WILLIAM & MARY
CHARTERED 1693

W&M ScholarWorks

Undergraduate Honors Theses

Theses, Dissertations, & Master Projects

5-2010

Closing the Communication Gap Between Undergraduates and Mathematics Professors

Daniel James Villarreal
College of William and Mary

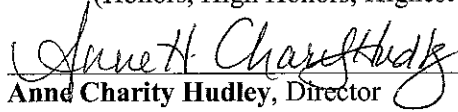Follow this and additional works at: https://scholarworks.wm.edu/honorstheses

Closing the Communication Gap Between Undergraduates and Mathematics Professors

A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelors of Arts in **Interdisciplinary Studies** from
The College of William and Mary

by

Daniel James Villarreal

Accepted for __Highest Honors__
(Honors, High Honors, Highest Honors)

Anne Charity Hudley, Director

Talbot Taylor

Chi-Kwong Li

Williamsburg, VA
April 28, 2010

Abstract

This research sought to determine the sources of communicative difficulties that exist between undergraduate students and international faculty (the *communication gap*) specifically within the field of mathematics. The hypotheses were as follows:

1) The communication gap results from students' perceptual difficulties in understanding their professors *and* their own biases against international faculty.

2) The communication gap can be addressed by administering to students a training program that not only provides instruction on accent features, but also attempts to confront accent bias and persuades the student to adopt a more accommodating view of their professors' accents.

Fifteen experimental sessions were conducted in October 2009, in order to collect both quantitative data and qualitative data on the communication gap and students' views thereof. Quantitative data was collected through testing sessions that assessed students' baseline performance on mathematics assessments and their performance on one of three assessments after completing either the linguistic training program, a program meant to simulate bias creation, or a control program. Eighty-one undergraduates at the College of William and Mary in Williamsburg, VA, took part in one of six testing sessions. Each assessment was tied to a video lesson taught by a professor from India, and the training program was specifically engineered to address the features of this professor's accent.

The variable of interest was each student's improvement in scores between the baseline and post-training assessments, as following from Hypothesis 2, I hypothesized that the students who participated in linguistic training program would produce greater

improvement scores than the control group. I also hypothesized, on the basis of

Hypothesis 1, that students who participated in the bias program would produce

significantly worse improvement scores than the control group. An analysis of the data

resulting from the testing sessions revealed no significant difference in improvement

scores arising from membership in one of these three testing groups.

Qualitative data was collected through discussion sessions with testing session

participants two weeks after the testing sessions and through questionnaires administered

at the end of the testing sessions. Fifty-seven undergraduates from the original sample of

81 participated in discussion sessions. The discussion sessions addressed issues

surrounding the communication gap, including classes with international professors,

frustrations with communication breakdown, and suggestions for solutions to the

communication gap.

Data from these sessions were analyzed using an ethnographic approach,

revealing substantial cross-group trends and themes. While students did not universally

embrace the idea that they contributed to the communication gap and so bore

responsibility for closing it, almost all agreed that further research on the issue was vital.

A quantitative analysis of response data on the post-testing questionnaire revealed a

significant effect of linguistic training on linguistic attitudes. Therefore, although it was

not reflected in assessment scores, the use of linguistic training did have a positive effect

on students. Further research in this area is vital to determine a reliable application of this

result to greater professor-student communication.

Acknowledgements

The phrase that appears on the front of this thesis, "by Daniel James Villarreal," is a bold distortion of the truth; indeed, a long line of people have been instrumental in making this thesis happen, and it is as much "by" them as it is "by" me. I will attempt to give them their due here, and I sincerely apologize for any omissions.

First, I owe a great debt of gratitude to my participants. Your willingness to set aside time for my research made this thesis possible, but you did so much more than idly participate. The eagerness and candor with which you addressed the discussion sessions revealed a vast network of issues, emotions, and concerns surrounding the communication gap, making possible a rich analysis of your responses. Thank you, thank you for everything.

Second, I thank the professionals who guided this project along the way, with contributions both large and small: Anya Lunden, who first introduced me to linguistics and helped with acoustic analyses; Talbot Taylor, whose service as a committee member has been irreplaceable; Chi-Kwong Li, who has unfailingly encouraged my exploration of this issue—one that is met with unease by many mathematics colleagues all across the country—from the earliest stages of this project; Jack Martin, who expressed faith in my abilities to do linguistic research and provided advice with this project; Kushal Sen, who was a lifeline for my project when finding stimulus materials looked to be impossible; Richard Wright, whose simple suggestion drastically improved my project's design; Pauline Filemoni, Iyabo Osiapem, Marylou Zapf, Gexin Yu, Hyunju Ban, Doug Price, and Christen Cullum, who generously allowed me to speak to their classes/seminars for

recruitment; Paul Showalter, who was more than happy to let me, only an undergraduate, reserve the Dulin Learning Center; Ross Iaci, who provided me essential advice on statistical methods; and Susan Bosworth, David Lutzer, and Carl Strikwerda, who provided me with essential information about hiring practices and teaching statistics at William and Mary. Most importantly, however, I thank Anne Charity Hudley, my advisor in linguistics, from the bottom of my heart. Over the last four years, you have guided and shaped me as a student, at the same time giving me freedom to choose my own path. You were there from the moment I first had the germ of an idea to do linguistic research, and you've been an unyielding ally in all of my research and academic endeavors since. Beyond all of that, you've been a friend. As much as I look forward to studying in Davis next year, it is a shame that you won't be there, too. Thank you, thank you for everything.

Third, I thank the wonderful people at the Charles Center: Joel Schwartz, Lisa Grimes, Diana Morris, and others. You have been behind me in my research endeavors as an undergraduate ever since I decided to spend ten days trekking around Manhattan the summer after my freshman year. You expressed powerful confidence in my abilities as a student and person with the Class of 1940 Scholarship; to that end, I also thank Captain Garrett and Virginia Wetter, remarkable alumni whose example of giving back to William and Mary I can only dream of matching. Many thanks are of course also due to Ted Dintersmith, whose generosity made my fellowship possible, and who I imagine received the reaction of confusion, with which I am now well acquainted, associated with telling people of his combination of concentrations (English and physics). My fellowship was also made possible by the generosity of alumni Eric and Carolyn Mollen. To the

people who have supported my studies and research I cannot express sufficient gratitude.

Thank you, thank you for everything.

Fourth, I thank the fellow William and Mary students who provided help in ways

I could never have conceived prior to this project. Thanks are due to Anna Dausman and

Jacob Lassin, who assisted with my testing sessions; Allison Corish, whose steady eye

made far fewer grading errors than did mine; Mike Blaakman, who helpfully informed

me on day last year that I *had* to do an Honors thesis; Kristine Mosuela, Tara Safaie, and

all the members of Prof. Charity Hudley's lab group, who were instrumental in helping

recruit students for this project when numbers seemed frightfully low; Meg Southern,

who provided helpful suggestions and steadfast support during the times when the

outlook for this research seemed bleakest; and Chelsea Marotta, who attended my pilot

testing session and provided invaluable advice. Most of all, I am grateful to my

extraordinary friends at William and Mary, a compassionate, brilliant, energetic group of

people who have made William and Mary my second home. You have all made the hard

work worthwhile. Thank you, thank you for everything.

Fifth, I thank my family, both distant and close, for their love and encouragement

for 22½ years and counting. Diana, it has been a blessing to have you at school with me

this year, and in a few short months I have watched you grow from a frightened

prospective student to a confident, knowledgeable, and well-loved member of the

William and Mary community. I also cannot forget the help you have provided me with

this project, from recruiting your friends to storing dozens of Cheese Shop sandwiches in

your kitchen. Mom, you have been everything a son could ask for. You have let me

become my own person, and you did not protest when I decided to spend my last summer

of college away from home in pursuit of this project. I love you both very much. Thank you, thank you for everything.

Finally, I dedicate this thesis to my father, James Villarreal. Your "accent that I couldn't hear" (in the words of Rosina Lippi-Green) was the impetus behind this project, and you are no doubt a large part of my desire to pursue work in academia. You have always been a wonderful father to me, and I cannot hope to repay you for all of these years of love and support. You are an inspiration to me, and I love you very much. Thank you, thank you for everything.

Table of Contents

Tables

Figures

Chapter 1

Introduction

These people are geniuses, but I don't understand them. It's a lose-lose situation.

Most of the lectures, I have no idea what's going on.

I think a lot of times people are like, "oh, they have a foreign accent, I don't

understand anything they're saying," and then kinda just shut down.

Everywhere you go, everyone's always talking about how, in the Math

department, there's so many foreign teachers, it's so hard to understand them.

<div align="right">

--William and Mary undergraduates

</div>

These quotations illustrate an issue that burdens faculty and students not only at

William and Mary, but also at institutions of higher learning across the United States.

International faculty, who are especially prevalent in science, technology, engineering,

and mathematics (STEM) fields, may be leading researchers in their discipline but are

nevertheless beset with the additional task of becoming proficient in a foreign language.

Undergraduates, who must pay tens of thousands of dollars to attend college, feel as

though the value of their education is diminished if they must contend with an unfamiliar

accent on top of unfamiliar course material.

As a mathematics major at William and Mary, I am no stranger to hearing

comments such the above from my fellow undergraduates. Students recognize their

professors' brilliance and dedication, their teaching abilities and commitment to students,

but as far as their actual speech, to many students these professors will always be

deficient. The existence of a single barrier preventing students from rating their

professors highly across the board has always struck me as unfortunate.

Your dad's not...from around here, is he?

For years, friends puzzled me by asking me this question on their first encounter

with my father. How they could surmise my father's immigrant status from a minute of

polite, non-cultural chatter was beyond me. His accent, a voice I had known since birth,

could not sound any more normal to me. (I did not even pick up on it until I decided to

really listen to it one day in high school.) Similarly, when I began to take mathematics

classes at William and Mary, I found none of the difficulties in understanding and

processing the speech of my international professors that my classmates and friends

claimed to suffer. It was as if I were listening to a speaker from my hometown.

Still troubled by the comprehension issues my fellow undergraduates were

experiencing, I began to wonder if my own experience growing up with a parent with a

foreign accent could inform these issues. I postulated that my father's accent had played a

large part in allowing me to understand these professors, and I wondered if it would be

possible to replicate this positive experience, albeit in miniature, for other students. Out

of this musing grew the idea of an accent training program, and out of my education on

how powerfully language attitudes can affect our entire perception of other people grew

the idea that linguistic bias must also be addressed in any such program.

In order to investigate these ideas, I designed a training program engineered

toward helping undergraduates better comprehend the accents of their professors, an

experiment to gauge its effectiveness, and focus groups to gauge students' experiences

and attitudes on this issue (from which the above quotes are derived). This thesis

describes the motivation, methodology, and results of this research, as well as a

discussion of what this research means within the broader scope of the communication

gap between undergraduates and mathematics professors.

Chapter 2

Literature Review

2.1 Terminology

A major terminological issue in the literature on communicative difficulties between instructors who speak varieties of English that many American-born undergraduates have difficulty understanding and students revolves around the label that should be used for these instructors. Almost all studies on the topic focus on teaching assistants (TAs) and not professors, so any group label typically includes TAs only. The two main labels are *international teaching assistant* (ITA), in contrast with *United States teaching assistant* (USTA), and *non-native-speaking teaching assistant* (NNSTA), in contrast with *native-speaking teaching assistant* (NSTA). Neither name is perfect, as ITA is overly inclusive, whereas NNSTA is overly exclusive. The label *international TA* implies that the TA is from any country other than the United States, but there are a fair amount of university faculty from the United Kingdom (DePalma, 1980), and the high regard in which Americans hold British accents (Jones, 2001) leads us to believe that TAs from the UK should be excluded. On the other hand, among the foreign countries that send scholars to the United States is India (Johnson, 1987; Smith, Byrd, Nelson, Barrett, & Constantinides, 1992), where, by one estimate, there are 350 million English speakers, dwarfing the combined Anglophone population of the United States and UK (Crystal, 2004). Whereas only a tiny minority speaks it natively, "English is virtually the first language for many educated Indians" (Hohenthal, 2003, n.p.). Unlike the UK, however, Indian natives' native-speakerness or near-native-speakerness does not grant

them special status among foreign speakers. Indian dialects are stigmatized to a similar

extent as other foreign dialects (Lindemann, 2003; 2005), and faculty with Indian accents

are seldom treated differently in research on this topic (Gorsuch, 2006; Zhou, 2009).

Despite its flaws, I prefer the term ITA, and so this term will be used for the

remainder of this thesis, with the understanding that speakers with UK and other non-

stigmatized accents will be excluded from the scope of this term (in spite of the fact that

they, too, are international). The complementary term will then be *non-international*

teaching assistant (NITA), which will include American-born and UK-born speakers. In

addition, since this research focuses not only on TAs, but on instructional faculty in

general, the more inclusive terms *international teaching faculty* (ITF) and *non-*

international teaching faculty (NITF) will also be used.

I use the word *discrimination* in two different senses in this chapter. The term

appears first in the section on Auditory Phonetics (§2.4), wherein *discrimination* takes on

the more technical and neutral meaning reflected by Merriam-Webster's definition 2:

"the quality or power of finely distinguishing" (Discrimination, 2010, n.p.). When the

term is used is in the section on Language Attitudes (§2.5), it takes on the more colloquial

and negatively-connoted meaning reflected by definition 3b: "prejudiced or prejudicial

outlook, action, or treatment <racial discrimination>" (Discrimination, 2010, n.p.).

The sections Learning Standard American English and Auditory Phonetics (§2.3

and §2.4, respectively) use the linguistic terms *phoneme* and *phonological*. A phoneme is

"a class of speech sounds that are judged by a native speaker to be the same sound"

(Tserdanelis & Wong, 2004, p. 105). For example, English speakers consider the 't'

sounds in *little*, *top*, and *stop* to be the same sound, while they are in fact different. (The

't' in *little* is a *flap*, similar to Spanish 'r' as in *toro*; the 't' in *top* is an *aspirated stop*,

accompanied by a puff of air; the 't' in *stop* is *unaspirated*.) Phonemes are notated

between slashes, such as /t/ (Tserdanelis & Wong, 2004).

Two or more sounds are *in contrast* or *contrastive* if it is possible to assemble a

minimal pair of words that differ only by those sounds and have different meanings. For

example, English *tier* and *dear* differ only by the first consonant (despite spelling

differences), but the words have different meanings, therefore 't' and 'd' are contrastive

in English. Different languages have different sets of phonemes, and so different

phoneme contrasts. For example, the unaspirated and aspirated versions of 'p', notated

[p] and [p^h], respectively, belong to the same phoneme in English, meaning they are

noncontrastive in English. In Hindi, however, there is a minimal pair [p^{h}əl] 'fruit' and

[pəl] 'moment,' so these two sounds are contrastive in Hindi. As a result, they belong to

two different phonemes in Hindi (but not in English) (Tserdanelis & Wong, 2004).

Speakers use a variety of *phonological rules* to dictate how phonemes are

pronounced in certain environments. In Japanese, for example, 's' and 'sh' both belong to

the phoneme /s/. This phoneme is pronounced 'sh' before the vowel [i] (English long

'ee'), and 's' everywhere else. In addition to having different sets of phonemes and

contrasts, different languages therefore obey different sets of phonological rules. In fact,

phonological features may vary between speakers of the same language (Tserdanelis &

Wong, 2004); consider the way a native Virginian's pronunciation of the word *car* differs

from that of a native Bostonian who does not pronounce 'r' at the end of a word.

Finally, in order to address the idea of teachers with a foreign accent, it is

necessary to consider what exactly an *accent* is. Lippi-Green (1997) defines accents as

"loose bundles of prosodic and segmental features distributed over geographical and/or

social space" (p. 42). That is, a speaker's accent consists of the stress, rhythm, intonation

(prosody), and sound inventory (segments) with which they speak. A *dialect* combines

the factors of accent with the words a speaker uses and the meanings assigned to them

(lexicon and semantics), how words are formed from smaller word parts (morphology),

and how words are put together into sentences (syntax) (Lippi-Green, 1997).

2.2 Background of the Problem

The issue of miscommunication between students and foreign-born faculty is

rooted in fundamental changes within the American higher education system, beginning

in the second half of the 20th century. The boost that science and mathematics education

received from the space race of the 1950s and 1960s began to cool off by the time of the

Reagan administration (Hechinger, 1981). This shortcoming was most pronounced in

comparison to other nations: "At least half of all American high school graduates have

taken…no mathematics beyond algebra. Calculus is studied annually by five million

Soviet high school students, compared with just over 100,000 Americans" (Hechinger,

1981, p. C6). Whereas Soviet students were required to take two years of Calculus, "only

one-third of U.S. school districts require more than one course in science or mathematics

for graduation" (Mathews, 1981, p. A23).

As American-born students began to lag behind other nations in mathematics

education, American research universities began to give fewer advanced mathematics

degrees to American-born students. Despite the United States' population growing seven

percent between 1977 and 1984 (U.S. Census Bureau, n.d.), the number of American-

born graduate students in mathematics fell from 7,910 to 6,710 in the same time period—

an 18% drop (Heller, 1987). By 1985, two out of every five mathematics graduate

students were foreign-born, and that number was rising (Heller, 1987). American

universities collectively awarded 933 mathematics doctorates in 1989, but only 43% went

to American citizens (DePalma, 1990). The result was that a growing number of students

in science, technology, engineering, and mathematics (STEM) classes had graduate

teaching assistants (or TAs) who were not born in the United States. Many of these ITAs

had (to put it judiciously) "less than perfect control of English" (Bailey, 1984, p. 3).

These problems, however, were not limited only to TAs. A 1987 article in the

New York Times detailed how American universities were reaching out to professors in

other countries to fill academic positions. Although there had been a surge of late in

British professors coming to work in the United States, "nearly half the new foreign

teachers hail from Asian countries, a phenomenon that has been occurring since long

before the recent increased immigration of British scholars and scientists" (Johnson,

1987, p. EDUC30-31). These countries included India, Taiwan, and South Korea, which

contributed the second, third, and sixth-largest contingents of new teachers (Johnson,

1987). American universities found themselves with open positions for two major

reasons, on top of the dearth of graduate students described above. First, an entire

generation of academics, hired during the 1950s and 1960s to teach the deluge of baby

boomers that was coming of college age, was expected to begin retiring (Mooney, 1989).

In addition, more and more advanced degree recipients elected to go into private industry

rather than teaching, as the meager salaries and benefits of teaching could not stand up to

ever-growing compensation in the private sector (Heller, 1987; Johnson, 1987; Mooney, 1989).

These shifts in teaching staff hardly went unnoticed by American undergraduates—or the American public at large—and the issue saw a good amount of discussion in student newspapers, much of it negative (Berger, 2006; Gandelsman, 1999; Thomas, 2007; Yahalom, 2006; Zeldin & Hassel, 1976). Students were often mercilessly frank in their critiques of ITFs: "Wharton freshman Steve Bachman said that his recitation 'was not about trying to understand the information, but trying to figure out what the hell [the TA] was saying'" (Yahalom, 2006, n.p.). Stories of students switching sections, dropping courses, or changing majors abounded (Croman, 2006; Finder, 2005; Gourlay, 2008); in one study, four out of ten students had dropped a class because of an ITF (Rubin & Smith, 1990). By the turn of the millennium, more than a dozen states had passed legislation requiring that all instructors in state universities be proficient in English (some with exceptions for foreign-language instructors) (King, 1998). By 1983, the issue had become widespread enough that it had its own name: the "foreign TA problem" (Bailey, 1983, p. 309; Bailey, 1984, p. 3).

As suggested by the term *problem*, students' attitudes toward ITFs became reliably negative. In a 1980 study of University of Minnesota undergraduates, almost half reported that having an ITA had hurt the quality of a course they had taken, whereas only 9% believed that they had helped (cited in Bailey, 1984). In another survey, 85% gave their ITAs ratings of "fair" or "poor" in language proficiency, and 93% felt that these TAs had a "fair" or "poor" relationship with students (Damron, 2000). Several student governments in Florida even weighed a plan to have "volunteers pose as new students in

classes where professors' English-speaking abilities have generated complaints" in order to obtain tape recordings of professors' speech (Students say, 1987, n.p.).

These sorts of complaints have at least some validity. A 1989 study examined the effects of instructor gender, student SAT score, class term, age, ITA, and textbook on undergraduates' test scores in a macroeconomics survey course. Of these, no variable was responsible for a greater drop in scores than was the presence of an ITA (Watts & Lynch, 1989). Another study compared students' grades in microeconomics and macroeconomics courses, finding that "after controlling for a student's overall GPA, a foreign-born TA reduces the scholastic achievement of undergraduates by 0.2 grade points" (Borjas, 2000, p. 356-357).

Students are not mere victims of this miscommunication, however, as there is evidence that students' attitudes actually contribute to widening the gulf in communication. In a 1992 study, students listened to a lecture recorded by a native English speaker, with one group of students viewing the image of a Caucasian lecturer and another viewing the image of an Asian lecturer. The students who believed they were listening to an Asian lecturer performed significantly worse on comprehension tasks than did the other group, despite the fact that the audio was identical for both groups (Rubin, 1992). A focus-group study of undergraduates revealed that

> At the first sight of a "foreign TA" undergraduates would succumb to a prejudice
> towards [international] TAs and simply drop the class or switch to a section led by
> [a NITA]…for those who actually did stay in the class, many would simply "tune
> the teacher out" since he or she "obviously couldn't speak English." (Damron,
> 2000, p. 72)

In other words, miscommunication between instructor and student may begin before any words are uttered, with the student shutting themselves off to the possibility that their teacher will have an accent they can comprehend.

Thus, it appears that where miscommunication between students and instructors exists, it is co-created, and responsibility ('blame' is an unproductive term) for this miscommunication must be assigned to both parties. If any progress on this issue is to be made, then it requires corrective efforts on behalf of both students and instructors. Unlike the general public, linguists recognize this fact, and yet the majority of research on this issue has centered on programs for instructors, not for students. In addition, the issue pertains not only to TAs—who have received a disproportionate amount of focus in this issue—but also to faculty, including tenured professors.[1]

As a result, I am theorizing that "the foreign TA problem" is an inadequate term to describe this issue. Instead, I propose a term that recognizes that the problem is co-constructed and goes beyond TAs: the *communication gap between students and instructors* (or simply the *communication gap* for short). Furthermore, I view the communication gap (on the students' side) as consisting of two components. First, it should be accepted that most students have a least some legitimate issues with understanding their ITFs' speech.[2] Second, Rubin (1992) suggests that linguistic bias plays an essential role in impeding students' comprehension of their instructors. In order

---

[1] Brown (1988) measured students' perceptions of ITFs, using educational status as an independent variable (i.e., whether the speaker was said to be a TA or a professor) in light of the fact that most of the prior literature "has focused almost exclusively on teaching assistants" (p. 40). The factor of perceived educational status was significant only in students' judgments of "personal aesthetic quality" (passim), including how pleasant and sympathetic the lecturer was perceived to be. This factor did not significantly affect students' assessments of the lecturer's linguistic or educational competence. In other words, the study found little motivation to approach students' issues with ITAs or international professors differently in further research.

[2] This specific component of the communication gap will be referred to as *honest misunderstanding* or simply *misunderstanding*.

to fully understand these forces shaping the communication gap, it is necessary to

consider auditory phonetics and second language acquisition, which affects

misunderstanding, and language attitudes, which affects bias.

2.3 Learning Standard American English

Non-native speakers of any language face considerable difficulties in attempting

to approximate the accent of a native speaker. Capraro (2002) describes the difficulties

that a native speaker of Japanese encountered with English sounds not native to Japanese:

/θ, ð, ɹ, l, dʒ, z, ə, ʌ, ɪ, ɛ, ʊ, æ, u/. In Flege (1980), Saudi Arabian immigrants and

Americans who spoke English as a native language (*L1*) were tested on the parameters of

voice onset time, vowel length, and stop duration, parameters that differ between English

and Arabic and are not easily controlled on a conscious level. Across each of these

parameters, the Saudis' speech yielded means that were midway between English and

Arabic values. In other words, their accent when speaking English was influenced by

phonological features of their first language. Furthermore, Saudis who had been speaking

English for one to two years exhibited values closer to the American English norm than

those who had been speaking for less than one year. This study supports the notion that

second-language learners come to more closely approximate the phonological norms of

their non-native language (*L2*) as time passes.

Encouraging as the findings of Flege (1980) may be, it is important to remember

that if a speaker is not exposed to a second language early in life, there is little chance

that the speaker will be able to fully replicate a native accent (Gass & Selinker, 2001;

Lippi-Green, 1997; Zhou, 2009). It is true that adult learners can acquire the *structure* of

a second language more quickly than can children. The older a student is, however, the

more difficult it will be for the student to acquire the *phonological* characteristics of the

language (Gass & Selinker, 2001; Krashen, Long, & Scarcella, 1979). In other words,

while adult learners and older children may acquire a language more *quickly* than

younger children, younger children will end up acquiring a language more *completely*

than later learners (Krashen, Long, & Scarcella, 1979). Moyer (1999) suspects that "late

learners may face neurological or motor skill constraints, such as entrenched articulatory

habits or restricted perceptual targets for phonetic categories, that render the possibility of

nativelike attainment highly unlikely or impossible" (p. 82). Thompson (1991) suggests

that even if a speaker begins to learn an L2 very early in life, "the acquisition of fully

accentless speech in L2 may not be possible if L1 is maintained at a high level of

proficiency" (p. 177). In other words, if a longtime speaker of an L2 uses a 'foreign'

accent, it is unlikely that he or she will ever be able to 'lose' it.

For ITFs from India, there is a fair chance that English is a native language, not a

second language (Hohenthal, 2003), so their difficulties actually involve learning a

second *dialect* (see §2.1, Terminology). Nevertheless, the challenges that second

language learners face similarly extend to speakers acquiring non-native dialects of their

native language (for example, a Phoenix-born native English speaker moving to

Vancouver). A 1999 study showed that Canadians who had moved to Birmingham,

Alabama, as adults exhibited Canadian accent features despite long stays in Birmingham

(a mean of 7.7 years); in addition, these accent features were apparent both to native

Canadians and native Alabamians (Munro, Derwing, & Flege, 1999). Furthermore,

learning a non-native dialect is an uneven process, with phonological features taking

longer to acquire than lexical features. Phonological rules are also acquired unevenly, as some are simplistic, transparent rules that are acquired quickly, but others are complex and opaque, making them much more difficult to acquire. Finally, the adoption of these rules does not occur overnight, but in some instances on a word-by-word basis (Chambers, 1992).

2.4 Auditory Phonetics

If speakers cannot be made to reliably speak with the accent of a Standard American English (SAE) speaker, then those who listen to these speakers will be forced to deal with segments, phonological patterns, and prosodic tendencies that are absent from SAE. A substantial amount of work from the field of auditory phonetics formalizes some of the difficulties that arise from these L2 accent features. For example, when given discrimination tests for the /l-r/ phonemic contrast, which is native to English but not to Japanese, English speakers performed significantly better than Japanese speakers (whose performance was barely better than random guessing) (Miyawaki, Strange, Verbrugge, Liberman, Jenkins, & Fujimura, 1975). Furthermore, the degree to which English speakers can discriminate between two phonemes in non-native contrasts is a function of the degree to which the non-native contrast can be mapped to a contrast native to English. If this contrast is such that native English speakers can map both phonemes to an English phoneme, discrimination is poor (Best, McRoberts, & Goodell, 2001). On the other hand, if English speakers can map, one-to-one, multiple non-native phonemes to multiple contrastive English phonemes, then discrimination is possible. For example, English speakers demonstrate native-like adeptness in discriminating Zulu click phonemes,

despite the lack of click consonants in the English language (Best, McRoberts, and

Sithole, 1988).

In addition, speakers are capable of these sorts of judgments with even the

smallest amount of stimulus. Flege (1984) discovered that untrained listeners could tell

whether a single speaker was a native or non-native English speaker solely on the basis of

the syllable /ti/ or /tu/. He then discovered that when a native /t/ and non-native /i/ or /u/

(or a non-native /t/ and a native /i/ or /u/) were spliced together, native English-speaking

listeners still chose these hybrid syllables as more foreign than /ti/ or /tu/ produced by a

native speaker. Amazingly, in another experiment, listeners were able to correctly

determine whether or not a speaker spoke English natively, basing their judgments on a

30 millisecond clip of sound (Flege, 1984). This finding suggests that humans have a

highly sophisticated perceptual apparatus for discerning accent.

Critical to the idea of accent formation is that at birth, most human children (who

have no pathological speech impediments) are capable of learning any sound in any

language, but as children develop, they will only acquire those sounds necessary for

speaking their native language(s) and dialect(s) (Lippi-Green, 1997). Similarly, newborn

babies are capable of phoneme discrimination that is simply unnecessary in the language

spoken around them, which will soon become their native language. For example, "6-

month-old infants who were raised in English-speaking environments could discriminate

Czech alveolar trills and palato-alveolar fricatives…Swedish front rounded and

unrounded vowels…and Salish glottalized velar and uvular stops" (Clopper & Pisoni,

2004, p. 31). Well before children have acquired the ability to speak, however, they lose

the ability to identify these contrasts and instead become attuned only to the sounds and

contrasts native to the language spoken around them (Kuhl, Williams, Lacerda, Stevens,

& Lindblom, 1992).

2.5 Language Attitudes

One axiom that is universally accepted within the field of linguistics is that every

human speaks their language(s) with an accent (Lippi-Green, 1997; Matsuda, 1991;

Tserdanelis & Wong, 2004). In this sense, an accent is just another feature of who a

person is, along with their height, their age, their skin tone, their blood type, and other

personal characteristics. It would sound highly unusual to hear someone described as

having "no blood type" or "no height." "Yet, in ordinary usage," Matsuda (1991) notes,

"we say a person 'has an accent' to mark difference from some unstated norm of non-

accent, as though only some foreign few have accents" (p. 1330).

In contemporary United States society, most reasonable citizens would find

discrimination on the basis of height, age, skin tone, or blood type odious, and our laws

reflect this belief. At the same time, most Americans have no problem with

discrimination on the basis of accent, which is no less inherent a personal quality; in fact,

accent discrimination is often encouraged. In 1999, the Kentucky Supreme Court upheld

the conviction of an African-American man in a narcotics case based on the testimony of

a police officer, who opined that the voice of the crack seller on an audiotape of the

illegal transaction "sounded black" (Wiehl, 2002, p. 185). As the author notes, this

testimony should never have been admitted to the court; she describes another study in

which 92% of subjects misidentified a Caucasian man who "had adopted the style and

speech associated with African Americans" as black (p. 194). Purnell, Idsardi, and Baugh

(1999) found that landlords were more likely to make follow-up appointments with apartment-seeking speakers of mainstream Standard American English (SAE) than speakers of African-American Vernacular English (AAVE) or Chicano English (ChE).

Rosenthal (1974) demonstrates that the ability to discriminate against speakers on the basis of their accent is learned almost as early as the ability to speak. Children completed two tasks choosing between two anthropomorphized boxes, one of which had a SAE accent, and the other of which had an AAVE accent. In each task, both Caucasian and African-American children (from ages three to five) showed a significant preference for the SAE-speaking box (Steve) over the AAVE-speaking box (Kenneth). When asked the reason for their preference, children said, "cause he talk better," "I like Steve, but I'm afraid of Kenneth," "Cause Kenneth doesn't have nothing," and "He needs it cause he doesn't talk clearly, so he needs a pad to write it down. He better write than talk" (p. 61-62).

There is evidence that the bias effects present in the communication gap between undergraduates and professors can also shape day-to-day interactions. In a 1997 study, two groups of Detroit natives were presented with speech samples of another Detroit native and asked to identify the nature of selected low back vowels in the samples. Although the speaker exhibited *Canadian raising*, a phonological feature typical of the Detroit dialect, the group that was led to believe that the speaker was a Michigan native identified these vowels as canonical /a/, whereas the group that thought the speaker was Canadian identified the Canadian raising (Niedzielinski, 1997). In another study, listeners rated the speech of three videotaped children—one Caucasian, one African-American, and one Hispanic—for standardness and fluency. In fact, the same SAE speech sample

was used for each video, with only the ethnicity of the pictured child changing. Regardless, the Caucasian child was judged both standard and fluent, the African-American child was judged nonstandard but fluent, and the Hispanic child was judged neither standard nor fluent. In other words, the listeners' assumptions about the children's speaking ability actually caused them to *hear* the same voice differently (Williams, 1973).

While any accent is subject to discrimination, East Asian accents may be more susceptible to negative evaluation in the classroom setting than in other settings. Students rated a Chinese-accented speech passage lower in attractiveness, status, and dynamism when they believed that the speaker was a professor than when they believed the speaker was an interviewee for a non-academic job (Cargile, 1997). In the aforementioned Rubin (1992) study, students performed worse on comprehension tasks when they believed their instructor to be Chinese-born than when they believed their instructor to be American-born. A 1997 study showed that American-born students who had traveled outside the country had significantly more positive attitudes toward ITAs than students who had never traveled outside the country (Plakans, 1997). These studies suggest a link between cultural understanding in general and willingness to work with ITFs. In general, much sociolinguistic research supports the concept that students are at least partially responsible for their difficulties in understanding ITFs, in line with the idea that "The ability of the listener to understand a speaker's message, i.e., the listener's interpretive competence, is very much a function of the listener's attitude toward the speaker" (Brown, 1988, p. 25).

2.6 Attempts to Address the Communication Gap

Many previous studies have investigated strategies for addressing the communication gap, often focusing on ITAs' contributions to the communication gap. (As far as I can tell, no studies address professors or ITFs in general, aside from the Brown (1988) study.) One such strategy uses standardized tests developed by the Educational Testing Service (ETS), such as the Test of English as a Foreign Language (TOEFL) or the Speaking Proficiency English Assessment Kit (SPEAK) (Cassell, 2007; Davies, Tyler, & Koran, 1989; Halleck & Moder, 1995; Hoekje & Williams, 1992; Plakans, 1997).

The work of several researchers has cast doubt on the effectiveness of standardized tests in evaluating classroom readiness, however (Tyler, 1992; Young, 1989). Hoekje and Williams (1992) argue that the use of a single cut-off score for screening ITAs shows "no recognition of the fact that communication standards legitimately vary according to participants and context" (p. 245). Halleck and Moder (1995) argue that the TOEFL may be too generalized to adequately serve as a screening instrument, with their study showing that TOEFL scores were not strongly correlated with classroom performance. For a time, the TOEFL did not have a way to test spoken English proficiency, so ETS developed the Test of Spoken English (TSE). Some schools use the TSE rather than the TOEFL to screen potential ITAs, though TSE scores are also not strongly correlated with students' ratings of TAs (Bailey, 1984).

Effective or not, universities have often coupled these tests with training programs for ITAs. Purdue University, for example, uses the SPEAK as a screening test; the 40% or so of prospective ITAs who fail to attain a satisfactory score must enroll in an English

language learning course for at least one semester (Cassell, 2007). At Iowa State

University, prospective ITAs must pass both the SPEAK test as well as a performance

test that simulates the in-class setting. Those who do not pass both tests (about 30% of

prospective ITAs) undergo a semester-long training course and may retake the tests

(Plakans, 1997). The University of Michigan, on the other hand, requires all its incoming

ITAs to take a special training course, not just those who did poorly on screening tests

(Briggs & Hofer, 1991). Very few of these university-mandated training courses,

however (one out of every twelve), grant academic credit (Bauer & Tanner, 1994). This

practice raises issues of discrimination, as noted by Hoekje and Williams (1992):

> If…the goal of ITA training is viewed as preparing the student to effectively take
>
> on the role of TA with all that entails (teaching, managing the classroom,
>
> advising), as we have proposed here, they lay themselves open to charges of
>
> discrimination, either against ITAs, who are forced to do extra work, or against
>
> NSTAs, who did not have access to special training. (p. 263)

Whether or not they are mandatory for ITAs, linguists have experimented with a

number of different models and features for ITA training programs. One program at the

University of Michigan has prospective ITAs participate in role-play that simulates the

classroom environment (Gravois, 2005). At the University of Florida, ITAs who scored

poorly on the SPEAK and were forced to take a semester-long training course actually

regressed in their comfort with and proficiency in English after completing the training,

due in part to the fact that they resisted using English except where necessary (i.e., during

lectures and office hours) As a result, a program was designed in which native-speaking

undergraduates participated in simulated office-hour interactions with ITAs (Davies,

Tyler, & Koran, 1989). Seeking to meet ITAs' discipline-specific teaching needs, a

training program was devised that paired experienced TAs (both ITAs and NITAs) with

ITAs-in-training. The program was received well by both the new ITAs and the mentor

TAs, with all of the new ITAs agreeing with the statement, "I learned from this

experience" (Gorsuch, 2006, p. 97).

Of course, the communication gap does not pertain only to linguistic issues; there

is a consensus in the field that adequate ITF training should include culture, pedagogy,

and language, but the question of the relative importance of each and the relationship of

one area to the other remains (Hoekje & Williams, 1992). The issue of culture can be

especially difficult, as ITFs often come from cultures with drastically different

conceptions of the teacher-student relationship than the American model. As Crusan-

Alviani (1998) notes, "in many other cultures, the teacher is lecturer, imparter of all

knowledge, and presumably omnipotent in the classroom" (p. 63). ITFs from some

cultures may become offended when students ask questions in class: "Koreans rarely

even ask questions in class because to do so is thought to be an indication that the teacher

somehow failed in his/her responsibility to anticipate the students' needs" (Tyler, 1995,

p. 141). A survey of both ITAs and experienced faculty on teaching styles and

philosophies showed the two groups agreeing on most principles. The ITAs as a group,

however, did not clearly show agreement or disagreement with the ideas that students

should do their own work or that students could answer questions posed by other students

(the experienced faculty approved of both) (Gorsuch, 2003).

2.7 Student-Centered Research

In contrast to the resources that have been put into programs to train ITFs for interactions with students, relatively little research has focused on students' role in constructing miscommunication with ITFs. By and large, "The current training curriculum still aims at bringing ITAs into an American norm," despite the fact that this is linguistically untenable (Zhou, 2009, p. 21). As Rubin and Smith (1990) point out, "This approach presumes that NNSTAs 'own' the problem and that they are ones who must resolve it" (p. 338). Two studies attempted to improve students' attitudes toward ITAs by letting them take part in ITA training; these effort were largely unsuccessful (Civikly & Muchisky, 1991; Rubin, 1992). Damron (2000) concluded that ITA training programs that involve undergraduate students in hopes of fostering greater intercultural understanding among the undergraduates have mostly fallen flat.

Regardless, there is still a recognizable need for student-centered programs and research, and several researchers in the field have called for such research (Bailey, 1983; Crusan-Alviani, 1998). Rubin (2005) noted,

> Support for ITAs (and also continuing support for non-native English speaking faculty members) is key, and much progress has been made in many fine programs on that score. But also key is attention to undergraduates' listening abilities. Very few--if any--programs exist to support undergraduates as listeners of World Englishes. (n.p)

Zielinski (2007) calls for "explicit instruction in how the features of different accents might impact on their listening strategies, and which non-standard features are likely to have an impact on intelligibility might also have a positive effect on their actual ability to understand" ITAs, but notes that this is an untapped area of research (p. 82).

Derwing, Rossiter, and Munro (2002) provide a blueprint sketch for accomplishing this sort of instructional program. A pool of English L1 students in a social work training program took a pre-test and post-test (separated by eight weeks) to assess their comprehension of a native Vietnamese speaker who spoke English as a second language. In between the tests, a third of the L1 speakers participated in a weekly presentation and discussion about cross-cultural differences between American society and the Vietnamese speaker's cultural background, a third received the weekly cultural lessons augmented by lessons on specific linguistic features of the Vietnamese speaker's accent, and a third simply took the tests. All groups showed a significant increase in comprehension, though no group's increase was significantly greater than the other two. Part of what may explain this apparent lack of effectiveness of the accent/cultural training programs relative to the control group is the laboratory effect exerted on all three, as the "admittedly artificial" testing instruments "themselves served as a training tool" (p. 255). The fact that this small amount of exposure had *any* effect on the control group is encouraging.

The accent/cultural lessons had their greatest impact, however, on the speakers' confidence in their ability to interact with L2 speakers (and the accent training group showed a significantly greater increase in confidence than the group that only received cultural lessons). Furthermore, both variable groups (and to a greater extent, the accent group) showed significant gains in empathy toward English L2 speakers. The accent training group overwhelmingly agreed (with a mean rating of 8.65 on a 9-point scale) that such a program would help other L1 speakers become more confident and able in their interactions with L2 speakers:

16 months after data collection was completed, the social work instructor of the

Accent group received a telephone call from a student who had participated in the

study. She reported having been the only member of an intervention team able to

communicate with a Vietnamese woman in an elder abuse case. The former

student attributed her success to the listening training she had received the year

before. This incident suggests the instruction had a lasting effect. (p. 256-257)

2.8 The Unique Case of Mathematics

This study places a particular focus on the issue of the communication gap

between undergraduates and *mathematics* professors for several reasons. As a major in

the William and Mary Department of Mathematics, I have been exposed both to ITFs and

to students who report major issues with ITFs' accents. As a result, I wanted to pursue a

project specially geared to the needs of students in mathematics classes.

Several studies support this idea that mathematics occupies a special domain

within the larger problem of the communication gap. As Rounds (1987) argues,

"mathematics enjoys a certain mystique. It is generally conceived of as an abstract,

precise, symbolic discipline, demanding economy of notation and a high level of

accuracy" (p. 645). Since topic familiarity influences comprehension of ITFs to an even

greater degree than familiarity with the ITF's accent (Gass & Varonis, 1984), students in

ITF-led mathematics classes may be at an even greater disadvantage than students in

other subjects. In addition, since "mathematics teachers can be expected to talk almost

continuously during the whole class session," mathematics students have ample exposure

to speech they may not be able to understand and/or may not find appealing (Byrd &

Constantinides, 1992, p. 164). Finally, the problem of *math anxiety* (Ashcraft, 2002), a

fear of dealing with mathematical concepts and taking mathematics classes, only

amplifies students' bias and anxiety about ITFs. The confluence of all these factors

means that "so many of our early assumptions about teaching (based on teaching styles

preferred in ESL) do not hold for the teaching of mathematics" (Byrd & Constantinides,

1992, p. 166). The mathematics classroom, in other words, is a creature unto itself.

