University of Pennsylvania Working Papers in Linguistics

Volume 20
Issue 2 *Selected Papers from NWAV 42*

Article 20

10-1-2014

Social Differences in the Processing of Grammatical Variation

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Abstract
This paper presents analysis of data aggregated from three experiments, investigating whether there are social differences in the processing of sociolinguistic variation. Three self-paced reading experiments tested the processing of variable subject-verb agreement in English. Sentences appeared in one of three agreement conditions: standard [singular+*doesn't*] or [plural+*don't*], nonstandard [singular+*don't*], or "uncommon" [plural+*doesn't*]. While the nonstandard form is common in vernacular English dialects, the uncommon form is not known to be a dialect variant. For participants as a whole, relative to standard sentences, both nonstandard and uncommon sentences took longer to read. Uncommon sentences took the longest, reflecting participants' greater familiarity with the nonstandard compared to uncommon form. To explore social differences, I compared responses by grouping the data on three social dimensions: class (higher- and lower-class participants), race (white and African American participants), and sex (female and male participants). The hypothesis was that if these social groups map onto differences in linguistic experience/knowledge, such differences would be reflected in different responses to the nonstandard variant. The main findings are a) groups show differences in reading speed, independent of agreement, and b) agreement was not a significant predictor of reading times for the African American participant group. I discuss the implications for experimental methodology and future research on sociolinguistic perception.

This working paper is available in University of Pennsylvania Working Papers in Linguistics: http://repository.upenn.edu/pwpl/vol20/iss2/20

Social Differences in the Processing of Grammatical Variation

Lauren Squires

1 Introduction and Background

The cognitive and perceptual dimensions of linguistic variation have recently developed into a major area of study, which I will broadly call sociolinguistic perception (Campbell-Kibler 2009). One aim of this research is to better understand speakers' knowledge of linguistic variation: How is knowledge of variation acquired and stored? Is there a social component? Is it similar at all levels of linguistic structure? A second, related aim is to shed light on how variation is accommodated during production and perception: Is variation disruptive or facilitative to processing? Are novel linguistic patterns ignored or stored? How are they categorized? What is the role of social information in processing? These are just some of the many questions that scholars have asked in this growing area of interest (see, e.g., Wolfram 1982, Campbell-Kibler 2009, Labov et al. 2011).

While much sociolinguistic perception research is grounded theoretically, for instance in exemplar theory or the idea of the sociolinguistic monitor, the present study's goals are largely empirical and exploratory. I present the results of three experiments testing how morphosyntactic variation—subject-verb agreement variability in English—is processed during sentence comprehension. My analysis aggregates the data from these experiments in order to explore demographic differences among participants. The question is whether social differences among perceivers—differences that might reasonably be thought to relate to the linguistic variation in question—are related to differential processing patterns.

There is little research on how (morpho)syntactic sociolinguistic variation is processed, but there is a body of work within psycholinguistics that deals with syntactic variability in sentence comprehension. One key finding is that speakers face initial difficulty with unfamiliar syntactic structures, but can come to accommodate those structures fairly rapidly. For instance, Kaschak and Glenberg (2004) investigated processing of the regionally-specific [*need*+past participle] construction ("needs washed") among participants who were not from the dialect region where the construction is found. Participants had slower reading times for the dialect variant than the standard variant, but the effect dissipated with repeated exposure. Such a phenomenon has also been identified for more globally ungrammatical structures (that is, not dialect variants), known as a syntactic satiation effect (Luka and Barsalou 2005). Whether people in these studies were *learning* the new structures (in the sense of acquiring competence in producing them) or simply learning to *tolerate* them is an open question, but it is clear that less familiar syntactic structures are more difficult to process than familiar ones. Processing reflects familiarity; the further outside of one's own competence a dialect variant lies, the more difficult it will be to process.

Another relevant phenomenon is structural priming, whereby more recently experienced structures are more likely to be produced or perceived than less recent alternatives (for a review, see Pickering and Ferreira 2008). A structural priming effect has been found for the production and comprehension of syntactic alternatives that are more or less semantically equivalent (as are many sociolinguistic variants). Priming results indicate that sentence processing is somewhat expectation-based, and expectations can be shifted by recent input (Jaeger and Snider 2013). Thus, if a speaker has underlying knowledge of dialect variants for a particular variable, recent exposure to a less-frequent variant may boost the likelihood that the speaker will produce it or expect to encounter, even if it is not the "baseline" variant in the speaker's production (Squires 2013).

