$, $p\text{-value} = 0.7485$, which suggests that there is no significant difference in baseline RT's among the four conditions. ANOVA also yielded no statistically significant difference in RT's among the four conditions, $F(3,7) = 1.84$, $p = 0.1385$. However, a Wald chi-square test (see Appendix F) yielded a difference in error rates, with the NNS/NNS condition having a significantly higher error rate than the other conditions, $\chi^2(3, N = 656) = 8.20$, $p = 0.0421$. Therefore, the baselines are similar in RT'S; however, error rates for the NNS/NNS condition were higher than expected. This will be further discussed below.

The baselines also provide each condition with what should be the listener's most accurate RT's so that we can compare within condition performance. The following chart in Figure 3 depicts the difference between the RT means of the baselines and the RT means of the first twelve tokens and the last four tokens for each condition.

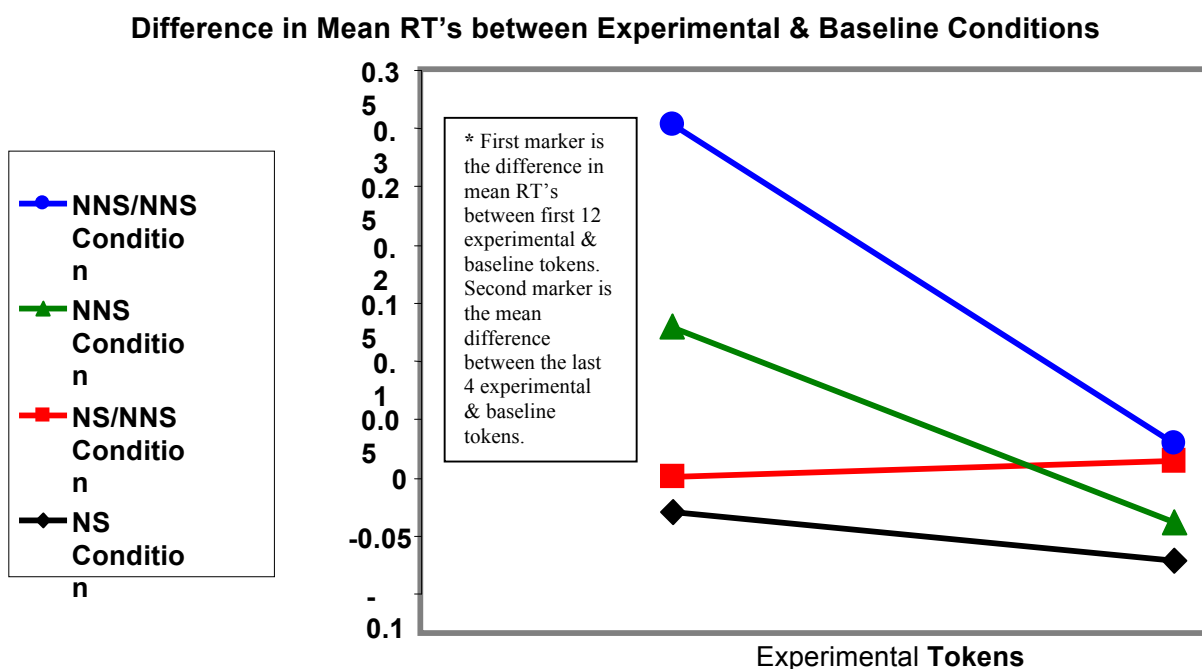


Figure 3: Differences in RT's between Experimental and Baseline Tokens

In Figure 3 above, the first marker (marker on the left) indicates a difference in the mean RT's between the baseline (or best times) and the first twelve experimental tokens' mean RT's, The final marker represents a difference between the baseline tokens' mean RT's and the last four tokens' mean RT's. If we look at Figure 3 above, we notice that all lines, with the exception of the NS/NNS condition, have a negative slope, and that the difference in the RT's from the baselines, with the exception of the NS/NNS condition, become smaller by the time we reach the last four token mean differences between the experimental tokens and the baselines. We would expect there to be a rise for the NS/NNS condition as this is only a comparison of the difference of the slope between the baseline RT's and the first 12 experimental tokens' mean RT's versus the final four tokens' mean RT's. The depiction in Figure 3 does represent a lowering of RT's in conditions in which the listeners hear non-native speech, with the exception of NS/NNS because the rise represents the mean of all of the final four tokens. We then need to look at the individual

means of the last four tokens of all of the conditions. If we look at the mean RT's of the individual final four tokens of all the conditions in the chart in Figure 4 below, we see that they come in line or with one another or cluster together by the final token (token 16) for all conditions.

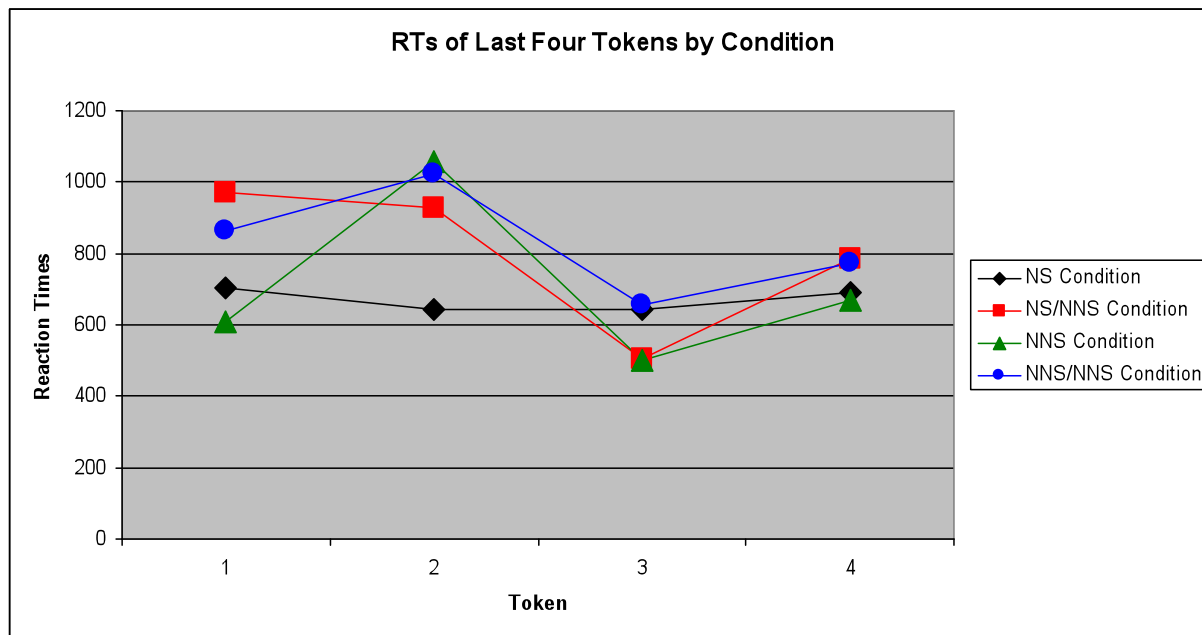


Figure 4: Comparison of RT's of the Last Four Tokens by Condition

As expected in Figure 4 above, the NS condition shows an almost flat line. All of the other conditions show a lowering in RT's, which in some cases comes below the RT's of the NS RT's.

Hypothesis Results

The following section is a discussion of each of the four hypotheses listed in Chapter Three.

Hypothesis one: NS condition will have the lowest error rates and RT's of all the conditions.

In order to compare reactions times, the RT's of all of the conditions were examined.

The two variables of condition and token were found to be significant using an ANOVA analysis.

We would expect the token and condition to affect RT's, since there was a different speaker for some tokens, depending on condition. We would also expect some tokens to be more difficult as they differed in sounds that are very similar. An example would be the token "Bill might discuss the foam" in which "phone" was the visual stimulus.

For RT's, a one-way ANOVA analysis of the RT's suggests that there is a significant difference between the four conditions in terms of RT's, $F(3, 7) = 1.84, p < 0.0001$. However, the ANOVA test determines only that these conditions differ in RT's. The ANOVA analysis does not inform us about which condition had the lowest RT's. In order to determine whether the NS condition was the lowest, a linear contrast was performed on the data. It was determined that the NS condition mean RT's were the lowest (NS $M = 6.45$, NS/NNS $M = 6.54$, NNS $M = 6.47$, NNS/NNS $M = 6.53$), but was the NS condition statistically significant in terms of having lower RT's than the other conditions? To determine if the NS condition RT's were significantly lower than the other conditions as hypothesized, an LMM² test was run. A one-tailed mixed model analysis yielded marginally significant results, $F(3, 1214) = 2.07, p = .0512$. Thus, the NS condition does have the lowest RT's.