2.9 The College of William and Mary

The College of William and Mary (W&M) is an accredited, public, four-year,

coeducational institution of higher learning located in Williamsburg, Virginia. Whereas

most of the institutions mentioned in ITF literature are large, public universities with over

10,000 undergraduates, W&M is a medium-sized school, with 5,836 undergraduates and

2,038 graduate students (Office, 2009). Because of its medium size, W&M is able to

offer small class sections; over 65% of undergraduate courses enroll fewer than 30

students (Office, 2008). W&M's medium size also presents an advantage in that very few

of its undergraduate courses are taught by TAs. In the fall 2009 semester, for example,

W&M offered 2,446 undergraduate, graduate, and law courses; only 21 (0.86%) had a

graduate student as the instructor of record. Of these, seven were lab sections, six were

lectures, and four were topics courses (S. L. Bosworth, personal communication,

February 19, 2010). Relatively few of its faculty (6.34%) are nonresident aliens (though

ITFs are not necessarily aliens, as they could have attained citizenship) (Office, 2008).

The William and Mary Mathematics Department faces a set of difficult and often

contradictory demands. In addition to offering sufficient course selections each semester

for Mathematics concentrators,[3] it must offer a sufficient number of seats in courses

satisfying W&M's quantitative reasoning general education requirement. Since few

courses outside the department satisfy this undergraduate requirement, a fair amount of

William and Mary undergraduates will take at least one Mathematics Department class

before they graduate. Additional strains arise from the need to offer foundational courses

for science majors, the need to offer freshman seminars,[4] the desire to pursue research,

including research experiences for undergraduates (REUs), and a small graduate program

(Mathematics, 2008a). Faced with these competing priorities, the department is often

forced to make difficult choices, for example, between offering upper-level courses less

frequently or expanding the size of lower-level sections like Calculus I and II, which may

negatively affect the learning experiences of students in those classes (Mathematics,

2008b). Furthermore, since "it is problematic to find adjunct instructors who are right for

our upper division mathematics courses, we tend to use tenured and tenure-track faculty

in 300- and 400-level courses and to assign our adjuncts to the larger lower-level

courses" (Mathematics, 2008b, p. 2) Thus, students who take only one or two

mathematics courses at W&M are unlikely to be exposed to more experienced

Mathematics Department faculty.

     ITFs have a considerable presence in the Mathematics Department. A 2008

internal review of the department noted that "The Faculty Appointments Handbook

issued to department chairs by the College's Equal Opportunity Office clearly indicates

that diversification of the faculty by nationality is one of the College's hiring priorities"

---

[3] The graduating classes of 2005-2009 included an average of 35 mathematics majors and 33 minors (S. L. Bosworth, personal communication, December 1, 2009).
[4] "Unlike other departments at the College, the mathematics department did not receive a new faculty position in return for offering freshman seminars" (Mathematics, 2008b, p. 1).

(Mathematics, 2008a, p. 12). To that end, "in fall 2008, of our 20 tenured and tenure-eligible faculty, four came from Russian-speaking areas and five from China, and one has dual U.S.-Swiss citizenship" (Mathematics, 2008a, p. 12). While these faculty enhance the scholarship and diversity of the department, they also act as convenient targets for student complaints.

2.10 Summary: The Need for this Research

In response to the problem of the communication gap, I have designed this research with several features that make it unique and necessary. First, whereas the overwhelming majority of research on the communication gap has focused on ITAs—the label "foreign TA problem" is telling—this research focuses on professors. Second, whereas popular opinion holds that ITFs are more or less wholly responsible for having created (and therefore for solving) the communication gap, this research shifts a share of communicative burden to students. Third, whereas the foundational research upon which this project is based is generalized, this research focuses specifically on the communication gap within the mathematics classroom. Finally, this research seeks to address the communication gap as a whole, not just as the product of honest misunderstanding or student bias.

Chapter 3

Methodology

Abstract An accent training program, in the form of an educational website, was designed to aid undergraduates' linguistic understanding of a mathematics professor with an Indian accent. An experiment was designed to test the hypothesis that students who took part in this program would better understand the professor in question, relative to students who did not take part in the program, and relative to their own understanding prior to taking part in the program. Each participant viewed two lessons given by the professor, and their comprehension of the professor was measured by their scores on assessments taken directly after each lesson. Over 80 students at the College of William and Mary in Williamsburg, Virginia, were recruited for this experiment, which was conducted across several testing sessions in early October 2009.

Participants who took part in testing sessions were also invited to take part in discussion sessions in mid-October 2009. These sessions encouraged students to discuss issues relating to ITFs, including their own experiences and opinions. These sessions also served to debrief participants as to the project's motivation and structure. Participants were offered a free meal from the Cheese Shop, a local eatery popular among William and Mary students, as an incentive for their participation.

3.1 Experimental Design

The experiment consisted of two parts: a *testing session* to collect quantitative data, and a focus group-style *discussion session* to collect qualitative data. I designed the testing session to assess the effectiveness of an accent training program in helping undergraduates better understand mathematics ITFs (see §2.1, Terminology), with the hypothesis that this program could indeed be effective. I designed the discussion session to elicit the students' opinions and experiences about the communication gap between undergraduates and professors, especially ITFs. Undergraduates at the College of William and Mary were the population of interest in this experiment. Over 80 William and Mary undergraduates were recruited to take part in both sessions in October 2009.

The testing session had several components: two mathematics video lessons, separated by an inter-lesson module, with a Linguistic Profile Questionnaire at the conclusion. The main factor was the content of the inter-lesson module, a linearly-organized website that students were to read through, with three factor levels of Control, Bias, and Training. (These groupings of students will be referred to as *module groups*.) The Training module informed students about general accent ideology and specific linguistic features of the professor whose voice was used in the lesson videos for the experiment. The Bias module presented students with widely-held points of view asserting that professors held most, if not all, of the responsibility for the communication gap. I designed the Control module to be neutral, presenting students with information about mathematics education in general and at William and Mary, but avoiding the topic of international professors or accents.

The lessons that a student viewed also varied from student to student. I produced three lesson videos for the experiment in total, so each student, viewing two videos, could view one of six permutations of videos. The order in which a student viewed these videos was independent from the inter-lesson module they viewed, so there were 18 testing groups in total for a total of six subgroups within each of the three module groups. This practice served to control for any possible confounding variables arising from one lesson being significantly harder or easier than others. Students were given a relevant one-page assessment after each video.

The main variable of interest in the experiment was the student's improvement in scores from the first assessment to the second, relative to the improvement scores of all other students. In statistical terms, then, the hypothesis was thus: Students in the Training group will have significantly greater improvement scores than those in the Control group, whereas students in the Bias group will have significantly lower improvement scores than those in the Control group.

At the end of the testing session, participants completed a Linguistic Profile Questionnaire with questions about their linguistic background. This questionnaire was primarily used to assess the amount of accented speech the participant had grown up around, in case there was some association between comprehension and prior foreign accent exposure (see §4.6, Foreign Accent Exposure, Concentration, and Mathematics Experience).

I created the lesson videos with audio taken from the Discrete Structures course on the National Programme on Technology Enhanced Learning (NPTEL) website (NPTel Video Course, n.d.), provided by the Indian government. I used Microsoft PowerPoint to

provide animations for this audio, simulating the professor writing on a chalkboard. The

introduction to the first lesson video led participants to believe that Prof. Kamala was an

applicant for an open faculty position in the William and Mary Department of

Mathematics. The purpose of this deception was to engage participants in the study by

lending relevance to their participation in it. A debriefing statement at the end of the

experiment informed participants that Prof. Kamala was not actually an applicant for a

Mathematics Department position at William and Mary.

I selected these lessons for two major reasons. First, the professor who taught

each of these lessons, Professor Kamala Krithivasan of the Indian Institute of Technology

Madras, speaks with a noticeable Indian accent, as confirmed by Prof. Anya Lunden, a

phonologist (personal communication, April 2, 2010). Second, the lessons were

elementary enough to be grasped by most undergraduates, but difficult enough that

students could not afford to ignore the professor herself.[5]

I also invited participants to take part in discussion sessions two weeks after the

testing sessions. These sessions were segregated by module group (Control, Bias, or

Training) so that all participants in any one group had seen the same inter-lesson module.

Participants who attended the discussion session were compensated with a sandwich and

drink from the Cheese Shop in Williamsburg.

3.2 Earlier Experimental Designs

The design of this experiment went through several conceptual iterations before

reaching its final form. I originally planned to first recruit several international professors

---

[5] Most online mathematics lessons addressed either pre-college topics such as introductory algebra or more advanced topics such as combinatorial analysis; very few courses occupied an introductory undergraduate middle ground.

from the William and Mary Department of Mathematics to record a few simple

mathematics lessons in June 2009. I would then conduct a pre-study to determine which

lesson was most suitable for the study by being moderately difficult, and I would

separately determine which professor's speech was the most heavily accented. I would

use the results of the pre-study to construct several sets of stimuli in which undergraduate

participants would view either a Control, Bias, or Training module, after which all

participants would view the same lesson video.

Several factors contributed to these changes. First, I found that recruiting

mathematics professors for the study to be much more difficult than expected. Some

professors did not have enough free time to prepare lessons to record; I underestimated

the amount of time that a professor would have to commit to make a coherent lesson.

Other professors who would have been willing to put time in to plan the lessons could not

fit a recording session in their schedules. The Protection of Human Subjects Committee

did not approve the original project forms until June 19, leaving me only two weeks for

recording William and Mary mathematics professors before I left to spend the remainder

of the summer in Berkeley, CA. I also attempted to recruit mathematics professors at the

University of California, Berkeley, and other schools in the San Francisco Bay Area, but

I found that getting these professors—with whom I had no personal connection—to

invest several hours of their time on my project to be nearly impossible.

Finally, several mathematics professors had major philosophical differences with

the project, rejecting outright the supposition that some students' struggles in some

mathematics classes were due at least in some part to the professor's accent. Many

professors asserted that any complaints about accent existed only for the sake of

complaint; if not for accent, these professors argued, students would find something else
to complain about. One or two professors even went so far as to state that a professor's
accent is always a non-issue, existing only in the heads of students. The use of
mathematics lessons available online solved the professor recruitment issue.

I also changed the design of the experiment from the initial between-groups
design to a longitudinal design because of several potential benefits unique to the
longitudinal design. First, students would be assessed both before and after their inter-
lesson module, so it would be possible to gauge students' quantitative abilities prior to
the study in addition to the effects of the accent training. Second, the new experimental
design required the use of more than one lesson video, so a pre-study gauging which one
was most fit for the study became unnecessary, thus decreasing the number of
participants that needed to be recruited and fed. Finally, the longitudinal design enjoyed
more support in the communication gap literature. In particular, this design resembled a
study in which participants listened to two sets of sentences recorded by non-native
speakers and completed transcription exercises to test comprehension, separated by a folk
fable that put one of the sentence sets in context (Gass & Varonis, 1984).

3.3 Stimulus Videos

I created three stimulus videos for the testing sessions, based on lessons from the
Discrete Structures course on the National Programme on Technology Enhanced
Learning (NPTEL, n.d.) website, taught by Prof. Kamala Krithivasan. I only used the
audio from these videos, in order to provide greater confidentiality for the professor,
whom the participants would almost certainly never meet in person, and in order to avoid

additional bias effects related to the visible ethnicity of the professor (cf. Rubin, 1992). I

associated the audio files with animated PowerPoint slides to provide a visual element. I

created three lessons in total: Permutations and Combinations, the Proof that the Square

Root of 2 is Irrational, and Relations and the Cartesian Product (see Appendix 1).

Prof. Kamala speaks with a noticeable Indian accent, though it is unclear which

Indian language(s) she speaks natively.[6] An acoustic analysis that was performed for the

purposes of developing the Training module (see §3.5, Module Development; Appendix

6) determined some salient features of Prof. Kamala's accent that do not appear in

Standard American English (SAE) speech. These included initial voiceless stop

deaspiration, interdental fricatives changing to dental stops, and word-final sibilant

devoicing; in fact, these features are shared by many of the Indian speakers' accents on

the Speech Accent Archive, regardless of first language (George Mason University,

2010). Prof. Anya Lunden, a phonologist, attested to the presence of each of these accent

features after hearing and analyzing several samples of Prof. Kamala's speech (S. L. A.

Lunden, personal communication, April 2, 2010).

I obtained permission from the Video Coordinator for NPTEL to use the videos

for my research (K. Sen, personal communication, July 20, 2009). I downloaded the

lessons from which I would take audio excerpts as Flash video (.FLV) files, using the

DownloadHelper 4.6.4 add-on for Mozilla Firefox (Sarl, n.d.). I then used the Media

Converter utility online (Beyeler) to strip audio from the videos, making sound files

(.WAV) for use in the stimulus lessons. I chose to download the files in PCM WAV

format despite their large size, in order to prevent degradation of the audio sample

resulting from lossy compression (i.e., MP3 compression). Several of the videos I wanted

---

[6] I emailed her with an inquiry about her native language, but the inquiry was never returned.

to use for sound files were too large for Media Converter to process, so I had to trim them using a program called Free Video to Flash Converter 4.1.3.52 (DVD, n.d.) before stripping the audio with Media Converter. Prof. Richard Wright, an acoustic phonetician, judged that the final audio files were of no lesser quality than the original audio on the NPTEL website (personal communication, August 6, 2009). WAV files were used in the final lesson videos to avoid further degradation of sound quality, despite the fact that this made the PowerPoint files considerably large (~60MB).

I extracted all of the audio clips from different lessons within the Discrete Structures course: Permutations and Combinations from lecture 28, Permutations and Combinations, the Proof that the Square Root of 2 is Irrational from lecture 7, Methods of Proof, and Relations and the Cartesian Product from lecture 13, Relations. The lessons were chosen to be roughly equal in difficulty level, so that students who had taken up to William and Mary's Mathematics 214 course, Foundations of Mathematics—typically the fourth course taken after Calculus I (Department, n.d.)—would have seen the material in each of the lessons. Each final lesson video was between five and seven minutes in length, and the audio was mostly preserved from the lecture to the lesson video. Exceptions to this rule were lengthy explanations about computer engineering applications of the principles presented; the course was actually geared toward future computer engineers. Once I chose each lesson and downloaded the sound files, I had to storyboard the lessons by cutting the overall file into segments of about one minute apiece. These segments would later correspond to individual slides in the lesson videos (see Appendix 1).

In designing the stimulus materials, I had to decide whether to use only audio. On one hand, the experiment sought to test students' auditory understanding, so the use of video could compromise this effect. Conversely, as many participants attested in discussion sessions (see §5.7.3, Importance of written materials), students can understand more content when the teacher writes on a chalkboard.[7] As a result, I chose to use video as well as audio, but I also chose not to use the original lesson videos featuring Prof. Kamala's image, for reasons of confidentiality and bias avoidance. Instead, I created animations on Microsoft PowerPoint to represent Prof. Kamala writing on a chalkboard.

3.4 Lesson Video Animation

A fair amount of consideration was involved in animating the lesson videos. First, I chose to use white characters in 40-point Arial on a black background, in order to simulate text on a blackboard. Each lesson was subdivided into two sections to provide greater structure, and these sections were introduced with title slides. Next, I avoided the tendency to use these animations as subtitles, spelling out every word the professor said. Rather, nearly all of the text that appeared on the animated chalkboard appeared in the original videos themselves, with Prof. Kamala either writing them on the real chalkboard during the course of the lesson or displaying them on the screen as a PowerPoint slide.

I chose to let characters, words, and/or phrases appear on the screen at the same time that Prof. Kamala spoke them, even though there would still be some time before they were written on the chalkboard in the original lesson. It would have been overly

---

[7] According to Abrams and Haefner (1998), "the two most important components of a mathematics classroom presentation are the use of some sort of 'chalkboard' (in order to visually, efficiently transmit mathematics), and the voice/words of the instructor (in order to describe, explain and otherwise guide the students through the material)" (p. 53).

difficult to synchronize the appearance of text on the screen with the time during which they were written on the real chalkboard, and it was not clear that this would make a substantive difference. In addition, I chose to have the desired blocks of text simply appear on the screen at the appointed time, without a fancy animation simulating the writing of individual characters. Finally, I included one or two dynamic animations in each lesson, which were meant to simulate chalk movements such as drawing an ellipsis (…) dot-by-dot or drawing axes in a Cartesian plane. These were used sparingly to avoid making the videos look too slick, although several participants later noted that these animations made the videos themselves much more convincing as chalkboard simulations (see §5.7.3, Importance of written materials; §5.8.3, Helpfulness of lesson animations).

In order to animate the text, I used the acoustic analysis program Praat 5.1.10 (Boersma & Weenink, n.d.) to determine when to line up the appearance of text with the associated speech. I chose the convention of making text appear at the release of the onset consonant of the syllable carrying the main stress in the word or phrase. I made a list of blocks of text and the times at which they would appear—rounded to the nearest tenth of a second, thanks to PowerPoint's programming limitations—then mapped out a sound file's worth of text on a single slide (see Appendix 2). I drew black rectangles (to blend in with the background) over each block of text and timed these rectangles to disappear at the moment the text needed to appear.

3.5 Module Development

As mentioned above, there were three inter-lesson modules corresponding to the three major module groups: Control, Bias, and Training (see Appendices 3, 4, 5). All

modules were presented as a series of web pages set in HTML, with identical

backgrounds and similar text and page formatting. Each of the three modules ended by

directing students to http://djvill.people.wm.edu/End.html, a page that instructed students

to proceed to the second lesson (see §3.10, Testing Sessions).

The Bias module consisted of three pages, totaling about 1500 words of text. The

first page was an April, 2006 article from the Daily Pennsylvanian, the student daily

newspaper at the University of Pennsylvania, entitled, "Hard to decipher your TA's

English?" The article outlined Penn students' difficulties with ITAs, taking a more

negative stance toward these TAs, for example, "Wharton freshman Steve Bachman said

that his recitation 'was not about trying to understand the information, but trying to figure

out what the hell [the TA] was saying'" (Yahalom, 2006, n.p.).

The second page was a table of ratings from RateMyProfessors.com about a

female mathematics professor of Indian heritage (whose name was excluded from the

module).[8] The table included both positive and negative ratings, but the negative ratings

focused especially on her accent; for example, "her accent made it very hard to

understand, plus she doesn't explain the means to getting the answer, if you don't know

the material don't plan on her teaching it to you" (RateMyProfessors.com, n.d., n.p.). The

final page was an April, 2005 blog post from North Dakota, entitled, "Addressing the

Professor Accent Problem." This post was also biased in favor of students, stating:

"higher education is a business and that the students are the clients" (Port, 2005, n.p.).

The Control module consisted of two pages, totaling about 1300 words in length.

The first page was a September 2007 article from William and Mary's Ideation research

---

[8] I deliberately chose ratings for a female mathematics professor of Indian heritage to match the gender, profession, and nationality of Prof. Kamala.

website, entitled, "NSF grant supports computational math initiative" (McClain, 2007).

This article detailed the Computational Science Training for Undergraduates in the

Mathematical Sciences program, as well as how the NSF grant funding the program

would allow for the hiring of new faculty, thus playing into the scenario of a prospective

new faculty member. The second page was an excerpt from the Wikipedia article on

Mathematics Education as it appeared in late September 2009, including the first two

subheadings: "History" and "Objectives" (Mathematics, n.d., n.p.). Neither page of the

Control module specifically addressed issues of professors' foreignness or accentedness

in any way.

The Training module consisted of four pages, totaling about 1600 words in length,

and was modeled to a great extent on the website Language Variation in the Classroom

(Askin, 2007). In 2007, a William and Mary senior linguistics major, Hannah Askin (now

Franz), created this website to help teachers better comprehend students who spoke a

dialect of English called African-American Vernacular English (AAVE). Whereas I used

primary sources for the text of the Control and Bias modules, I wrote the Training

module in my own words. The first two pages outlined standard accent ideology,

including the principles that every speaker uses an accent, that prospective employees

should not have to face discrimination on the basis of their accent, and that all accents are

highly rule-based. Per Askin (2007), I used the concept of rule-based speech to assert that

listeners who made themselves aware of the rules and patterns particular to an unfamiliar

accent could tune their ears to better understand speakers with this accent.

In turn, the second half of the Training module involved familiarizing listeners

with Prof. Kamala's accent by presenting six linguistic features particular to her accent,

three for each of the two pages. I chose to present six features in depth in hopes that

participants would internalize most of the features, as opposed to presenting a greater

number of features that participants might forget about. In order to determine the features

that would be used in the module, I performed an acoustic analysis wherein I listened to

several samples of Prof. Kamala's lectures that were not used in any of the final lesson

videos. From these samples, I made a list of marked accent features, including /u/

rounding, eɪ > e, and unreduced ə. I then took six random samples of ten seconds apiece

from the audio for each of the three lessons and notated the number of tokens of each

marked feature (see Appendix 6). This stratified sampling method ensured that each

lesson was represented equally, in case certain features appeared with disproportionately

greater frequency in certain lessons; such overrepresentation would affect the results of

students whose second lesson following the Training module was this overrepresented

lesson.

The six marked features that had the greatest number of tokens were, in order: ɹ >

ɾ; T^h > T / #__, where T = voiceless stops; z > s / __# (especially in the plural

morpheme); non-native intonation contours, including a sharply rising tone on the

penultimate word or phrase of an utterance; ʔV > jV / #__; and θ > t, ð > d. Furthermore,

none of these features occurred with disproportionate frequency in one lesson over

another; no one lesson claimed more than 55% of the tokens of each feature (see

Appendix 6). Thus, these six features were ultimately presented to participants in the

final Training module, albeit in a different order.

Each of the last two pages of the Training module contained three features. The origin and production of each feature was explained in paragraph form, and then two sound files were presented. The first sound file played a token of the feature, taken out of context so as to obscure its meaning. For example, for the interdental fricatives feature, the sound file "thirty-six" sounded like "dirty six". The second sound file placed the first clip in context, allowing its meaning to become more transparent; for example, "each of them is assigned a number between one to thirty-six." The first file was accompanied by a phrase under the heading "What it sounds like," whereas the second file went next to a phrase under the heading "What she's saying;" this section was also modeled off of a section of Askin (2007). Finally, all of the sound clips were taken from parts of Prof. Kamala's lessons that did *not* appear in any of the lesson videos. This practice served to simulate real-life conditions in which listeners do not get the luxury of hearing accented tokens exactly the same way a second time, but must build new knowledge off of similar prior tokens.[9]

The Control module used in the experiment was the second version of the module; the first version presented an article and blog post on gardening. In light of the mathematics-education-oriented scenario presented in the experiment, though, I created the newer module focusing on mathematics education. I forgot to replace the old Control module with the new one on the Web until after the first testing session, however, and so three out of 30 members of the Control group viewed the wrong Control module. It is not clear whether or not this had any significant effect on the performance of those participants.

---

[9] This assertion follows directly from the principle that no two utterances are produced identically (Lippi-Green, 1997).

3.6 Web-Based Content

I hosted most of the testing session content (lessons, inter-lesson modules, and Linguistic Profile Questionnaire) on the Internet. The alternative, loading the PowerPoint files and modules directly onto the computer workstations in the computer lab used for the experiment, would have taken a considerable amount of time, especially given the large size of the PowerPoint files thanks to using WAV format for the sounds. Beyond that consideration, I judged that little additional benefit, if any, would accrue from a non-Web-based format. As a result, I loaded these files onto the webspace allotted for me by William and Mary: http://djvill.people.wm.edu.

One challenge was finding a way to display PowerPoint shows online. The nature of the files I produced was that minimal user interaction was necessary or desired; once the show began playing, the user's role was to watch through until the end. However, most PowerPoint presentations are designed with different purposes, such that the user is expected to interact with the show throughout its duration in order to advance it toward its conclusion.

In addition, I wanted the presentations to be not only Web-hosted, but completely Web-viewable. It would have been possible to tweak some settings on a presentation file so that it played as a video, but this would have required participants to download the files onto their computer workstations. Given the size of the files,[10] this would have entailed a significant bandwidth load, especially at the start of the experiment. Furthermore, whenever content is downloaded rather than Web-based, there is a much

---

[10] The largest lesson file, the Proof that the Square Root of 2 is Irrational, was about 65MB in size.

greater risk that the desired file or application will be incompatible with the end user's

personal computer (DB Net, n.d.).

As a result, I searched for a service that would allow me to convert PowerPoint

files into a Web-viewable format that I could easily embed on another webpage. After

several false starts with programs and online services that failed to preserve the

animations, layout, or timing of my original files, I discovered a website called

SlideBoom, a free online service that converts PowerPoint files to Shockwave Flash

(.SWF) format (iSpring, n.d.). SWF files can be embedded within an external page and

personal computers—including the computers in the Dulin Learning Center, where the

testing sessions were to be conducted—almost universally support the format (Adobe,

n.d.). In addition, with SlideBoom I only had to make two or three minor alterations to

the source PowerPoint files to get the output layout and timing to match the original.

The only major issue with the files is that SlideBoom includes a control bar in the

output SWF files such that viewers can jump from slide to slide or pause the presentation,

potentially compromising my linear conception for viewing the lesson videos. To protect

against participants taking advantage of these view controls, I included a statement in the

preface instructing participants not to use them, as it would compromise the ability of the

video to simulate a real-time lesson. On the whole, I found that participants complied

with this instruction.

I embedded each of the three resultant SWF files at the bottom of two different

pages. The first set of pages, titled "A New Math Professor," described the purpose of the

study, including the premise about participants helping to evaluate the teaching

effectiveness of an applicant for a faculty position and the fact that participants would

take an assessment on the lesson videos they viewed. The other set of pages, titled

"Lesson 2," included a shorter preface. The end result was six different pages for lesson

videos: Permutations and Combinations (first lesson), The Proof That the Square Root of

2 is Irrational (first lesson), Relations and the Cartesian Product (first lesson),

Permutations and Combinations (second lesson), The Proof That the Square Root of 2 is

Irrational (second lesson), and Relations and the Cartesian Product (second lesson).

      I created seventeen content pages for the testing sessions: six pages for the lesson

videos (see Appendices 7, 8), two pages for the Control module (see Appendix 3), three

pages for the Bias module (see Appendix 4), four pages for the Training module (see

Appendix 5), one page for the conclusion of all of the inter-lesson modules (see

Appendix 9), and one page for the Linguistic Profile Questionnaire (see Appendix 10).

The Linguistic Profile Questionnaire was hosted as a Google Form, and all other pages

were hosted on my William and Mary webspace, with similar page formatting.

      Participants had to load three pages in the course of the testing session —the first

lesson, inter-lesson module, and second lesson—that varied depending on their testing

group. I judged that giving participants a list of URLs to visit could violate blinding, and

even if the pages were given URLs that did not hint to their content, confusion could

ensue. Therefore, in order to cleanly shepherd participants through each of the steps of

the testing session, I created abstract names to correspond to the eighteen testing groups.

These group names were used to define URLs which, when loaded, would automatically

redirect the participant to the desired lesson or inter-lesson module. This setup preserved

blinding and clarity, as well as linearity.

I chose the eighteen group names in alphabetical order (skipping 'K'), with titles

that would not evoke emotions one way or another on the issue of ITFs; for example,

"Mumbai" would not be an appropriate group name for my purposes. The group names

were then shuffled somewhat, resulting in the names in Table 3.1:

	A-B	A-C	B-A	B-C	C-A	C-B
Module group						
Control	Apricot	Honeybee	Primrose	Daffodil	Lily	Sunflower
Bias	Nature	Butterfly	Iceberg	Quill	Eggplant	Market
Training	Gateway	Opal	Clarinet	Jackrabbit	Radish	Fuchsia

Table 3.1. Testing group names by module group and lesson order.
A = Permutations and Combinations, B = The Proof That the Square Root of 2 is
Irrational, and C = Relations and the Cartesian Product

These group names appeared in three different URLs that redirected participants

to the first lesson, inter-lesson module, and the second lesson, respectively:

http://djvill.people.wm.edu/<groupname-nocaps>_lesson.html,

http://djvill.people.wm.edu/<groupname-nocaps>_mid.html,

http://djvill.people.wm.edu/<groupname-nocaps>_lesson2.html. These redirects are

arrayed linearly in Table 3.2.

While the stimulus content and the Linguistic Profile Questionnaire were Web-

based, I decided to make the consent form and assessment sheets paper-based (see

Appendices 11, 12). For the consent form, I wanted to use paper copies not only for my

own records but also for participants to take home if they so desired. Given that most

students who are attending college in 2009 still do the majority of their primary and

secondary school mathematics on paper, I determined that the post-lesson assessments

should be done on paper, rather than on the computer. This use of paper assessments was

especially important for the Permutations and Combinations assessment, for which students were told to show all of their work.

Testing Group	..._lesson.html	..._mid.html	..._lesson2.html
Apricot	PermComb (1)	Control	Root2 (2)
Butterfly	PermComb (1)	Bias	Relations (2)
Clarinet	Root2 (1)	Training	PermComb (2)
Daffodil	Root2 (1)	Control	Relations (2)
Eggplant	Relations (1)	Bias	PermComb (2)
Fuchsia	Relations (1)	Training	Root2 (2)
Gateway	PermComb (1)	Training	Root2 (2)
Honeybee	PermComb (1)	Control	Relations (2)
Iceberg	Root2 (1)	Bias	PermComb (2)
Jackrabbit	Root2 (1)	Training	Relations (2)
Lily	Relations (1)	Control	PermComb (2)
Market	Relations (1)	Bias	Root2 (2)
Nature	PermComb (1)	Bias	Root2 (2)
Opal	PermComb (1)	Control	Relations (2)
Primrose	Root2 (1)	Training	PermComb (2)
Quill	Root2 (1)	Bias	Relations (2)
Radish	Relations (1)	Training	PermComb (2)
Sunflower	Relations (1)	Control	Root2 (2)

Table 3.2. Target webpages for redirect URLs by group.

3.7 Participant Recruitment

I aimed to recruit 100-120 participants for the study from introductory mathematics and linguistics classes. I intentionally sought to recruit freshmen and sophomores, since most students, including those who complain about their professors' accents, take required mathematics classes in their first two years. Linguistics and mathematics students were also targeted because the experiment had the most relevance to those fields of study.

I emailed professors teaching Calculus I and the Study of Language, the introductory linguistics course at William and Mary, during the first week of the Fall 2009 semester in late August 2009 to ask if I could speak to their classes about taking

part in my study. Over the following two weeks, I gave five-minute presentations at the

beginning or end of five of the eight Calculus I sections and all four Study of Language

sessions. These presentations involved me speaking in front of the class about my project,

passing out a recruitment flyer (see Appendix 13), and leaving a signup sheet at the front

of the room for interested students. In all, this recruitment method yielded the names and

email addresses of about 70 students. In an effort to recruit more participants, I made a

similar presentation to the Sharpe Community Scholars freshman course and asked

several Calculus II professors to email a .PDF version of the flyer out to Calculus II

students; this strategy garnered a few more names. About half of the final participant pool

was recruited this way.

On Sunday, September 13, 2009, I sent an email to all interested students with a

link to an availability survey (see Appendix 14). This survey, hosted by Google

Documents, listed possible weekday evening times and weekend afternoon times for

testing sessions, and students were asked to indicate the times they were free to take part

in the study. I used the responses of the 45 students who responded to the survey to

determine when to schedule the testing and discussion sessions.

On Monday, September 21, 2009, I submitted several requests to use the Dulin

Learning Center in Swem Library between Monday, September 28, 2009, and Sunday,

October 4, 2009, for my testing sessions. After a little bit of rescheduling, I finalized the

dates and times for the testing sessions: Tuesday, September 29, 8-9pm (pilot session),

Saturday, October 3, 3-4pm & 4:30-5:30pm, Sunday, October 4, 6-7pm, Monday,

October 5, 6-7pm & 7-8pm, and Tuesday, October 6, 8-9pm

Once the session times were finalized, on Friday, September 25, 2009, I sent an email to the interested students with a link to a signup sheet for testing sessions (see Appendix 15). On the form, I indicated that participants could also sign up a friend for a session, in hopes of raising the number of participants. By mid-day on Tuesday, September 29, 2009, however, only 25 participants had signed up, so in addition to sending another email to the students who had signed up in the classes I visited, I began to pursue other avenues for recruitment. I posted information about the study in the campus-wide email bulletin, Student Happenings, for the Thursday, October 1, 2009, and Sunday, October 4, 2009, emails. I also asked friends in the South Asian Students Association, Filipino American Students Association, and Heritage Language Learners of William and Mary student organizations to send out recruitment emails to their groups' listservs. Finally, I enlisted the aid of students in my advisor's lab group as well as my sister, a freshman at the College, to recruit friends. Fortunately, these efforts were effective; by the time the first session began, a total of 84 participants signed up for sessions. Eighteen additional participants signed up for sessions during the testing session period. One participant entered the study without signing up online when her friend brought her to the testing room.

3.8 Research Assistants

I recruited three research assistants for this study: Anna Dausman, Jacob Lassin, and Allison Corish. All three were sophomores at the College of William and Mary, with interests and/or majors in linguistics, education, and mathematics, respectively. Anna and Jacob assisted with the testing sessions as moderators, and Allison assisted with grading.

Anna and Jacob were not compensated for their time; Allison was compensated at minimum wage. All research assistants were fully briefed on human subjects protections.

In addition, Allison, the grading assistant, sat in on one of the testing sessions under the guise of being a participant in the experiment. The purpose of this exercise was for her to experience the conditions under which participants would take the assessments. Neither of the testing session assistants, Anna or Jacob, were informed of the presence of a confederate amongst the true participants.

3.9 Pilot Session

A pilot session was held on Tuesday, September 29, 2009, to simulate the testing sessions in order to practice the session and attempt to identify any issues, with several of my friends acting as participants. No major problems were identified, but the assessment sheet for the Proof That the Square Root of 2 is Irrational was re-formatted for greater readability.

3.10 Testing Sessions

There were six testing sessions for the project, all in October 2009: Saturday, October 3, 3-4pm & 4:30-5:30pm, Sunday, October 4, 6-7pm, Monday, October 5, 6-7pm & 7-8pm, and Tuesday, October 6, 8-9pm. All sessions took place in the Dulin Learning Center on the first floor of Earl Gregg Swem Library, the main library at the College of William and Mary. The sessions were run almost identically, with small modifications made over the course of the sessions. I had two research assistants aid me

in moderating the sessions: Anna Dausman, who assisted with all of the sessions, and
Jacob Lassin, who assisted with the final three.

Sessions began when participants entered the Learning Center and came to the
registration table that was in the corner of the room. Participants were given the two-page
consent sheet and told to log onto a computer station, read and sign the consent form, and
bring the form back to the table. In each of the first two sessions, there were participants
who received the consent form, only to discover that they could not participate because
they were 17 years old. As a result, I began to ask participants if they were 18 or older
before giving them the consent form. I also asked participants if they needed headphones
or writing implements before giving them the form, and I supplied those who were
lacking.

Once a participant brought their form back to the table, they were marked as
present on the spreadsheet. I used the random integer function on a TI-84 Plus calculator
(Math > Prb > 5:randInt > randInt(0,5,2)) to assign the participant an ordered pair of
random integers between zero and five, inclusive. This ordered pair determined the
participant's testing group membership, with the first number denoting the module group
(i.e., Control, Bias, or Training), and the second denoting the lessons the participant
would view and the order in which the participant would view them (with six
permutations). Thus, a participant could fall into any of eighteen testing groups, as in
Table 3.3. These testing groups were given group names (see §3.6, Web-Based Content),
which are displayed in Table 3.4:

		Second Coordinate					
		A-B (0)	A-C (1)	B-A (2)	B-C (3)	C-A (4)	C-B (5)
First Coord-inate	Module Group						
	Control (0, 3)	ACtrlB	ACtrlC	BCtrlA	BCtrlC	CCtrlA	CCtrlB
	Bias (1, 4)	ABiasB	ABiasC	BBiasA	BBiasC	CBiasA	CBiasB
	Training (2, 5)	ATrngB	ATrngC	BTrngA	BTrngC	CTrngA	CTrngB

Table 3.3. Summary of testing groups, with selection coordinates.
A = Permutations and Combinations, B = The Proof that the Square Root of 2 is
Irrational, and C = Relations and the Cartesian Product

		Second Coordinate					
		A-B (0)	A-C (1)	B-A (2)	B-C (3)	C-A (4)	C-B (5)
First Coord-inate	Module Group						
	Control (0, 3)	Apricot	Honeybee	Primrose	Daffodil	Lily	Sunflower
	Bias (1, 4)	Nature	Butterfly	Iceberg	Quill	Eggplant	Market
	Training (2, 5)	Gateway	Opal	Clarinet	Jackrabbit	Radish	Fuchsia

Table 3.4. Names of testing groups, with selection coordinates.
A = Permutations and Combinations, B = The Proof that the Square Root of 2 is
Irrational, and C = Relations and the Cartesian Product

Once a participant received their group assignment, I recorded their assignment

on the spreadsheet and gave the participant a mostly blank notes sheet (see Appendix 16)

with their group name written on it. I instructed the participant to return to their computer

station and wait for further directions.

I waited until almost all of the registered participants had signed the consents and

received their group assignments before giving further directions. By this point, Anna had

already written the URL http://djvill.people.wm.edu/………_lesson.html on the board, a

note that the group name was to replace the dots, and an example using the fictional

group Scuba. I proceeded to explain to the participants that they needed to log onto that

URL, I read off the URL to them, and I instructed them to type their group name in

lowercase characters instead of the dots. In addition, one of the Sunday session

participants noted that she had difficulty hearing the professor. As a result, in following

sessions, I instructed students to make sure that the volume level on their computer was

adequate and gave them directions for how to adjust the volume. Finally, after several

students indicated confusion about the purpose of the notes sheets, I made a point to

instruct students that they could use their notes sheets however they chose.

Most participants loaded their lessons successfully, and those who did not were

steered in the right direction. This URL redirected participants to one of three lesson

pages, depending on their testing group (see Appendix 7). For example, members of the

Lily, Eggplant, Radish, Sunflower, Market, and Fuchsia groups were all directed to the

same page, which contained the Relations and the Cartesian Product lesson video. The

pages differed only in which SlideBoom lesson video they contained; the title, "A New

Math Professor," and text content preceding the video were identical:

> The William and Mary Math Department is looking to hire a new faculty member,
> and this applicant is one of the department's top choices. In order to make the
> final decision, the department is having students view some of her lessons and
> take short assessments on these lessons.
>
> To begin the first of two lessons, click the play button on the player below and
> then put the video in a full screen by clicking the button on the bottom right of the
> player. Since we are trying to evaluate these lessons in a holistic manner, please
> do not jump from slide to slide or pause the video. Thank you for your help with
> this important personnel decision!

Each lesson video concluded with the title screen showing the name of the lesson,

plus the statement, "Please ask a moderator to give you the assessment sheet."[11]

Participants raised their hands, and moderators brought them the assessment sheet

corresponding to the lesson video the participant had just seen. The assessment usually

took three to ten minutes to complete, depending on the lesson and the participant's level

of mathematics ability. The assessment for the Proof that the Square Root of 2 is

Irrational was significantly more difficult (see §4.4, Module Groups), and several

---

[11] The Permutations and Combinations video accidentally omitted this slide.

students took up to twenty minutes attempting to complete it. In these cases, I assured the

participants that completion was not necessary and encouraged them to give up in order

to move on with the experiment.

    Upon completing the first assessment, participants raised their hands and a

moderator collected their assessment sheets. Participants were then given a slip of paper

that read:

    http://djvill.people.wm.edu/   _mid.html

    Participants were instructed to load the URL on the slip of paper, with the name

of their testing group in the blank. This URL redirected students to one of three inter-

lesson modules, depending on their module group (see §3.6, Web-Based Content;

Appendices 3, 4, 5). For example, members of the Apricot, Honeybee, Primrose,

Daffodil, Lily, and Sunflower groups were all directed to the same page: the first page of

the Control inter-lesson module. All three modules ended with the same page (see

Appendix 9), which instructed participants to input the URL

http://djvill.people.wm.edu/<groupname-no caps>_lesson2.html into their address bars,

with their testing group name in the appropriate place.

    The URL redirected participants to one of three lesson videos, depending on their

testing group (see Appendix 8). For example, members of the Apricot, Nature, Gateway,

Sunflower, Market, and Fuchsia groups were all directed to the same page, which

contained the Proof That the Square Root of 2 is Irrational lesson video. The pages

differed only in the SlideBoom lesson video that they contained; the title, "Lesson 2" and

text content preceding the video were identical:

    This is another lesson offered by the Math department applicant. To begin this
    lesson, click the play button on the player below and then put the video in a full

screen by clicking the button on the bottom right of the player. Again, since we are trying to evaluate these lessons in a holistic manner, please do not jump from slide to slide or pause the video. Thank you again for your help with this important personnel decision!

The embedded lesson videos did not change depending on order. For example, a participant in the Sunflower group viewing the Proof That the Square Root of 2 is Irrational lesson video as their second lesson would see the same video that a member of the Daffodil group would see as their first lesson. Lesson videos ended with the statement, "Please ask a moderator to give you the assessment sheet." Participants raised their hands, and moderators brought them the assessment sheet corresponding to the lesson video the participant had just seen. As with the first assessment, participants generally needed three to ten minutes to complete the second assessment.

Upon completing the second assessment, participants raised their hands and a moderator collected their assessment sheets. Participants were then given a slip of paper that read:

http://djvill.people.wm.edu/LPQ.html

Participants were instructed to load this URL, which redirected students to a Google Form containing the Linguistic Profile Questionnaire (see Appendix 10). Most participants spent at least ten minutes filling out the questionnaire, with some spending up to twenty minutes crafting thoughtful responses. Once participants clicked "Submit", a new screen loaded that displayed this message:

DEBRIEFING STATEMENT

The professor whose lectures you heard today is NOT an applicant for any open faculty position in the Mathematics department at William and Mary; such a story was contrived to attach relevance to the tests. The professor is actually Dr. Kamala Krithivasan, a professor at the Indian Institute of Technology-Madras, and the audio for the lessons was provided by courtesy of the National

Programme on Technology Enhanced Learning, an agency of the the Ministry of Human Resource Development, Government of India.

