The Linguistic and the Social Intertwined: Accommodation to Southern Speech

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1 Introduction

Five decades ago, William Labov objected to the term "sociolinguistics," on the grounds that there is no way to truly study language without taking social dimensions into account. Since then sociolinguists have continued to find that social and linguistic information are inextricably linked. Linguistic features have been shown to index various social meanings (e.g., Campbell-Kibler, 2009,0; Eckert, 2000; Mendoza-Denton, 2008). Conversely, individuals have been shown to possess implicit social knowledge that can influence the way language is perceived (e.g., Niedzielski, 1999; Hay et al., 2006a).

Discovering the mental reality underlying linguistic behavior has been a goal of linguists for at least the latter half of the last century (e.g., Chomsky, 1965). However, a focus on abstract properties and categorical phenomena means linguistic variability has often been viewed as a mere complication and discarded when this mentalist approach is adopted. Though there has been some work on the mental representations of variability in linguistic theory, such as the variable rule framework (Labov, 1969; Cedergren and Sankoff, 1974), much less attention has been paid to the representation of the social factors inherent in variability and how they interact with linguistic representations.

Linguistic accommodation[1], when language users alter their speech in response to an interlocutor, offers a strong testing ground for the cognitive interaction of linguistic and social information.

[1] I refer to the process where speakers shift their speech in response to the speech of their interlocutors as *accommodation*, in order to encompass both *convergent* and *divergent* responses to interlocutor speech. The term "accommodation" is rooted in the Communication Accommodation Theory (CAT) literature, and has connotations of speaker agency in managing social distance through convergence or divergence. While I make no specific assumptions at this point about speaker agency or the automaticity of accommodative behaviors, use of the term *accommodation* is fitting in that it connotes the importance of social dimensions, which aligns with the goals of the dissertation. I also alternately use the term *convergence* to refer specifically to accommodative behavior that entails becoming more *similar* to an interlocutor. The behaviors discussed here have also been referred to as with various other terms including alignment and spontaneous imitation.

For one, social factors are inherent in accommodation. While convergence can be (and has been) explained with automatic priming mechanisms that rely on tight perception-production feedback loops, divergence behaviors, which are well documented in the accommodation literature (e.g., Bourhis and Giles, 1977; Giles et al., 1991; Babel, 2010) are difficult to account for without appealing to social motivations. Furthermore, even convergence in relatively asocial laboratory contexts has been shown to be modulated by social and attitudinal factors (e.g., Babel, 2010, 2012). Additionally, accommodation likely comprises both more rapid, automatic perceptual behaviors, as well as more deliberate production behaviors. Understanding the cognitive basis of accommodation may shed light on the role of social information in linguistic behaviors that differ in automaticity and consciousness. Finally, it is possible that accommodation can have widely differing triggers (non-linguistic triggers such as social information) and targets, while still being considered the same basic phenomenon. Accommodation is a complex and rich phenomenon, making it ideal for answering a variety of questions on the mental representations of both linguistic and social information.

I crucially distinguish in the dissertation between two types of accommodation: First, is the more traditionally cited type of accommodation, which requires a linguistic target that is triggered by the same linguistic form[2] observed in real time. An example would be producing lengthened VOT for voiceless stops after hearing a talker produce voiceless stops with lengthened VOT. In other words, the target of accommodation and the trigger of accommodation are the same. I refer to this as *input-driven* accommodation because the target is directly derived from the input. I contrast this with what I refer to here as *knowledge-driven* accommodation, which entails accommodating toward a previously stored and then recalled target that is not locally observed. The trigger of convergence in these cases can be linguistic, but need not be, and the target is derived from expectations based on pre-existing knowledge. An example comes from Bell (2001) who recounts an Anglo interviewer who uses the tag *eh*—a stereotypical feature of Maori speech—frequently when conversing with Maori interviewee (but not when conversing with an Anglo interviewee) even though the Maori speaker did not use the tag. Though such *knowledge-driven* accommodation is theoretically possible and has been cited anecdotally, the phenomenon has not been established in a controlled laboratory study.[3])

In this document, I propose a set of experiments to test the relationships between linguistic and social information in both speech perception and production, using accommodation to the Southern dialect as a test case. The research questions guiding my inquiry can be outlined as follows:

1. **Is there evidence for knowledge-driven accommodation in a controlled laboratory setting?** Experiment 1 attempts to answer this question by determining whether participants converge to a Southern talker by producing more monophthongal /aɪ/ tokens, a salient Southern feature, after exposure to a Southern talker who produces no tokens of /aɪ/ throughout the course of the experiment.

[2] *Linguistic form* can refer to linguistic units at basically any level of linguistic structure, including but not limited to the acoustic properties of phonemes, syntactic structures, or lexical usage, as my definition of input-driven convergence makes no assumptions about the level of linguistic structure at which convergence operates or the extent to which convergence generalizes across lexical items or phonemes, for instance.

[3] Though note, a few recent studies have found shifts in participants' speech in response to social concepts, without an explicit interlocutor (e.g., Drager et al., 2010; Sanchez et al., 2015; Love and Walker, 2013). Additionally, addressee and topic-based style shifting have also been observed in the literature (Bell, 1984; Love and Walker, 2013), though style-shifting is generally considered to be shifting along a single spectrum of formality within a single dialect. It is unclear as of yet how these phenomena relate to knowledge-driven accommodation, though understanding this relationship is a goal of the dissertation.

2. **What cognitive mechanisms are responsible for the generalization observed in Experiment 1?** Experiment 2 investigates this question by manipulating the dialect labels for the talker toward whom participants have the opportunity to converge. I specifically attempt to tease apart two potential explanations: A socially-rooted, top-down explanation that relies on identifying the talker as "Southern" and a structurally-rooted bottom-up explanation that relies on knowledge of variant co-occurrence.

3. **What is the perceptual basis for accommodation, and is it the same for input-driven and knowledge-driven accommodation?** Experiment 3 compares responses to input-driven and knowledge-driven triggers in both perception and production to determine the perceptual underpinnings of accommodative behaviors and whether they are the same for both input-driven and knowledge-driven accommodation. Precise alignment of perception and production would support a more automatic mechanism of convergence in which production is derived directly from perception. I, however, predict only a partially automatic account that allows for the inhibition or enhancement of automatic behavior via social and attitudinal influences.

4. **What is the role of social information at both the perceptual and productive stages of the accommodative process, and does this vary for input-driven and knowledge-driven accommodation?** Experiment 3 includes various social and attitudinal measures derived via self-administered surveys in order to investigate inhibitory or enhancing roles of various social factors on accommodation. I determine whether social information modulates shifts in perception and/or production resulting from exposure to a model talker.

The immediately following sections provide an overview of the relevant background information. Section 2 discusses evidence of the interaction between grammatical and social information in linguistic processing. Section 3 provides an overview of the relevant literature on accommodation, as well as on cognitive models that may account for input-driven and/or knowledge-driven accommodation. Section 4 provides an overview of the Southern regional dialect, the test case and model for accommodation. I then go on to propose three experiments and present pilot results in Section 5 and conclude with a summary and discussion of contributions to the field in Section 6.

2 The relationship between the linguistic and the social

The strong relationship between the linguistic and the social was recognized relatively early on. In one of the first quantitative sociolinguistic studies, Fischer (1958), examined the social factors that influence variation of IN and ING in New England schoolchildren. He found that boys produced more of the non-standard IN variant, and that this finding stemmed from gender differences in conformity to linguistic norms. He further found that "typical boys" produced more of the non-standard IN variant than "model boys." On Martha's Vineyard, Labov (1963) found that centralization of the /au/ and /aɪ/ diphthongs correlated with a desire to identify oneself as a Vineyarder. Later, Labov (1966) found that use of vocalic *r* varied in predictable ways based on the social class of the language user, and the amount of attention paid to speech, such that higher social classes and more attention paid to speech correlated with increased rates of *r*. Rather than exemplifying "free variation" as had previously been assumed, these early studies all showed that previously unexplained linguistic variation patterned with the social attributes of the language users; this is referred to as *orderly heterogeneity* (Weinreich et al., 1968). Early studies providing evidence for orderly

heterogeneity were a first step toward understanding the cognitive relationships between the social and the linguistic, showing that these two dimensions vary together in predictable ways, though much of the focus was on the actual facts of language usage across various social dimensions and not as much on the way linguistic features are socially perceived. More recently, sociolinguistics have shifted attention to the fact that, not only do the social and the linguistic correlate, but the are linked mentally.

For instance, more recent *Third Wave* approaches to the study of sociolinguistics shift the focus from static macro-social demographic categories to real-time construction of social meaning. As Eckert (2012) notes, "variables cannot be consensual markers of fixed meanings; on the contrary, their central property must be indexical mutability. This mutability is achieved in stylistic practice, as speakers make social-semiotic moves, reinterpreting variables and combining and recombining them in a continual process of bricolage" (p. 94). Demonstrating that speakers utilize varying linguistic various to index a wide range of (ever-changing) social meanings suggests that the linguistic and the social do not just happen to covary, but that they must be linked together in a more substantial way in speakers' awareness. As Eckert (2012) puts it, "Whereas the first two waves viewed the meaning of variation as incidental fallout from social space, the third wave views it as an essential feature of language" (Eckert, 2012, p. 94).[4]

The ability of linguistic forms to actually signal social meaning has not just been inferred based on ethnographic work, but can actually be empirically tested. For instance, the primary tool for isolating particular social meanings attached to speech styles or variants is the Matched Guise task, for which participants rate various "guises" that differ in the linguistic dimension of interest on various social attributes. The original matched guise task, conducted by Lambert et al. (1960), examined bilingual French Canadians' attitudes toward French and English and found that English was typically rated higher on dimensions such as intelligence, likability, and even height, even though it was the same speaker (and content) they heard in both the English and French guises. Since then, the matched guise technique has been developed to examine the social meanings attributed to individual variants or clusters of variants as well. Often this involves synthetic manipulation of the same exact sound file. One well-known example is Campbell-Kibler (2011) who found that a guise using sociolinguistic variant ING was rated more intelligent, more articulate, and less likely to be a student, while the IN guise was rated less formal and less likely to be gay. It has been found repeatedly in the sociolinguistic literature that linguistic variants signal social meaning.

