



Experimental priming of phonological variant identification

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In conversational speech, it has been observed that speakers tend to reuse the variant they have recently used. This recency effect, also called ‘persistence’ or ‘repetitiveness’, has often been attributed to ‘priming’ in psycholinguistic terms. However, it is still not clear whether one can really be primed to choose one variant over another with discrete phonological variation at the segmental level in an experimental set-up. This study empirically tests the hypothesis that having most recently perceived one variant increases the probability of reusing the same variant in speech perception in a subsequent trial, controlling for overall variant rates. Using the well-studied variable ING, i.e., the alternation between *-ing* and *-in*, as a test case, our results reveal that phonological variant identification can be primed and that this variant priming decays rapidly after one intervening word. The difference between the decay profiles for variant persistence and variant priming ultimately calls into question whether priming truly drives repetitiveness in conversational speech.



1. Introduction

When a word has multiple pronunciation variants (such as *workin'* versus *working*), language users must choose a variant every time they produce that word in everyday conversation. Decades of research on conversational speech have shown that a multitude of linguistic and stylistic factors shape those choices simultaneously; as the output of the speech production system, the processing system can also influence speakers. One well-established empirical observation from the quantitative study of variation in conversational speech is that speakers tend to repeat the linguistic variant they have most recently used or encountered (e.g., Sankoff & Laberge, 1978; Szmrecsanyi, 2006). For example, shortly after saying or hearing the word *workin'*, an English speaker is more inclined to choose the informal *jumpin'* than if they had just said or heard *working* (Tamminga, 2016b). This effect, which we refer to here as *variant persistence*, has been observed for probabilistic linguistic alternations at different levels of grammar and across different languages (Abreu, 2012; Gries, 2005; Li et al., 2023; Poplack, 1980; Scherre & Naro, 1991; Szmrecsanyi, 2006; Weiner & Labov, 1983). Understanding variant persistence promises insight into theoretical issues such as the mechanisms of linguistic convergence (Babel, 2010; Giles et al., 1991), the grammatical locus of linguistic variation (Ecay & Tamminga, 2017; Tamminga, 2016b), and the impetus for language change (Clark, 2018; Mayol, 2012; Pickering & Garrod, 2017).

Variant persistence as observed in conversational data is often attributed to priming, in the psycholinguistic sense of repetition being facilitated in processing (Clark, 2018; Clark & Walsh, 2015; Pickering & Garrod, 2017; Szmrecsanyi, 2006; Tamminga, 2016b, 2019). When it comes to syntactic alternations, such as the English active/passive alternation in “the boy kicked the ball” vs. “the ball was kicked by the boy,” the persistence of *syntactic* variants has been linked to experimental syntactic priming (Bock, 1986; Pickering & Branigan, 1999; Pickering & Ferreira, 2008), when participants are more likely to describe a picture using a word order option to which they have just been exposed. Various empirical parallels between syntactic variant persistence in conversation and experimental syntactic priming are taken as evidence that naturalistic and experimental data reflect a common underlying mechanism, and these lines of research can be mutually informative (Pickering & Ferreira, 2008; Szmrecsanyi, 2006).

When it comes to *phonological* variation, recent work has demonstrated phonological priming at the supersegmental level (e.g., Moore-Cantwell et al. [2024] on stress priming). To our knowledge, however, it has not been shown that the choice between discrete phonological variants at the segmental level, such as *-in'* versus *-ing*, can be similarly primed in a controlled experiment. Instead, researchers have appealed to the properties of other types of priming, especially syntactic priming, to motivate the interpretation of phonological persistence in conversation as arising from priming (Clark, 2018; Tamminga, 2016b). However, syntactic variation and phonological variation are quite different linguistic phenomena, so this interpretation is better supported by

evidence that phonological variants themselves are, in fact, the kind of linguistic object that can be primed. Moreover, it is desirable to know whether any experimentally-demonstrated priming effect exhibits comparable empirical properties to what is known about phonological variant persistence in conversational data.

In this paper we will address these two goals in turn, using a perception experiment that exposes participants to prime variants through lexical decision trials and then elicits forced-choice variant identification in response to ambiguous stimuli on subsequent trials. Our case study will be the ING variable, as in *workin'* versus *working*. First, we will ask whether phonological variants can be experimentally primed in perception and show in Experiment 1 that they can. Having established this point, we will use Experiment 2 to ask whether phonological variant priming in perception is robust to the presence of intervening trials, as corpus persistence can be long-lasting. Here we will show that the priming effect is extremely short-lived, dissipating to become undetectable after only a single intervening trial. Although the results of Experiment 1 offer support, in principle, for the idea that language users' repetitiveness in choosing pronunciation variants could be driven by priming, the results of Experiment 2 call into question whether that priming effect is long-lasting enough to produce the kind of long-duration persistence that has been previously found in conversational data in the same variable.

2. Background

2.1 Corpus evidence for variant repetitiveness

Following Szmrecsanyi (2006), we use the term *persistence* to describe a speaker's tendency to repeat the same variant in their own naturalistic production. At the syntactic level, persistence has been documented for a wide range of phenomena. In English, for example, it has been found for word-order alternations, including the passive (Weiner & Labov, 1983), ellipsis (Nykiel, 2015), and genitives, particle placement, and complementation (Szmrecsanyi, 2006). It is also a well-established factor influencing Spanish subject pronoun omission (Cameron, 1992; Cameron & Flores-Ferrán, 2004; Travis, 2007; Travis & Torres Cacoullos, 2012) and noun phrase agreement (Poplack, 1980, 1984; Scherre & Naro, 1991, 1992), and has more recently been shown to influence Mandarin locative variation (Li et al., 2023). In the domain of phonological variation, persistence has been shown to influence American English coronal stop deletion (e.g., *old* ~ *ol'*), DH-stopping (e.g., *them* ~ *dem*), and *-ing* ~ *-in'* variation (Tamminga, 2014, 2016b), as well as TH-fronting (e.g., *think* ~ *fink*) in Scottish English (Clark & Walsh, 2015) and /t/-flapping in New Zealand English (Clark, 2018).

Corpus data also shows that speakers tend to repeat variants they have recently heard from other speakers, sometimes called *convergence*. There are sizable literatures on convergence in sociolinguistics (where it is also called *accommodation*) and phonetics (where it is also called *imitation*). As with persistence, convergence has been documented across languages and across levels of the grammar (Pellegrino et al., 2024). Syntactic convergence in conversational data has

also been viewed in the syntactic priming literature as relevant naturalistic evidence for syntactic priming, as the experimental data shows considerable common ground between production-to-production priming and comprehension-to-production priming in syntactic alternations (Mahowald et al., 2016; Tooley & Traxler, 2010). There is also some evidence for this kind of parallel in corpus data: Li et al. (2023) found both persistence and convergence in Mandarin locative variation, meaning speakers tended to repeat a recently-used variant whether the prior instance came from the same speaker or a different speaker. Moreover, this paper showed that the empirical properties of persistence and convergence for the same variable in the same conversational data show broad qualitative similarities, including similar decay profiles where the effects persevere across multiple intervening sentences.

2.2 Connecting corpus repetitiveness to experimental evidence

A longstanding question in the study of corpus repetitiveness, both within and across speakers, is whether it should be attributed to automatic processing mechanisms such as priming, or to socially-motivated behavior such as style-shifting and accommodation (Pickering & Garrod, 2017; Szmrecsanyi, 2006; Tamminga, 2014). For syntactic variation, many researchers have taken syntactic priming to be the source of conversational repetitiveness, with evidence for their shared empirical properties being an important line of evidence for this link. One such property is temporal durability. It has been consistently observed that corpus persistence decays over time, but only gradually (e.g., Gries, 2005; Szmrecsanyi, 2005). For example, in the case of English dative alternation, Gries (2005) found in a corpus analysis that priming did not decline significantly over the course of an intervening sentence. Experimental syntactic priming studies have similarly found long-lived effects that endure beyond adjacent sentences, but do decay gradually over time (Bock & Griffin, 2000; Gries, 2005; Pickering & Garrod, 2004). Given that decay is an important signature of structural priming, the fact that conversational syntactic repetitiveness also undergoes decay with increasing distance between prime and target further strengthens the attribution of corpus repetitiveness in syntactic variation to syntactic priming (Bock & Griffin, 2000; Clark, 2018; Pickering & Garrod, 2004; Tamminga, 2026).

However, the argument that variant repetitiveness is driven by priming has also been extended to cases of phonological variation, despite the fact that there does not yet exist corresponding experimental evidence for phonological variant priming. It has been argued that repetitiveness in phonological variation reflects priming in conversational speech on the grounds that phonological variables also exhibit decay similar to that observed in syntactic priming (Clark, 2018; Tamminga et al., 2016). However, we might expect the repetition of syntactic constructions to behave differently from the repetition of phonological elements, operate over different time scales, and implicate different kinds of representations and sets of options (Levelt, 2001).