Finally, more recent work is showing that sentence processing is at least somewhat sensitive to features that are typically considered nonlinguistic, or social. Information that a listener has about who is talking can lead to differences in processing the same stimuli. For instance, Hanulíková et al. (2012) found that when listeners were cued to believe that a speaker was a nonnative speaker, their brains responded less strongly to grammatical errors than when they viewed the speaker as native. Kamide (2012) found support for talker specificity in structural priming: priming effects that are boosted when the personal information about the talker is held constant. There may be significant interplays between perceptions of social and linguistic stimuli, affecting how sociolinguistic variation is processed and how it is stored.

The results of these prior inquiries, which by and large are not situated within the field of sociolinguistics, suggest three rough predictions regarding sociolinguistic variation:

(1) a. Processing is gradiently sensitive to degrees of experience with variants, and is more difficult for variants outside of one's own baseline;
b. Processing depends on one's expectations about which variants are likely; and
c. Both linguistic and nonlinguistic information can affect expectations.

This study deals with (1a) and presents some starting points for more directly investigating (1b) and (1c). My study focuses on whether social differences correlate with processing differences, presumably due to different linguistic experience/knowledge between groups.

There is little research on social (rather than individual) differences in sentence processing. Bresnan and Ford (2010) conducted a self-paced reading experiment for sentences with the dative alternation, and found processing differences between Australian and US English speakers. These differences mirrored probabilistic facts about the structures used within either dialect, as measured by corpus frequencies; the participants' relative experiences with the two structures showed up in their processing sensitivities. In structural priming experiments testing the perception of two subject-verb agreement variables, I found that response patterns were different between lower- and upper-class participants (Squires 2013).

This study extends the research in several ways. First, I investigate the processing of a variable that is known to pattern socially within a large speech community (English speakers in the United States). Second, I use an on-line measure of sentence processing that is temporally sensitive (self-paced reading), rather than a choice or ratings task; this method potentially permits detection of very subtle differences between participants, and does not rely on metalinguistic judgments (though such judgments may be unavoidable; see discussion in Squires forthcoming).

2 Method

For this exploration, I aggregated the data from three self-paced reading experiments, which created a more diverse overall participant sample, enabling the exploration of social differences. The full experimental descriptions and experiment-specific analyses are in Squires 2014 and Squires forthcoming; I give an overview here.

Throughout each experiment, participants read sentences on a computer screen word-by-word at their own pace, pressing a button on a response box to proceed. Critical sentences contained the structure [NP+*don't/doesn't*], where the combination of number on the subject noun and auxiliary verb form was variable. Some sentences contained standard agreement, some contained nonstandard agreement, and some contained "uncommon" agreement, as exemplified in (2a-d):

(2) a. Standard (plural):	After eating, the	turtles	don't	walk	very fast.
b. Standard (singular):	After eating, the	turtle	doesn't	walk	very fast.
c. Nonstandard:	After eating, the	turtle	don't	walk	very fast.
d. Uncommon:	After eating, the	turtles	doesn't	walk	very fast.
		1	2	3	4
		noun	don't	verb	verb+1

The nonstandard variant [SG+*don't*], or "invariant *don't*," is common across varieties of English, including vernacular dialects of US English (see references in Squires 2013, 2014). In contrast, the "uncommon" form [PL+*doesn't*] is not known to be a dialect variant. It provides a way of testing prediction (1a) from above, by testing participants' processing of a structure they would likely have experienced but probably do not use themselves, versus one that they would likely neither use nor experience. There were four critical word regions within each sentence, labeled in (2): [1] the subject before *don't/doesn't* (noun); [2] *don't/doesn't* (don't); [3] the main verb following *don't/doesn't* (verb); and [4] the word following the main verb (verb+1).

Each experiment contained 64 target sentences with NP+*don't/doesn't* and 64 filler sentences, which were standard and did not contain *don't/doesn't*. There were periodic yes/no comprehension questions. The three experiments differed only in the total ratio of standard sentences to nonstandard and uncommon sentences: Version 1 contained 75% standard sentences; Version 2 contained 81% standard sentences, and Version 3 contained 94% standard sentences. See Squires (forthcoming) for discussion of this manipulation.

