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The Effects of Cognitive Load on the Perception of Foreign-Accented Words

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THE EFFECTS OF COGNTIVE LOAD ON THE PERCEPTION OF FOREIGN-ACCENTED SPEECH

LEAH M. BONATH

ABSTRACT

A significant amount of the research conducted in the area of foreign-accented speech has examined the influence that intelligibility, comprehensibility, and strength of accent have on the perception of foreign-accented speech. Factors such as speaking rate, signal-to-noise ratio, number of talkers, familiarity with the foreign-accent and, most relevant to the present study, cognitive load all play a role in how accented speech is perceived. In the current study, we explored the inverse of this relationship. We hypothesized that degree of cognitive load would affect participants' accent ratings. The purpose of this research was to evaluate two competing hypotheses. According to a difficulty-based account, increases in cognitive load should lead to increased accent ratings, such that both native and non-native accents are rated stronger. According to an alternative resource-based account, increases in cognitive load should push accent ratings toward more neutral ratings, such that native accents are rated stronger and non-native accents are rated weaker, as there will be fewer available resources to attend to the accent-rating task. Results showed that cognitive load led to significantly weaker ratings of the foreign-accented speakers, as predicted by the alternative resource-based account. However, the influence of cognitive load only emerged in a high cognitive load condition, and cognitive load had no significant effects on the native-accented speakers. In addition to a

number of potential practical implications for accented speakers, our results have important theoretical implications for the perception of foreign-accented speech and for the relationships between language and accent perception.

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CHAPTER I

INTRODUCTION

In the most recent report by the United Nations (2016), approximately 244 million people worldwide are classified as immigrants. Between 2000 and 2015 the United States is reported to have to the largest percentage of immigrants. These data suggest that it is not uncommon for listeners to encounter foreign-accented speech. In the present study, we aimed to further our understanding of how listeners perceive foreign-accented speakers. Specifically, I examined whether or not manipulations in cognitive load influenced participants' subjective ratings of a foreign accent. Participants were asked to rate accented words while simultaneously performing a relatively difficult secondary task (high load), a relatively easy secondary task (low load), or no secondary task (no load). Understanding how foreign-accented speakers are perceived is an important topic with real potential for widespread practical implications.

Foreign Accents and Comprehension

The relationships between foreign-accented speech and comprehension, intelligibility, and perception have been widely studied in the field of spoken language research. Much of the literature focuses on how foreign accents affect speech processing

and comprehension (Bent & Holt, 2013; Bradlow & Bent, 2003; Bradlow & Bent, 2008; Clarke & Garrett, 2004; Flege, Munro, & MacKay, 1995; Levi, Winters & Pisoni, 2007; Shi & Farooq, 2011; Ulbrich, 2013). However, there have been only a few studies that have looked at the inverse of that relationship, how degree of speech comprehension affects the perception of accents (Behrman & Akhund, 2013; Derwing & Munro, 1997; Kennedy & Trofimovich, 2008).

It is important to understand how the difficulty of the speech being produced affects the perception of foreign accents for a number of reasons. One such reason is the increasing number of international students and international job opportunities. Employment opportunities, travel, and technology are making interactions with someone who speaks a native language other than your own increasingly likely. Consequently, it is becoming increasingly important for foreign-accented speakers to understand the circumstances under which his or her speech may be more difficult for listeners to understand. It is also important in a classroom setting, as instructors with foreign accents may be unfairly judged as being difficult to understand if the topic of study is difficult. Identifying the factors that have the potential to cause speech to be more or less comprehensible will allow foreign-accented speakers to optimize their communication with native speakers of that language.

There have been a number of variables that have been identified in previous research that could potentially increase or decrease comprehensibility, perceived accentedness, intelligibility of speech, or any combination. The simplest of these is the ability of the listener to adapt to foreign-accented speech. A study conducted by Bradlow and Bent (2003) showed that familiarizing the participants with an accent improved their

ability to understand that speaker when listening to sentences. Bradlow and Bent (2003) also found that familiarizing the participants with multiple talkers before administering a post-test led to even greater performance when transcribing sentences than training with a single talker. A later study conducted by the same authors in 2008 supported these findings and showed that with a single talker, adaptation to accented speech is affected by the intelligibility of the individual talker, but when exposed to multiple talkers during training, participants are able to better understand the speaker in the post test. It was also found that the more intelligible the talker was, the faster the participants were able to adapt to the speech (Bradlow & Bent, 2008). In the Bradlow and Bent studies (2003; 2008), training occurred over the course of two days and after the second day's training was completed, a post-test was immediately administered. However, Clarke and Garrett (2004) found that adaptation to foreign-accented speech occurs after as little as two to four sentences of exposure. These studies provide evidence that accent perception can be altered so that increased experience with the same type of accented speech can cause it to seem less accented. Given these findings, the question of why foreign accents can be so difficult for listeners to understand remains unanswered. A number of alternative possible explanations will be discussed below. In the present study, I aim to look at one particular factor, cognitive load, and its role in listeners' perception of foreign accents.