One particular reason we might not expect phonological persistence to mirror syntactic priming is that experimental work on basic phonological priming suggests quite different temporal properties. For example, facilitation effects in primed lexical decisions between phonologically-related words such as *dough* → *snow* tend to be short-lived (Dufour, 2008; Wilder et al., 2019). For instance, Wilder et al. (2019) examined the effect of phonological similarity between the prime and target (e.g., *gray* → *grape*) in lexical processing and found that phonological priming appears to be restricted to immediately sequential trials as opposed to persisting across a number of intervening trials. With respect to phonological variation specifically, recent work found that when variable ING is manipulated in a primed lexical decision experiment, *-in'* → *-in'* prime-target pairs enjoy a larger priming boost than the other pair types (White, 2021; White et al., 2024), but this extra boost does not last across an intervening filler trial. There has also been some work on repetition priming and semantic priming that involves different pronunciation variants (Sumner, 2013; Van de Ven et al., 2011). However, because almost all of these results come from experiments on how variation influences word recognition speed (as opposed to the choice between variants being the dependent variable), they are not as comparable to corpus phonological repetitiveness as the syntactic priming paradigm is to corpus syntactic repetitiveness.

When it comes to phonological variant repetitiveness in corpus data, though, we see a complex picture. Some research points to remarkably durable persistence effects. For the ING variable in particular, Tamminga (2016a) finds that in conversational speech, although ING persistence does decay significantly over time, this decay proceeds so slowly that it can last for over two minutes. In the same larger study, Tamminga (2014) also finds significant but slow decay for /ð/-stopping and /ð/-deletion, both lasting around 30 seconds. The decay picture for /t,d/ deletion is less clear, with no evidence for decay in monomorphemes and seemingly faster decay in past tense tokens; however, /t,d/ primes and targets are on average much closer together, making it difficult to assess the effect's durability. Other studies report much shorter-lived corpus phonological persistence effects. For example, persistence for /t/-flapping (Clark, 2018) and the short front vowel shift (Villarreal et al., 2021) in New Zealand English is lost rapidly after about 3 seconds. Crucially, the decay effect was explicitly explored in these studies because it has been treated as a marker of priming; these studies argue that rapid decay is a hallmark of activation-based priming mechanisms. This contrast between the temporal properties of experimental phonological priming and existence of long-lasting corpus phonological persistence for at least some variables further motivates the investigation of decay in phonological variant priming. After all, even if phonological *variant* priming does exist, it may not share the same decay profile as the basic phonological priming effects. If phonological variant priming for ING turns out to be short-lived, it would cast doubt on variant priming as the primary cause of the long-lived

persistence effect in corpus data; conversely, if phonological variant priming for ING is longer-lasting, it would strengthen the connection between persistence and priming.¹

Against this background, our goal is thus to test whether phonological variants can be primed in a controlled experiment, making use of an “inference under uncertainty” paradigm (Allen et al., 2003; Kleinschmidt & Jaeger, 2015; Levon et al., 2022; Newman et al., 2001; Peterson & Barney, 1952; Xie et al., 2023). Inference under uncertainty refers to the idea that as speech signals unfold over time, listeners constantly draw linguistic inferences, update expectations and generalize knowledge across words, sentences and talkers, given their pre-existing knowledge of probabilistic distributions of acoustic, linguistic and social cues (Kleinschmidt et al., 2018; Norris et al., 2003). For instance, in a typical phoneme categorization task, listeners would hear an ambiguous sound halfway along a continuum, and their choice of perceiving the ambiguous sound as either A or B would be modulated by which cue distributions they were exposed to and how they upweighted or downweighted certain cues (Kraljic & Samuel, 2005; Norris et al., 2003). In the current case, by asking participants to categorize ambiguous instances of the ING variable, we create uncertainty and the conditions in which a preference for a recently-primed variant may be revealed. Our experiment is thus closely related to more familiar tasks, such as phoneme categorization. However, a typical phoneme categorization task leads listeners to access distinct words with different meanings or perhaps even to perceive ungrammatical forms. In contrast, in our case, the ING variable, the competitors (*-ing* and *-in'*) are equally well-formed options that do not differ in their meaning, although, of course, they differ stylistically. We discuss this variable next.

2.3 The sociolinguistic variable ING

The sociolinguistic variable ING refers to the alternation between word-final velar nasal (/ŋ/) and alveolar nasal (/n/) after unstressed /ɪ/, as in words like *thinking* ~ *thinkin'*. We chose ING as our test case for this study in part because it is one of the best-studied sociolinguistic variables in English, meaning that we can rely on existing knowledge about how its production and perception are conditioned by different social and linguistic factors (e.g., Campbell-Kibler, 2007, 2011; Fischer, 1958; Hazen, 2008; Houston, 1985; Labov, 1972). ING also offers a number of desirable practical properties for use in the lab: It is easy for a model talker to produce the variants, it is phonetically straightforward to cross-splice the variants across verb stems, and it is possible to represent the variants orthographically in a familiar way. Most importantly, there is also prior corpus work documenting ING persistence

¹ The wide variability in how persistence effects decay over time further suggests that the decay of phonological persistence is variable-specific. Therefore, a phonological variant priming effect found for one variable, such as ING, may not be generalizable to others. The root of this specificity may lie in how different variables are represented, which can further influence their durability.

in conversational speech (Abramowicz, 2007; Tamminga, 2014, 2016a, 2016b), giving us a point of comparison in line with our broad motivation to connect corpus and experimental work on phonological priming. This prior work shows that ING persistence is a very large effect that decays significantly but slowly over time: The effect is still detectable after two minutes of intervening speech (Tamminga, 2016a).

3. Experiment 1: Evidence for variant priming in the lab

Experiment 1 tests the hypothesis that hearing one variant of ING will make listeners more likely to perceive that same variant when given an ambiguous target for categorization in the following trial: We compare whether a target word with an ambiguous final nasal, such as *sleepING*, is more likely to be categorized as *sleepin'* after a prime, such as *walkin'*, than after *walking*. To rule out the possibility that participants converge to the model talker's overall ING rate rather than being influenced by the intended prime, we control for the overall rates of the two variants throughout the experiment: Whenever a participant responds to a target, they have been exposed to exactly 50% clear *-ing* and 50% clear *-in'* primes from the model talker up to that point, regardless of which prime condition they were in. Showing that immediate prior experience can shift how listeners perceive phonological variation when the broader pattern of input is consistent serves as a step to establish priming as one of the underlying psycholinguistic processes that can facilitate decision-making when perceiving phonological variation.

3.1 Methods

The experiment combines two established methodological paradigms: the lexical decision task and the two-alternative forced-choice task (2AFC). Lexical decision trials, where the participant gives a word/non-word response by pressing a key, were used to expose participants to critical prime items containing clear *-ing* or clear *-in'*. The lexical decision response confirms that the participant recognized the form as a word, even if it contained a nonstandard variant. Critical ING targets, differing from their primes in the verb stem, are manipulated to be ambiguous, and participants are asked to respond with a 2AFC identification of which word pronunciation they heard (with the options presented orthographically, as in [WORKING WORKIN']). The prediction is that the variant used in the prime should influence participants to favor that variant in their identification of the ambiguous target.

While every trial involves some kind of response, critical sequences occur as triplets (that participants are not made aware of): two lexical decision trials followed by the target 2AFC trial. The second of those trials (immediately preceding the target trial) is the ING prime, while the first trial in the sequence contains a different ING word with the opposite variant to the prime. This avoids a possible confound, when during *-ing*-primed trials the participant has also heard more *-ing* overall, and vice versa. We refer to the trial preceding the prime as the "pre-prime."

Note that the inclusion of the pre-prime may bias participant behavior against our hypothesis, as the two variants could cancel each other out if their effects both extend to the prime.

A within-subjects design with two critical conditions is adopted. In one condition, participants encounter sequences of *-ing* → *-in'* → *ING* (*-in'*-primed condition, with *ING* indicating the ambiguous suffix), whereas in another condition, participants have sequences of *-in'* → *-ing* → *ING* (*-ing*-primed condition). This is further illustrated using concrete examples in **Table 1**.

Pre-prime	Pre-prime Task	Prime	Prime Task	Target	Target Task
working	LexicalDecision	jumpin'	LexicalDecision	teachING	Categorization
workin'	LexicalDecision	jumping	LexicalDecision	teachING	Categorization

Table 1: Conditions and example critical items used in Experiment 1

3.1.1. Stimuli

The base stimuli for the present study were originally created for White (2021) and generously shared by the author. An adult, white male speaker of North American English who grew up in New Jersey recorded the sound files. Recordings were conducted in a sound-attenuated booth using a BlueSnowball iCE microphone. Soundfiles were segmented using Praat (Boersma & Hamann, 2008) and normalized to a consistent peak amplitude. There were 119 *ING*-suffixed words, each recorded once with *-ing* and once with *-in'*.