Conversely, social information has been shown to affect linguistic processing as well. In a most basic example, unexpected social information can hinder language processing. Expectations about a speaker have been shown to be extremely important to speech perception, and when expectations do not align, individuals are in general worse at perceiving speech. A notable example is that, when a man utters a sentence with semantic content outside of what might be expected for a man (e.g., "I'm pregnant") or when a child utters a sentence with content outside of what might be expected for a child (e.g., "I just quit smoking"), event-related brain responses indicate surprisal as early as 200-300 ms (Van Berkum et al., 2008). Relatedly, McGowan (2015) finds that, when a Chinese-accented voice is played, participants are more accurate in transcribing the recording when presented with a Chinese face than with a Caucasian face.

Social information of many different types has been shown to alter linguistic perception in pre-

[4]I discuss the Third Wave approach to sociolinguistic cognition here not because the dissertation is particularly grounded in the Third Wave framework (indeed, the social category of interest is the macro-level demographic category of regional origin) but because the third-wave focus on agency in manipulating linguistic forms for social means demonstrates the necessity for cognitive models that allow for tight linkage of social and linguistic information.

dictable ways beyond processing ease. For instance, beliefs about the region a speaker is from influence classification of linguistic variants. Niedzielski (1999) found that, when speakers believed they were listening to a Canadian speaker, they chose raised-diphthong tokens as representative of the /au/ diphthong, but when they thought they were listening to a Detroit speaker they did not, even though all speakers were listening to the same Detroit speaker; because the raised /au/ diphthong is stereotypically associated with Canadians but not with Detroit speakers (though both use it), participants perceived the token as more raised only when it fit their expectations based on speaker place of origin. Similar effects have been noted for beliefs about the age of a speaker. Similarly, Similarly, D'Onofrio (2015) found that listeners were more likely to look at and click on TRAP (as opposed to LOT) category words after hearing an ambiguous word between TRAP and LOT, when presented with an image signalling "California" or "Valley-Girl," both of which exemplify TRAP-backing. Hay et al. (2006b) manipulated the age of a speaker via pictures presented during the experiment. When asked to judge vowels undergoing merger for younger speakers of NZE, participants were influenced by perceived speaker age, such that those who saw an image of a younger speaker were less able to distinguish between the vowels in a perception task. In a similar study, Koops et al. (2008) found that the perceived age of a speaker influences the degree to which participants believe a speaker participates in the PIN/PEN merger, which is receding among younger speakers. Gender is another feature known to influence perception. For instance, Strand (1999) found that a listener's belief about the gender of a speaker influences categorization of /s/ and /ʃ/.

Such effects have been shown to occur even when participants are not told to attribute a trait to the speaker—or even when no speaker is present at all. For instance, in a partial replication of Niedzielski (1999), Hay et al. (2006a) found that participants who were told that they were listening to a New Zealander were still influenced by the words "Australia" or "New Zealand" printed at the top of their answer sheet, in that they were more likely to hear a fronter /I/ vowel in the Australia condition, reflecting the realization of this vowel in Australian English. Hay and Drager (2010) have suggested that even subtler nonconscious activation of regional groups can influence speech perception as well. For each experimental condition, a stuffed animal representative of either Australia (kangaroo and koala) or New Zealand (kiwi) was placed somewhere in the room, though the participant's attention was not drawn to it. This brief exposure to objects meant to simply *evoke* the concept of a particularly region was enough to influence participants' behavior on a vowel identification task. Though participants all heard the same vowels (which differ in Australian and New Zealand English) produced by a New Zealander, they classified vowels on a continuum differently depending on whether the concept of New Zealand or Australia was activated. Similarly, Sanchez et al. (2015) found that speakers in a corpus produced more Australian-like variants of KIT and TRAP (but not DRESS) when talking about Australian topics, and experimental participants showed the same effect after producing Australia-related lexical items. Relatedly, Love and Walker (2013) found that soccer fans in the UK became more r-ful when talking about American football. These studies all show that social information (even quite abstract social concepts) is able to influence both linguistic perception and production.

3 Linguistic accommodation

The dissertation focuses specifically on the relationship of social and linguistic information in linguistic accommodation. The literature on linguistic accommodation is vast, so I focus here on findings that bear directly on the three experiments proposed above. Section 3.1 addresses a com-

mon question in the accommodation literature: how much can the target of convergence generalize away from the trigger? This topic is particularly relevant to an investigation of knowledge-driven accommodation, in which some abstraction is necessary to get from a locally-observed trigger to a non-locally-observed target. Section 3.2 discusses potential mechanisms for convergence, juxtaposing primarily automatic mechanisms with mechanisms that allow for the influence social factors. Section 3.3 then focuses on the relationship between perception and production, particularly in regard to accommodation.

3.1 The target of accommodation

The crucial difference between input-driven accommodation and knowledge-driven accommodation is the extent to which the target of accommodation can generalize away from the trigger. We may, then, wish to think of input-driven and knowledge-driven accommodation not as categorically different phenomena, but as two points on a gradient scale. Convergence to the same lexical item previously heard from an interlocutor would be maximally input-driven—but what about convergence to the same phoneme but in a novel lexical item? What about to a different but related phoneme? There are in theory varying degrees to which accommodation could generalize, and the question of the extent to which accommodation generalizes is not new in accommodation research. The literature on this topic will be reviewed here.

There have been several claims in the literature that suggest that the target of convergence is quite narrow and unable to generalize. For instance, Goldinger (1998); Goldinger and Azuma (2004) argue that phonetic convergence does not extend beyond the lexical level, based on findings that speakers imitated various properties of lexical items they have heard, but imitation did not generalize to novel lexical items. Other studies have contradicted this claim with evidence that imitation is in fact generalized beyond the word level. Pardo (2006) for instance, found that speakers' vowel productions became more similar to their conversational partners'. Crucially, these productions consisted of words that participants did not hear in the exposure phase, suggesting that convergence can be generalized at the phonemic level across words.

Others have provided evidence that phonetic convergence can even generalize across phonemes. Importantly, Nielsen (2011) found that imitation of sub-phonemic features can be generalized to new lexical items and even new phonemes. Specifically, she found that, when participants were exposed to artificially lengthened VOT for /p/-initial words, not only did participants imitate artificially lengthened VOT for new /p/-initial words, but they also produced lengthened VOT for new /k/-initial words, though the effect was somewhat weaker. She proposed that the target of imitation in this case may be at the level of the shared [+ spread glottis] feature, though the mechanism that allows for such generalization is not apparent. Recent work by Wilson et al. (2016), for instance, questions this assumption that the target of convergence might be featural. They suggest that, perhaps imitation in the Nielsen (2011) study did not occur at the featural level, but rather at the level of the speaker. They found that mean VOT of voiceless stops covaries within speakers. This means that the speakers may have actually produced lengthened VOT of /k/-initial words when they heard lengthened VOT of /p/-initial words because they were accessing knowledge that VOT of /k/ and /p/ generally covary within speakers. This is a plausible explanation of Nielsen's findings, as previous research has shown that listeners know that longer VOT of /k/ is more likely to be/ produced by a speaker who also produces longer VOT for /p/, even if the listener has never heard the speaker produce a /k/ (Theodore et al., 2009).

Zellou et al. (2017) have also recently suggested that listeners are influenced by a more holistic

model of the talker in shadowing tasks, as opposed to individual instances of the linguistic form itself. They found that participants who heard a hyper- nasalized speaker in the first block of shadowing increased their degree of coarticulatory nasalization. However, if hyper-nasalization was heard in a second block (that is, after an initial block of regular nasalization) participants' degrees of nasalization leveled out as if they were averaging the nasalization across all tokens they had heard from the speaker and converging toward that average. They ultimately suggest that participants may imitate isolated phonetic forms immediately after hearing them, but after a decent amount of exposure (or a delay between exposure and their own productions), they converge toward a holistic model of the speaker based on accumulated utterances, rather than only toward the most recent tokens. Such findings have provided evidence that accommodation can generalize to a greater extent than previously thought.

The idea that speakers may converge more holistically, rather than toward specific individual targets, is not new. In fact, various literature rooted in Communication Accommodation Theory (CAT) has proposed that speakers often shift their speech to align with some abstract idea of whoever they are speaking with. For instance, Auer and Hinskens (2005) advocate for an "Identity-projection model" of convergence, which suggests that instead of converging toward "observable behaviour of the recipient ... speakers converge to a stereotype of the 'model' receiver, not the actual partner in direct communication" (p. 341). That is, speakers may change the way they speak to match how they believe their conversational partner speaks, regardless of whether their conversational partner actually speaks that way. As evidence, they cite Bell (2001), in which an Anglo interviewer uses the tag *eh* frequently when conversing with Maori interviewee but not when conversing with an Anglo interviewee. Although the Maori speaker did not use the tag *eh,* it is a stereotypically feature associated with Maori speech. This is given as (admittedly somewhat anecdotal) evidence that speakers shift their speech to align with pre-existing beliefs about what an interlocutor should sound like. This idea of accommodation triggered by the speaker rather than the speech itself can be traced further back to Thakerar et al. (1982), who terms accommodation which "responds to what the speaker mistakenly assumes will be the addressee's speech on the basis of the addressee's nonspeech attributes" to be "subjective accommodation" (Bell, 1984, p. 168). Earlier models of convergence in sociolinguistics such as Communication Accommodation Theory and Audience Design suggest that ideas about an interlocutor's identity are equally—if not more—important in eliciting convergence than the actual linguistic forms themselves. While research has continued to show that accommodation can generalize to a greater extent than previously thought, a promising finding for knowledge-driven accommodation, such findings, have yet to be tested in a controlled laboratory study.

3.2 Mechanisms of Accommodation

There have been several models proposed to account for linguistic accommodation, which can be separated into two broad categories: automatic accounts of convergence which rely on tight perception-production feedback loops and more controlled or intentional accounts that maintain that convergence is motivated primarily by external (usual social) factors.