Speaker-Dependent Variables

Timing or *speaking rate* is another of the variables that can affect how understandable foreign-accented speech is to a listener. It might be intuitive to believe that when listening to a foreign language or a speaker with a strong foreign accent, it

would benefit the listener if the speaker slowed down his or her speech. In support of this idea, Jones, Berry, and Stevens found that when using a text-to-speech method to deliver a message, the comprehensibility of the message was lower at faster speaking rates than at slower ones (2007). Shi and Farooq found that slowing down speech also benefited non-native listeners both with and without noise (2011). When participants were allowed to control the rate of the foreign-accented speech that they heard, participants slowed the speech down, which improved their comprehension. Participants' comprehension scores decreased as their control over the rate of speech decreased (Zhao, 1997). On the other hand, Derwing and Munro (2001; see also, Munro & Derwing, 2001) suggest that there is a limit to how slow speech can become before it becomes disadvantageous to the listener. That is, these researchers found that the relationship between speech rate and comprehensibility results in an inverted u-shaped function, suggesting that as long as the cognitive demands of processing the language are not too great, such as when proficiency in the language is high, the listener can benefit from faster speech (Derwing & Munro, 2001). In another study, listeners rated speech at a normal rate as more comprehensible than both the slowed down and sped up stimuli (Munro & Derwing, 2001).

Taking all of these studies into account, it appears there may be an ideal speech rate range for comprehension. However, the exact range may vary depending on how proficient the speaker is in that language, such that less proficient listeners would prefer slower speech while more proficient speakers would be able to listen to faster speech with less difficulty. These findings provide further support for the malleability of accent perception. The present study will avoid any potential issues related to speech rate by only presenting participants with one word at a time.

The *number of talkers* has also been shown to play a role in how comprehensible foreign-accented speech is to the listener. Bent and Holt (2013) conducted two experiments, the first of which looked at whether a single talker or multiple talker condition would lead to higher word identification rates. In this experiment, the participants in the single talker condition were able to accurately identify more words than the participants in the multiple talker condition. The second experiment further extended the results by using a within-participants design to test the effects of individual accents in the single talker condition. All participants heard single and multiple talker blocks, but which accent the participants heard varied in the single talker blocks. The findings from this experiment showed that when the multiple talker condition is comprised of speakers with the same foreign accent, word recognition is improved. However, the single talker condition still had the overall highest levels of word recognition, supporting the findings by Brent and Bradlow (2003; 2008) and Clarke and Garrett (2004), mentioned earlier, in that adaptation to a specific accent in the multiple accent condition contained words from speakers of various backgrounds and therefore listeners would not be able to adapt to the accent and improve their performance.

Another speaker-dependent factor that affects perceived accent is the *age of acquisition* of the speaker's second language (L2). A study by Flege et al. (1993) provides support for the idea that there is a critical age after which speech in an L2 will be accented. In particular, Flege and his colleagues found that native Italian speakers who learned English before the age of 15 were much more likely to be rated as non-accented than native Italian speakers who learned English after the age of 15. This study also found a gender effect when learning an L2. When the L2 was learned in childhood,

females were found to be less accented than males, but when the L2 was learned in late adolescence, males were found to be rated as less accented than females, possibly due to differences in language use patterns. Length of residence in the country that spoke the participant's L2 was also found to have a small effect on foreign-accent ratings (Flege et al., 1993).

Speaker-Independent Variables

There are also some speaker independent factors that can affect how foreign accents are perceived. Two of them, lexical frequency and listening context, were examined in a study conducted by Levi et al. (2007). In this experiment, commonly used (high frequency) words and uncommon (low frequency) words were spoken by speakers with native- and non-native (German) accents. About half of the participants only heard the words spoken, and the other half were aided by the spoken word also appearing on a screen. The researchers found that the high frequency words were listed as less accented than low frequency words. Also, seeing the words on a screen at the same time as hearing them had two effects. First, it lessened the effect that word frequency had on perception of accent. Second, the participants in this condition rated native English speakers as less accented while rating non-native speakers as more accented compared to the ratings given to native- and foreign-accented speakers who did not see the words presented visually to them on the screen.

Comprehension Affects Foreign Accent Perception

In the present work, my focus is on the inverse of this relationship between comprehension and foreign accent perception. There has not been as much research looking at how comprehension can influence subjective accent perception, but a few studies have touched on the topic. Derwing and Munro (1997) examine the relationships between intelligibility, comprehensibility, and accentedness when asking participants to listen to a short story told by speakers with foreign accents. Their results show that the majority of accent ratings fell between 6 and 8 on a 1 to 9 scale (1 is no accent, 9 is extremely strong accent). Comprehensibility scores were generally rated 5 or less on a scale of 1 to 9 where 1 is extremely easy to understand and 9 is extremely difficult to understand. To measure intelligibility, participants copied down the sentences that they heard and the number of errors made in transcription was recorded. Participants generally had 80% or more correctly transcribed words (60% of the passages were completely accurately transcribed). These findings suggest that listeners' subjective perception of accents is somewhat independent of intelligibility, although the authors were cautious not to make strong claims regarding the exact cause of the discrepancies between accent ratings and intelligibility.