Thanks so much for participating!!

You will get an email soon about the discussion session and how to get free Cheese Shop!

At this point, participants came up to the registration table and/or left on their own. A moderator thanked students for their participation and collected their notes sheets and slips of paper with URLs. Several participants were curious about the study, and I chatted with them for a few minutes after they were formally done with the testing session.

3.11 Irregularities

A few minor irregularities occurred during the testing sessions. First, the Learning Center serves as an extension of the computing area on the first floor of the library when there are no scheduled events, and students often use the computers there. Before sessions when I was anticipating about twenty participants, I asked the non-participant students in the room to leave so that all the computer stations could be available for the study. For the sessions when I was anticipating fewer participants (about ten or twelve), I did not ask the non-participant students to leave, since I judged that their presence in the room would not cause any interference with the study.

Second, I realized during the first testing session on Saturday that while I had loaded the new content for the Control inter-lesson module onto my webspace, I had forgotten to update the redirect pages (such as http://djvill.people.wm.edu/iceberg_mid.html). As a result, the three participants in the

Control group in the first session viewed the first version of the Control inter-lesson

module, featuring gardening topics. I quickly loaded new redirect pages onto my

webspace to point Control participants to the correct module, featuring mathematics

education topics.

Finally, participants did not all arrive to the session at the same time, and they did

not all begin the experiment at the same time. At least one participant in every session

arrived fifteen minutes early, though these participants did not start the experiment early,

and several participants arrived more than ten minutes late. In my judgment, this would

not affect the participant's experience, since the experiment was entirely individually-

paced, so I allowed late participants to do the experiment. One student arrived to the

second Saturday session, which began at 4:30pm, 40 minutes late; since the library closed

at 6pm, this student had only 50 minutes for the experiment. I allowed him to participate

in almost all of the experiment and, in the interest of time, gave him instructions to fill

out the Linguistic Profile Questionnaire on his own, which he did. This participant was a

mathematics major and finished with fifteen minutes remaining, but the fact that he was

working under a time constraint that applied to none of the other participants could have

affected his responses.

3.12 Profile of Participants

In all, 101 participants signed up for sessions, and 84 students actually

participated. 83 were William and Mary students,[12] and 81 of those 83 William and Mary

students were undergraduates (WM UGs). The median age of all participants was 19,

with an age range of 18-24; by design, this distribution was skewed slightly right, with a

---

[12] One participant brought a friend who was a student at George Mason University.

mean age of 19.298. Among WM UGs, the median age was also 19, and the mean age, 19.125, was virtually the same. Over 60% of WM UGs were sophomores or freshmen; only 11 of the 81 WM UGs were seniors.

The participant sample reflected a diversity of academic plans, including students from nearly all majors and/or concentrations offered at William and Mary. Since the participant pool overrepresented the first two years of undergraduate study, more than half of the students involved in the study had likely not yet declared a major.[13] The large freshman and sophomore presence also meant that several students listed that they were undeclared. The two most popular majors within the sample were English and linguistics, with fourteen concentrators apiece. While English is one of the most popular majors at William and Mary, linguistics is certainly not,[14] meaning that the sample overrepresented linguistics majors. Other popular concentrations were psychology (ten majors), international relations (seven majors), mathematics (six majors), and anthropology (five majors).

The majority of participants had relatively little mathematics experience, as over 80% of participants—both WM UG and total—had taken either one or zero mathematics classes at William and Mary, including the Fall 2009 semester. Taking high school or community college courses into account, only 35% had taken any mathematics beyond Calculus I or its equivalent, Advanced Placement Calculus AB. No student had taken more than six mathematics classes at William and Mary, and no WM UG had taken more than five. One participant had withdrawn from a William and Mary mathematics class,

---

[13] The Linguistic Profile Questionnaire did not ask students whether or not they were actually majors or simply prospective majors.

[14] The graduating classes of 2005-2009 included an average of 140 English majors, as opposed to an average of 18 Linguistics majors and 5 Linguistics minors (it is not possible to minor in English at William and Mary) (S. L. Bosworth, personal communication, December 1, 2009).

and it is possible that some participants in mathematics classes at the time of the testing

session, early October 2009, withdrew later in the semester. Only six participants (7.4%

of WM UGs) were mathematics concentrators.

Likewise, over 90% of participants had taken no more than one linguistics class at

William and Mary; 26 students, or 32% of WM UGs, were in Study of Language classes

at the time of the study. Five students had taken between two and six linguistics classes,

and one had taken eleven. Given the almost complete lack of linguistics departments,

aside from some applied tracks such as English as a Second Language training and

speech pathology, in community colleges and high schools,[15] it is unlikely that

participants' academic linguistics experience extended prior to their time at William and

Mary. Fourteen participants (17.2% of WM UGs) were linguistics concentrators.

The Linguistic Profile Questionnaire did not ask for students' experiences with

modern languages and literatures (MDLL) classes at William and Mary, but some

students misinterpreted the intent of the question about linguistics classes and entered this

information in the field asking for linguistics experience. Since MDLL experience was

not requested, it is unclear how many participants had MDLL experience but did not

indicate it. Ten students had taken at least one MDLL class, with five having taken just

one class and one having taken six. Ten participants (not necessarily the same students

who indicated that they had taken a MDLL class) were MDLL concentrators.

Participants in the study had also lived in a diverse array of places before

attending William and Mary. Each regional division of the United States, as defined by

the U.S. Census Bureau (United States Census Bureau, n.d.), was represented by at least

---

[15] Among the 208 programs listed by the Linguistic Society of America, none are at community colleges (Linguistic Society of America, n.d.).

two participants, with the smallest representations of students from the East South

Central (Kentucky, Tennessee, Mississippi, Alabama) and West North Central (North

Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri) regions (see

Appendix 17). Over half of all participants (54 total, 51 WM UGs) had lived in Virginia

prior to attending college, and half of those participants (27 total, 26 WM UGs) had lived

exclusively in Virginia. About half of all participants (44 total, 42 WM UGs) had never

lived outside the East coast of the United States, and only 18 participants (all WM UGs)

had experience living outside the U.S. Among these were students who had lived in Asia

(nine participants), Europe (seven), South America (two), Africa (one), and the Middle

East (one). Among these students, just two had never lived in the U.S. prior to attending

William and Mary.

Participants were not asked to provide racial/ethnic data on the Linguistic Profile

Questionnaire. My own observations of the participants indicated that the sample's ethnic

diversity reflected that of William and Mary in general, with Caucasians most heavily

represented.

3.13 Assessment Grading

Allison Corish, a sophomore mathematics major, and I graded all 168 assessments

(two for each participant) on October 14, 2009. Assessments were graded on a scale of 0-

16, with different grading rubrics tailored to each lesson (see Appendix 12 for answer

keys). Prior to grading, I reviewed the grading scales with Prof. Chi-Kwong Li of the

William and Mary Mathematics Department to ensure that the scales were consistent for

each lesson (personal communication). The scales are given below:

The Proof that the Square Root of 2 is Irrational
- Begin with 1 point
- Add 1 point for each blank correctly filled (15 total)
- For the 2nd and 3rd blanks ($6\ldots p^2/q^2$), $q\sqrt{6}\ldots p$ was an acceptable pair of answers
- For the 9th and 10th blanks ($2k \ldots 4k^2$), letters other than k were acceptable answers as long as they were consistent (i.e., used for both blanks)
- For the 10th blank, $(2k)^2$ was an acceptable answer

Relations and the Cartesian Product
- Begin with 16 points
- Deduct 1 point for each incorrect bound
- Deduct 2 points for correct bounds, but Cartesian product in wrong order
- For each part of problem 2, deduct 1 point if either variable is uppercase (denotes set, not element)
- For each part of problem 2, deduct 1 point if any of the inequalities ($\leq$) are written as strict inequalities ($<$)

Permutations and Combinations
- Begin with 0 points and apply the rubric below to each problem
- Add 8 points for a correct answer with all work correctly shown (did not need to show variables, just numbers)
- Add 6 points for an incorrect answer, but a correct number of terms in the summation (i.e., the incorrect answer was due to an addition error)
- Add 4 points for an incorrect answer with an incorrect number of terms in the summation (although it is clear that the student has a general understanding of the problem)
- Add 2 points for an incorrect answer where it is not clear that the student has an understanding of the problem
- Do not add any points if there is no answer, or if there is an incorrect answer given and no work shown

Prior to grading, the top 2½ inches of each assessment sheet was folded behind the page, concealing the name and testing group of each participant. This practice prevented the possibility that graders' knowledge of participants' names and/or testing groups would affect the score they gave each assessment. Each grader received half of all assessments at the beginning of the grading session. The grader determined the score for an assessment, then wrote the score on the folded-over portion of the sheet so that the score was also hidden. Once the graders finished grading their halves of the total stack,

they traded stacks and re-graded. If the second grader determined a different score than

the first, the graders deliberated over the correct score until a consensus was reached.

This method cut down on grading error by allowing another grader to look over the

assessment, arriving at a grade independently of the first grader's score.

3.14 Discussion Sessions

      I emailed participants on Saturday, October 10, 2009, with a link to a form to sign

up for a discussion session and order their Cheese Shop sandwich and drink. I scheduled

nine discussion sessions so that members of the Control, Bias, and Training groups would

have discussions only among members of the same module group; thus any participant

could choose between the three discussion sessions available for his or her module group.

As a result, I created three different forms (see Appendix 18) and sent members of each

module group a link to the form corresponding to their group. Participants who had not

yet signed up by Wednesday, October 14, 2009, were sent a reminder email to sign up for

a session. In all, 66 students signed up for sessions and 57 participated.

      I held the nine discussion sessions from Saturday, October 17, 2009, to

Wednesday, October 21, 2009, to collect qualitative data from the participants. All

sessions except one were held in the Linguistics Lab, located in Tyler Hall 220A.[16] A

total of 57 students participated in the sessions; the smallest sessions involved four

participants and the largest involved 11. I set up the lab with chairs around a central table,

so that participants could eat their sandwiches and be visible to all other participants. In

light of an injunction against a focus group moderator sitting at the head of a table (Bloor,

---

[16] The last one was held in Tyler 219 because of a scheduling conflict in the Lab.

Frankland, Thomas, & Robson, 2001), I sat on the corner of the table, hoping to avoid being the focal point of the discussion.

As participants entered the Linguistics Lab, I checked their name off of a spreadsheet and then gave them their sandwich order. I waited until ten minutes after the appointed start time so latecomers could arrive and so participants could mostly finish their sandwiches before beginning the session. The sessions were all recorded with a Marantz PMD660 Solid State Recorder.

The discussion sessions, lasting between 60 and 75 minutes in total, were composed of three parts. In the first part, I went over some basic ground rules for the discussion as well as reviewed human subjects protections; this lasted no more than ten minutes. The second part of the session consisted of the discussion itself, as I posed six discussion questions to the participants. This portion of the session lasted between 45 and 55 minutes. Finally, since I found during the testing sessions that several participants were interested in the inner workings of the study, I included the third part: a description of the motivation for the project and the methodology with which I carried it out. I finished this part of the session with a final question about the accent training program and participants' perceptions of its effectiveness. My explanation for the project usually lasted ten to fifteen minutes, and the following discussion lasted between five and ten minutes. I used a PowerPoint presentation to provide a visual aid during the session (see Appendix 19), positioning my laptop at the head of the table so participants could view, for example, the discussion question currently under consideration.

The ground rules I laid out for the discussion are given below:

1. This is a **discussion** session, not an **interview** session. Questions on the screen are meant to provoke discussion.

2. Take the discussion **wherever you want** (within reason).
3. One person talking at a time, please!
4. Say your (first) name the first few times you speak.
5. Relax! You're protected by the PHSC!

The first rule was motivated by the description of an ideal focus group dynamic in Bloor,

Frankland, Thomas, and Robson (2001): one in which discussion is focused not on the

moderator, but on the internal group dynamic and the individual group members. The

second rule was motivated by the fact that under William and Mary Protection of Human

Subjects Committee (PHSC) rules, I was not permitted to ask any questions other than

the ones that had been spelled out on the protocol form. I thus encouraged students to

take ownership of the discussion and to feel free to ask follow-up questions to the other

participants. The third and fourth rules were originally intended to make later

transcription of the sessions much easier, but the fourth rule had an unexpected positive

effect: It encouraged a more fluid group dynamic in that participants were able to address

one another. When a student hears somebody reply to his point with, "Building off what

he said," it is not as personal as if the student heard, "Building off what Dan said." At the

same time, the use of only first names offered a level of anonymity for the participants.

I used the fifth rule to segue into a brief discussion of PHSC protections, noting

that I would neither release the names of any participants in the study nor attribute

quotations to the participants' names. I reiterated this point several times to ensure that

participants had no reservations about speaking truthfully during the discussion session. I

also mentioned the fact that I was prohibited from asking follow-up questions, in hopes

that participants would feel comfortable taking ownership of the discussion. Once I

answered any final questions that the participants had, we began the discussion portion of

the session.

I posed the following six questions, some of which were multi-part questions, to the students, each appearing on their own PowerPoint slides. The second part of the sixth question was posed only to the sessions whose participants were in the Training group:

1. For starters, how many classes, if any, have you taken with a foreign-born professor? Have any been Math classes? Did his or her accent ever hurt your understanding of the material?
2. Do you talk about professors' accents a lot with your friends?
3. Have you ever dropped a class or even changed your academic plans because the professor had a foreign accent? What about other students you know?
4. What do you think impedes communication between students and professors the most, regardless of accent?
5. What do you wish professors (or even the College) would do to deal with the issue of the communication gap between undergraduates and mathematics professors?
6. Do you feel that you gained anything from this process? [Do you think that you are now at least somewhat better equipped to deal with issues of accent in your instructors?]

After the discussion portion concluded, I reviewed the experimental methodology so that students could understand the mechanics of the study. This review included showing each module group the inter-lesson modules that they did not see during the study. After briefly walking each of the groups through the Training module, I asked the participants, "Do you think that programs such as these would be effective in dealing with the communication gap?" Once discussion for this question concluded, I thanked the students for their participation and ended the session.

I paid $631.25 in total for food orders at the Cheese Shop. This amount was reimbursed in full by the Charles Center, a research and scholarship office at William and Mary.

Chapter 4

Quantitative Results and Discussion

4.1 Quantitative Data Methodology

The source of all quantitative data in this project is the series of testing sessions, in which all 84 participants took part (see §3.10, Testing Sessions). Since the scope of this project involved undergraduates at the College of William and Mary (W&M), the scores of two W&M graduate students and one non-W&M undergraduate in the study were not used in the analysis. In addition, the responses of one participant on the first of her assessments led the other grader and me to believe that she had gotten frustrated and written nonsensical answers; this score was the only '0' assigned to any assessment for any participant. For this reason, I also excluded her scores, leaving 80 participants whose scores were used in the analysis. I analyzed the data using Minitab 15.1.30.0 (Ryan, 2007). I chose to use an α-level of $p = .05$ for all tests of significance, with p-values between .05 and .1 judged to be statistically suggestive but not significant.

As mentioned in §3.10 (Testing Sessions), I randomly assigned participants to a lesson order and module group using a TI-84 Plus calculator. The resultant group sizes are given in Table 4.1. A gender breakdown of the module groups is given in Table 4.2.

	A-B	A-C	B-A	B-C	C-A	C-B	**Totals**
Module Group							
Control	5	4	6	4	4	5	28
Bias	3	4	4	3	3	6	23
Training	4	8	4	3	5	5	29
Totals	12	16	14	10	12	16	80

Table 4.1. Distribution of participants by testing group.
A = Permutations and Combinations, B = The Proof That the Square
Root of 2 is Irrational, and C = Relations and the Cartesian Product

	Control	Bias	Training	**Totals**
Female	19	19	24	62
Male	9	4	5	18
Totals	28	23	29	80

Table 4.2. Module group by gender[17].

Assessments were graded on a scale from zero to sixteen. See §3.13 (Assessment Grading) for an overview of this process and Appendix 12 for the assessments and answer keys.

4.2 Terminology

In this chapter, *score1* refers to a subject's score on the first assessment they took, given on a 0-16 scale; *score2* similarly refers to a subject's score on their second assessment. *Improvement* refers to the test statistic *score2 – score1*, regardless of whether or not this statistic is positive (i.e., whether or not the subject actually 'improved' from one assessment to the next). In addition, I will refer to lessons and assessments by shortened names in this chapter for the sake of convenience. *PermComb* will refer to Permutations and Combinations, *Root2* to The Proof that the Square Root of 2 is Irrational, and *Relations* to Relations and the Cartesian Product.

4.3 Overall Descriptive Statistics

Across all module groups, the average score1 was 12.163 (SD = 4.196). The average score2 was 11.838 (SD = 4.382), and accordingly, the average improvement was -0.325 (SD = 6.515). Improvement scores are summarized in Figure 4.1.

---

[17] Gender was not self-reported; these statistics are based on my own observations.

Figure 4.1. Histogram of improvement for entire sample.

4.4 Module Groups

Counter to my hypothesis, the mean Control group improvement score (0.79, SD = 6.48) was higher than the mean improvement scores for both the Training group (-0.79, SD = 6.24) and the Bias group (-1.09, SD = 6.99). This relationship is summarized in Figure 4.2.
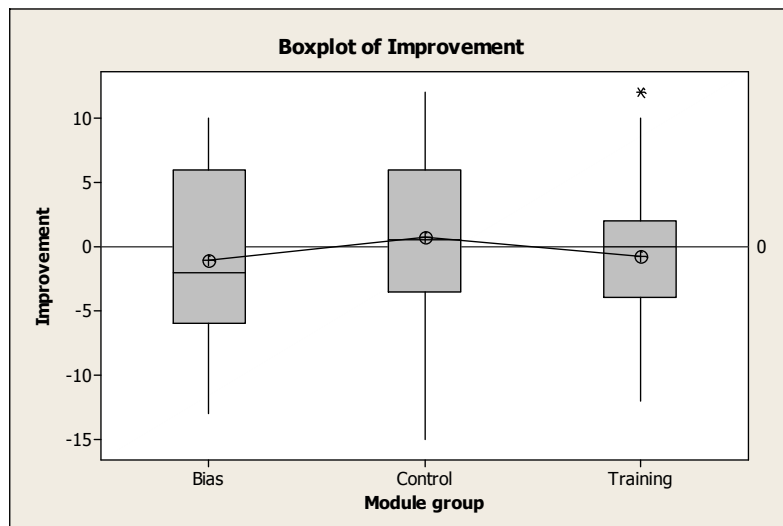

Figure 4.2. Boxplots of improvement scores by module group.

Two-sample t-tests failed to show that any differences in mean improvement scores between module groups were significant, as shown in Figure 4.3. I confirmed these results with a one-way ANOVA comparing improvement to the variable of module group, which was not significant ($F(2,77) = 0.63$, $p = .534$).

Control vs. Training	Estimate for difference of means: 1.58 $t(54) = 0.94$, $p = .177$
Control vs. Bias	Estimate for difference of means: 1.32 $t(45) = -0.98$, $p = .165$
Training vs. Bias	Estimate for difference of means: 0.29 $t(44) = -0.16$, $p = .438$

Table 4.3. Two-sample t-tests for improvement between pairs of module groups.

I performed a one-way ANOVA to compare score1 to module group to determine if students' baseline mathematics abilities were in fact different between the groups; these results were not significant ($F(2,77) = 0.19$, $p = .830$).

4.5 Lesson Videos

There was a large discrepancy in score1 means between the three lesson videos (PermComb, Root2, Relations), as shown in Figure 4.3. The score1 means were, in decreasing order of difficulty, Relations (14.86, SD = 2.66), PermComb (12.71, SD = 3.18), and Root2 (8.38, SD = 4.01). Notably, the difference between the score1 distributions of Relations and Root2 was so great that the median of Root2 (8.5) would have been an outlier among other Relations score1 data. A one-way ANOVA revealed that the first lesson had a significant effect on score1 ($F(2, 77) = 25.65$, $p < .001$)

Not surprisingly, this disparity affected improvement scores, as lesson ordering had a significant effect ($F(5, 74) = 21.74$, $p < .001$) on improvement. In Figure 4.4 below,

'PC' stands for Permutations and Combinations, 'R2' for The Proof that the Square Root

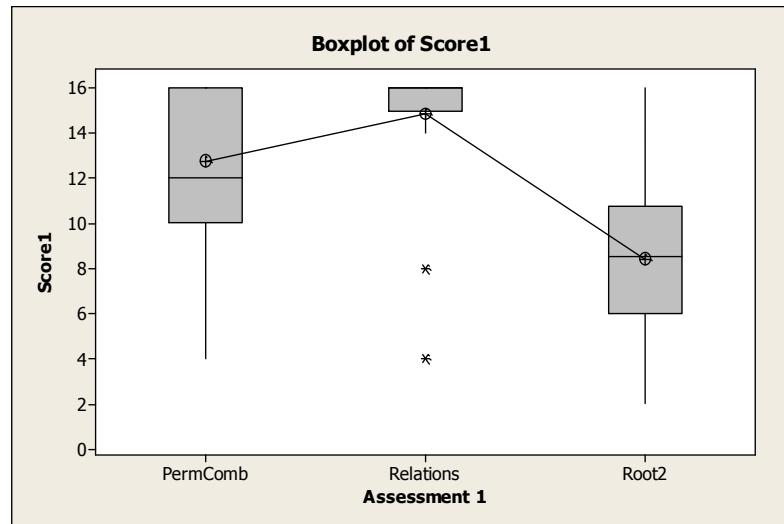of 2 is Irrational, and 'Rel' for Relations and the Cartesian Product.

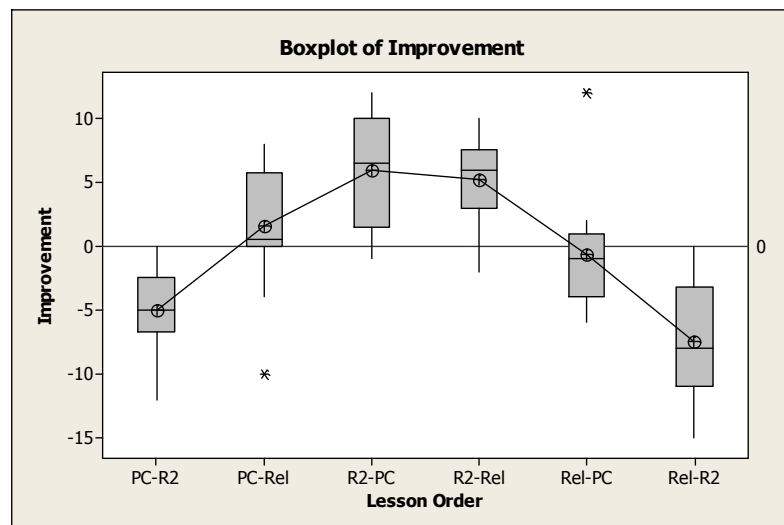*Figure 4.3*. Boxplots of score1 by module group.

Figure 4.4. Boxplots of improvement by lesson order.

In addition, a 2×2 general linear model revealed no significant effect from the

interaction between lesson order and module group ($F(10, 62) = 0.46$, $p = .909$). The

resultant interaction plot is given in Figure 4.5. It is notable that for two of the lesson

orders, the mean Bias group improvement is higher than the other two module group means, and that for half of the lesson orders, the mean Training group improvement is the lowest of the three.
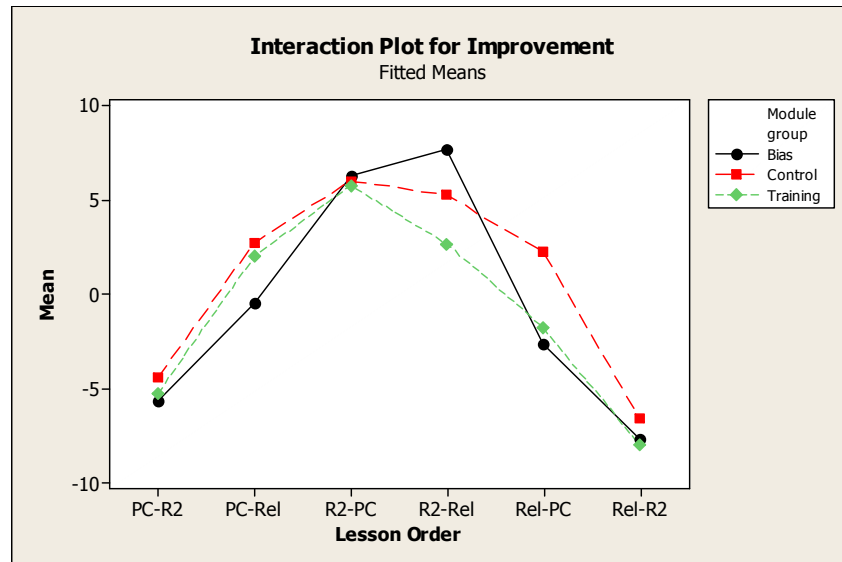

Figure 4.5. Interaction plot of improvement means for different lesson orders and module groups.
Solid lines and circles indicate Bias group, dashed lines and squares indicate Control group, and dotted lines and diamonds indicate Training group.

4.6 Foreign Accent Exposure, Concentration, and Mathematics Experience

Data from the Linguistic Profile Questionnaire was used to assess the possibility of external variables affecting assessment results. Following Plakans (1997), in which students who had no experience with international travel had significantly more negative attitudes toward ITAs, I added the question "On a scale of 1-5, where 1 is 'not at all' and 5 is 'all the time', how often were you around foreign accents while growing up?" to the Linguistic Profile Questionnaire. I hypothesized that students with less foreign accent exposure (FAE) would have more negative attitudes toward the professor in the lesson videos, as reflected in bias and manifested in lower score1 and/or improvement. My

hypothesis was not supported by the data, however, as the highest mean score1 within

FAE groups was actually for FAE 3 (13.93, SD = 3.515), and not FAE 5 (11.67, SD =

4.479), as my hypothesis would predict; this relationship is shown in Figure 4.6.

Consequently, FAE 3 had the lowest mean improvement score (-2.8, SD = 7.21) of the

FAE groups, although FAE 5 had the second lowest (-1.75, SD = 5.77), as shown in

Figure 4.7. One-way ANOVAs failed to show a significant effect of FAE on score1 ($F(4$,

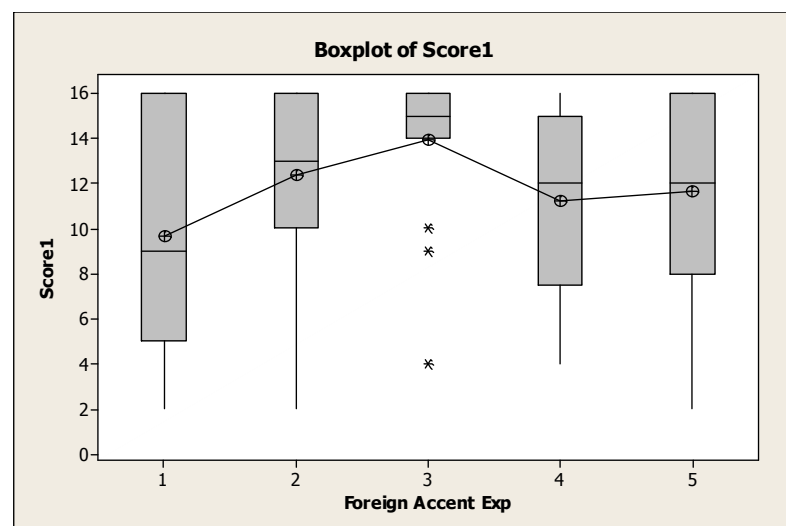$75) = 1.45$, $p = .226$) or improvement ($F(4, 75) = 1.17$, $p = .333$).

Figure 4.6. Boxplots of score1 by foreign accent experience.

In addition, I ran a one-way ANOVA to determine if there were significant

differences between mean FAE between module groups. While the ANOVA itself was

not significant ($F(2, 81) = 0.94$, $p = .394$), further analysis of the difference between FAE

for the Bias and Training groups revealed a suggestive, though not significant, increase in

FAE from the Bias group to the Training group ($t(51) = -1.31$, $p < .1$). This relationship is
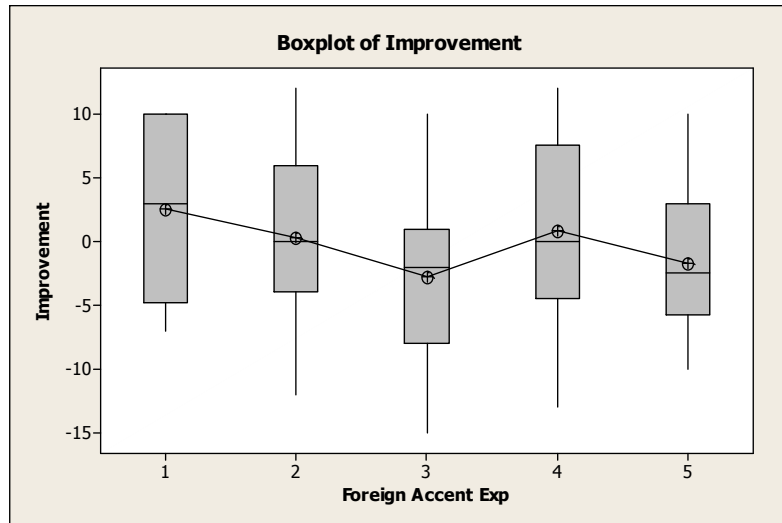
shown in Figure 4.8.

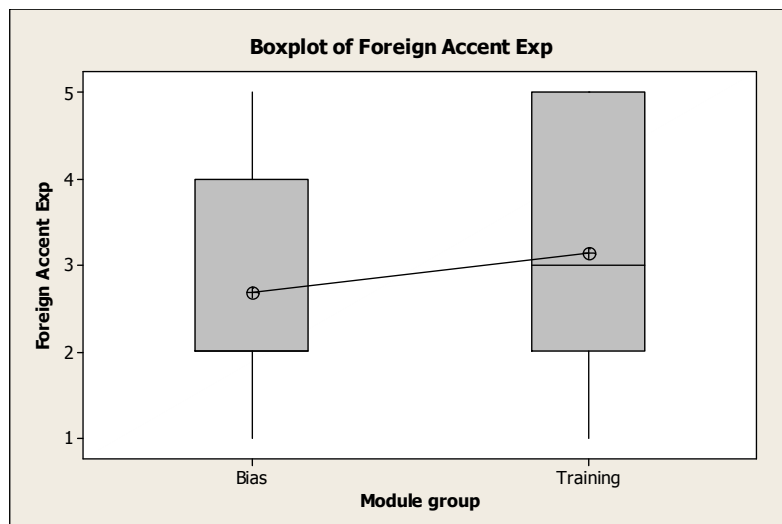*Figure 4.7*. Boxplots of improvement by foreign accent experience.

Figure 4.8. Boxplots of foreign accent experience for Bias and Training groups.

I also investigated the possible effect of a student's concentration on scores, regardless of whether this concentration was first major, second major, minor, or merely intended concentration. Seven out of the 80 participants were mathematics majors, and thirteen were linguistics majors (none were both).

		Control	Bias	Training	Subtotals	Totals
Concentration					**Subtotals**	
Mathematics	Freshman	1	1	0	2	
	Sophomore	0	1	2	3	
	Junior	1	1	0	2	
	Subtotals	2	3	2		7
Linguistics	Freshman	0	2	3	5	
	Sophomore	1	1	0	2	
	Junior	2	1	1	4	
	Senior	1	0	1	2	
	Subtotals	4	4	5		13
Neither		22	16	22		60
Totals		28	23	29		80

Table 4.4. Distribution of mathematics and linguistics concentrators by module group and year in school.
Includes first major, second major, and minor (both declared and intended).

Mathematics majors had a higher mean score1 (13.14, SD = 3.08) than non-mathematics majors (12.07, SD = 12.07), but this was not significant ($t(8) = 0.85$, $p = .211$). Mathematics majors' mean improvement (2.14, SD = 3.85) was also greater than the mean improvement for non-mathematics majors (-0.56, SD = 6.69); this difference in scores was suggestive but not significant ($t(9) = 1.64$, $p < .1$). The interaction between mathematics major status and module group was not significant ($F(2, 74) = 0.60$, $p = .551$) No such score differences between linguistics and non-linguistics majors approached significance.

I investigated participants' responses to the question "Which Math classes, if any, have you taken at this school?" to see if an association existed between this experience and their scores. Of the 80 students included in the analysis, 41 had taken (or were currently taking) at least one mathematics class at William and Mary. Among this subsample, the average number of mathematics classes was 1.646 (SD = 1.174). A regression analysis indicated that number of classes was a suggestive predictor of score1

$(F(1, 39) = 3.84, p < .1)$, although this correlation was weak ($R^2 = .09$); this relationship

is displayed in Figure 3.9. Number of classes was not a significant predictor of
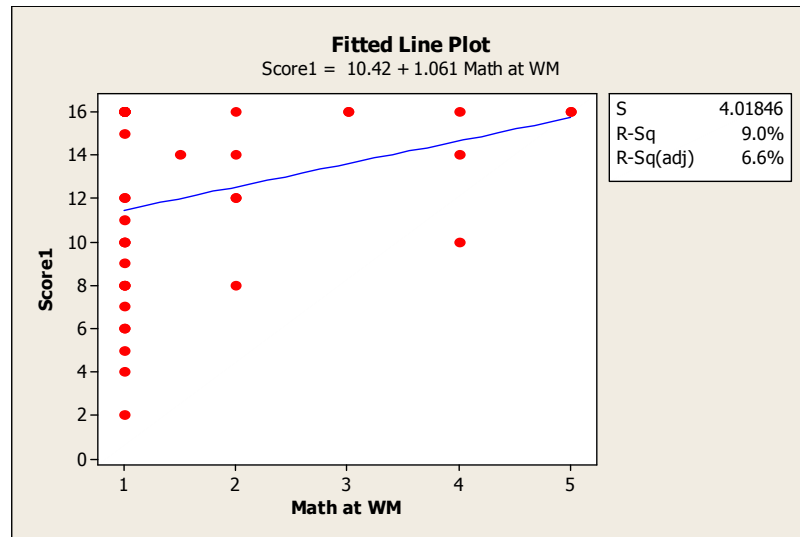
improvement ($F(1, 39) = 0.10, p = .756$).

Figure 4.9. Scatter plot showing score1 versus number of
mathematics classes taken at William and Mary (excludes 39
participants with no classes).
Student with 1.5 classes withdrew from one class and took
another.

Mathematics classes taken at William and Mary may be a misleading statistic,

however, if a student has substantial mathematics experience prior to college (or prior to

transferring to William and Mary) but takes few William and Mary mathematics courses.

As a result, the students who did not indicate their mathematics experience were surveyed

post-questionnaire to determine the highest level of mathematics they had studied. I

quantified the responses of each participant with the Mathematics Experience Index

(MEI), a value corresponding to the number of college-level or college-level equivalent

courses (excluding statistics) that the student was taking or had taken. For example, I

gave a '2' to a student whose highest mathematics class was Advanced Placement

Calculus BC (which corresponds to college-level Calculus II). A negative value was

possible if a student's highest level of mathematics was Mathematics of Powered Flight,

a low-level course in the William and Mary Mathematics Department. The mean MEI

across all students was 1.606 (SD = 1.828); there was no significant difference in MEI

between module groups ($F(2, 77) = 0.46$, $p = .632$). One-way ANOVAs did not show that

MEI was a significant predictor of either score1 ($F(1, 78) = 1.93$, $p = .169$) or

improvement ($F(1, 78) = 2.53$, $p = .116$).

Rubin and Smith (1990) show that the number of classes students have taken with

ITAs affect students' attitudes toward ITAs, and Plakans (1997) suggests an effect of

year in school on ITA attitudes. I performed one-way ANOVAs on the data to determine

if similar effects existed in this sample. Age was not a significant effect on either score1

($F(1, 78) = 0.23$, $p = .633$) or improvement ($F(1, 78) = 0.12$, $p = .729$). There was a

noticeable discrepancy in the age means between the three groups (see Figure 4.10); the

Training group had mean age 19.21 (SD = 1.082), the Control group had mean age 19.46

(SD = 1.319), and the Bias group had mean age 18.74 (SD = 1.010). Two-sample t-tests

revealed a suggestive age difference between the Training and Bias groups ($t(48) = -1.61$,

$p < .1$) and a significant age difference between the Bias and Control groups ($t(48) = -2.22$, $p < .05$)[18].

---

[18] The Control group had an older outlier that inflated its mean and standard deviation age; this data point
has been removed from Figure 4.10 in order to protect the confidentiality of the participant. The difference
between mean Control and Bias age remains significant even after this datum is removed ($t(46) = -1.96$, $p < .05$).
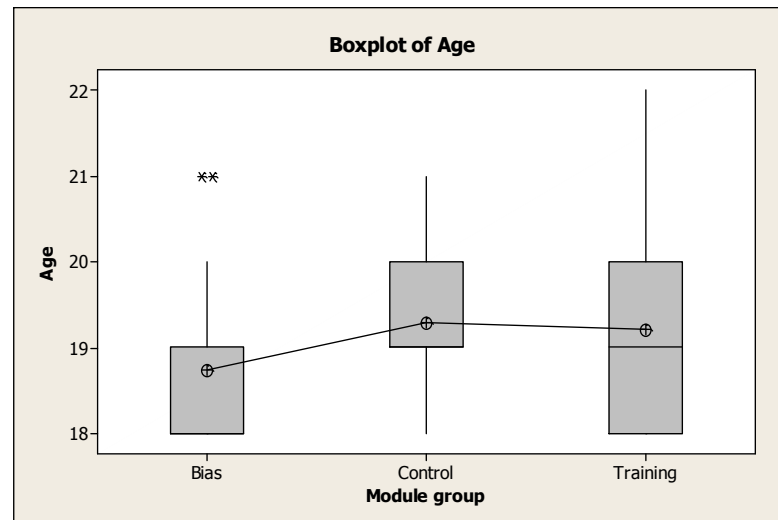
Figure 4.10. Boxplots of age by module group.

4.7 Discussion

Whereas module group had little effect on improvement, lesson order had a much greater effect. This unexpected result suggests several methodological changes that can be made to this project in future. First, I will need to ensure that lesson videos are roughly equal in difficulty by more tightly controlling their content and using preliminary tests to determine relative difficulty. In fact, controlling the content of the lesson videos was a major challenge, as the original plan to use recruit and record professors ultimately proved unfeasible (see §3.2, Earlier Experimental Designs). In a future project with greater resources, I could conceivably recruit professors who would be willing to participate. Greater care will also need to be taken to ensure that the assessments are neither too easy (Relations) nor too hard (Root2), as in that case, the score distribution is not meaningful.

It is also possible that I could have designed the Training and Bias modules (see §3.5, Module Development) better in order to obtain the desired results. For example, a more careful analysis of Prof. Kamala's accent features (the analysis I did for the project

is given in Appendix 6), as well as specific instruction on non-accent items like word choice and syntax, could have yielded a more effective Training module. In terms of the Bias module, it is conceivable that the text-only nature of the module was an insufficient simulation of the social conditions that create student bias against ITFs. In a later experiment, I may try a Bias module that includes experimental confederates playing the role of bias creators.

Finally, with a large number of testing groups (18), the sample size of 80 may not have been large enough. One solution to this problem would be to reduce the number of lesson videos from three to two; this solution would not only collapse the number of testing groups to six (allowing for two permutations of lessons), but would also relieve the need to obtain three lessons of equal difficulty, only two. The issue of randomization is also related to the issue of sample size. I hoped that the random assignment scheme would create module groups of roughly equal characteristics, but from analyses of foreign accent experience and age, it seems that the groups were ultimately somewhat unequal (although it is not clear that this had any effect on scores). A future experiment would stand a greater chance of alleviating issues of assignment bias with a greater sample size.

Chapter 5

Qualitative Results and Discussion

5.1 Qualitative Data Methodology

This project included two sources of qualitative data: the Linguistic Profile Questionnaire that all participants completed at the conclusion of their testing session (see §3.10, Testing Sessions) and the discussion sessions held two weeks after the testing sessions, in which the majority of participants took part (see §3.14, Discussion Sessions). There were nine discussion sessions in total, lasting between 60-75 minutes each, so there is a large amount of data from these sessions, much more than there is from the Linguistic Profile Questionnaire. As a result, the majority of this chapter will be devoted to an analysis of the data collected from the discussion sessions. Reflective discussion on the results will be interspersed throughout.

In order to protect the confidentiality of the professors discussed in this chapter, especially those at William and Mary, some personal information about the professors (i.e., country of birth and/or subject field) has been omitted. These omissions are noted in brackets in direct quotations (for example, [nationality] in place of the professor's country of birth).

5.2 Format of Discussion Sessions

The nine discussion sessions were held from Saturday, October 17 to Wednesday, October 21, in the Linguistics Lab, located in Tyler Hall 220A (the last one was held in Tyler 219 because of a scheduling conflict in the Lab). Participants were served a

sandwich and drink from the Cheese Shop (a Williamsburg eatery popular among the

William and Mary undergraduate population), which they had ordered prior to the

session. The smallest sessions involved four participants, and the largest session involved

eleven. The average session size was six to seven students. In addition, the sessions were

segregated so that they would only involve members of the same module group (Control,

Bias, or Training). Thus, there were three discussion sessions for students in the Control

group, three sessions for students in the Bias group, and three sessions for students in the

Training group.

Each session began with a briefing on ground rules for the discussion as well as

some basic information on human subjects protections. Participants were then asked

several questions, one question at a time, to provoke discussion among the participants.