There were 112 total participants; all were undergraduate students in the US. A questionnaire at the end of the experiment asked demographic questions whose responses were used to group participants on three social dimensions: class, race/ethnicity, and sex. For the social class dimension, participants were grouped as higher-class if they reported having at least one parent or caregiver with a bachelor's degree. Table 1 lists the number of participants in each social category. Note that two participants' data were removed who reported having a reading disability, and six had data removed for not having English as their native language.

Social Dimension	**Class**		**Race/ethnicity**			**Sex**	
Social Category	Higher	Lower	White	African American	Other	Male	Female
Participants	55	49	82	11	11	32	72

Table 1: Number of participants in the aggregated dataset, by social category (104 total).

Note that the group sizes are unbalanced because they were not controlled for; it is for this reason that the analysis here can only be considered exploratory, hopefully encouraging more controlled future comparisons. With regards to race/ethnicity, only the white and African American groups are analyzed, due to the very small samples in the other categories.

I assumed as a baseline that all participants (as US university students) would have knowledge of the standard agreement patterns, and further, because of the nature of the laboratory setting and the use of written stimuli, that the standard forms were most expected. I also assumed that because of the prevalence of invariant *don't* in colloquial US English, most (if not all) participants would have experienced, but may not typically use, the nonstandard pattern. Finally, I assumed that participants neither knew nor used the uncommon form.

There were more specific predictions related to social categories, based on descriptive evidence about the social distribution of invariant *don't.* This feature cuts across vernacular regional and ethnic dialects, being more prevalent among lower-class than higher-class speakers (see Squires 2013, 2014). The feature is also prominent in African American English (Weldon 1994). In terms of gender, there is marginal evidence that invariant *don't* is more frequently used among men than women (Eisikovits 1991), in line with other nonstandard dialect features, but this is not well documented in the US. Based on this evidence, if there were group differences, I expected them to be as follows: lower-class, African American, and male participants would be less affected by the agreement differences—that is, have their reading times slowed less—than higher-class, white, and female participants. Such a hypothesis rests on the assumption that participants' identification within a social category meaningfully indexes their sociolinguistic experience, and I acknowledge that such an assumption is problematic. Future work should more systematically test processing amongst participants whose sociolinguistic experiences are demonstrably variable.

3 Results

3.1 All Participants

The mean reading times for all participants are depicted in Figure 1 (observations over 2000 ms and under 30 ms were removed as outliers). Because *don't/doesn't* is the word at which the agreement form becomes apparent, I conduct statistical analyses for the don't, verb, and verb+1 regions (2, 3, and 4 in the figures). For these regions, the fastest response times were for standard sentences, the slowest were for uncommon sentences, and nonstandard sentences were intermediate.

I verified the significance of agreement in the aggregated dataset by building separate mixed-effects linear regression models for each of these three critical word regions. I used a model comparison procedure. I began with a model that included four terms: the fixed effects of experiment and experimental block; and random intercept effects for subjects and items. From this base model, I tested the effect of agreement via chi-square, comparing the models with and without agreement as a predictor. Agreement was a significant predictor of reading times at all three regions: don't ($X^2(9) = 67.899$, $p<.001$), verb ($X^2(9) = 170.08$, $p<.001$), and verb+1 ($X^2(9) = 24.25$, $p<.001$). The summarized regression models are presented in Table 2. The reference level for agreement is standard, thus the model estimates show that the nonstandard and uncommon sentences had longer reading times than standard sentences. The divergence was largest for the uncommon sentences.

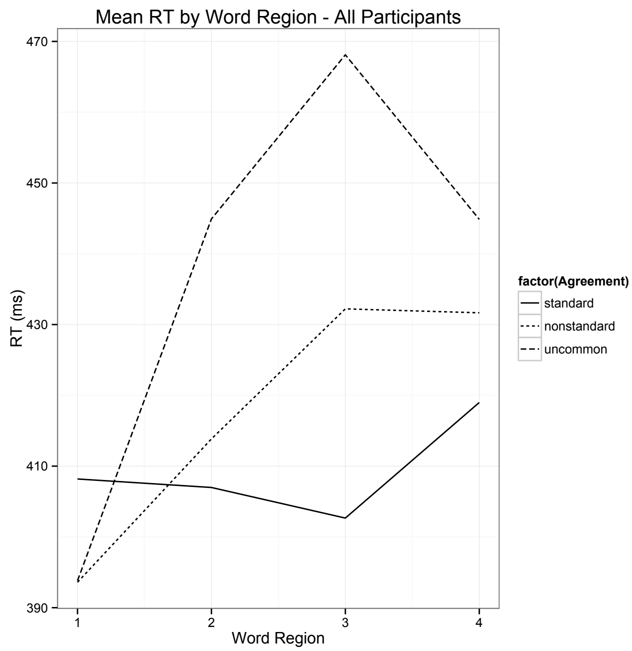

Figure 1: Mean reading times for complete dataset, by word region and agreement. (Word region 1 = noun, 2 = don't, 3 = verb, 4 = verb+1).