Semantic context is another one of the ways this relationship has been studied in the past. Kennedy and Trofimovich (2008) studied whether semantic context and what they called "real-world expectations" (sentences that could be answered as a true or false statement) affect perception of foreign accents. Their results indicated that the sentences that were more difficult to understand (semantically meaningless) were rated as more

accented for the non-native speakers. The true-false statements were judged to be more accented than the semantic contexts as well. The authors themselves state that these results are surprising because the speakers are the same throughout the experiment, but attribute these results to Munro and Derwing's (1995) paper that suggested the listeners' ability to understand the nonsense speech affected accent ratings. A similar study (Behrman & Akhund, 2013) tested the same question but added strength categories to the accents to see the effect that a stronger accent had on the listeners' understanding. Similar results were found in that the semantically meaningful sentences were found to be less accented than the meaningless sentences. Semantic context was found to have the largest effect on the strongest accents and the true-false statements were rated as more accented, as in previous work.

A strength of the design in the present study is the use of the *exact same recordings* of each word for all participants. Using the same recordings prevents any possible differences in accent ratings being attributed to noise or other objective differences. The use of single words instead of sentences, as used in some of the studies mentioned previously, also limits what each participant is hearing so that the results cannot be attributed to anything but the perception of the accent. Additionally, a simplified, non-linguistic cognitive load task can increase difficulty between conditions while keeping the list of stimuli the same across all participants.

Cognitive Load

Cognitive load can play a role in the way language is perceived. Rudner, Lunner, Behrens, Thorén, and Rönnberg (2012) give an example of this by describing the cocktail

party problem. These researchers state that it is harder to hear what someone is saying to you when your attention is split between that person's speech and all of the other noise in the room. Researchers presented participants with hearing loss with speech at varying signal-to-noise ratios (SNR) and the participants rated how difficult it was to understand the speech at each of these ratios. It was found that while participants performed better with modulated noise, as opposed to steady-state noise, they reported that this task was more difficult to perform. While increased performance is most likely attributed to the brief periods in noise reduction in the modulated stimuli, the authors attribute the higher difficulty ratings to the participant needing to pay closer attention to the changing levels of signal and noise.

Also related to speech and working memory, Goldinger, Pisoni, and Logan (1991) found that recall for words presented by one talker was better than recall for word lists read by multiple talkers. Goldinger and colleagues found that initial perception for the words spoken by multiple talkers was slower than single talker words. If these findings can be extended to sentences as well as words, this finding could have important implications for academic settings where students are routinely asked to recall pieces of spoken information. More directly related to the present study, if accent is included in the list of factors that affect word recall, students with professors who have a foreign accent may be at a disadvantage. Rudner et al. (2012) reported that participants reported more difficulty, likely due to a need to increase their attention, but better performance on a modulated-noise task. Modulated noise for that study, as opposed to static noise, was noise that increased and decreased in volume throughout the presentation of the word. This may seem to contradict the Goldinger et al (1991) study where difficulty, despite

assumed increase in attention, would still lead to decreased performance. However, the easy task with a SNR study (no noise) is extremely easy. Students in a classroom setting would be starting with a more difficult task, remembering course material, and when that is compounded with a foreign accent, their performance may be worse despite any increase in attention.

Chen and Chang (2009) investigated how cognitive load, test performance, and foreign language anxiety (the anxiety felt when faced with a foreign language) interact with one other. It was hypothesized that when dealing with anxiety from a foreign language, more cognitive resources are being used and test scores would suffer. The results supported this hypothesis, with the authors reporting that foreign language anxiety and increased cognitive load were in fact related, such that test scores declined in individuals with higher anxiety.

In the present study, I focused on the subjective perception of foreign-accented speech. I aimed to understand if hearing a foreign-accented word when faced with a challenging task (high cognitive load) would affect listeners' accent ratings.

Rating Foreign Accents

As the present study involves rating accented speech, it is important to note previous research on this topic. Huang (2013) asked participants with varying types of accent familiarities and levels of English as a Second Language (ESL) training to rate how accented they thought speech samples by foreign-accented speakers were. Although the ratings did not actually differ depending on the participants' previous experience with certain accents and teaching experiences, the participants reported that they felt they were

being more lenient or biased toward those whose accents they were more familiar with. These findings were supported by Winke, Gass, and Myford (2012). Both studies obtained support for the notion that foreign accents may be perceived as less accented when the participant is more familiar with the accent being spoken. These studies show that foreign-accented speech ratings can be affected by the listeners' experience.

One hypothesis for the study is that as difficulty increases, perceptions of foreign-accented speech will be rated as more accented, if cognitive load acts similarly to semantic context. As the studies used participants familiar with the language and did not manipulate cognitive load, it is not particularly surprising that they did not find differing ratings (Bradlow & Bent, 2003; Rudner et al., 2012). It is interesting to note that the participants' perceptions changed, which provides support for the present hypothesis that perception can differ from the objective degree of accentedness of the speech.