The ambiguity in the critical targets needed for the current study was created by performing source extraction on the *-in'* suffix through inverse filtering. We segmented each word into separate stem and suffix portions and then both portions were resampled to allow for the application of Linear Predictive Coding (LPC) analysis, the technique needed to conduct source extraction. Source extraction was then conducted using a Praat script developed according to the manual on inverse filtering (Boersma, 2001). This results in removing the information filtered by the vocal tract, leaving the information produced by the vocal folds remains unchanged. Specifically, this means the source signal contained in the suffix *ING* remains unchanged (including pitch, amplitude, and vocal cord vibrations), while information about the place of articulation, such as the distinction between velar and alveolar nasals, is removed. As a result, it is possible to identify the portion as related to *ING* but not the exact variant. After the extraction of the source signal from each suffix, it was then recombined with its own original stem sound file through concatenation.

A series of norming studies was conducted to establish how listeners perceived *ING* before and after any ambiguity was introduced. Based on these norming studies, we decided to use only stimuli created from originally *-in'*-suffixed items. We then selected 38 critical target items that had low rates of identification, as either *-in'* or *-ing*, and were of moderate lexical frequency

(2–3 in the SUBTLEX Log10CD measure [Brysbaert & New, 2009]). The average baseline *-ing* identification rate for these ambiguous items was 70%, reflecting an unsurprisingly persistent baseline bias towards *-ing* for words presented in citation form in an experimental context. The 38 critical ambiguous targets were paired with primes and pre-primes that contained different verb stems and clear *-ing* or *-in'* variants, depending on the experimental condition. The whole-word frequency of pre-primes, primes, and targets was matched, again using the SUBTLEX Log10CD measure, and all pre-primes, primes and targets were disyllabic. Additionally, the consonants immediately preceding the suffix ING also varied across pre-primes, primes, and targets, as the realization of ING is known to be influenced by its surrounding phonological context.

Other than critical primes and targets, different types of fillers (e.g., filler real words and nonwords) were constructed to avoid contingencies that might bias participants toward the critical items in the current experiment. Similar to critical sequences, the filler structure was constructed using the same sequence structure. That is, each filler sequence was also composed of two trials of lexical decision and one trial of categorization. A total of 102 filler sequences were constructed to distract from the critical sequences such that about 27.5% of all trial sequences were critical ones.

The word-nonword ratio was 50% for lexical decision trials to avoid response bias during those trials. Other than nonword filler trials in lexical decision trials, real word fillers such as TRAIN were also included. In the categorization trials, no nonwords were included because we did not want to present participants with orthographically-illegal strings in writing. Ambiguous trials involving /t,d/ deletion (e.g., *ornament* ~ *ornamen'*) were included in filler sequences. Moreover, sequences in which participants heard two ING lexical decision trials but had to categorize a non-ING word were also included to further prevent participants from predicting that they would do ING identification on the 2AFC trial whenever they heard two instances of ING in a row. Note that these sequences also pair an *-in* with an *-ing* to keep the overall ING exposure rates at 50%. In the end, there were 102 filler sequences.

The experiments consisted of four lists, counterbalancing the form of variants as well as the sequence of pre-primes and primes for each word stem (2 variants × 2 possible sequences in pre-primes and primes). Participants were randomly assigned to one of these lists. Each list contained all 38 ambiguous targets, paired with 38 critical primes and 38 corresponding pre-primes. Together, with the 102 filler sequences, there were in total 140 sequences with 420 items in each list.

3.1.2. Obtaining word-specific *-ing* bias

Notably, it has been shown that the relative frequencies of the pronunciation variants of words can affect speech production and perception (Bürki et al., 2010; Racine & Grosjean, 2002).

Following the practice in Bürki et al. (2010), we used a written pronunciation rating task to elicit individuals' estimations of word-specific variant frequencies. Participants were instructed to use a slide bar to indicate which pronunciation of a given word (e.g., *studyin'* vs. *studying*) they were more likely to use in everyday conversational speech with their friends. We refer to each verb's average score on this metric, averaged across all participants, as the WORD-SPECIFIC *-ING* BIAS, i.e., the probability of *-ing* given a verb stem. To validate this elicited measure, we conducted a correlation analysis comparing it to word-specific *-ing* frequencies extracted from the Philadelphia Neighborhood Corpus (Labov & Rosenfelder, 2011). The analysis revealed a significant, albeit modest, correlation between the elicited and corpus-derived measures (Pearson's $R = 0.315$, $p < 0.001$), suggesting that this measure may help us control for some, but not all, variation attributable to word-specific differences. A full report of this correlational analysis is detailed in (Li & Tamminga, 2026).

3.1.3. Participants

A total number of 102 participants, all self-reported monolingual American English speakers, were recruited from Prolific to participate in an English Word Identification experiment. Participants were paid USD\$5. Participants were randomly assigned to one of the four lists. Detailed demographic information about the participants, including their age, gender, and race/ethnicity, can be found in the Appendix.

3.1.4. Procedure

Experiment 1 was implemented online using PClbex (Zehr & Schwarz, 2018). The experiment started with a consent form, after which participants were given a sample test audio to make sure they were able to listen to sound files on their device. After the basic set-up, participants were then informed that during the experiment, they would hear real and nonsense words of spoken American English and that they needed to respond to these words through two different tasks. In Task 1, participants heard a word and then, after seeing the prompt question, "Is this a word?", had to decide whether the spoken word was a real or nonsense English word. They pressed the J key for real words and the F key for nonsense words. In Task 2, when participants saw a prompt sentence, "Which word did you hear?", they had to choose the word exactly as they heard it (WORKING or WORKIN') by clicking a button on a screen that displayed the two orthographically-presented variant options randomized in their placement.

To license the appropriateness of perceiving non-canonical, informal pronunciations in an experimental setting, following White (2021), participants were informed that some of the words they would hear might be pronounced in a casual way, but that these words were real words of spoken American English and should be classified as such in the task. To reinforce this point,

participants were also given audio examples (sound clips of words pronounced with an *-in'* and words pronounced with a word-final glottaled /t/).

After being familiarized with these instructions, participants then completed 10 practice trial sequences with the same set-up as the final experiment, where two lexical decision trials were followed by a categorization trial. Participants were given written feedback on each practice lexical decision trial (e.g., “Correct, because you can say ‘She was *bikin'* to school today,” or “Incorrect, you can say ‘I’ll just put that in the *documen'*.”), but not on the practice categorization trial, since some ambiguous cases did not have a correct answer. During the practice, casual and formal pronunciations of ING-suffixed words and *-ment*-suffixed words were included. Similarly, to further avoid surprising participants with ambiguous ING-suffixed items during the final experiment, extra ambiguous items were also included as categorization targets during the practice phase.

After the practice trials, participants proceeded to the main experiment and received no further feedback. The task had a randomized inter-stimulus interval (henceforth ISI) between 400-800ms. The ISI was measured from the end of the sound file or participant response, whichever was later. The stimuli were spread across three blocks, with critical items being randomized within each block. After each block, participants could choose to take a break before continuing the experiment.

After the experiment, participants filled out a questionnaire that collected basic demographic information, including their age range, gender, race/ethnicity, and country of birth/growth. Finally, participants were debriefed on the purpose of the experiment. It took participants around 25 minutes to complete the whole experiment.

3.2. Analysis and results

Responses during lexical decision trials (including both critical and filler trials) were coded for accuracy: whether a word was correctly identified as a real word or whether a nonword was correctly identified as a nonword. Responses to critical categorization trial targets were coded for each ING variant chosen by participants. A total of 31 participants were removed because their overall accuracy in the lexical decision task was lower than 80%. Data from the remaining 71 participants was analyzed (number of participants in each list: List 1 = 22, List 2 = 14, List 3 = 15, List 4 = 20). Critical sequences, where participants judged *-in'*-containing prime and pre-primes to be nonwords, were also excluded from the final analysis, since failure to recognize the item as a word in these cases might interfere with the priming effect. In the end, the final statistical analysis included 2,197 observations (75% of the original data). The overall mean accuracy for pre-primes (88%) and primes (89%) was nearly identical. For primes, the mean accuracy for *-in'*-suffixed items was 85%, and the mean accuracy for *-ing*-suffixed ones was 96%.

In terms of pre-primers, the mean accuracy for *-in'*-suffixed and *-ing*-suffixed items was 82.9% and 94.3%, respectively. The high accuracy results indicate that participants successfully recognized the prime and pre-prime as words. This is crucial, as recognition is not always guaranteed for isolated words containing nonstandard variants.

Statistical analysis was conducted using R version 4.0.5 (R Core Team, 2021). Mixed effects logistic regression was run using the lme4 package version 1.1-27.1 (Bates et al., 2015), and plots were created using the ggplot2 package version 3.3.5 (Wickham, 2010) and the sjPlot package version 2.8.9 (Lüdtke et al., 2019). Data and analysis scripts are available at <https://osf.io/j7c3d/>.