There are a few different ways of viewing convergence as automatic. The first relies on exemplar-based representations, derived from linguistic perception and which production targets are drawn from (e.g., Goldinger, 1998; Goldinger and Azuma, 2004). Under such a model, episodic lexical entries are stored in memory with detailed phonetic information attached to each. "Echoes" or memory traces of previously heard lexical items are activated during production of the same lexical

item, and production targets are derived from the average of these activated traces. Convergence occurs when a person hears a particular word form and the average phonetic realization that the person draws from in production has shifted to encompass the recently heard form. There are number of distinct pieces of evidence that support such a model. For instance, in Goldinger (1998); Goldinger and Azuma (2004), imitation only occurred for identical lexical items (though note that later studies have not replicated lexical specificity in convergence), providing support for an exemplar model which is lexically specific. Secondly, imitation was found to be greater for lower frequency words (Goldinger, 1998), which supports an exemplar model in that the fewer traces there are to compete with the prime words that listeners heard in the experiment, the more influential the memory traces of these words would be. A second distinct proposal for an automatic model of linguistic accommodation is the Interactive alignment model (Pickering and Garrod, 2004), which suggests that individuals align their linguistic representations due to automatic priming mechanisms that serve to increase intelligibility for both speakers. Under this model, linguistics accommodation is viewed as the result of automatic structural priming mechanisms that align on all levels of linguistic structure. Relatedly, Pickering and Garrod (2013) and Sancier and Fowler (1997) appeal to a general tendency to imitate gestures as a mechanisms of speech perception, an idea rooted in Motor Theory (Liberman and Mattingly, 1985). For instance, Pickering and Garrod (2013) suggest that "actors construct forward models of their actions before they execute those actions, and that perceivers of others' actions covertly imitate those actions, then construct forward models of those actions" (p. 36). However, while most automatic models have been criticized for failure to allow for social influences (e.g., Brennan and Metzing, 2004; Brown-Schmidt and Tanenhaus, 2004; Krauss and Pardo, 2004), this model has also been criticized for failure to account for gradient phonetic effects (e.g., Krauss and Pardo, 2004; Pardo et al., 2012). As Pardo et al. (2012) notes, "it is unclear how an automatic priming mechanism can incorporate the sorts of situational modulations that have been observed in conversational phonetic convergence. That is, if a perceiver automatically resolves the articulatory gestures that a talker made while producing an utterance, then production should follow suit and result in maximally converged phonetic forms" and concludes that, "because talkers do not match more precisely or consistently and their departures from matching are not due to random variability in perception and production, speech perception and production during conversational interaction are not well-explained by automatic priming mechanisms" (p. 758). Divergence effects have also been difficult to account for without appealing to (at least partially) socially-motivated models of convergence.

Those who argue for more intentional motivations for accommodation often appeal to social influences. For one, some groups have been found to converge more than others. For instance, the role participants were assigned to in a map task has been shown to influence degree of accommodation (Pardo, 2006; Pardo et al., 2010). If automatic mechanisms were primarily responsible for convergence, it is unclear why different groups would exhibit differing degrees of convergence. Further, the fact that perceived social traits of and attitudes toward the interlocutor modulate convergence effects suggests social motivations. Babel (2009) found that vowel imitation was affected by implicit social measures of how the participant felt abut the talker including ratings of likability and attractiveness. Babel (2010) also found that participants degree of convergence correlated with their social biases toward entire dialect groups, with speakers who scored highly for pro-Australia bias converging more to an Australian speaker. Similarly, Balcetis and Dale (2005) found that syntactic alignment occurs to a confederate who acts nice (compared with a mean confederate) and annoyed (compared with a patient confederate), perhaps as a means of communicative repair. These findings may seem counter to one another, which highlights the fact that we don't as of yet have a good

idea of what to expect in regard to how social factors precisely influence accommodation, though there is a good deal of evidence that they play *some* role.

The role of social factors is particularly apparent in the sociolinguistic literature that treat accommodation as a form of style shifting that occurs in response to others present in the conversation. Communication Accommodation Theory (CAT), for instance, assumes that the primary motivation for shifts in speech is to win approval and manage social distance (Giles et al., 1991). CAT also accounts for non-convergence behaviors such as speech divergence and maintenance, as well as for hyper-convergence, where a speakers overshoots the convergence target (Giles, 1980). As Bell (1984) notes, accommodative style shifting is necessarily social, as "Variation on the style dimension within the speech of a single speaker derives from and echoes the variation which exists between speakers on the 'social' dimension" (p. 151). Bell in a sense extends CAT to allow for speech to be influenced by not only one's primary addressee, but also by others who may be involved in the communicative situation (auditors, overhearers, eavesdroppers), as well as other nonpersonal variables such as topic and setting. His model of audience design assumes that, when people speak, they take into account primarily those who would be listening to that speech.

In general, the influence of social factors on linguistic accommodation has been taken as evidence that speakers have (at least some) control over their accommodative behavior. Labov (1963), for instance, concluded about the centralization of /aɪ/ and /au/ in Martha's Vineyard that "centralized diphthongs are not salient in the consciousness of Vineyard speakers. They can hardly therefore be the direct objects of social affect." (p. 40). However, it is not a given that social influence requires conscious awareness. Campbell-Kibler (2016), for instance, argues that "social" does not necessitate consciousness, providing evidence that many social cognition behaviors observed must occur very rapidly and without conscious awareness. Particularly in light of the findings that social information influences linguistic perception, sociolinguistic associations have been considered to occur more rapidly and automatically than previously thought. As Campbell-Kibler (2016) notes, "sociolinguistic cognition is a kind of cognition" and "many important processes, including social processes, at least occasionally occur quickly, without introspective awareness and/or in ways apparently at odds with verbally reported or experimentally instructed intentions" (p. 10-11). In fact, recent studies on social cognition have found an influence of social information in linguistic processing as rapidly as 200-300 ms. Rather than asking whether automatic accounts or those which allow for the integration of social information are better suited to account for linguistic accommodation, it is perhaps a better question to ask *how* social information modulates perception-production links in accommodative behavior.

It is also important to note, in a review of mechanisms proposed to account for convergence, that it is unclear whether a single mechanism would be able to account for—or whether particular variables are equally able to be targeted for—both input-driven and knowledge-driven convergence. For instance, we know that convergence occurs to variables that attract less social awareness (e.g., nasalization in Zellou et al. (2017)), but could knowledge-driven accommodation also occur to these variants? What types of non-linguistic information would even be able to trigger convergence in the dimension of hyper-nasalization? Whether input-driven and knowledge-driven accommodation are actually governed by the same mechanisms is an empirical question that has yet to be answered. As such, I also consider a few additional possible mechanisms that are not typically discussed in the accommodation literature—but that may be well suited to explain knowledge-driven accommodation specifically, in the discussion of Experiment 2 in Section 5.2.

3.3 Perception-Production relationships

Finally, the relationship between perception and production is important to investigating mental models of the social and the linguistic. It is presumably impossible to accommodate toward something without perceiving it, and the goal here is not to determine *whether* perception plays a role in accommodation, but rather *what* the role is. If perception and production are governed by different mechanisms, findings of studies focusing on perception may not be applicable to studies on accommodation, for instance. If perception and production appear to be linked, then our mental model should be able to account for the influence of social information on linguistic perception, as well as on linguistic behavior. A tight perception-production link is assumed by many models of linguistic cognition, including Motor Theory (Liberman and Mattingly, 1985) and Exemplar Theory (e.g., Pierrehumbert, 2001), which seems well suited to account for social-linguistic relationships. Though it is intuitive that perceptual changes may be required in order for changes in production to occur, there is some evidence to suggest that this may not be the case. For instance, Pardo et al. (2012), provides evidence that perception does not directly mirror production in linguistic convergence. Others, however, imply that the same types of behaviors observed in production (i.e., convergence and divergence) can be derived directly from perception in that divergence is possible in speech perception (c.f., Walker et al. (2018) who discuss the possibility of "divergence" in speech perception). As of yet, linguists know surprisingly little, however, about the perceptual underpinnings of accommodative behavior.

4 Case study: The Southern Shift

The Southern Vowel Shift (SVS) offers an excellent opportunity for a case study of accommodation to a regional dialect. The Southern Shift is a vocalic chain shift affecting practically the entire vowel space. This shift is considered a "pull" chain shift (as opposed to a "push" chain shift) because the vowels move in order to fill empty spaces caused by previous vocalic movement. The shift is thought to have begun during the mid-to-late 1800s (Bailey, 1997) and is still progressing in many rural regions of the South, though it is retreating in more urban areas (Labov et al., 2006; Dodsworth and Kohn, 2012; Dodsworth, 2014).

The shift affecting the front vowels is often described as comprising three stages, beginning in Stage 1 with a monophthongization of /aɪ/ (Labov et al., 2006). The phonological constraints on this shift vary throughout the South: In more inland regions of the South, and among lower class speakers, monopthongization occurs in all environments, including before voiceless segments. However, in the majority of the South, monophthongization only occurs in coda position or before voiced segments. Regardless, when /aɪ/ monophthongizes in the South, it shifts slightly forward and enters the system of long, ingliding vowels and exits the system of upgliding vowels. This triggers Stage 2, which begins with the nucleus of /ey/ shifting downward along a non-peripheral path, essentially taking the place of /aɪ/ (Labov et al., 2006). /ey/, once on a non-peripheral path, follows Labov's Principle II of chain shifting: *Lax nuclei fall along a non-peripheral track* (Labov, 1994). This movement of /ey/ allows room for the nucleus of /eh/ to tense, then follow Principle I of chain shifting: *Tense nuclei raise along a peripheral track.* The nuclei of /ey/ and /eh/ are typically discussed in terms of "reversing" their positions in relation to one another. Stage 3 extends this reversal to the higher /i/ and /ih/ vowels, which follow a parallel shift in some (but not all) regions of the South, particularly in the inland South. While the Southern Shift of the front vowels is often simplified and referred to as a "reversal" of the front tense and lax pairs, the tense pairs

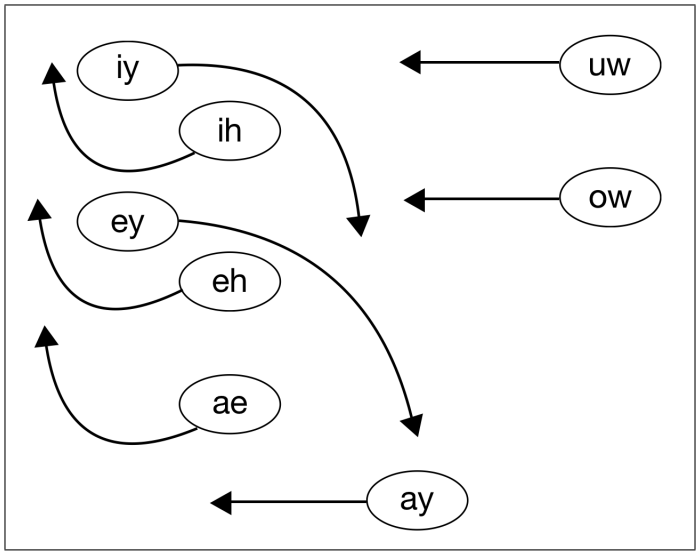

Figure 1: The Southern Shift

actually fall further than this, so that /ey/ approaches /aɪ/ and /i/ approaches /ey/. Short-/a/ also follows along with the other lax vowels by tensing then rising along a peripheral path. This movement is illustrated in Figure 1.