Whenever considering participants' ratings or judgments, it is also important to take the effects of anchoring into consideration. *Anchoring* is the way in which being presented with one stimulus (in the present study's case, a foreign accented speaker) could affect the judgment of any subsequent stimuli (Wilson, Houston, Etling, & Brekke, 1996). However accented the participants perceive the first stimulus they hear to be could serve as the anchoring point for how accented all other speech sounds. To minimize any possible anchoring effects, the present study is using a within-participants design. In addition to counterbalancing cognitive load and the order of native- and foreign-accented words, ratings during the, no, low, and high cognitive load blocks are compared within the same participant so that any anchoring effects will be confined within an individual participant's ratings. If a participant begins in the high cognitive load condition and is

anchored to a higher (more accented) point on the scale, these higher ratings will be compared within the participant and will not affect the relative, lower anchored ratings of another participant who began in the no load condition.

Previous Work

The present study is based off of findings from recent work done by Incera, Shah, M^{c}Lennan, and Wetzel (2016) on perceptions of accented spoken language using sentences with semantic contexts that did or did not make sense. In their study, participants were given 12 meaningful and 12 meaningless sentences and asked to rate the accentedness of the last word in the sentence. The sentences, except for the last word, were spoken by a native accented female speaker and the last word was spoken by a foreign accented male speaker rated as having a moderate degree of accentedness, and this final word either did or did not make sense with the rest of the sentence. The same speakers were used in both the meaningful and meaningless conditions and so perceived differences in accent ratings would be due to the semantic context manipulation and not differences in objective accentedness. MouseTracker (Freeman & Ambady, 2010) was used to record participant reaction times, responses and trajectories of the mouse in order to show how participant responses unfold in real time. Participants were given the response options "weak accent" and "strong accent" as two response boxes and clicked on one of them to end a trial. It was found that accentedness ratings increased significantly in both the native and foreign accent conditions in the meaningless condition compared to the semantically meaningful condition. When the context did not make sense, participants reported hearing a stronger perceived accent than when the context did

make sense. However, it is unclear as to why these findings occurred. It is possible that participants in the meaningless condition were responding to the oddness of a meaningless sentence and blamed this oddness on a stronger accent. This question is addressed in the current study by removing the semantic context and using single-word stimuli.

The Present Study

The current study builds on this work by teasing apart the possible reasons for the findings. By using single words instead of sentences in the present study, the effects of semantic context on the perceptions of accents that were found in Kennedy and Trofimovich (2008), Munro and Derwing (1995), and Behrman and Akhund (2012) will no longer be a confounding factor.

There are two competing hypotheses for the current study. Either cognitive load will act similarly to semantic context and the results will be similar to the findings of Incera et al. (2016), or cognitive load will reduce participants' abilities to attend to the task and accent ratings will approach chance as cognitive load increases. The addition of a cognitive load secondary task paired with the lack of semantic context allows for a more direct interpretation of whether changes in accent perception are related to difficulty (manipulated by increases in cognitive load) or some other factor (such as semantic context). The practical implications of this work in the areas of academia and medicine will be discussed.

CHATPER II

METHOD

Participants

Seventy-three native monolingual English speakers were recruited for this study[1]. One participant was excluded due to having a native Australian accent, which could potentially confound responses to the native accented speakers used in this study. The final number of participants included in the study was 72. All participants were undergraduate students at Cleveland State University, ages 18-30 (M = 19.03 (2.08)), 12 Males and 60 Females, who participated in the study for research participation credit. All participants were right-handed and reported having no hearing or speech impairments. [2]

Design

The design was a 2 X 3 X 2 mixed-design. The factors were Accent (Foreign, Native), Cognitive Load (No, Low, High) and Instructions (Focus on Accent, Focus on Cognitive Load). Accent and Cognitive Load were within-participants while the

[1] A G-Power analysis was performed to determine the number of participants needed. With a conservative effect size estimated at 0.25, α=0.05, and β=0.80 a minimum of 19 participants is needed per condition. To be able to counterbalance evenly between conditions, a multiple 24 is the fewest participants required.

[2] Gender and age were collected for reporting purposes. Participants were also asked if they have any experience with foreign accents that could be considered to be above average (a family member or close friend with an accent) but these data are beyond the scope of this thesis.

Instruction conditions were between participants. The accent condition (foreign- or native-accented) was counterbalanced using a within-participants design so that all participants heard 12 foreign- and 12 native-accented words in random order. In addition, all participants completed a secondary cognitive load task with no, low, and high levels. The low and high conditions closely followed the procedure detailed in Francis and Nusbaum (2009) so that in the low cognitive load condition, the participants were presented with 2 two-digit numbers (e.g., 26, 68) at the beginning of the block and in the high cognitive load condition participants were presented with 5 two-digit numbers (e.g., 17, 30, 92, 76, 65). The numbers were chosen randomly by a random number generator and were the same across participants. Numbers with two of the same digit (i.e., 11) were excluded. The numbers were presented one at a time for two seconds on the screen with a one second break in between numbers. After the blocks that had a cognitive load, participants were asked to recall as many of the numbers as they could from the beginning of that block, as illustrated in Figure 1. Each block consisted of eight words for a total of three blocks per participant. The order of cognitive load levels was counterbalanced between participants. The order of the speakers was also counterbalanced as described below in *Stimuli*. Each speaker heard eight words per block but heard all speakers at least one time per block. The exact same recording of each word was heard multiple times between participants so differences in ratings across participants could be attributed to perception and not to the recording itself.

