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Intra- and interspeaker repetitiveness in Chengdu Mandarin locative variation

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Abstract

In producing linguistic variation, language users display a tendency to reuse the same variant. This paper compares the empirical properties of different types of repetitiveness in a single case study: locative variation in Chengdu Mandarin. Using conversational data from sociolinguistic interviews, we ask whether within-speaker repetitiveness (persistence) and cross-speaker repetitiveness (convergence) behave similarly with respect to (1) their sensitivity to the linguistic similarity of the prime and target, and (2) their tendency to decline with greater temporal distance between the prime and target. Our results suggest that intraspeaker persistence and interspeaker convergence behave similarly in both respects. We therefore propose that repetitiveness has a common underlying mechanism within and across speakers and encourage future work aimed at testing this hypothesis across other variables and varieties.

Keywords: repetitiveness; persistence; convergence; priming; corpus analysis; morphosyntactic variation; Chengdu Mandarin

It has been well established that language users tend to reuse linguistic variants that they have recently used (Clark, 2018; Gries, 2005; Poplack, 1980; Scherre, 2001; Szmrecsanyi, 2006; Travis & Torres Cacoullos, 2012, inter alia). For example, an English speaker who just said *workin'* is more likely to say *playin'* a few moments later, repeating the use of the *-in'* variant, than they would be if they had just said *working* (Tamminga, 2016). We will refer to this phenomenon of within-speaker repetitiveness in variant choice as *persistence*. At the same time, there is also robust evidence that speakers tend to become more like their interlocutors, in the sense of using more of the variants their interlocutors favor during conversational speech (Coupland, 1980; Eisikovits, 1987; Giles, Coupland, & Coupland, 1991; Pardo, 2006; Rickford & McNair-Knox, 1994, inter alia). We will refer to this phenomenon of cross-speaker alignment in variant use during an interaction as *convergence*. Both persistence and convergence involve what we will refer to in a general sense as repetitiveness: exposure to certain linguistic forms—whether in production or perception—leading to increased adoption of those forms in later language use. It

has not been established, however, whether within-speaker repetitiveness (persistence) and across-speaker repetitiveness (convergence) are distinct phenomena or merely two sides of the same coin. In this paper, we undertake a direct comparison of the empirical properties of within- and across-speaker repetitiveness. The central question we are interested in is whether these phenomena plausibly share an underlying causal mechanism.

Variant repetitiveness has been of interest in variationist sociolinguistic research since Sankoff and Laberge (1978), for a number of reasons. One reason is that persistence has been used as a diagnostic tool to help define the envelope of variation and understand the relationship between different variants (Ecay & Tamminga, 2017; Tamminga, 2016). Another is that convergence has rich implications for understanding how social relationships and interactions can shape the joint use of variation between individuals (Babel, 2010; Pardo, Gibbons, Suppes, & Krauss, 2012; Sonderegger, Bane, & Graff, 2017; Wade, 2022, inter alia), including the acquisition of variation (Nardy, Chevrot, & Barbu, 2014). It has also been proposed repeatedly that speakers' tendencies to persist in their own variant choices and alter their speech in response to an interlocutor's choices may underlie language change over time (Clark, 2018; Jäger & Rosenbach, 2008; Mayol, 2012; Pickering & Garrod, 2017). Finally, repetitiveness phenomena are also of keen interest in psycholinguistics (Bock, 1986; Bock & Griffin, 2000; Mahowald, James, Futrell, & Gibson, 2016; Pickering & Branigan, 1998), providing a domain in which we can forge a stronger connection between psychological and social perspectives on language variation. Therefore, a better understanding of the relationship between persistence and convergence has the potential to shed light on how individuals make variant choices, how communities coordinate around shared patterns of variation, and how innovations can take hold over a longer time span.

Notably, both the persistence and convergence literatures have grappled with parallel difficulties in pinpointing the mechanisms that give rise to repetitiveness. On some accounts, repetitiveness has been seen as potentially mechanistic, driven by automatic perception-production feedback loops such as spreading activation, exemplar resonance, or implicit learning (e.g., Cameron & Flores-Ferrán, 2004; Clark, 2018; Tamminga, 2016). On other accounts, repetitiveness has been seen as motivated by speakers' social, discourse, or stylistic goals rather than being an automatic consequence of the language processing system (e.g., Bell, 1984; Coupland, 1984; Ochs, 1979; Podesva, 2008; Tannen, 1987). Much of the argumentation on these points has appealed to evidence from experimental paradigms to interpret the quantitative patterns of conversational speech data. These appeals often draw on evidence from across different grammatical levels and different variable phenomena, as well as across inter- and intra-speaker behavior. The question of the relationship between persistence and convergence, then, is relevant to efforts to understand the causes of repetitiveness in addition to being a question of interest in its own right.

One step toward learning whether persistence and convergence share a commonly underlying mechanism is to ask whether they exhibit similar empirical properties. To this end, this paper compares persistence and convergence within a single sociolinguistic variable being used within and across speakers in the same conversations. The variable is locative variation in Chengdu Mandarin: the probabilistic alternation

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between the Chengdu Mandarin variant *-tou* and the standard Mandarin variant *-mian* as a locative marker that can convey either spatial or temporal meaning. This variable has recently been documented as an ongoing change in the speech community of Chengdu, with increasing use of *-mian* over time, arising from language contact between Chengdu Mandarin and standard Mandarin (Li, 2022).

In data drawn from thirty-one sociolinguistic interviews involving forty native speakers of Chengdu Mandarin, we treat each token of the variable as a *target*, with the previous instance of *-mian* or *-tou* (no matter how far back) as its *prime*. We observe repetitiveness if target variant choice is conditioned by the variant used in the prime, such that speakers are more likely to use *-mian* after *-mian* and vice versa. We then ask whether persistence (where prime and target come from the same speaker) and convergence (where prime and target come from different speakers) behave similarly with respect to two factors that previous work has found to modulate repetitiveness:

1. Linguistic similarity (lexical/semantic overlap) between the prime and target: greater similarity is expected to strengthen repetitiveness.
2. Temporal distance between the prime and target: longer distances are expected to weaken repetitiveness.