To determine if the NS condition had the lowest error rates, a logistic regression approach (see Appendix G) was used to determine the probability of an event, in this case the

²Test 1: $C1 = (C2+C3+C4)/3$ vs. $C1 < (C2+C3+C4)/3$

Test 2 (simultaneous) : $\{C1 = C2, C1 = C3, C1=C4\}$ vs. $\{C1 < \text{any of } C2, C3 \text{ or } C4\}$

The p-values of both tests are smaller than 0.0001, meaning that both $C1 = (C2+C3+C4)/3$ and $\{C1 = C2, C1 = C3, C1=C4\}$ are rejected; this suggests that C1 has the lowest reaction time.

Note that the ANOVA approach assumes that all data are independent, which is probably not true here. In the experiment, each subject was repeatedly tested with different tokens. Data from the same subject may be correlated. Some people may tend to react faster than others. Ignoring the within-subject correlation may lead to overestimated difference due to condition. Therefore, a linear mixed effects model was used to re-analyze the data.

binary condition of error or no error in each condition³. The odds of error in the NS/NNS condition was 1.559 times the odds of error in NS condition; the odds of error in the NNS condition was 2.446 times the odds of error in the NS condition, and the odds of error in the NNS/NNS condition was 2.867 times the odds of error in the NS condition. Thus, the NS condition corresponded to the lowest probability of error rate. Hypothesis one was confirmed for both error rate and reaction time, showing that the NS condition does have the fewest errors and lowest RT's.

Hypothesis two: The NS/NNS condition will rise at token 13 (when the NS is introduced) but will lower as adaptation to the speaker occurs.

Using both a linear regression model and the LMM, the slope of the NS/NNS condition in which the non-native speaker had been introduced was examined to see if the listeners were adapting to the non-native speech. If adaptation occurred, it would be expected that the RT's would lower by the end of the experiment for NS/NNS condition. It was expected that at token 13 – the token in which the NNS is introduced – the slope of the line would be significantly positive; however, as the listeners adapt, the line would be expected to have a negative slope

³ A logistic model is used to model the conditional probability of a certain event (in this case, an error) given a set of explanatory variables. Let p denote the probability of an event, and $\{X_1, \dots, X_k\}$ denote the set of explanatory variables, then a logistic model can be written as

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \dots + \beta_k X_k,$$

where β_0 is the intercept, $\{\beta_1, \dots, \beta_k\}$ are the regression coefficients, and 'ln' is the natural logarithm function. One can use the logistic model to predict the probability of getting an error given any set of $\{X_1, \dots, X_k\}$ values. The prediction equation will be

$$P(\text{error}|X_1, \dots, X_k) = \frac{\exp(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)}{1 + \exp(\beta_0 + \beta_1 X_1 + \dots + \beta_k X_k)},$$

where 'exp' is the exponential function (the inverse function of 'ln'). If the parameter β_1 is significantly positive (or negative), then it means that X_1 has a significant positive (or negative) effect on the likelihood of error.

value. Figure 1 displays the lines lowering in all conditions, but if we take the NS/NNS condition and look at it as a scatter plot in Figure 5 below, we have the following depiction:

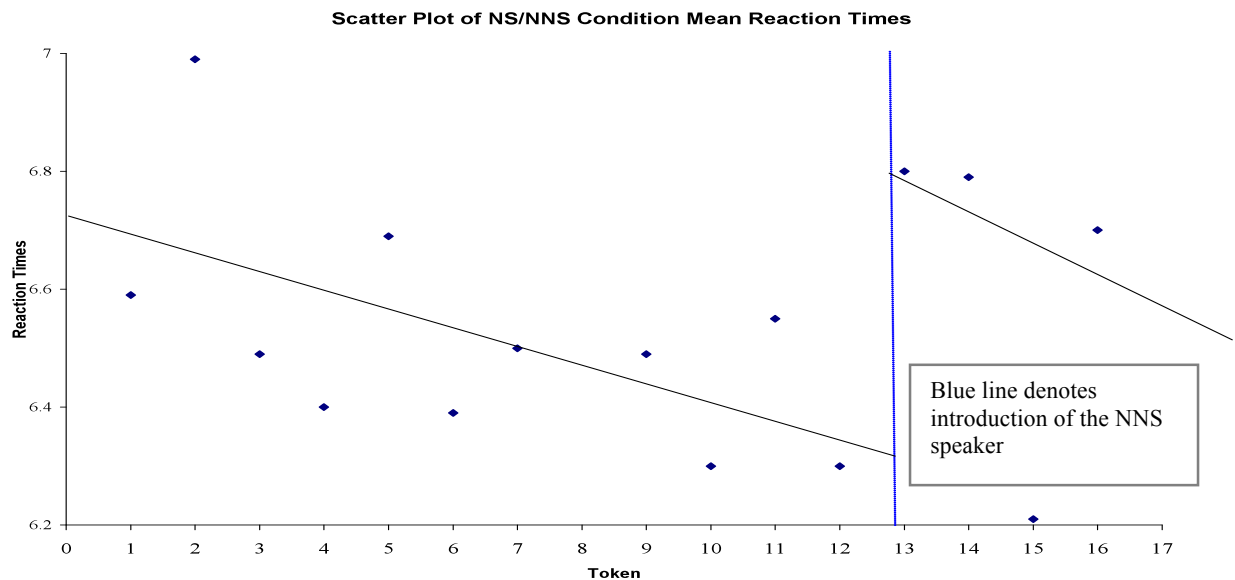


Figure 5: Scatter Plot of NS/NNS Condition Mean Reaction Times

According to LMM analysis, the slope of the line between tokens twelve and thirteen (as denoted in Figure 3 above by the dotted line) was 1.358, $p=0.0011$, and the slope of the line of the following tokens was -0.075 , $p = 0.0009$. The results show that there was a statistically significant spike in RT's with the introduction of the NNS, but that the listeners then began to have lower RT's, providing evidence that the listeners adapted to the novel speech. Therefore, hypothesis two was confirmed and the adaptation occurred in less than 16 seconds of speech in this case. Notably, if we compare the last four experimental tokens of the NS condition to the NS/NNS condition, even though there is a statistically significant rise at the 13th token, by the end of the experiment, or by the 16th token, there was no statistically significant difference between the means of these two conditions. The mean score for the final four tokens for the NS group ($M = 665.68$, $SD = 29.17$, $N = 4$) was not significantly greater than the RT's for the NS/NNS condition ($M = 797.18$, $SD = 210.35$) using a two-sample t-test for unequal variances

$t(3) = -1.24$, two-tailed $p = .30$. The t-test results indicated that the listeners in the NS/NNS condition performed in-line with the listeners in the NS condition.

Hypothesis three: The NNS condition will begin with higher RT's than the NS condition, but will lower as listeners adapt to the speaker.

From hypothesis one, we have already established that the NS condition had the lowest reaction times, so we know that the NNS condition had higher reaction times than the NS condition. Therefore, we need to establish if the NNS condition had a significantly negative slope to show that adaptation occurred in this condition. A fixed-effect linear regression analysis revealed that the slope of the line for the NNS condition experimental tokens is significantly negative ($\beta = -.014$, $p = .0008$), indicating that the listeners in the NNS condition adapted to the unfamiliar accent, but were they adapting with reaction times similar to the NS conditions' RT's? A t-test for unequal variances revealed no statistically significant differences in a comparison of the last four tokens between the NS group ($M = 665.68$ $SD = 31.4$, $N = 4$) and the NNS group ($M = 709.43$ $SD = 242.6$ $N = 4$), $t(3) = -.36$, $p = .74$. To summarize, the speakers became very adept at listening to the same non-native speaker, not significantly different in the last four tokens than the listeners performed in the NS group. These findings support Clarke and Garrett's (2004) conclusions of rapid adaptation to non-native speech. Therefore, hypothesis three was confirmed, and the listeners are adapting to the individual non-native speaker.

Hypothesis four: The NNS/NNS condition will have lower RT's than the NS/NNS condition for tokens 12-16 (when the second speaker is introduced in each condition).