Stimuli

Three male native speakers of American English in a Standard Midwestern Dialect were given a list of 24 target words and one practice word to read, which were

recorded and used in the native-accent condition. A list of all words is included below in the Appendix. All three male native speakers were students at Cleveland State University and did not participate in the experimental trials.

There were six practice trials where all foreign- and native-accented speakers spoke the same word. The 25 (24 target, one practice) words spoken by the foreign-accented speakers were recently recorded for a previous study (Incera et al., 2016). These speakers consisted of three male native speakers of Mandarin Chinese, Arabic, or Hindi. These speakers were matched on relative perceived accentedness before being included in the Incera et al. (2016) study, and were all rated as moderately accented.

None of the words were altered with noise or distortion, and the native and foreign accented words were matched on duration ($F_{(1,24)} = 3$, $p > 0.1$). Native speakers had a mean word duration of 510 ms, while the foreign speakers had a mean word duration of 530 ms.

All 24 target words were recorded by each speaker resulting in a total of 144 stimuli. Each participant only heard each word once to prevent practice effects. As a result, each participant heard four (different) words per speaker. Each participant heard 24 target words that were counterbalanced between speaker, accent condition, and cognitive load level. All stimuli were normalized and equalized to account for acoustic differences between the recordings not related to accent.

Procedure

Participants were asked to give informed consent and fill out demographic and handedness questionnaires before beginning the trials. Once completed, they first

completed a practice session with six trials before beginning the target trials. Participants were then asked to listen to a series of 24 words spoken either in a native (12) or foreign (12) accent, with either a no, low, or high cognitive load task, and rate how accented they thought the speaker was on a scale of 1-10. A 1 on this scale was the most native-accented sounding and a 10 was the most foreign-accented sounding. The left-to-right or right-to-left orientation of the scales (1-10 or 10-1) was counterbalanced between participants but low numbers remained native and high numbers remained foreign. Therefore, using this scale, a 5 would be considered a moderately strong foreign-accent. There were 12 final versions of the experiment, which were doubled to account for the differences in instructions between the participants. Half of the participants were instructed that while both tasks are important, the accent ratings are the primary task and the other half were instructed that the load task is the primary task. This manipulation could allow the data to show how attention to a particular task affects accent perception.

To measure participants' accent ratings, MouseTracker (see Freeman & Ambady, 2010 for details on the program) was used to record and track participants' responses in real time. Mousetracker recorded the trajectories of the participants' mouse movements approximately every 15 ms throughout each trial and the coordinates of the mouse click, which ended the trial. MouseTracker also recorded each participant's reaction times and coordinates on the screen where the mouse was clicked which corresponded to his or her choice on the scale. Participants were instructed to respond as quickly and accurately as possible. While accent ratings are subjective, accuracy for this task could mean rating accents appropriately for each accent type (rating foreign speakers between 5-10 and

native speakers from 1-5) or in terms of their own perceived accentedness (not rating all accents as 5 despite perceiving the accents as varying degrees of accentedness).

Each participant, after completing the practice trials, was presented with either no numbers or 2 or 5 two-digit numbers and asked to remember them for the duration of that block (eight trials). At the end of each block, except in the no load condition, participants were asked to recall as many numbers as possible and to write them on a separate response sheet. In the no load condition, participants were reminded that there were no numbers to remember and were prompted to move on. Participants then started the next block of trials and were presented with either a new set of numbers or, if the next block of trials was a no load block, the participants were prompted to begin the next block of trials. The order of the load conditions was counterbalanced and each participant was in each load condition once. Each participant's *x*-coordinate, which was converted to his or her response on the scale of 1-10 (described further in *Final Click*), reaction times, and number of correctly recalled numbers in the memory task were analyzed. Reaction time was measured as the time between word onset and the participant's click in the response area (scale of 1-10).

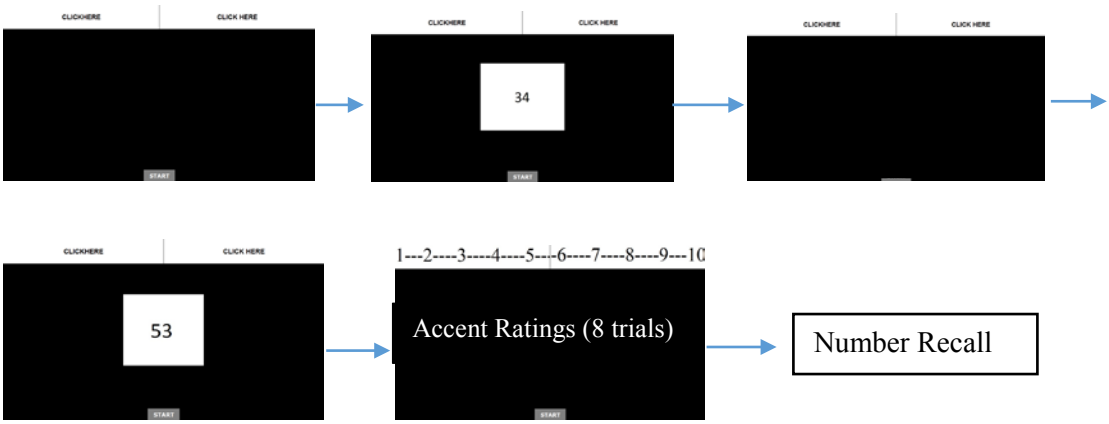

Figure 1: Progression of a block of trials (low load condition shown). The details of how a block unfolds is described in detail in the design and procedure sections above.