The back vowels also shift in the South, though this is not typically considered to be part of the chain shift just described. As Labov et al. (1972) note: "It is not at all obvious that a chain shift is involved in this situation, since there seems to be no back upgliding vowel which moves up behind /u/ and /o/ to assume their positions and which might have been held back by /u/" (p. 124). Instead, the back upgliding vowels front in parallel, following Labov's (1994) Principle III of chain shifting: *back vowels move to the front.* Note though that the fronting of /u/ is in some cases so extreme that it is realized phonetically directly behind /i/ (Labov et al., 1972, 2006). However, the fronting of these back vowels is not unique to Southern phonology. In fact, fronting of /u/ occurs to some extent in most of North America and while /o/ fronting is most advanced in the South, fronting is common in the Midlands as well. Further, another chain shift, the "back upglide shift," which involves fronting of /au/ (as in *house*) and upgliding of /ɔ/ (as in *caught*) occurs in the South. These are not the only features of Southern English. For instance, velar nasal fronting, the *pin-pen* merger and vowel "breaking" (i.e., the "Southern Drawl") are associated with the South, as is /r/-vocalization in some areas.

The southern U.S. dialect region was chosen for this study because of its distinctiveness and social salience. It is perhaps the most distinct dialect region in the U.S. Glide-weakening of /aɪ/[5] is a particularly salient and stereotypical feature of Southern English (e.g., Reed, 2016; Hall, 1942; Wolfram and Christian, 1976; Reed, 2014). Labov (2010) notes, "The most generally recognized feature of Southern speech is the monophthongization of /aɪ/" (p. 55). Choosing a salient dialect is an important starting point for investigations of the mental relationship between linguistic and

[5]The phenomenon referred to as "glide-weakening" is also commonly called "glide reduction," "glide deletion," "ungliding," or "monophthongization."

social information. If accommodation indeed stems from top down social cues, in order to allow sufficient opportunity for such mechanisms to work, the link between linguistic features and social label should be tightly established in the minds of listeners, both Southern and non-Southern alike.

Figure 2: Southern isogloss

5 Proposed Experiments

5.1 Experiment 1: Evidence for Knowledge-Driven Accommodation

The goal of Experiment 1 is to provide evidence for a previously unestablished phenomenon: *knowledge-driven* accommodation. Specifically, I investigate whether speakers produce more monophthongal /aɪ/—a salient feature of Southern English—when communicating with a Southern-accented talker who never produces any /aɪ/ tokens. The experiment utilizes a novel methodological paradigm—the Word Naming Game—in order to create an environment of social interaction between the participant and the model talker while eliciting specific tokens that are not in the input. Showing that convergence can generalize to non-locally-observed variants suggests that social information can alter not just linguistic perception, as has been previously established, but also linguistic behavior. Illustrating the conditions under which socially-triggered convergence occurs is important to more generally understanding how social and linguistic information may be mentally represented and interact.

5.1.1 Methods

120 participants will be recruited to participate in the study, using Prolific Academic and will receive $10 for their participation. Participant compensation will be funded by a small grants research fund through the University of Pennsylvania's Social and Behavioral Sciences Initiative, a subsidiary of MindCORE. Sixty participants will be from within the Southern isogloss where /aɪ/ monopthongization reliably occurs and will be labeled as "Southern." The remaining 60 will be from elsewhere in the U.S. and labeled as "Non-Southern."

Participants will take part in a Word-Naming task using Ibex, in which "clues" are presented to participants in written or audio format. Participants will be recorded naming the word being described embedded within the sentence "The word is [ ]." For instance, a participant may be given the clue "The saying goes, if at first you don't succeed, do this three letter T-word again," and should respond aloud "The word is 'try.'" The task consists of three phases. The Baseline Phase (Phase 1) serves as a way of collecting participants' baseline vowel measurements prior to any auditory exposure. In this phase, clues are presented on the screen in written format and participants read the clues silently to themselves before giving their response aloud. The Exposure Phase (Phase 2) serves as the experimental phase. Clues are presented in audio format over headphones, though the task was the same. Clues in this phase are read by either a Southern talker or a Midland talker, depending on the condition to which the participant is randomly assigned. By comparing the Exposure Phase to the Baseline Phase, it is possible to determine whether phonetic convergence has occurred. In the final, Post-Exposure Phase, clues are again presented in written format. Comparing the Exposure Phase to the Post-Exposure phase allows us to isolate changes directly caused by exposure to a new voice from general changes in speech across the course of the experiment. It is possible that participants will show general fatigue as the experiment progresses, which may result in overall reduction of vowels. Since this experiment targets /aɪ/ glide-weakening, a reduction process, this is a problem. If participants produce more monophthongal tokens in Phase 2 and even more monophthongal tokens in Phase 3, we cannot attribute this glide-weakening to the experimental manipulation. However, if participants produce more monophthongal tokens in Phase 2 and then revert back to their baseline in Phase 3, we can assume that increased glide-weakening in Phase 2 was a result of the experimental manipulation. Comparing the Southern Condition to the Midland Condition should also help to tease these potential influences apart. Additionally, the Post-Exposure Phase is included in order to investigate the longevity of convergence effects.

At the beginning of the experiment, directions are presented in written format on the screen. Before the auditory presentation of clues in Phase 2, the directions are given again over the headphones so that participants can familiarize themselves with the speaker. Crucially, the /aɪ/ vowel is never used in any of the clues or in the directions. In order to minimize data loss due to incorrect responses, participants will be allowed to ask for a hint by pressing the 'h' key on their keyboard at any point throughout the course of the experiment.

A Word-Naming task was chosen for several reasons. First, such a method would be more likely to maximize participants' feelings of interaction in a necessarily non-interactive task. Secondly, participants would be focused on the goal of the game, which would take their attention away from their own speech production. Finally, this method would allow for elicitation of specific words containing vowels of interest for this study while not necessarily requiring participants to have heard the word from the talker, as would be the case with a shadowing or repetition task. This last point will be important when examining the /aɪ/ vowel, which was elicited from speakers though never produced by the Southern or Midland model talkers. This design allows us to examine whether convergence can be generalized at the level of social associations (monophthongal /aɪ/ is a notable

and salient feature of Southern speech) without participants ever having been exposed over the course of the experiment to the vowel of interest.

After the Word Naming Task, participants will complete a survey to gauge (1) familiarity with the south (2) attitudes toward the south (3) attitudes toward the talker (3) ability to identify the talker as Southern/Midland and (4) cognitive/personality traits.

Elicited tokens consist of 60 /aɪ/ words in pre-pausal or pre-voiced conditions, as this is the environment in which /aɪ/ glide-weakening reliably occurs in the U.S. South. Additional words will also be elicited for each of four additional target vowels: /e/, /ɛ/, /u/, and /o/. Tokens were elicited in three separate lists, with one list being elicited in each Phase. The order in which the sets are presented will be counterbalanced across participants, and individual items within each list will be elicited in a randomized order for each participant. The three lists of elicited words are balanced for place of articulation of adjacent segments, as well as for lexical frequency, determined using the SUBTLEX corpus Log10CD measure.

Clues are 1-2 sentences long and contain at least one stressed instance each of /i/, /ɪ/, /e/, /ɛ/, /u/, and /o/. This gives participants sufficient evidence for the dialect of the talker. Crucially, the /aɪ/ vowel is not included in any of the clues or directions. When clues are presented auditorily, they are read by either a Midland or Southern Male talker in his early 30s.

Recordings will be force-aligned using the Penn Phonetics Lab Forced Aligner (p2fa). Force alignment will then be hand corrected as necessary. FAVE extract will be used to automatically measure the first three formants of target vowels at 5 time points throughout the course of the vowel: 20% 35%, 50%, 65%, and 80%. Measurements will be normalized using the Lobanov (Lobanov, 1971) method.

5.1.2 Pilot results

Two pilot versions of the experiment were run in 2017. In Spring 2017, a version was run with 21 Penn participants (not differentiated by dialect background), 12 of which were in the Southern condition and 9 of which were in the Midland (control) condition. Results showed significantly more monophthongal /aɪ/ in the exposure phase than in the baseline or post-exposure phases. The version run in spring 2017 was then revised to exclude commonly missed tokens and reduce the length of the experiment. This version was run in fall 2017 with 84 participants, 42 from the South and 42 from outside of the South. Twenty-one participants from each dialect background were assigned randomly to the Southern condition, and 21 were assigned to the Midland (control) condition. I report here on the results of the fall 2017 study, which involved more rigorous methodology than the spring 2017 pilot, and an experimental design almost identical to the version to be run as a replication for the dissertation. The results between the spring 2017 and fall 2017 pilots are comparable.

As Figure 3 illustrates, speakers did converge toward the Southern talker; in the aggregate, there is a general tendency to produce the /aɪ/ vowel with a glide lower in the vowel space (i.e., a weakened glide) during Phase 2. Speakers then shift back to their baseline immediately after exposure, producing higher /aɪ/ glides again in Phase 3. This effect cannot be attributed to general reduction or fatigue over the course of the experiment since participants actually produce *stronger* glides in the last phase of the experiment. Furthermore, speakers in the Midland condition show no comparable shift, further bolstering the argument that the glide weakening exhibited by speakers in the Southern condition is a direct result of the experimental manipulation. Participants in the Midland condition do not shift their production of /aɪ/ at all throughout the course of experiment,

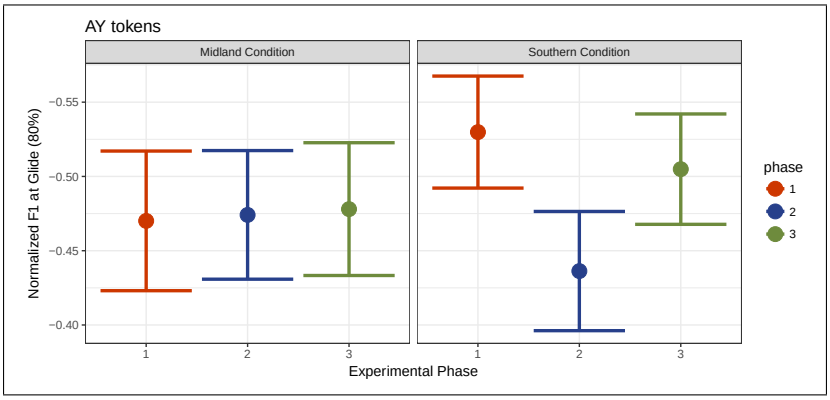

Figure 3: F1 of glide as a measure of glide-weakening. Mean values with 95% confidence intervals.

suggesting that the /aɪ/ glide is not a relevant dimension in which to converge toward the Midland talker.