We used the glmer() function from lme4 to fit a mixed-effects logistic regression model predicting listeners' ING responses (*-in'* = 0, *-ing* = 1) when identifying ambiguous targets. We included as fixed effects a critical predictor that tests our hypothesis, plus a set of control predictors to capture other factors that may influence variant identification:

- **Critical predictors**
 - PRIME CONDITION: Categorical variable comparing the *-in'*-primed vs. *-ing*-primed conditions, with the contrast coded as *-ing*-primed = 0.5, *-in'*-primed = -0.5
- **Control predictors**
 - TARGET WORD-SPECIFIC *-ING* BIAS: Continuous predictor indicating the probability of *-ing* given the verb stem in the ambiguous target; z-scored.
 - TARGET FREQUENCY: Continuous predictor indicating the whole-word lexical frequency in the ambiguous target, z-scored.²
 - TRIAL NUMBER: Continuous predictor referring to the sequence of trials throughout the experiment, z-scored.

We selected a random effects structure following the recommendation from Sonderegger (2023) to prioritize random slopes associated with critical predictors. Accordingly, we included random intercepts by SPEAKER and TARGET, as well as correlated random slopes of PRIME CONDITION by SPEAKER and PRIME CONDITION by TARGET. We do not perform further model selection, but rather report the full results of this design-driven model.

The model output is given in **Table 2**. There is a significant main effect of PRIME CONDITION ($\beta = 0.77, p < 0.001$), visualized in **Figure 1** along with one reference value: the *-ing* input rate in

² A correlation of a magnitude that would not pose collinearity concerns (if both values were included in a regression, a correlation between target word-specific *-ing* bias and target whole-word lexical frequency was found [Pearson's $R = -0.48, p < 0.001$]), implying that target word-specific *-ing* bias and target frequency are moderately correlated in a negative direction: The higher the target frequency, the lower is the target word-specific *-ing* bias. However, this correlation is negligible.

the experiment (the black dashed line). Participants were significantly more likely to categorize an ambiguous target as containing the variant *-ing* when they had just heard an *-ing* variant on the previous trial than when the previous trial contained *-in'*. No other control predictors were statistically significant.

Fixed Effects	Estimate	SE	z value	Pr(> z)
(Intercept)	-0.44	0.23	-1.96	0.05 *
PRIME CONDITION (<i>-ing</i> -primed)	0.77	0.16	4.84	<0.001 ***
TARGET WORD-SPECIFIC <i>-ING</i> BIAS	0.02	0.14	0.15	0.88
TARGET FREQUENCY	-0.13	0.13	-0.98	0.33
TRIAL NUMBER	0.09	0.12	0.75	0.45

Table 2: Model output of Experiment 1: RESPONSE ~ PRIME CONDITION + TARGET WORD-SPECIFIC *-ING* BIAS + TARGET FREQUENCY + TRIAL NUMBER + (PRIME CONDITION |SPEAKER) + (PRIME CONDITION |TARGET)

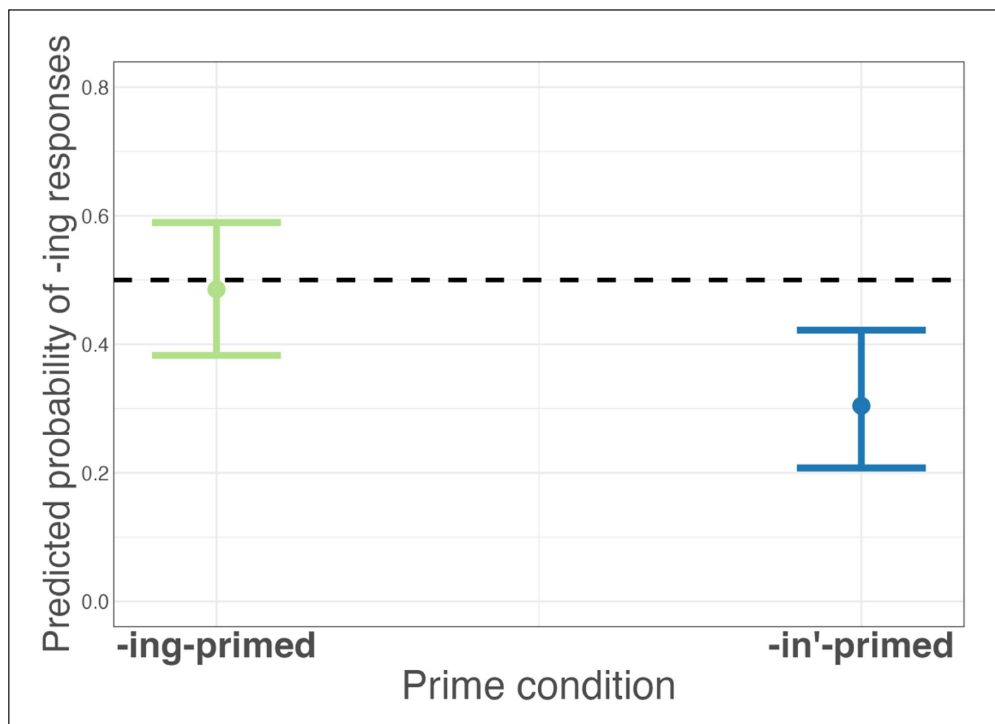


Figure 1: Predicted probability of *-ing* response in categorization of ambiguous ING target, with all other predictors held at their average values. The black dashed line represents the overall *-ing* rate participants that were exposed to during the experiment (50%).

3.3. Interim discussion

In Experiment 1, we found that exposure to an immediately preceding variant in perception can influence the subsequent categorization of an ambiguous variant in a different word. This suggests that the identification of phonological variants can be primed, supporting the basic proposal that conversational repetitiveness in phonological variation could be caused by priming. The difference between the two conditions cannot be attributed to perceptual convergence towards the talker's overall ING rate, because the conditions do not differ in that rate. Rather, participants were sensitive to their immediately prior perception, taking the input into account in a highly local way.

Apart from this predicted effect of prime condition, notice that in both conditions, listeners were more likely to perceive ambiguous targets as containing *-in'* than they were in the perception norming studies (i.e., compared to the average *-ing* response baseline of 70% in the norming study). Note that this shift was not tested in the model, since the norming study is not a condition of the experiment itself. The norming bias itself may reflect participants' stylistic awareness that words presented in isolation in a laboratory context most often contain standard pronunciations. We speculate that the apparent shift away from that bias might reflect that participants were *also* adapting to the overall distribution of the two variants in their perception of the model talker. It is possible that when inferring which of two variants they heard, in the *-ing*-primed condition, listeners were matching their *-ing* responses to the model talker's overall *-ing* rates (the black dashed line in **Figure 1**), perhaps due to a global expectation during the course of the experiment.

It is also worth noting that the effect of the prime is significant even though participants heard the opposite variant as a pre-prime only one trial earlier. If there is any hold-over facilitation from the pre-prime, which we cannot rule out in this design, that effect would exert an influence in the opposite direction of the prime, attenuating the observed priming effect. Despite this possibility, we still observed the priming effect from the immediately preceding trial. To better understand whether this kind of priming effect plausibly extends across multiple trials, we now turn to Experiment 2 to ask whether variant priming decays over time. Recall that ING persistence has been found to be long-lasting in prior corpus research (Tamminga, 2016a). The fact that the pre-prime's influence does not cancel out the prime's influence is one hint that the experimental effect we are looking at may decay more quickly. Questions about the temporal decay properties of different kinds of priming have played a key role in connecting corpus and experimental work in other domains and are also linked to questions about the precise mechanisms underlying experimental priming effects. So, in Experiment 2 we tested whether the priming effect observed in Experiment 1 persists across an intervening trial.

4. Experiment 2: Variant priming across an intervening trial

Experiment 2 tests whether the variant priming effect found in Experiment 1 persists when there is an intervening item between the prime and the ambiguous target. If variant priming in perception diminishes after one intervening trial, it would suggest that phonological variant

priming is rather short-lived, unlike syntactic priming, syntactic persistence, and phonological variant persistence. This could imply that persistence and priming in phonological variation operate under different underlying mechanisms. On the other hand, evidence for longer-lasting phonological variant priming would strengthen the connection with the persistence behavior of ING established in conversational corpus data.

4.1 Methods

The experimental design of Experiment 2 exactly mirrored that of Experiment 1. Two different types of response tasks were employed in a within-subjects set-up: lexical decision task for pre-primers and primes, and forced-choice categorization task for ambiguous targets. The only difference between these the two experiments was in the trial make-up. Unlike in Experiment 1 where each trial always consisted of a sequence of Pre-prime → Prime → Target, participants in Experiment 2 sometimes encountered sequences of Pre-prime → Prime → Intervener → Target. We compared listeners' likelihood of identifying an ambiguous target as the *-ing* variant between the *-in'*-primed condition and the *-ing*-primed condition, both with and without a single intervening filler trial.

4.1.1. Stimuli

Experiment 2 consisted of 36 targets (paired with 36 pre-primers and 36 primes) that were selected from the original 38 targets in Experiment 1 ($36 * 3 = 108$ trials), allowing the number of critical items included in each condition to be equivalent. To illustrate, half of the pre-primers, primes and targets was presented sequentially, while the other half was separated by a monosyllabic nominal intervener (e.g., *bus*). This means nine items were included in each of the four critical conditions (i.e., *-in'*-primed, with intervener; *-in'*-primed, no intervener; *-ing*-primed, with intervener; *-ing*-primed, no intervener). Given that 38 cannot be divided by 4, we only selected 36 items to be the critical targets in this experiment. Eight lists were created to counterbalance the form of variants, the sequence of primes as well as whether or not the target had an intervener. A total number of 102 sequences were included as fillers ($102 * 3 = 306$ trials), most of which were taken from Experiment 1. To match the trial structure of critical sequences (either pre-prime → prime → target or pre-prime → prime → intervener → target), the same number of sequences with monosyllabic nominal interveners ($N = 36$) was included in the filler structure.