Word Region	Factor Level	Estimate	SE	t value	p value
don't	Intercept	485.177	17.727	27.369	<.001
	Experiment-Version2	18.931	24.835	.762	-
	Experiment-Version3	40.364	25.567	1.579	-
	Block	-39.618	2.034	-19.476	<.001
	Agreement-Nonstandard	18.475	5.819	3.175	<.01
	Agreement-Uncommon	48.051	5.833	8.238	<.001
verb	Intercept	488.028	16.954	28.786	<.001
	Experiment-Version2	13.798	23.551	.586	-
	Experiment-Version3	48.253	24.251	1.99	<.05
	Block	-42.637	2.051	-20.790	<.001
	Agreement-Nonstandard	38.980	5.865	6.646	<.001
	Agreement-Uncommon	75.561	5.870	12.873	<.001
verb+1	Intercept	489.066	18.332	26.678	<.001
	Experiment-Version2	24.972	22.612	1.104	-
	Experiment-Version3	57.801	23.301	2.481	<.05
	Block	-37.977	2.337	-16.250	<.001
	Agreement-Nonstandard	17.262	6.380	2.705	<.01
	Agreement-Uncommon	30.037	6.379	4.709	<.001

Table 2: Summary of regression analyses for complete dataset.

These results fit the general predictions for this population as a whole: Standard sentences were read fastest, uncommon sentences were read slowest, and nonstandard sentences were intermediate. This effect began as early as the auxiliary *don't/doesn't* and continued to the second subsequent word. The following sections present an exploration into differences between social categories of participants. For each social factor, first I test whether it is a significant predictor of reading times between groups for the full dataset. Then, I separate the data by social category to test for the agreement effect.

3.2 Class

Figure 2 shows response times divided into higher-class participants (55) and lower-class participants (49). Lower-class participants had longer reading times than higher-class participants. I used model comparison to test the significance of this difference for all reading times conflated across the four word regions. I began with a model including the fixed effects of experiment, block, and agreement and a random intercept effect for items (I did not include a random effect of subjects, since social class is a subject-level effect). Then I added class as a fixed effect and compared the models. Class significantly improved the model ($X^2(9)=196.41$, $p<.001$), with the lower-class factor level predicting longer reading times (estimate=32.496, SE=2.315, t=14.04, $p<.001$).

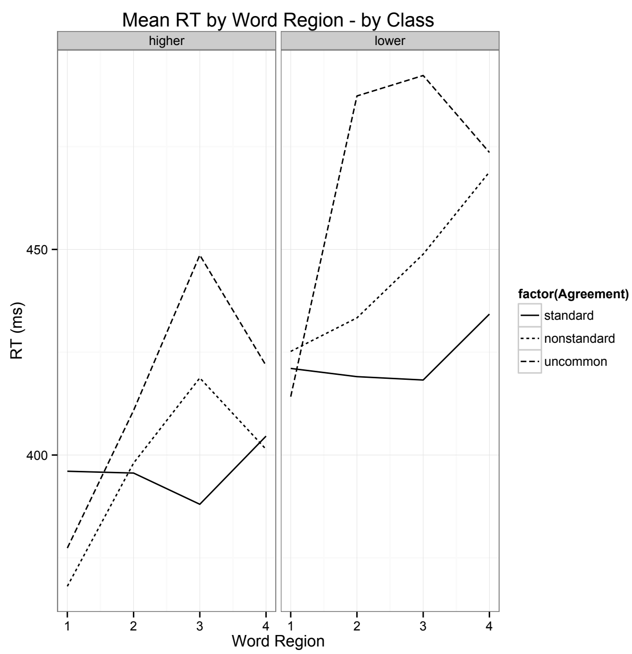

Figure 2: Reading times divided by participants' social class.