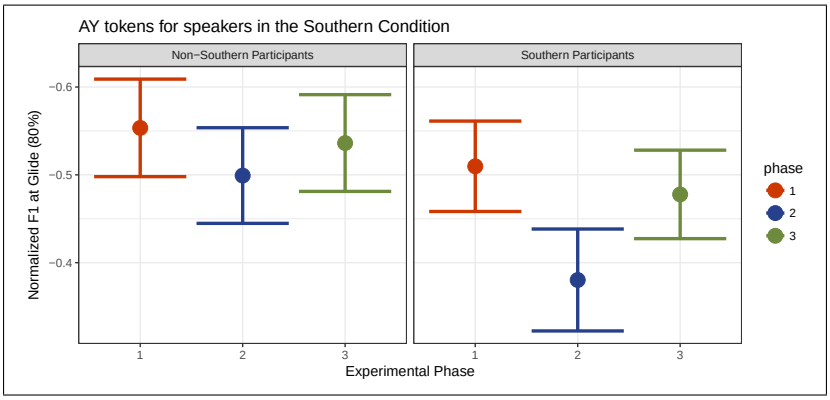

Figure 4: Productions of /aɪ/ tokens in just the Southern Condition, faceted by participant dialect group. Mean values with 95% confidence intervals.

Figure 4 breaks down the results of the Southern condition by participant dialect background. Data elicited from participants who grew up outside of the South is shown on the left, and data from Southern participants is shown on the right. Both groups of participants roughly exemplify the general pattern, with a lowering of the glide during Phase 2 and a return to baseline in Phase 3. However, the effect is much clearer for Southern participants.

Linear mixed effects regression was run on the data set of elicited /aɪ/ tokens using the lme4 package in R. Normalized F1 at the glide is the dependent variable. Fixed predictors were included based on significance of likelihood ratio tests. The final model is shown in Table 1. Fixed effects include Experimental Phase (1, 2, 3), Talker Voice (Midland or Southern), Participant Dialect Background (Southern or Non-Southern), Duration, Frequency, as well as two two-way interactions: Phase*Voice and Phase*PartDialect. By-participant and by-item random intercepts were also included in the model.

Fixed effects	Estimate	Std. Error	t-value
(Intercept)	-0.06702	0.11741	-0.571
Phase1	-0.12152	0.03360	-3.617
Phase3	-0.08535	0.03359	-2.541
VoiceMidland	-0.03195	0.06798	-0.470
PartDialect Non-South	-0.21110	0.06796	-3.106
Duration	-1.83213	0.17341	-10.566
Freq	0.06862	0.03362	2.041
Phase1:VoiceMidland	0.09090	0.04020	2.261
Phase3:VoiceMidland	0.07332	0.04013	1.827
Phase1:PartDialectNon-Southern	0.09007	0.04013	2.244
Phase3:PartDialectNon-Southern	0.04593	0.04010	1.145

Table 1: Linear mixed effects regression table. Normalized F1 at glide (80%) is the dependent variable.

Likelihood ratio tests reveal the expected significant main effects of Duration and Frequency; more Frequent words are produced with weaker glides ($\chi^2 = 4.18$, p = .04) and longer vowels tend to have stronger glides ($\chi^2 = 103.28$, p < .001). There is also a significant interaction between Phase and Voice ($\chi^2 = 10.735$, p = .013), suggesting that participants in the Southern talker condition produce stronger glides in Phase 1 (Est = -.122) and in Phase 3 (Est = -.085), and these shifts are significantly greater in the Southern Voice condition. Additionally, there is a significant interaction between Phase and Participant Dialect ($\chi^2 = 10.014$, p = .018), suggesting that Southern participants show greater convergence than Non-Southern participants. Overall, Southern participants converge to the Southern talker, and do so significantly more than the Non-Southern participants.

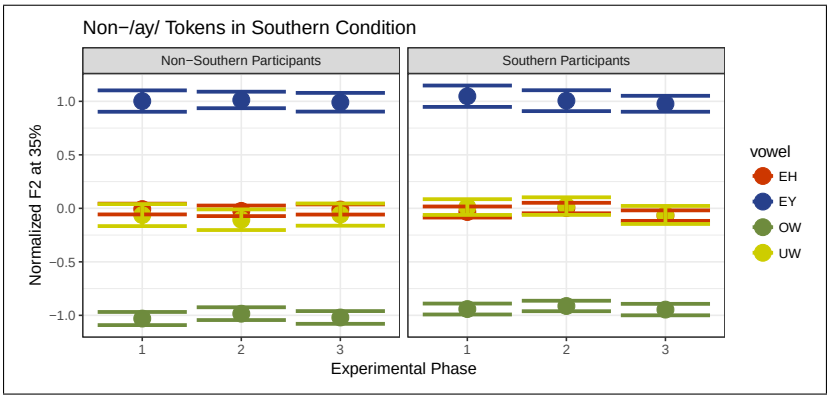

Figure 5: Mean F2 values at 35% for each vowel class. 95% confidence intervals.

No clear shifts were found for other vowels elicited from participants (/u/, /o/, /e/, and /ɛ/). Vowels were measured at various time points, including 20%, 35%, 50%, 65% and 80%. The 35% measurements will be shown here, as this is where the most differentiation between phases occurs. Figures 5 and 6 plot the mean F2 and F1 values, respectively, of each vowel class for each group of participants across phases, with 95% confidence intervals. These figures only include data from participants assigned to the Southern Condition, as this convergence to the Southern voice is of

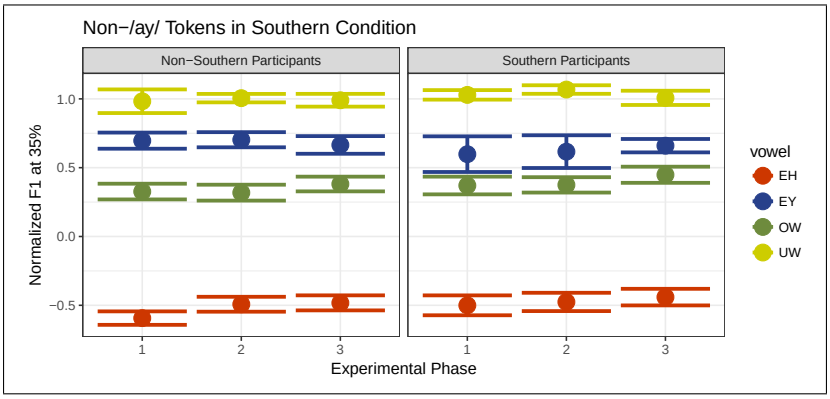

Figure 6: Mean F1 values at 35% for each vowel class. 95% confidence intervals.

primary interest. In the aggregate, there is little to no shift in production across phases, though some trends in the expected direction are apparent: both groups produce slightly fronted /o/ during exposure (6) and Non-Southern participants produce a raised /ɛ/ vowel during exposure (5). However, linear mixed effects regression models run on each vowel class reveal that these shifts are not statistically significant ($p > .05$). Analysis of formant values extracted from the vowel at all other time points similarly fail to reveal notable shifts in the expected direction. It must be concluded that, on the whole, speakers in this task do not converge toward Southern-shifted /u/, /o/, /e/, and /ɛ/, even after relatively recent exposure to Southern productions of these vowels.

5.1.3 Conclusions

From the pilot, we can make several conclusions and pinpoint several areas for further study. First and foremost, the pilot experiment has provided evidence that knowledge-driven accommodation occurs, though it will be important to be able to replicate such a novel finding with more participants for the dissertation, as described in the methodology section above. Another key finding is that the convergence effect observed is interlocutor-specific and not subject to general social priming mechanisms. That is, participants shifted their speech during the exposure phase when communicating with a Southern talker, but this shift did not persist into the immediately following post-exposure phase, suggesting perhaps that attributing social cues to an interlocutor is an important component of knowledge-driven accommodation. This finding contrasts with Sanchez et al. (2015) and Drager et al. (2010), who found shifts in New Zealanders' speech toward or away from Australian variants triggered by facts about Australia, even without an interlocutor present. Another initial finding that will be important to keep in mind when moving forward is that the convergence effect is modulated by dialect background, suggesting experience with Southern variants is a pre-requisite for knowledge driven accommodation. This is unsurprising since knowledge-driven accommodation by definition draws from pre-existing knowledge of variants. Without a variant to model from in the input, reliance on pre-existing experience with Southern monophthongal /aɪ/ is necessary. What is unclear is whether a similar constraint exists for input-driven accommodation or whether participants are able to converge entirely based on real-time input without reference to pre-existing knowledge of the targeted variant. The pilot experiment attempted to include a quasi-comparison between input-driven and knowledge-driven convergence in that vowels that *were*

produced by the Southern talker were also elicited from participants. However, no convergence effects to these vowels were observed, perhaps due to lower Ns for these vowels or because of differences in the variants themselves, such as salience. In order to compare knowledge-driven accommodation and input-driven accommodation, it will be necessary to conduct an experiment in which type of accommodation is not confounded by other factors such as salience. Experiment 3 accomplishes this goal.

5.2 Experiment 2: The Mechanisms Underlying Knowledge-Based Accommodation

The purpose of Experiment 2 is to determine the mechanisms responsible for the type of generalization in convergence observed in Experiment 1. Specifically, I aim to tease apart two potential explanations: A socially-rooted, top-down explanation that relies on identifying the talker as "Southern" and a structurally-rooted bottom-up explanation that relies on knowledge of variant co-occurrence. Understanding the extent to which reliance on social information is necessary for the type of generalization in convergence observed in Experiment 1 is necessary to understanding the cognitive relationships between linguistic and social information.