It was expected that the second non-native speaker tokens (13-16) in the NNS/NNS condition would have lower RT's than the NS/NNS condition (also tokens 13-16) because the experience with a similar Korean accent (tokens 1-12) would prime the listeners for the last four tokens. Analysis of the slope of the NNS/NNS condition showed that there was a spike with the

introduction of the second NNS at token 13. However, it was expected that the experience from the first 12 tokens would prime listeners for the last four tokens spoken by a second speaker from the same native language (Korean), thus facilitating in lower RT's for the NNS/NNS condition than in the NS/NNS condition. Hypothesis four, which predicted that experience with the non-native accent in the first twelve sentences or tokens would help in adapting to the second novel voice from the same language, was not confirmed. The rise in RT's in the NS/NNS and NNS/NNS conditions showed no statistically significant difference through analysis with LMM. The coefficient of the first 12 tokens or sentences was 0.881 with $p\text{-value} = 0.064$, and the coefficient of the last four tokens in which the second non-native speaker was introduced was -0.063 with $p\text{-value} = 0.059$, thus showing that the NS/NNS and NNS/NNS conditions had similar rise rates when using a significance level 0.1. However, when comparing the last four sentences or tokens in the NS/NNS and NNS/NNS conditions, using LMM and ANOVA, the data showed that the NS/NNS and NNS/NNS conditions were not significantly different, $p = .6298$. Actually, the mean of the NNS/NNS condition ($M = 6.615$) was larger instead of being smaller than the mean of the NS/NNS condition ($M = 6.564$). A difference between the two conditions cannot be detected, probably due to the small sample size of only four tokens in the NS/NNS and NNS/NNS conditions.

Summative Conclusion of the Four Hypotheses

To summarize, three of the four of these hypotheses were confirmed, and the baseline analyses also confirmed that the groups were similar in listening ability and RT's from the beginning of the experiment. Hypothesis one that the NS condition had the lowest reaction times and the fewest errors was confirmed. Hypothesis two, that the NS/NNS condition would have a rise in RT's with the introduction of the non-native speaker but then the listeners would adapt,

thus coming in the line with the NS condition, was confirmed. Hypothesis three that the NNS condition listeners would have higher RT's than the NS condition, which then would decline and come in line with the mean RT's in the NS condition, was confirmed. Hypothesis four, that the NNS/NNS condition would have lower RT's than the NS/NNS condition for the last four tokens in which the second speaker is introduced because of a priming effect, was not confirmed. A lack of priming and reasons for this lack will be further discussed below.

Discussion of Hypotheses

This section will contain further analysis of hypothesis four's lack of confirmation and a discussion of how longitudinal language experience, in this case Korean, may be the key to facilitating adaptation. Next, I will discuss speculative reasons for the NNS/NNS condition's high error rates.

Lack of Priming in the NNS/NNS Condition

The results of hypothesis four not being confirmed -- that the NNS/NNS condition would be faster than the NS/NNS condition for the last four tokens -- may lead us to believe that only four tokens constituted too little time for a "priming" effect. However, further analysis of this experimental data may reveal the idea that the human phonological system is adapting to individual speakers, instead of speaker groups. From the findings in this dissertation, we can conclude that the listeners are trying to adapt automatically to novel voices they hear, but they are not necessarily able to rapidly apply the experiential information to a second speaker. The adaptation takes time, albeit milliseconds, and the RT's are greater in the adaptation process to non-native speech when compared to native speech, speech with which the listeners would be more familiar, but then the RT's decline, becoming similar to those of the NSs.

Data of Listeners with Extensive Korean Language Experience

Clearly, adaptation to individual speakers is occurring, but experience with the first non-native speaker does not necessarily appear to help with the RT's in listening to the second speaker who is from the same language. However, let us again revisit the metaphor of the park path and the concrete road from Chapter Two, in which I hypothesized that the park path is actually the way that listeners process new information, but that the concrete road is how they process information that is similar to their experiential stored information. The listeners seem to be creating the park pathway when listening to the non-native speaker, but when listening to the native speaker, it is clear that there is an established base of knowledge and that the listeners have access to the concrete road. This leads to a question: would listeners with extensive experience with Korean yield differing results from the native-English speakers with little to no experience with Korean or Korean accents?

To explore the question of whether experience with Korean facilitated some of the individual listeners, the data were further divided into participants who had experience with the Korean language to examine if past Korean-language experience was significant. There were six participants in the study who reported having had experience with the Korean language or speakers. A t-test was conducted to compare RT's and error rates between the six participants who had experience with Korean and the rest of the population who reported no experience with the Korean. There was no discernible statistical difference between these two groups for RT or error rate, but then the sample population for participants having experience with Korean speakers or the Korean language is very small ($n = 6$), $t(8) = .096$, $p = .46$.

We would expect that if experience with a language would be beneficial in this task, we would see a statistically significant difference between the group with experience and the group without experience. However, our test was conducted for all conditions; therefore, a look at the

individual conditions revealed that participants reporting experience with Korean speakers or language actually performed worse than those reporting no experience with Korean language or speakers. This result was somewhat surprising, so a look at the actual tokens that the listeners with extensive Korean language experience missed was analyzed by condition.

Below is a table of the six participants who reported experience with Korean by condition they were in and the actual tokens by condition with error counts. The information displays whether the six participants were missing tokens spoken by native or non-native speakers.

Table 2: Errors of Participants with Korean Experience by Condition & Speaker

Listener/Condition	NS Tokens	NNS Tokens	Total
Participant #5 NS Condition	3	0	3
Participant #16 NS Condition	2	0	2
Participant #41 NS/NNS Condition	1	1	2
Participant #55 NNS Condition	5	2	7
Participant #66 NNS Condition	3	2	5
Participant #77 NNS/NNS Condition	4	1	5
Totals	18	6	24

Reexamining the data reveals that the participants are actually making fewer errors on the non-native tokens than on the native-speaking English tokens. These results must be analyzed cautiously because two of the participants were in the NS condition in which no non-native speaker was heard; however, examining the other four participants in conditions with non-native speakers reveals that the participants with Korean language experience performed better on the non-native speaking tokens than they did on the native-speaking tokens, so we can conclude that the extensive experience with Korean speakers may be beneficial in this task for these

participants. Again, the sample size of the participants who had a history of experience with the Korean language or speakers was small, so this conclusion must be regarded cautiously; however, this finding suggests that further testing is needed to determine whether extended or longitudinal experience is beneficial to adaptation or not.

We need to determine whether the experience with Korean is statistically significant in terms of facilitating the listener in RT's or error rates. If we look at a comparison of the mean RT's ($M = 6.61$, $SD = .233$) between all of the other participants in all conditions and the mean RT's of the speakers with Korean experience ($M = 6.59$, $SD = .298$), there is not a statistically significant difference between the two groups, $t(80) = 1.99$, $p = .83$. The Korean speakers' mean is smaller than the rest of the group, and I hypothesize that with a larger sample we would see a greater difference in the means, with the Korean-experienced group showing significant lowering in their RT's, but these results must be further investigated with a larger sample population to determine if there really is no significant difference in RT's between the two groups. These results suggest that in this experiment, experience with Korean did not necessarily help the listeners in terms of RT's, but that a larger sample population may show significant difference between means. Experience with Korean does appear to be facilitating the individual listeners in terms of error rates. Again, these findings are speculative and should be further investigated with a larger population of Korean-experienced listeners.

NNS/NNS Condition's High RT & Error Rates

In the above analysis of the general data, it was found that the NNS/NNS condition had the highest error rates and RT's, but it was also found that the slope analysis of the final four tokens in which the second speaker is introduced was statistically no different between the NS/NNS and NNS/NNS conditions. Derwing and Munro's findings concerning reaction times

may help us understand these findings more fully. According to Munro and Derwing (1995, 2006) and Derwing and Munro (2005), even while the participants can understand accented speech, they often report it as difficult because of the added cognitive effort in processing the speech that differs from speech with which listeners are familiar; therefore, listeners report tasks with non-native speech as difficult and also give non-native speakers lower intelligibility ratings even when every word of the speech can be transcribed correctly. The comprehension difficulties are evident in the NNS/NNS condition, which not only has one non-native speaker from the beginning of the experimental trials, but also introduces a second non-native speaker. The non-native speakers are heard after the practice token and before the baselines which are tokens spoken by native-accented speakers. Even though these items are separated by directions that the listeners must read, the listeners still must adapt to yet another voice after listening to the NS in the practice section and the two NNSs in the experimental section; consequently this condition contains several variables which could easily lead to pausing and doubt, thus causing higher RT's and higher error rates. If we revisit our metaphor, in this case the listeners in the NNS/NNS condition rely on the concrete road for the practice and baseline sections of the experiment, but they must try to begin two park paths if they process the voices of each speaker separately in this short period of time, as the findings in this research indicate. Therefore, the short period of time and the multiple voices cause a great deal of processing on the part of the listener, which I speculate affects the RT's and error rates.

Lack of Priming Effect in This Study Compared to Previous Pilot Study

In this dissertation, a comparison of the NS/NNS and NNS/NNS condition revealed that the two conditions had no statistically significant difference in terms of the last four tokens; however, both of these conditions showed negative slopes of lines, particularly for the final

tokens, thus demonstrating that the listening participants were adapting to the speech of the individual non-native speakers. However, our alternative hypothesis for a comparison between these two conditions was that the NNS/ NNS condition would have even faster RT's and higher error rates than the NS/NNS condition because of a priming effect from the first NNS speaker.