Next, I divided the data and conducted model comparisons separately for the three critical word regions, for each group. In each case, the beginning model had fixed effects of experiment and block and random intercept effects for subjects and items. Agreement was added as a fixed effect and the models were compared. If adding agreement produced a significantly better model at the $p<.05$ level, it was retained in the model. Due to space limitations, I do not present the full model summaries here, but rather simply show which factor levels predicted significantly longer reading times than standard agreement, in Table 3. Interested readers may contact me for the complete model summaries.

For both groups, agreement was significant at all three word region. At the verb+1 region, the nonstandard sentences were not significantly longer than standard sentences for the higher-class group, though they were for the lower-class group. Thus, apart from raw reading time differences, sensitivity to nonstandard agreement may be slightly higher for the lower-class participants. This is contrary to the hypothesis that lower-class participants might be less sensitive to nonstandard agreement, if they had more experience with this form (though it may nonetheless reflect surprisal at encountering the form in writing in a university laboratory setting).

	don't		verb		verb+1	
	nonstandard	uncommon	nonstandard	uncommon	nonstandard	uncommon
Lower	<.05	<.001	<.001	<.001	<.01	<.01
Higher	<.05	<.001	<.001	<.001	-	<.001

Table 3: Statistical significance of agreement for lower- and higher-class participants.

3.3 Race/Ethnicity

I followed the same procedures to compare the responses of white (82) and African American (11) participants. As shown in Figure 3, African American participants had longer reading times than white participants. This effect was significant ($X^2(9)=130.97$, $p<.001$; estimate=-45.041, SE=3.931, t=-11.46, $p<.001$).

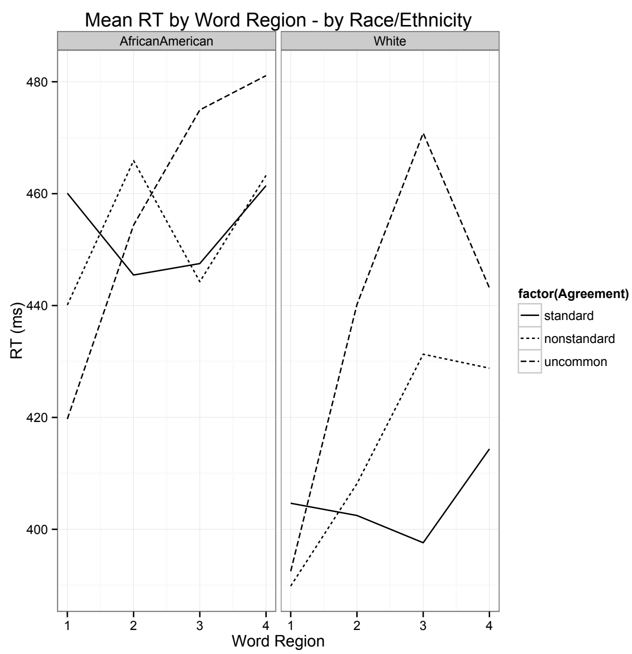

Figure 3: Reading times divided by participants' race/ethnicity.

Table 4 summarizes statistical significance for the effect of agreement for the two groups. While agreement was a significant predictor at every word region for the white participant group, the effect of agreement was not significant at the $p<.05$ level for the African American participant group. While the lack of significance could be due to lower statistical power because of the smaller sample size of African American participants, testing for agreement with much smaller subsets of participants from the other ethnoracial categories did reveal significant effects, so it does not appear to be due to sample size.

African Americans' lesser sensitivity to the nonstandard form [singular+*don't*] was predicted, on the assumption that African American participants may have had more experience with AAE, a dialect in which this form is common. In particular, at the verb and verb+1 regions, the mean reading time for the nonstandard and standard sentences are nearly the same for African American participants. In comparison, the mean reading time for the uncommon form is visibly longer at these two regions, yet this effect also did not reach statistical significance—which was not expected. It is possible that the overall longer reading times created greater overall variability in the data of African American participants, making subtle effects difficult to detect.

	don't		verb		verb+1	
	nonstandard	uncommon	nonstandard	uncommon	nonstandard	uncommon
White	<.05	<.001	<.001	<.001	<.01	<.001
African American	-	-	-	-	-	-

Table 4: Statistical significance of agreement for white and African American participants.

3.4 Sex

Finally, I compared the responses of females (72) and males (32). As shown in Figure 4, males had faster reading times than females ($X^2(9)=244.99$, $p<.001$; estimate=-38.91, SE=2.480, t=-15.69, $p<.001$).