4.1.2. Participants

A total of 158 participants, all self-reported monolingual native speakers of American English who did not participate in Experiment 1, were recruited from Prolific. They each received USD\$5 for their participation in an online English Word Identification experiment administered through PClbex. The recruited participants were then randomly assigned to one of the eight lists, with 20 participants recruited for each list. The demographic information of these participants is further detailed in the Appendix.

4.1.3. Procedure

The procedure resembled that of Experiment 1. On average, participants took approximately 25 minutes to complete Experiment 2.

4.2. Analysis and results

Prior to statistical analysis, the data collected were first pre-processed following the same practice adopted in Experiment 1. Of the original 158 participants, data from 32 participants were removed from the final statistical analysis due to their poor performance on lexical decision trials (overall accuracy score of less than 80%). The final statistical analysis was therefore based on data from the remaining 125 participants. In Experiment 2, we took an additional step by excluding responses that involved interveners but were treated as ‘nonword’. In the end, the final statistical analysis was conducted based on 4313 observations (81% of the original data). The overall mean accuracy for pre-primed and primed was both 88%. For primed, the mean accuracy was 83% for *-in'*-suffixed items and 96% for *-ing*-suffixed ones. In terms of pre-primed, the mean accuracy for *-in'*-suffixed and *-ing*-suffixed ones was 79% and 97% respectively.

Statistical analysis was conducted following the same principles as detailed in Experiment 1. A generalized mixed-effects regression model was configured to predict participants' *-ing/-in'* responses when identifying ambiguous targets (0 for *-in'*, 1 for *-ing*). The fixed effects in this case are:

- **Critical predictors**
 - PRIME CONDITION: Categorical predictor referring to the within-subjects conditions that differ in which prime immediately precedes to the ambiguous target. Levels: *-in'*-primed vs. *-ing*-primed, sum-coded (*-ing*-primed = 0.5, *-in'*-primed = -0.5)
 - INTERVENERYN: Categorical predictor standing for the within-subjects conditions that differ in whether there is an intervener word between the prime and target. Levels: 1 intervener vs. 0 interveners, sum-coded (0 interveners = 0.5, 1 intervener = -0.5)
 - The two-way interaction of PRIME CONDITION * INTERVENERYN
- **Control predictors:** same as Experiment 1

Following the same approach as in Experiment 1, we started a random effects structure with correlated random slopes. To resolve the singularity issue, the correlation has to be dropped. PRIME CONDITION by PARTICIPANT and INTERVENERYN by PARTICIPANT were thus included as uncorrelated (rather than correlated) random slopes and TARGET was included as a random intercept.

Model output, as shown below in **Table 3**, revealed a significant main effect of PRIME CONDITION ($\beta = 0.31$, $p < 0.001$): Listeners were significantly more likely to identify the ambiguous target as *-ing*-containing after immediately hearing a clear *-ing*-suffixed word. The effect of INTERVENERYN was statistically significant ($\beta = 0.18$, $p = 0.03$): Overall, the perceived *-ing* response rates increased significantly when there were no intervening items between the

prime and ambiguous target. The interaction between PRIME CONDITION and INTERVENERYN was also significant ($\beta = 0.49, p < 0.01$), suggesting that in the *-ing*-primed condition, participants were significantly more likely to perceive the ambiguous target as *-ing*-containing, compared to the global mean, when there was no intervener between the prime and ambiguous target. No other control predictors turned out to be statistically significant. The predicted effects of PRIME CONDITION and its interaction with INTERVENERYN are further plotted in **Figure 2**.

Fixed Effects	Estimate	SE	z value	Pr(> z)
(Intercept)	-0.09	0.18	-0.48	0.63
PRIME CONDITION (<i>-ing</i> -primed)	0.31	0.09	3.50	< 0.001 ***
INTERVENERYN (0 interveners)	0.18	0.08	2.12	0.03 *
TARGET WORD-SPECIFIC <i>-ING</i> BIAS	-0.08	0.13	-0.67	0.50
TARGET FREQUENCY	-0.07	0.12	-0.58	0.56
TRIAL NUMBER	0.08	0.09	0.95	0.34
PRIME CONDITION : INTERVENERYN	0.49	0.15	3.22	< 0.01 **

Table 3: Model output of Experiment 2: Response (1 for *-ing*) \sim PRIME CONDITION \times INTERVENERYN + TARGET WORD-SPECIFIC *-ING* BIAS + TARGET FREQUENCY + TRIAL NUMBER + (1 + PRIME CONDITION + INTERVENERYN || SPEAKER) + (1 | TARGET)

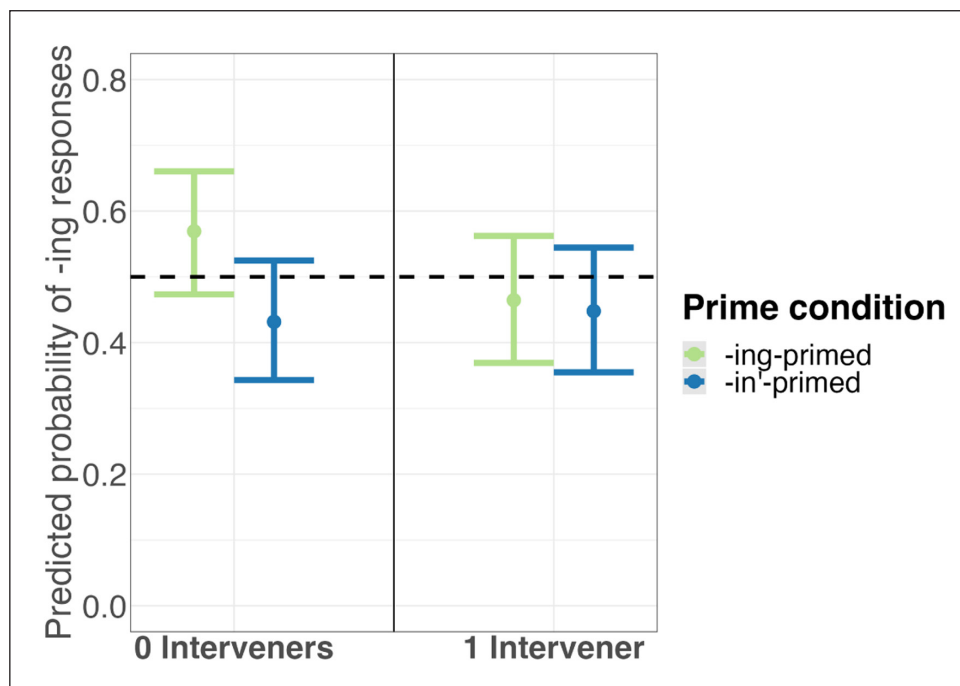


Figure 2: Predicted probability of perceived *-ing* responses in **categorization**, when all other predictors held at their average values, in probability terms.

The model as specified does not test whether there is priming within each intervener condition in isolation. Thus, post-hoc pairwise comparisons were made using the emmeans package version 1.5.5-1 (Lenth et al., 2019), with p-values corrected for multiple comparisons using the Tukey method. As shown in **Table 4**, these comparisons found that the difference between *-ing*-primed condition and *-in'*-primed condition was significant in the no-intervener condition ($\beta = 0.55, p < 0.001$), but not significant with an intervener ($\beta = 0.07, p = 0.58$).

Contrast	Pair	Estimate	SE	z.ratio	p value
IntervenerYN = 0 0 interveners	(<i>-ing</i> -primed) – (<i>-in'</i> -primed)	0.55	0.11	4.91	<0.001
IntervenerYN = 1 1 intervener	(<i>-ing</i> -primed) – (<i>-in'</i> -primed)	0.07	0.12	0.56	0.58

Table 4: Experiment 2: Post-hoc pairwise test results of the model fit differences between the two prime conditions at each level of intervenerYN (with Tukey’s adjustment)

4.3. Experiment 2 discussion

The goal of Experiment 2 was to investigate whether the variant priming effect from Experiment 1 is robust to the presence of an intervening trial between the prime and target. In the no-intervener condition, we replicated the finding of variant priming from Experiment 1. However, with an intervening trial consisting of a lexical decision to a single monosyllabic word, the phonological variant priming was no longer detectable. Phonological variant priming appears to be short-lived.

While the main effect of variant priming was replicated in Experiment 2, notably, the trend of global convergence towards the model talker’s rates was absent. Given that the instructions were identical across both experiments—which should have resulted in a comparable salience of the *-in'* form—this is an unexpected result. We propose that future research could systematically vary the model talker’s *-ing* rates to investigate this discrepancy further.