We will show that although persistence and convergence are not completely identical, they share notable similarities in these two modulating factors, and the places where their apparent properties might diverge all involve failures to falsify null hypotheses rather than positive evidence for qualitative differences. These parallels motivate us to propose that within and across-speaker repetitiveness share a common underlying mechanism as a hypothesis for future work to test.

Background

The sociolinguistic variable

Chengdu, the capital of Sichuan province, is located in Southwest China. Its dialect belongs linguistically to South Western Mandarin (Li & Thompson, 1981). As in other parts of China, a process of language standardization meant that standard Mandarin (Putonghua) came to be the major variety taught in Chengdu schools and used over mass media starting in the late 1980s. The national promotion of standard Mandarin has also "standardized" the local Chengdu dialect, giving rise to contact-induced variation and change within the Chengdu community. In the variable we focus on here, one variant (*-tou*, 'head') is the Chengdu dialect form, and the other (*-mian*, 'face') is the contact form from standard Mandarin.

While the surface forms *-tou* and *-mian* also occur in a range of nonvariable environments, the *-tou* and *-mian* variants we are concerned with here arise and compete within a narrowly defined set of linguistic contexts (although that narrow environment occurs quite frequently). One way to express location or direction in Chinese is with a postpositional locative particle, such as *shang* (up) 'on top of.' For instance, *zhuozi-shang* (table-up) means 'on the table.' These postpositional locative particles can sometimes further be suffixed with an additional locative marker. When they

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are, this additional locative marker is where we find the variation between *-tou* and *-mian*. For example, *zhuozi-shang-tou* and *zhuozi-shang-mian* both mean 'on top of the table.' In addition to marking spatial reference in this way, locative *-tou* and *-mian* can also convey a temporal meaning. For example, *qian-(tou/mian)* (front-LOC) can mean either 'in front of' (spatial) or 'before' (temporal). The post-positional particles that the variable locative marker can attach to for spatial reference are *qian* 'front,' *hou* 'behind,' *shang* 'up,' *xia* 'down,' *li* 'inside,' and *wai* 'outside.' Of these, *qian* 'front' and *hou* 'behind' can also have a temporal interpretation (meaning 'before' and 'after,' respectively). Examples are provided below in (1).

(1) a. *yu dou zai shitou feng-feng li-**tou**.*
fish all at stone crack-crack inside-LOC
'Fish are all in stone cracks.'
(ZJ/1999/Female/Conversation3/180/Spatial/High school graduate)

b. *jiu zai ticao-fang li-**mian** you yi-ge fangjian.*
just at gym-room inside- LOC have one-CLF room
'There is one room right inside the gym.'
(GQL/2000/Female/Conversation3/239/Spatial/High school graduate)[1]

While *-tou* is favored in temporal rather than spatial contexts, there is a change in progress toward increased use of the standard variant *-mian* with both social and stylistic conditioning (Li, 2022).

Variant repetitiveness in conversational speech

Persistence and convergence have both been widely observed in naturalistic conversational speech. The evidence for persistence comes from a wide range of variables in different languages and at different levels of the grammar (e.g., Cameron & Flores-Ferrán, 2004; Clark, 2018; Gries, 2005; Poplack, 1980; Scherre, 2001; Szmrecsanyi, 2006; Tamminga, 2016; Travis & Torres Cacoullos, 2012). The evidence for convergence in conversational speech is also very robust, whether assessed within single interactions or over longer spans of time (e.g., Coupland, 1984; Giles et al., 1991; Pardo et al., 2012; Rickford & McNair-Knox, 1994; Trudgill, 1986).

It has been shown that, during conversational interaction, speakers become more similar to their interlocutor along various acoustic-phonetic dimensions, such as consonants, vowel formants, vowel duration, and speech rate (see Wynn & Borrie, 2022 for a review). The same is true of sociolinguistic variables at other levels of the grammar as well: speakers tend to shift from their typical rate of variant use toward their interlocutors' use of variants, as has been seen in English zero copula, invariant *be*, plural *-s*, third singular present *-s*, and possessive *-s* (Rickford & McNair-Knox, 1994); English ellipsis alternation (Nykiel, 2015); Swedish alveolar *r* (Nilsson, 2015); Scottish *r* (Llamas, Watt, & Johnson, 2009); and others.

We have every reason, therefore, to expect the locative *-tou/-mian* variable to exhibit both persistence and convergence in conversational interaction. We have less clear expectations, however, about exactly how these phenomena compare. One obstacle to comparing them is differences in the way that persistence and

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convergence have been operationalized: corpus persistence analyses have typically focused on a token-by-token analysis like the one we undertake here, whereas convergence is often measured by averaging over larger time windows. Recent work from Wynn and Borrie synthesizing the literature on conversational entrainment (i.e., convergence) in phonetics provided a helpful framework for understanding these differences as involving the *level* of entrainment, which they defined as "the temporal interval at which entrainment is measured" (2022:4). Although they distinguished between local (turn-level) and global (above the turn level), we interpret these levels as existing on a continuum, which the variationist and corpus linguistic repetitiveness literatures span.

In addition to the methodological disjunction, there are few prior studies directly comparing within- and across-speaker repetitiveness patterns in conversational speech. Gries (2005) focused on corpus repetitiveness in dative alternation and particle placement of transitive phrasal verbs. He found that for both alternations, the intraspeaker repetitiveness is slightly stronger than interspeaker cases (in one case with a p-value just under 0.05, in the other, just over). Szmrecsanyi combined both forms of repetitiveness together by default, then, where possible, included same/different speaker as a predictor. For variation in English genitives, particle placement, and complementation strategy, he failed to find a significant interaction between the same-speaker predictor and the effect of the previous token, suggesting that the interspeaker and intraspeaker effects may be similarly strong. For future marking variation, however, he found evidence in three out of five corpora for the persistence effect being significantly stronger than the convergence effect. As he put it, "speakers prefer repeating themselves over repeating what others have said" (2006:191).