5.2.1 Methods

Experiment 2 uses the same general design as Experiment 1, and will not be repeated here. The key difference is that this experiment will manipulate dialect labels to determine whether this has an effect on convergence. Rather than two conditions, Midland, and Southern, then, there will be four conditions which vary in whether the dialect label matches the dialect of the model talker:

- Matched Southern: Southern talker with Southern label
- Matched Midland: Midland talker with Midland label
- Mismatched Southern: Southern talker with Midland label
- Mismatched Midland: Midland talker with Southern label

These four conditions will be compared the data from Experiment 1 so that Matched and Mismatched labels can be compared to two unlabeled conditions (Southern Unlabeled and Midland Unlabeled), as a control. Sixty participants from the South will be recruited for each of the remaining conditions, totaling 240 participants. As in Experiment 1, participants will be recruited through Prolific Academic and the experiment will be administered through Ibex. Participants will receive $10 for their participation. Participants in the labeled conditions will be told explicitly before the Exposure Phase of the experiment the state and dialect region of the talker they will be listening to. For instance, "The clues will now be presented by Adam. He is from North Carolina and speaks with a Southern accent." The crucial comparison is that between the Mismatched Southern condition (Midland label, Southern Talker) and the Mismatched Midland condition (Southern Label, Midland Talker). If convergence is observed in the Mismatched Southern condition, it can be inferred that participants were able to converge toward monophthongal /aɪ/ using statistical information about variant co-occurrence. In other words, participants could access knowledge that monophthongal /aɪ/ and other Southern shifted vowels co-occur and utilize this information in speech production. If convergence is instead observed in the Mismatched Midland condition, this

would suggest a top-down, socially-rooted explanation, such that identifying the talker as "Southern," even without acoustic evidence to confirm this classification, can alter speech production[6]. It is also likely that the results will not be so neatly divided. Convergence may be observed in both Mismatched conditions, for instance, or may occur in all conditions but be more robust in the Matched label conditions. Such findings may provide initial evidence that the processes work in tandem and contribute independently to accommodative linguistic behavior.

5.3 Analysis

The dissertation aims to tease apart two very broad explanations for the type of knowledge-driven convergence observed in Experiment 1: socially-rooted or structurally-rooted mechanisms. Though Experiment 2 does not aim to more specifically identify the precise mechanisms responsible for this behavior, I devote the next two subsections to a discussion of potential ways of more precisely breaking down these potential explanations. Part of the work of the dissertation involves figuring out how to experimentally tease apart more precise explanations for knowledge-driven convergence.

5.3.1 Socially-rooted mechanisms

If Experiment 2 finds evidence of a top-down mechanism driving convergence, I may also attempt to tease apart explanations involving general social priming mechanisms from those involving an interlocutor-specific application of social knowledge. Explanations that don't rely on interlocutor specificity can be found in both Exemplar Theory and Social Priming, for instance. While exemplar models of speech perception and production rely on tight perception-production feedback loops, they also allow for tight links between social and linguistic information (Goldinger, 1998; Pierrehumbert, 2001). Under such models, when perceived linguistic items are mentally stored, they are stored along with not only detailed phonetic information, but also detailed information about the social situation, including information about the interlocutor who uttered the form and the context in which the form was uttered. When primed by concepts relating to social categories (e.g., being primed by the concept of Australia (Hay et al., 2006a; Hay and Drager, 2010)), exemplars relating to Austraia (for instance, words spoken by an Australian or in Australia) will become activated in working memory, and subsequent speech will be weighted more heavily on these activated exemplars. Shifts in speech, then, emerge "as a subtle automatic consequence of the socioindexical labeling of selected exemplars" (Sanchez et al., 2015, p.90). Linguists have appealed to such models to account for the influence of social information on linguistic processing (e.g., Hay et al., 2006a; Hay and Drager, 2010) as well as addressee- and topic-based style-shifting (e.g., Sanchez et al., 2015; Drager et al., 2010). An exemplar account seems well suited to explain knowledge-driven accommodation, and other instances of social and linguistic information influencing one another in speech perception and production. However, by relying on purely automatic links between linguistic and social information, such models fails to account for divergence behavior and modulation of accommodative behaviors by things like attitude.

Social priming is in many ways similar to the "activation" of stored knowledge proposed by such exemplars models. While social priming explanations are not utilized often in linguistic research (such mechanisms are appealed to to explain similar behavior in social psychology) they seem

[6]I assume here that this is a possible explanation for the convergence observed in the pilot of Experiment 1 if participants are able to identify the talker as "Southern" (whether consciously or not) based on bottom-up acoustic cues). The primary difference between the top-down and bottom-up explanations I propose is whether a participant must access (consciously or not) the "Southern" label at some point during processing or not.

similarly well-suited to explain the mental relationship between social and linguistic information. Social priming, or the "nonconscious activation of social knowledge structures," encompasses a wide range of phenomena across "a wide array of psychological systems, such as perception, motivation, behavior, and evaluation" (Bargh, 2006, p.147). While the range of phenomena that could be considered "social priming" is quite large, the classic examples of social priming involve exposing participants to a "prime" related to some social concept, which then activates social knowledge surrounding that concept, which ultimately affects participant behavior or judgment. For instance, individuals who are subliminally primed with concepts relating to groups that help others (e.g., nurses) have been suggested to show more willingness to help in an unrelated task (Aarts et al., 2005) or to pick up a dirty tissue (Custers et al., 2008). Similarly, Bargh et al. (1996) found that, after being exposed to concepts relating to the concept of "elderly," participants subsequently walked down a hallway more slowly. While, to my knowledge, social priming has not been appealed to as a plausible explanation for the influence of social information on linguistic perception or production, such a mechanism could well account for such findings.

It is important to note, however, that "social priming" research is at the heart of social psychology's recent replication crisis. After a well-known psychology researcher admitted to falsifying data in several published papers, several well-established findings in the field of social psychology also failed to replicate (Carey, 2011; Earp and Tramifow, 2015), shedding doubt on the reliability of social priming research. Though replicability is a current issue for many fields, including medicine, economics, and other fields, and is not limited to psychology or social psychology, it highlights the importance of rigorous methodology and statistical analysis. Still, some findings in linguistics that could be considered examples of "social priming" *have* been at least partially replicated. As noted above, Niedzielski (1999) found that regional labels (Detroit vs. Ontario) influenced classification of a vowel on a synthesized continuum. This finding was replicated in a different lab by Hay et al. (2006a), who found the same effect for different New Zealand and Australian labels applied to the same New Zealand speaker. Further, Hay and Drager (2010) and Drager et al. (2010) went on to find that simply evoking concepts of Australia vs. New Zealand resulted in the same general effect.

In these models, the social concept itself is enough to directly influence linguistic behavior. While some studies have found evidence for shifts in speech production without an interlocutor present (Hay and Drager, 2010; Drager et al., 2010; Sanchez et al., 2015), it is not clear whether knowledge-driven accommodation operates under the same mechanisms, particularly since, in the pilot of Experiment 1, I found convergence only during the Exposure Phase in which participants were interacting with a model talker, but not in the immediately following Post-Exposure Phase. Additionally, it has been repeatedly shown that information that is understood as being about a person is structured differently and retained better than information that is not attributed to a speaker, such as unrelated items in a list (e.g., Asch, 1946; Chartrand and Bargh, 1996). Is it possible, then, that attributing traits based on abstract social categories evoked in the experimental environment to speakers may enhance the influence on linguistic processing, or even allow for this influence to exist at all? Under an interlocutor-specific explanation, convergence would rely on the fact that top-down social information such as "Southernness" are applied *to the person* with whom the participant is communicating, not just abstractly activated. While comparison of the Exposure and Post-Exposure phases of the experiment may help to tease apart these potential explanations, there is a confound in that, in the post-exposure phase, more time has past since exposure to the concept of "Southernness," which may also reduce or eliminate any convergence effects. A direct comparison of knowledge-driven accommodation and input-driven accommodation to the same variable is therefore warranted, which Experiment 3 accomplishes.

5.3.2 Structurally-rooted mechanisms

If Experiment 2 finds evidence for a structurally-rooted bottom-up mechanism responsible for knowledge-driven accommodation, I will work to tease apart two more specific explanations: Associative co-occurrence and structural extrapolation. An associative co-occurrence explanation would involve a listener hearing other Southern vowels and accessing strictly statistical knowledge that /aɪ/ monophthongization often co-occurs with the particular acoustic realizations of the other vowels observed from the model talker. In other words, participants may be able to access knowledge of variant co-occurrence without ever needing to access social labels such as "Southern." For such an explanation to be valid, it would be necessary to show that the Southern dialect is in fact a coherent system. "Coherence," a notion introduced by Guy (2013), is essentially the "systematic covariation of variable features which have some social characteristic in common" (p. 64). However, we cannot assume that coherence actually exists for the Southern dialect. This may seem to be an odd statement; after all, deeming something a "dialect" implies a set of shared features and some degree of uniformity. However, with the recent surge of interest in coherence, there has been some doubt shed on assumptions that even standard languages *are* coherent (e.g., Grondelaers and van Hout, 2016; Guy and Hinskens, 2016). Why should regional dialects be any more coherent? Recent evidence suggests that they are not. Becker (2016), for example, found that over 70% of speakers were incoherent in their use of three non-standard New York City English variants: vocalized r, raised BOUGHT and raised BAD.

In order to determine the plausability of a mechanism accessing knowledge of variant co-occurrence, I conducted small study of coherence of eight Southern vowels, using the Raleigh Corpus. To determine whether the Southern dialect coheres at the individual level (e.g., whether the acoustic properties of one vowel such as /aɪ/ can be predicted based on the acoustic properties of another vowel). The vowels of interest are as follows:

- The nuclei of BAIT and BEET are lowering and backing in Southern English. While almost all Southern dialects show retraction of BAIT, only those more advanced in the Southern Shift show retraction of BEET. Though Raleigh is not considered to be part of the Inland South, which typically exhibits retraction of BEET, some speakers in the corpus do exhibit "more Southern" productions of this vowel. These vowels are measured as the inverse of the vowels' normalized diagonal measurements (i.e., normalized F2 − normalized F1) at the vowel nucleus, which indicates the degree of retraction. The inverse of this value is used so that all measurements are in the same direction. A higher number therefore indicates a more retracted (i.e., more Southern) vowel.

- The nuclei of BET, BIT, and BAT are raising and fronting in Southern English. BIT only follows this trajectory in the most advanced Southern speakers, particularly in the inland South, though some Raleigh speakers do produce more peripheral BIT nuclei. These vowels are measured as the normalized diagonal at the vowel nucleus. A higher number therefore indicates a more peripheral (higher and fronter) vowel, indicating a more Southern production.

- BITE is monophthongizing in Southern speech. Monophongization is measured as the inverse Euclidean distance between the nucleus and glide in the F1-F2 vowel space. A higher number therefore indicates a more monophthongal (i.e., more Southern) production of BITE.