This short-lived phonological variant priming effect differs notably from the temporal properties of phonological variant persistence in conversational speech in the same variable. In corpus data, ING persistence has been found to last for over two minutes (Tamminga, 2016a). The fact that phonological variant priming of ING in a controlled experimental setting does not survive even a single intervening word thus suggests that variant priming may not be the only cause of the long-lived persistence effect of ING in conversational speech. However, this conclusion needs to be treated with some caution, as we will discuss. The rapid decay observed here may be exacerbated by the presence of the pre-prime (the opposite variant) in the experimental design—a factor we cannot isolate in this study. While the prime was evidently

strong enough to overcome any hold-over interference from the pre-prime, the rapid decay after one intervener may reflect the complex interplay between the pre-prime and the prime.

5. General Discussion

The primary goal of this study was to test whether phonological variant identification can be primed in a controlled perception experiment, with the sociolinguistic variable ING as our test case. In Experiment 1, we found that priming, in the form of an identification preference for the variant heard in a different word on the prior trial, can indeed be observed when listeners categorize ambiguous variants of ING. In Experiment 2, we further examined whether this variant priming effect exhibits a decay profile comparable to that of the variant repetitiveness effects previously reported for ING in conversational speech. Unlike the long-lasting ING repetitiveness in naturalistic data, we found that ING variant priming in the context of our experiment is short-lived, decaying to become undetectable after just one intervening monosyllabic word. One main takeaway from this study is thus that phonological variants *can* be primed, which supports the plausibility of analyses where conversational repetitiveness is attributed to this kind of psychological facilitation. But the other main takeaway is that phonological variant priming in the experimental context exhibits a decay profile that is *not* the same as we see in the corpus persistence data for the same variable. Instead, it appears that phonological variant priming, like the priming of basic phonological overlap, is fleeting (Dufour, 2008; Wilder et al., 2019). In the following sections, we discuss these findings in more detail.

5.1. Is corpus repetitiveness really a result of priming?

The mixed empirical results mentioned above naturally lead us to question the extent to which we should view them as strong evidence for or against the idea that conversational variant repetitiveness has its source in priming. If one follows the line of thinking from Clark (2018)—that parallels between the empirical properties of priming and corpus repetitiveness can be taken to suggest a shared underlying mechanism—one might be tempted to conclude that any divergence in the empirical properties of these phenomena should conversely be interpreted as suggesting that they do *not* have a common mechanism. We do think the results of Experiment 2 should raise doubts as to whether conversational repetitiveness in phonological variation can be straightforwardly attributed to priming. However, this is not the same as concluding that we now have good evidence against this kind of explanation. There are any number of reasons why we might see divergences between the behavior of phonological variation in our experimental task and conversational data, even if they did indeed arise from a common mechanism. We consider several of these caveats here, and leave open the possibility that there may be others.

The first type of caveat involves perception-production asymmetries. Our experiments target perception-to-perception priming, whereas in corpus data we are observing either repetition from perception to production (between-speaker convergence), or repetition from production to production (within-speaker persistence). Furthermore, the majority of the literature based on corpus data consistently finds stronger repetitiveness when speakers prime their own choices in production (Li & Tamminga, 2021; Li et al., 2023). The specific ING repetitiveness decay profile we have appealed to here comes from prior work specifically on ING persistence (Tamminga, 2016a), where all observations involved within-speaker variant repetition in production (with no intervening speech from the interlocutor, see Tamminga, 2014, for methodological details). The variant priming observed here nevertheless was based on the listeners' responses to ambiguous targets produced by a model talker, more akin to cross-speaker repetitiveness. On top of this, priming effects may not always behave uniformly across comprehension and production tasks, with prior work documenting notable discrepancies between the two (see Pickering and Ferreira, 2008, for a detailed discussion). Therefore, in the case of priming evidence derived from an individual's perceptual behavior, the results should not be translated directly into a straightforward understanding of production repetitiveness.

Second, even though a controlled context may help tease apart possible mechanisms that give rise to repetitiveness, the paradigm adopted here with words in isolation differs in many ways from natural conversations that deal with connected speech with rich contextual information. For instance, connected speech often licenses the variation that is stylistically unexpected in the citation form of words. The listener responses elicited under the context of words in isolation thus may differ from those elicited under connected speech.

A third caveat concerns a range of other potential factors in the rich interactional context of conversational speech that could make a difference. It is possible that in corpus repetitiveness, while priming may be at play, its effect may be too subtle to be detected due to the co-influence of other factors such as interspeaker convergence and style-shifting. This being said, it remains unclear why these factors would make priming effects last longer, if they indeed play a role.

With these possibilities kept in mind, it is unclear how to interpret the fact that the rapid decay of experimental ING variant priming observed in our Experiment 2 is strikingly divergent from the long-lasting ING repetitiveness observed in prior corpus work. One conclusion is that we should not jump too quickly to any interpretation of corpus phonological repetitiveness as priming, since there are reasons to doubt this connection. The difference in decay properties for the same variable suggests that priming alone is not a straightforwardly sufficient explanation for corpus persistence. It may well play a role, but we also need to understand how it interacts with other factors to generate the observed patterns of conversational repetitiveness. This uncertainty highlights that major gaps remain in our understanding of the relationship between priming and conversational repetitiveness and, more broadly, between basic processing mechanisms

and the production of sociolinguistic variation in real-world contexts, inviting a more detailed consideration of these factors in future research.

5.2. Is phonological variant priming merely phonological overlap priming?

The variant priming effect we found in Experiment 1 raises a new question: Might this priming effect be the same as phonological overlap priming in contexts not involving variation? In other words, does the effect we observed necessarily involve phonological *variants*, or does it reflect a more general process of phonological facilitation? The question is salient in light of the rapid decay of ING variant priming observed in Experiment 2, because there are independent reasons to believe that phonological facilitation is short-lived. In spoken word recognition, listeners have been found to become faster at responding to a target word after they have encountered a preceding prime that shares some phonological overlap with the target, especially if the overlap is in the syllable rhyme (e.g., *dough* → *snow*). Like the variant priming effect we observed, phonological priming in word recognition seems to be short-lived, significant only at immediate distances (Dufour et al., 2023; Radeau et al., 1995; Wilder et al., 2019).

Although a role for phonological overlap in facilitating lexical access may not be the same as an increased likelihood of identifying one variant or the other in a categorization task, the possible links are worth considering. Insofar as the literature on variation in word recognition evidence is relevant, it provides us with some preliminary evidence against the idea that variant priming can be fully reduced to phonological overlap priming (White et al., 2024). In particular, White (2021) finds that recognition of targets ending in the *-in'* variant, like *thinkin'*, is faster when preceded by a different word containing the *-in'* variant (such as *jumpin'*), but not when preceded by a word ending in the non-variable phonological string /In/, like *dolphin*. On the corpus side, Tamminga (2014) finds that there is no detectable influence of a recent instance of /ŋ/ on the use of the *-ing* variant in conversational data. So, while we might think of phonological variant priming as a type of priming within phonology that may therefore have some of the same general qualities as phonological overlap priming, including very limited durability, there is reason to suspect that there is some independent facilitation process here, distinct from priming of phonological strings. This possibility also speaks to the theoretically interesting question of whether phonological variants have the same representational and/or grammatical status as obligatory phonological phenomena. Future work is thus needed to examine to what extent phonological variant priming resembles or differs from phonological priming.

This study shows that phonological variant identification in perception is subject to psycholinguistic priming. All else being equal, hearing a clear *-ing* makes listeners more likely to choose *-ing* again, given an ambiguous target for categorization. We also show that this phonological variant priming effect decays rapidly over time, after only one monosyllabic word, suggesting that phonological variant priming may not be the underlying mechanism that drives

long-lasting phonological variant repetitiveness in conversational speech, at least in the case of ING variation. We thus argue that when it comes to detecting and interpreting processing phenomena in conversational speech, the results could be strengthened by the development of more precise experimental analogues, as opposed to cross-referencing assumptions from different domains.

Appendix

Demographic information of participants in Experiment 1

The demographic information about the participants in Experiment 1 including their age, gender and race/ethnicity is further summarized below (Number of participants in each experimental list: List 1 N = 28, List 2 N = 22, List 3 N = 25, List 4 N = 27):

- Age distribution: N. of 17–20y = 64; N. of 21–25y = 38;
- Race/ethnicity distribution: N. of Asian = 28; N. of Black/African = 11; N. of Caucasian/White = 48; N. of Hispanic/Latinx = 6; N. of Mixed race = 4; N. of Native American = 0; N. of Other = 5; N. of Pacific Islander = 0;
- Gender distribution: N. of woman = 59; N. of Man = 41; N. of Other = 2;

Demographic information of participants in Experiment 2

The demographic information of participants in Experiment 2 is further summarized below (Number of participants in each experimental list: List 1 = 14, List 2 = 16, List 3 = 18, List 4 = 19, List 5 = 14, List 6 = 14, List 7 = 15, List 8 = 15):

- Distribution of gender: N. of Man = 76, N. of Woman = 80, N. of Other = 2;
- Distribution of race/ethnicity: N. of Asian = 2, N. of Black/African = 22, N. of Caucasian/White = 119, N. of Hispanic/Latinx = 5, N. of Mixed Race = 6, N. of Native American = 1; N. of Other = 0; N. of Pacific Islander = 0;
- Distribution of age: N. of 17–20y = 3, N. of 21–25y = 41, N. of 31 + y = 113;

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Competing interests

The authors have no competing interests to declare.