The second (bracketed) part of the sixth question was posed only to the Training group:

1. For starters, how many classes, if any, have you taken with a foreign-born professor? Have any been Math classes? Did his or her accent ever hurt your understanding of the material?
2. Do you talk about professors' accents a lot with your friends?
3. Have you ever dropped a class or even changed your academic plans because the professor had a foreign accent? What about other students you know?
4. What do you think impedes communication between students and professors the most, regardless of accent?
5. What do you wish professors (or even the College) would do to deal with the issue of the communication gap between undergraduates and mathematics professors?
6. Do you feel that you gained anything from this process? [Do you think that you are now at least somewhat better equipped to deal with issues of accent in your instructors?]

At the conclusion of discussion, students were given an overview of the

methodological design of the project. This overview ended with a walkthrough of the

Training inter-lesson module (see §3.5, Module Development), after which I asked the

participants, "Do you think that programs such as these would be effective in dealing with the communication gap?"

The broad themes on the topic of the communication gap that emerged from these discussions will structure my analysis of the discussion sessions.

5.3 Perceptions of Accent

According to students, their experiences with ITFs were fundamentally shaped by their perceptions of the professors' accents. These perceptions were partially related to internal linguistic features such as syntax, phonology, prosody, and word choice. External factors, however, played a major role in perceptions of professors' accents, including the student's own surprise at hearing a professor's accent, the degree of accentedness that students ascribed to the professor's speech, the professor's teaching style, and the professor's personality.

5.3.1 Syntax. Some students mentioned specific linguistic features of their professors' accents that struck them as odd, including syntax. For example, a statistics student remarked that she sometimes had to "flip the [professor's] words around" (see §5.4.6, Processing delays). "It's not always necessarily the accent that could be the problem," this student said, "it could just be the way they think about things in their language, and the way that translates into English is not the way we would say it in English."

5.3.2 Phonology and prosody. Several students also mentioned their difficulties with professors who exhibited phonological patterns that were not native to Standard American English (SAE). A few participants, for example, noticed that their professors failed to produce a contrast between /l/ and /r/ sounds, which is a well-known feature of

Japanese L2 speakers of English (Miyawaki, Strange, Verbrugge, Liberman, Jenkins, &

Fujimura, 1975). One student noted that his professor merged the /n/ and /m/ phonemes,

and another noted that her German-born professor had difficulty forming SAE-like /r/

sounds. Not all phonological descriptions were quite so specific; a fair number of

students described their professors' accents as simply as "really weird pauses between

some words, and she says some words really weirdly." As this quotation suggests, several

students had issues with their professors' prosodic tendencies. Another student had a

professor of Slavic origin whom she could understand fairly well, save for odd stress

patterns.

    5.3.3 Mispronunciation of specific words. Many students were able to recall

specific words that their instructors pronounced in ways that they found unusual, and

these 'mispronunciations' were a source both of humor and frustration. While this issue

deals with phonological patterns, I interpret it as a different phenomenon; whereas issues

with phonology are related to professors' phonological *systems* in general, issues with

certain words are related to *specific* manifestations of these systems. Students seemed to

be able to notice phonological differences in terms of certain words, but the overall

phonological system governing these 'mispronunciations' remained opaque.

    The pronunciation of specific words was a frequent topic of conversation between

participants and their classmates (see §5.5.1), such as the student whose Differential

Equations professor "said some words pretty funny. For instance, we'd make fun of how

he said *origin*. He called it the *orange*. It's no harm meant, just kinda funny." A student

from Texas described her 10th grade mathematics teacher, who "liked the word *focus* a

lot; he'd be like, 'you need to focus, you must focus,' only with his accent, it came out

fuckus." Likewise, another student's friends "couldn't get past the way [a mathematics professor] said certain words. They would just sit there…laughing about it, and so they missed like ten minutes of lecture because you can't get around that" (see §5.4.5, Accent and attentiveness).

Not all accounts of word-specific pronunciation issues were lighthearted in nature, however. In some cases, these pronunciations represented only a minor hurdle: "[my calculus professor] had a really, really heavy accent, and I wasn't used to [nationality] accents…he said *derivative* like *DERV-ative*, so after like 3 classes, once I knew how he said the words each over and over again," the problem was ameliorated (see §5.4.8, Habituation to accents). In other cases, students indicated that the mispronunciation of just a single word could have an appreciable negative effect on a student's comprehension of entire sections of a lecture: "if the professor…pronounces something just in a really strange way, you'll eventually catch on, but for a while, you'll have no idea what they're talking about, even if you're familiar with the term pronounced in a different way."

At times, the words in question were central to the course content, as in the case of the student who took Elementary Probability and Statistics, wherein the professor "doesn't pronounce the word *probability* anywhere close to *probability*. It actually took me until he wrote it down on the board when he said it, which was a couple classes in, to figure out that's what he was saying." One pre-medical student took a physics course over the summer with an ITF. One of the first lectures was on the topic of vectors, so the professor frequently used the word *length*, which the student repeatedly interpreted as *lens*: "they're very different, and the lens chapter is all the way at the very end of the

semester, so I was so confused, and I was like, 'how did we go this quickly in class?'".

This misunderstanding created untold frustration for the student, who ended up dropping

the class (see §5.5.3, Changing academic plans because of accent).

      5.3.4 Word choice and cultural issues. Some students remarked that their ITFs'

choice of words and use of vocabulary created communicative issues. One said, for

example, that "a lot of [misunderstanding] has to do with word choice and grammar."

Another participant commented that her sister had major difficulties with a Chinese

mathematics professor at another school "because his accent was so thick and his word

choice was so weird" (see §5.3.6, Degrees of accentedness). A freshman noted that word-

choice difficulties could be aggravated in subjects that are conceptually complex (see

§5.4.3, Accent issue exacerbated in the mathematics classroom): "if you can't get that

very specific description and explanation going on, that can be really, really difficult."

Some students differentiated accent-related problems from word-choice-related

problems: "the words [professors] use to express themselves [are] sometimes a little

odd." A senior talked about her economics professor, who she said has an accent, but "his

word choice and everything is normal American English, so it's really easy to understand

him."

      Students' discussions about word choice were also closely related to discussions

about cultural divisions between students and professors. This trend was typified by the

student who said of one Modern Physics teacher, "I could understand through his accent,

but his words didn't necessarily make all that much sense culturally." A psychology

major said that her Eastern European TA is "usually pretty understandable…we

sometimes talk about his cultural understanding, because last month [September], he sent

us an email that said 'Happy Halloween,' and we were confused." These observations

point to the significance of cultural misunderstanding to communicative issues; Byrd,

Constantinides, and Pennington (1989) and Twale, Shannon, and Moore (1997) similarly

suggest that cultural misunderstandings can contribute to communicative barriers

between students and professors.

     5.3.5 Initial surprise at hearing professor's accent. A few students reported that

their first reaction to hearing a professor speak was surprise or dismay at the professor's

accent. One statistics student said about his ITF, "the first lecture, I heard his accent, I

was like, 'oh my gosh, what's he saying?'". A senior recalled her first class as an

undergraduate, which was taught by an ITF in an unfamiliar subject. Her anxiety about

the situation impeded her ability to understand the professor's accent, while her

misunderstanding fueled more anxiety, and she ended up dropping the class (see §5.5.3,

Changing academic plans because of accent). Another participant noted that she plugged

in her earphones midway through the first lesson video in the testing session, and upon

hearing Prof. Kamala's accent, "I felt like I got even more confused."

     5.3.6 Degrees of accentedness. Students indicated that they made more precise

appraisals of their professors' accents than just the binary judgment of whether or not a

foreign accent existed. For example, several drew a distinction between accent and word

choice, as discussed above (§5.3.4). Other students' descriptions of their professors'

accents ranged from "thick" to "slight" or even nonexistent.[19] One student talked about

how her ITF "speaks English very well, but you can tell that it wasn't her first language."

Some students did not allow accent to affect value judgments about a professor's

---

[19] This is at odds with the assertion that "North American undergraduates apparently are not very discriminating in discerning levels of accentedness" (Rubin, 1992, p. 514).

intelligibility, such as the Chinese professor who "speaks English with an accent, but perfectly well." Other students remarked on the unexpected lack of a foreign accent with which some ITFs spoke, such as a Japanese-born professor whom one student said had lived in the United States since age 14.

One prospective linguistics major observed that for English-speaking students native speakers of languages that are more closely related to English have accents that are easier to interpret:

> German accents are pretty easy to get through, but then you get to Asian accents, and they're really hard to understand because everything they do is different, like they form their sentences differently, their intonation is different, so I think that has something to do with it, too.

Even if this observation is true, the number of anecdotes about German-born professors in the discussion sessions indicated that this closer linguistic kinship to English did not necessarily ameliorate communication issues in the classroom environment.

Finally, a sophomore acknowledged that professors' accentedness is more apparent in different environments: "I saw my Arabic professor outside of class one time, and I didn't realize she had an accent until I talked to her outside of that situation." This experience is similar to those of students with foreign-born parents recognizing their parents' accents for the first time late into childhood.[20]

---

[20] There were several participants in the study, in fact, who were first-generation Americans, and most reported that it took them several years before they picked up on the fact that their parent(s) had an accent. One student said that one day in 8th grade, "my friend was like, 'you know, sometimes your mom's really hard to understand'—and they've been here since they were 20, but they still have an accent, my dad not as much—and I asked, 'what are you talking about? She speaks perfect English!'" Similarly, Lippi-Green (1997) dedicates *English with an Accent* to her father, "who had an accent that I couldn't hear" (p. v).

5.3.7 Teaching style. Many students who complained about ITFs blamed communicative failures not on their accents, but on their "teaching style." Some qualified this assertion: "[my calculus professor] essentially was like a human typewriter and would start on one side of the board, go down, and erase it, and never turn around." Most participants who mentioned a professor's teaching style, however, did so without further qualification, such as the mathematics major who said of a professor whose class she dropped, "I don't think it was his accent, he just couldn't teach." A student from Virginia said that her high school physics class encountered "a lot of problems not necessarily with [the teacher's] accent, but with related things like how he taught and his cultural way of speaking." A sophomore dropped a class with a professor who "had a very, very heavy Indian accent, which I had a lot of trouble understanding on the first day. Like I said, I didn't drop the class because of the accent" (see §5.5.3, Changing academic plans because of accent). This last statement is curious in light of what a friend who had stayed in the class reportedly told her later that semester: "God, you were so smart to drop that class, because I didn't understand a thing [the professor] said the whole time."

Although students qualified their difficulties with their professors' teaching style, these descriptions were generally somewhat vague. It is possible that participants had difficulty vocalizing what exactly made their professors' teaching styles objectionable; perhaps they would say the same thing about SAE-accented professors who taught with the same style. Other on the hand, in light of research showing that accent affects students' judgments about professors' *personalities* (Rubin, Ainsworth, Cho, Turk, & Winn, 1999), it is possible that these students' complaints about "teaching style" would

be minimized or eliminated in absence of a foreign accent.[21] In this vein, several students

who made similar claims about teaching style later reflected that they had perhaps

downplayed the extent to which accent had influenced these judgments: "that might've

subconsciously had an effect on my decision to drop it." A prospective business major

observed that others may be reluctant to own up to accent judgments: "people feel

awkward about calling it out; I wouldn't feel comfortable [saying], 'I'm going to drop a

class because someone has an accent'."

The issue of teaching style is also related to the issue of differences in educational

cultures. For example, asking questions in class (see §5.6.1) is a common feature of the

American educational system, whereas "Koreans rarely even ask questions in class

because to do so is thought to be an indication that the teacher somehow failed in his/her

responsibility to anticipate the students' needs" (Tyler, 1995, p. 141). (For a broader

discussion of research on cultural issues in the classroom, see §2.6, Attempts to Address

the Communication Gap.)

5.3.8 Accent, personality, and self-awareness. Several students reported that

their professors' accents were simply one component of their distinctive personalities.

When asked if professors' accents were a frequent topic of discussion among friends, a

junior described one professor: "he was just this image of the [nationality] man…We

talked about his accent, we talked about him, and everything about him, because he was

just awesome." She also mentioned that this professor used Eastern European cultural

examples and analogies, and his accent lent these analogies credence[22]—somewhat

---

[21] As one linguistics major acutely remarked, "it's unfortunate, because we're conflating their intelligibility
with their intelligence."

[22] This idea is supported by Nelson (1992), in which the use of "personal cultural examples" enhanced
students' comprehension of ITAs and recall of subject material (abstract).

similar to the effect of having an ITF in a foreign language class (see §5.4.2, Accents preferred in language classes). A mathematics major described how he and his classmates imitated their professor's accent and mannerisms in admiration of his uniqueness. Another student noted that she had a Japanese professor who did not have a "strong" accent, but whose foreignness manifested itself in different ways.

Some professors, fully aware that they possessed non-SAE accents, exploited their accents in unique ways to feed into their personality. One student's Organic Chemistry class was taught by an ITF who emphasized his accent humorously at times, which helped students stay attentive in class. Similarly, a freshman talked about a Chinese-born high school mathematics teacher who had lived in America long enough that she could successfully modulate her accent: "she could say *today* perfectly well, but every class period, she would start off saying *to-DIE* [tuˈdaːɪ], very emphasized, just to make fun of it." Another participant noted that her Japanese professor could convincingly speak with a mainstream Japanese accent or an Osaka accent.

Most students contended that professors with "tough accents" were aware of them and aware that their accents could contribute to communicative difficulties with students. In these cases, professors were encouraged to acknowledge their accents, which several students argued creates a more comfortable classroom dynamic; "it makes people comfortable with asking questions, at least," and makes students more willing to go to office hours. Other students described their classmates' fears of criticizing their professors, international or not: "even [if] students have constructive criticism, the students are not willing to offer it up because they're afraid that maybe they'll upset or offend or otherwise seem to be judging the teacher, and they don't want to do that." A

linguistics student noted that one of her professors was open about the issue, specifically

instructing students to give him feedback about the course itself; the result has been

greater student-professor communication, and "the same thing can be applied to accent."

In that vein, one student praised her ITF, who she said sometimes speaks a little too

quickly in class, for addressing the class at the beginning of the semester: "remember:

slow me down if you don't understand. You don't—you shouldn't need to speak Chinese

to take my class."

On the other hand, another student mentioned that her statistics professor is aware

of his accent, but this self-awareness does not prevent him from going through the lecture

at an uncomfortably fast pace once he gets engaged with a lecture. Finally, despite the

general consensus that professors with foreign accents should address this issue head-on

with their students, this, too, can backfire. When asked if a professor's accent ever

impeded learning, one student exclaimed, "hells yeah. It was so bad. He pretty much told

us on the first day that we may have to learn [his language] to understand him." It is

possible that the professor in question made a comment in jest, but the student's

interpretation of the comment created a communicative barrier.[23]

5.4 Effects of Professors' Foreign Accents

Beyond students' first impressions and linguistic appraisals of professors' foreign

accents, participants reported a number of effects that these accents had on their learning

experience. Some of these effects were positive, such as when students found their

professors' accents to be pleasant-sounding, or when students had ITFs in foreign

---

[23] Students in the discussion sessions agreed that they preferred professors to have some sense of humor. Byrd, Constantinides, and Pennington (1989), however, discourage foreign professors from using humor in class if they are not certain of their delivery, since a joke could easily be taken the wrong way.

language classes. Most of these effects were negative, however, ranging from inattentiveness and processing delays to total breakdowns in communication. In some cases, students were able to grow accustomed to their professors' accents, while other students claimed that they could understand their professors' accents immediately.

5.4.1 Favorable professor accents. Not all foreign accents were classified negatively; in particular, every student who talked about having a professor with a British accent spoke fondly of the professor's accent (or, at least, did not have complaints about it). One talked about her experience with a British priest: "when you listened to him teach his sermons, you felt sophisticated." Another student took a class with an older British professor and found the combination of his accent, age, and demeanor—which together made him the "typical professor"—enchanting. The largest communication breakdown stemming from a British accent was in a high school literature class, in which the students could not understand a certain character's name. Even this, however, did not reflect negatively on the teacher, as a participant explained, "we just thought it was cool that our English teacher was British."[24] The accent-centered Anglophilia expressed by these students is rather common among United States speakers (Jones, 2001).

There were other students who felt positively about professors' accents regardless of where they were from. For example, one Virginia native found Spanish accents endearing and said that she was more excited to take classes with professors with this accent, since she had taken six years of Spanish. An English major noted that if the professor's accent is not too thick (see §5.3.6, Degrees of accentedness), she actually likes listening to him or her more than SAE-speaking professors "because it's more fun to

---

[24] Jones (2001) also notes this phenomenon: "Even when Americans cannot understand what [British-accented speakers] are saying, the miscommunication is good-humored" (p. 120).

hear them talk." A theatre major found professors' accents "fun," saying that "I'll catch myself being in a class and using the mannerisms and terms the same way [the professor does], just in normal conversation." Unfortunately, these students were the exception to the rule. The overall student sentiment toward the experience of being in a class with a professor with a foreign, non-British accent was negative.

5.4.2 Accents preferred in language classes. While foreign accents were considered to have negative effects on students' experiences in most subject areas (especially mathematics and science; see §5.4.3), they were actually *preferred* in the modern languages and literatures (MDLL) classroom. A student who had taken several Italian classes explained that foreign accents are expected in MDLL classes, so their presence is beneficial to learning. Most participants who remarked on this issue noted that their professors' accents helped them better understand the correct pronunciation of words in that foreign language. Interestingly, this greater understanding was not confined to situations in which the professors were using their native language. One student talked about her native Japanese professor:

> The fact that she was born in Japan and has a Japanese accent when she speaks
>
> English makes it easier for me, because the ways that she pronounces certain
>
> things can correlate to the way that I expect to pronounce it in
>
> Japanese…sometimes makes it easier to learn.

Whether consciously or not, the student is tracing the professor's accent by comparing SAE phonemic distributions to distributions present in the professor's English and mapping these distributions to those present in Japanese.

In addition, this benefit seems to accrue not only when ITFs teach traditional language-learning classes, but also foreign literature and cultural classes. For example, one student noted, "last year, most of my professors were Chinese, and I took Chinese film classes, and they seemed like they were really familiar with the material. Maybe subconsciously, I was thinking, 'well, they're Chinese, so they must really know this'." In other words, for students, the presence of a foreign accent indexes greater familiarity with a non-American culture, and these ITFs naturally seem more competent to teach these classes than an equally-skilled NITF. The connection between a Japanese-born instructor and a Japanese-based class, for example, is seemingly natural, and so it aids comprehension.

This observation raises an interesting point. It seems to be the case that mathematics classes, to an increasing degree, are associated with professors from Eastern Europe, South Asia, and East Asia.[25] It becomes almost natural to assume that many mathematics classes will be taught by individuals from these regions, and their accents will be expected. Why, then, is there no benefit when these teachers are present in the mathematics classroom, as there is when an ITF is present in the foreign-language classroom? Perhaps this association between ITFs and mathematics classes is not strong enough to obtain this benefit, or perhaps there is something fundamentally different about the humanities classroom versus the mathematics classroom. Evidence from the discussion sessions does not necessarily support the first conjecture (how to determine

---

[25] One student who admitted that he was "horrible at math" wanted to take a class, but "when I went and saw the roster of professors, I decided that I'm only going to take a math class after I've taken at least another semester of Chinese here, just so I can maximize my chances of understanding what's going on," to which another participant interjected, "that's not a bad idea!" Another student noted, "everywhere you go, everyone's always talking about how, in the Math department, there's so many foreign teachers, it's so hard to understand them."

what is a sufficiently strong mental association between ITFs and mathematics?), but does strongly point to the second.

    5.4.3 Accent issue exacerbated in the mathematics classroom. A major trend in the discussions indicated that mathematics classes were different from non-mathematics classes by nature, almost always in ways that make mathematics classes more difficult (see §2.8, The Unique Case of Mathematics). A statistics student noted that the pacing of mathematics classes differentiates the subject from others, with accents presenting an issue "just because there's so many chapters to get through in a semester." A physics major remarked that mathematics professors, especially, are not always certain what is "taught in the classes that precede them…they don't know that some students take classes out of sequence because they're doing it as bio-math double majors or physics-math double majors, where you have to take different classes in different orders." Another student reported intimidation with professors: "some professors' knowledge base is so up above me, especially in mathematics classes." Several students also indicated that they were just plain bad at mathematics, with statements like "it's a math class, so my brain wasn't there anyway," "I just cannot understand math for the life of me," and "for me, I'm naturally bad at math." This phenomenon, which educational psychologists call *math anxiety* (Ashcraft, 2002), creates another barrier between the student and instructor, as the student simply lacks faith in their ability to learn. A student's math anxiety translates into doubt that the professor will be able to help them.

    Many mathematics-specific complaints indicated that what made these problems especially acute was the professor's accent. A freshman noted that accents were an issue "especially in a technical field like math." Another student elaborated, saying that

professors' accents presented problems "especially in mathematics, where they're using

Greek terms, and they're explaining it all theoretically, and I can't understand that and

apply it without actually being walked through the steps." Similarly, a sophomore

explained that Prof. Kamala was not only "using…names of symbols that I just haven't

looked at in years, but she's saying that with an accent." Mathematics classes are harder,

one student noted, because students do not necessarily have a general idea of the subject

matter, so accents compound these issues. As another observed,

> If something's a brand new term to you, then you might not be able to figure it out
>
> [with a professor] with an accent, but if you're more familiar with a subject area,
>
> then I'd think you'd be more equipped to figure out a professor with an accent.

The difficulties engendered when single, specific words are pronounced in an unfamiliar

way (see §5.3.3) were likewise perceived to have special bearing to mathematics:

> Occasionally, even one word that's mispronounced can throw you off, especially
>
> in a math class, I think, because the terminology is not words that you'll be using
>
> in everyday life, so it's not a familiar term…For a while, you'll have no idea what
>
> they're talking about, even if you're familiar with the term pronounced in a
>
> different way.

Misunderstanding specific words seems to be a particular problem in mathematics

classes due to the progressive structuring of concepts. Failing to understand the American

Civil War, for example, will slightly damage a student's comprehension of the Roaring

Twenties, but failing to grasp derivation will be fatal to a student's comprehension of

integration.[26] This need to understand everything the professor says, in addition to the

---

[26] Specifically, the notion of derivatives forms the basis for concepts in integral calculus, including the Fundamental Theorem of Calculus, *u*-substitution, integration by parts, and error bounds in approximate

technical, often esoteric nature of the subject, makes mathematics even harder to comprehend when the student has difficulty simply understanding the professor's words.

5.4.4 Total breakdown in communication. Several students indicated that a professor's accent caused or contributed to a complete or nearly complete breakdown in communication, with statements like, "oh, I don't understand anything he's saying." An anthropology major had this sort of experience with an ITF, such that "most of the class didn't listen to what she said because she was so actually impossible to understand." A pre-medical student likewise lamented about her physics class, "I've had 'significant figures' as a lecture topic like 7000 times in my life. I did not understand the significant figure lecture at all." These experiences were not limited to the classroom, as in the case of a Sri Lankan priest with a "really thick Sinhalese accent, and my Catholic friends would come to school on Monday and still be talking to each other, trying to figure out what the sermon was about." Even a student who "stuck with it" in a class that he considered dropping because of his professor's accent conceded, "most of the lectures, I have no idea what's going on."

Statements such as these are alarming whether or not they are meant to be hyperbolic. If they are presented completely in earnest, then it is quite unfortunate that students experienced entire courses in which the professor conveyed only a fraction of the information successfully. Even if these statements are exaggerations, however, they are still a major problem, in that they feed into students' bias about ITFs. When students hear this sort of statement enough times, the statements become accepted fact, and

---

integration (Stewart, 1998). By contrast, the index of a book on the Roaring Twenties contains only one listing for the American Civil War. Although other topics related to the Civil War are also listed (there are fourteen listings for the Ku Klux Klan, for example), these account for a small portion of the overall content of the book (Streissguth, 2007).

impediments to communication between students and ITFs exist even before their first

encounter (see §5.5.1, Accent as topic of conversation).

5.4.5 Accent and attentiveness. Several students reported that one negative

consequence of having a professor who speaks with a difficult-to-understand accent is

decreased attentiveness. One talked about his Differential Equations professor (whom he

said was also not a great teacher), whose accent "definitely made it easier to sometimes

just mentally check out. When you can't really follow what he's doing, barely understand

what he's saying, it was easier to just kinda space out." An accounting student

complained that her professor's accent made it "easier to not pay attention," since

"obviously, she was smart, but it sucks that you don't wanna listen to her." A student

with experience living abroad discovered this phenomenon for the first time during the

testing session:

> I just remember being like, "okay, zoning out, I have no idea." It just makes it
>
> easier to zone it if you're not getting things clearly [because of] the accent…I
>
> didn't think that I would be one of those people to be just like, "oh, whatever,"
>
> but I did find myself doing that.

This sentiment was not universal; one student in an Ethics class remarked that "it's not

that her accent hurt my understanding of the material, but when the class was boring, it

was easier to zone out." She posited that the line of thought accompanying this sort of

inattentiveness was "oh, she has an accent, I'm not gonna try so hard." Finally, one

linguistics major reported an opposite effect: "I find class a lot more interesting if my

professor has an accent. I don't know, even if it's difficult to understand, it kind of makes

me pay attention more if I have to work to understand." For the majority of students,

however, it seems that conscious knowledge of a professor's accent impedes their ability

and/or willingness to pay attention in class.

5.4.6 Processing delays. In a similar vein, several students reported that

professors' accents retarded mental processes involved in understanding and internalizing

the content of the professors' speech. This processing slowdown was sometimes

presented as a minor annoyance (a professor's accent "may take you longer to place all

the words"), and other times, was presented as a major issue ("The whole class, you're

trying to decipher [the accent] the whole time, let alone trying to understand the actual

material"). A sophomore said that Prof. Kamala's accent, combined with the student's

inexperience in mathematics, "made the brain work a little bit harder." An international

relations major reflected on her teacher's unusual use of prosody, suggesting that these

processing delays were not a major issue: "[at] times she puts the accent on the wrong

part of the word, but [for] three seconds you think about it and you understand what she

said." Another student, however, talking about her ITF's odd word ordering, said that "it

just takes a sec to flip the words around or think about how he's getting to his point, but

then, by that point, he's moved on, and it does take longer to process it." This observation

is an important point, as it provides a model for how students can fall behind in these

classes: The extra mental effort needed to process what the professor just said comes at

the expense of understanding what the professor is currently saying. These processing

delays create a cascading effect, and only a fraction of the professor's speech is

adequately internalized.

Such remarks about processing delays corroborate an important aspect of the

theoretical framework underlying this project. It was my hypothesis that extensive

experience at home with a foreign-born speaker afforded me greater cognitive flexibility in understanding foreign accents, and this greater flexibility was manifested in my understanding ITFs in real time. This flexibility is not available to all speakers, however, and so the presence of a foreign accent creates tangible cognitive impediments to communication. This disparity in students' ability to comprehend their professors' speech suggests the need for training programs to bring students up to speed with those for whom foreign accent comprehension presents few cognitive problems.

The combination of these interpretive barriers caused some students to completely give up on trying to understand their professors' accents: "I think a lot of times people are like, 'oh, they have a foreign accent, I don't understand anything they're saying,' and then kinda just shut down." In fact, three out of four students in one Bias discussion group reported that they had made less of an effort to understand Prof. Kamala in the second lesson video than the first. One said, "I tried a lot harder [in] the first lesson to try to figure out what she was saying, then the second lesson came around, and I was like, 'not happening'." It is possible that the exposure to the Bias module (see Appendix 3) caused these students to approach the second lesson with a perspective in which the communication gap was Prof. Kamala's burden (see §5.7.1, Ownership of the communication gap: Sharing the communicative burden).

5.4.7 Innate accent comprehension ability. Several students in the discussion sessions seemed to believe in the existence of an innate ability (and inability) to comprehend unfamiliar accents. In the same way that some people will claim, "Oh, I'm just not a good singer" or "Writing just isn't my thing," some students maintained that they or people they knew were helpless at understanding accents. Other students claimed

that they were naturally good at understanding accents: "sometimes, I'll meet people and I'll think they're speaking perfect English, and my friend will be like, 'what did they say?'". A linguistics student talked about a mathematics class with an ITF: "many other students complained in the class, but I was able to understand everything she said perfectly, and it was a math class—and math's not my subject."

The assertion about the existence of such an innate ability is particularly salient within the context of this project, since a fundamental presupposition behind the experiment was that students could be conditioned to better understand unfamiliar foreign accents. If, as these students assume, it is true that people who excel at understanding accents do so not as a result of their environment but as a product of genetics, then an accent training program cannot hope to aid students who lack this innate ability. On the other hand, if bias is a contributing factor to the communication gap, then a training program that confronts bias could be effective for everyone, regardless of innate accent comprehension ability.

5.4.8 Habituation to accents. Standing in counterpoint to the assumptions about innate accent comprehension ability were the examples wherein students familiarized themselves with either a specific accent or accentedness in general. A Virginia native, for example, said that in interactions with international students, "you have to immerse yourself by hearing it more than once; it becomes easier to understand the accent." One mathematics major said that his professors' "accents take a while to get used to, but it's usually manageable." Another mathematics major noted that visits to office hours have the positive side effect of familiarizing her with professors' accents.

Three students who were in classes with ITFs remarked that by that point in the semester (about halfway through the semester), they had already grown accustomed to their professors' accents. On the other hand, in a previous semester, one student who had dropped a sociology class partially because of the professor's accent had a friend who stayed in the class remark to her, "God, you were so smart to drop that class, because I didn't understand a thing [the professor] said the whole time." While presumably hyperbolic, this statement indicates that accent habituation midway through the semester is by no means the rule.

In many cases, this habituation was limited to one accent. For example, one participant had experience working in a pharmacy where several coworkers had Indian accents. Thus, when he encountered Prof. Kamala's accent in the testing session, he had little trouble with her accent: "I think a lot of it's experience; once you've been around an accent long enough, you can figure out how to interpret different things." An English and psychology major doubted the effectiveness of the Training module because she had few issues with Indian accents: "I feel like it is pretty easy to pick up the [phonological] rules, even without being walked through it as a student," but then conceded, "but I don't know, I watch a lot of Bollywood." Conversely, one East Asian studies and Chinese major who was "a little more used to hearing certain kinds of accents" nevertheless had trouble with Prof. Kamala's accent.

Some participants who had experienced accent habituation went into further detail about how their ability to notice specific phonological patterns in accents aided their comprehension of accented speech. One student remarked that her knowledge of features such as the /l-r/ merger in Japanese "definitely helps ease the flow of conversation" when

communicating with her Japanese-born friends. A linguistics major noted that if her

Korean-born professor "says something that's different, she says it that way every time."

Some students' accent habituation was narrowly focused on specific words (see §5.3.3),

as with a student whose calculus professor spoke with "a really, really heavy accent, and

I wasn't used to [nationality] accents…he said *derivative* like *DERV-ative*, so after like 3

classes, once I knew how he said the words each over and over again, it wasn't really an

issue."

In addition to accent-specific habituation, several students reported that prior

exposure to some accented speech had granted them a greater capacity to understand

accents in general: "exposure to all different types of accents, not even just a specific one

[aids the comprehension of all accents]." A student with two foreign-born parents

mentioned, "I don't even notice [some speakers] have [an accent], because I guess I've

gotten used to deciphering it?" The same student, however, doubted the effectiveness of

an accent training program for students with such extensive experience with foreign

accents: "I personally didn't feel like I got anything out of [the Training module], but I'm

really used to accents."

This line of thought about habituation to accents is central to the ideological

underpinnings of this project. If greater exposure to an accent entails greater

comprehension, then it should be possible to expose students to an accent to prepare them

for listening and understanding it. Furthermore, the knowledge of specific features should

enhance this comprehension. Students with extensive foreign accent exposure (myself

included) may have enhanced accent comprehension abilities, and an accent training

program would be least effective for these students. It is their example, however, that

leads us to try to replicate their experience for other students, in hopes of enhancing

accent comprehension ability for all.

5.5 Responses to Professors with Foreign Accents

As participants reported, students reacted to the experience of taking a class with

an ITF in a variety of ways. The most common response involved talking about

professors' accents with friends. These conversations sometimes centered on course

enrollment, including the avoidance of certain ITFs. At times, students decided that they

simply could not remain in the course and dropped it, a decision that had long-term

academic implications for some students. Not all responses were negative, however, as

some students were able to use a professor's accent to their advantage as a memory

device. Finally, some students had similar experiences in high school.

5.5.1 Accent as topic of conversation. Students had a diverse set of responses to

the second discussion question ("Do you talk about professors' accents a lot with your

friends?"). Some stated that ITFs were "not a major topic of discussion." A few students,

especially freshmen and non-mathematics majors, mentioned that they never really talked

about professors' accents because they had no personal experience with ITFs. A New

Jersey native said that discussions about professors centered more on their personalities

than their accents (see §5.3.8, Accent, personality, and self-awareness). A student who

had experience living in Asia noted, "I have a great respect for the professors, so I don't

really discuss their accents much," and "everyone has an accent…there are better

shenanigans happening in the day to talk about." Another student taking a Japanese class

with a Japanese-born professor noted that her accent is never discussed "because it helps" (see §5.4.2, Accents preferred in language classes).

Conversely, most students indicated that professors' accents were indeed a frequent discussion topic, especially among classmates and fellow members of residential communities. For example, one calculus professor's accent was a "hot topic of discussion" among members of one participant's freshman residence hall. She noted that "they all bombed a test" because the professor's accent caused them to misinterpret the directions for the test. Another student said, "I feel like you hear people talk about it all the time." Some students indicated that their discussions about professors were positive: "it's never in a derogatory manner; we're very fond of the professor." For the most part, however, students tended to talk about professors' accents out of frustration. One senior, for example, had a particularly negative experience with a physics professor, "so I ranted to a lot of people, and that made me feel a little bit better." A neuroscience student (who said he seldom discussed professors' accents) observed, "most of the time I hear when people are talking about professors' accents, it's in a way that sort of blames the professors' accent for their failures." This observation speaks to the difficult question of which parties are responsible for the communication gap, which underlies much of the controversy about the gap (see §5.7.1, Ownership of the communication gap: Sharing the communicative burden).

These discussions about professors' accents took place not only at William and Mary, but at other schools. A participant from Kentucky mentioned that many of her friends who attend the University of Kentucky "complain a lot about not being able to understand [their chemistry TAs'] directions at all, which is kind of bad in a chemistry

lab." Another student talked about her sister's Chinese mathematics professor, whom she could barely understand "because his accent was so thick and his word choice was so weird." A freshman talked about the high school teacher whom she labeled "the worst teacher I've ever had in my entire life." She reflected on the morality of imitating the teacher's accent: "that just got into the way we talked about [her]…for some people it was humorous, and whether or not it actually should be, I don't know."

Students mentioned discussions of professors' accents in a variety of subjects, including the natural sciences, history, government, accounting, physical education, and modern languages and literatures (see §5.4.2, Accents preferred in language classes). Nevertheless, mathematics professors were by and large the most frequent topic of conversation (a trend that I would assume partially owed to the title of this project). According to some students, friends studying mathematics tended to discuss accent more than other majors. A prospective chemistry major stated even more directly, "that's normally the only thing they really have to say about it: 'I don't like my teacher, I can't understand anything he says'." One mathematics major presented a contrary view: "I don't think we talk about it as much because it happens so often for people in math." Whereas this mathematics major was a junior, the student whose mathematics major friends complain constantly is a freshman; perhaps as mathematics majors progress through college, they indeed get more used to foreign accents and stop complaining about them.

Other students reported that being in a class with an ITF fosters some sort of solidarity among classmates. One said that her chemistry ITF's accent made "a big difference. I think if your professor has an accent, you and your classmates rely on each

other a lot more in class to get the material down." As a result, students were more likely

to form study groups and communicate with one another. This experience was echoed by

another participant whose Spanish teacher spoke English with a difficult-to-understand

accent. The student had little faith in her ability to perform well in the class, so she and

her classmates formed a study group and "I actually did *really* well, surprisingly." The

increased tendency to collaborate with classmates and the use of a professor's accent as a

memory device (§5.5.4) are potential positive effects that do not exist for professors with

SAE accents.

Despite being non-spontaneous and partially directed (i.e., the students were

presented with discussion questions), the discussion sessions themselves served as

models for conversations about ITFs. The stories that discussion participants heard

discouraged some from registering for classes with ITFs; a sophomore said that the

session "has made me even more wary about signing up for classes where there might be

an accent problem." Another student "decided that I'm never taking another math or

finance-related class…I guess that's a good thing to know about yourself." The

discussion sessions also validated some students' prior biases, such as the student whose

session "made me feel better about how I think about it, like, 'oh, I'm not alone in

thinking some of the things I think'." While it is rather unfortunate that this effect

occurred, it does support a central assumption for this project: Spontaneous discussions

among students can create or confirm negative biases.

5.5.2 Accent's role in course enrollment. Students reported that many of their

accent-centered discussions pertained to course enrollment. A law student said that an

ITF "was talked about a lot in the law school when students were doing registration."

One mathematics major discussed, "if [professors] have a foreign-sounding name, I might ask [fellow mathematics majors] about [if their accent is an issue]." Another student was considering taking Calculus II with an ITF; lacking experience with international instructors in high school, she asked her advisor about the professor's accent (and ended up taking the class on her advisor's counsel). Even if participants did not use accent as a factor in course enrollment, it was clear to them that others did: "I don't think that's ever influenced my decision, maybe subconsciously, but obviously, it affects other people's choices." Finally, one participant's friend had asked her about her statistics professor (not just his accent) just before the discussion session. Her response was,

> It's a good class, he teaches it well, but you're going to have to make sure you're
>
> paying attention to what's up on the PowerPoint so that you follow along with
>
> what he's saying…know [that his accent is] coming and be ready for it.

Statements like these were among the inspirations for this project; in my experience, mathematics students will often praise their professors but attach the crucial caveat about accent.

Students also frequently reported using RateMyProfessors.com, a website where students can post anonymous reviews of their professors, as a tool in course enrollment. One dismissed the idea that accents played a large role in RateMyProfessors.com ratings. Conversely, another said, "that's one of the main things, especially with certain classes…it definitely would weigh into someone's decision whether or not to take that class." Some participants mentioned that accent ratings on RateMyProfessors.com had never influenced their decision as to whether or not to take a class, but these students were in the minority. Most students who talked about using RateMyProfessors.com had

views similar to a mathematics major: "[accent] definitely does influence which classes I

would choose or which professors I choose to take a class with." For some students,

accent-related comments on RateMyProfessors.com played an indirect role, but for

others,

> I look for specifically accent-related things, especially for math classes. I
>
> probably will continue to do that, because this is only my first math class here,
>
> and I can understand everything fine, even with a slight accent, and I want to
>
> make sure that continues, you know?

In addition, some students who had a lack of faith in their mathematics abilities (see

§5.4.3, Accent issue exacerbated in mathematics classroom) felt that they had an even

greater need to safeguard against accent-related issues: "an accent wouldn't be a deal

breaker for me, but I'm terrible at calculus…so I'd probably try to go to

RateMyProfessors and look for professors who people say doesn't have a strong accent."

It is not difficult to see how bias against ITFs can escalate among students,

especially those who take multiple mathematics classes. Students who take classes with

ITFs, whether rightly or not, begin to blame their professors' accents for their failures, as

with the group of students who "all bombed a test" because of accent. Even if students do

not personally experience such difficulties, they hear about them from their friends and

internalize an invalid association between a professor's accent and poor teaching

quality.[27] And even if students are told that an ITF "teaches [a class] well" (as with the

statistics professor mentioned above), it is almost always followed by a warning about

accent. It follows from this sort of warning that ameliorating the communication gap,

---

[27] It is no coincidence that a table of RateMyProfessors.com ratings was used in the Bias module for the
project's testing sessions (see §3.5, Module Development).

created by students' inabilities to comprehend professors' accents, would increase

significantly the quality of students' learning experiences. This deterioration in learning

experience is especially pronounced when it causes students to alter their academic plans.

5.5.3 Changing academic plans because of accent. Several students reported

dropping at least one class with an ITF and claimed that the professor's accent had played

at least some role in their decision to drop the class.[28] For some students, accent was the

sole factor involved in dropping a class; one freshman had already dropped her calculus

class and two others because professors' accents. Another student said that while she had

not personally dropped a class because of accent, she knew plenty of people who had,

especially when they anticipated that the class would be heavily lecture-based. For one

senior, accent was not the only issue, but it was the most prominent:

> [My friend] was already kind of nervous about physics in the first place because
>
> she thinks she's terrible at it, but I think she dropped the class more because the
>
> accent was so strong and decided to take it next semester instead.

For other students, a professor's accent was incidental to their decision to drop a class.

One European studies major, for example, decided to drop a Russian language class

because of the anticipated workload associated with a language immersion course.

In most reports of dropping a class taught by an ITF, however, students asserted

that accent played neither a prominent nor nonexistent role, but a subsidiary or minimal

role. The reasons one participant gave for dropping a class with an Indian professor were,

---

[28] At William and Mary, students have the opportunity to attend any class they wish in the first two weeks
of classes, and may register for or drop any courses (for which they meet prerequisites) without penalty.
Beyond this period, students may withdraw from a class, and this withdrawal is noted on their transcript.
However, it is my experience that in the parlance of William and Mary students, the term *drop* may refer to
dropping a class in either of these two periods, so when students talked about "dropping a class" in the
discussion sessions, it was unclear whether this took place at the beginning or middle of the semester.

"the way she talked, and her mannerisms, and how incredibly boring the material was."

Similarly, one sophomore had enrolled in a philosophy class with five friends, but all of

them later dropped the class because of the subject material, the professor's accent, and

his "teaching abilities" (see §5.3.7, Teaching style). A participant who noticed that a lot

of people in her calculus class "disappeared after the first class [meeting]" speculated that

while accent was one factor, students were likely scared off by the subject of calculus

itself (see §5.4.3, Accent issue exacerbated in the mathematics classroom). One student

downplayed the extent to which a professor's accent encouraged her to drop a class, but

then revisited her assertion: "the accent, I guess, helped the fact that I wanted to switch,

because it made it a little bit harder for me, especially when I didn't understand stuff."

A few students even talked about professors' accents causing them to alter their

academic plans on a larger scale. A senior recalled, for example,

> I came into college thinking I wanted to be an IR [international relations] major,
>
> and I was like, "oh, Intro to International Politics is a good place to start," and so I
>
> signed up for a class with [a professor] who I believe is [nationality], and I sat
>
> through two classes, and I could not understand his accent, could not understand
>
> the material, and I was just like, "I'm getting out of here."