In a previous pilot study, adaptation for the NNS/NNS condition was found to have faster RT'S than the NS/NNS condition. A contrastive analysis in the pilot comparing the tokens when the second speaker was introduced showed that the NNS/NNS condition had a significantly smaller rise in magnitude than the rise in RT's in the NS/NNS condition. A slope analysis of the pilot study data with 36 native-speaking listeners yielded the following results $t(12)=1.90$, $p=.04$, a difference of an average of 312.2 milliseconds of rise for listeners in the NS/NNS condition, but only approximately 62 milliseconds on average for listeners in the NNS/NNS condition.

Several factors in the pilot study may have caused this difference in findings for priming between the pilot and this study, namely speaking proficiency and gender. First of all, for the pilot, the speakers were of a different non-native stage of development. In the pilot, Chinese-accented speakers of English who had only been in the U.S. for approximately six months participated in the experiment as the speakers in the non-native conditions. The speakers also had been tested, but had not achieved the TOEFL speaking scores to be able to teach in a university. These factors establish that the two sets of speakers were at varying abilities.

Secondly, gender is a factor that could have affected the pilot results. In the pilot, male non-native speakers of English participated. In this study, female non-native speakers participated. While this variable might seem to be insignificant, it actually could be an important variable. In all conditions, the practice, baseline, and experimental speaker is a native-speaking female. In the pilot, the difference of gender could have added an extra factor that listening

participants had to adapt to, especially for the NS/NNS condition in which the female native-speaker would have been heard prior to the male non-native speaker; in contrast, for condition four, both male non-native speakers would have been heard. It seems that gender was an additional feature for the listeners to contend with in adapting to the novel speech. In the pilot, the NS/NNS condition's RT's were lower than those of the NNS/NNS conditions, but I speculate that the difference between the NS/NNS condition that did not occur in the NNS/NNS pilot condition is due to gender. So, to summarize, after contrasting the results from the pilot with the results from the study, we can surmise that gender and speaking level both are at play in understanding the tokens. Because of constraints in access to participants who could be appropriate speakers, these variables were not easily controlled for in the pilot, but they were controlled for in the actual experiment, and the differences point to the need for further experiments testing the features of gender and speaking level.

Findings Compared to Other Studies

This final section will be a discussion of my findings in comparison to the adaptation studies discussed in Chapter Two. Next, I will contrast this experiment's findings to a previous pilot study's findings to discern factors that need to be controlled for in future studies. Finally, in this section, I speculate about what my findings say about the human phonological systems.

Comparison of My Results to Other Adaptation Studies

This dissertation's findings support Clarke and Garrett's (2004) conclusion of rapid adaptation to a single non-native speaker. However, the findings contradict Clarke's (2003) unpublished earlier findings. Clarke (2003) found weak or marginally significant support for the ability to adapt to foreign accented speech from one speaker of Spanish-accented speech when followed by a second accented Spanish speaker. Clarke (2003) reported weak or marginal

results only with longer sections for the listeners who heard more tokens in the mixed NNS condition. Weil (2001) and Bradlow and Bent (2008) found positive effects for adaptation to accented speech in training listeners to adjust to accent. For example, Bradlow and Bent's listeners improved on transcription tasks for Chinese-accented English after having received training with one speaker. Bradlow and Bent's findings for exposure are similar to this dissertation's. The listeners of the Chinese-accented speech in Bradlow and Bent's study may be adapting similarly to listeners in this research who have experience with Korean speech because of the more extensive input, since Bradlow and Bent's American listeners went through training with Chinese speakers. While the listeners in this experiment are not explicitly trained as Bradlow and Bent's were, the results suggest that prolonged exposure to Korean aids in the adaptation process in terms of error rates, and potentially for RT's in a study with more participants. While the brief experience with the new accent does not aid in rapid adaptation, longitudinal experience does appear to facilitate adaptation to a talker-independent accent (Bradlow and Bent, 2008; Weil, 2001).

Lack of Priming and the Human Phonological System

The question remains, then, what does the lack of priming mean for the human phonological system? There are several factors to be considered here. First, the experiment may be too short to allow listeners to take elements from the first speaker and relate them or use them when processing speech from the other speaker. If extensive experience is the key to rapid adaptation, we would expect the participants with extensive Korean experience to perform better than other participants. In many cases, they do outperform the other listeners showing a lower error rate in understanding the accented speech; however, since the sample of population that had experience with Korean is so small, we can only state that longer experience appears beneficial

to adaptation for these participants. We cannot determine if it is statistically significant compared to the other listeners who reported no experience with Korean language. Longitudinal experience and its effects on rapid adaptation needs further investigation.

Second, in the NS/NNS, NNS, and NNS/NNS conditions, the slope analysis suggests that adaptation is occurring at similar rates, but not faster. This finding indicates that adaptation does occur, but it occurs individually for each speaker, and it begins as soon as the listener comes into contact with the speaker. Put another way, the listener is trying to discern the speech individually and may not be importing information garnered from previous speakers'. After all, if each individual has his or her own voice print, then these voice prints may be discerned individually in human phonological perceptual systems and may be recorded individually in the human memory system.

The Human Phonological System, Exemplar Theory, and SLA

In this section, I will speculate on what this dissertation's findings reveal about phonological adaptation and whether my findings support exemplar theory. Next, I will apply these findings to interaction theories in SLA. Finally, I will discuss limitations and future directions for this kind of research and the implications for theories in SLA as well as implications for the language classroom.

What does this research say for theories of the human phonological system, specifically exemplar theory? These findings suggest that humans can only use examples from one person at a time in adapting to a voice during rapid encounters, similar to short, real-time first encounters with an interlocutor. This research suggests that the examples from the first speaker cannot be immediately transferred to a second speaker. That is not to say that examples don't build over extensive experience for later use, as exemplar theory posits. We also don't know whether the

listener is truly creating a separate park pathway to process novel speech, or trying to access already stored examples (the concrete road) by matching characteristics. From the NS condition RT's, we can see that there is a benefit from experience with speech with which listeners are familiar. Analogously, whereas the speech that we encounter extensively every day creates the concrete road for smooth, fast processing, the characteristics of novel speech begin a park path that just doesn't create as smooth a conduit for the processing in short time frames. With novel speech, the processing is slower, but as we use the road more, it becomes easier going, thus RT's lower. In this experiment, the lowering of RT's occurred rapidly, similar to Clarke and Garrett's (2004) findings. Exemplar theory posits that the "variation is explicitly represented in the cognitive system by distributions of remembered examples. These distributions are built up gradually as example after example is experienced and remembered, and each example can be multiply indexed by context or function" (Pierrehumbert, 2006, p. 518).

In this experiment, I am proposing that listeners don't have time to build up or create the examples to understand the NNS in exactly the same way that they do for the native speech that they are more familiar with, and, yet, this study suggests that listeners, in fact, do adapt to the non-native speech. It would seem that the lack of evidence of the listeners' taking characteristics from the experience with one speaker and applying them to the second speaker does not necessarily support exemplar theory. Further analysis of all of the data actually suggests otherwise.

We can see from the RT's in Figure 3 that the NS and the first twelve tokens of the NS/NNS conditions are fairly static, flat lines. These findings suggest that the listeners in these two conditions have built up examples of native speech characteristics from their life experiences to actually retrieve and utilize in rapid processing of the new voices. Compared to the non-

native-speaker voices in the NS/NNS, NNS, and NNS/NNS conditions, the processing in the NS conditions suggests fairly automatic processing of the native-speaker tokens. The rise in RT's with the introduction of the NNS voice indicates that the processing is more difficult, but that adaptation does occur. The finding that the listeners are adapting to the individual speakers demonstrates an ability to adapt to new speakers even without indexed examples. Not only is our language production creative, but our perception is creative as well. These findings support the human need not only to generate speech but also to communicate both actively and receptively. As for exemplar theory, these findings suggest that the listeners are using characteristics from each individual speaker, building on those examples, and then using the examples to adapt to the individual, thus suggesting a usage-based phonological system. This system would be one in which the listener is utilizing the characteristics in a usage-based system with adaptability to help in processing, but it may be that another type of processing occurs, which exemplar theory has not adequately addressed.

What we don't know, however, is whether the listener is creating different paths or if the listener is trying to match the new characteristics to the concrete road already in existence. Both could explain the rise in RT's when listeners are exposed to speech that is outside their experience. The only way to test whether two different roads exist or just one path with difficult access would be with brain scans of reaction-time to see if the centers employed are the same or different when the listeners encounter non-native speech.