The Gries (2005) and Szmrecsanyi (2006) studies both also looked at prime-target similarity and prime-target distance, the two modulating factors we will investigate. Here, we undertake a more fine-grained comparison of whether persistence and convergence pattern together across similarity and distance, which stands to shed new light on whether conversational variant repetitiveness effects within and across speakers exhibit empirical similarities that may point to shared underlying mechanisms.

Repetitiveness can be sensitive to prime-target similarity

One key property that has been repeatedly demonstrated in corpus repetitiveness is that it is enhanced by linguistic similarity between prime and target. Gries (2005) showed that repetition of verb lemma and/or form strengthened word order alternant repetitiveness for the dative alternation and verb particle placement. Similarly, Szmrecsanyi (2006) showed that the repetitiveness effects for particle placement and complementation strategy were larger when prime and target shared a verb lemma and/or, in the latter case, verbal morphology. Lexical repetition can also enhance persistence when the words being repeated *contain* the variable (as opposed to themselves being embedded in word order alternants). Tamminga (2016) found that persistence in both (ING) variation and coronal stop deletion was stronger in cases where the prime and target were the same word, while Villarreal and Clark (2022) similarly found that persistence in New Zealand English vowel changes was enhanced when prime and target repeated the same lexical item. In the extreme,

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persistence may be absent (or at least too weak to detect) when potential primes and targets are too dissimilar. Tamminga (2016) found no evidence for persistence in (ING) and coronal stop deletion when prime and target differed in whether or not they were morphologically complex, while Clark (2018) found persistence in /t/-flapping only when prime and target were the same lexical item.

The modulation of persistence by prime-target similarity has been seen as a key point of theoretical interest. Corpus persistence researchers have connected this modulation to the considerable evidence for similarity enhancement in the laboratory-based experimental priming literature. In syntactic priming experiments, where participants are more likely to describe a picture or complete a sentence fragment using a word order option they have just been exposed to, lexical overlap between prime and target increases the strength of the priming effect—a modulation sometimes referred to as the "lexical boost" effect (e.g., Hartsuiker, Bernolet, Schoonbaert, Speybroek, & Vanderelst, 2008; Tooley, 2020; Traxler, Tooley, & Pickering, 2014). Such a lexical boost is a parallel, then, between experimental priming and corpus persistence. As such, it has been argued to support the idea that persistence in conversational speech arises automatically from heightened activation after exposure and thus preferential retrieval for subsequent use—in other words, that persistence *is* priming (Clark, 2018; Pickering & Garrod, 2017; Szmrecsanyi, 2006; Tamminga, 2016; Villarreal & Clark, 2022). For example, Clark pointed to a lexical boost as one of the "clear signatures of priming" (2018:731) that can be used to recognize priming in conversational speech.

With respect to repetitiveness *across* talkers, we are not aware of any papers testing the similarity-enhancement effect in true conversational data on convergence specifically, beyond the combined inter- and intraspeaker studies cited above. However, lab-based research using various experimental analogues to convergence has also produced evidence for similarity enhancement. For example, in word shadowing (where participants repeat after a model talker), imitation may be lexically specific (Goldinger, 1998; Goldinger & Azuma, 2004). Although not all phonetic imitation studies find this lexical restriction, similarity across stimuli still typically enhances the imitation effect. For example, Nielsen (2011) demonstrated that participants trained on long-VOT for /p/ words went on to imitate that extended VOT more strongly for /p/ than for /k/. On the syntactic side, Branigan, Pickering, and Cleland (2000) used a confederate scripting experimental task to show that syntactic priming can be elicited with primes that participants merely comprehend rather than producing themselves (in our terms, interspeaker priming). They found that verb repetition enhanced priming in the dative alternation, which they pointed out is parallel to the results of earlier comprehension-to-production syntactic priming studies (such as those we just discussed).

Across these literatures, similarity-enhancement effects (or their absence) have played a role in arguments about (a) the mechanisms underpinning repetitiveness and (b) what the nature of those mechanisms tells us about the architecture of the linguistic system. Branigan et al. (2000), for example, took the lexical boost they detected as evidence for the equivalence of production-to-production and comprehension-to-production priming, which in turn served as evidence for models of sentence processing that share some syntactic representations (such as a lemma

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stratum) across comprehension and production. When Tamminga (2016) found that persistence was modulated by morphological similarity and lexical repetition between prime and target, she suggested it may point to distinct repetitiveness mechanisms operating differently on variables with different grammatical loci (following Pickering & Ferreira, 2008), such that familiar sociolinguistic variables like (ING) might be better analyzed as comprising "sets of distinct probabilistic processes that produce similar surface outcomes" (Tamminga, 2016:349). Nielsen (2011) argued that the generalization of phonetic imitation across phonemes was evidence for a sub-phonemic level of phonological representation, while the lack of a lexical-repetition effect failed to support a key prediction of exemplar theoretic models of phonology.

To recap, both persistence and convergence are often stronger when prime and target are more similar. In some cases, persistence may even be absent for maximally distinct contexts, which could point to a lack of representational identity between those contexts (Pickering & Ferreira, 2008; Tamminga, 2016). Further, the specific ways in which linguistic similarity shapes repetitiveness, in both the lab and conversational speech, have been taken as key evidence about the properties of the linguistic system.

Here we ask whether persistence and convergence arise, and, if so, to a comparable degree in similar and dissimilar prime-target pairs (see Table 1). The dimension of similarity we look at is a mixture of lexical and reference-type overlap between prime and target. Since the variable locative affix can be used for spatial or temporal reference, prime and target can have the same kind of reference (both spatial or both temporal) or different (one spatial and one temporal). An interesting possibility suggested by previous work on other variables (e.g., Tamminga, 2016) is that repetitiveness might fail to arise across these different environments. Another possibility suggested by prior work (e.g., Clark, 2018) is that *-tou/-mian* repetitiveness might appear only when the postpositional locative particle that *-tou/-mian* attaches to (*shang*, *qian,* etc.) is the same between prime and target. When we cross-tabulate these two independent similarity dimensions, we will not have enough data to compare all four resulting similarity combinations. Rather than trying to resolve whether possible similarity effects are due to lexical overlap or shared reference type per se, we draw a two-way distinction between **maximally dissimilar** pairs, in which prime and target have different meanings and attach to distinct particles, and **similar** pairs, in which prime and target have any degree of similarity in reference type and/or particle overlap. We isolate the maximally dissimilar pairs, because in the prior work just mentioned the most telling piece of the puzzle is the prime-target combination in which repetitiveness is *not* observed. However, it is important to keep in mind that we will not be able to make claims about what aspects of our combined similarity category are driving any observed similarity-enhancement effect.