CHAPTER III

RESULTS

Accent ratings are subjective; there are no correct or incorrect responses and therefore, all trials were included in the analyses. Two dependent variables, reaction time (RT) and final mouse click (*x*-coordinate from 1 to 10), are reported below. A 2 (Accent: Foreign, Native) X 3 (Load: No, Low, High) X 2 (Condition: Accent Focus, Cognitive Load Focus) mixed ANOVA was performed on RTs and final *x*-coordinates (the location of the click on the 1-10 scale).

Reaction Times

RT data show a significant main effect of Accent ($F_{(1,70)} = 15$, $p < 0.001$, $\eta_p^2 = 0.17$. Participants were slower to rate the foreign speakers (M = 2,353 [2,240, 2,465]) than the native speakers (M=2,176, [2,079, 2,272] ms). No other main effects or interactions for RT were significant.

Table 1: Reaction times for foreign- and native-accented words per cognitive load condition. Asterisk denote $p < 0.05$.

	Mean [95% CI]				
	No	Low	High	High vs. No	Low vs. No
Foreign	2409 [2251, 2566]	2289 [2157, 2421]	2361 [2215, 2506]	-48	-120
Native	2150 [2039, 2260]	2188 [2070, 2306]	2189 [2042, 2336]	39	38

Final Click

MouseTracker records *x*-coordinates from -1, the far left of the screen, to +1, the far right. In order to convert these responses to the scale of 1-10 used for the response bar, a linear transformation was done on the data. Not surprisingly, a main effect of Accent was found $F_{(1,70)} = 1057$, $p < 0.001$, $\eta_p^2 = 0.94$. Overall, the foreign-accented speakers ($M = 6.60$ [6.27, 6.93]) were rated as more foreign-accented than the native-accented speakers ($M = 1.54$ [1.35, 1.74]). There was also an Accent X Load interaction $F_{(2,140)} = 4$, $p = 0.028$, $\eta_p^2 = 0.05$. Cognitive Load only changed the ratings for the foreign speakers (see Table 1). For the foreign speakers, post-hoc tests using Fisher's LSD revealed an interaction between accent and load. The High Load condition was rated as significantly less accented than the No Load condition ($p = 0.012$) and marginally less accented than the Low Load condition ($p = 0.068$). No other main effects or interactions were significant. For comparison, the final click results both collapsed across instruction

conditions (Table 2a), and separated by accent-focused instructions (Table 2b) and cognitive load-focused instructions (Table 2c) are included below.

The data suggest that, at least for the foreign-accented speakers, as cognitive load increases, accents are perceived as less foreign-accented. The same trend is observed with the native-accented speakers, but the differences between high, low, and no load conditions were not significant. These findings support the second hypothesis laid out in the Introduction in which increased cognitive load reduces participants' abilities to fully attend to the accent, so the ratings approach more central or neutral ratings.

Table 2a: Means and 95%CI for each cognitive load condition in the foreign and native accent condition collapsed across instructions. Asterisk denote $p < 0.05$.

	Mean [95% CI]				
	No	Low	High	High vs. No	Low vs. No
Foreign	6.83 [6.48, 7.18]	6.54 [6.14, 6.94]	6.42 [6.03, 6.80]	0.41*	0.13
Native	1.47 [1.22, 1.72]	1.47 [1.20, 1.74]	1.69 [1.37, 2.00]	-0.22	0.21

Table 2b: Accent ratings for each accent type and cognitive load condition for participants in the accent-focus instruction group only. Asterisk denotes $p < 0.05$.

	Mean [95% CI]				
	No	Low	High	High vs. No	Low vs. No
Foreign	6.78 [6.28, 7.27]	6.66 [6.10, 7.22]	6.56 [6.12, 7.12]	-0.22*	-0.12
Native	1.43 [1.08, 1.78]	1.55 [1.17, 1.93]	1.78 [1.34, 2.22]	0.35	0.12

Table 2c: Accent ratings for each speaker type and cognitive load condition for the cognitive load-focus instruction group only. Asterisk denotes $p < 0.05$.

	Mean [95% CI]				
	No	Low	High	High vs. No	Low vs. No
Foreign	6.88 [6.39, 7.37]	6.42 [5.86, 6.98]	6.27 [5.72, 6.81]	-0.61*	-0.46
Native	1.50 [1.15, 1.86]	1.39 [1.02, 1.77]	1.59 [1.15, 2.03]	0.09	-0.11

Memory Performance

The scoring procedure for the cognitive load number task followed Francis and Nusbaum (2009). Participants were scored per correct digit for a possible score of four correct on the low load condition and 10 correct in the high load condition. There was a main effect of Load ($F_{(1,70)} = 143$, $p < 0.001$, $\eta_p^2 = 0.67$). Participants in the high cognitive load condition remembered 66.94% ($SD = 21.21$) of the numbers, and participants in the

low cognitive load condition remembered 93.06% (*SD* =18.87) of the numbers. There was no significant main effect of instruction condition. The interaction between participants' performance on the memory task between the instruction conditions was non-significant ($F_{(1, 70)} = 0.58$ $p = 0.448$, $\eta_p^2 = 0.008$).