- BOOT and BOAT are fronting in Southern speech. Fronting of these vowels is measured as the normalized F2 value at the nucleus, such that a higher value indicates a more fronted (i.e., more Southern) vowel.

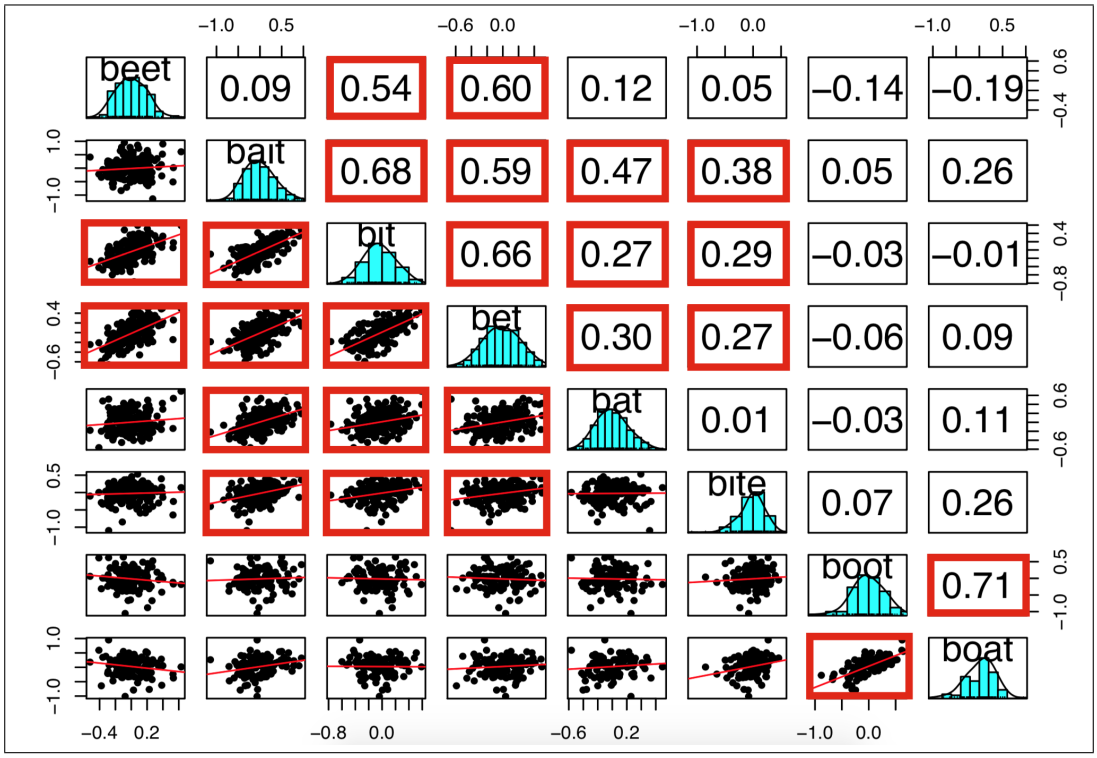

Figure 7: Correlation matrix for all vowel classes. Scatter plots are fit with linear regression lines. Numbers indicate Pearson's R. Boxes highlighted in red indicate statistically significant correlations with adjusted p-values of $p < .05$.

Pairwise correlations were conducted for each vowel pair. Figure 7 displays the results. The numbers indicate the Pearson's r for each comparison, and scatter plots are fitted with linear regression lines. The statistically significant (adjusted $p < .05$) are highlighted in red. Results show that the /aɪ/ vowel (BITE) is somewhat predictable based on a speaker's production of three other vowels: BAIT, BIT, and BET. While these correlations are not as strong as those between most of the other vowel pairs, it is still plausible that participants could converge toward monophthongal /aɪ/ based on knowledge of its co-occurrence with other Southern-shifted vowels.

Knowledge of variant co-occurrence is distinct from a structural extrapolation explanation, which would involve participants being able to predict a speaker's acoustic realization of one vowel based on its relationship to other structurally-related vowels in the vowel space, particularly in the case of chain shifts. Weatherholtz (2015), for instance, has demonstrated listener's ability to make such extrapolations with novel chain shifts. While different results from different participant backgrounds may hint at which mechanism is better able to account for the data (non-Southern participants with less experience with the Southern dialect should be equally able as Southern participants to structurally extrapolate, but would not be expected to have as much pre-existing associative co-occurrence information to access), I could test this more explicitly by determining which individual vowel variants trigger convergence. For instance, if vowels variants not structurally related to /aɪ/ but that co-vary with /aɪ/ in the South still trigger convergence, this would be

evidence for and associative co-occurrence explanation based purely on knowledge of statistical relationships.

5.4 Experiment 3: Perceptual basis for Accommodation

The purpose of Experiment 3 is to pinpoint the perceptual underpinnings of input-driven and knowledge-driven accommodation. I seek to determine how perceptual shifts may translate into production and how social information may influence this process. Speakers are known to show varying types of accommodative behavior including convergence, divergence, and maintenance. It is not known, however, whether these differences in productive behavior reflect differences in speaker's repertoires or social motivations, or whether they more directly reflect differences in perceptual processes (which could also be affected by different social motivations. Several more specific research questions guide this inquiry: (1) Do accommodative behaviors have direct perceptual correlates? (2) Do convergers/divergers differ in their perception behavior or just their production behavior? (3) If perceptual correlates to accommodative behavior can be found, are the equivalent for input-driven and knowledge-driven convergence? (4) What is the role of social information in both perception and production? For instance, do convergers and divergers differ in their perceptual behavior, or just in production? By comparing perception and production responses to the same stimuli on a participant-by-participant basis, while accounting for potential variation in external social dimensions, I hope to answer these question.

The experiment will consist of a pre-/post-exposure perception task and a production task. The perception component consists of a lexical decision task, in which participants will hear a monophthongal /aɪ/ word and will classify it as a word (e.g., *bribe*) or a non-word (e.g., *brahb*). Filler items containing non-Southern shift vowels will be included and all items will be spoken by the same Southern talker. This task will be administered before and after exposure to a Southern voice, and participants' "word" classifications rates will be compared. If significantly more items are accepted as words post-exposure, participants can be said to have undergone a perceptual shift. During the exposure phase, participants will listen to and read sentences aloud. Participants will read aloud sentences first as a means of collecting their baseline speech production. Then, they will hear and read sentences in alternating order; the heard sentences will serve as the exposure component for both the perception and production tasks, and will be read by the same Southern talker; the read sentences will serve as the experimental condition and will be compared to sentences read for the baseline. There will be two conditions: /aɪ/-present (testing input-driven convergence) and /aɪ/-absent (testing knowledge-driven convergence). In the /aɪ/-present condition, participants will hear at least one /aɪ/ token from the model talker in each sentence they hear. In the /aɪ/-absent condition, they will hear no /aɪ/ words from the model talker. At the end of the task, participants will complete several short surveys gauging 1) attitudes toward the talker 2) attitudes toward Southern speech 3) dialect experience and 4) cognitive/personality traits of the participant. This will allow for exploration of how social factors influence perception and/or production.

Sixty Southern participants and 60 non-Southern participants will be recruited for each of the two conditions via Prolific Academic and will be paid $10 for their participation. Perception results will be compared to production results on a participant-by-participant basis to determine the types of perceptual changes that allow for different accommodative behaviors.

6 Conclusions

In this proposal, I have provided preliminary evidence for knowledge-driven accommodation and an experimental design for testing the replicability of this finding. I additionally presented several potential explanations for knowledge-driven accommodation,to be empirically tested in Experiment 2. I also proposed a final experiment to better understand these mechanisms by considering the role of an automatic perception-driven influence independently from social influences, and comparing input-driven and knowledge-driven accommodation. The three proposed experiments each investigate their individual research questions. Taken together, I hope that the experiments proposed for the dissertation will also make several novel contributions to accommodation research, and linguistic theory more generally:

1. Sound evidence for knowledge-driven accommodation as a phenomenon and insights into how knowledge-driven accommodation relates to (a) input-derived accommodation and (b) socially-induced shifts in production (e.g., style shifting)
2. A better understanding of the cognitive mechanisms driving both input-driven and knowledge-driven accommodation
3. Significant insights into the relationship between linguistic and social representations
4. Insights into the relationship between linguistic perception and production

Timeline

December 2018–January 2019	Compile NSF dissertation improvement grant application Submit by January 15th
January–February 2019	Design Experiments 1 and 2 in Ibex
March–April 2019	Run Participants for Experiments 1 and 2 Design Experiment 3
May–June 2019	Run Participants for Experiment 3 Analyze data from Experiments 1 and 2
July 2019	Analyze data from Experiment 3
August–September 2019	Design any small follow up experiments (as needed)
October–November 2019	Run follow up experiments and analyze data
December 2019	Write, receive feedback on, and revise Chapter 2 on Knowledge-Driven Accommodation
January 2020	Write, receive feedback on, and revise Chapter 3 on Mechanisms of Accommodation
February 2020	Write, receive feedback on, and revise Chapter 4 on Perception/Production Relationships
March 2020	Write, receive feedback on, and revise Intro and Conclusion
April 2020	Defend dissertation
May 2020	Submit dissertation

References

Aarts, H., Chartrand, T. L., Custers, R., Danner, U., Dik, G., and Jefferis, V. E. (2005). Social stereotypes and automatic goal pursuit. *Social Cognition*, 23:464–489.

Asch, S. (1946). Forming impressions of personality. *Journal of Abnormal and Social Psychology*, 41:258–290.

Auer, P. and Hinskens, F. (2005). The role of interpersonal accommodation in a theory of language change. In Auer, P., Hinskens, F., and Kerswill, P., editors, *Dialect change. The convergence and divergence of dialects in contemporary society*, pages 35–57. Cambridge University Press.

Babel, M. (2010). Dialect divergence and convergence in new zealand english. *Language in Society*, 39(4):437–456.

Babel, M. E. (2009). *Phonetic and social selectivity in speech accommodation*. University of California, Berkeley.

Bailey, G. (1997). When did southern american english begin? In Edward, S., editor, *Englishes around the world 1: Studies in honor of Manfred Gorlach*, pages 255–275. John Benjamines, Amsterdam.

Balcetis, E. and Dale, R. (2005). *An exploration of social modulation of syntactic priming*, pages 184–189. Lawrence Erlbaum Associates.

Bargh, J. (2006). What have we been priming all these years? on the development, mechanisms, and ecology of nonconscious social behavior. *European Journal of Social Psychology*, 36(2):147–168.