Repetitiveness can be sensitive to prime-target distance

Another pattern that has been repeatedly demonstrated in corpus repetitiveness is a tendency toward weakened repetition when prime and target are farther apart. This dampening of the effect of repetitiveness over time is often referred to as *decay*. Decay has been observed, for example, for /th/-fronting in Scottish English (Clark, 2014),

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(ING) variation (but not monomorphemic coronal stop deletion) in Philadelphia English (Tamminga, 2016), and New Zealand English /t/-flapping and vowel shifts (Clark, 2018; Villarreal & Clark, 2022). Gries (2005) and Szmrecsanyi (2006) both found that corpus repetitiveness of syntactic alternations (such as English datives and particle placement) tended to decay logarithmically, declining sharply over one or two sentences and then leveling off. Villarreal and Clark found that persistence of vowel peripherality "diminishes considerably" by around 670 milliseconds after the prime (2022:726), while Tamminga (2016) found that (ING) persistence decayed more slowly. We are not aware of corpus-based studies that isolate the decay profile of convergence in a way that exactly parallels the corpus-based persistence studies, but there is some evidence for long-lasting phonetic convergence in naturalistic data. Pardo (2006) found that phonetic imitation effects extended from an unscripted, interactional map task into a postmap-task reading phase. On a longer time scale, Pardo et al. (2012) and Sonderegger et al. (2017) found evidence for phonetic convergence over the course of months.

Just as corpus repetitiveness decays over time, so too do its potential experimental analogues. However, the characteristic decay profiles of different laboratory-based priming and imitation effects are contested. Experimental studies have typically found that syntactic priming tends to be long-lived (on the order of at least several intervening sentences), both in production-to-production priming (Bock & Griffin, 2000; Hartsuiker & Kolk, 1998; Hartsuiker & Westenberg, 2000; Hartsuiker et al., 2008) and comprehension-to-production priming (Bock, Dell, Chang, & Onishi, 2007); in some cases, though, the effect dissipates more rapidly (Branigan, Pickering, & Cleland, 1999; Wheeldon & Smith, 2003). On the phonetic level, results for the decay of lab-based imitation effects are also mixed. Sometimes experimental phonetic imitation is reported to last for many days (e.g., Goldinger, 2000), but it may also fail to persist beyond the experimental task where the stimuli are directly present (e.g., Wade, 2020).

Researchers have been keen to understand the time course of how repetitiveness decays because these temporal profiles have theoretical consequences. In the experimental syntactic priming literature, decay is key to the theoretical debate around what underlying mechanisms drive priming. When syntactic priming exhibits rapid decay, it suggests priming may arise from transient activation of the speaker's recent experience of using a structure; in contrast, when priming does not seem to decrease over time, it suggests a longer-lasting implicit learning mechanism (see Bock & Griffin, 2000; Pickering & Garrod, 2004, and Jaeger & Snider, 2013 for discussion). Decay, or lack thereof, plays a similarly important role in understanding phonetic convergence. For example, Goldinger's (2000) demonstration of long-lasting phonetic imitation has played a prominent role in arguments for episodic models of phonology and the lexicon (see Pierrehumbert, 2002). Decay properties are also highly relevant to theories of how sociolinguistic variation connects with language change. For example, models of language change via accommodation require interpersonal convergence during interaction to "have a lasting effect on the accommodating speaker's linguistic 'habits'" (Auer & Hinskens, 2005:335; see also discussion in Sonderegger et al., 2017).

In our study of the Mandarin locative variable, then, we undertake a comparison of the temporal properties of any apparent decay profile across persistence and convergence, because it is of interest for understanding possible similarities between these types of repetitiveness. We operationalize distance here as the number of written

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Chinese characters (which correspond to both syllables and, in most cases, morphemes) intervening between prime and target in the interview transcript.

Data and methods

Data collection

Thirty-one sociolinguistic interviews were conducted in the summer of 2017 with forty native speakers of Chengdu Mandarin (nineteen men, twenty-one women, ages 17-74). All of them had lived in the urban area of Chengdu since birth and were contacted through a "friend of a friend" approach. The education level of the speakers ranged from primary to postgraduate school. Two female native speakers of Chengdu Mandarin conducted all the interviews; while one was the first author and the other was linguistically naive, the interviews preceded selection of the target variable and phenomenon.

The interviews were conducted at places chosen by the speakers where quiet for recording could be guaranteed (mostly at participants' homes), and recorded using a digital voice recorder with a sampling rate of 22kHz. One-on-one interviews were conducted only if the interviewer was friends with the interviewee; other interviewees were interviewed as pairs of friends, so that every interview involved participants who already knew each other. Each interview lasted for at least forty-five minutes for one interviewee or 1.5 hours for two interviewees.

During the interviews, each speaker was encouraged to tell stories of personal interest in response to open-ended questions (Briggs, 1986). While the same set of interview questions was prepared for each interview, not all of them were asked since interviewees' preferences were prioritized to elicit the most natural speech. Although data from both interviewers and interviewees are included for the current analysis, in most cases interviewees produced more speech than interviewers. More than forty hours of speech in total was recorded.

Transcription and coding

The sociolinguistic interviews were fully transcribed and time-aligned at the sentence level using the software *ELAN* (Brugman & Russel, 2004). We extracted the fifteen characters before and after each token to provide a context that would be informative enough for us to manually check the interpretation for each token. We used a *Python* script to automatically code several properties of each token itself: (1) what variant the token contained (*-tou/-mian*), (2) which speaker produced the token, and (3) the interpretation of the locative as spatial or temporal (also manually checked by the authors).