Table 3: Percent of numbers correctly recalled in each cognitive load condition (there are no numbers to remember in the no load condition, as shown with dashes) for the accent-focus and cognitive load-focus instruction groups. Asterisks denote significance levels of $p < 0.001$

	Mean [95% CI]			
	No	Low	High	High vs. Low
Accent	-	93.06 [86.74, 99.37]	68.61 [61.53, 75.69]	-24.44*
CogLoad	-	93.06 [86.74, 99.37]	65.28 [58.20, 72.36]	-27.78*

CHAPTER IV

DISCUSSION

The results of the current study showed that high cognitive load significantly decreased perceived accentedness in foreign speakers while the native speakers and low and no cognitive load levels remained unaffected. Accent ratings can be confidently attributed to participant perception because the identical recordings of each word by each speaker were used across all cognitive load conditions and, therefore, should have received equal ratings if cognitive load had no effect.

It is interesting to note that the current results show a very different pattern than the results in the Incera et al. (2016) study, which motivated the present study. In the Incera et al. (2016) study, participants rated both foreign and native speakers as more accented (increased ratings) when the sentence context was not meaningful. In the present study, I found no differences between the native speakers in any cognitive load level, and I also found that when cognitive load increased, accent ratings in the high load condition decreased for the foreign speakers. There are reason(s) for the different pattern of results between the current study and the previous work on sentence context merits further investigation. One possible reason that no differences were found in the native

speakers in the present study is that participants are so accustomed to their own native accent that the cognitive load manipulation was not sufficient to increase or decrease accent ratings (Bradlow & Bent, 2003; Bradlow & Ben, 2008; Clarke & Garrett, 2004). Another possibility is that participants in the Incera et al. (2016) study were responding to the oddness of the meaningless sentence context by choosing "strong accent." Finally, perhaps semantic context works differently from cognitive load in that lack of semantic context is not as cognitively demanding as some dual tasks, such as the high cognitive load condition in the present study. Further work should be conducted to identify the locus of the difference between the results of the two studies.

The current results, in which a decrease in perceived accentedness for foreign speakers was observed with high cognitive load, seems contradictory to what is observed, at least anecdotally, in everyday situations such as in the classroom. Such an apparent discrepancy may be due to the portion of the task in which participants are focused. That is, as accent ratings are subjective (there is no objective correct or incorrect answer), participants may have chosen to focus on the cognitive load task, performance on which is not subjective, regardless of what they were instructed to do. As a result, if participants focused primary on the cognitive load task in all conditions, they may not have been paying as much attention to the accent, and as a result either did not perceive it as strongly or simply chose a more neutral rating as they did not have the cognitive resources to attend to it. Perhaps, if participants can be driven to focus primarily on the accent, such as asking them questions about the accent (ie. how many speakers were heard) after a block instead of a number recall, the pattern of results may have changed. If this study were taken outside of the laboratory into more natural settings, it would be

interesting to see if students are primarily focusing on a professor's accent, and if so, would it sound more or less accented as the coursework became more difficult? It is unclear if it is possible to focus primarily on the coursework, and not the accent, in naturalistic settings, but if this were possible, the question remains whether such an attentional shift would lead to the same the pattern of results reported in this study. Of course, future work would need to be done to address this issue.

It is also important to note that the present study was still able to find differences between the accent ratings even when most speaker-dependent and speaker-independent features were held constant. By using individual words, whose recordings were matched on length, the present study was able to eliminate confounding effects potentially caused by speaking rate (Derwing & Munro, 2001; Jones et al., 2007; Munro & Derwing, 2001; Shi & Farooq, 2012; Zhao, 1997). All participants heard all six speakers an even number of times so while they still may be at a disadvantage compared to if they had only heard one speaker, this disadvantage should be constant across all participants (Bent & Holt, 2013). Also, Levi et al. (2007) states that words with low lexical frequency were perceived as more accented than words with higher lexical frequency. The words used in the present study (See Appendix) were all of relatively high lexical frequency and should have all been rated as relatively weakly-accented yet differences in cognitive load were still sufficient to evoke changes in perception.

One of the goals of this study was to address the findings of Clarke and Garrett (2004). Clarke and Garrett found that an individual can adapt to the accent of a speaker in as few as 2-4 sentences of exposure. However, in daily life outside the laboratory, accents remain a challenge to comprehension for a much longer period of time. Anecdotally,

students will say a professor's accent makes them hard to understand for the entire duration of the course. Gill (1994) provides some support for this observation. Students asked to rate foreign and native-born teachers reported a preference for the native-born teachers, perhaps in part because of this issue of accentedness. Semantic context is a meaningful way to observe how accentedness affects speech perception in the lab but meaningless sentences are not commonly encountered in in daily life unless a speaker's proficiency in the spoken language is extremely low. As this is not common in university settings, cognitive load seems to be a more realistic way to investigate accent perception. This line of research should help to address how accents can remain a barrier to comprehension even though adaptation can occur so quickly (Bradlow & Bent, 2003; Bradlow & Bent, 2008; Clarke & Garrett, 2004). If cognitive load uses up too much of a participant's (or student's) cognitive resource pool, this use of resources could possibly explain why they do not adapt as quickly to accents as the participants in the Clarke and Garrett study (2004). If the task is easy, there would be more resources to be devoted to the accent and so it would not be as much of an obstacle to comprehending speech as it could to be when the task is hard and there are fewer resources available.