(The student did mention, however, that also she found her classmates "kind of

obnoxious.") Another student learned that a professor's accent can affect a student's

enjoyment of the subject material itself. She was interested in majoring in international

relations, an interdisciplinary major at William and Mary that primarily combines

government and economics classes, and after taking an introductory government course

with an ITF, "I kept telling myself, 'oh, I hate government, I like econ more', which is

really rare to hear from IR students…I took a different class with an American-born professor and I liked [government] a lot better." Another participant described her "dilemma over the summer over whether to drop physics or not, and I was just in so much pain every class, and I would just sit down with my homework and not understand anything." She ended up deciding that she could not continue taking the class, despite being a pre-medical student, and this decision "totally ruined my entire plan…and now I need to take a year or two off to get physics before I can study for grad school, so that kind of sucks." A junior had a friend who wanted to be a mathematics major, but changed plans after twice faring poorly in Linear Algebra classes taught by ITFs (although the participant mentioned that her friend did not comment on the professors' accents).

5.5.4 Accent as memory device. Some students reported that having a professor with a foreign accent prompted students to associate the accent with the subject material. For example, one student's friend had an accounting class with an ITF, and the friend exclaimed one day, "I'm reading my accounting book with a [nationality] accent in my head!" Many students who had experienced similar phenomena indicated that this association was useful as a memory device, often when studying in groups. A philosophy student noted that "when we're studying with each other, we'll say it the way she says it in class with her accent." Another student who reported doing the same thing for a Japanese class talked about a funny expression her professor used and how "we thought it was funny, so it helped us remember what it was when we were studying." This use of accent as a memory device is not always done consciously, as explained by one mathematics major:

> When I think about math, I think about it in a Russian accent, and other people in
>
> the class have expressed the same sentiment. We'll be trying to explain a proof to
>
> each other, and all of a sudden, catch ourselves saying words the way [the
>
> professor] does.

The latter two examples occurred in cases in which the students found their professors'
accents to be exotic yet endearing (see §5.4.1, Favorable professor accents). The example
with the philosophy professor, on the other hand, occurred in a case in which the students
did not particularly like the professor's accent ("I could not understand her if my life
depended on it"). Thus, a professor's accent can actually be beneficial to students' recall
of the subject material, regardless of whether or not students find the accent pleasant.

5.5.5 Accent-related problems in high school. When I designed this project, I
did not anticipate that students would have had issues with understanding certain teachers
in high school (since all of my high school teachers were American-born). Several
participants, however, reported similar issues with instructors in high school, not just as
an undergraduate; in fact, several participants suggested that ITFs present *greater*
problems for high school students. One chemistry major said so directly: "in high school,
accents mattered a lot more, just because students didn't really care about school in my
high school, whereas here, at college, we've all chosen to be here." Emotional maturity
seemed to be the main factor in this discrepancy, since "at that age, if you don't
understand what's going on, you're not like, 'oh, I'm going to go follow up and ask [the
teacher],' you…give up, and you don't care." Another participant described her high
school calculus teacher, who had lived in China his entire life, save for two or three
months before that school year. The student felt bad for the teacher for enduring the

ridicule of immature 16 and 17-year-olds in his class who "immediately would walk out

the door and be like, 'Oh my God, why can't he speak English?'". This story is similar to

the experience of a student whose classmates had major issues with a Japanese-born

chorus teacher:

> The second she'd leave the room, [they] would relentlessly make fun of her
>
> accent, especially the whole l/r thing, they would constantly get on her for that,
>
> and even actually to her face sometimes. It was kind of a messed-up situation.

This story was met with disapproving mumbles from the discussion group, with one

participant chiming in, "oh, high school." This last comment not only reflects a belief that

high school students have inadequate emotional maturity in these situations, but also

suggests that undergraduates would never commit such a childish indiscretion.

One student even mentioned a middle school issue with an international

instructor. Her younger sister took a geometry course in middle school with a teacher

with an undesirable accent and manner of speaking, so this girl's friends created a

website with quotations from the teacher. Some of the quotations were related to the

teacher's accent, while others resulted from the teacher's peculiar self-expressive

mannerisms. The student defended the website, saying, "I don't really think it was

intended to be detrimental, it was just a way to get their frustrations out."

When students made fun of their undergraduate professors, it was always outside

of the professors' attention. On the other hand, the stories about the Japanese chorus

teacher and the quotation website indicate a trend of students underestimating the impacts

of their criticisms of their instructors' accents. When participants talked about making

fun of their international high school teachers to their faces, they always presented these

interactions in a playful, benign light. One participant talked about joking around with his Farsi teachers (in military training) about their accent: "it was fine because we were all more mature then." The student who talked about her Chinese calculus teacher mentioned that students would also participate in "playful teasing" with the teacher while in class. Whether or not this teasing was done with insidious intent, it most likely insulted the teacher and increased his or her sense of linguistic insecurity, which He and Li (2009) identify as a major issue among international instructors.

5.6 Communication Breakdown in General

Difficulties in communication between students and professors were not limited to situations in which the professor had a foreign accent, as participants had a variety of responses to the fourth discussion question ("What do you think impedes communication between students and professors the most, regardless of accent?"). Many responses to this question were general, and since the scope of this thesis pertains to the communication gap between students and ITFs, these responses to the fourth discussion question will be discussed briefly. The themes that emerged from these responses are nevertheless applicable to the specific situation of ITFs.

5.6.1 Difficulties with in-class questions. Many students complained about the difficulties presented by in-class questions to professors. One described her frustrations with professors when

> [They] assume or anticipate my question, and then they don't listen to the
> question I actually ask, so then their answer is completely not the question I

> asked, and then they go on for five minutes, and at the end, they're like, "so does
>
> that answer your question?"

An international relations major talked about a professor who sometimes asked questions to elicit a quick, one-phrase response and other times asked questions to elicit lengthy, thought-out responses, but never indicated which type of question she was currently asking. Discussion participants expressed a general reluctance to ask in-class questions, especially in lecture classes, for fear of being "that person" who held the lecture up. This tension was mitigated by some professors who openly expressed willingness to answer questions at office hours.

Issues with in-class questions were sometimes magnified when the professor had limited English proficiency. For example, in a class with a Chinese-born Chinese professor,

> There would be occasions where we'd have a question, and we didn't know
>
> enough Chinese to say it in Chinese, so we'd be talking in English, and I
>
> remember a couple of times listening to one of my classmates trying to ask a
>
> question, and our teacher trying to answer it, but answering a different question,
>
> or not really understanding what question was being asked.

One Russian student mentioned that her professor had a good grasp of English, but had difficulty with in-class questions. "She can prepare a lesson in a certain way," the student noted, but students often need to reframe their questions several times, otherwise the professor will "think she's understanding the question, but the answer is completely off the mark, and the student either gives up or is like, 'okay, I guess I'm not going to get that question answered' or keeps trying to rephrase it." This illustration is reminiscent of

difficulties discussed by Davies, Tyler, and Koran (1989), in which ITFs' difficulties with speaking extemporaneously in English come to light when students ask questions in the middle of a lecture.[29]

      5.6.2 Use of PowerPoint presentations and chalkboards. Several students commented on their professors' use of PowerPoint presentations in their lectures, often critically. For example, one student's Ecology discussion session featured the professor merely reading off a PowerPoint: "it's not really discussion at all…every class, I count, at least, about 5 people sleeping." For many students, PowerPoint detracted greatly from the teacher's worth:

> I feel like PowerPoint is actually really detrimental…because it leads to teachers
> who just rely on that for what they're going to say in class. I could flip through
> your 30-slide PowerPoint in 5 minutes at home; I'm here to listen to your insights
> about this and how you think there could be greater implications about what's
> being taught, not simply [the plain facts].

An anthropology major blamed an over-reliance on PowerPoint for a "professor versus students" classroom environment that developed by the end of the semester: "nobody was coming and everybody was bombing the exams and nobody cared because it was such a boring class."

      Students hardly felt that PowerPoint was an unequivocal evil, however. One neuroscience major opined that PowerPoint presentations generally improve science classes. Another student felt that keeping track of the organization and structure of a lecture was more difficult without PowerPoint. Other advantages to PowerPoint included

---

[29] It should be noted that it is not the professors' foreign accents per se that create these problems with in-class questions, but their English proficiency. These issues are closely-related but not synonymous; Lippi-Green (1997) notes that a speaker can be fully proficient in English but still speak with a nonnative accent.

the avoidance of bad handwriting and the ability to post presentations online (although

this could encourage students to stop coming to lectures; one participant attributed her

improved grade on a final exam to skipping class and reading the posted presentations

instead).

Despite these advantages to PowerPoint, students preferred that their professors

use chalkboards instead of PowerPoint presentations: "there's a difference between

someone who just gives a PowerPoint full of slides and professors who end up

demonstrating that they're actually good at what they do." Contrasting the two

instructional media, one kinesiology student said that the chalkboard was "the best way

of learning, ever, because it's active, you're engaged, and you're actually writing what's

on the board and thinking about it." Another student remarked that his in-class note-

taking was "vastly better" in classes that used chalkboards.

5.6.3 Communication outside of class. Many students complained that

communication issues extended beyond the classroom, especially with regard to emailing

and office hours. Complaints about email sometimes centered on professors' inability to

respond to emails quickly enough: "it would help if professors would respond to emails

within a day or two instead of five days later, when it doesn't really help you anymore."

Other times, professors were accused of overusing email, such the professor who asked a

class to turn in homework and was met with blank stares; "[the professor said,] 'I sent

you an email; that's the main form of communication in this class', but I'm sorry, I'm not

a machine, I'm not always on my computer…I also have a life." On the other hand, email

did have distinct advantages; for example, a student who appraised her own English as

"pretty poor" often asked questions via email so she could look up definitions of

unfamiliar words in their responses. One prospective French major praised her professor for answering emails in French or English, whichever the student preferred.

Office hours were another point of contention, especially when professors "get stuck in one way of explaining things," a problem similarly encountered with in-class questions (see §5.6.1, Difficulties with in-class questions). A junior took calculus with an ITF and described her frustration when "I would go to office hours and he would explain it the exact same way, which didn't help me at all." Another student was greatly annoyed by a professor who was absent during the professor's posted office hours.

5.7 Solutions

Part of the discussion sessions revolved around solutions for the communication gap, usually in response to the fifth discussion question ("What do you wish professors (or even the College) would do to deal with the issue of the communication gap between undergraduates and mathematics professors?"). These included the use of linguistic training programs (such as the Training module) in a variety of contexts, involving students in the professor hiring process, using written materials, and course evaluations.

5.7.1 Ownership of the communication gap: Sharing the communicative burden. One consideration that bore strongly on proposed solutions for the communication gap was the question of who "owns" the gap. If ITFs own the problem, then it is their responsibility to resolve it, but if students own the problem, it is students' responsibility. A fundamental assumption driving this project was that instructors were commonly assumed to own the problem (and that prior research was heavily focused on instructors' responsibilities in closing the communication gap), but that students should

also be made to accept ownership (see §2.10, Summary: The Need for This Research).

Linguistic ideology about accents and ownership was included in the Training module as

a result.[30]

These assumptions were largely confirmed by the discussion sessions, in which

many students doubted the willingness of their peers to take responsibility for the

communication gap. One English major described such an attitude as, "I want William

and Mary to change for me, I don't want to have to change for [William and Mary]." A

freshman remarked that

> [Students' ownership of the problem] kind of depends on the student's attitude,
>
> because I have a feeling at least a lot of the guys I hang out with probably
>
> wouldn't want to learn, or go to a class, for them to learn how to understand
>
> accents. They would just be like, "mmmm, no, they can learn English"…I think
>
> that there would be a lot of people that would be upset that they have to go to an
>
> extra class just to understand the professor.

Another participant attributed a lack of ownership partially to complacency on the

students' part: "it's so much easier to be like, 'oh, I failed this class because my professor

has an accent and it sucks,' as opposed to, 'It's my fault for not understanding his accent

and not doing anything about it'."

At the same time, students recognized that "initiative on both sides" of the

communication gap was crucial to communicative success. A mathematics major noted,

"it has to be something that both the students and the professors work on…we need to

work together to fill the gap." Likening the communication gap to American civil rights

---

[30] In fact, the first page of the Training module (see Appendix 5) included a heading entitled "Who 'owns' the problem?" (cf. Rubin & Smith, 1990).

struggles in the 1960s, the student noted that any solution "needs to be a cooperative effort." Regardless, students felt that any program that asked students to contribute "would have a lot of negative reactions." When presented with the fifth discussion question ("What do you wish professors (or even the College) would do to deal with the issue of the communication gap between undergraduates and mathematics professors?"), no participants in any Control or Bias discussion sessions suggested any sort of program that would require students' involvement. In general, students seemed to be reluctant to claim any part of the communicative burden in the classroom (cf. Lippi-Green, 1997).

      5.7.2 Involving students in hiring process. A general suggestion arose from the sessions that the administration or academic departments could enlist students' help in evaluating prospective faculty hires. Students hoped that this practice would screen out any prospective hires whose English was too difficult to comprehend; this sort of solution, then, puts the burden of closing the communication gap on ITFs. One Virginia native who "liked the setup of [the] experiment" with regard to the professor evaluation scenario suggested that certain departments should pilot such an evaluation scheme, which could be expanded to the entire College if it proved successful. Several students suggested that prospective hires could conduct live mock lectures so students could assess their teaching abilities. Although one student asked where to draw the line as to who would have to undergo this "audition" process (see §5.7.7, Concerns about discrimination), another suggested that all prospective faculty, not just international applicants, could do an "audition." A freshman suggested that mock lectures could be conducted via an Internet video-chat client like Skype to cut down on costs and logistical

difficulties. Students defended the need for this sort of process, saying, "if they have a communication barrier, then the class is just an awful experience."

In fact, this is not a novel idea. In addition to personal interviews, all candidates for faculty positions at William and Mary must "teach a class or present a seminar in order to ensure that they are sufficiently proficient in English to teach at the College" (C. J. Strikwerda, personal communication, November 19, 2009). Since "[t]he process of evaluation varies by department," (C. J. Strikwerda, personal communication, November 19, 2009) this may not necessarily involve students' input. In the Department of Mathematics, for example, prospective hires must participate in one-on-one interviews with current faculty and give a talk. A practice that involved students is no longer in place:

> In the past, we also required candidates for faculty positions to give a talk to our undergraduate math club, but that has not worked very well because our undergraduates don't have time to attend so many talks (in some years we have had 11-12 job candidates visit campus in February and March). (D. Lutzer, personal communication, November 20, 2009)

In other words, a program that enlisted students' help in the hiring process was discontinued because students themselves could not commit to it, as if students chose to renounce even minor responsibility for the communication gap.[31]

---

[31] These guest lectures were presented not to a representative sampling of students but to the school's mathematics club, which presumably consisted primarily of mathematics concentrators. If students who end up majoring in mathematics can do so in part because of their ability to deal with professors' foreign accents (i.e., that those who have difficulty with accents get screened out of the major, as one participant suggested), then these guest lectures would have been given to an audience that failed to represent the students who had difficulty with foreign accents, especially in lower-level classes.

Other students suggested the use of English proficiency testing to screen potential candidates for faculty positions, which several schools have used in screening international graduate students for TA positions (Briggs & Hofer, 1991; Cassell, 2007; Plakans, 1997; see §2.6, Attempts to Address the Communication Gap). Despite one mathematics major being certain that ITFs had to fulfill an English requirement, the Department of Mathematics in fact requires no language testing (D. Lutzer, personal communication, November 20, 2009). Likewise, the School of Arts and Sciences at William and Mary has no official language testing policy. Although the "ability to teach well and speak clearly" plays a role in evaluating candidates, accent is not a specific field of assessment, as "the use of English is factored into a holistic evaluation" (C. J. Strikwerda, personal communication, November 19, 2009).

5.7.3 Importance of written materials. Many students stressed the importance of writing down course content, using a chalkboard or PowerPoint presentations, in order to avoid ambiguity and reinforce concepts. Whereas students could be uncertain about their interpretation of a professor's spoken accent, "words on a piece of paper don't have an accent." Several participants, when asked if professors' accents had ever hurt their understanding of course material, mentioned that accent problems were largely mitigated by the use of written materials. A computer science student said that despite his mathematics ITF's "pretty thick accent," his use of the chalkboard meant that he "never had trouble understanding what he was talking about." One mathematics major said that her professor "overcompensated" for his accent, and the fact that he wrote everything down meant that students did not have to ask for clarification. This practice is especially important given that in-class questions can create particular difficulties (see §5.6.1).

Some participants even commented on the helpfulness of the lesson videos' visual elements (see §3.4, Lesson Video Animation), remarking that they would have been unable to follow "anything she was saying if it wasn't for those little PowerPoints." A non-mathematics major mentioned that "the fact that I saw everything [in the lesson videos], I saw [the concepts] perfectly." One participant even commented positively that the timing with which text appeared on the lesson videos "was more like simulating someone writing [on the board]."

5.7.4 Use of course evaluations. Several students suggested that the College could use course evaluations (which students fill out anonymously at the end of each semester) to address problems posed by the communication gap. Some students thought that evaluations should include a specific question about the professor's accent, while others thought it should be addressed less directly or more generally ("was there a communication gap?"), in the hopes of avoiding discrimination.

5.7.5 Helpfulness of accent self-awareness. A majority of participants felt that professors who were open to students about their accents contributed positively to communication between themselves and their students (see §5.3.8, Accent, personality, and self-awareness). As a result, they suggested this as a solution (or partial solution) to the communication gap. Other participants suggested that professors themselves could receive accent training, in order to figure out which features of their accent were most difficult for SAE-speaking students to comprehend. One even suggested accent-reduction classes, mentioning that family friends operated a "pretty successful" accent-reduction business.

5.7.6 Accent training program for students. As mentioned above, no participants in the Control or Bias discussion sessions responded to the fifth discussion question by suggesting any sort of accent training program for students. On the other hand, several participants in the Training group, having experienced such a program in the testing session (see §3.5, Module Development; Appendix 5), believed that it could be useful: "it might be nice if [accent training] were a service." One prospective linguistics major found that "just explaining some things about the accent really helped," especially with the feature on the Prof. Kamala's use of word-initial glides. Another student, reading about the features of Prof. Kamala's accent, found the information to be highly effective: "I was sitting there like, 'why don't people do this all the time?'".

Some students felt that the Training module's information on accent features was a little complex: "[I] didn't really understand it when you had [phonological descriptions] written in words, but then it made sense when you put the sound bite in there, to be specific." One anthropology major mentioned that she found the phonological component of the module interesting but guessed that it might not be interesting to all students. A linguistics major stressed that the ideological element was nevertheless crucial: "I literally don't have as much of a problem of [understanding foreign accents] just because I'm more open to it in my attitude, so I think that could be really helpful." This assertion is interesting, given the theoretical foundations of this project. One of the goals of the Training module was to present standard linguistic ideology about accents in order to eliminate the communicative impediment created by accent bias; this student reported that taking linguistics classes had this desired effect of better comprehension of foreign accents.

Several Training session participants remarked they planned on using interpretive skills that they learned in the second half of the Training module in their real-life classes. One prospective linguistics major said that

> [It's helpful to] have a set of things that you can keep in mind when you're listening to someone, that if I hear this, it's probably this going on. Even if you don't have a specific professor now, if I have one later, I'll probably be listening for specific things instead of just sitting forward in my seat.

Another participant mentioned the importance of "just focusing and trying to find patterns." In fact, one freshman had already used what he had learned in the testing session in an actual classroom situation: "[I] really found it useful thinking about specific things a professor's accent does to what they're saying, and actually that did help me understand some of my professors." This is an encouraging observation, given that only eight school days had passed in between this student's testing session and discussion session.

Several members of the Training group similarly indicated that they had already internalized the tenets of accent ideology presented in the first half of the Training module. A native of Washington State particularly remembered the comment that professors are some of the best in their fields, calling it "eye-opening." One anthropology major echoed the Training module's sentiment about the burden of communication that some place solely on ITFs:

> They're very intelligent people, obviously, and by the fact that they're teaching in a second language in a foreign country, that's a lot to deal with already. It's a

cultural difference as well as a linguistic difference, so you don't want to alienate

them by requiring that, as well.

An English major who was actually in the Bias group reacted to the phonological training

example about 'th' sounds by denying confusion about what Prof. Kamala was saying.

She did feel, however, that students could come to believe that they could not understand

her words, citing Rubin (1992):[32] "some kid who's already conditioned not to know this

accent would be like, 'I don't know what she said,' but you really do know what she

said!"

If it is accepted that a linguistic training program can indeed aid students'

comprehension of ITFs, then the challenge becomes implementing this sort of program in

a way that will be "appealing and productive" for students. Discussion session

participants evaluated ways to implement accent training, including Orientation and a

permanent website, as well as difficulties that implementation would likely engender.

5.7.7 Concerns about discrimination. Many students expressed concerns that

any policies or procedures implemented to address the communication gap would entail

institutionalized discrimination against ITFs. One student reacted negatively to the idea

of screening out applicants for faculty positions on the basis of English proficiency (see

§5.7.2, Involving students in hiring process). Several students mentioned that such

policies would be offensive and "insulting" to ITFs: "they're brilliant people, they're the

best at what they do, but limiting them because of the way they speak is almost like a

slight to them." One mathematics major, referring to the United States' history of civil

rights, opined, "I wouldn't want them to be discriminated against, because obviously we

---

[32] The Rubin (1992) study was erroneously cited in the discussion sessions as having been published in 1999.

have a history of that, and still in [the] present day it happens." At the same time, students

recognized that the current state of relations with ITFs was already discriminatory: "it

would be good if they could work to their maximum potential, because I'm sure it

frustrates them if students are like, 'I don't understand what you're talking about because

it's you talking'."

Some of these discussions about discrimination were put to rest when other

students suggested a solution: designing policies that can address problems posed by

foreign accents, but that apply to all faculty. In one discussion session, when students

were talking about the possibility of mock lectures in the hiring process (see §5.7.2,

Involving students in hiring process), one suggested that every candidate for a faculty

position could give a mock lecture. A Missouri native mentioned that the College could

implement a policy dealing with situations where multiple students reported

communicative issues with a professor; this policy would cover accent, but would also

apply to any communicative difficulties with any professor. Expanding such policies to

the entire faculty seemed to quell students' legal and moral qualms with potential

discrimination.

5.7.8 Students' initiative to use training program. Several students mentioned

that students might not put out the effort to take advantage of an accent training program

if it were optional. One student noted that the success of any program would hinge on

"students being willing to embrace the idea of 'okay, I'm actually going to try and

attempt to understand what my professor is saying,'…because there's a possibility that

they're not even going to try and make the attempt to understand," a problem that relates

to ownership of the communication gap (see §5.7.1). A few participants simply did not

believe that students would be motivated enough to do a training program, saying, "I don't know if people would do it."

In contrast, some students expressed faith in their peers' willingness to use an optional accent training program, as with the junior who "would definitely try it. If I was having a problem understanding a professor, I would probably do anything to try to better understand the class…I think it could work." Participants stressed that grade concerns would provide an important incentive: "especially students here and at similar schools— we're so intent on getting good grades—would take the time." Similarly, a training program could ameliorate students' complacency; a Maryland native noted, "I think a lot of times people are like, 'oh, they have a foreign accent, I don't understand anything they're saying,' and then kinda just shut down;" if students knew there was an available resource, "they might actually make an effort." One participant made the point that "if you advertise this like, 'I have something that will help you understand your teacher better,' everybody's going to want to take it…you could get a whole lot of people."

5.7.9 Over-specificity and bias creation. Another option, implementing accent training as a compulsory program, had its own issues. One of these issues was the risk of being overly specific, applying only to certain students. A mathematics major mentioned, for example, that an accent training program would be useful for her, but not necessarily for majors in other departments, such as government. Another student was concerned that "if I don't [ever] have an Indian professor, it won't help me." On the other hand, one student contended that over-specificity was not an issue:

> Yes, the probability of you having a professor with that accent may be small, but
> if you do have a professor with that accent, you'll be able to understand it better.
> So it may not apply to everyone, but it will help many.

One participant mentioned that even a program focused on just one foreign accent could have a foot-in-the-door effect: Training for one type of foreign accent would encourage students to seek out help with other accents. A senior remarked that "some people understand the accent right away, [for] other people it's really difficult…to have a training program can only help you."

Students pointed out another potential issue arising from a mandatory training program: the *creation* of accent bias. One participant mentioned that if professors suggested an accent training program for students, they would be more likely to drop the class. Another participant expressed his fear that

> If you let people know, "this person has a thick…German accent," for example,
> the students will come to class and say, "oh, man, he's gonna have a German
> accent, I'm not sure if I'm going to be able to understand this," and it kinda
> creates that perception.

Indeed, several participants replied to the sixth discussion question ("Do you feel that you gained anything from this process?") by saying that the discussion sessions had heightened their wariness to enroll in courses taught by ITFs (see §5.5.2, Accent's role in course enrollment). While this was certainly an unintended consequence, it demonstrates that an open, non-moderated dialogue[33] about the communication gap would be a poor substitute for a more directed sort of accent training.

---

[33] Although I did serve as a moderator during these discussions, I sought to do so without influencing the opinions that participants brought to the sessions.

5.7.10 Integration into new student Orientation. Several participants suggested that an accent training program (or awareness thereof) could factor into Orientation, a mandatory five-day program for new students directly before the start of the fall semester (Dean of Students, 2010a). "As a part of the dorky Orientation things we have to do," an anthropology major remarked, "this might be a useful one to include." A freshman replied, speaking on the value of Orientation as a mandatory program: "if you're required to do it, people will be exposed to it, because if you just put it out there as, 'here's a tool you can use,' people are going to forget, and they're not going to use it." A prospective linguistics major mentioned that accent training or accent awareness could be substituted for a presentation on diversity "because this kind of plays into diversity anyway."[34] One student suggested that accent training could be implemented as a part of Extended Orientation, a series of presentations that extend through students' first semester at William and Mary (Dean of Students, 2010b); another participant in the discussion session, who had worked as a facilitator for Extended Orientation diversity sessions, agreed. Finally, a sophomore mentioned that a training program could be included as one of several optional presentations given on the last day of Orientation.

Several students pointed out flaws in any plan to implement an accent training program as a part of Orientation. In addition to the difficulties of over-specificity and bias creation that could arise from a mandatory program (see §5.7.9), Orientation programs entail obstacles entirely their own. As a freshman remarked, "the easy answer is to do it during Orientation, but speaking honestly, something done during Orientation is probably

---

[34] Speaking from personal experience as a performer and facilitator for these diversity presentations for the 2007 and 2008 Orientations, these presentations addressed multiple forms of diversity: race, ethnicity, religion, gender, socioeconomic status, sexual orientation, and geography. Linguistic diversity, either among students or instructors, was not addressed.

going to get ignored by most of the students."[35] Thus, even a compulsory program can

encounter the same issues facing an optional program (see §5.7.8, Students' initiative to

train), in that students can simply choose to ignore the training and disown responsibility

for the communication gap. To that end, two participants suggested that any mandatory

accent training program should be implemented not at the undergraduate level, but at the

high school or middle school level (see §5.5.5, Accent-related problems in high school).

Not only is it likely to have a greater effect on younger students, one argued, but it would

also run into less resistance since "there's more room for a mandatory type of thing."

5.7.11 Training website as a permanent resource. Several students suggested

that an accent training website, like the Training module presented in the testing sessions

(and in the Control and Bias discussion sessions), could be a useful permanent resource

for students. One psychology major mentioned that a training page used could be a good

"general resource" that professors could load onto their Blackboard Academic Suite

course websites and recommend for students. More generally, several students suggested

putting a webpage on the William and Mary Linguistics Program website. Although it is

not a very direct strategy, students argued, it would be helpful if students could always

"find the 'guide to understanding a Russian accent' page." Some students stressed that

such a resource should be expanded to cover accents of native speakers of other

languages, in addition to Indian accents. A junior noted,

> I think it would be more helpful if there were more of these, if it was some
>
> accessible reference to, "okay, how is my professor talking? And how can I

---

[35] Rubin (2005) echoed this sentiment: "do students at your institution pay much attention to the materials they recieve [*sic*] at orientation?" (n.p.).

interpret that? Oh, okay, that's what she's saying!" would be even more helpful

than just the little example.

In addition, one participant suggested something of a hybrid of the two main

implementation strategies for a training program, saying that training could be a

permanent resource that is introduced during Orientation. She argued that students will

likely forget specific accent features long after Orientation, "but knowing that the

resource is there and already having been forced to look at it once might help you to go

back and reference it again." This solution would have the advantage of universal

exposure to the resource, while reaching motivated students to a greater extent.

5.8 Results from Linguistic Profile Questionnaire

The Linguistic Profile Questionnaire (Appendix 10), given to participants at the

end of their testing session, was designed more as a tool to collect demographic data from

the participant pool than to collect pertinent results about the experiment itself. (These

demographic data are summarized in §3.12, Profile of Participants.) Nevertheless, two

items on the questionnaire yielded interesting results that are worthy of discussion in this

section: "Do you think you speak with an accent? If so, how would you describe it?" and

"Do you have any final questions or comments about this survey? If so, please write them

here." I have edited participants' responses for readability (capitalization, apostrophes,

etc.), but I have not altered any content.

5.8.1 Participants' accents. Participants had a fairly broad range of answers to

the first of the two above questions, ranging from single-phrase responses ("Yes,

British") and outright denials ("No") to nuanced descriptions ("Yes, but I don't know

how to describe it... perhaps colored a little by Pittsburghese, a little Northeastern, and a

touch of the south.") and comprehensive profiles:

> I don't think so, but sometimes people comment on certain words. Some say I
>
> speak with a bit of a southern accent (from Texas) and some say that I have a
>
> northwest accent (from Ohio). And then some Californian words slip out, and my
>
> "no" is influenced by the summer abroad in England. Mostly, I get asked, "Where
>
> on earth are you FROM?"

The second category of responses, outright denials, is particularly interesting, since

standard linguistic ideology teaches that there is no such thing as a non-accent (Lippi-

Green, 1997; Matsuda, 1991). This principle was conveyed in the Training module (see

Appendix 5 for full text):

> Question: What percentage of English speakers use an accent?
>
> Answer: 100%.
>
> There's no such thing as speaking English without an accent, as
> everybody, including you, your roommate, your grandparents, and your
> doctor, has some sort of accent. It may be that the accent you use is a
> pretty typical one for where you grew up, or maybe even for America at
> large. In this case, it's not unusual for you to consider yourself as having
> "no accent", since you sound more or less the same as everyone around
> you. But undoubtedly, there's another English speaker out there who will
> think your accent is peculiar; more likely than not, you'd feel the same
> way about their accent, even though their accent couldn't sound more
> normal to them!

As a result, it should be expected that if participants in the Training group

adequately internalized the accent-related ideology in the Training module, they should

report that they have an accent, even if it is a "neutral" or "standard" accent. Formulated

statistically, a greater proportion of participants in the Training group than in the Bias and

Control groups should respond affirmatively to the question "Do you think you speak

with an accent?"

        To test this hypothesis, all participants' responses to "Do you think you speak

with an accent?" were coded either '0' or '1', corresponding to a reported absence or

presence of accent, respectively. Participants' names and testing groups were hidden

during coding to avoid bias. Although some responses were easy to code (such as "No"),

other responses represented borderline cases. For example, "not really, sometimes I slip

into a combination of Pittsburgh, Baltimore, and southern VA accents" was coded '0',

since the overall impression of the response was "not really." Likewise, "Not really, but I

do tend to speak with a slight African-American southern accent depending on my

diction and the setting/situation I am in" was coded '0', since the qualifications to this

response were presented as anomalous. On the other hand, "yes, Midwestern. I guess I

would describe it as the 'standard' American accent, not southern drawl or something that

would identify me as from a specific city or anything" was coded '1'; although the

participant described her accent as "standard," she acknowledged the presence of an

accent and did not assume that standardness meant non-accentedness. I likewise

interpreted the use of quotation marks in the phrase "typical 'accentless' American" as an

acknowledgement that no speaker is 'accentless' in reality, and so this response was

coded '1'.

        Among the 81 William and Mary undergraduates in the study, 46 (56.79%) self-

identified as having an accent, including 15 out of 28 (53.57%) in the Control group, 9

out of 24 (37.5%) in the Bias group, and 22 out of 29 (75.86%) in the Training group.

Neither the Control nor the Bias group viewed the accent training materials (so for the

purposes of this question they constitute a single non-treatment group), and within these

two groups only 24 out of 52 (46.15%) believed that they spoke with an accent. A 2-

proportion *t*-test comparing these two groups on reported accentedness was significant at

the $\alpha = .05$ significance level ($t(63) = 2.40$, $p = .010$). Thus, the Training module had a

significant effect on the Training group's responses to "Do you think you speak with an

accent?" This result demonstrates that respondents were able to internalize the accent

ideology presented in the Training module.

     5.8.2 Lack of faith in mathematics ability. Several trends apparent in

participants' responses to "Do you have any final questions or comments about this

survey?" on the Questionnaire mirrored themes present in the discussion sessions. One of

these was students' lack of faith in their ability to do higher mathematics (see §5.4.3,

Accent issue exacerbated in mathematics classroom), typified by statements like "I did

really badly on the second work sheet, but this had nothing to do with not understanding

the professor. I am just terrible at math" and "Also, I can't do math to save my life!!!

Therefore, the answers to some are just guesses for some of them." Several participants

expressed concern that their mathematical deficiencies would negatively affect the

experiment's statistics: "I hope my answers aren't skewed just because math is not my

strong suit." An English major remarked on the particular difficulty of mathematics itself:

"I really could understand her accent decently. If she were discussing literature I could

prove it. But I haven't done math since calc three years ago and stats on occasion, which

is a bigger problem." A student with an advanced mathematics background noted, on the

other hand, "I was already pretty familiar with both the proof of the irrationality of sqrt(2)

and the Cartesian product, so I probably could have figured out both assessment worksheets without the lectures."

5.8.3 Helpfulness of lesson animations. As several students commented in the discussion sessions that ITFs compensated for auditory communication issues by using a chalkboard or PowerPoint presentation (see §5.7.3, Importance of written materials), several participants noted on their Questionnaire that the lesson video animations, meant to simulate Prof. Kamala writing on a chalkboard (see §3.4, Lesson Video Animations), had aided their comprehension of the lessons. For example, one pre-medical student wrote, "The teacher was difficult to understand, but what made it relatively moderate was everything was written down on the board or computer." A fair number of students indicated that "If it weren't for the pictures I would be completely lost." Some were even concerned that the assistance that they received from the animations had an unwarranted positive influence on their scores, since "the existence of the slides during the lessons greatly helped my ability to learn the material. The professor's voice was not my primary focus during the lesson. Hopefully, this will not be problematic." A junior suggested, "I think it would be more effective if there were not PowerPoint on showing what the professor was teaching about. Even though I understood most of it, the writing made me stop paying close attention."

5.8.4 Lack of preparedness for assessments. One theme apparent from the responses to "Do you have any final questions or comments about this survey?" did not surface in the discussion sessions. Several participants indicated on the questionnaire that they did not realize that they would be given assessments for each lesson, resulting in inadequate attentiveness or note-taking: "I didn't really know that we would be tested on

the math lecture so I probably would have paid more attention the first time." An

international relations major mentioned that

> The only criticism that I would have would be to tell the subjects beforehand that
>
> there will be a kind of 'examination' -- I didn't pay attention to the first lesson as
>
> much as the second as a result.

Even more drastically, a student complained, "No one told me I'd have to do math during

this experiment. My day has been killed :(."

Despite these comments, the assessments were not given without warning. The

web pages in which the lesson videos were embedded included a header introducing the

video (see Appendix 7 for full text). This header included the statements,

> The William and Mary Math Department is looking to hire a new faculty member,
> and this applicant is one of the department's top choices. In order to make the
> final decision, the department is having students view some of her lessons and
> take short assessments on these lessons.

Although this does not expressly state that the student sitting at the computer

would take an examination on the lesson they were about to view, it was assumed that

students could be reasonably expected to infer this fact. It is possible that more

unambiguous language would have been preferable; I will take greater care to make

directions clear in future experiments.

Chapter 6

Conclusion

It has to be something that both the students and the professors work on...we need

to work together to fill the gap.

If I was having a problem understanding a professor, I would probably do

anything to try to better understand the class.

--Discussion session participants

To recapitulate, this idea for this research topic arose from my personal

experience hearing William and Mary undergraduates' complaints about ITFs, including

those in the Department of Mathematics, as well as a desire to address the issue of this

communication gap. I hypothesized that this gap resulted not only from legitimate

misunderstanding, but also from student bias against ITFs, and that a linguistic training

program designed to address both components of the communication gap could

effectively improve students' comprehension of mathematics lessons taught by an ITF. In

order to test these hypotheses, I conducted a controlled, randomized experiment

involving 81 William and Mary undergraduates. This experiment tested the effects of a

linguistic training program designed around the accent of an ITF whose lectures were

used in the experiment, as well as a simulation of bias creation. I also conducted

discussion sessions involving most of these undergraduates in order to more fully explore

the issues constituting and surrounding the communication gap.

It appears that the linguistic training program was not effective in improving students' comprehension of mathematics lectures taught by an ITF, and it appears that the bias simulation was not effective in worsening students' comprehension of these lectures (see §4.4, Module Groups). This result does not mean, however, that the notion of training students to understand their professors' speech is invalid. Several other factors, such as the stimulus lessons (see §4.5, Lesson Videos), played an unexpectedly large role in affecting students' assessment scores. In a future experiment, I would take greater care to control for these factors. Notwithstanding the difficulties this experiment incurred, there is evidence that the Training module had an effect on students' beliefs about accent, as students absorbed information on language attitudes (see §5.8.1, Participants' accents).

The discussion sessions revealed a rich diversity of themes involving the communication gap. Students discussed several themes of communication breakdown that related to professors in general but ITFs to a greater degree, including in-class questions (§5.6.1). Many issues, on the other hand, such as students' inattentiveness (§5.4.5) and cultural issues (§5.3.3), were attributed to ITFs and their accents. While not all students were affected equally by professors' accents (see §5.4.1, Favorable professor accents; §5.4.7, Innate accent comprehension ability; §5.4.8, Habituation to accents), students as a whole agreed that the communication gap was a major problem. The accounts of these students indicate that this is an area that badly needs continuing research.

This fall, I will begin my studies in the Linguistics Ph.D. program at the University of California, Davis. I plan to take advantage of a strong sociolinguistics program at Davis to pursue further research in language attitudes, a field that informs this

project. The resources of Davis as a large, public university—an environment that more closely mirrors the site of much of the prior ITF research than does William and Mary (§2.9)—will allow me to pursue further research into the communication gap. This future research may include a more long-term, longitudinal approach than this project's testing sessions, which lasted no more than 90 minutes (see §3.10, Testing Sessions). Another possible approach would involve testing a linguistic training program on students in an actual undergraduate mathematics class. In addition to its strength in sociolinguistics, Davis's program includes a focus on second language acquisition and development (SLAD), a field that has obvious consequences for studies involving ITFs (see §2.3, Learning Standard American English). Davis will thus give me the opportunity to investigate the communication gap in new ways.

Regardless of how the communication gap is addressed, it is clear from the responses of participants in the discussion sessions that this is an issue that cannot simply be left alone. Nearly 30 years of research on the communication gap have failed to produce satisfactory progress on this problem, and it is up to linguists and educational researchers alike to continue to generate new ideas and strategies for addressing this problem. Despite the lack of demonstrated effectiveness of the training program used in this experiment, there are indications that students not only internalize linguistic ideology that confronts bias, but are also willing to participate in programs that aid their comprehension of professors. Linguistic training for students, an area of research that is still ripe, may indeed be our most effective strategy for closing the communication gap between undergraduates and mathematics professors.

References

Abrams, G., & Haefner, J. (1998). S.H.O.W.M.E.: Spear-heading online work in mathematics education. *T H E Journal (Technology in Higher Education), 25*(10), 53-55. Available from http://web.ebscohost.com/ehost/detail?vid=4&hid=103&sid=46be5abb-c35e-4726-a7a6-6cfe24de65fd%40sessionmgr4&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=ehh&AN=585942.

Adobe Systems, Incorporated. (n.d.) *Flash Player 10: System Requirements*. Retrieved from http://www.adobe.com/products/flashplayer/systemreqs/

Ashcraft, M. H. (2002). Math Anxiety: Personal, Educational, and Cognitive Consequences. *Current Directions in Psychological Science, 11*, 181-185. Retrieved from http://www.jstor.org/stable/20182804.

Askin, H. (2007). *Language Variation in the Classroom*. Retrieved from http://people.wm.edu/~heaski/index.html.

Bailey, K. (1983). Foreign Teaching Assistants at U.S. Universities: Problems in Interaction and Communication. *TESOL Quarterly, 17*, 308-310. Retrieved from http://www.jstor.org/stable/3586658.

Bailey, K. M. (1984). The "Foreign TA Problem". In K. Bailey, F. Pialorsi, J. Zukowski/Faust (Eds.), *Foreign Teaching Assistants in U.S. Universities* (3-15). Washington: National Association for Foreign Student Affairs.

Bauer, G., & Tanner, M. (Eds.). (1994). *Current Approaches to International TA Preparation in Higher Education: A Collection of Program Descriptions*. Washington, D.C.: Center for Instructional Development and Research.

Berger, M. (2006, March 30). Professor languages a growing concern. *Collegiate Times*. Retrieved from http://collegiatetimes.com/stories/6796.

Best, C. T., McRoberts, G. W., & Goodell, E. (2001). American listeners' perception of non-native consonant contrasts varying in perceptual assimilation to English phonology. Journal of the Acoustical Society of America, 109, 775–794.