Author Contribution

Author A: Conceptualization (lead), Experiment set-up (lead), Stimuli manipulation (lead), Data collection (lead), Formal analysis (lead), Writing – Original Draft (lead), Writing – Review and Editing (lead).

Author B: Conceptualization (supporting), Experiment set-up (supporting), Stimuli manipulation (supporting), Data collection (supporting), Formal analysis (supporting), Writing – Original Draft (supporting), Writing – Review and Editing (supporting).

References

- Abramowicz, L. (2007). Sociolinguistics meets exemplar theory: Frequency and recency effects in (ing). *University of Pennsylvania Working Papers in Linguistics*, 13(2), 27–37.
- Abreu, L. (2012). Subject pronoun expression and priming effects among bilingual speakers of Puerto Rican Spanish. In K. Geeslin & M. Díaz-Campos (Eds.), *Selected proceedings of the 14th Hispanic linguistics symposium* (pp. 1–8). Cascadilla Proceedings Project.
- Allen, J. S., Miller, J. L., & DeSteno, D. (2003). Individual talker differences in voice-onset-time. *Journal of the Acoustical Society of America*, 113(1), 544–552. <https://doi.org/10.1121/1.1528172>
- Babel, M. (2010). Dialect divergence and convergence in New Zealand English. *Language in Society*, 39(4), 437–456. <https://doi.org/10.1017/s0047404510000400>
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, 67(1), 1–48. <https://doi.org/10.18637/jss.v067.i01>
- Bock, K. (1986). Syntactic persistence in language production. *Cognitive Psychology*, 18(3), 355–387. [https://doi.org/10.1016/0010-0285\(86\)90004-6](https://doi.org/10.1016/0010-0285(86)90004-6)
- Bock, K., & Griffin, Z. M. (2000). The persistence of structural priming: Transient activation or implicit learning? *Journal of Experimental Psychology: General*, 129(2), 177–192. <https://doi.org/10.1037//0096-3445.129.2.177>
- Boersma, P. (2001). Praat, a system for doing phonetics by computer. *Glott International*, 5(9/10), 341–345.
- Boersma, P., & Hamann, S. (2008). The evolution of auditory dispersion in bidirectional constraint grammars. *Phonology*, 25(2), 217–270. <https://doi.org/10.1017/s0952675708001474>
- Brysaert, M., & New, B. (2009). Moving beyond Kučera and Francis: A critical evaluation of current word frequency norms and the introduction of a new and improved word frequency measure for American English. *Behavior Research Methods*, 41(4), 977–990. <https://doi.org/10.3758/BRM.41.4.977>
- Bürki, A., Ernestus, M., & Frauenfelder, U. H. (2010). Is there only one “fenêtre” in the production lexicon? On-line evidence on the nature of phonological representations of pronunciation variants for French schwa words. *Journal of Memory and Language*, 62(4), 421–437. <https://doi.org/10.1016/j.jml.2010.01.002>

- Cameron, R. (1992). *Pronominal and null subject variation in Spanish: Constraints, dialects, and functional compensation* [Doctoral dissertation, University of Pennsylvania].
- Cameron, R., & Flores-Ferrán, N. (2004). Perseveration of subject expression across regional dialects of Spanish. *Spanish in Context*, 1(1), 41–65. <https://doi.org/10.1075/sic.1.1.05cam>
- Campbell-Kibler, K. (2007). Accent, (ING), and the social logic of listener perceptions. *American Speech*, 82(1), 32–64. <https://doi.org/10.1215/00031283-2007-002>
- Campbell-Kibler, K. (2011). The sociolinguistic variant as a carrier of social meaning. *Language Variation and Change*, 22(3), 423–441. <https://doi.org/10.1017/s0954394510000177>
- Clark, L. (2018). Priming as a motivating factor in sociophonetic variation and change. *Topics in Cognitive Science*, 10(4), 729–744. <https://doi.org/10.1111/tops.12338>
- Clark, L., & Walsh, L. (2015). Recency effects on word-medial /t/ in New Zealand English: Initial observations. *Asia-Pacific Language Variation*, 1(1), 28–57.
- Dufour, S. (2008). Phonological priming in auditory word recognition: When both controlled and automatic processes are responsible for the effects. *Canadian Journal of Experimental Psychology*, 62(1), 33–41. <https://doi.org/10.1037/1196-1961.62.1.33>
- Dufour, S., Mirault, J., & Grainger, J. (2023). Rime priming effects in spoken word recognition: Are they really due to the rime? *Experimental Psychology*, 70(3), 164–173. <https://doi.org/10.1027/1618-3169/a000598>
- Egay, A., & Tamminga, M. (2017). Persistence as a diagnostic of grammatical status: The case of Middle English negation. In É. Mathieu & R. Truswell (Eds.), *Micro-change and macro-change in diachronic syntax* (pp. 202–215). Oxford University Press. <https://doi.org/10.1093/oso/9780198747840.003.0013>
- Fischer, J. L. (1958). Social influences on the choice of a linguistic variant. *Word*, 14(1), 47–56. <https://doi.org/10.1080/00437956.1958.11659655>
- Giles, H., Coupland, N., & Coupland, J. (1991). Accommodation theory: Communication, context, and consequences. In H. Giles, J. Coupland, & N. Coupland (Eds.), *Contexts of accommodation: Developments in applied sociolinguistics* (pp. 1–68). Cambridge University Press. <https://doi.org/10.1017/CBO9780511663673.001>
- Gries, S. T. (2005). Syntactic priming: A corpus-based approach. *Journal of Psycholinguistic Research*, 34(4), 365–399. <https://doi.org/10.1007/s10936-005-6139-3>
- Hazen, K. (2008). (ING): A vernacular baseline for English in Appalachia. *American Speech*, 83(2), 116–140. <https://doi.org/10.1215/00031283-2008-008>
- Houston, A. (1985). *Continuity and change in English morphology: The variable (ING)* [Doctoral dissertation, University of Pennsylvania].
- Kleinschmidt, D. F., & Jaeger, T. F. (2015). Robust speech perception: Recognize the familiar, generalize to the similar, and adapt to the novel. *Psychological Review*, 122(2), 148–203. <https://doi.org/10.1037/a0038695>
- Kleinschmidt, D. F., Weatherholtz, K., & Jaeger, T. F. (2018). Sociolinguistic perception as inference under uncertainty. *Topics in Cognitive Science*, 10(4), 818–834. <https://doi.org/10.1111/tops.12331>

- Kraljic, T., & Samuel, A. G. (2005). Perceptual learning for speech: Is there a return to normal? *Cognitive Psychology*, 51(2), 141–178. <https://doi.org/10.1016/j.cogpsych.2005.05.001>
- Labov, W. (1972). Some principles of linguistic methodology. *Language in Society*, 1(1), 97–120. <https://doi.org/10.1017/s0047404500006576>
- Labov, W., & Rosenfelder, I. (2011). The Philadelphia Neighborhood Corpus of LING 560 studies, 1972–2010 [Unpublished manuscript, University of Pennsylvania].
- Lenth, R., Singmann, H., Love, J., Buerkner, P., & Herve, M. (2019). *Emmeans: Estimated marginal means, aka least-squares means* [R package version 1.4.1]. <https://CRAN.R-project.org/package=emmeans>
- Levelt, W. J. M. (2001). Spoken word production: A theory of lexical access. *Proceedings of the National Academy of Sciences*, 98(23), 13464–13471. <https://doi.org/10.1073/pnas.231459498>
- Levon, E., Sharma, D., & Yang, Y. (2022). Dynamic sociolinguistic processing: Real-time changes in judgments of speaker competence. *Language*, 98(4), 749–774. <https://doi.org/10.1353/lan.2022.0020>
- Li, A., & Tamminga, M. (2021). Priming and “anti-priming” in intra- and interspeaker variation. *University of Pennsylvania Working Papers in Linguistics*, 27(1), Article 15.
- Li, A., & Tamminga, M. (2026). Validating explicit rating tasks for measuring pronunciation biases: A case study of ING variation. *Behavior Research Methods*, 58, Article 66. <https://doi.org/10.3758/s13428-026-02952-y>
- Li, A., Tamminga, M., & Hu, H. (2023). Intra- and inter-speaker repetitiveness in Chengdu Mandarin locative variation. *Language Variation and Change*, 35(1), 107–127. <https://doi.org/10.1017/S095439452300008X>
- Lüdecke, D., Waggoner, P. D., & Makowski, D. (2019). Insight: A unified interface to access information from model objects in R. *Journal of Open Source Software*, 4(38), 1412. <https://doi.org/10.21105/joss.01412>
- Mahowald, K., James, A., Futrell, R., & Gibson, E. (2016). A meta-analysis of syntactic priming in language production. *Journal of Memory and Language*, 91, 5–27. <https://doi.org/10.1016/j.jml.2016.03.009>
- Mayol, L. (2012). An account of the variation in the rates of overt subject pronouns in Romance. *Spanish in Context*, 9(3), 420–442. <https://doi.org/10.1075/sic.9.3.03may>
- Moore-Cantwell, C., Bosch, D., Kahn, E., Kim, C., Shoemaker, G., & Kahn, E. X. (2024). Production priming of stress in nonwords. *Laboratory Phonology*, 15(1). <https://doi.org/10.16995/labphon.9573>
- Newman, R. S., Clouse, S. A., & Burnham, J. L. (2001). The perceptual consequences of within-talker variability in fricative production. *Journal of the Acoustical Society of America*, 109(3), 1181–1196. <https://doi.org/10.1121/1.1348009>
- Norris, D., McQueen, J. M., & Cutler, A. (2003). Perceptual learning in speech. *Cognitive Psychology*, 47(2), 204–238. [https://doi.org/10.1016/S0010-0285\(03\)00006-9](https://doi.org/10.1016/S0010-0285(03)00006-9)
- Nykiel, J. (2015). Constraints on ellipsis alternation: A view from the history of English. *Language Variation and Change*, 27(2), 227–254. <https://doi.org/10.1017/s0954394515000071>