Practical Implications

Classroom Setting

Research has shown that although listeners may report explicitly that they are not biased against foreign-accented speech, results of the Implicit Association Test (IAT) show that there is an implicit bias toward American-accented speech for American participants (Pantos & Perkins, 2013). The authors state that a possible reason for the foreign-accented explicit preference is that the participants may be slightly aware of their

implicit preferences and overcorrect their explicit attitudes to reduce the chance that they would look biased to the researchers. Also, many of the participants were from a group of students taking a class about biases toward foreign-accented speech, which may have skewed the way they reported their explicit attitudes. Regardless of the reason, this study shows that individuals are not always completely aware of their biases toward foreign-accented speech and this could possibly affect the way they perceive accents in the real world.

Evidence supports the idea that it is more difficult to understand a professor who speaks with a foreign accent than one who does not. Winke et al. (2012) found that listeners rated foreign-accents that were more similar to their own native language or accents that they were more familiar with as generally more understandable than unfamiliar accents. Moreover, Gill (1994) examined listeners' perceptions of accented teachers and how accents affect comprehension. Students assigned more favorable ratings to teachers with standard North American accents and teachers' accents affected comprehension. Anecdotal observations allude to the possibility that context may affect listeners' subjective judgments of the strength of a speaker's foreign accent. For example, students in college classrooms often report difficulty understanding foreign-accented instructors. I argue that the complexity of the material can impact the subjective perception of foreign accents, especially given that listeners often have no problem with the accent when the conversation is casual (less difficult). A controlled laboratory experiment investigation should lead to a better understanding of this effect. Students may report that their professor's speech is more accented if they attribute (or

misattribute) any difficulty with the class material (which would be associated with increasing cognitive load) to the foreign accent.

Clinical Setting

In the medical field, patients are often presented with complex and confusing medical information after they have received a diagnosis. If this information is sufficiently complex to use up a large portion of their cognitive resources and the doctor has an accent, patients may be more likely to have a negative bias toward that doctor. A bias due to the foreign accent could be confounded with other negative biases that immigrants face. Louis, Lalonde, and Esses (2010) presented participants with fictional resumes for two physicians that were being considered potential candidates for a job opening. Participants were asked to choose which candidate they would hire for the position based only on information from the resumes, which were the same except for the candidates' country of origin and location of their medical training. Louis et al. (2010) stated that although the foreign-born or trained doctors were trained in Pakistan, the quality of their schooling would be comparable to that of a UK school, so inadequate training would not be a reason to choose the UK-born doctor over the Pakistani-born doctor. The results showed that foreign-born candidates were rated as less favorable by the participants. However, if the candidates were trained in a first-world country (the UK was used in the study), participants were able to overcome the negative bias and rated these candidates as comparable to the native physician candidate. Outside the laboratory, doctors who are foreign-born and not trained in a first-world country may face biases in how they are perceived by their patients.

Future Work

This study serves as the first in a series of studies that would need to be done to further address the question of how cognitive load affects accent perception in more naturalistic settings. While the findings of this study are important, further studies would need to be done to address how cognitive load affects stimuli consisting of full sentences, and in more realistic contexts, such as a classroom. Chen and Chang (2009) showed that students who reported higher foreign accent anxiety performed more poorly on exams compared to those with less foreign accent anxiety. These findings could have important implications for students of professors with foreign accents and future work is needed to determine possible solutions for this issue. As a first step, future work could give participants a task where they have to follow complex instructions to complete the task successfully. Participants could be instructed by a native-accented instructor, or one with a foreign accent, who either encourages participants to ask questions if they do not understand something or to repeat back instructions to ensure they were understood or doesn't do so. Such a study would begin to get at a more realistic setting ("students" learning and following instructions of a "professor") before conducting an experiment with a class of actual students. Experiments set in medical contexts would be much more difficult to test, given strict patient privacy laws, but such experiments would be interesting in order to examine how the idea of high cognitive load situations affects the medical field as well, as physicians often have to deal with conveying technically difficult information to their patients. Finally, it may also be of interest to test another method of manipulating cognitive load. In the present study, there were no differences between the low and no load conditions and it is unclear whether that was due to a lack of

difficulty with the method used in the present study or if perception of accents is only affected when cognitive load is high.

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APPENDIX

Practice Word: Dream

Target Word List:

Stamp

Plate

Oven

Office

Play

Size

Tree

Dinner

Knife

Hair

Tip

Word

Milk

Neck

Broom

Color

Disease

Closet

Window

Letter

Mother

Cotton

Money

Dishes