Bargh, J., Chen, M., and Burrow, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality and Social Psychology*, 71:230–244.

Becker, K. (2016). Linking community coherence, individual coherence, and bricolage: The co-occurrence of (r), raised BOUGHT and raised BAD in New York City English. *Lingua*, 172–173:87–99.

Bell, A. (1984). Language style as audience design. *Language in Society*, 13(2):145–204.

Bell, A. (2001). *Back in style: Reworking audience design*, page 139?169. Cambridge University Press, Cambridge.

Bourhis, R. and Giles, H. (1977). *The Language of intergroup distinctiveness*. Academic Press, London, UK.

Brennan, S. E. and Metzing, C. A. (2004). Two steps forward, one step back: Partner-specific effects in a psychology of dialogue. *Behavioral and Brain Sciences*, 27.

Brown-Schmidt, S. and Tanenhaus, M. K. (2004). Priming and alignment: Mechanism or consequence? *Behavioral and Brain Sciences*, 27.

Campbell-Kibler, K. (2009). The nature of sociolinguistic perception. *Language Variation and Change*, 21:135–156.

Campbell-Kibler, K. (2011). The sociolinguistic variant as a carrier of social meaning. *Language Variation and Change*, 22:423–441.

Campbell-Kibler, K. (2016). *Toward a cognitively realistic model of meaningful sociolinguistic variation.*

Carey, B. (2011). Fraud case seen as a red flag for psychology research. *New York Times.*

Cedergren, H. J. and Sankoff, D. (1974). Variable rules: Performance as a statistical reflection of competence. *Language*, 50(2):333–355.

Chartrand, T. and Bargh, J. (1996). Automatic activation of impression formation and memorization goals: Nonconscious goal priming reproduces effects of explicit task instructions. *Journal of Personality and Social Psychology*, 71(3):464–478.

Chomsky, N. (1965). *Aspects of the theory of syntax.* The MIT Press, Cambridge, MA.

Custers, R., Maas, M., Wildenbeest, M., and Aarts, H. (2008). Nonconscious goal pursuit and the surmounting of physical and social obstacles. *European Journal of Social Psychology*, 38:1013–1022.

Dodsworth, R. (2014). Network embeddedness and the retreat from Southern vowels in Raleigh. *University of Pennsylvania Working Papers in Linguistics*, 20(2):41–50.

Dodsworth, R. and Kohn, M. (2012). Urban rejection of the vernacular: The SVS undone. *Language Variation and Change*, 24:221–245.

D'Onofrio, A. (2015). Persona-based information shapes linguistic perception: Valley Girls and California vowels. *Journal of Sociolinguistics*, 19(2):241–256.

Drager, K., Hay, J., and Walker, A. (2010). Pronounced rivalries: Attitudes and speech production. *Te Reo*, 53:27–53.

Earp, B. and Tramifow, D. (2015). Replication, falsification, and the crisis of confidence in social psychology. *Front. Psychol.*

Eckert, P. (2000). *Linguistic variation as social practice.* Blackwell, Oxford.

Eckert, P. (2012). Three waves of variation study: The emergence of meaning in the study of sociolinguistic variation. *Annual Review of Anthropology*, 41:87–100.

Fischer, J. (1958). Social influence of a linguistic variant. *Word*, 14:47–56.

Giles, H. (1980). Accommodation theory: Some new directions. *York Papers in Linguistics*, 9(105–136).

Giles, H., Coupland, N., and Coupland, I. (1991). 1. accommodation theory: Communication, context, and. *Contexts of accommodation: Developments in applied sociolinguistics*, 1.

Goldinger, S. D. (1998). Echoes of echoes? An episodic theory of lexical access. *Psychological Review*, 105(2):251–279.

Goldinger, S. D. and Azuma, T. (2004). Episodic memory reflected in printed word naming. *Psychonomic Bulletin and Review*, 11(4):716–722.

Grondelaers, S. and van Hout, R. (2016). How (in)coherent can standard languages be? a perceptual perspective on co-variation. *Lingua*, 172-173:62–71.

Guy, G. R. (2013). The cognitive coherence of sociolects: How do speakers handle multiple sociolinguistic variables? *Journal of Pragmatics*, 52:63–71.

Guy, G. R. and Hinskens, F. (2016). Linguistic coherence: Systems, repertoires and speech communities. *Lingua*, 172–173:1–9.

Hall, J. S. (1942). The phonetics of great smoky mountain speech. *American Speech*, 17.

Hay, J. and Drager, K. (2010). Stuffed toys and speech perception. *Linguistics*, 48(4):865–892.

Hay, J., Nolan, A., and Drager, K. (2006a). From fush to feesh: Exemplar priming in speech perception. *The Linguistic Review*, 23(351–379).

Hay, J., Warren, P., and Drager, K. (2006b). Factors influencing speech perception in the context of a merger-in-progress. *Journal of Phonetics*, 34(4):458–484.

Koops, C., Gentry, E., and Pantos, A. (2008). The effect of perceived speaker age on the perception of pin and pen vowels in houston, texas. *UPenn Working Paper in Linguistics*, 14(2):Article 12.

Krauss, R. M. and Pardo, J. S. (2004). Is alignment always the result of automatic priming? *Behavioral and Brain Sciences*, 27.

Labov, W. (1963). The social motivation of a sound change. *Word*, 19(3):273–309.

Labov, W. (1969). Contraction, deletion, and inherent variability of the English copula. *Language*, 45(4):715–762.

Labov, W. (1994). *Principles of Linguistic Change, Vol. 1. Internal Factors.* Blackwell, Oxford.

Labov, W. (2006 [1966]). *The social stratification of English in New York City.* Cambridge University Press.

Labov, W. (2010). *Principles of Linguistic Change, Vol. 3. Cognitive and Cultural Factors.* Wiley-Blackwell.

Labov, W., Ash, S., and Boberg, C. (2006). *The atlas of North American English: Phonetics, phonology and sound change.* Mouton de Gruyter, Berlin.

Labov, W., Yaeger, M., and Steiner, R. (1972). *A Quantitative Study of Sound Change in Progress.* Number v. 2 in A Quantitative Study of Sound Change in Progress. U.S. Regional Survey.

Lambert, W., Hodgson, R., Gardner, R., and Fillenbaum, S. (1960). Evaluational reactions to spoken languages. *Journal of Abnormal and Social Psychology*, 60(1):44–51.

Liberman, A. M. and Mattingly, I. G. (1985). The motor theory of speech perception revised. *Cognition*, 21(1):1–36.

Lobanov, B. (1971). Classification of Russian vowels spoken by different speakers. *Journal of the Acoustical Society of America*, 68:1636–1642.

Love, J. and Walker, A. (2013). Contextual activation of australia can affect new zealanders' vowel productions. *Journal of Phonetics*, 48:76–95.

McGowan, K. (2015). Social expectation improves speech perception in noise. *Language and Speech*, 58(4):502–521.

Mendoza-Denton, N. (2008). *Homegirls : Language and Cultural Practice among Latina Youth Gangs*. Blackwell, Malden, MA.

Niedzielski, N. (1999). The effect of social information on the perception of sociolinguistic variables. *Journal of Language and Social Psychology*, 18(1):62–85.

Nielsen, K. (2011). Specificity and abstractness of vot imitation. *Journal of Phonetics*, 39(2):132–142.

Pardo, J., Gibbons, R., Suppes, A., and Krauss, R. (2012). Phonetic convergence in college roommates. *Journal of Phonetics*, 40(1):190–197.

Pardo, J. S. (2006). On phonetic convergence during conversational interaction. *Journal of the Acoustical Society of America*, 119(4):2382–2393.

Pardo, J. S., Jay, I. C., and Krauss, R. M. (2010). Conversational role influences speech imitation. *Attention, Perception, & Psychophysics*, 72(8):2254–2264.

Pickering, M. J. and Garrod, S. (2004). Toward a mechanistic psychology of dialogue. *Behavioral and Brain Sciences*, 27:169–226.

Pickering, M. J. and Garrod, S. (2013). Uncovering the roles of gender stereotypes in speech perception. *Behavioral and Brain Sciences*, 36:329–392.

Pierrehumbert, J. (2001). *Exemplar dynamics: Word frequency, lenition and contrast*, pages 137–158. John Benjamins, Amsterdam and Philadelphia.

Reed, P. (2014). Inter- and intra-generational monophthongization and southern appalachian identity. *Southern Journal of Linguistics*, 38:159– 193.

Reed, P. (2016). Sounding appalachian: /ai/ monophthongization, rising pitch accents, and rootedness. *Doctoral Dissertation*.

Sanchez, K., Hay, J., and Nilson, E. (2015). Football versus football: Effect of topic on /r/ realization in american and english sports fans. *Language and Speech*, 56(4):443–460.

Sancier, M. L. and Fowler, C. A. (1997). Gestural drift in a bilingual speaker of brazilian portuguese and english. *Journal of Phonetics*, 25(4):421–436.

Strand, E. (1999). Uncovering the roles of gender stereotypes in speech perception. *Journal of Language and Social Psychology*, 18(1):86–99.

Theodore, R., Miller, J., and DeSteno, D. (2009). Individual talker differences in voice-onset-time: Contextual influences. *J. Acoust. Soc. Amer*, 125(6):3974? 3982.

Van Berkum, J. J. A., van den Brink, D., Tesink, C. M. J. Y., Kos, M., and Hagoort, P. (2008). The neural integration of speaker and message. *Journal of Cognitive Neuroscience*, 20(4):580–591.

Walker, A., Hay, J., Drager, K., and Sanchez, K. (2018). Divergence in speech perception. *Linguistics*, 56(1).

Weatherholtz, K. (2015). *Perceptual learning of systemic cross-category vowel variation*. PhD thesis, The Ohio State University.

Weinreich, U., Labov, W., and Herzog, M. I. (1968). Empirical foundations for a theory of language change. In Lehmann, W. and Malkiel, Y., editors, *Directions for historical linguistics: A symposium*, pages 97–195. University of Texas Press, Austin and London.

Wilson, C., Chodroff, E., and Nielsen, K. (2016). Generalization in vot imitation: Feature adaptation or acoustic-phonetic covariation? *Acoustical Society of America*.

Wolfram, W. and Christian, D. (1976). *Appalachian Speech*. Center for Applied Linguistics, Arlington, VA.

Zellou, G., Dahan, D., and Embick, D. (2017). Imitation of coarticulatory vowel nasality across words and time. *Language, Cognition And Neuroscience*, page 1? 16.