Exemplar theory has traditionally proffered an explanation of episodic learning so that the examples have time to build up; however, this research suggests that exposure need not be episodic or extensively prolonged for adaptation to occur. Episodic exposure appears to have benefits in terms of the RT's. Exemplar theory, then, should be expanded to include rapid

adaptation that occurs daily and within seconds when novel interlocutors are encountered. I use the park path metaphor to describe this rapid adaptation. The listeners adapt through the short experience to individual speakers, which suggests that humans are learning from the events and, thus, adjusting their phonological systems to process automatically. It is apparent, from contrastively looking at the data of the listeners of NS tokens, that the listeners have already stored information that they are drawing upon to process quickly. In essence, listeners have the concrete road, but they are also able to create park paths.

Clarke (2003) rejects exemplar-based models in explaining adaptation to foreign-accented novel speech for two reasons: first, exemplar theory fails to recognize the adaptability of the phonological system; second, exemplar-based models posit that “categorization is a passive process of memory trace activation” (p. 81). Clarke proffers another explanation, the Adaptive Resonance Theory (ART) (Grossberg and Stone, 1986), to explain rapid adaptation to foreign-accented speech. Adaptive Resonance Theory not only explains adaptation in terms of frequency, but it proposes that listeners are able to process both top-down, through template matching, and adapt bottom-up, phonologically, while at the same time networking semantic information through visual stimulation. Grossberg and Stone’s (1986) model is an extensive one with broad explanatory power. Clarke states that “conscious perception occurs when resonances build up between the bottom-up speech input and matching top-down expectancies from long-term memory” (81), and the ART model certainly takes both the bottom-up and top-down processing, as well as long-term memory and attention need for short-term memory, into account. On the other hand, as Johnson (2007) states, “It should be noted, however, that there is no one ‘exemplar theory.’” (p. 28). Exemplar theory as a phonological theory can be expanded to include

both types of processing, which is why I offer the metaphors of the park path and concrete road for a better model to explain the two types of processing that occur in this dissertation.

This new exemplar theory of phonology would incorporate both the active and passive processing of language, as well as frequency. In some cases where items are frequent, the listeners may process them passively. In other cases, they may attend more, as in cases with the NNS. In my experiment, there is evidence that the processing is happening passively, particularly in the case of error, but the learner probably is not consciously aware of why he or she misperceives a token. For example, it was noted that items that were incorrectly identified did not necessarily have higher RT's, which suggests that the listener feels confident in his or her perception. An example would be practice token three, "Bill might discuss the foam," with the visual probe word "phone" which had a 93% error rate. This token did not have an RT's outside the means of the other tokens, even with 93% of the listeners incorrectly identifying it. In this case, the listeners probably are relying on frequency of the word "phone" in their lexicons. The listener's RT's suggest that with frequent words, the listener does not attend as well, which is why I propose the explanation of passive processing. There is further evidence to support my conclusion that the listener is passively relying on frequency from the Corpus of Contemporary American English (COCA).

The COCA is an extensive corpus containing a collection of both written and spoken language, from 1990 to 2008, which would be representative for the listening subjects' contemporary usage. A search of the Corpus of Contemporary American English (COCA) revealed that "phone" occurred 62,969 times compared to "foam," only 3,287 times (Davies, M. retrieved May 2009). The high frequency of the word "phone" compared to "foam" as found in the COCA supports the theory that frequency, along with similarity of sounds, is affecting the

listeners' ability to perceive this token. Therefore, the listeners are probably relying on their internal lexicons and not attending to this token as they do with some of the more difficult non-native speaker tokens. This finding also informs methodology for future laboratory studies. Even though frequency was controlled for in this experiment by utilizing Clarke and Garrett's tokens from the revised SPIN Test, this information points to the fact that the listening test word frequencies have changed since the SPIN Test's origination and that the listeners are retrieving the more familiar example "phone" when they hear a similar word "foam." The listeners misidentify the word based on frequency and choose the more frequent "phone," but their RT's, which are well within the means of the other tokens, suggest that they are not aware of the mistake, therefore, making it a passive one.

While the above "foam/phone" example suggests passivity in the adaptation process, there is also some evidence that the listeners are actively attending as well but still may not be aware of their attending. For example, at experimental token 13, "Ruth must have known about the pie" with visual stimuli "pine," the RT's rise for the NS/NNS and NNS/NNS conditions, indicating that the listeners are actively engaged in the process. In this case, I am arguing that the higher RT's suggest that the processing is causing them to work harder. However, listeners may not be aware of this active engagement. Put another way, the listeners may unconsciously recognize that the processing becomes more difficult but they may not be able to articulate why. We recall Labov's (2006) call for scholars to study the salient and socially significant which I discussed in Chapter Two. While the accent may be salient, or noticeable for listeners, the fact that they are taking more time to process the accented speech may not be recognized. This lack of automatic processing that listeners are accustomed to can become socially significant because it may be one of the reasons why listeners avoid accented speech or report it as difficult even

when they are accurately able to identify it. This may also explain “irritation” that native speakers report when listening to accents (Fayer and Krasinski, 1987).

Because the processing may be happening in two ways, exemplar theory should not be ruled out as an explanation for how these listeners perceive and adapt to the speech in this research. Exemplar theory should be expanded to incorporate the two ways that it seems to be occurring—for the long-term or extensive experience adaptation and the processing in novel or short-term experience adaptation. For example, just as there are at least two types of memory, short term and long-term, perhaps there are also at least two types of phonological adaptation, and maybe more. Perhaps there is a type of adaptation for short term instances, and these can degrade over time. To explain different types of recall in language, Johnson (2006, 2007) discusses two types of memory which he ties to exemplar theory—recognition and declarative memory.

In his description of recognition memory, Johnson (2007) tells the story of a patient, HM, who lost part of his hippocampus which was responsible for short-term memory. To test memory, doctors played a game with HM. While HM could not remember the game or the rules to the game that doctors played with him on a daily basis, he somehow was able to improve at the game. Johnson argues that HM underwent a type of priming which is part of our recognition memories. Recognition memory, according to Johnson, is not explicitly able to be consciously retrieved, but nonetheless, it passively helps us in activities. Declarative memory, on the other hand, is expressible, retrievable memory. Johnson uses the example of a good friend who we may be able to recognize visually in a glance, but we may have a much more difficult time putting this information in explicit descriptions for others. The two types of memory are not always mutually exclusive, but often recognition memory is much more implicit and passive.

The same may be true for the processing and adaptation that occurs in this research. Accents with which we are familiar may be easier to recognize, therefore, we passively process them. However, accents with which we are much less familiar with, may take more power to retrieve or to create new pathways altogether in learning them.

Listeners take their recognition memories of the native-speaking voices and react rapidly. They start out much less adept at processing the NNS categories, but gradually become better at it. They have high recognition memory rates in the NS sections. On the other hand, these rates slow down in the non-native speaker tokens. If we were to ask listeners if the voices were non-native or not, they would most assuredly be able to identify with more than chance (as shown in Flege, 1984) which tokens were non-native, but they may not be able to declare that they had higher RT's or that they had difficulty in processing the speech as rapidly as they did the native speech. Exemplar theory needs to be expanded to take into account that experience is based not only on episodic experience for our L1 acquisition but also short and long-term storage of memories in our experience for any speech that we encounter, particularly any speech that differs greatly from that which we encounter frequently.

Exemplar and Second Language Acquisition (SLA)

What does this experiment mean for SLA? This research provides evidence that native-speaking listeners learn or acquire in the process of NS-NNS contact. They do not begin with some underlying, perfect sense of a phoneme, sound, word, or speaker; they adapt to the speaker and experience, based on the frequency of their experience. Listeners may not be able to carry over the learning from one experience with a single speaker to another in these cases, but they adapt nevertheless. This adaptation points to learning that interactionist theorists posit in NS-NNS negotiations (particularly the input, interaction, output (IIO) model); however, this learning

or acquisition is not for the second language learner, but for the native listener. I use both learning and acquisition here because I think that the listeners are adapting unconsciously, thus acquiring the phonological information, but I also think they can be instructed explicitly to gain this knowledge as Bent and Bradlow (2008) and Derwing and Rossiter (2002) have shown.

The findings of adaptation on the part of the native speaker have numerous applications in SLA. The first application is to include exemplar theory in interactionist models, particularly in looking at the interaction phases of NS-NNS contact research. Second, the fact that the listeners do adapt to the NNS speech supports research that does not control for pronunciation but begins with the assumption that listeners adapt to a single speaker, such as Williams's (1992) and Tyler's (1992). Finally, this research has the following two classroom applications. First, if listeners do adapt to speech of a single speaker, then teachers of pronunciation should probably not be the evaluators of their students. Second, for the ITA literature, this research may also point to pronunciation instruction being less significant for successful communication than the amount of experience of the native-speakers with the particular non-native individual. In fact, helping the native-speaking listeners understand their own adaptation may aid them more in becoming successful multi-cultural interlocutors than actually trying to reduce accents.