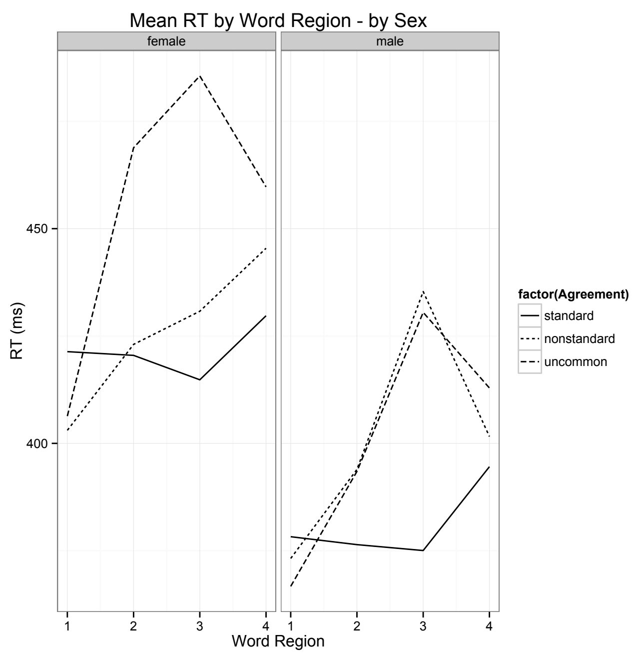

Figure 4: Reading times divided by participant sex.

As summarized in Table 5, agreement was a significant predictor for both groups at all three word regions. However, at the verb+1 region, nonstandard agreement did not produce significantly longer reading times for males, whereas it did for females. Also, the effect of uncommon agreement is more highly significant for the female group at the don't and verb+1 regions.

	don't		verb		verb+1	
	nonstandard	uncommon	nonstandard	uncommon	nonstandard	uncommon
Female	<.05	<.001	<.001	<.001	<.05	<.001
Male	<.05	<.05	<.001	<.001	-	<.01

Table 5: Statistical significance of agreement for male and female participants.

4 Discussion

The guiding logic of these analyses was that social group differences might index participants' differing linguistic experience/knowledge, which would lead to differences in processing grammatical variation. Viewing the participants as a uniform group, nonstandard and "uncommon" agreement led to longer reading times than standard agreement. Separating the data based on social dimensions revealed some differences between groups, not all of which were expected.

First, there were significant differences in overall reading times in all group comparisons. Higher-class participants read faster than lower-class participants, white participants read faster than African American participants, and male participants read faster than female participants. These reading time differences were independent of the effect of agreement on reading. Though examining general reading speed was not the primary goal of this study, the results warrant consideration, as they were not anticipated. Research has shown that reading skill varies with socioeconomic status, race/ethnicity, and sex. My results seem to mirror the well-known "achievement gap" present in American education: students with lower socioeconomic status and who are in racial minority groups tend to have lower reading/literacy abilities (Seidenberg 2013, Terry et al. 2012). As Seidenberg (2013) points out, the relationship between these social dimensions and reading is complex, with multiple factors at play; and of course, these are generalizations about individuals within extremely diverse groups. Interestingly, Seidenberg proposes that language itself (as in dialect) could be a major contributor to the persistence of the reading achievement gap between whites and African Americans—essentially because AAE speakers are expected to read Standard English, and the two dialects map differently to standard written representations. My findings regarding race/ethnicity and social class would seem to fall in line with these generalities, if slower reading time is indicative of more global reading skill or ability.

However, the majority of research on this topic has been done with young children or adolescents, not the adult college students of my population—there is very little work on reading speed, ability, or comprehension among literate adults in general (Lewandowski et al. 2003). I have not found any literature regarding reading time differences of adults in terms of social class or race/ethnicity. More educated people have been found to have faster processing speed (Roivainen 2011), but this is not specific to reading. What is interesting in terms of the results of this sample is that despite the social differences I've explored here, all participants were nonetheless college students at four-year American universities. Saint-Aubin et al. (2012) suggest that college students represent a fairly homogeneous population in terms of reading skill; hence, the differences found here are even more intriguing, and it is unclear what they actually represent.