The same *Python* script also automatically coded each token for what properties its preceding token had, which was used to compute several aspects of the *relationship* between each token (target) and the preceding one (prime): (1) whether they were produced by the same speaker, (2) whether they are similar or dissimilar (where "similar" means having the same locative interpretation, attaching to the same particle, or both), and (3) the distance between them. The distance between two observations was automatically measured by the script as the number of intervening characters.

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Since Chinese characters represent syllables (and map closely to the number of morphemes), and the time-alignment was only done to the sentence level, a character-based distance measure was most practical. Distance is base-2 log-transformed because priming phenomena typically decline logarithmically (e.g., Szmrecsanyi, 2006:79).

We excluded targets from speakers ($n = 3$) who use either 100% *-tou* or 100% *-mian* and do not alternate in variable contexts. Because we are not confident these speakers produce the variation at all, we do not analyze what factors might influence their own use of the variable. However, we do allow their tokens of the variable to serve as cross-speaker primes. Note that tokens that had no primes (such as at the beginning of a recording) were thrown out, but they could serve as primes for the next target. After these exclusions, a total of 1,602 tokens of variable *-tou/-mian* were analyzed (see data and analysis script available at https://osf.io/yfm67/).

Statistical analyses

Statistical analyses were conducted using *R* version 4.0.5 (R Core Team, 2021) and the *tidyverse* packages (Wickham et al., 2019). Generalized mixed-effects logistic regression (GLMM) was conducted using the *glmer* function from the *lme4* package version 1.1-27.1 (Bates, Machler, Bolker, & Walker, 2015). While the full model specification is reported in the online appendix, we focus our presentation of the results on sets of custom contrasts that we designed to correspond to our research questions using the *emmeans* package (Lenth, Singmann, Love, Buerkner, & Herve, 2019). For readers who are unfamiliar with this approach, we offer an explanatory overview and suggested tutorials and resources in the appendix. The critical predictors encode the interactions of speaker repetition, prime/target similarity, prime variant, and prime-target distance, while the control predictors of speaker gender, education, and birth year were included to obtain a robust multivariate picture; details are in the appendix. Speaker was included as a random intercept to account for different baseline rates of variation.

Here, we present the custom contrasts of interest with labels that are intended to be transparent to all readers, regardless of their statistical background. Table 1 lists the cross-tabulated conditions of interest, with an alphabetic label as a shorthand for each. Table 2 then uses these alphabetic labels in the Contrast column to show which groups' means are being compared using the custom contrast method described in the appendix. For example, the contrast labeled "A-B" in Table 2 means that the estimate reflects the difference between the *-mian* rate in the Intraspeaker, Dissimilar, *Mian*-primed condition (A) and the *-mian* rate in the Intraspeaker, Dissimilar, *Tou*-primed condition (B). We annotate each of these rows with the intuitive wording of the question that the contrast addresses. We will return to the statistical results in Table 2 in the Results section.

Results

Persistence and convergence in similar and dissimilar pairs

We first test the significance of the contrasts comparing *-tou*-primed to *-mian*-primed *-mian* rates for intraspeaker pairs (i.e., persistence) and interspeaker

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Table 1. Summary of observed data in each condition

Label	Speaker	Similarity	Prime	Raw *-mian* rate	Count
A	Intraspeaker	dissimilar	*-mian*	0.62	137
B	Intraspeaker	dissimilar	*-tou*	0.36	148
C	Intraspeaker	similar	*-mian*	0.86	449
D	Intraspeaker	similar	*-tou*	0.16	426
E	Interspeaker	dissimilar	*-mian*	0.29	66
F	Interspeaker	dissimilar	*-tou*	0.46	105
G	Interspeaker	similar	*-mian*	0.46	112
H	Interspeaker	similar	*-tou*	0.40	159

Table 2. Statistical comparisons of interest: similarity in persistence and convergence (estimates reflect log-odds differences in use of *-mian*)

Question	Contrast	Estimate	Std Error	*z* value	Pr (>|z|)
Is there persistence in dissimilar pairs?	A-B	−1.07	0.36	−3.01	<0.01
Is there persistence in similar pairs?	C-D	1.82	0.23	8.00	<0.001
Is there convergence in dissimilar pairs?	E-F	−0.60	0.51	−1.17	0.24
Is there convergence in similar pairs?	G-H	1.25	0.33	3.77	<0.001
Does persistence differ from convergence in similar pairs?	(A-B)-(E-F)	−0.48	0.62	−0.77	0.44
Does persistence differ from convergence in dissimilar pairs?	(C-D)-(G-H)	0.57	0.41	1.42	0.16

pairs (i.e., convergence) when the prime and target are similar or dissimilar. Table 1 summarizes the number of tokens ($n = 1602$) and the raw *-mian* rate (overall *-mian* rate = 47.7%) observed in each cross-tabulation context. Figure 1 further plots the predicted *-mian* rates in different contexts using the estimated marginal means.[2]

Table 1 presents notations (specified through the "Label" column) that represent various prime-target conditions based on our eight-level meta predictor mentioned above. Statistical comparisons using the contrasts of interest are presented in Table 2. In the second row of Table 2, we see a significant effect of prime variant (*-tou* versus *-mian*) for intraspeaker pairs when prime and target are similar (e.g., *qian-tou* 'in front of' and *shang-tou* 'on top of') ($\beta = 1.82$, $p < 0.001$). When prime and target are dissimilar (e.g., *qian-mian* 'before' and *shang-tou* 'on top of') for intraspeaker pairs, however, the prime variant difference is also significant but in the opposite direction ($\beta = -1.07$, $p < 0.01$). In the fourth row, we see a significant effect of prime variant for similar interspeaker pairs ($\beta = 1.25$, $p < 0.001$), but no significant effect of prime variant for dissimilar interspeaker pairs ($\beta = -0.60$, $p = 0.24$). The first four rows, then, correspond to the results visualized in Figure 1: there is significant