Limitations and Future Directions

This section includes a discussion of limitations of the research in this dissertation as well as laboratory experiments that test adaptation. This section will also begin a preview of the next chapter, which highlights other factors that may be affecting adaptation to non-native speech, but which cannot necessarily be tested in a laboratory study. Finally, I consider qualitative avenues of research that could deepen the understandings of this research as well as our understandings of NS-NNS contact in academia.

Probably the greatest limitation of this research is that it is a laboratory study and social context is not considered. I believe that social context and factors are as important a feature of the communicative activity as the phonological perceptual factors affecting cognitive processing measured here. A further procedure to supplement these findings would be to conduct exit interviews with participants to not only discuss how they felt they had performed during the activity but also follow up with the experiences and attitudes that may be affecting their abilities to perceive accented speech. All of the listeners, with the exception of two outliers, adapted well to the NNS speech. These findings are not necessarily predictive of successful communication or even predictive of the NS's motivation to take part in communication with internationals who have foreign accents. If resources were unlimited, then the laboratory listeners in this study would be studied in terms of their real-time communicative success with accented speakers. The listening factor is only one feature of the communicative success. This study cannot measure the interlocutors' abilities or inclinations to negotiate communication in real-time or natural communicative contexts.

A further limitation is the difference between this experiment's and the pilot study's results. In the pilot study, I found that the NNS/NNS condition had significantly lower RT's than the NS/NNS condition. In the pilot study, the NNSs were male, but the NSs were female. I conclude that gender may be a factor that needs further analysis. The added component of gender may produce RT's that actually skew data to look like priming rates as it seemed to in the pilot study, in which male NNSs participated but all of the NSs were female. Gender as a factor in adaptation needs to be further investigated. For example, do women hearing women have better RT's than men or vice versa?

The sample size and population is also a limitation in this study. All of the participants were in first and second level courses at a southeastern university, so while they are as random a sampling as this study could manage, more research needs to be carried out with broader audiences and in varying geographical regions.

Future research on other language groups and language levels also needs to be conducted. This study examined adaptation to only one foreign-accented language accent (Korean) with only two non-native speakers at quite a high level, chosen specifically because those two would exemplify the level native speakers at this university would encounter. Clarke and Garrett (2004) tested adaptation to native speakers of Spanish as well as Chinese. Similar to this study, their results concluded that rapid adaptation occurs. However, a multitude of languages have yet to be sampled and tested. Another future direction is in testing not only micro units of language but also larger units; adaptation to full discourse should be tested. This study delves into intelligibility at the lexemic and phonetic level, but to be truly applicable for second language classrooms, this study needs to examine larger chunks of discourse. For example, we looked at the sentence level, but there could be further characteristics of prosody in larger chunks of language that listeners may adapt to differently than on the lexemic level demonstrated in my experiment. In this research, we have looked at sentences, but there will be further intonation patterns that need to be tested in longer discourse, such as transitional intonation and comparative stress, which would easily be found in lectures in university classrooms.

Finally, while this study did not show a priming effect for experience with one speaker that carries over into the ability to perceive another speaker, it may be that longer blocks in the experimental tokens will convey such an effect. While rapid adaptation did not occur for priming, that does not mean that adaptation from one accent's features to another's cannot and

does not occur. The results from the individuals who had had experience with Korean language reveal that extended experience may be key to building up the exemplars that are used cognitively in drawing phonological connections, but these findings need further exploration. It is also my belief that further exploration between NS-NNS contact may reveal that communication breakdowns are sometimes caused by language factors that are not necessarily phonological, such as discourse styles and the differing cultural ways to express openness and concern for students (Smith et al, 1992). Also non-language factors (Rubin, 1992), including attitudes, preconceived notions, and differing perceptions of communication goals and roles of teachers in the classroom should be explored as potential reasons for communication breakdown. These will be discussed in the following chapter.

CHAPTER FIVE: CONCLUSIONS—GREAT EXPECTATIONS & MULTIPLE PATHS

In this dissertation, I found that native speaking listeners adapted to non-native accented speech. Listeners' understanding of non-native speech improves; thus they find it more and more intelligible. It would seem logical that if intelligibility is accomplished, then comprehensibility will follow. However, Isaacs (2008) found that international teaching assistants who were judged the most intelligible speakers by undergraduate raters were not always deemed the most successful communicators. Why would listeners have difficulty with intelligibility if adaptation occurs? The answer is not merely about intelligibility but about expectations, organization, and attitudes. That is, ITA-student relationships are affected by the interlocutors' cultures.

Much of the literature about ITAs follows one of two routes—either a look at the ITA's language use in terms of intelligibility or comprehensibility or a look at non-language factors, such as attitudes, that cause communication breakdowns. What may be more important than adaptation to language is adaptation to interlocutors' cultures, or at least an understanding of the differences in cultures and language use within cultures. When I say an understanding of interlocutors' cultures, I do not mean merely on the part of the ITA, but also on the part of the native-speaking student who resides in the majority culture.

For example, I conducted a pilot research project to determine if there were differing views of respect and politeness in the classroom between native-speakers and non-native speakers of English. After we viewed videos concerning teacher-student conflict, I asked the

American group of participants who were studying phonetics and phonology if they could think of anything cross-cultural that would affect how they reacted in the situations of classroom conflict that they viewed. One participant, a young woman, offered the following statement:

- 1 Speaker 11: ...I think there can be like a major major distance between foreign
- 2 teachers and students... in science and math classes. Also depending on how
- 3 much time the professor has spent in the country and is aware of the culture or the
- 4 dynamic of the classroom it would be harder for me to go even to a
- 5 professor's office hours . . . you seem like you're up there with your knowledge
- 6 and I'm down here.

What Speaker 11 is referring to in the discourse above is perceived distance, or what Michael Singer (1988) has termed the “perceptual approach” to intercultural communication. This approach is another viable road to understand the ITA’s issues in the American classroom.

Speaker 11 recognizes that perceived distance or lack of personal connection may be another main factor in her inability to seek help from the international instructor. Speaker 11 also clearly states that she would not feel comfortable approaching a teacher whose language she had difficulty in comprehending, but even more important for this student is the teacher’s trying to personally engage with her and understanding American dynamics. While speaker 11 does not explain what she means by the “dynamics of the classroom,” her statement raises important questions. First, what does it mean to act “American” in the classroom? Second, should universities be asking ITAs to Americanize their teaching, or should universities view international teaching as a way to expand students’ experience with people of other cultures and initiate undergraduates into understanding diversity and multiculturalism? Third, how do we get both parties to recognize a shared responsibility to bridge communication gaps?

Perhaps the most important element in our global educational venues is the recognition that language is not the only factor in creating successful communication; we must also analyze American undergraduates' attitudes (see Lindemann, 2002, 2003, 2005), specifically students who view American culture as homogenously English-speaking and middle class. We teachers must also question our roles and others' roles in the communities in which we find ourselves. How can we help students like Speaker 11 bridge the gap they perceive and simultaneously help the international interlocutor bridge the gap they perceive without asking them to act or become American?

The onus of communicative success is not simply on the ITA who travels to the U.S. to teach. In an increasingly global world, the onus is on everyone. It has been decades since Dell Hymes (1966) coined the term "communicative competence," but language educators have taken that term up mainly for the language learner. This dissertation argues that we are all learners, particularly in the communicative process, especially novel situations. As globalization continues, intercultural communication is an everyday occurrence, so we need to redefine what communicative competence is as well as what communicative responsibility is. In the above discourse, Speaker 11 does not recognize her responsibility to bridge any communicative gap, but believes the international should meet her expectations so that she feels comfortable. I am arguing that both interlocutors have the shared responsibility to create successful communication. I have at least three suggestions for bridging these gaps.

First, universities cannot force either interlocutor to change attitudes or behaviors or even to reach out to one another. However, universities can provide students with insights about their language, their language attitudes, and their place in a global community as well as their responsibility for successful communication. While many universities have a multicultural

component in their curriculum, few of them actually provide opportunities to mentor and be mentored internationally. I suggest that teaching assistants should not teach their first semester in the university, but instead should observe the classes that they will teach before they actually are placed in the classroom. Speaker 11 astutely discusses cultural dynamics, and every university has its own culture. One semester of observation for all teaching assistants, not just international teaching assistants, would help them become aware of the dynamics of the specific university culture in which they work. During this semester, each TA should work closely with an expert teacher as well as with the students in the expert teacher's classes. This way the TA becomes familiar with classroom procedure as well as undergraduate students' expectations. Rubin (1993) recommends classroom communication workshops for international students as a voluntary program to facilitate ITAs' development of classroom communication skills. This type of workshop is a start, but it ignores the other side of the successful communication equation—the American undergraduate students.