Additionally, the finding that females read more slowly than males is counter to much of the reading research, which shows higher verbal and reading skills for females (e.g., Roivainen 2011, Hannon 2014), including faster reading rates (Saint-Aubin et al. 2012). It is possible that what I've been calling *reading time* differences may be somewhat simpler *reaction time* differences, as it has also been found that males have faster task reaction times (Adam et al. 1999). This may partly be mediated by males' greater propensity to have played computer games (McPherson and Burns 2008), and therefore a product of greater practice with the motor component of computerized speeded tasks. It has also been suggested that women complete verbal experimental tasks more strategically, prioritizing accuracy over speed (Saint-Aubin et al. 2012). There may be task strategies or other task-related factors behind the differences seen here, and this could be the case for the other social groupings (class and race/ethnicity) as well.

The reading speed differences indicate that caution should be taken in interpreting the agreement effect differences, since group-level reading time differences could be a confound to understanding true group-level differences in processing variation, and since reading time differences may not actually reflect reading comprehension differences. Nonetheless, there were two compelling differences in the effect of agreement between groups. First, the most dramatic was between African American participants, whose responses were not predicted by agreement, and white participants, whose responses were predicted by agreement. This implies that African American participants may have had more previous experience with (knowledge of) agreement variability; this was predicted. Other research has shown that comprehension mirrors competence, in that child speakers of African American English do not readily interpret morphemes that are part of Standard English grammar (Beyer and Kam 2011). Yet the fact that not even the uncommon form reached significance for this group was surprising. Again though, we have little knowledge of how *adult* speakers, who have a much broader range of experiences, comprehend variable forms. The present study contributes to that effort, though a much larger sample size would be needed to interpret these results as anything more than suggestive.

Second, the differences between groups showed up in the same word regions across the class and sex analyses, speaking to the time-course of variation's effect on processing. Comprehensively, the verb region showed the most reliable effects: both nonstandard and uncommon agreement were significantly longer than standard agreement at the $p<.001$ level, for all participant groups except African Americans. Effects at the surrounding regions—don't and verb+1—were less consistent. In particular, at the verb+1 region, for higher-class and male participants, only uncommon agreement remained different from standard; whereas for lower-class and female participants, nonstandard agreement also took longer. Thus, uncommon agreement seems to lead to the longest-lasting disruption effect, with the effect of nonstandard agreement more quickly dissipating for some participants. The groups of speakers who did continue to be affected by nonstandard agreement was somewhat surprising, however: based on the hypotheses set out above, it should be lower-class speakers who are less sensitive to the nonstandard variant, yet it was these participants who continued showing the effect two words after the auxiliary verb. It could be that my measure of class does not get at real class/status differences, or that even people who have experience/knowledge with the form are surprised to see it in print, in a university setting. The roles of different sources of expectation will be important to consider in future work.

As stated at the outset, these analyses were exploratory, and should be taken to point the way toward future research on processing and variation. For instance, it is possible that the measure of reading time does not reflect the same things in all participants. My method was assumed to measure the impact of variable forms on processing. I considered the effect of agreement to represent departure from one's processing baseline—the most-expected linguistic form. However, some of the differences found might have to do with differing task performance or strategy, rather than baseline (especially the gender difference). It will be important to develop more sophisticated ways of tapping into processing baselines, and controlling for processing strategies. Additionally, it would be useful to explore which sociolinguistic experiences and contextual factors affect processing baselines and expectations, and which do not. In this vein, another possibility to explore is that the verb+1 region results, inconsistent as they were across groups, reflect *recovery* from disruption rather than disruption itself. Perhaps the participants who were not affected by agreement at the verb+1 were not experiencing a lesser disruption, but rather a faster recovery. Such differences could play a role in how individuals deal with variation upon encountering it.

One particularly important methodological task is to develop ways of diagnosing dialect experience that go beyond inferences from social properties. Moreover, even production measures would not be able to tell us the level of dialect familiarity participants come into an experimental setting with. As has been shown in multiple studies, increasing structural familiarity alone—repeated exposure—leads to a growing acceptance of structures as grammatical. Presumably processing baselines are formed both from one's production grammar and from what they know or expect about forms that they have some knowledge of but don't (or rarely) produce. A comprehensive understanding of how variation is processed will take into account both production and more passive knowledge/familiarity, in addition to sociolinguistic attitudes, which were not dealt with at all here.

Finally, self-paced reading has led to many important psycholinguistic discoveries, and thus it is a promising method to use to investigate sociolinguistic processing. However, it is inevitably confounded with (mediated by) reading skill and expectations of what is written (e.g., Standard English). Other methods that use listening paradigms and different response mechanisms will allow us to gather more evidence and make stronger conclusions, as would diversifying the participant populations from whom we gather evidence.

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