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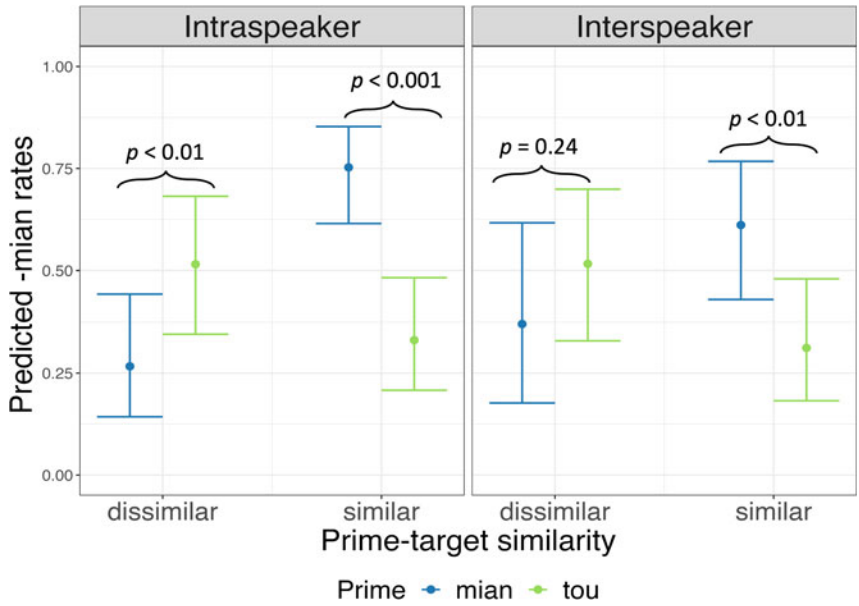

Figure 1. Predicted *-mian* rates by prime and similarity for interspeaker and intraspeaker pairs.

persistence and significant convergence when prime and target are similar. When prime and target are dissimilar, the direction of the prime influence reverses, such that having recently heard or produced *-mian* makes it *less* likely a speaker will use *-mian* again; this reversed effect is only significant, though, for intraspeaker pairs.

The final two rows of Table 2 directly compare intraspeaker persistence to interspeaker convergence. For similar prime-target pairs, persistence is not significantly stronger than convergence ($\beta = 0.57$, $p = 0.16$). For dissimilar pairs, however, persistence is not significantly different from convergence ($\beta = -0.48$, $p = 0.44$).

Distance between the prime and target

We next turn to the question of whether intraspeaker persistence and interspeaker convergence decay over time. We extract the comparisons of theoretical interest from the same fitted model described in the online appendix (see Table A1), using the *emtrends* function from the *emmeans* package. This function allows us to compare the slopes of a continuous predictor over levels of specified other predictors in a fitted model. The results are presented in Table 3. For the similar prime-target pair conditions, where we found significant repetitiveness when controlling for distance, we now see that the effects decay significantly for both intraspeaker persistence ($\beta = -0.28$, $p < 0.01$) and interspeaker convergence ($\beta = -0.41$, $p < 0.01$). When prime and target are dissimilar, however, there is no significant decay for either the reversed intraspeaker "anti-persistence" effect ($\beta = 0.11$, $p = 0.52$) or for the nonsignificant interspeaker context ($\beta = -0.19$, $p = 0.39$). When we compare persistence to convergence for similar pairs, the intraspeaker and interspeaker decay slopes do not differ significantly from each other ($\beta = 0.13$, $p = 0.50$). Unsurprisingly, the nonsignificant

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Table 3. Statistical comparisons of interest: decay in persistence and convergence (estimates reflect log-odds differences in changes per log2(characters) in use of *-mian*)

Question	Contrast	Estimate	Std Error	*z* value	Pr (>|z|)
Does persistence decay over time in dissimilar pairs?	A-B	0.12	0.18	0.65	0.52
Does persistence decay over time in similar pairs?	C-D	−0.28	0.10	−2.75	<0.01
Does convergence decay over time in dissimilar pairs?	E-F	−0.19	0.22	−0.86	0.39
Does convergence decay over time in similar pairs?	G-H	−0.41	0.16	−2.59	<0.01
Does persistence decay differ from convergence decay in dissimilar pairs?	(A-B)-(E-F)	0.31	0.29	1.07	0.29
Does persistence decay differ from convergence decay in similar pairs?	(C-D)-(G-H)	0.13	0.19	0.68	0.50

decay profiles for persistence and convergence in dissimilar pairs do not differ significantly either ($\beta = 0.31$, $p = 0.29$).

Figure 2 gives a more intuitive visual presentation of how the intraspeaker persistence effect and interspeaker convergence effect are predicted by the model to unfold over time, within the similar prime-target pairs where this decay is significant. In both intraspeaker and interspeaker contexts, when the number of characters between the previous token and the subsequent token increases, the difference between the *-mian* rates in *-tou*-primed and *-mian*-primed tokens gets smaller. In other words, the persistence/convergence effects are weaker when the prime and target are further apart. Although it appears from Figure 2 that there is some "crossover" (i.e., the error bars do not exclude each other) at long lags for the interspeaker cases, we do not think this is a reliable effect that should be given any theoretical interpretation. Loosely, it appears that the difference between the *-tou*-primed and *mian*-primed rates is robust for at least a distance of around 256 characters (2^8) for intraspeaker pairs and 32 characters (2^5) for interspeaker pairs. Since the average Mandarin sentence is about eleven or twelve syllables/characters (Huang, 2018), this suggests that these repetitiveness effects last across multiple intervening sentences.

Discussion

Linguistic similarity between prime and target

Our first research question was whether persistence and convergence in Mandarin locative variation are modulated in similar ways by prime-target linguistic similarity. We found that both within and across speakers, there is significant repetitiveness when the prime and target overlap in some respect. The size of this effect does not differ significantly within and across speakers. For maximally dissimilar pairs, use of *-mian* in the prime is unexpectedly associated with *lower* probability of *-mian* in