Second, while a multicultural component is a good beginning for undergraduate students, it is not necessarily enough to make them understand specific intercultural communication they may encounter in classrooms. Most multicultural components are fulfilled with a literature or language class, but not through an exploration of the students' communities and attitudes within those communities. While it is important for teaching assistants to get mentoring within their departments, it is equally important for American students to take part in the diversity that their university communities offer. One way to accomplish this is through service. In addition to a multicultural component, each student should be required to have an intercultural course component in which they become conversation partners with a non-native speaker either in the community or at the university. If conversation partnering is not feasible because of population

constraints (i.e. too many American students for too few international students), then at the very least, undergraduate students should have intercultural orientations, not just at the beginning of their first semester when they are overwhelmed by information, but throughout the first year of their university study. Intercultural orientations would include information about playing a proactive responsible role in successful communication in a global world. Orientations should include ITAs and U.S. students in an open forum in which they discuss concerns and options for conflict resolution. Optimally, these orientations would be held at regular intervals, even biweekly like labs, to discuss issues in the community, particularly in the classroom, and to gain perspectives from both ITAs and American students about any problems that might arise through the semester. Another benefit of this type of meeting could be that the ITAs and undergraduates come to be better negotiators in their communication with one another. These meetings could be a chance to chronicle the successes that ITAs and American students have in their classrooms.

Finally, researchers need to be aware that language cannot be studied unidirectional. It must be approached not just attitudinally *or* linguistically but both ways. Language is complex, and with it come cognitive and cultural comprehension challenges. My research, while confirming adaptation to non-native speech, cannot confirm that listeners are actually working harder to process and comprehend the NNSs. The reaction times (RT's) suggest that the listener is actually working harder in the beginning to adapt, but, even though the RT's for NNSs are similar to those for NSs by the end of the task, we don't know if the listeners are working harder to maintain these lower RT's. Speaker 11 in the above discourse points to the fact that bridging a cultural distance, not only a linguistic distance, could be considered work as well. I would argue that the work is not only worthwhile, but integral to globalization. What we need to continue to explore is the complexity of language and the multitudinous paths and roads that it

takes us down. Language in communication is so complex and affected by so many diverse factors that no two contexts are alike. No two interlocutors are equivalent. Looking at perceptual studies can best be done through interdisciplinary study from diverse fields. In this dissertation, I assert that we have a concrete road for phonology that we frequently encounter, but only newly beaten park paths for novel linguistic experience. In this conclusion, I argue that we need to explore attitudes behind language to continue creating different paths along which to travel to a new understanding on our global journey.

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APPENDICES

APPENDIX A

Questionnaire of Language Experience & Interests

1. Name: _____ Male _____ Female _____ Age: _____

2. Languages you have studied:

3. How many years for each: (example—French 4 years, Spanish 2 semesters)

4. Do your parents and /or relatives speak a language other than English at home?

Yes _____ No _____

If yes, please list the relation to you and the language he or she speaks. (Example: Mother, Japanese).

5. Have you ever traveled out of the country? Yes _____ No _____ If yes, please list the country (ies):

6. Have you ever lived in a country other than the U.S.? Yes _____ No _____ If yes, please list the country or countries and the amount of time spent residing in each. (Example: Spain, 1 year, 3 months).

7. Why were you living abroad (example: study abroad or military duty)?

8. At this current time, do you have an instructor or professor who is an international?

Yes _____ No _____

If you are unsure, please skip down to # 10. If you answered yes to #8 and you are sure of the answer, please list the class, and the country that your instructor (s) /professor (s) is/are from:

9. What language or languages does he/she/they speak?

10. If you are sure that your instructor or professor is not from the U.S., but you are unsure of where he or she is from, please check the blank below but try to guess your instructor or professor's native language (s):

Unsure _____

Guess About Native

Language(s): _____

11. Do you have acquaintances who speak a language other than English?

Yes _____ No _____

If yes, please list the relationship, the language he/she/ they speak(s), and how long you have known him/her/them (example: coworkers, 3 years)

12. Do you have close or intimate friends who speak a language other than English?

Yes _____ No _____

If yes, what language or languages are spoken and approximately how long have you known each friend? (Example: German, 4 years and Thai, 2 years.)

13. Do you have an interest in learning another language? Yes _____ No _____

If yes, please list the language or

languages: _____

APPENDIX A-2

Waiver: Spring 2008

Dear Student:

I am a graduate student in the Department of Linguistics at The University of Georgia. I invite you to participate in a research study entitled “Comprehensibility of Non-Native Speech Using Multi-Methods for Investigation” that is being conducted under Dr. McCreary. The purpose of this study is to determine exposure to languages and if or how different kinds of exposure affect phoneme discrimination.

If you are not 18 years of age, please do not sign this letter, and let the researcher know prior to the research activity.

Your participation will involve filling out a questionnaire and listening to a foreign language sound discrimination task while marking answers on a sheet. These activities should take approximately thirty minutes. Your involvement in the study is voluntary, and you may choose not to participate. Your results and information from the questionnaire will be completely confidential, and at no time will your name be used. The results of the research study may be published, but your name will not be used. In fact, the published results will be presented in summary form only. Your identity will not be associated with your responses in any published format.

The findings from this project may provide information on the flexibility of the human phonology system as well as the benefits of linguistic diversity to ability to attenuate to different kinds of speech. There are no known risks or discomforts associated with this research. If you participate in this activity, you will be granted one quiz grade by your instructor.

If you have any questions about this research project, please feel free to e-mail me at cjanay@uga.edu. Questions or concerns about your rights as a research participant should be directed to The Chairperson, University of Georgia Institutional Review Board, 612 Boyd GSRC, Athens, Georgia 30602-7411; telephone (706) 542-3199; email address irb@uga.edu.

By completing and returning this questionnaire in the envelope provided, you are agreeing to participate in the above described research project.

Thank you for your consideration! Please keep this letter for your records.

Sincerely,

Janay Crabtree

APPENDIX B

List of All Token Sentences and Visual Stimuli

Practice

- 1 6Miss Brown shouldn't discuss the sand. SAND Yes
- 2 7The man could not discuss the mouse. MOUSE Yes
- 3 5Bill might discuss the foam. PHONE No (cons end)
- 4 5They knew about the fur. FIRM No (cons end)
- 5 6The boy might consider the trap. TRACK No (cons end)
- 6 6Sue was interested in the bruise. BRUISE Yes
- 7 5The man spoke about the clue. CLAY No (vowel end)
- 8 7He hears she asked about the deck. DECK Yes ****

Experimental

- 9/1 5Paul has discussed the lamp. LAMP Yes
- 10/2 7You should not speak about the braids. BRIDES No (vowel mid)
- 11/3 6The old man discussed the dive. DIVE Yes
- 12/4 6The old man considered the kick. COOK No (vowel mid)
- 13/5 7She's glad Jane asked about the drain. DRAPE No **** (cons end)
- 14/6 6He wants to talk about the risk. RISK Yes
- 15/7 6He is thinking about the roar. ROPE No (cons end)
- 16/8 5I'm talking about the bench. WRENCH No (cons begin)
- 17/9 5Betty has considered the bark. BARK Yes
- 18/10 5Tom is considering the clock. CLOCK Yes
- 19/11 5Ruth's grandmother discussed the broom. BRIM No (vowel mid)
- 20/12 5Nancy should consider the fist. FIST Yes
- 21/13 7Ruth must have known about the pie. PINE No (cons end)
- 22/14 5We're speaking about the toll. TAIL No (vowel mid)
- 23/15 6I am thinking about the knife. KNIFE Yes
- 24/16 7Paul hopes we heard about the loot. LOOT Yes ****

Baseline

- 25/1 7Jane wants to speak about the chip. CHOP No (vowel mid)
- 26/2 5Paul can't discuss the wax. WAX Yes
- 27/3 5I was considering the crook. CREEK No (vowel mid)
- 28/4 7Ruth hopes she called about the junk. JUNK Yes ****
- 29/5 6Miss Smith knows about the tub. TONGUE No (cons end)
- 30/6 6Will can't have considered the wheels. MEALS No (cons begin)
- 31/7 7Bill heard we asked about the host. HOST Yes
- 32/8 6Paul should know about the net. NET Yes

****Denotes complex construction (clause within clause)

The tokens have a number to the far left which denotes the number of the sentence in the experiment and then the number within its condition. For example “Paul has discussed the

lamp” was the ninth token, but the first experimental token and “Jane wants to speak about the chip” is the twenty-fifth token but the first baseline token. The number directly before the token sentence denotes how many words are in the full sentence. The fully capitalized word at the end of each sentence is the visual stimuli that listeners saw, and the “yes” or “no” next to the capped word denotes the correct response of whether the visual stimuli matched the aural stimuli.