Best, C. T., McRoberts, G. W., & Sithole, N. M. (1988). Examination of Perceptual Reorganization for Nonnative Speech Contrasts: Zulu Click Discrimination by English-Speaking Adults and Infants. *Journal of Experimental Psychology: Human Perception and Performance, 14*, 345-360. Retrieved from http://web.ebscohost.com/ehost/detail?vid=2&hid=101&sid=8482ce09-dfc5-448f-8fe3-f072254f2f45%40sessionmgr114&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d

#db=pdh&AN=xhp-14-3-345#db=pdh&AN=xhp-14-3-345#db=pdh&AN=xhp-14-3-345.

Beyeler, P. Media Converter [online utility]. Available from http://www.mediaconverter.org/.

Bloor, M., Frankland, J., Thomas, M., & Robson, K. (2001). *Focus Groups in Social Research*. London: SAGE Publications.

Boersma, P., & Weenink, D. Praat (Version 5.1.10) [software]. Available from http://www.fon.hum.uva.nl/praat/.

Borjas, G. (2000). Foreign-Born Teaching Assistants and the Academic Performance of Undergraduates. *The American Economic Review, 90*, 355-359. Retrieved from http://www.jstor.org/stable/117250.

Briggs, S., & Hofer, B. (1991). Undergraduate Perceptions of ITA Effectiveness. In J. Nyquist, R. Abbott, D. Wulff, & J. Sprague (Eds.), *Preparing the Professoriate of Tomorrow to Teach* (435-445). Dubuque, Iowa: Kendall/Hunt.

Brown, K. A. (1988). *Effects of perceived country of origin, educational status, and native speakerness on American college student attitudes toward non-native instructors*. (Unpublished Ph.D. Dissertation). University of Minnesota, Minneapolis, MN.

Byrd, P., & Constantinides, J. (1992). The Language of Teaching Mathematics: Implications for Training ITAs. *TESOL Quarterly, 26*, 163-167. Retrieved from http://www.jstor.org/stable/3587384.

Capraro, F. P. (2002). *A Journal Study of the Spoken English Learning Experience of Prospective International Teaching Assistants*. Ph.D. Dissertation, The Ohio State University.

Cargile, A.C. (1997). Attitudes toward Chinese-accented speech: an investigation in two contexts. *Journal of Language and Social Psychology, 16*, 434–44.

Cassell, E. C. (2007). *Understanding community linguistic diversity: An ecological approach to examining language use patterns of international graduate students*. Retrieved from Dissertations & Theses: Full Text database. (Publication No. AAT 3287301).

Chambers, J. K. (1992). Dialect Acquisition. *Language, 68*, 673-705. Retrieved from http://www.jstor.org/stable/416850.

Civikly, J., & Muchisky, D. (1991). A collaborative approach to ITA training: The ITAs, faculty, undergraduate interns, and undergraduate students. In J. D. Nyquist, R. D.

Abbott, D. H. Wulff, & J. Sprague (Eds.), *Preparing the Professoriate of Tomorrow to Teach* (382-392). Dubuque, Iowa: Kendall-Hunt.

Clopper, C. J. & Pisoni, D. B. (2004). Homebodies and army brats: Some effects of early linguistic experience and residential history on dialect categorization. *Language Variation and Change, 16*, 31-48. Retrieved from http://journals.cambridge.org/action/displayFulltext?type=1&fid=211031&jid=LVC&volumeId=16&issueId=01&aid=211029.

Croman, J. (2006). Professor sought: Must clearly speak English. *KARE 11 News*. Retrieved from http://www.kare11.com/news/news_article.aspx?storyid=122425.

Crusan-Alviani, D. (1998). Is it Just the Accent? Undergraduates Perceptions of International Teaching Assistants. *The Pennsylvania Speech Communication Annual, 54*, 57-73. Retrieved from http://www.scap.duq.edu/1998.pdf#page=61.

Crystal, D. (2004, November 19). Subcontinent raises its voice: With an English-speaking population now likely to have surpassed that of Britain and the US, India, with its dynamic variety of English, is set to become a linguistic superpower, argues David Crystal. *The Guardian Weekly*. Retrieved from http://www.guardian.co.uk/education/2004/nov/19/tefl.

Damron, J. A. (2000). *Chinese 101, a prerequisite to Math 100? A look at undergraduate students' beliefs about their role in communication with international teaching assistants*. Retrieved from Dissertations & Theses: Full Text. (Publication No. AAT 3018186).

Davies, C. E., Tyler, A., & Koran, J. J., Jr. (1989). Face-to-Face with English Speakers: An Advanced Training Class for International Teaching Assistants. *English for Specific Purposes, 8*, 139-153.

DB Net Solutions. (n.d.) *The Benefits of Web Based Applications and Systems*. Retrieved from http://www.dbnetsolutions.co.uk/Articles/BenefitsOfWebBasedApplications.aspx.

Dean of Students. (2010a). *So what is Orientation?* Retrieved from http://www.wm.edu/offices/deanofstudents/services/orientation/about/index.php.

Dean of Students. (2010b). *After Orientation*. Retrieved from http://www.wm.edu/offices/deanofstudents/services/orientation/afterorient/index.php.

DePalma, A. (1990, November 29). Graduate Schools Fill With Foreigners: Apathy and Inability of Americans Opens Doors to Others Foreigners Flooding Colleges in U.S. *The New York Times*. Retrieved from http://proquest.umi.com/pqdweb?index=0&did=115682247&SrchMode=1&sid=1

&Fmt=10&VInst=PROD&VType=PQD&RQT=309&VName=HNP&TS=12646
41678&clientId=2281.

Department of Mathematics. (n.d.) *Planning Your Major*. Retrieved from
http://www.wm.edu/as/mathematics/undergrad/major/planmajor/index.php.

Derwing, T. M., Rossiter, M. J., & Munro, M. J. (2002). Teaching Native Speakers to
Listen to Foreign-accented Speech. *Journal of Multilingual and Multicultural
Development, 23*, 245-259.

Discrimination. (2010). In Merriam-Webster Online Dictionary. Retrieved February 2,
2010, from http://www.merriam-webster.com/dictionary/discrimination.

DVD VideoSoft. (2009). Free Video to Flash Converter (Version 4.1.3.52) [software].
Available from http://dvdvideosoft.com/.

Finder, A. (2005, June 24). Unclear on American Campus: What the Foreign Teacher
Said. *The New York Times*. Retrieved from
http://proquest.umi.com/pqdweb?index=22&did=1174136532&SrchMode=1&sid
=1&Fmt=10&VInst=PROD&VType=PQD&RQT=309&VName=HNP&TS=126
6082857&clientId=2281.

Flege, J. E. (1980). Phonetic Approximation in Second-Language Acquisition. *Language
Learning, 30*, 116-134.

Flege, J. E. (1984). The detection of French accent by American listeners. *The Journal of
the Acoustical Society of America, 76*, 692-707. Retrieved from
http://scitation.aip.org/getpdf/servlet/GetPDFServlet?filetype=pdf&id=JASMAN
000076000003000692000001&idtype=cvips&prog=normal.

Gandelsman, M. (1999, November 29). Language barrier. *The Daily Nebraskan*.
Retrieved from http://www.dailynebraskan.com/opinion/language-barrier-
1.1029408.

Gass, S. M., & Selinker, L. (2001). *Second Language Acquisition: An Introductory
Course* (2nd ed.). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Gass, S., & Varonis, E. (1984). The effect of familiarity on the comprehensibility of
nonnative speech. *Language learning, 34*, 65-89.

George Mason University. (2010). *Speech Accent Archive*. Retrieved from
http://accent.gmu.edu/.

Gorsuch, G. (2003). The Educational Cultures of International Teaching Assistants and
U.S. Universities. *Teaching English as a Second or Foreign Language, 7*, A-1.

Gorsuch, G. J. (2006). Discipline-specific practica for international teaching assistants. *English for Specific Purposes, 25*, 90-108. Retrieved from http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6VDM-4H9YC4P-2-1&_cdi=5986&_user=650606&_orig=browse&_coverDate=12%2F31%2F2006&_sk=999749998&view=c&wchp=dGLzVtb-zSkzV&md5=0b468556df17e11a969edc5028ca893b&ie=/sdarticle.pdf.

Gourlay, B. E. (2008). *An Investigation of Communication Patterns and Strategies between International Teaching Assistants and Undergraduate Students in University-level Science Labs* (Ph.D. dissertation, University of Rhode Island and Rhode Island College). Retrieved from http://digitalcommons.ric.edu/cgi/viewcontent.cgi?article=1011&context=etd.

Gravois, J. (2005, April 8). Teach Impediment. *Chronicle of Higher Education, 51*, A10. Retrieved from http://chronicle.com/free/v51/i31/31a01001.htm.

Halleck, G. B., & Moder, C. L. (1995). Testing Language and Teaching Skills of International Teaching Assistants: The Limits of Compensatory Strategies. *TESOL Quarterly, 29*, 733-758.

He, D., & Li, D. C. S. (2009). Language attitudes and linguistic features in the 'China English' debate. *World Englishes, 28*, 70–89. Retrieved from http://www3.interscience.wiley.com/cgi-bin/fulltext/122200088/PDFSTART.

Hechinger, F. M. (1981, September 22). About Education: The Science Age Is Turning Darker. *The New York Times*. Retrieved from http://proquest.umi.com/pqdweb?index=33&did=112085410&SrchMode=1&sid=4&Fmt=10&VInst=PROD&VType=PQD&RQT=309&VName=HNP&TS=1264281719&clientId=2281.

Heller, S. (1987, July 15). Fewer and Fewer Americans Take Graduate Work in Mathematics; Peril to Nation's Prosperity Seen. *Chronicle of Higher Education, 33*, 11-12.

Hoekje, B., & Williams, J. (1992). Communicative Competence and the Dilemma of International Teaching Assistant Education. *TESOL Quarterly, 26*, 243-269. Retrieved from http://www.jstor.org/stable/3587005.

Hohenthal, A. (2003). English in India: Loyalty and Attitudes. *Language in India, 3*(May). Retrieved from http://www.languageinindia.com/may2003/annika.html.

iSpring Solutions. SlideBoom [online utility]. Available from http://www.slideboom.com/.

Johnson, D. (1987, November 8). America's New Brain Gain. *The New York Times*. Retrieved from http://proquest.umi.com/pqdweb?index=39&did=115690767&SrchMode=1&sid= 2&Fmt=10&VInst=PROD&VType=PQD&RQT=309&VName=HNP&TS=1264 392410&clientId=2281.

Jones, K. W. (2001). *Accent on Privilege: English Identities and Anglophilia in the U.S.* Philadelphia: Temple University Press.

Kuhl, P. K., Williams, K. A., Lacerda, F., Stevens, K. N., & Lindblom, B. (1992). *Science, 255*, 606-608. Retrieved from http://pages.pomona.edu/~rt004747/lgcs11read/KuhlEA92.pdf.

King, K. (1998). Mandating English Proficiency for College Instructors: States' Responses to the TA Problem. *Vanderbilt Journal of Transnational Law, 31*, 203-256. Retrieved from http://heinonline.org/HOL/PDF?handle=hein.journals/vantl31&collection=journal s&id=217&print=54&sectioncount=1&ext=.pdf.

Krashen, S. D., Long, M. A., & Scarcella, R. C. (1979). Age, Rate and Eventual Attainment in Second Language Acquisition. *TESOL Quarterly, 13*, 573-582. Retrieved from http://www.jstor.org/stable/3586451.

Lindemann, S. (2003). Koreans, Chinese or Indians? Attitude and ideologies about non-native English speakers in the United States. *Journal of Sociolinguistics, 7*, 348-364. Retrieved from http://www3.interscience.wiley.com/cgi-bin/fulltext/118896184/PDFSTART.

Lindemann, S. (2005). Who speaks "broken English"? US undergraduates' perceptions of non-native English. *International Journal of Applied Linguistics, 15*, 188-212. Retrieved from http://www3.interscience.wiley.com/cgi-bin/fulltext/118656749/PDFSTART.

Linguistic Society of America (n.d.) *LSA: Linguistics Programs*. Retrieved from http://lsadc.org/programs/browse-programs.cfm.

Lippi-Green, R. (1997). *English with an Accent*. New York: Routledge.

Mathematics Department. (2008a). *4b.1 Undergraduate advising in the mathematics department*. Retrieved from http://web.wm.edu/wmoa/ProgramReview/MATH4b_Priorities.pdf.

Mathematics Department. (2008b). *5c. Contributions to the University Mission: General Education*. Retrieved from http://web.wm.edu/wmoa/ProgramReview/MATH5c_GeneralEducation.pdf.

Mathematics Education. (n.d.) Retrieved September 29, 2009, from Wikipedia: http://en.wikipedia.org/wiki/Math_education.

Mathews, J. T. (1981, October 13). Decline in Education: (I) The Evidence. *The Washington Post*. Retrieved from http://proquest.umi.com/pqdweb?index=16&did=142849722&SrchMode=1&sid= 2&Fmt=12&VInst=PROD&VType=PQD&RQT=309&VName=HNP&TS=1264 358672&clientId=2281.

Matsuda, M. J. (1991). Voices of America: Accent, Antidiscrimination Law, and a Jurisprudence for the Last Reconstruction. *The Yale Law Journal, 100*, 1329-1407. Retrieved from http://www.jstor.org/stable/796694.

McClain, J. (2007, September 1). NSF grant supports computational math initiative. Message posted to http://www.wm.edu/news/ideation/current/index.php.

Miyawaki, K., Strange, W., Verbrugge, R.R., Liberman, A.M., Jenkins, J.J., & Fujimura, O. (1975). An effect of linguistic experience: the discrimination of [r] and [l] by native speakers of Japanese and English. *Perception and Psychophysics, 18*, 331–340.

Mooney, C. J. (1989, January 25). Uncertainty is Rampant as Colleges Begin to Brace for Faculty Shortage Expected to Begin in 1990's. *Chronicle of Higher Education*, A14-A17.

Moyer, A. (1999). Ultimate attainment in L2 phonology. *Studies in Second Language Acquisition, 21*, 81-108. Retrieved from http://journals.cambridge.org/action/displayFulltext?type=1&fid=36620&jid=SL A&volumeId=21&issueId=01&aid=36619.

Munro, M. J., Derwing, T. M., & Flege, J. E. (1999). Canadians in Alabama: a perceptual study of dialect acquisition in adults. *Journal of Phonetics, 27*, 385-403.

Nelson, G. R. (1992). The relationship between the use of personal, cultural examples in international teaching assistants' lectures and uncertainty reduction, student attitude, student recall, and ethnocentrism [Abstract]. *International Journal of Intercultural Relations, 16*, 33-52. Retrieved from http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V7R-4697NF8-S&_user=650606&_coverDate=03%2F31%2F1992&_rdoc=1&_fmt=high&_orig =search&_sort=d&_docanchor=&view=c&_searchStrId=1181014667&_rerunOri gin=scholar.google&_acct=C000035099&_version=1&_urlVersion=0&_userid= 650606&md5=6c43c3d8549d4edcecf24a56dfc1c31d.

Niedzielski, N.A. (1997) *The effect of social information on the phonetic perception of sociolinguistic variables*. (PhD Dissertation). UC Santa Barbara.

NPTel Video Course. (n.d.) Retrieved from
        http://www.nptel.iitm.ac.in/video.php?courseId=1003.

Office of Institutional Analysis and Effectiveness (2008). *2008-2009 Common Data Set*
        [Excel spreadsheet]. Retrieved from http://web.wm.edu/ir/CDS/cds0809.xls.

Office of Institutional Analysis and Effectiveness (2009). *2009-2010 Common Data Set*
        [Excel spreadsheet]. Retrieved from http://web.wm.edu/ir/CDS/cds0910.xls.

Plakans, B. (1997). Undergraduates' Experiences with and Attitudes toward International
        Teaching Assistants. *TESOL Quarterly, 31*, 95-119. Retrieved from
        http://www.jstor.org/stable/3587976.

Port, R. (2005, April 5). Addressing the Professor Accent Problem. Message posted to
        http://sayanythingblog.com/.

Purnell, T., Idsardi, W., and Baugh, J. (1999). Perceptual and Phonetic Experiments on
        American English Dialect Identification. *Journal of Language and Social
        Psychology, 18*, 10-30. Retrieved from
        http://www.ling.udel.edu/idsardi/work/1999jlsp.pdf.

RateMyProfessors.com. (2009). ***** ******* *– University of Texas at San Antonio*.
        Retrieved from
        http://www.ratemyprofessors.com/ShowRatings.jsp?tid=449115&page=1.

Rosenthal, M. S. (1974). The Magic Boxes: Pre-School Children's Attitudes Toward
        Black and Standard English. *The Florida FL Reporter, 12*, 55–93. Retrieved from
        http://www.stanford.edu/~eckert/PDF/rosenthal1974.pdf.

Rounds, P. L. (1987) Characterizing successful classroom discourse for NNS teaching
        assistant training. *TESOL Quarterly, 21*, 643-671. Retrieved from
        http://www.jstor.org/stable/3586987.

Rubin, D. L. (1992). Nonlanguage factors affecting undergraduates' judgments of
        nonnative English-speaking teaching assistants [abstract]. *Research in Higher
        Education, 33*(4). Retrieved from
        http://www.springerlink.com/content/w61u8661503000ww/.

Rubin, D. L. (2005, April 7). [message posted to moderated chat]. Retrieved from
        http://chronicle.com/colloquy/2005/04/english/.

Rubin, D. L., Ainsworth, S., Cho, E., Turk, D., & Winn, L. (1999). Are Greek Letter
        Social Organizations a Factor in Undergraduates' Perceptions of International
        Instructors? *International Journal of Intercultural Relations*. Retrieved April 27,
        2009, from

http://www.sciencedirect.com/science?_ob=MImg&_imagekey=B6V7R-
3VV0CTY-1-
1&_cdi=5849&_user=650606&_orig=search&_coverDate=02%2F01%2F1999&
_sk=999769998&view=c&wchp=dGLbVlW-
zSkWz&md5=02d04ddeb12517cab67b403b77f9340e&ie=/sdarticle.pdf.

Rubin, D. L., & Smith, K. A. (1990). Effects of Accent, Ethnicity, and Lecture Topic on
Undergraduates' Perceptions of Nonnative English-Speaking Teaching Assistants.
International Journal of Intercultural Relations, 14(3), 337-353. Retrieved from
http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V7R-
469PK1T-
V&_user=650606&_coverDate=12%2F31%2F1990&_rdoc=5&_fmt=high&_orig
=browse&_srch=doc-
info(%23toc%235849%231990%23999859996%23326808%23FLP%23display%
23Volume)&_cdi=5849&_sort=d&_docanchor=&_ct=10&_acct=C000035099&_
version=1&_urlVersion=0&_userid=650606&md5=8e90863cccd8c971dbb3dd2e
49f762a6.

Ryan, B. (2007). Minitab [statistical analysis software]. State College, Pennsylvania:
Minitab Inc.

Sarl, A. (2009). Video DownloadHelper (Version 4.6.4) [Firefox add-on]. Available from
http://downloadhelper.net.

Smith, R. M., Byrd, P., Nelson, G. L., Barrett, R. P., & Constantinides, J. C. (1992).
*Crossing Pedagogical Oceans: International Teaching Assistants in U.S.
Undergraduate Education*. Washington, D. C.: The George Washington
University, School of Education and Human Development.

Stewart, J. (1998). *Calculus: Concepts and Contexts, Single Variable*. Pacific Grove,
California: Brooks/Cole.

Streissguth, T. (2007). *The Roaring Twenties, Revised Edition*. New York: Facts on File.

Students say they might record teachers who speak poor English. (1987, June 19). *The St.
Petersburg Times*. Retrieved from
http://pqasb.pqarchiver.com/sptimes/access/50034383.html?dids=50034383:5003
4383&FMT=ABS&FMTS=ABS:FT&type=current&date=Jun+19%2C+1987&au
thor=&pub=St.+Petersburg+Times&edition=&startpage=8.B&desc=Students+say
+they+might+record+teachers+who+speak+poor+English.

Thomas, M. (2007, May 1). International teachers are benefit to campus. *The Dakota
Student*. Retrieved from
http://media.www.dakotastudent.com/media/storage/paper970/news/2007/05/01/
News/International.Teachers.Are.Benefit.To.Campus-2890142.shtml

Thompson, I. (1991). Foreign Accents Revisited: The English Pronunciation of Russian Immigrants [Abstract]. *Language Learning, 41*, 177-204.

Tserdanelis, G., & Wong, W. Y. P. (Eds.). (2004). *Language Files: Materials for an Introduction to Language & Linguistics* (9th ed.). Columbus, OH: The Ohio State University Press.

Twale, D. J., Shannon, D. M., & Moore, M. S. (1997). NGTA and IGTA Training and Experience: Comparisons Between Self-Ratings and Undergraduate Student Evaluations. *Innovative Higher Education, 22*, 61-77. Retrieved from http://web.ebscohost.com/ehost/pdf?vid=3&hid=4&sid=7a99fac8-6ef7-425a-8f53-a9c62f9e344d%40sessionmgr9.

Tyler, A. (1992). Discourse Structure and the Perception of Incoherence in International Teaching Assistants' Spoken Discourse. *TESOL Quarterly, 26*, 713-726. Retrieved from http://www.jstor.org/stable/3586870.

Tyler, A. (1995). The Coconstruction of Cross-Cultural Miscommunication. *Studies in Second-Language Acquisition, 17*, 129-152.

United States Census Bureau. (n.d.) *Census Regions and Divisions of the United States* [PDF document]. Retrieved from http://www.census.gov/geo/www/us_regdiv.pdf.

United States Census Bureau. (n.d.) *Historical National Population Estimates: July 1, 1900 to July 1, 1999* [Data file]. Retrieved from http://www.census.gov/popest/archives/1990s/popclockest.txt.

Watts, M., & Lynch, G. (1989). The Principles Course Revisited. *The American Economic Review, 79*, 236-241. Retrieved from http://www.jstor.org/stable/1827763.

Wiehl, L. (2002). "Sounding Black" in the Courtroom: State-Sanctioned Racial Stereotyping. *The Harvard Blackletter Law Journal, 18*, 185-210. Retrieved from http://heinonline.org/HOL/Page?handle=hein.journals/hblj18&div=8&g_sent=1&collection=journals.

Williams, F. (1973). Some Research Notes on Dialect Attitudes and Stereotypes. In R. W. Shuy & R. W. Fasold (Eds.), *Language Attitudes: Current Trends and Prospects* (113-128). Washington, D. C.: Georgetown University Press.

Yahalom, T. (2006, April 19). Hard to decipher your TA's English?. *The Daily Pennsylvanian*. Retrieved from http://media.www.dailypennsylvanian.com/media/storage/paper882/news/2006/04/19/News/Hard-To.Decipher.Your.Tas.English-2144640.shtml.

Young, R. (1989). Introduction. *English for Specific Purposes, 8*, 101-107.

Zeldin, I., & Hassel, K. (1976, November 12). Foreign TAs: Student learning enhanced despite language problems. *The Lantern*. Retrieved from http://digital.olivesoftware.com/Default/Scripting/ArticleWin.asp?From=Archive &Source=Page&Skin=Ohio&BaseHref=OHI/1976/11/12&PageLabelPrint=1&En tityId=Ar00102&ViewMode=HTML.

Zhou, J. (2009). What Is Missing in the International Teaching Assistants Training Curriculum? *The Journal of Faculty Development, 23(2)*, 19-24.

Zielinski, B. W. (2007). The listener: No longer the silent partner in reduced intelligibility. *System, 36*, 69–84. Retrieved from http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VCH-4RTCV67-1&_user=650606&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&view =c&_rerunOrigin=scholar.google&_acct=C000035099&_version=1&_urlVersion =0&_userid=650606&md5=b4e838383f5795652e19226908e2ea1a.

Appendices

Note: Several of these appendices are drawn from Internet pages, in which case the formatting and page layout displayed here will be slightly different than those of the actual pages. Background graphics are omitted entirely. The text, however, is preserved exactly.

Appendix 1: Lesson Audio Files

Following are transcriptions of the files that served as the audio on which the three lesson videos were based. All audio files were drawn from videos of lectures in the Discrete Structures course on the National Programme on Technology Enhanced Learning website, taught by Prof. Kamala Krithivasan (http://www.nptel.iitm.ac.in/video.php?courseId=1003). This is not a phonetic transcription, so even words for which Prof. Kamala had non-Standard American English (SAE) pronunciations are transcribed with SAE spellings. In addition, the following conventions are used:

Symbol	Meaning
—	Stutter/disfluency, often accompanied by a glottal stop
[N]	Pause of N seconds (only pauses for $N \geq 1.0$ are notated)
{N}	Pause of N seconds occurring as Prof. Kamala is writing on the board
(?)	Uncertain transcription
uh, um, etc.	Pitched, schwa-like disfluencies (similar to "um," etc. in SAE)

Permutations and Combinations
Source: Lecture 28

PermComb_Intro.wav
(:00)   Today, we shall see permutations and combinations. What do you mean by combination? It is the ways of selecting—eh, some objects out of some
(:10)   objects. Suppose you are having n objects, you want to select r objects out of it: it is a selection. This is called combination.
(:20)   And the number of ways of arranging r objects out of n objects, that is called arrangement or, permutation. And, we shall,
(:30)   uh, see some formulae, and we shall also s-what quite a few (?) examples [1.0] regarding this.
Duration: 37.707 seconds

PermComb_Rules_Intro.wav
(:00)   Generally, we have two rules. One is the rule of product [1.3], and another is the rule of sum [1.2], to at—attack

(:10)   problems based on permutations and combinations. [1.0] The
Duration: 15.000 seconds

PermComb_Rule_Prod.wav
(:00)   Rule of products is that [1.5] if one event can occur in m ways, and, another event
          can occur in n ways,
(:10)   then, there are m into n ways in which these two events can occur. [1.1] This is
          known as the rule of product; we'll be using both these rules
(:20)   frequently.
Duration: 21.000 seconds

PermComb_Rule_Sum.wav
(:00)   The rule of sums is, if one event can occur in m ways, and another event can
          occur in n ways, there are
(:10)   m plus uhh n ways in which one of these two events can occur.
Duration: 14.606 seconds

PermComb_Books_1.wav
(:00)   Let us take a simple problem and see [2.0] how we, errm, tackle the problem.
Duration: 7.563 seconds

PermComb_Books_2.wav
(:00)   The problem is, in how many ways can you choose two books of different
          languages, among five books in Latin,
(:10)   seven books in Greek, and ten books in French?
Duration: 14.302 seconds

PermComb_Books_3.wav
(:00)   So you are having {2.4} Latin, {1.7} Greek, {1.9} French {2.9}.
(:10)   How many books do you have in, uhhh, L—Latin? Five books in Latin {1.4},
          seven books in Greek, and {1.1}
(:20)   ten books in French.
Duration: 21.805 seconds

PermComb_Books_4.wav
(:00)   And, you are asked to select two books of different languages.
Duration: 5.415 seconds

PermComb_Books_5.wav
(:00)   So you can choose this way: you can choose one book from Latin, one f—book
          from Greek. Or you can choose one book from Latin, one book from French.
(:10)   Or you can choose one book from Greek, and one book from French. Suppose
          you choose from Latin and Greek, [1.3] one book from this, one book from
(:20)   this. In how many ways can you choose a book from Latin—out of the five books,
          you can choose one in five ways. [2.4] And in, uhhhh,

(:30) (sigh) [1.1] uh—Greek, [1.8], out of the seven books, you can choose one book in seven ways. So five into seven: there are thirty-

(:40) five ways of selecting one book in Latin and one book in Greek. This is the rule of product we are w—making use of. Then in how many ways can you choose a book from

(:50) Latin and one book from French? One book from Latin and one book from French? [1.0] In-[1.1] you can choose one book from Latin in five ways.

(1:00) And if…you can choose one fuh—from the set of French books in ten different ways. So totally, in fifty different ways you can

(1:10) select a book from Latin, and a book in French. [1.5] Again, you are making use of the rule of product. Now suppose you are choosing a

(1:20) book in Greek, and you are choosing a [2.7] book in French. In how many ways can you choose a book in Greek? You

(1:30) can choose a book in Greek in seven different ways, and you can you—choose a b—book in French in ten different ways. So [1.4] in

(1:40) seventy different ways, you can choose a book from Greek and a book from French. [2.2] So the—we are uh, making use of the rule of product, now we'll make use of

(1:50) the rule of sum. So you can either choose [2.2] a book from Latin and Greek, a book from Greek, a l—book from Latin and a book

(2:00) from French, or a book from Greek and a [1.3] book from French. So, in how many ways can you choose [1.5]

(2:10) books of different, uhh, from different languages? That means you have to add this, this the rule of sum, so you'll get five, uhh [2.1]

(2:20) one-fifty-five {1.8}. In one-fifty-five different ways, you can select [1.7] two books of different languages,

(2:30) among five books in Latin, seven books in Greek, and ten books in French. So we have seen how to make use of the rule of product, and rule of

(2:40) sum.

Duration: 2 minutes, 40.856 seconds

Total audio duration: 4 minutes, 58. 253 seconds[36]

The Proof that the Square Root of 2 is Irrational
Source: Lecture 7

PfbyCont_Intro.wav
(:00) Proof by contradiction. {1.2} Proof {1.0} by {1.0} contradiction. {5.8}
(:10) Or reductio {3.0} ad absurdum.
Duration: 16.472 seconds

PfbyCont_1.wav

---

[36] Note that because of transitions between slides, this is shorter than the actual lesson duration of 5 minutes, 10 seconds.

(:00)   A contradiction is a propositional form which is always false. Something like P and not-P. {1.5}
(:10)   This will always be false, okay? [1.0] So, in this type of proof, [1.0] supposing you want to prove some statement P.
Duration: 20.000 seconds

PfbyCont_2.wav
(:00)   You want to prove {2.3} some statement P. {2.1} Then, you assume that
(:10)   {7.7} P is not true. [1.9]
(:20)   Then from this, by some argument, you arrive at a contradiction, something like that Q and not-Q. You arrive at a contradiction: [2.1]
(:30)   Q and not-Q. That is, assuming P is not true or assuming not P, you arrive at a statement of the form Q and not-Q. That means your
(:40)   assumption is not correct, that is, not-P is not true, that is, P is true. This sort of a argument is called
(:50)   proof by contradiction.
Duration: 52.055 seconds

Root2_1_1.wav
(:00)   Let us take an example {3.1}. Root-2 is {1.0}not {1.0} a rational
(:10)   number. {8.3} We want to prove that root
(:20)   2 is not a rational number. This is statement P. [1.8] So you assume not-P. [2.0] What is not-P?
(:30)   {1.0} Not-P is root-2 {1.3} is a rational number. {16.4}
(:40)   (Still writing on board)
(:50)   Now from this, [1.9] y-you show that not-P implies another
(1:00) statement Q, {1.2} where Q {1.9} denotes {1.4} root-2 is {1.2} p by q[37], {1.7}
(1:10) where p and q {1.4} are integers, {2.3} and e—and also relatively prime. {1.5}
(1:20) Relatively {2.1} prime. What do you mean by relatively prime? p and q do not have common
(1:30) factor. [1.0] So you assume that root-2 [1.1] is equal to p by q, where p and q do not have any common
(1:40) factor. [3.9] So if root-2 is a rational number, obviously it can be written in the form of an
(1:50) integer by an integer, and so you get this statement: not-P implies Q. [4.0] So [1.2]
(2:00) what do you get? [1.8] You get
Duration: 2 minutes, 4.562 seconds

Root2_1_2.wav
(:00)   uh root-2 is equal to p by q, now squaring, you'll get 2 is equal to {1.2} p by—p squared by q squared, {1.2}
(:10)   or {1.8} p squared equal to q square. {1.4} Two q square. [2.0]
(:20)   So p squared is even, {1.0} p squared is even, {1.3} which would mean {1.3} p is even. {4.8}

---

[37] In Prof. Kamala's dialect, this apparently is short for "p divided by q".

(:30)   Right?
Duration: 33.679 seconds

Root2_1_3.wav
(:00)   {1.9} So p is even means p you can write as {1.0} two r [2.8]. So [1.5]
(:10)   what do you get? [3.7] two r the whole squared is equal to two q squared. {2.3}
(:20)   Or four r squared equal to two q squared, or q squared equal to two r squared, which would mean
(:30)   q is even. Q squared is even, so q is even, [1.0] so, [1.0] q is of the form two of s.
(:40)   [2.0] So p is of the form two of r, and q is of the form two of s, where r and s belong to a set of
(:50)   integers. [2.1] That means p and q have a common factor, 2, and not relatively prime. [1.2]
(1:00) Okay? [1.7] So [2.4], from this, actually starting with Q, [2.7]
(1:10) Q is, root-2 can be expressed in the form p by q, where p and q are integers and relatively prime, from this, you come to the conclusion
(1:20) that {1.9} not-Q. [1.2] That is, you don't express root-2 as p and q, where they do
(1:30) not have a common factor. They have a common factor; you come to the conclusion that, if you assume like that, you'll come to the conclusion that they have a common factor, and not relatively
(1:40) prime. [1.2]
Duration: 1 minute, 41.795 seconds

Root2_3.wav
(:00)   And this is a contradiction. {1.0} This is {1.3} a contradiction. {8.2}
(:10)   Usually, you denote it like this: {1.5} contradiction, you use this symbol to
(:20)   show that you have arrived at a contradiction. So assuming not-P, you have arrived at a contradiction, so, the assumption is wrong, or false,
(:30)   not-P is false, so P is true.
Duration: 33.000 seconds

Total audio duration: 6 minutes, 21.563 seconds

Relations and the Cartesian Product
Source: Lecture 13

Relations_Intro.wav
(:00)   What is a relation? [1.2] In ordinary [1.1], uh, English and in ordinary life, you talk about relationships. [1.4] See, you c—you
(:10)   have a collection of boxes, [1.1] and you say that one box is heavier than the other. That is a relationship among the boxes.
(:20)   And among human beings, you say that one man is more intelligent than the other man. That is another relationship between men, the
(:30)   human beings. [1.2] But you may also have a relationship between different sets: [1.0] X lives in the city Y. {2.5}

(:40) You can have something like this: X lives {1.0} in city Y, {2.0} or

(:50) X was {1.0} born {1.7} in city {1.0} Y {1.3}

(1:00) in the year {3.0} Z^{38} {1.9}. So this brings out the relationship between [1.7]

(1:10) different sets: X is a human being, Y is a city, and Z is a year. So you can talk about relationship between

(1:20) different sets.

Duration: 1 minute, 21.163 seconds

Relations_ntuple.wav

(:00) Now, let us start with the definition of an ordered n-tuple, and what is a relation, inner relation, and so on. For n greater than 0, an

(:10) ordered n-tuple, or simply n-tuple, with i^{th} component a-i^{39}, is a sequence of n objects denoted by

(:20) a-1 comma a-2 comma a-3 comma a-n. [1.3] Two ordered n-tuples are equal if and only if their i^{th} components

(:30) are equal for all i.

Duration: 33.674 seconds

Relations_Order.wav

(:00) When you say ordered tuple, the order is very important. For example, consider the relation "less," and consider the ordered pair

(:10) {1.2} three-seven. {1.1} This would mean three is uh—less than seven. If you change the order and write it as seven-three, this would mean

(:20) seven is less than three, and this is true, while this is false. So, the order is very important. [1.0]

(:30) And similarly, when you say X lives in s—city Y, or X was born in the city Y in the year Z, you represent it as a tuple: X,

(:40) Y, Z. That means X was bor—uhh, i—in the city Y in the year Z. X represents a human being, Y represents a city,

(:50) Z represents a year.

Duration: 52.498 seconds

Relations_Cartesian_1.wav

(:00) Now, before going further into the ordered tuple, let us consider the Carte—what is meant by Cartesian product. [1.4] Let A-1, A-2, A-

(:10) 3, A-n [1.1] be an indexed collection of sets with indices from 1 to n, where n greater than zero. [1.0]

(:20) The Cartesian product, or cross product of the sets A-1 through A-n is denoted A-1 cross A-2 cross A-3 et cetera A-n,

(:30) or, [] X i is equal to 1 to n A-i. [1.6] It represents the set of ordered n-tuples

Duration: 39.000 seconds

Relations_Cartesian_2.wav

---

[38] Prof. Kamala pronounces "Z" in the British style: [zɛd]

[39] That is, a$_i$

(:00) So if you, uhh, [1.4] represent the Cartesian product, it is A-1, A-2, {1.3} A-n {2.1}, or you represent

(:10) it as X i is equal to 1 to n {1.8} A-i {1.2}, in the case of—the set of [1.0], uhh, this X was born in city

(:20) Y in the year Z, {1.0} you can represent it as A cross B cross C, {1.8} A will represent human beings—

(:30) set of human beings, {2.5} B will represent cities, {1.3} C represents {1.1} years.

Duration: 30.460 seconds

Relations_Presquares.wav

(:00) Now, here again the order is very important. [3.1] Let us take some example, {1.2} and consider what is meant by

(:10) this.

Duration: 10.266 seconds

Relations_squares.wav

(:00) Suppose {4.3} you have A cross B, {1.6} where A is the set of real

(:10) numbers, set of {1.7} real numbers {2.4} between {4.2}

(:20) one. That is, x belongs to A means it is a real number between zero and one, and [1.1] y {1.0}

(:30) is a real number between one and two. [1.8] y belongs to B. {2.3} Both are real numbers.

(:40) [1.0] So A sep—represent the set of real numbers between zero and one, B represent the set of real numbers between one and two. What does

(:50) {1.2} A cross B represent? {3.5} x varies from zero to one, {4.0}

(1:00) and y varies from {1.8} one to two. [1.4] So it'll represent {2.8}

(1:10) the set of points {1.2} in the square. {2.4} Now suppose I consider {1.6} B

(1:20) cross A. {2.7} Then, it represents orde—ordered pairs {1.8} y, x {5.1}

(1:30) Now, th—interchanging the order, {1.7} the first component varies between x and—

(1:40) one and two [1.0], and the second component varies b—between zero and one, so it'll represent the set of points {2.1} in this

(1:50) square. So the set represented are different, they are not the same, so here the order is important, A cross

(2:00) B is different from bree ca—bree—cross A.

Duration: 2 minutes, 4.249 seconds

Total audio duration: 6 minutes, 20.310 seconds

Appendix 2: Lesson Videos

Three lesson videos were created as stimulus materials, with animations synchronized with the audio from Prof. Kamala's Discrete Structures course (http://www.nptel.iitm.ac.in/video.php?courseId=1003). These lesson videos were created with Microsoft PowerPoint, and as a result, it is possible to represent them in a slide-by-slide format. Most of the text on the slides was divided into blocks of several characters, and each block was hidden by a black rectangle animated to disappear when Prof. Kamala articulated the block of text, giving the illusion of the (white) text appearing on the black background. The black rectangles are represented by teal outlines (gray in a printed version); any text within these outlines was initially hidden when the slide appeared on the screen.

In addition, each video included at least two object animations other than the object appearing (for example, a block of text moving or a line appearing from left to right). These animations are indicated by small teal arrows (gray in a printed version). Several slides had opening animations (mostly Fade Through Black); other slides had audio files that began to play automatically at the beginning of each slide. Finally, all slides were timed to advance after a specified duration.

Permutations and Combinations

1

Fade Through Black
2s

2

Permutations and Combinations

Fade Through Black
0s

3

Permutations and Combinations

- **Selection — Combination**

- **Arrangement — Permutation**
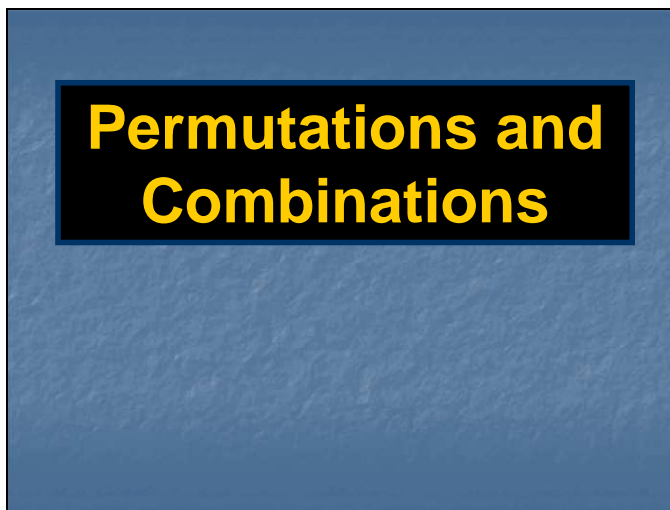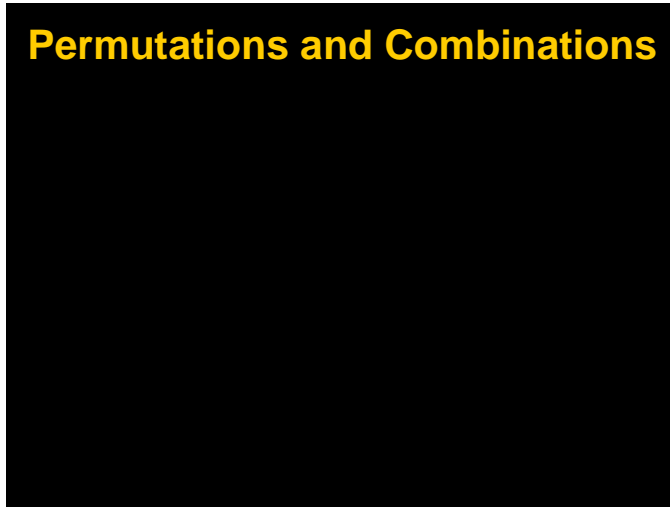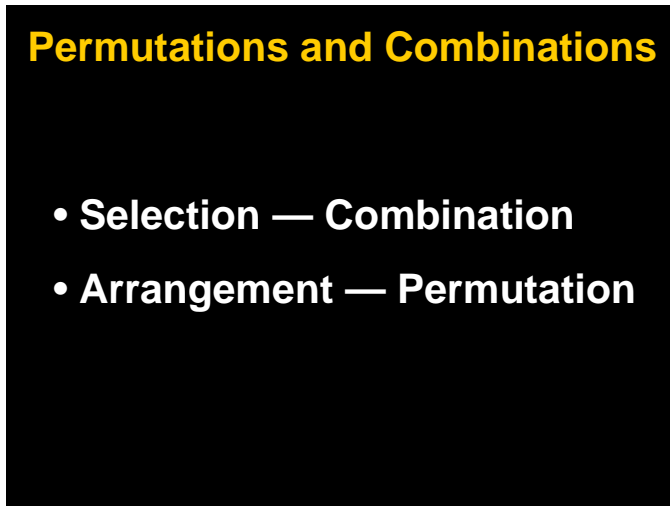
PermComb_Intro.wav
37.7s

4

Permutations and Combinations
Rules

1. *Rule of Product*
2. *Rule of Sum*
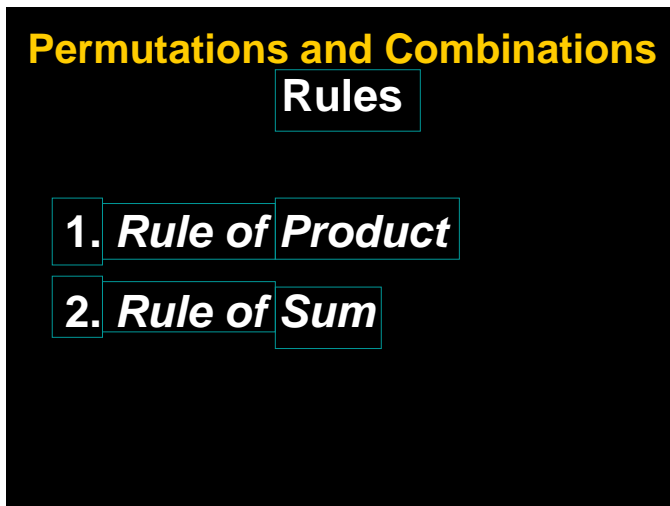
PermComb_Rules_Intro.wav
15s

5

Permutations and Combinations
Rules

Rule of Product: If one event can occur in *m* ways and another event can occur in *n* ways, then there are *m* × *n* ways in which these two events can occur.