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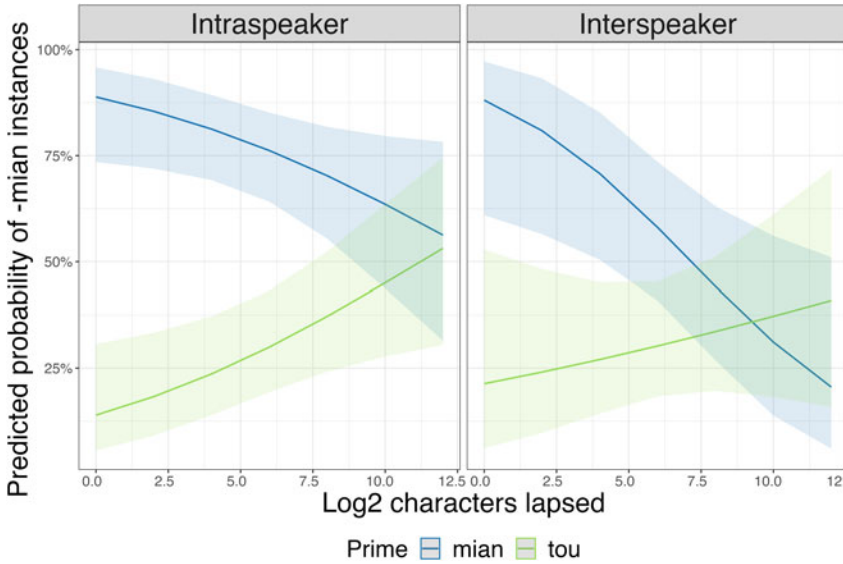

Figure 2. The decay of intraspeaker persistence and interspeaker convergence effects (similar pairs only).

the target. While the predicted direction of the effect is reversed both within and across speakers, it is only significant within speakers; however, the difference between the significant and nonsignificant effects here is not itself statistically significant, leaving open the question of how the intra- and interspeaker effects compare. Especially because the dissimilar interspeaker pairs where we failed to find significant repetitiveness are represented by the smallest amount of data (meaning the test may be underpowered), we would hesitate to conclude that there is any evidence for a qualitative difference between persistence and convergence here. Rather, the evidence taken as a whole suggests quantitatively comparable similarity-modulation across persistence and convergence, with some remaining points of statistical uncertainty but no compelling evidence for any major differences.

The reversal of repetitiveness has been reported previously and is sometimes called *horror aequi* (Rohdenburg, 2003; Szmrecsanyi, 2006). At least one prior study, Melnick and Wasow's (2019) study of optional infinitival *to*, found repetition being favored in one context and disfavored in another, as we do here. As we discussed in the background, at least one earlier study where persistence arose only in linguistically similar prime-target pairs, Tamminga (2016), interpreted this pattern as an indication that what seemed to be the same variable operating in different contexts might actually be multiple distinct variables. One might, therefore, wonder whether our results point to multiple underlying variables producing the surface variation between *-tou* and *-mian*. We do not put forward such an analysis in this case. On the logic of Tamminga (2016), a lack of influence across primes and targets with different morphological structures suggests a lack of representational identity: variable tokens with different structures do not prime each other because they do not share a

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representation to be primed. In contrast, what we see with the locative variable *is* an apparent influence of primes on dissimilar targets, even though that influence goes in the opposite direction. This is not consistent with the idea that the primes and targets in dissimilar pairs are wholly unrelated to each other.

Similarity enhancement has been of particular interest because it resembles a number of empirical findings from experimental priming studies in psycholinguistics. Clark (2018) proposed that when corpus persistence effects are observed to have empirical properties that resemble experimental priming effects, it strengthens the case that observed corpus persistence arises from an automatic priming mechanism. This logic is stronger when those same properties are *not* expected by competing accounts. For example, a possible nonpriming source of repetitiveness is what Tamminga, Ahern, and Ecay (2016) referred to as *baseline deflection*: if certain stretches of conversation are differentiated by variant rates (for example, because of topic changes or style shifts), then adjacent tokens are more likely to be shaped by the same contextual pressures in the interaction than very remote tokens are. On the assumption that baseline deflection pressures on the locative variable are not sensitive to its referential interpretation as temporal or spatial or to what particle it attaches to, then any repetitiveness derived from baseline deflection should apply regardless of prime-target similarity, contra our results.

However, automatic facilitatory priming and fluctuations in the variant baseline rates are not the only mechanisms that might give rise to repetitiveness. In connectionist, activation-based models of language production, "constraints on production decisions are translated into excitatory *and inhibitory* inputs to units representing the options open to the system" (Dell & O'Seaghdha, 1994:413, emphasis added). When a number of competing options are considered in the course of language production, the competitors that do not get chosen may instead be not just left to the side but actively *suppressed* in these systems. Here, then, there seems to be a possibility that processing inhibition is at play—a possibility that would receive stronger support if future research with a larger data set confirmed that there is significant divergence in the interspeaker data as well.

But why do similar pairs exhibit facilitation and dissimilar pairs, at least within speakers, exhibit inhibition, and why do linguistic differences between prime and target lead to inhibition in this case when sometimes they do not? We do not have an answer, but we suspect it may be related to the fact that the form variation between *-tou* and *-mian* intersects here with a second competition of sorts—between the two distinct meanings of the locative (spatial and temporal). On this analysis, when one of the variants is used to convey one of the two possible meanings of the locative, the subsequent reuse of that variant *to convey the other possible meaning* is inhibited, leaving the other variant to be preferred for the expression of that different meaning. While we believe it is possible that the combination of excitatory and inhibitory activation could, in principle, give rise to the empirical patterns we have observed here, working out the processing details would be far beyond the scope of this paper. It is also, however, plausible that such a pattern could arise from discourse-motivated repetitive behavior, in the sense of Tannen (1987) and as discussed by Szmrecsanyi (2006) in the context of variant repetitiveness specifically. Speakers might choose, whether automatically or with some degree of awareness or deliberation, to avoid

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reusing a variant they have just used to convey a distinct semantic meaning when they have a different alternative at hand, for reasons such as facilitating their interlocutor's comprehension.

Distance between prime and target

With respect to the question of whether intraspeaker persistence and interspeaker convergence display similar decay profiles over time, our answer is again that the general results point more strongly to similarity than difference. Within the similar pairs where we observed significant repetitiveness, we also observed a significant tendency toward weakening of that repetitiveness at greater prime-target distances for both intraspeaker persistence and interspeaker convergence. This suggests that both persistence and convergence are susceptible to a decay effect over time (when prime and target have some shared meaning or lexical form). Further, we did not find any evidence that the persistence and convergence effects differ in how quickly this decay takes place over time. In both cases we would characterize the duration of the repetitiveness effect as fairly long-lasting, extending over multiple intervening sentences. Generally speaking, the degree of durability here seems similar to previous results from other morphological and syntactic variables (Gries, 2005; Szmrecsanyi, 2006), but longer-lasting than corpus persistence in vowel peripherality (Villarreal & Clark, 2022).