APPENDIX C

Revised Praat Script for Lengthening or Condensing Length of Tokens

```
# This script will add the two selected sounds with variable gains

# revised 1/9/00 to have consistent new-style syntax - cjd

# To make this script dynamic under the "Combine Sounds -" button run the next line:

# Buttons... Sound 2 "" 0 "" 0 Add2... Add... 1 yourdisk:yourfolder:scripts:Add2_variable

# The "Preserve real time" option keeps the samples that are added together in their absolute time
positions.

# If sounds have been Extracted from another Sound, then their absolute time position will
ONLY have been preserved

# if you have used "Extract windowed selection..." with the "Preserve times" option checked.

# To preserve absolute times when you extract an UNwindowed waveform you should use
"Extract windowed selection..."

# with a Rectangular window with "Relative width"=1.0, since "Extract selection" does not
have a "Preserve time" option.

# Sampling frequency is set to that of the last-finishing sound

form Add Sounds
sentence source_directory C:\Documents and Settings\Janay Crabtree\Desktop\Normalized
Chosen Tokens\
```

```

word base_name file

sentence destination_directory C:\Documents and Settings\Janay Crabtree\Desktop\Normalized

Chosen Tokens with BG Noise\

sentence noise_file C:\Documents and Settings\Janay
Crabtree\Desktop\normalizedbackgroundnoise.wav

boolean Play_after_synthesis 1

comment =====

positive Scaling_factor_1 1.0

positive Scaling_factor_2 1.0

comment =====

comment Use "Real time" to preserve real time

comment across different time domains and sampling rates (beware distortion)

choice Mode: 1

button Point-by-point values

button Real time

comment =====

comment Sampling frequency and duration of sum become that of longest sound

comment

endform

Create Strings as file list... list 'source_directory"$base_name$'*.wav

number_files = Get number of strings

numberOfSounds = 2

```

```

        for j from 1 to number_files
            select Strings list
            current_file$=Get string... 'j'
            #println 'current_file$'
Read from file... 'source_directory$current_file$'
            ifile = 1
names'ifile'$=selected$("Sound")
            ids'ifile' = selected("Sound")
            ifile = 2
Read from file... 'noise_file$'
names'ifile'$=selected$("Sound")
            ids'ifile' = selected("Sound")

# set up arrays with names and IDs of selected Sounds
#for ifile from 1 to numberOfSounds
#sound$ = selected$("Sound",'ifile')
#soundID = selected("Sound",'ifile')
#ids'ifile' = soundID
#names'ifile'$ = sound$
#endfor

# find the file with the most samples or longest duration

```

```

maxduration = 0
for ifile from 1 to numberOfSounds
    filenum = ids'ifile'
    select 'filenum'
        if mode = 1
            duration = Get number of samples
        elseif mode = 2
            # get finishing time of sound
            duration = Get finishing time
        endif
        if duration > maxduration
            maxID = filenum
            maxduration = duration
        endif
    endfor

# create a blank file that will run from zero to the end of the latest finishing time
# with a sampling frequency that is the same as that of the last-finishing sound

    select 'maxID'
    sf = Get sample rate
        if mode = 1
            Create Sound... sum 0 (maxduration/sf) sf 0
        elseif mode = 2

```

```
Create Sound... sum 0 maxduration sf 0
```

```
endif
```

```
#now cycle through all selected files, add to sum
```

```
for ifile from 1 to numberOfSounds
```

```
    sound$ = names'ifile'$
```

```
        if ifile = 1
```

```
            amp = 'Scaling_factor_1'
```

```
        else
```

```
            amp = 'Scaling_factor_2'
```

```
        endif
```

```
        if mode = 1
```

```
            Formula... self + 'amp'*Sound_'sound$'[]
```

```
        else
```

```
            Formula... self + 'amp'*Sound_'sound$'()
```

```
        endif
```

```
    endfor
```

```
endfor
```


APPENDIX D

Summary of Raw Data

Table D1: Summary of Raw Data

		NS Condition	NS/NNS Condition	NNS Condition	NNS/NNS Condition	Total
Practise(8)	n(total number of tokens)	165	166	167	166	664
	Error rates	0.200	0.205	0.246	0.187	0.209
	error count	33	34	41	31	139
	Median of logtime	6.78106	6.83733	6.74641	6.92707	6.863
	Mean of log(time)	6.82081	6.85026	6.81918	6.96145	6.823
	standard derivation of logtime	0.53023	0.43653	0.59341	0.47233	0.514
Experiment(12)	n(total number of tokens)	251	252	252	252	1007
	Error rates	0.056	0.032	0.087	0.091	0.067
	error count	14	8	22	23	67
	Median of logtime	6.449	6.483	6.490	6.721	6.533
	Mean of log(time)	6.523	6.509	6.533	6.721	6.572
	standard derivation of logtime	0.500	0.392	0.451	0.440	0.455
Experiment(4)	n(totalnumber of tokens)	84	84	84	84	336
	Error rates	0.048	0.155	0.321	0.202	0.182
	error count	4	13	27	17	61
	Median of logtime	6.41673	6.50279	6.26051	6.56596	6.485
	Mean of log(time)	6.44291	6.56352	6.40779	6.61518	6.507
	standard derivation of logtime	0.3492	0.47679	0.51543	0.44606	0.457
Base(8)	n(total number of tokens)	168	168	168	168	672
	Error rates	0.11	0.06	0.14	0.14	0.11
	error count	19	10	24	23	76
	Median of logtime	6.511	6.470	6.447	6.542	6.495
	Mean of log(time)	6.529	6.478	6.456	6.547	6.500
	standard derivation of logtime	0.424	0.399	0.448	0.380	0.415

APPENDIX E

Summary of Data After Removal of Outliers

Table E1: Summary of Data After Removal of Outliers

		NS Condition	NS/NNS Condition	NNS Condition	NNS/NNS Condition	Total
Practice(8)	n(total number of tokens)	100	104	100	103	407
	Error rates	0.070	0.125	0.110	0.078	0.096
	error count	7	13	11	8	39
	Median of logtime	6.748	6.819	6.715	6.893	6.782
	Mean of log(time)	6.775	6.819	6.787	6.881	6.816
	standard derivation of	0.488	0.425	0.513	0.401	0.458
Experiment(12)	n(total number of tokens)	239	252	240	252	983
	Error rates	0.033	0.032	0.042	0.091	0.050
	error count	8	8	10	23	49
	Median of logtime	6.438	6.483	6.485	6.721	6.529
	Mean of log(time)	6.482	6.509	6.532	6.721	6.562
	standard derivation of	0.466	0.392	0.459	0.440	0.449
Experiment(4)	n(totalnumber of tokens)	80	84	80	84	328
	Error rates	0.013	0.155	0.288	0.202	0.165
	error count	1	13	23	17	54
	Median of logtime	6.396	6.503	6.261	6.566	6.478
	Mean of log(time)	6.414	6.564	6.404	6.615	6.501
	standard derivation of	0.331	0.477	0.523	0.446	0.457
Base(8)	n(total number of tokens)	160	168	160	168	656
	Error rates	0.08	0.06	0.10	0.14	0.09
	error count	13	10	16	23	62
	Median of logtime	6.474	6.470	6.448	6.542	6.488
	Mean of log(time)	6.485	6.478	6.457	6.547	6.492
	standard derivation of	0.381	0.399	0.449	0.380	0.404

APPENDIX F

RT's & Error Rates after Logarithmic Transformations with Wald Chi Square

Table F1: RT's & Error rates after Logarithmic Transformation Regression & Error Probability

1. Type III Test			
Effect	DF	Wald	Pr > ChiSq
		Chi-Square	
Condition	3	22.552	<.0001
Token	15	189.989	<.0001

2. ML estimates					
		Estimate	Standard	Wald	
Parameter	DF		Error	Chi-Square	Pr > ChiSq
Intercept	1	-4.135	0.494	70.156	<.0001
condition condition2	1	0.444	0.262	2.882	0.090
condition condition3	1	0.894	0.250	12.782	0.000
condition condition4	1	1.053	0.245	18.553	<.0001

3. Odds Ratio (OR)		
Effect		OR Point Estimate
condition condition2 vs condition1		1.559
condition condition3 vs condition1		2.446
condition condition4 vs condition1		2.867