PermComb_Rule_Prod.wav
23s

6

Permutations and Combinations
Rules

Rule of Sum: If one event can occur in *m* ways and another event can occur in *n* ways, there are *m* + *n* ways in which one of these two events can occur.

PermComb_Rule_Sum.wav
16s

7

A Simple Problem

Fade Through Black
2s

8

Permutations and Combinations
A Simple Problem

Fade Through Black
PermComb_Books_1.wav
7.6s

9

Permutations and Combinations
A Simple Problem

In how many ways can you choose two books of different languages among five books in Latin, seven books in Greek, and ten books in French?

PermComb_Books_2.wav
14.5s

10

Permutations and Combinations
A Simple Problem

Latin   **Greek**   **French**
5   **7**   **10**

PermComb_Books_3.wav
22s

11

Permutations and Combinations
A Simple Problem

In how many ways can you choose two books of different languages among five books in Latin, seven books in Greek, and ten books in French?

Push Right
PermComb_Books_4.wav
5s

12

Permutations and Combinations
A Simple Problem

Latin   Greek   French
5   7   10

Push Left
0s
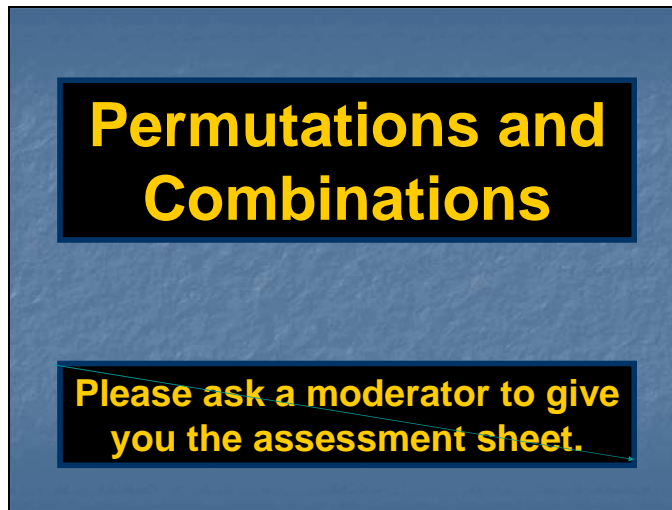
13

Permutations and Combinations
A Simple Problem

Latin   Greek   French
↗5   ↗7   ↗10

L & G: 5 × 7   = 35
L & F: 5 × 10 = 50
G & F: 7 × 10 = 70
                    155

PermComb_Books_5.wav
2m 45s

14

Permutations and Combinations
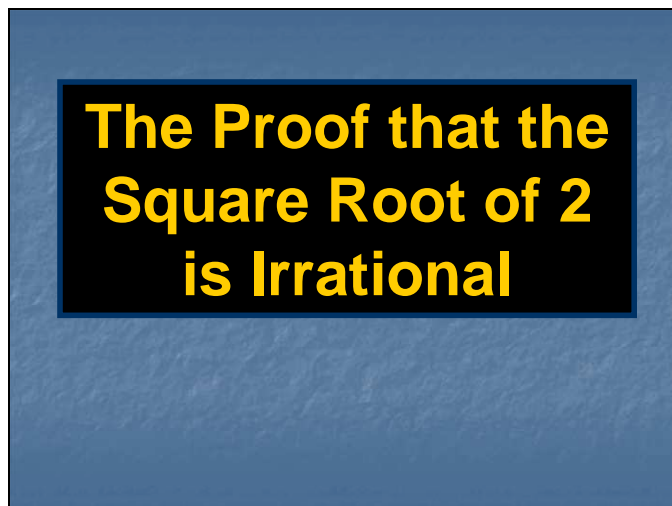
Please ask a moderator to give you the assessment sheet.

Fade Through Black

Total duration: 5 minutes, 10 seconds

The Proof that the Square Root of 2 is Irrational

1

The Proof that the Square Root of 2 is Irrational

Fade Through Black
2s
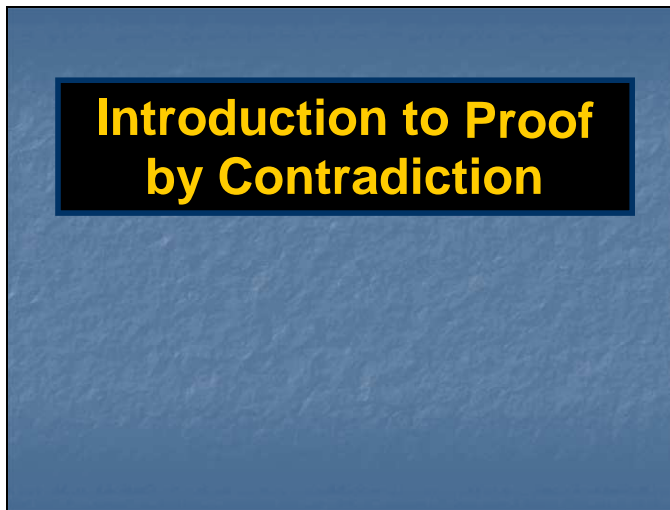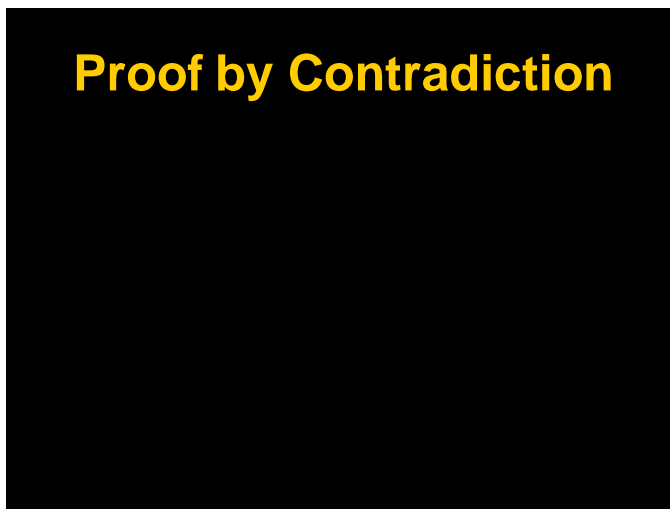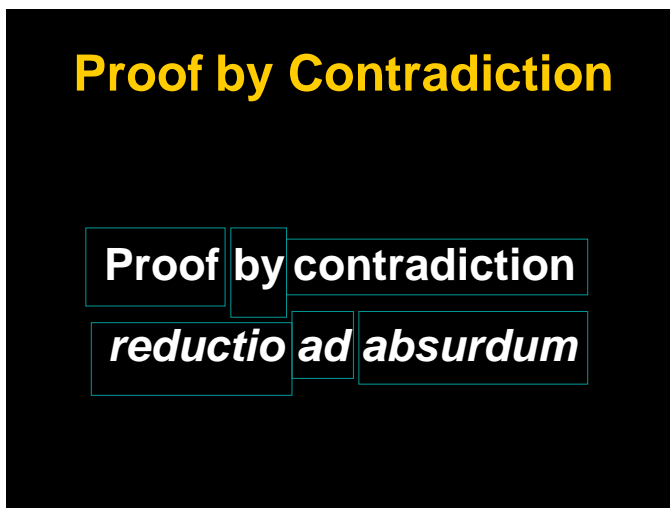
2	**Introduction to Proof by Contradiction**	Fade Through Black 2s
3	**Proof by Contradiction**	Fade Through Black 0s
4	**Proof by Contradiction** **Proof by contradiction** *reductio ad absurdum*	PfbyCont_Intro.wav 17s

5

Proof by Contradiction

contradiction

A propositional form which is always FALSE

P ^ ~P (P and not-P)

PfbyCont_1.wav
20s

6

Proof by Contradiction

Want to prove P

Assume ~P (P is not true)

Arrive at Q ^ ~Q

~(~P) => P is true

PfByCont_2.wav
55s

7

The Proof that $\sqrt{2}$ is Irrational

Fade Through Black
2s

8

The Proof that √2 is Irrational

Fade Through Black
0s

9

The Proof that √2 is Irrational

P: √2 is not rational number.

~P: √2 is a rational number.

~P => Q   **Q:** $\sqrt{2} = \frac{p}{q}$

p, q are integers,
     relatively prime

Root2_1_1.wav
2m 3s

10
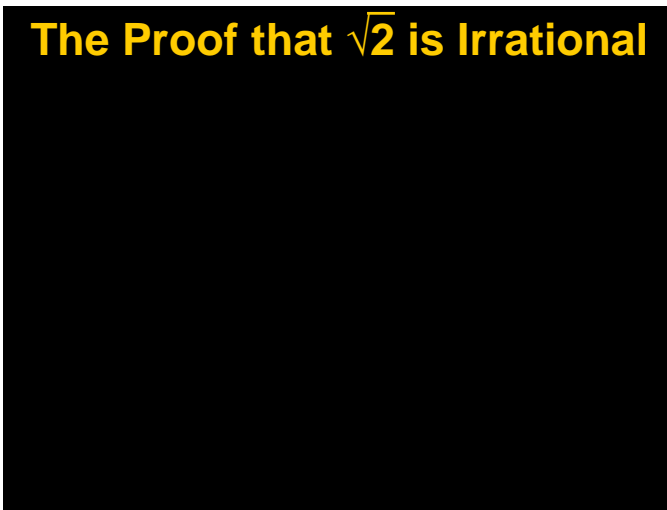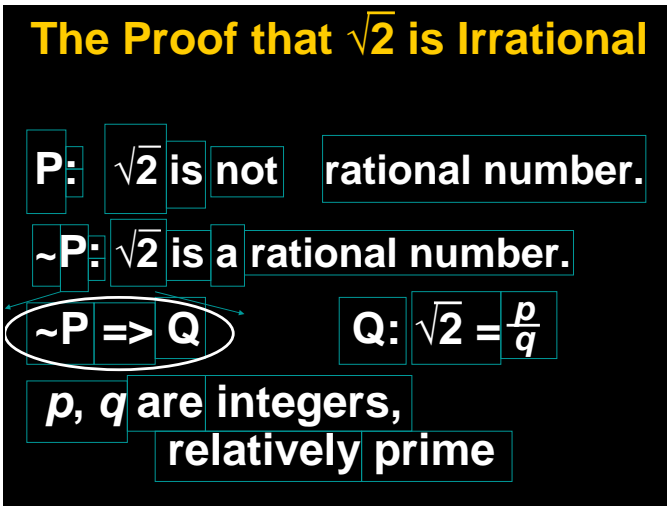
The Proof that √2 is Irrational
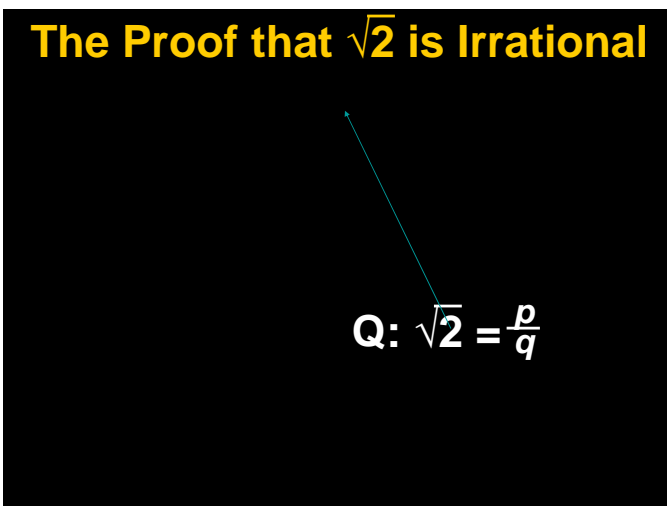
Q: $\sqrt{2} = \frac{p}{q}$

0s

11

The Proof that $\sqrt{2}$ is Irrational

$$Q: \sqrt{2} = \frac{p}{q}$$

$$2 = \frac{p^2}{q}$$

$$p^2 = 2q^2$$

$$p^2 \text{ is even} => p \text{ is even}$$

Root2_1_2.wav
34s

12

The Proof that $\sqrt{2}$ is Irrational

$$Q: \sqrt{2} = \frac{p}{q}$$

$$p = 2r$$
$$(2r)^2 = 2q^2$$
$$4r^2 = 2q^2$$
$$q^2 = 2r^2 \qquad q \text{ is even}$$
$$p = r, \qquad q = 2s, \qquad r, s \in I$$
$$Q => \sim Q$$

Root2_1_3.wav
1m 41s

13

The Proof that $\sqrt{2}$ is Irrational

$$Q: \sqrt{2} = \frac{p}{q}$$

$$p = 2r$$
$$(2r)^2 = 2q^2$$
$$4r^2 = 2q^2$$
$$q^2 = 2r^2 \qquad q \text{ is even}$$
$$p = 2r, \qquad q = 2s, \qquad r, s \in I$$
$$Q => \sim Q \quad \text{- contradiction}$$

Root2_3.wav
2s

14

The Proof that $\sqrt{2}$ is Irrational

$$Q: \sqrt{2} = \frac{p}{q}$$

P: $\sqrt{2}$ is not a rational number.

Q => ~Q

This is a contradiction. => =

P - FALSE

P is true

(Previous sound still playing)
35s

15

The Proof that the Square Root of 2 is Irrational

Please ask a moderator to give you the assessment sheet.

Fade Through Black

Total duration: 6 minutes, 39 seconds

Relations and the Cartesian Product

1

Relations and the Cartesian Product

Fade Through Black
2s

2

Relations

Fade Through Black
2s

3
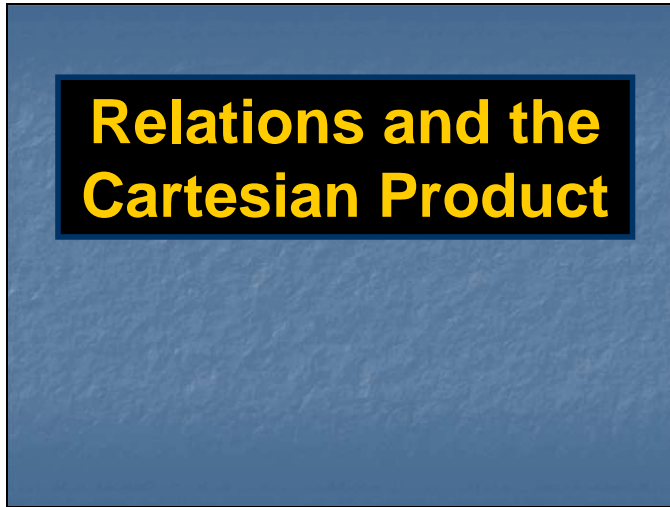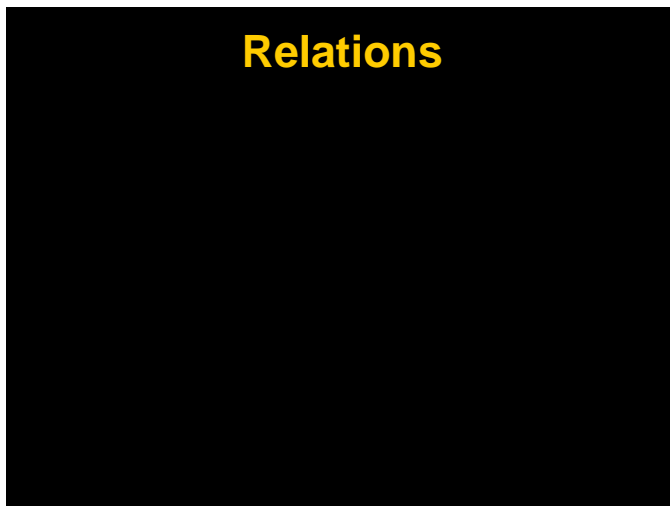
Relations

Fade Through Black
0s

| 4 | **Relations** | Relations_Intro.wav
40s |

| 5 | **Relations**

X lives in city Y.

X was born in city Y in the year Z. | (Previous sound still playing)
42s |

| 6 | **Relations**

For $n>0$, an ordered n-tuple (or simply n-tuple) with ith component a_i is a sequence of n objects denoted by $<a_1, a_2, a_3, \dots, a_n>$. Two ordered n-tuples are equal if and only if their ith components are equal for all i, $1 \le i \le n$. | Relations_ntuple.wav
36s |

7

Relations_Order.wav
54s

8

Fade Through Black
2s

9

Fade Through Black
0s

10

The Cartesian Product

Let $\{ A_1, A_2, A_3, \ldots, A_n \}$ be an indexed collection of sets with indices from 1 to n, where $n>0$. The Cartesian product (or cross product) of the sets A_1 through A_n, denoted by $A_1 \times A_2 \times A_3 \times \ldots \times A_n$, or $\times_{i=1}^{n} A_i$, is the set of n-tuples $\{ <a_1, a_2, \ldots, a_n > \mid a_i \in A_i \}$.

Relations_Cartesian_1.wav
41s

11

The Cartesian Product

Let $\{ A_1, A_2, A_3, \ldots, A_n \}$ be an indexed collection of sets with indices from 1 to n, where $n>0$. The Cartesian product (or cross product) of the sets A_1 through A_n, denoted by $A_1 \times A_2 \times A_3 \times \ldots \times A_n$, or $\times_{i=1}^{n} A_i$, is the set of n-tuples $\{ <a_1, a_2, \ldots, a_n > \mid a_i \in A_i \}$.

Relations_Cartesian_2.wav
2s

12

The Cartesian Product

$$A_1 \times A_2 \ldots \times A_n$$
$$\times_{i=1}^{n} A_i$$

$$A \times B \times C$$

Human beings   Cities   Years

(Previous sound still playing)
40s

13

The Cartesian Product

Relations_Presquares.wav
10.5s

14

The Cartesian Product

$A \times B$

$A =$ set of real numbers $0 \leq x \leq 1$

$x \in A$

$B \times A$

$1 \leq y \leq 2$

$y \in B$

$<y, x>$
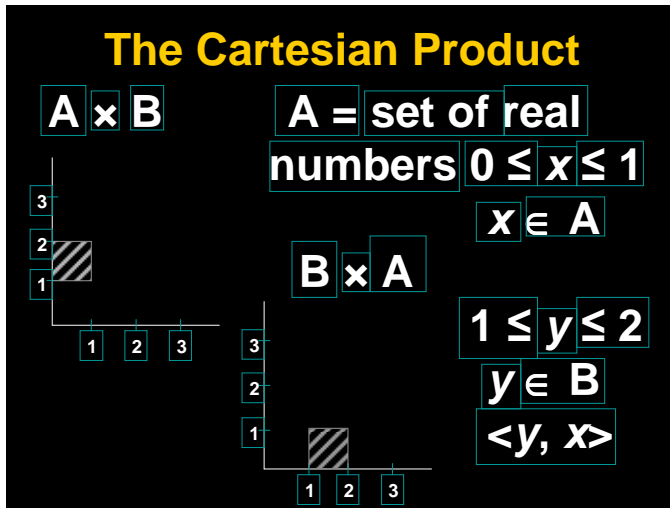
Relations_squares.wav
2m 6s
Axes, squares, and shadings were all dynamically animated.

15

Relations and the Cartesian Product

Please ask a moderator to give you the assessment sheet.
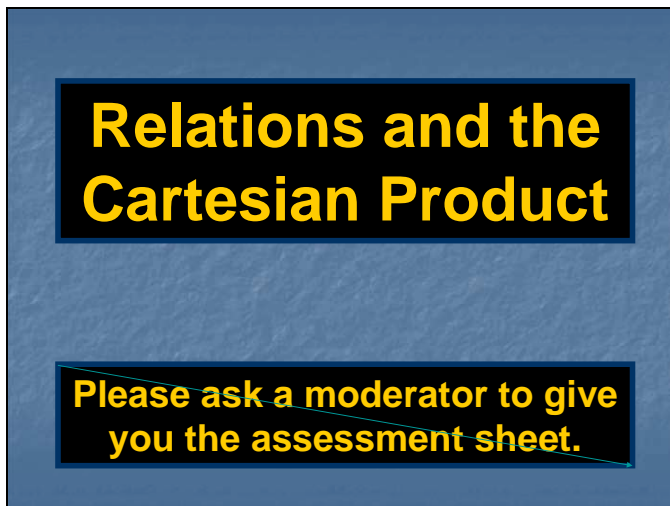
Fade Through Black

Total duration: 6 minutes, 42 seconds

Appendix 3: Control Group Inter-Lesson Module

http://djvill.people.wm.edu/Ideation.html

And now, for a little light reading...

The following post appeared on the Ideation blog, from the William and Mary website. Please read the article all the way through, then hit "Next" when you are done.

NSF grant supports computational math initiative

by Joe McClain | September 1, 2007

The College of William and Mary has entered the vanguard of undergraduate computational mathematics instruction, fueled by a multiyear $800,000 grant from the National Science Foundation.

The NSF grant will fund the operations through 2012 of an interdisciplinary program called CSUMS— Computational Science Training for Undergraduates in the Mathematical Sciences. The goal of CSUMS is to increase undergraduate proficiency in computational mathematics, by development of new courses and by incorporation of computational mathematics examples into existing courses.

Chi-Kwong Li, Ferguson Professor of Mathematics, is director of the CSUMS program at William and Mary. He also is the principal investigator on the NSF grant and was department chair when the application was filed.

"At the NSF, they see the need that the current generation, the younger students, should be trained to have a good sense about computation in the mathematical sciences," Li said. He stressed that CSUMS is not just for mathematicians and the William and Mary program includes students and faculty from applied science and computer science.

The nucleus of a computational mathematics initiative had been forming at the College for some time. Michael Lewis, an associate professor of mathematics, had spearheaded an NSF-funded initiative to establish a computing cluster in the department, a good start on the hardware infrastructure necessary to support a program.

"The main goal of the NSF is to support research in science and mathematics, but it's also interested in keeping the curriculum in these disciplines as modern as possible," said David Lutzer, Chancellor Professor of Mathematics and current chair of the department. "When we saw the NSF call for proposals, we asked if this was something we wanted to do. As it happens we had recently hired several people whose strong interests were on the computational side of mathematics."

One such new hire is Sarah Day, an assistant professor of mathematics, who is teaching a senior seminar titled Computational Dynamics and Topology, one of the CSUMS training courses. At the other end of the undergraduate computational experience, Lewis is teaching a freshman seminar he says is "innocuously titled Mathematics and Computation," but which takes first-year students to mathematics's jumping-off point.

"The idea is to make the students aware of the whole other interesting set of questions that arise when you go to actually solve problems," Lewis explained. "Mathematical analysis can tell if solutions exist. Finding those solutions is apt to be a much more difficult problem, a computational problem."

Lutzer said CSUMS will facilitate the introduction of computational techniques at every level of the curriculum. "You can just ignore computing in freshman calculus if you want to. But you can also address computation issues that arise when calculus is used, if you want to," he said. "Part of this project is because we want to."

Virginia Torczon, associate professor of computer science, says that CSUMS will encourage interdisciplinary thinking among students in two departments. "We want computer science students to take more math courses to complement their computing curriculum and we want more students in mathematics to take classes in computer science to complement their research there," she said. "We also want to incorporate projects within individual courses to involve more computers, to show the students that they can use computing as a tool."

Li noted that CSUMS will have an intensive undergraduate research component in addition to the curricular restructuring. "New courses are only part of it. What we are doing now is to increase the sense—the sense and sensibility—of students about computational issues," Li said. "Do we expect a freshman seminar to train students to be competent in computational math? No. But it will increase the sense that there are many problems related to computational issues."

Next

http://djvill.people.wm.edu/Wikipedia.html

The following is an excerpt from the Wikipedia article on Mathematics education. Please read these sections all the way through and click "Next" when you are done. You will not be tested on this material.

History

Elementary mathematics was part of the education system in most ancient civilisations, including Ancient Greece, the Roman empire, Vedic society and ancient Egypt. In most cases, a formal education was only available to male children with a sufficiently high status, wealth or caste.

In Plato's division of the liberal arts into the trivium and the quadrivium, the quadrivium included the mathematical fields of arithmetic and geometry. This structure was continued in the structure of classical education that was developed in medieval Europe. Teaching of geometry was almost universally based on Euclid's Elements. Apprentices to trades such as masons, merchants and money-lenders could expect to learn such practical mathematics as was relevant to their profession.

The first mathematics textbooks to be written in English and French were published by Robert Recorde, beginning with The Grounde of Artes in 1540.

In the Renaissance the academic status of mathematics declined, because it was strongly associated with trade and commerce. Although it continued to be taught in European universities, it was seen as subservient to the study of Natural, Metaphysical and Moral Philosophy.

This trend was somewhat reversed in the seventeenth century, with the University of Aberdeen creating a Mathematics Chair in 1613, followed by the Chair in Geometry set up in University of Oxford in 1619 and the Lucasian Chair of Mathematics, established by the University of Cambridge in 1662. However, it was uncommon for mathematics to be taught outside of the universities. Isaac Newton, for example, received no formal mathematics teaching until he joined Trinity College, Cambridge in 1661.

In the eighteenth and nineteenth centuries the industrial revolution led to an enormous increase in urban populations. Basic numeracy skills, such as the ability to tell the time, count money and carry out simple arithmetic, became essential in this new urban lifestyle. Within the new public education systems, mathematics became a central part of the curriculum from an early age.

By the twentieth century mathematics was part of the core curriculum in all developed countries.

During the twentieth century mathematics education was established as an independent field of research. Here are some of the main events in this development:

- In 1893 a Chair in mathematics education was created at the University of Göttingen, under the administration of Felix Klein
- The International Commission on Mathematical Instruction (ICMI) was founded in 1908, and Felix Klein became the first president of the organization
- A new interest in mathematics education emerged in the 1960s, and the commission was revitalized
- In 1968, the Shell Centre for Mathematical Education was established in Nottingham
- The first International Congress on Mathematical Education (ICME) was held in Lyon in 1969. The second congress was in Exeter in 1972, and after that it has been held every four years

In the 20th century, the cultural impact of the "electric age" (McLuhan) was also taken up by educational theory and the teaching of mathematics. While previous approach focused on "working with specialized 'problems' in arithmetic", the

emerging structural approach to knowledge had "small children meditating about number theory and 'sets'."

Objectives

At different times and in different cultures and countries, mathematics education has attempted to achieve a variety of different objectives. These objectives have included:

- The teaching of basic numeracy skills to all pupils
- The teaching of practical mathematics (arithmetic, elementary algebra, plane and solid geometry, trigonometry) to most pupils, to equip them to follow a trade or craft
- The teaching of abstract mathematical concepts (such as set and function) at an early age
- The teaching of selected areas of mathematics (such as Euclidean geometry) as an example of an axiomatic system and a model of deductive reasoning
- The teaching of selected areas of mathematics (such as calculus) as an example of the intellectual achievements of the modern world
- The teaching of advanced mathematics to those pupils who wish to follow a career in science
- The teaching of heuristics and other problem-solving strategies to solve non routine problems.

Methods of teaching mathematics have varied in line with changing objectives.

[Next](#)

Appendix 4: Bias Group Inter-Lesson Module

http://djvill.people.wm.edu/DailyPenn.html

And now, for a little light reading...

This article appeared in an issue of the Daily Pennsylvanian in April, 2006. Please read the article all the way through and click "Next" when you are done. You will not be tested on this material.

Hard to decipher your TA's English?

Politicians consider law against heavily accented teachers

Engineering junior Jonathan Lehr thinks he knows why he did poorly in an introductory chemistry lab he took freshman year, and he says it wasn't because he didn't put in the work. He didn't get the grade he wanted, he says, because he could barely understand his foreign teaching assistant.

Lehr said that the course, which is a requirement for most Engineering students, was predominantly taught by foreign students who are not native English speakers.

But this type of problem is not unique to Lehr, or even to the Chemistry Department.

It's not even unique to Penn.

Students across the country -- on campuses like Penn State and the University of California, Berkeley -- are issuing loud and often formal complaints that they are failing courses and losing scholarship opportunities because they literally can't understand a word their professors are saying.

And the complaints have even reached some state governments.

Minnesota State Rep. Bud Heidgerken (R-Freeport) introduced a bill earlier this month that would force the University of Minnesota to make English fluency a bigger factor in hiring decisions. The university already has strict English language tests for its teaching assistants.

The bill is currently standing before the Minnesota House of Representatives' Higher Education Committee.

People have been complaining about the problem for 25 years, said Heidgerken, who said he was told by Minnesota students that they could send him "busloads of students with similar complaints."

The bill would not affect any school outside of Minnesota, but Penn officials say they have been tackling the issue themselves for decades.

And University administrators say they have everything under control, though they occasionally get complaints about teachers with heavy accents.

College of Arts and Sciences Dean Dennis DeTurck said that the University "provides assistance, not punishment" to faculty members who do not speak English well, in the form of extra training programs.

Still, a University policy adopted in 1989 states that anyone teaching classes must speak English clearly. Graduate and professional student teaching staff

must be evaluated and certified as having met the University's standard of English fluency in the classroom before being hired.

"I can't imagine that someone in the state legislature has a better idea of how we should be doing our jobs," said Finance professor Andrew Metrick, said that only the University should determine how best to teach students and hire faculty. Metrick often teaches large lecture courses graded by TAs from foreign countries.

"It's easy to pick on foreigners," added Metrick. "But whatever the motivation is ... it seems silly."

While Heidgerken's bill doesn't dictate exactly how the University of Minnesota would change its hiring practices, Penn officials are still doubtful of the bill's actual worth.

"On the surface, it sounds xenophobic," DeTurck said. "We have much more to gain from the perspectives of international faculty than we have to lose by making some accommodations to understand accented English."

"There is a difference between accented English and unintelligible English," he added.

But some students still would have preferred a more intelligible classroom experience.

While saying that his TA's accent did not affect his performance in an Economics class, Wharton freshman Steve Bachman said that his recitation "was not about trying to understand the information, but trying to figure out what the hell [the TA] was saying."

http://djvill.people.wm.edu/Ratemyprofs.html

The following is a table of Ratemyprofessor.com ratings for a certain Math professor at a public university in the U.S. Please read through the ratings and hit "Next" when you are done.

Date	Class	E	H	C	RI		User Comments
5/4/09	Math1013	5	5	5	3	🙂	Very easy class, extremely nice professor who is always trying to help students. Definitely recommend her, you will be glad you had a nice teacher and made an A. But make sure you go to class!!
10/21/08	MAT1214	2	1	2	3	🙂	Concise, direct, extremely competent. Indian accent, but usually very easy to understand.
7/31/08	MAT1073	2	1	2	1	🙁	She has a severe accent. I love math and I found myself falling asleep. The actual math wasn't that hard but that was from my own studying.
10/25/07	MATSECT	5	3	3	1	🙂	She has a severe accent. However, this class is cake, and she goes over everything thoroughly, so as long as you know how to do math, you should be okay in the long run.
7/10/06	MTC 0113	2	2	2	3	🙁	Hard to understand! Goes over questions very fast! Doesn't really explain how to get answer just gives an example but doesn't explain it. Homework due on Fridays which will effect your grade if you don't turn it in.
5/3/06	remedial m ath	4	4	4	3	🙂	this professor is really helpful and i guarantee you will make an A if you keep up with the work. she has an accent that is kind of hard to understand at first, but if you give her a chance, you won't regret it. plus, you get used to the accent after a while. shes so kind and cares about the students. her tests are so easy too!
11/28/05	mtc 0113	4	1	1	3	🙁	her accent made it very hard to understand, plus she doesn't explain the means to getting the answer, if you don't know the material don't plan on her teaching it to you.
9/10/05	Pre Cal	3	4	2	2	🙂	***** was friendly and helpful but her accent

made the topic so hard to understand!

12/1/04	math	4	4	3	2	🙂	good teacher, took her for 3 different classes. her being indian doesn't matter.
11/18/04	Math	4	5	4	5	🙂	I really liked her. She doesn't require contant attendance and she is understanding when you have to miss class. I would definitely take her again. She moves fast, so be prepared and pay attention and you will pass!
11/17/04	mtc	5	5	3	1	🙂	The class is simple and she's nice. Her accent isn't so bad thaat you can't understand anything. She'll go over problems if you tell her you don't understand.
11/15/04	MTC 0113	4	2	1	4	🙁	Her accent and the way she speaks is very hard to understand. However, the information is a piece of cake. Everyone should pass her class!
11/3/04	MTC 0113	5	5	1	1	🙂	She is hard to understaand. The class is extremely easy.
10/26/04	MATH	3	1	1	1	🙁	She seems really nice at first but she turns into a drag. She is also really hard to understand. She is indian

http://djvill.people.wm.edu/SayAnything.html

The following post appeared in a North Dakota blog in 2005. Please read through it and hit "Next" when you are done.

Tuesday, April 05, 2005

Addressing The Professor Accent Problem

By Rob on April 5, 2005 at 07:04 am
23 Comments

Currently there is a battle brewing in my home state over professors with accents so heavy their students can't understand what they're saying.

John Gravois has an excellent article about this issue in the latest issue of *The Chronicle of Higher Education*.

Here's an excerpt:

On the phone from Fargo, N.D., State Rep. Bette Grande's voice rings with clarity. "Colleges are a business," she says in a starched Midwestern accent. "When we put research as our No. 1 focus, we forgot the student," she says. "We got ourselves all turned around."

Ms. Grande could be talking about any of the ills plaguing a modern university -- drops in per-student spending, tuition increases, or maybe the lack of face time with professors. But she has something much more contentious in mind.

She wants her state's university system to do something about the fact that its students can't understand what the heck their foreign-born instructors are saying.

Late in January, Ms. Grande proposed a bill in the North Dakota legislature to prod public institutions of higher education in precisely that direction. Under her bill, if a student complained in writing that his or her instructor did not "speak English clearly and with good pronunciation," that student would then be entitled to withdraw from the class with no academic or financial penalty -- and would even get a refund.

Further, if 10 percent of the students in a class came forward with such complaints, the university would be obliged to move the instructor into a "nonteaching position," thus losing that instructor's classroom labor.

Almost as soon as the bill went public, Ms. Grande realized she had touched a nerve. Calls and e-mail messages poured in from all over North Dakota and from as far away as Florida and Arizona. In nearly a decade as a legislator, Ms. Grande had never attracted such a prodigious and impassioned response.

Read the whole thing.

I had previously posted on this issue here (be sure to read some of the comments).

I think a lot of people have written this off as some sort of tacit red-state racism, but it really isn't. Rep. Grande is very much correct when she points out that higher education is a business and that the students are the clients. The University owes it to its students to provide them with a quality product. I think that most college students would agree with me in saying that a professor with an inpenetrable accent cannot provide them with the type of product (education) they wish to purchase from the university.

[Next](#)

Appendix 5: Training Group Inter-Lesson Module

http://djvill.people.wm.edu/Opening.html

Opening your ears

"Help! My professor has an accent!"

Chances are, at some point, you'll take a class with at least one professor whose first language is not English, if you haven't taken a class with one of these professors already. Sure, he or she is trying hard and is obviously highly knowledgeable, but can you really help it if you can't understand your professor? What can you do in this situation?

"Get me out of here!"

Some people respond to having a foreign-accented professor by switching classes or sections, avoiding lectures and relying on the textbook, or just shutting their ears altogether. But none of these "strategies" is particularly sound; you need to be able to adapt to the situation by doing your best to understand your professor.

Who 'owns' the problem?

Many students assume that because they're paying thousands of dollars for an education, they should be taught only by professors with crisp, mainstream American accents, and thus get frustrated or even morally offended when they encounter lecturers who were born abroad. But these professors are some of the top academics in the field, having devoted their lives to their work. Try to step into their shoes for a minute: can you imagine what it's like to have to master a language as convoluted and nuanced as English *on top of* doing all the hard work necessary to earn a Ph.D? While they must do their best to make themselves intelligible to English-speaking students, they clearly cannot be expected to shoulder the entire burden of bridging this communication gap.

"I sympathize with my professors, I really do. But I still just can't understand them!"

That's where we come in. We realize that while you may want to better understand your professors, you may not know where to start. You may recognize the presence of the professor's accent, but you may not be able to quantify what makes them accented.

Over the next few pages, we'll walk you through a little background information about accents, and how to better understand them. In particular, we'll shed a little light on the accent spoken by the applicant for the Math department professorship, whom you have just finished listening to.

[Next](#)

http://djvill.people.wm.edu/Background.html

A little background on accent

Pop Quiz about accent

Question: What percentage of English speakers use an accent?

Answer: 100%.

There's no such thing as speaking English without an accent, as everybody, including you, your roommate, your grandparents, and your doctor, has some sort of accent. It may be that the accent you use is a pretty typical one for where you grew up, or maybe even for America at large. In this case, it's not unusual for you to consider yourself as having "no accent", since you sound more or less the same as everyone around you. But undoubtedly, there's another English speaker out there who will think your accent is peculiar; more likely than not, you'd feel the same way about their accent, even though their accent couldn't sound more normal to them!

All accents are normal

The ways in which people speak English may vary widely, but one thing remains constant: they are all "normal". What do we mean? Despite variation between accents, there are patterned sets of rules that define each accent, rules that act regularly to make an

accent what it is. The regularity is the important part, since it means while the rules may be different between different people's accents, everybody's accent obeys rules.

For example, if a speaker omits the 'r' at the end of the word 'butter', does it make them stupid or lazy? Maybe you don't pronounce the 'l' in the word 'folk', and certainly you don't pronounce the 'g' in 'straight', but neither of these omissions make you lazy. The person who pronounces the 'r' in 'butter' does so because that's what their accent's rules call for; the person who doesn't pronounce the 'r' is also following the rules, just a slightly different set. Nothing makes one set of rules inherently better than the other.

Learning the rules

Let's keep exploring the above example of a person who drops 'r' at the end of the word 'butter'. Let's take William, who's from Arlington and *does* pronounce 'r' when it comes at the end of a word, and Mary, who's from Boston and does *not* pronounce 'r' at the end of a word. William chats with Mary for a little while, and he notices that certain words, like 'car' and 'fourth', sound a little different when Mary speaks them. It doesn't take long for him to catch on to the rules governing her accent, however, so that when she uses the word 'buttah', there's no ambiguity as to what she means. William and Mary are able to have a perfectly fluid conversation, and each one understands the other just fine.

But they each have a leg up on the situation. No doubt, William has already been exposed to people with 'r-dropping' in their accents, whereas Mary has already been exposed to 'r-keepers', well before the two ever spoke. In other words, prior familiarity aids their mutual comprehension. What if William instead spoke with a Hong Kong accent and Mary had never been exposed to it before? We would expect a much steeper learning curve for Mary (and also for William, if he was unaware of the way the Bostonian accent works), who would require much more time to piece apart the rules of William's accent.

A head start

More than likely, you've encountered some difficulties figuring just what the Math applicant has been saying. On the next page, we'll provide a few hints to the rules of her accent, so that you can better understand her.

http://djvill.people.wm.edu/CaseStudy.html

A head start

Aspiration

In American English, when we start a word with a 'p', 't', or 'k' consonant, we make an even stronger sound by adding a burst of air (called *aspiration*) between the 'p/t/k' and the first vowel in the word. If a speaker starts out an English word with 'p', 't', or 'k' without this burst of air, it will sound to an American English speaker like a 'b', 'd', or 'g', respectively.

The word	What it sounds like	What she's saying	In context
<F>[40]	'dew/do'	'two'	'One by two' <F>
<F>	'Biebl'	'people'	'Among 13 people, there are two who have their birthdays in the same month' <F>

'Th' sounds

Whereas in American English, we have two sounds that we spell as 'th' (one that is voiced—that is, the vocal folds in your throat vibrate when it is articulated—and another that is voiceless), but as it turns out, rather few of the world's languages have these sounds. The native language of the Math applicant does not have 'th' sounds, and so where an American English speaker would have these sounds, she uses a 't' or 'd' sound.

The word	What it sounds like	What she's saying	In context

---

[40] On the actual webpage, there were sound file players where the <F> symbols are. The file in the first column played a short clip of Prof. Kamala's speech, and the file in the last column played a longer clip from which the shorter one was drawn, placing it in context.

<F>	'dirty six'	'thirty-six'	'Each of them is assigned a number between one to thirty-six' <F>

'R' sounds

Almost all American English speakers form 'r' sounds by either curling their tongue tip back over the top of their tongue or by bunching up the front of their tongue in their mouth. The Math applicant instead uses a tapped 'r' similar to the 'r' sound used in Spanish and Italian. If 'r' falls at the end of a word, she will sometimes omit it altogether.