Clark (2018) suggested that temporal decay is a hallmark of priming that can be taken to support a priming-based mechanism for persistence effects; one could imagine extending this argument to argue that the more precise properties of the decay could provide evidence for a specific mechanism underpinning that priming effect. We might think that our results are intermediate between studies where decay is absent, or perhaps merely slow enough to be imperceptible on the time scale of the experiment, and studies where decay is quite rapid. As we discussed in the background, the former seems to be the dominant result in experimental syntactic priming (Pickering & Ferreira, 2008). We would not want to conclude, though, that the mere presence of decay in our data differentiates our results from that characteristic profile. Rather, it seems possible that corpus data affords a better opportunity to detect slow decay over longer time spans because it often naturally presents extended interludes between prime and target. On the other end of the spectrum, it seems clear that the long-lasting repetitiveness we found is not in line with other kinds of priming where the effect dissipates on a scale best measured in milliseconds (see Joordens & Becker, 1997 on semantic priming). Rather, we believe the decay profile seemingly shared by persistence and convergence in our results is more closely aligned with the longer-lasting experimental results, which have been argued to support an implicit learning mechanism over an activation-based mechanism as the source of syntactic priming (Bock & Griffin, 2000; Jaeger & Snider, 2013; Pickering & Garrod, 2004).

However, when it comes to the use of decay as a hallmark diagnostic of priming, we are not fully convinced that competing accounts would *not* predict what looks like decay. Although our discussion on the similarity enhancement results called into question a simplistic account deriving from baseline deflection, we do not think the appearance of decay here constitutes an additional argument against that kind

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of account. Rather, if repetitiveness derives from stylistic covariation, it is probably reasonable to expect that it should be strongest when prime and target are in closest proximity, since presumably on average the contextual considerations shaping sociolinguistic behavior are more likely to have changed as prime and target get further apart. It is less clear whether discourse-motivated accounts do or do not predict decay, but we do not think it can be taken for granted that such mechanisms would not produce characteristic temporal profiles. For example, a speaker might be motivated to repeat a variant by one of the discourse functions of repetitiveness identified by Tannen (1987) (e.g., showing listenership, providing back-channel responses, humor and play, etc.), but then gradually cease to hold that motivation or attend to the goal over time. While we consider the temporal decay on a similar timescale to be an interesting piece of evidence in favor of the empirical similarity of corpus persistence and convergence, we suggest it is far from a foolproof way to distinguish between the possible sources of repetitiveness in conversational speech.

One other point of interest regarding the temporal durability of persistence and convergence is that it has possible implications for language change. It has been suggested that priming can play a role in the "snow-balling" of language change, increasing the use of incoming variants to get changes off the ground (Clark, 2018; Mayol, 2012; Pickering & Garrod, 2017). If variant persistence effects were very fleeting, it would weaken the plausibility of the idea that they might exert substantial influence on the course of language change. Similarly, change-by-accommodation models require that convergence between speakers be sufficiently durable to take hold and influence others in the community (Auer & Hinskens, 2005; Sonderegger et al., 2017). The relatively long-lasting effects we found here provide at least a preliminary basis of plausibility for these ideas.

Finally, we are not inclined to attach an interpretation to our failure to find decay in the antipersistence effect in dissimilar pairs. The data available for dissimilar pairs is smaller than that of similar ones, so this null result may simply reflect insufficient statistical power to detect significant temporal slopes within those smallest subsets of the data. We believe the best conclusion at this point is that we do not know whether the antipersistence effect does or does not decay over time.

Conclusion

Our comparison of intra- and interspeaker repetitiveness in conversational Chengdu Mandarin locative variation has turned up some notable parallels between persistence and convergence. For both persistence and convergence, speakers tend to reuse variants when the prime and target overlap in their interpretation and/or lexical content. These effects both exhibit decay but last over relatively long distances. When the prime and target are maximally differentiated, on the other hand, the repetitiveness effects reverse: speakers become significantly *less* likely to reuse a variant they themselves just used, and the direction of the cross-speaker effect also flips but is not significant.

These particular properties do not furnish strong evidence regarding *why* speakers repeat variants. The various processing models on offer that involve tightly linked production and perception feedback loops may seem like a natural fit for producing

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comparable patterns of persistence and convergence. However, we have repeatedly noted that it is difficult to convincingly rule out stylistic and discourse motivations as the sources of repetitiveness. Indeed, the *horror aequi* effect seems entirely amenable to a discourse-based analysis. Another possibility is that this long-running debate over automatic versus socially motivated causes of repetitiveness is a false dichotomy, that the psycholinguistic processes that subserve language perception and production are fundamentally intertwined with social cognition and are the same ones that produce socially meaningful linguistic behavior in interaction (Campbell-Kibler, 2010; Wade, 2022). We believe this interpretation would be particularly compatible with an analysis unifying persistence and convergence.

We find the overall empirical resemblances here compelling enough to suggest that future work adopt and test the hypothesis that persistence and convergence share a common source. Although we acknowledge there are some areas of the comparison where we have not arrived at statistically satisfying conclusions, one thing we have *not* found at any point is positive evidence for any qualitative (or even quantitative) difference between persistence and convergence. Future work could bring larger datasets from other variables and varieties to the task of attempting to falsify this common-source hypothesis. Whether the hypothesis does or does not survive such attempts, it stands to improve our knowledge of the interplay between social interaction and psycholinguistic processing in the production of sociolinguistic variation.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S095439452300008X.

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Competing interests. The authors declare none.

Notes

1. Within parentheses is the speaker ID, birthyear, gender, conversation ID, sentence number, interpretation of the locative, and education level.

2. Table 1 contains *observed* values, and Figure 1 contains *predicted* values after other factors are accounted for, so they do not match perfectly.

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