- Pellegrino, E., Dellwo, V., Pardo, J. S., & Möbius, B. (2024). Forms, factors and functions of phonetic convergence. *Journal of Phonetics*, 102, 101292. <https://doi.org/10.1016/j.specom.2024.103142>
- Peterson, G. E., & Barney, H. L. (1952). Control methods used in a study of the vowels. *Journal of the Acoustical Society of America*, 24(2), 175–184. <https://doi.org/10.1121/1.1906875>
- Pickering, M. J., & Branigan, H. P. (1999). Syntactic priming in language production. *Trends in Cognitive Sciences*, 3(4), 136–141. [https://doi.org/10.1016/S1364-6613\(99\)01293-0](https://doi.org/10.1016/S1364-6613(99)01293-0)
- Pickering, M. J., & Ferreira, V. S. (2008). Structural priming: A critical review. *Psychological Bulletin*, 134(3), 427–459. <https://doi.org/10.1037/0033-2909.134.3.427>
- Pickering, M. J., & Garrod, S. (2004). Toward a mechanistic psychology of dialogue. *Behavioral and Brain Sciences*, 27(2), 169–226. <https://doi.org/10.1017/S0140525X04000056>
- Pickering, M. J., & Garrod, S. (2017). Priming and language change. In M. Hundt, S. Mollin, & S. E. Pfenninger (Eds.), *The changing English language: Psycholinguistic perspectives* (pp. 173–190). Cambridge University Press. <https://doi.org/10.1017/9781316091746.008>
- Poplack, S. (1980). Deletion and disambiguation in Puerto Rican Spanish. *Language*, 56(2), 371–385. <https://doi.org/10.1353/lan.1980.0033>
- Poplack, S. (1984). Variable concord and sentential plural marking in Puerto Rican Spanish. *Hispanic Review*, 52(2), 205–222. <https://doi.org/10.2307/473375>
- R Core Team. (2021). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. Vienna, Austria. <https://www.R-project.org/>
- Racine, I., & Grosjean, F. (2002). La production du e caduc facultatif est-elle prévisible? Un début de réponse. *Journal of French Language Studies*, 12(3), 307–326. <https://doi.org/10.1017/S0959269502000340>
- Radeau, M., Morais, J., & Segui, J. (1995). Phonological priming between monosyllabic spoken words. *Journal of Experimental Psychology: Human Perception and Performance*, 21(6), 1297–1311. <https://doi.org/10.1037//0096-1523.21.6.1297>
- Sankoff, D., & Laberge, S. (1978). Statistical dependence among successive occurrences of a variable in discourse. In D. Sankoff (Ed.), *Linguistic variation: Models and methods* (pp. 119–126). Academic Press.
- Scherre, M. M. P., & Naro, A. J. (1991). Marking in discourse: “Birds of a feather.” *Language Variation and Change*, 3(1), 23–32. <https://doi.org/10.1017/S0954394500000430>
- Scherre, M. M. P., & Naro, A. J. (1992). The serial effect on internal and external variables. *Language Variation and Change*, 4(1), 1–13. <https://doi.org/10.1017/S0954394500000636>
- Sonderegger, M. (2023). *Regression modeling for linguistic data*. MIT Press.
- Sumner, M. (2013). A phonetic explanation of pronunciation variant effects. *JASA Express Letters*, 134(1), EL26–32. <https://doi.org/10.1121/1.4807432>
- Szmrecsanyi, B. (2005). Language users as creatures of habit: A corpus-linguistic analysis of persistence in spoken English. *Corpus Linguistics and Linguistic Theory*, 1(1), 113–149. <https://doi.org/10.1515/cllt.2005.1.1.113>

- Szmrecsanyi, B. (2006). *Morphosyntactic persistence in spoken English: A corpus study at the intersection of variationist sociolinguistics, psycholinguistics, and discourse analysis*. Mouton de Gruyter. <https://doi.org/10.1515/9783110197808>
- Tamminga, M. (2014). *Persistence in the production of linguistic variation* [Doctoral dissertation, University of Pennsylvania].
- Tamminga, M. (2016a). Lexical specificity and temporal decay in intraspeaker priming of sociolinguistic variables.
- Tamminga, M. (2016b). Persistence in phonological and morphological variation. *Language Variation and Change*, 28(3), 335–356. <https://doi.org/10.1017/s0954394516000119>
- Tamminga, M. (2019). Sources of microtemporal clustering in sociolinguistic sequences. *Frontiers in Artificial Intelligence*, 2, 10. <https://doi.org/10.3389/frai.2019.00010>
- Tamminga, M. (2026). Extragrammatical factors and the locus of sociophonetic variation. In J. Nycz & L. Hall-Lew (Eds.), *Sociophonetics: Implications for phonetics and phonology*. Oxford University Press.
- Tamminga, M., MacKenzie, L., & Embick, D. (2016). The dynamics of variation in individuals. *Linguistic Variation*, 16(2), 300–336. <https://doi.org/10.1075/lv.16.2.06tam>
- Tooley, K. M., & Traxler, M. J. (2010). Syntactic priming effects in comprehension: A critical review. *Language and Linguistics Compass*, 4(10), 925–937. <https://doi.org/10.1111/j.1749-818X.2010.00249.x>
- Travis, C. E. (2007). Genre effects on subject expression in Spanish: Priming in narrative and conversation. *Language Variation and Change*, 19(2), 101–135. <https://doi.org/10.1017/S0954394507070081>
- Travis, C. E., & Torres Cacoullos, R. (2012). What do subject pronouns do in discourse? Cognitive, mechanical and constructional factors in variation. *Cognitive Linguistics*, 23(4), 711–748. <https://doi.org/10.1515/cog-2012-0022>
- Van de Ven, M., Tucker, B. V., & Ernestus, M. (2011). Semantic context effects in the comprehension of reduced pronunciation variants. *Memory & Cognition*, 39(7), 1301–1316. <https://doi.org/10.3758/s13421-011-0103-2>
- Villarreal, D., Clark, L., Hay, J., & Watson, K. (2021). Gender separation and the speech community: Rhoticity in early 20th century Southland New Zealand English. *Language Variation and Change*, 33(2), 245–266. <https://doi.org/10.1017/S0954394521000090>
- Weiner, E. J., & Labov, W. (1983). Constraints on the agentless passive. *Journal of Linguistics*, 19(1), 29–58. <https://doi.org/10.1017/S0022226700007441>
- White, Y. (2021). *The processing and mental representation of ING variation* [Doctoral dissertation, University of Pennsylvania].
- White, Y., Embick, D., & Tamminga, M. (2024). Affix priming with variable ING in English: Implications for unique vs. dual representation. *Journal of Memory and Language*, 138, 104535. <https://doi.org/10.1016/j.jml.2024.104535>

Wickham, H. (2010). A layered grammar of graphics. *Journal of Computational and Graphical Statistics*, 19(1), 3–28. <https://doi.org/10.1198/jcgs.2009.07098>

Wilder, R., Goodwin Davies, A., & Embick, D. (2019). Differences between morphological and repetition priming in auditory lexical decision: Implications for decompositional models. *Cortex*, 116, 122–142. <https://doi.org/10.1016/j.cortex.2018.10.007>

Xie, X., Jaeger, T. F., & Kurumada, C. (2023). What we do (not) know about the mechanisms underlying adaptive speech perception: A computational framework and review. *Cortex*, 166, 377–424. <https://doi.org/10.1016/j.cortex.2023.05.003>

Zehr, J., & Schwarz, F. (2018). PennController for internet based experiments (IBEX). <https://www.p cibex.net/>