The word	What it sounds like	What she's saying	In context
<F>	'vedifram (?)'	'vary from'	'i will vary from 1 to 10' <F>
<F>	'dirty Nawas (?)'	'thirteen hours'	'She will have studied exactly thirty—thirteen hours.' <F>

Proceed on to page 2!

http://djvill.people.wm.edu/CaseStudy2.html

A head start, continued

Gliding

Speakers use several different strategies to articulate words that start with vowels, and the strategy that American English speakers most commonly use is to insert a small glottal stop (the sound in 'uh-oh') right before the vowel. The Math applicant uses another

strategy: inserting a small 'y' sound (called a *glide*) before the vowel. This is especially important for Math problems that use letters for variables.

The word	What it sounds like	What she's saying	In context
<F>	'yay, I!"	'a_i'	'a_j minus a_i' <F>

Devoicing

Certain pairs of sounds differ only by *voicing*, the state of the vocal folds during articulation (remember that *voiceless* sounds involve no vibration from the vocal folds, but *voiced* ones do). The Math applicant often *devoices* sounds at the ends of words, making them sound like their voiceless counterpart. This is most often seen in plurals; whereas 'hours' is spelled with as 's', we actually pronounce it 'hourz', with a 'z' sound. Not only does the Math applicant use 's' rather than 'z' here, she also will sometimes draw these sounds out if they come at the end of an utterance.

The word	What it sounds like	What she's saying	In context
<F>	'Hess'	'has'	'A student has thirty-seven days to prepare' <F>
<F>	'sixty hoursss'	'sixty hours'	'She has studied for sixty hours' <F>

Intonation

Intonation is the pitch of a person's voice, and specifically the way a speaker uses rising and falling pitch to indicate emphasis and structure. The Math applicant uses intonation that is slightly different than what American English speakers are used to. She uses a sharply rising tone on the second-to-last word or phrase of each utterance, and then a very low-pitched, low-volume tone for the last word or phrase.

The phrase	What she's saying
<F>	'You can see the similarity between this problem and the previous problem.'

Now you've got some potent tools to help you better understand the faculty applicant's accent. Try to apply what you've just learned to hear less of the professor's accent, and more of the words themselves.

Click Previous to review Aspiration, 'Th' sounds, and 'R' Sounds. Click Next if you're sure you're ready for the next lesson.

Previous Next

Appendix 6: Acoustic Analysis of Professor Kamala's Speech

Six samples of ten seconds apiece were randomly drawn from the audio files for each of the three lessons, for a total of one minute of audio per lesson. Ten-second samples were discarded if Prof. Kamala's voice was not audible for 2.5 seconds of the sample or fewer. The samples are below:

#	Center (sec)	Start (sec)	End (sec)
	Permutations and Combinations		
1	267.4763	262.4763	272.4763
2	59.5699	54.5699	64.5699
3	25.8610	20.8610	30.8610
4	179.2112	174.2112	184.2112
5	214.4824	209.4824	219.4824
6	291.4827	286.4827	296.4827
	The Proof that the Square Root of 2 is Irrational		
7	17.2196	12.2196	22.2196
8	174.3497	169.3497	179.3497
9	142.8351	137.8351	147.8351
10	81.7701	76.7701	86.7701
11	274.9462	269.9462	279.9462
12	118.5344	113.5344	123.5344
	Relations and the Cartesian Product		
13	49.1408	44.1408	54.1408
14	226.1075	221.1075	231.1075
15	207.9703	202.9703	212.9703
16	8.6309	3.6309	13.6309
17	97.5072	92.5072	102.5072
18	130.6145	125.6145	135.6145

A list of marked accent features was made prior to analysis:

1. Initial voiceless stop deaspiration
2. Word-initial glide vocalic onset
3. ɔ > a / _R, where R = rhotic (i.e., *or* sounds more like *are*)
4. /u/ rounding
5. eɪ > e
6. ɹ > ɾ
7. Syllable-final /r/ dropping
8. Interdental fricatives ('th') to dental stops
9. Word-medial flaps to dental stops
10. Word-final sibilant devoicing
11. Odd intonation
12. Unreduced schwa

13. Labial glide to obstruent

I listened to each sample and tallied how many tokens of each feature were produced in each sample. The results are below:

Sample #	De-asp	Gli-ding	or > are	Rn-ding	eI > e	r > flap	r > Ø	th > t, d	flap > t, d	z > s	Inton	schwa	w > v, b
Permutations and Combinations													
1	3	0	0	2	1	4	0	1	0	4	0	1	0
2	2	6	0	0	1	5	0	2	0	2	0	0	2
3	2	1	1	0	2	5	0	0	0	2	2	2	1
4	1	0	0	0	1	5	0	3	0	1	1	0	1
5	2	0	0	0	0	6	0	1	0	0	1	1	0
6	0	0	0	1	1	3	0	0	1	1	3	0	0
The Proof that the Square Root of 2 is Irrational													
7	1	0	1	0	0	2	1	0	0	1	1	0	1
8	2	0	0	1	2	3	0	0	2	0	2	2	0
9	2	1	0	0	0	1	0	2	0	1	0	0	0
10	4	0	2	0	0	4	0	2	1	5	3	1	0
11	3	1	1	4	0	2	1	0	0	1	1	0	0
12	4	1	0	2	0	1	0	0	1	2	2	1	0
Relations and the Cartesian Product													
13	0	0	2	0	0	0	0	0	0	1	1	0	0
14	1	0	0	0	0	4	2	0	1	5	1	0	0
15	2	2	1	2	0	3	0	1	2	2	1	2	0
16	2	0	1	0	2	2	0	2	0	1	1	1	0
17	1	2	1	1	0	0	0	0	0	1	1	1	0
18	0	0	1	0	0	4	0	0	0	2	1	0	0
	De-asp	Gli-ding	or > are	Rn-ding	eI > e	r > flap	r > Ø	th > t, d	flap > t, d	z > s	Inton	schwa	w > v, b
PC total	10	7	1	3	6	28	0	7	1	10	7	4	4
PC share	31%	50%	9%	23%	60%	52%	0%	50%	13%	31%	32%	33%	80%
Root2 total	16	3	4	7	2	13	2	4	4	10	9	4	1
Root2 share	50%	21%	36%	54%	20%	24%	50%	29%	50%	31%	41%	33%	20%
Rel total	6	4	6	3	2	13	2	3	3	12	6	4	0
Rel share	19%	29%	55%	23%	20%	24%	50%	21%	38%	38%	27%	33%	0%
Total	32	14	11	13	10	54	4	14	8	32	22	12	5
Use?	Y	Y				Y		Y		Y	Y		

The six accent features that had the greatest number of tokens were chosen for inclusion in the Training module: deaspiration, gliding, flapping, 'th' fortition, final 'z' devoicing, and intonation.

Appendix 7: Lesson 1 Web Pages

All pages corresponding to the first lesson began with the same header. For example, http://djvill.people.wm.edu/PermComb.html looked like this:

A New Math Professor

The William and Mary Math Department is looking to hire a new faculty member, and this applicant is one of the department's top choices. In order to make the final decision, the department is having students view some of her lessons and take short assessments on these lessons.

To begin the first of two lessons, click the play button on the player below and then put the video in a full screen by clicking the button on the bottom right of the player. Since we are trying to evaluate these lessons in a holistic manner, please do not jump from slide to slide or pause the video. Thank you for your help with this important personnel decision!

The other two pages for the first lesson differed only in that a different video was embedded:

http://djvill.people.wm.edu/Root2.html

http://djvill.people.wm.edu/Relations.html
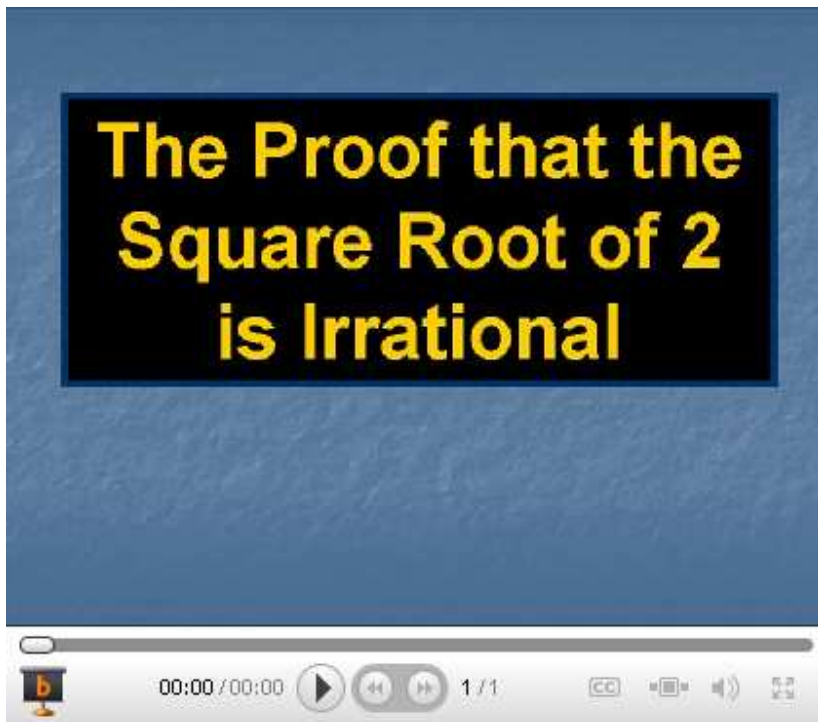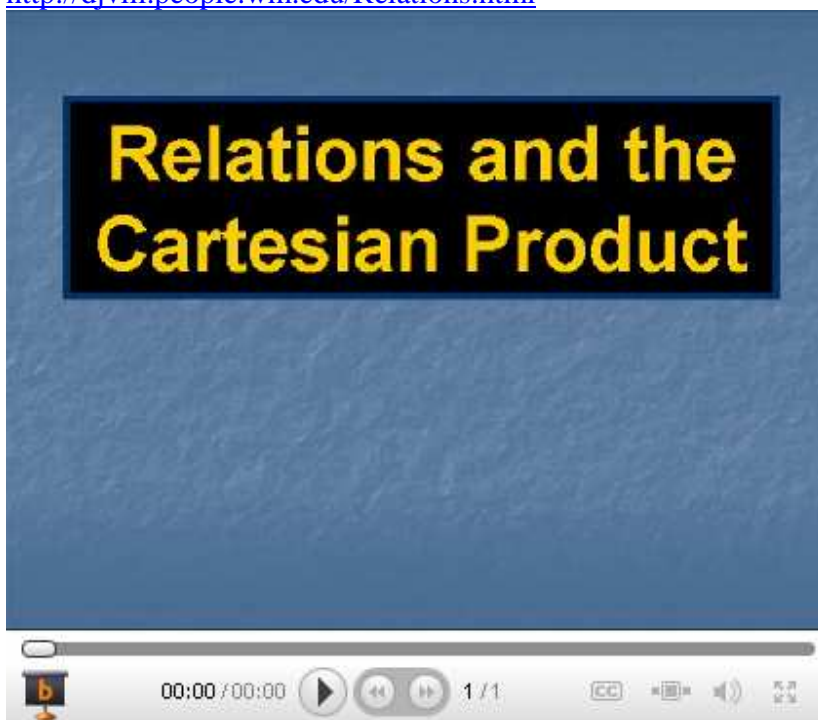
Appendix 8: Lesson 2 Web Pages

As with the first lesson, all pages for the second lesson began with the same header:

Lesson 2

This is another lesson offered by the Math department applicant. To begin this lesson, click the play button on the player below and then put the video in a full screen by clicking the button on the bottom right of the player. Again, since we are trying to evaluate these lessons in a holistic manner, please do not jump from slide to slide or pause the video. Thank you again for your help with this important personnel decision!

There were three pages: http://djvill.people.wm.edu/PermComb_2.html, http://djvill.people.wm.edu/Root22.html, and http://djvill.people.wm.edu/Relations_2.html. These pages differed only in the lesson video embedded below their headers (see Appendix 7 for videos).

Appendix 9: Inter-Lesson Module End Page

The following page (http://djvill.people.wm.edu/End.html) displayed once participants clicked "Next" on the final page of their inter-lesson module. Participants who followed instructions properly were re-directed to the second lesson corresponding to their testing group.

On to lesson 2!

Please input the following URL into the address bar above:
http://djvill.people.wm.edu/<groupname-no caps>_lesson2.html

Be sure to put your group name in the appropriate place (for example, if you were in group Zebra, you'd enter

http://djvill.people.wm.edu/zebra_lesson2.html)

Appendix 10: Linguistic Profile Questionnaire

The following questions appeared on the Linguistic Profile Questionnaire that students accessed at the end of the testing session by loading http://djvill.people.wm.edu/LPQ.html.

Name Last, First	
Experimental Group	
Age	
Major(s)/Minor If you have not yet declared, put down what you think you'll be majoring in.	
Graduating Class	
Which Math classes, if any, have you taken at this school? Course name, semester taken, and professor	
Which Linguistics classes, if any, have you taken at this school? Course name, semester taken, and professor	
Where have you lived before coming to William and Mary? Locations (in chronological order if possible); please be as specific as you can	
Where are your parents (or whomever you grew up with) from?	
Do you think you speak with an accent? If so, how would you describe it?	
What sort of accent(s) (either foreign or not) did you grow up around? Were they accents you heard at home, at school, etc?	
On a scale of 1-5, where 1 is 'not at all' and 5 is 'all the time', how often were you around foreign accents while growing up?	
Do you have any final questions or comments about this survey? If so, please write them here.	

Appendix 11: Student Participant Consent Form

All student participants were given this form once they entered the testing room. Participants were given the opportunity to keep a copy of the form if they so desired.

CONSENT TO PARTICIPATE IN RESEARCH:

Closing the Communication Gap Between Mathematics Professors and Undergraduates

Daniel J. Villarreal
djvill@wm.edu
The College of William and Mary

You are being asked to participate in a research study. Your participation is voluntary. If you would like, you may have a copy of this consent form for your own records. **If you are younger than 18 years old, you may not take part in this study.**

Please ask questions by emailing **djvill@wm.edu** if there is anything you do not understand.

What is the purpose of this study?
The purpose of the study is to gain more knowledge about undergraduates' perception of the speech of mathematics professors with a foreign accent.

What does this study involve?
The subject will listen to a clip of a mathematics professor walking the subject through a short mathematics lesson while watching an animation of the lesson. The subject will then be asked about his or her comprehension of the lesson. The subject will be requested to provide some linguistic background information (e.g., languages spoken). The subject may be asked to take part in a short interview about the subject's experiences with communicative difficulties in the classroom, which will be audio-recorded.

Are there any benefits from participating in this study?
The subject will be entitled to a free lunch from a local vendor totaling no more than $10 in value. Otherwise, there may be no direct benefits to you should you decide to participate in this study. Your participation will help us learn more about the difficulties involved in understanding foreign-accented professors.

How is this different from what will happen if you do not participate in this study?
There will be no negative consequences for you if you choose not to participate in this study.

What are the risks involved with being enrolled in this study?
Potential risks in participating in this study are minimal. The overall responses of the

study may be aggregated (e.g. "N% of respondents answered X"), and your text responses may be quoted in verbatim in the final report, but will not be explicitly linked to your identity. Your name will not be released to anyone, whether or not you choose to participate.

Other important items you should know:

Withdrawal from the study:
You may choose to stop your participation in this study at any time. You may also decide to have your responses erased and/or destroyed. Your decision to stop your participation will bear you no adverse consequences.

What about the costs of this study?
This study requires no monetary contribution, and should only take about 30 minutes of your time.

Will you be paid to participate in this study?
Participation in this study will be voluntary; you will not be directly paid to participate, but you will be entitled to a free lunch from a local vendor totaling no more than $10 in value.

Who should you call with questions about this study?
Questions or concerns about this study may be directed to Dan Villarreal, at djvill@wm.edu or Anne H. Charity Hudley acharityhudley@wm.edu, supervisor of the study.

If you would like to have further information regarding your rights as a research participant, please ask me by emailing djvill@wm.edu, or you may contact Dr. Michael Deschenes, Chair of the Protection of Human Subjects Committee at the College of William and Mary, at (757) 221-2778.

CONSENT

I have read the above information about "Closing the Communication Gap" and have been given an opportunity to ask questions. I agree to participate in this study and I have been given an opportunity to save this consent document for my own records. I further certify that I am at least 18 years old.

This project was approved by the College of William and Mary Protection of Human Subjects Committee (phone (757) 221-3901) on DATE and expires on DATE.

Signature _____ Date _____

Please print name _____

Appendix 12: Assessments and Answer Keys

Permutations and Combinations

Name: _____

Date: _____   Experimental group: _____

Please show all of your work.

1. Professor Millington has an affinity for wearing mismatched socks (two socks of different colors). He currently has 30 clean socks in his drawer: 12 white socks, 6 red socks, 7 brown socks, and 5 blue socks. How many different combinations of mismatched socks can Professor Millington wear?

2. An FDA inspector can inspect 3 different labs in one day, but never searches more than one lab at any given company. Company A has 3 labs, Company B has 5 labs, Company C has 1 lab, and Company D has 7 seven labs. In how many different ways can she search 3 labs in a day?

When you are done, please ask a moderator for further directions.

The Proof that the Square Root of 2 is Irrational

Name: _____

Date: _____ Experimental group: _____

Prove that $\sqrt{6}$ is not rational. Several steps have been provided for you.

Assume that $\sqrt{6}$ *is* rational.

Then $\sqrt{6} =$ _____ in lowest terms.

Then _____ = _____.

Then $p^2 =$ _____.

Then _____ is a multiple of _____.

Then _____ is a multiple of 6.

Then _____ is a multiple of 2.

Then for some integer k, $p =$ _____. This means that $p^2 = 6q^2$ implies _____ = $6q^2$.

Then $2k^2 =$ _____.

Then _____ is a multiple of _____.

Then _____ is a multiple of _____. But this violates the fact that p/q must be in lowest terms. This is a contradiction, and so $\sqrt{6}$ is *not* rational.

When you are done, please ask a moderator for further directions.

Relations and the Cartesian Product

Name: _____

Date: _____   Experimental group: _____

1. Please draw and shade the areas in the graph indicated by the cross product:
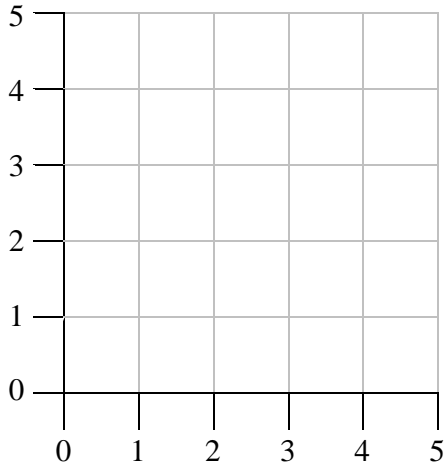
A × B, where
$a \in$ A if $3 \le a \le 5$
$b \in$ B if $1 \le b \le 3$
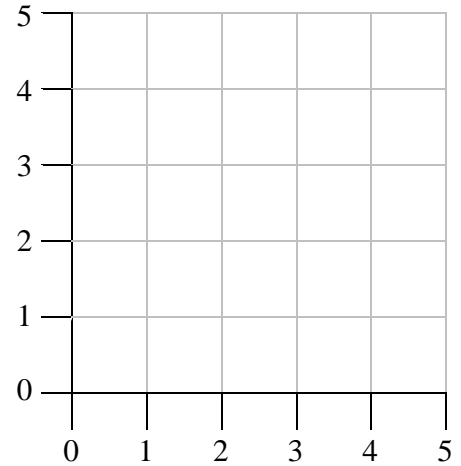
G × H, where
$g \in$ G if $7/3 \le g \le 3$
$h \in$ H if $1.5 \le h \le 3.5$

2. Fill in the blanks below:
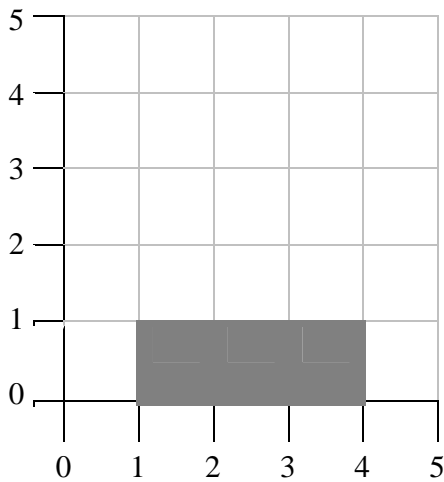
P × Q, where
$p \in$ P if _____
$q \in$ Q if _____
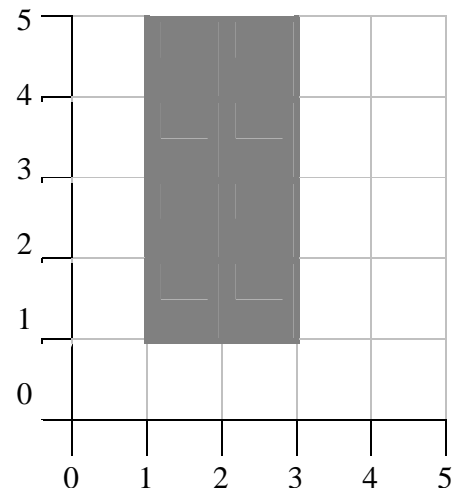
N × M, where
$n \in$ N if _____
$m \in$ M if _____

When you are done, please ask a moderator for further directions.

Permutations and Combinations

Name: _____KEY_____

Date: __KEY__   Experimental group: ____KEY____

Please show all of your work.

1. Professor Millington has an affinity for wearing mismatched socks (two socks of different colors). He currently has 30 clean socks in his drawer: 12 white socks, 6 red socks, 7 brown socks, and 5 blue socks. How many different combinations of mismatched socks can Professor Millington wear?

$$
\begin{array}{llll}
W & R & Br & Bl \\
12 & 6 & 7 & 5
\end{array}
$$

$$
\begin{aligned}
W \times R &= 12 \times 6 &&= 72 \\
W \times Br &= 12 \times 7 &&= 84 \\
W \times Bl &= 12 \times 5 &&= 60 \\
R \times Br &= 6 \times 7 &&= 42 \\
R \times Bl &= 6 \times 5 &&= 30 \\
Br \times Bl &= 7 \times 5 &&= \underline{35} \\
&&& 323 \text{ combinations}
\end{aligned}
$$

2. An FDA inspector can inspect 3 different labs in one day, but never searches more than one lab at any given company. Company A has 3 labs, Company B has 5 labs, Company C has 1 lab, and Company D has 7 seven labs. In how many different ways can she search 3 labs in a day?

$$
\begin{array}{llll}
A & B & C & D \\
3 & 5 & 1 & 7
\end{array}
$$

$$
\begin{aligned}
A \times B \times C &= 3 \times 5 \times 1 &&= 15 \\
A \times B \times D &= 3 \times 5 \times 7 &&= 105 \\
A \times C \times D &= 3 \times 1 \times 7 &&= 21 \\
B \times C \times D &= 5 \times 1 \times 7 &&= \underline{35} \\
&&& 176 \text{ ways}
\end{aligned}
$$

When you are done, please ask a moderator for further directions.

The Proof that the Square Root of 2 is Irrational

Name: _____KEY_____

Date: __KEY___   Experimental group: ____KEY_____

Prove that √6 is not rational. Several steps have been provided for you.

Assume that √6 *is* rational.

Then √6 = _p/q_ in lowest terms.

Then __6_ = _p^2/q^2_ .

Then p^2 = _$6q^2$_ .

Then _p^2_ is a multiple of _6_ .

Then _p__ is a multiple of 6.

Then _p__ is a multiple of 2.

Then for some integer k, p = _2k_ . This means that $p^2 = 6q^2$ implies _$4k^2$_ = $6q^2$.

Then $2k^2$ = _$3q^2$_ .

Then _q^2_ is a multiple of _2_ .

Then _q__ is a multiple of _2_ . But this violates the fact that p/q must be in lowest terms.

This is a contradiction, and so √6 is *not* rational.

When you are done, please ask a moderator for further directions.

Relations and the Cartesian Product

Name: _____KEY_____

Date: __KEY___   Experimental group: ___KEY____

1. Please draw and shade the areas in the graph indicated by the cross product:
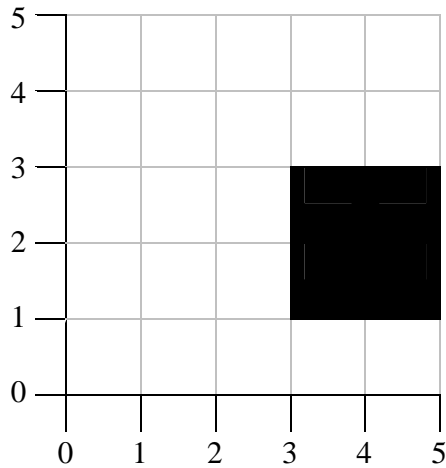
A × B, where
$a \in$ A if $3 \leq a \leq 5$
$b \in$ B if $1 \leq b \leq 3$
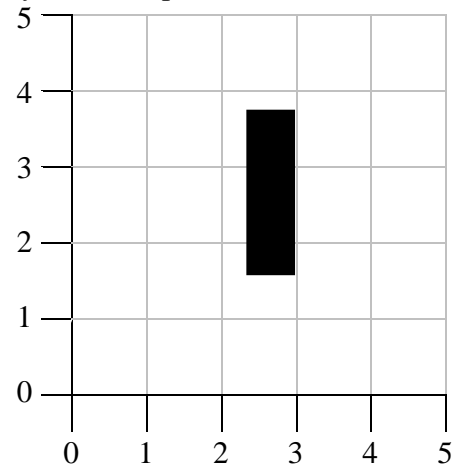
G × H, where
$g \in$ G if $7/3 \leq g \leq 3$
$h \in$ H if $1.5 \leq h \leq 3.5$

2. Fill in the blanks below:
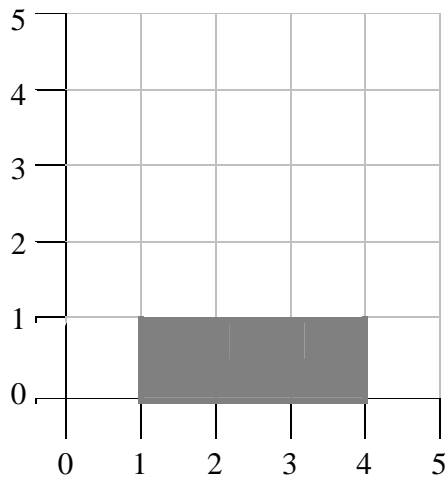
P × Q, where
$p \in$ P if $\underline{\ 1 \leq p \leq 4\ }$
$q \in$ Q if $\underline{\ 0 \leq q \leq 1\ }$
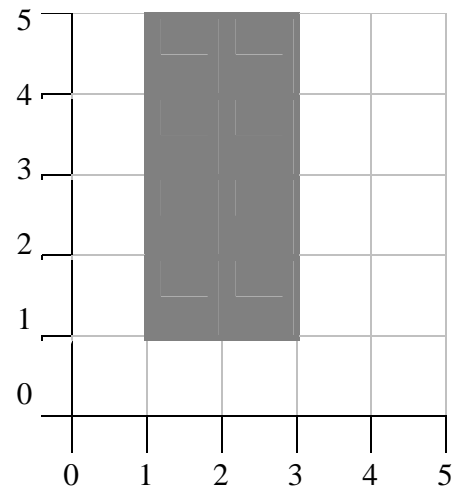
N × M, where
$n \in$ N if $\underline{\ 1 \leq n \leq 3\ }$
$m \in$ M if $\underline{\ 1 \leq m \leq 5\ }$

When you are done, please ask a moderator for further directions.

Appendix 13: Student Participant Recruitment Flyer

Participate in an Honors project

I am looking for students to help out with a project for my **Honors thesis** in Linguistics. This project involves viewing and answering a few questions on some mathematics lessons. The project will take little of your own time and you will get a **free lunch** out of it (literally!).

What you'll need to do

- Participate in a **testing session** between October 3 and 6, lasting about one hour
- Participate in a **discussion session** after Fall Break; this should also last about one hour
- Your privacy and confidentiality will be preserved throughout the process

What you'll get out of it

- A **FREE CHEESE SHOP LUNCH**; all you have to do is fully participate in the two sessions

HOW TO SIGN UP

- If you're interested in participating (and getting some **FREE CHEESE SHOP**), please sign up for a session at http://djvill.people.wm.edu/signup.html . Thanks a lot!

Appendix 14: Availability Survey

This form was hosted by Google Docs at
http://spreadsheets.google.com/viewform?hl=en&formkey=dHJZWmNQX1JHcmRCOG
cyY1UzUEMyVEE6MA..

Availability Survey

I am hoping to figure out viable times for scheduling my experimental sessions. These will probably take about 1 hour apiece, and you only need to come to one. FILLING OUT THIS FORM DOES NOT MEAN YOU'VE OFFICIALLY SIGNED UP. I'm just using it to figure out when people are free so I can schedule these sessions (most likely for the last week in September/first week in October). If multiple times would work for you, please check off multiple boxes.

* Required

When would you be free to participate in my project? *
Please check AT LEAST ONE box for when you would be free to participate. If none of these times work, please indicate so in "Other" and/or email me at djvill@wm.edu

- ☐ Monday 6-7pm
- ☐ Monday 7-8pm
- ☐ Monday 8-9pm
- ☐ Tuesday 6-7pm
- ☐ Tuesday 7-8pm
- ☐ Tuesday 8-9pm
- ☐ Wednesday 6-7pm
- ☐ Wednesday 7-8pm
- ☐ Wednesday 8-9pm
- ☐ Thursday 6-7pm
- ☐ Thursday 7-8pm
- ☐ Thursday 8-9pm
- ☐ Friday 6-7pm
- ☐ Friday 7-8pm
- ☐ Friday 8-9pm
- ☐ Saturday early afternoon (between 12-3pm)
- ☐ Saturday late afternoon (between 3-6pm)
- ☐ Saturday evening (between 6-9pm)
- ☐ Sunday early afternoon (between 12-3pm)
- ☐ Sunday late afternoon (between 3-6pm)
- ☐ Sunday evening (between 6-9pm)
- ☐ Other: _____

Appendix 15: Testing Session Signup Form

This form was hosted by Google Docs at
http://spreadsheets.google.com/viewform?hl=en&formkey=dHRTZDZHN1UyeWE4OH
g4Mm5qQ1VER3c6MA.. A redirect page was also created at
http://djvill.people.wm.edu/signup.html for ease of copying and pasting.

Testing Session Signup

Please sign up for a testing session below. Your responses will be kept strictly confidential.

You can also choose to bring a friend along to the same session you are signed up for. If so, please sign your friend up below.

All sessions will be held in the Dulin Learning Center (at the back of the first floor of Swem Library).

* Required

Name *
Last, First
_____

Email Address *
_____

Choose the session you will be attending *
Sign up for ONE session, and please note that this IS a commitment to the session you sign up for.

- o   Saturday, October 3, 3-4pm
- o   Saturday, October 3, 4:30-5:30pm
- o   Sunday, October 4, 6-7pm
- o   Monday, October 5, 6-7pm
- o   Monday, October 5, 7-8pm
- o   Tuesday, October 6, 8-9pm

Will you bring a friend? *
Please note that if you put a friend down, he/she is also committed to coming to the session.

- o   Yes
- o   No

Friend's Name
If bringing a friend
_____

Friend's Email
If bringing a friend
_____

Appendix 16: Notes Sheet

       All participants received this sheet after turning in their consent forms, with a moderator writing their group name on the "Experimental group" line:

Notes Sheet

Name: _____

Date: _____   Experimental group: _____

Please use the space below to take whatever notes you would like.

Appendix 17: Geographical Distribution of Student Participants

Below is a representation of where student participants had lived prior to attending William and Mary. Note that if one participant had lived in more than one region, that participant would count for both, so the totals for each map are greater than 84, the total number of participants.
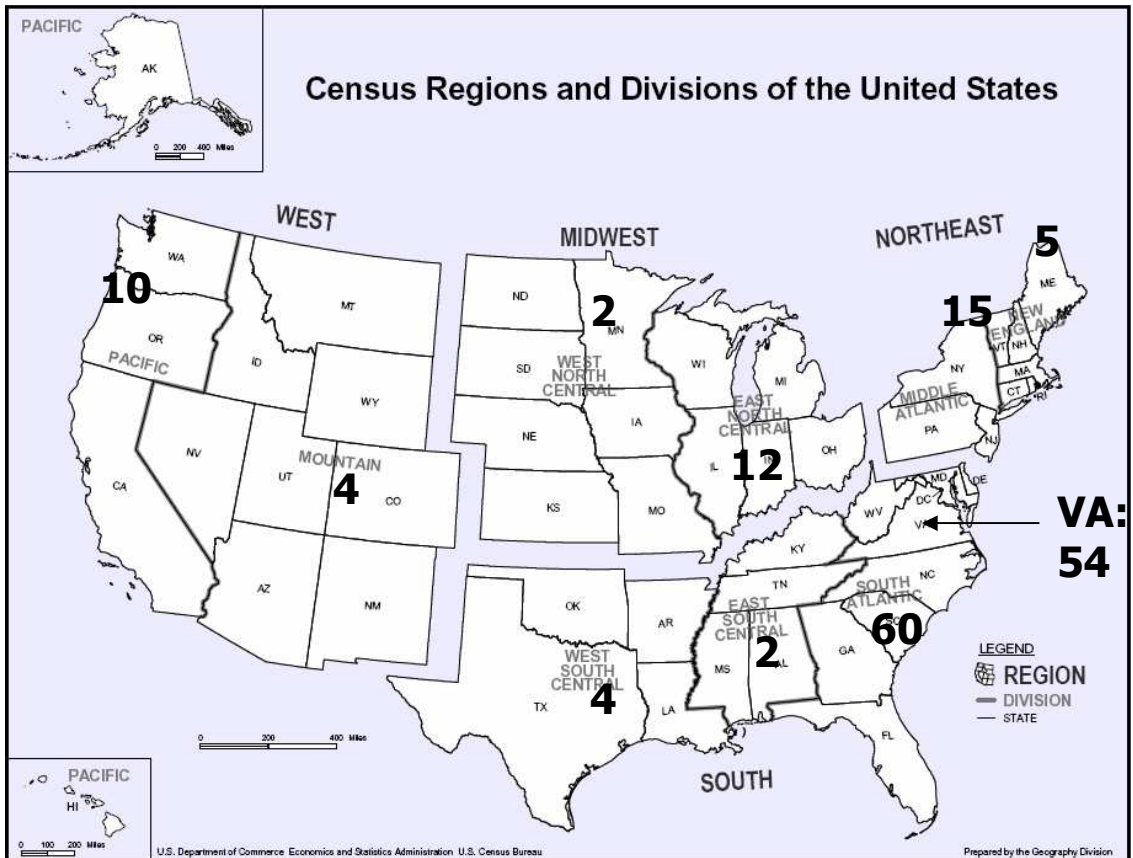
Images courtesy Wikipedia:
http://en.wikipedia.org/wiki/File:Census_Regions_and_Divisions.PNG
http://en.wikipedia.org/wiki/File:Equirectangular-projection.jpg

Appendix 18: Discussion Session Signup Forms

       Three discussion session signup forms were created for the three different module groups (Control, Bias, and Training), so that participants would take part in discussions only with other members of their module group. The only differences between the three forms were the titles and times available for signing up. The Bias form, for example, was hosted at http://spreadsheets.google.com/viewform?hl=en&formkey=dDZLWDIyVHpQcWV6Sjdl WjJYS0pDNXc6MA:

Discussion Session Signup B/Order Form

Please sign up for one of three discussion sessions below and fill out the order form. All discussion sessions will be held in the Linguistics Lab (on the main floor of Tyler Hall) and lunch will be delivered at the beginning of the session. All orders are from the Cheese Shop on Duke of Gloucester Street.

* Required

Session Signup

Name
* Last, First

Which discussion session will you attend? *
Please email me at djvill@wm.edu if you cannot make any of the sessions.

- o Sunday, October 18, 4:30-5:30pm
- o Monday, October 19, 6:30-7:30pm
- o Wednesday, October 21, 6:30-7:30pm

Food Order

Sandwich Order
All sandwiches come from the Cheese Shop

- o Roast Beef
- o Turkey
- o Virginia Ham (Edwards of Surry)
- o Combo (Turkey & VA Ham)
- o Baked Ham
- o Smoked Turkey
- o Corned Beef
- o Sliced Chicken
- o Usinger Salami & Cheese
- o Cheese (choose 1, 2, or 3)
- o Pate
- o Prosciutto on Focaccia (with provolone & roasted tomatoes)

- o Chicken Salad (with applewood bacon)
- o Tuna Salad (with grapes & walnuts)
- o Shrimp Salad
- o Egg Salad
- o Braunschweiger
- o Bar-B-Q
- o Veggie (with Edam on Focaccia)
- o Salmon (cream cheese on bagel)
- o Grilled Cheese
- o Peanut Butter & Jelly
- o Corn Dog
- o VA Hot Smoked Salmon (with mesclun greens on Focaccia)

Condiments

- o House Dressing
- o Mayonnaise
- o Mustard

Bread

- o French
- o Rye
- o Whole-wheat

Cheese
Choose more than one ONLY if you select the Cheese sandwich above

- ☐ Swiss
- ☐ Light Swiss
- ☐ Cheddar
- ☐ Edam
- ☐ Provolone
- ☐ Havarti
- ☐ Pepper Jack

Add-ons
Sorry, budget will only allow for one add-on per sandwich!

- o Watercress
- o Sprouts
- o Roasted Tomatoes
- o Roasted Peppers

Beverage
20oz bottles

- o Aquafina
- o Pepsi

- o   Diet Pepsi
- o   Dr. Pepper
- o   Diet Dr. Pepper
- o   Sierra Mist
- o   Mountain Dew

The form for the Control group was titled "Discussion Session Signup C/Order Form" and had session options of Saturday, October 17, 4:30-5:30pm, Sunday, October 18, 7:30-8:30pm, and Tuesday, October 20, 7:30-8:30pm. The form for the Training group was titled "Discussion Session Signup T/Order Form" and had session options of Saturday, October 17, 3-4pm, Sunday, October 18, 6-7pm, and Monday, October 19, 8-9pm.

Appendix 19: Discussion Session PowerPoint Presentations

PowerPoint presentations were used as visual aids during discussion sessions to structure the sessions and display discussion questions. Since the sessions were segregated by module group (Control, Bias, and Training), each session viewed a slightly different presentation. The Training group presentation follows:

Second Discussion Question

Do you talk about professors' accents a lot with your friends?

Third Discussion Questions

Have you ever dropped a class or even changed your academic plans because the professor had a foreign accent? What about other students you know?

Fourth Discussion Question

What do you think impedes communication between students and professors the most, regardless of accent?

Fifth Discussion Question

What do you wish professors (or even the College) would do to deal with the issue of the communication gap between undergraduates and mathematics professors?

Sixth Discussion Questions

Do you feel that you gained anything from this process?

Do you think that you are now at least somewhat better equipped to deal with issues of accent in your instructors?

A Look Inside…

- "Closing the Communication Gap Between Undergraduates and Mathematics Professors"
- Three major treatment groups: Control, Bias, and **Training**.
- Three different lesson videos: Root2, Relations, and Perm-Comb (all from NPTel Website)
- Six different permutations of 2 videos
- 18 testing groups

The Sorting Hat

Subgroup → Group ↓	A then B [0]	A then C [1]	B then A [2]	B then C [3]	C then A [4]	C then B [5]
Control (0, 3)	ACtrlB	ACtrlC	BCtrlA	BCtrlC	CCtrlA	CCtrlB
Bias (1, 4)	ABiasB	ABiasC	BBiasA	BBiasC	CBiasA	CBiasB
Training (2, 5)	ATrngB	ATrngC	BTrngA	BTrngC	CTrngA	CTrngB

A = Permutations and Combinations
B = The Proof That the Square Root of 2 is Irrational
C = Relations and the Cartesian Product

	0	1	2	3	4	5
0, 3	Apricot	Honeybee	Primrose	Daffodil	Lily	Sunflower
1, 4	Nature	Butterfly	Iceberg	Quill	Eggplant	Market
2, 5	Gateway	Opal	Clarinet	Jackrabbit	Radish	Fuchsia

Testing Session Mechanics

- Random coordinate pair in $\mathbf{Z}_6 \times \mathbf{Z}_6$
- URLs you went to (http://djvill.people.wm.edu/clarinet_lesson.html) were all redirects, in this case to http://djvill.people.wm.edu/Root2.html.
- The "mid" URL for everyone in this room redirected to http://djvill.people.wm.edu/Opening.html
- Lesson 2 URL pretty much the same as Lesson 1
- But what did those other groups see?

Bias Module

- Designed to represent real-life campus dialogue about foreign-accented professors

- http://djvill.people.wm.edu/DailyPenn.html

Control Module

- Designed to present a neutral point of view

- http://djvill.people.wm.edu/Ideation.html

Training Module

- The real crux of the experiment; designed to train students to better understand Prof. Krithivasan's accent.

- http://djvill.people.wm.edu/Opening.html

And now, the final question…

Do you think that programs such as these would be effective in dealing with the communication gap?

Be honest! My feelings won't get hurt ☺

There were only small differences between this presentation and the presentations for the Control and Bias groups. First, the second question under "Sixth Discussion Questions" ("Do you think that you are now at least somewhat better equipped to deal with issues of accent in your instructors?") was omitted from the other presentations, as it did not seem to be appropriate. Second, on the "Sorting Hat" slide (the white table), the different lines of the table were put in boldface font to match the group viewing the presentation. Third, the Control and Bias presentations omitted the "Control Module" and "Bias Module" slides. All three presentations, however, included "Training Module" as the third-to-last slide, as it led into the final question about the possible effectiveness of accent training programs. In all presentations, the links on the module slides were used to walk the groups through each of the modules.